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CapaCITIES

Technical Study of the existing
BRTS corridor for the last mile
connectivity and pre-feasibility of
potential electrification of the
corridor

21 December 2017





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1 Introduction

Bus Rapid Transit System (BRTS) is a high capacity bus based public transit system. It is a total/complete system; is safe, fast, comfortable, and comparatively affordable and makes the best use of the available road space. The system is designed and engineered with dedicated bus lanes on which no other vehicles encroach. Likewise, there are separate lanes for cyclists, motorized vehicles and pedestrians. The segregated bus lanes make for faster travel of commuters in the BRTS; it improves traffic management in general and as such, improves the driving conditions of all other vehicles on the road as well. This system produces a decreased load of pollution. Security, cleanliness, easy access, customer comfort, and minimal stoppage time, all combine to make for increased efficiency. In India, BRT system is adopted in many cities such as Delhi, Ahmedabad, Surat, Rajkot, Pune, Jaipur, Indore, Bhopal, Vijayawada and Vishakhapatnam (Table 1).

Table 1: Operational BRTS corridors in India

No s.	City	Operational corridor length (km)	Corridor Name
1	Delhi	5.6	Ambedkar Nagar to Moolchand
2	Ahmedabad	25	RTO Circle to Maninagar
3	Pune	17	Hadpsar-Swargate-Katraj
4	Surat	10.2	Udhana Darwaja to Sachin GIDC Naka
5	Jaipur	7	Sikar Road to Tonk Road
6	Indore	11.5	AB road corridor
7	Bhopal	21.7	
8	Vishakhapatnam	20	Pendurthi Transit Corridor
9	Vijayawada	15.5	Green Corridor: Loop Road
10	Rajkot	10.7	Gondal Chowk to Madhapar chowk

This document has been prepared as a part of the funded project - Technical Study of the existing BRTS corridor for the last mile connectivity and pre-feasibility of potential electrification of the corridor in Rajkot, Gujarat, India. Rajkot has proposed BRTS network of total 63.5kms (Figure 1). Out of which 10.7 km BRTS corridor i.e. from Gondal Road to Jamnagar road is operational at present. The study intends in exploring the feasibility of improving ridership and sustainability of this existing BRT corridor through improving the attractiveness and accessibility of the corridor and explore the possibilities for electrification of the bus fleet.

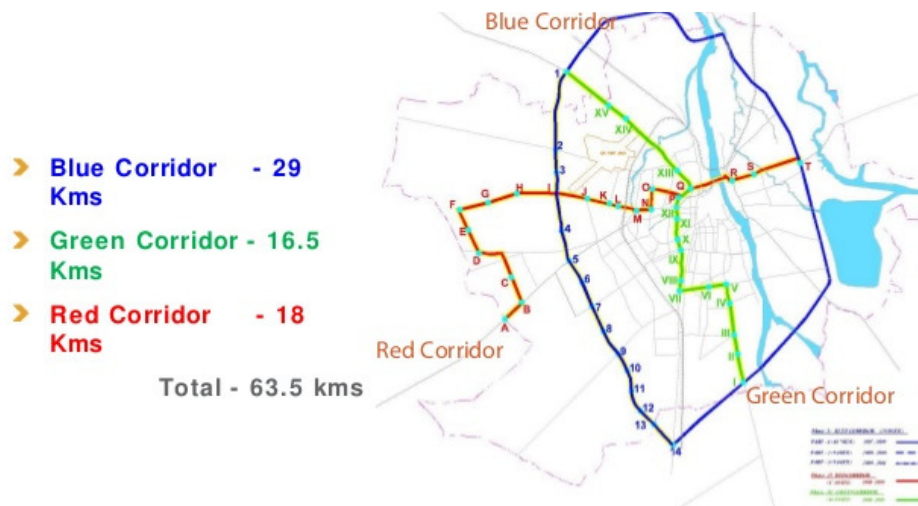


Figure 1: Rajkot BRTS network plan (Source: RUDA)

1.1 City Profile

Rajkot is the fourth-largest city in the state of Gujarat. Managed by Rajkot Municipal Corporation (RMC), the city itself is around 104 sq.km. The larger metropolitan region, which is under the jurisdiction of Rajkot Urban Development Authority (RUDA), has an area of about 483 sq.km (Figure 2). The city has a dense road network. The city is regionally connected with National highway NH-8B, State Highways (SH-26, SH-27, and SH-42) and district roads.

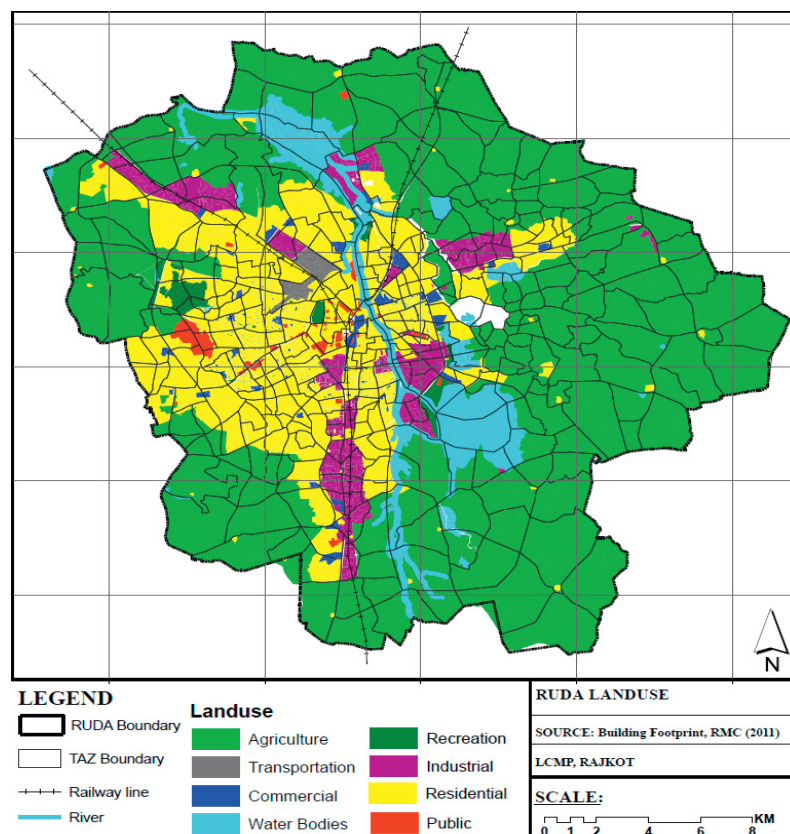


Figure 2: RUDA Land Use Map, 2011 (Source: RUDA)

The city has a very low average trip length of under 4 km. It has a high mode share of NMT and motorised two wheelers. Additionally, the city has an informal though very strong IPT presence. Rajkot's intermediate public transport (IPT) system relies on three wheelers, locally known as 'Chakdas'. Intra-City bus services are run by State Transport and private bus operators. Most of the mini buses are operated by private operators. Travel characteristics of Rajkot city are presented in (Figure 3).

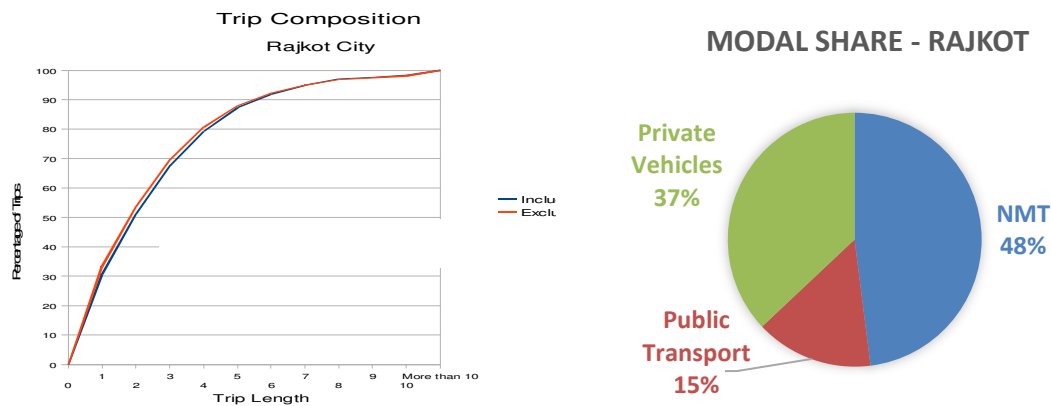


Figure 3: Travel Characteristics – Rajkot City

The rapid industrial development, concentration of various commercial and industrial activities coupled with rise in population over the past decade has contributed in a large-scale increase in traffic in the Rajkot city. Because of these factors, the city road network leading to the surrounding towns are heavily congested. This increasing intensity of traffic has resulted in the manifestation of many problems like traffic congestion, delay, accidents, pollution etc. which poses a potential threat to the economic vitality and productive efficiency of the city.

2 Need for the project

Rajkot BRT (Figure 4) was planned in year 2007-09, by SGArchitects (SGA) for Urban Mass Transit Corporation (UMTC), who were contracted by Rajkot Municipal Corporation to plan and implement the project under funding from MoUD as a part of JnNURM.

RMC had identified the two potential BRT corridors:

1. One on the Ring Road around the city
2. Other bisecting it and linking the city to the periphery.

The section of the Ring road was developed as the 10.7 km long first phase BRT corridor.



Figure 4: Operational Rajkot BRTS (<http://www.rajkotrajpath.com>)

The available ROW is 45m and the corridor was designed with two vehicular lanes, a parking lane, dedicated bus lanes, a continuous cycle track and a continuous and barrier free footpath along the length of the corridor. As a first for any BRT in the country, the corridor was designed with semi-signalized (three-phase signal, for buses, pedestrians and other motor vehicles) round about junctions. Rajkot BRTS corridors details are presented in (Table 2).

Table 2: Rajkot BRTS corridor details (<http://www.rajkotrajpath.com>)

Rajkot BRTS operational Corridor Details	
System type	Closed (However Initially planned as open)
Transit type	Bus rapid transit
Number of lines	1
Vehicle type	High floor CNG bus fleet
Number of stations	18
Daily ridership	15000-17000 daily average
Operator(s)	Rajkot Rajpath Limited
System length	10.5 kilometers (6.5 mi)

The selected corridor was planned towards the outskirts of the city, and attracted limited ridership because of limited demand (due to minimal origin-destinations on the corridor). Additionally, like most Indian cities, Rajkot has:

- Very low average trip length of under 4km.
- High mode share of NMT and motorized two wheelers.
- Informal though very strong IPT presence.

These factors point to a high sensitivity to access time, journey time and journey cost. As closed BRT system is not viable for the any city with low trip length and high access time and cost involved initially an open system was proposed for Rajkot - with bus routes connecting city core with BRT through critical nodes and important junctions on the corridor. However, the Rajkot Municipal Corporation felt that a closed BRT will present a better image to the system, and the plan was changed to closed BRTS, mid-way during implementation. As anticipated, this resulted in a significantly reduced ridership than planned for. Thus, to address this lack ridership on the BRT system, this project aims to identify solutions/measures to increase its attractiveness and demand. This study shall evaluate the effectiveness of different short and/or long-term measures to achieve these goals, and suggest a broad implementation strategy for the same. These measures include exploring different options to increase last mile connectivity including IPT integration, NMT integration, route modifications, etc. Other suggestions to improve attractiveness of the system, such as improved technology for ticketing, vehicle information, vehicle tracking etc. shall also be explored.

2.1 Aim and Objectives

The project aims to appraise the operational Bus Rapid Transit System in Rajkot added with an effective last mile connectivity. Additionally, exploring potential of electric mobility i.e. electrification of existing BRT buses in the city, to reduce its carbon footprint and to make it more sustainable. To achieve this, aim the primary objectives which are required to be addressed are:

1. Suggest improvements in the existing BRT system to help reaching out to larger population for each available BRT station based on demand assessment

2. To provide last mile improved connectivity between different modes (existing and envisaged) as well as safe pedestrian and non-motorized access to public transport.
3. To propose enhancements, add on for improving the system including new technology aspects and looking at the feasibility of scaling up such initiatives more widely in the city.
4. Delineate influence area over which ridership enhancement measures need be considered.
5. Identify various last mile connectivity modes such as E-rickshaw /Auto rickshaws as well as
6. NMT modes that need promotion.
7. Identify implementation pattern to promote the finalized modes for last mile connectivity improvement including the financial aspects such as cost, revenue etc.

2.2 Task to be Undertaken

As the project get initiated, the following task are required to be undertaken to attain the stated aim and objectives. These tasks are listed below:

1. Delineation of the Study Area, Time Frame and Demand Assessment
2. To conduct limited primary survey and collection of the secondary data to estimate BRT, NMT and IPT demand and trip characteristics.
3. To identify possible measures as well building scenarios for each measure improving BRT ridership.
4. To finalize most effective feeder by comparing estimated BRT ridership estimated in different measures, in different scenarios.
5. To develop plans for implementation of the selected measure along the BRT corridor.
6. To provide a required data for electrification of the BRT system in consultation with international expert.
7. NMT demand assessment for last mile connectivity
8. Identify various last mile connectivity modes such as E-rickshaw /Auto rickshaws as well as NMT Last Mile Connectivity Plan
9. Physical integration of last mile connectivity modes at BRTS Stations covering dispersal and circulation Plans
10. Institutional Integration
11. Preparation of Business and Implementation Plan

2.3 Scope of the Project

The scope of this projects includes assessing the current condition as well requirements of the present operational corridor and identifying the gaps to derive action points to improve the ridership along with integration of viable feeder service options to address last mile connectivity. The scope of the work will also include collaboration with an external expert to understand and help in the electrification of BRT fleet and subsequently incorporate electrification related parameters, such as vehicle size, range, capacity, vehicle cost, etc. To achieve this, the exercise will involve the following:

1. Preparation of an integrated accessibility (Last mile connectivity) plan for Rajkot BRTS. This will include 2.5 Km of buffer Zone from either side of BRTS corridor in Rajkot city.
2. Exploring the pre-feasibility of electrification of BRTS corridor in Rajkot. This will include
3. assist and coordinate with international consultant to develop the prefeasibility

2.4 List of deliverables:

The total period of the project is 5 months, from the start date of the contract. Deliverables will include the following:

1. Inception Report: The report will include the detailed work plan and methodology, timeline for the study etc. The inception report will be delivered within 2 weeks from the start date of the contract.
2. Interim Report: The report will include the literature review, primary survey & analysis and secondary data collection & analysis, scenario development with projected ridership, etc. The interim report will be delivered within 2.5 months from the start date of the contract.
3. Final Report: Final report will include the identification possible measures as well scenarios, finding from stakeholder discussions, scenario-wise factor evaluation in BEAD tool, draft financial plan and action plan for selected measure, recommendations on BRTS planning and last mile connectivity and future mobility recommendations the city, etc. Final report will be submitted within 4 months from the start date of the contract.

3 Project Methodology

The proposed methodology for exploring the feasibility of improving ridership and sustainability of existing BRT in Rajkot through improving the attractiveness and accessibility of the corridor and by electrification of the bus fleet is distributed in two broad steps (Figure 5). These are:



Figure 5: Methodology

Both steps are being elaborated in the following section:

3.1 Increasing BRT ridership

It is hypothesised that the primary reason for reduced attractiveness of BRT in Rajkot is the lack of accessibility. A two-step approach has been planned for identifying and recommending means of increasing BRT ridership. These are:

1. Existing Condition Analysis – Understanding existing and projected passenger trip characteristics and demand by all modes (including BRT) in a business as usual (BAU) scenario on the existing BRT corridor. This shall include a mode wise assessment of trip length, journey cost, access-egress distance (distance of origin and destination from the corridor) on identified links (between important nodes) on the corridor.
2. Evaluating Measures for Improving BRT Ridership – Based on the existing condition analysis, potential measures for improving BRT ridership shall be identified. These mainly include improving accessibility to the system. These measures shall be compared against each other through empirical means to identify and detail the most effective and efficient measure.

3.1.1 Existing Condition Analysis

The first step towards generating meaningful recommendations to achieve study objectives shall be developing an understanding of the current problems, possible reasons and possible solutions. This shall be based on an understanding existing and projected passenger trip characteristics and demand by all modes (including BRT) in a business as usual (BAU) scenario on the existing BRT corridor. This shall include a mode wise assessment of trip length, journey cost, access-egress distance (distance of origin and destination from the corridor) on identified links (between important nodes) on the corridor. This shall be achieved as following:

1. Assessment and review of available secondary data such as that from ticketing data, LCMP, census data, city development plans, and most importantly BRT DPR.
2. Limited primary surveys at identified (from observations and from the review of secondary data) 3 to 5 important nodes on the corridor. This shall include short video based traffic counts and occupancy counts at the nodes – to allow an assessment of current mode wise demand on the corridor. Limited, short questionnaire based O-D survey of commuters at the junctions – to collect access egress distance to the corridor, origin/destination points (or catchment area), trip lengths trip time and cost.
3. Collecting secondary BRT data on peak and daily ridership numbers, bus frequency, average bus occupancy, route length, depot locations, terminal locations and average operational speeds, current average dwell time, average layover time, etc.
4. Use secondary data such as low carbon mobility plan, city development plans, etc., to understand the existing and proposed land use in the vicinity of the BRT corridor. This shall also help identify any future potential for increasing demand due to developments planned. This shall also be used to augment an understanding of catchment area for the BRT service in scenarios, with or without a feeder network.
5. Observations and findings from limited primary surveys shall be used to estimate the type, quality and availability of existing IPT services along the corridor and in the catchment area of the corridor. This shall also include an assessment of their performance parameters such as average wait time, average speeds, average (informal) station spacing.
6. Understanding the travel characteristics in the Rajkot city through census data and other secondary sources. This shall include, an understanding of trip length frequency by different modes in the city, average trip length by different modes, etc.
7. Observations and findings from limited primary surveys shall be used to assess the utilization of existing NMT infrastructure and to assess the existing accessibility to NMT modes (either through ownership or through rental). This shall include an assessment of existing condition of NMT infrastructure in and around (in the catchment area) of the corridor.
8. Using Rajkot Urban population and trip growth trends, business as usual (BAU) scenario shall be developed to project BRT ridership estimates in the horizon year – 2022 and 2027. This shall also be refined where required, basis understanding from city development plan.

3.1.2 Evaluating and Proposing Potential Measures for Improved BRT Ridership

From the existing condition analysis, potential measures for improving BRT Ridership shall be identified. These shall be evaluated through the following methodology:

1. Based on existing condition analysis, literature review and discussions with stakeholders, a listing of possible measures to improve ridership on the BRT corridor shall be

generated. This may include potential for improving pedestrian and cycling environment in the BRT catchment area, introducing/planning BRT feeder from/to identified critical trip generators and attractors for the corridor and tweaking BRT operational plan and/or route network, introducing/ integrating IT based solutions (such as technology for aggregator type services, electronic ticketing, etc.). In addition to identifying measures of improving ridership, different scenarios of cost/fare, route lengths, access-egress distance, etc. for each of the scenarios shall also be finalised.

2. Depending on the data available (both from primary and secondary sources), a spread sheet or statistical model (such as SPSS or others) based analysis shall be undertaken to allow development of a relationship between current model (as dependent variable) and parameters such as journey time, cost, distance travelled on the corridor and access egress time/distance, as independent variables. A regression or a spreadsheet based model shall provide sensitivity to changes in the independent variable and its impact on the probability of the choice of that mode.
3. The factor values for the independent variables shall be estimated for each of the scenario (as identified in point 1 above) using the available data and/or relevant modelling tools. Modelling tools shall include such as BRTS Evaluation and Design Tool (BEAD) version 1.70 (Institute of Urban Transport, India).
4. These factor values of independent variables for different measures in different scenarios shall be input in the spread sheet or any regression model to estimate the probability change in the choice of BRT as against other modes. This shall be used to estimate probable changes in ridership of BRT for each measure in each scenario, in the current as well the horizon year.
5. Comparison of estimated BRT ridership in different measures in different scenarios in the horizon years including the comparison of ridership in a BAU scenario shall be presented and discussed. These shall be used to finalise the most effective measure and scenario/boundary conditions (such as route/network, fare, any electronic ticketing option, any priority signalling option, etc.) of that measure, in improving BRT ridership in Rajkot.
6. Based on existing condition assessment, a detailed list of requirements for implementing the identified measures along the corridor shall be drafted. This may include infrastructural changes/improvements required, institutional changes required, fleet changes/upgrades required, etc.
7. Based on the detailed list of requirements for implementing the selected measure, a broad estimate of capital investments required, and operational/maintenance costs involved shall be made. This along with revenues estimates (such as from fare), a broad financial approach and recommendations shall be developed for the selected measure.
8. A draft action plan shall be developed for implementing the selected measure. The action plan shall identify projects/studies that need to be undertaken for implementing the selected measure as per a defined timeline.

3.2 Electrification of the BRT Fleet

International mobility experts shall explore the financial and technical feasibility of electrification of BRT fleet. SGArchitects shall co-ordinate and advise the international experts for this study. The critical stages at which this co-ordination shall feed in to both the parts of the studies are:

1. Existing condition analysis – At this stage SGA shall co-ordinate with the international expert to understand any data requirements to help in the part B of the study.
2. Identification of possible measures as well scenarios for each measure for improving BRT ridership - At this stage of the study, co-ordination with the international expert can help include measures and scenarios necessary for electrification of Rajkot BRTS fleet. Such possible scenarios can be exploring possibility of use smaller size/capacity buses, modifying bus routes (to meet any charging requirements), exploring means of minimising bus delays (to return more km's for each charge), etc.
3. Developing a detailed list of requirements, as well financial and action plan for the selected measure – At this stage co-ordination with the international expert will help integrate any electrification plans for BRT fleet in the action plan and will also help include and account for any associated costs as well additional revenues.

3.3 Project Timeline

The timeline for the project has been designed to minimize the project period. It is suggested that the project and all activities are expected to last 18 weeks or approximately 4 months. The Table 3 below, presents a comprehensive activity schedule chart for the project.

Table 3: Project Time line

Study of the existing BRTS corridor for the last mile connectivity and pre-feasibility of potential electrification of the corridor																			
Project Timeline																			
Months		4 Months																	
Week		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Nos.	Task																		
A	Inception Report																		Deliverable 1
B	Understanding of the current problems, possible reasons and possible solutions	Stage 1																	
1	Limited primary surveys at identified 3 to 5 important nodes on the corridor - traffic count & occupancy survey, O-D survey, etc.																		
2	Secondary data collection from ticketing data, LCMP, census data, CDP and BRT DPR, peak daily ridership, etc.																		
3	Using primary and secondary data estimate BRT, NMT, IPT and private mode demand and trip characteristics																		
5	Projecting ridership in Business as usual (BAU) scenario																		
C	Interim Report																		Deliverable 2
D	Evaluation of Potential measures for improving accessibility & attractiveness	Stage 2																	
1	Identification of possible measures as well scenarios for each measure for improving BRT ridership																		
2	Development of statistical model - relationship between current model & parameters																		
3	Assessment of factor values for each scenario using modelling tool/BEAD tool																		
4	Finding possible changes in the choice/ridership of BRT as against the other modes with the help of regression model																		
5	Comparison of estimated BRT ridership in different measures in different scenarios and Finalizing the most effective measure and scenario																		
6	Listing of requirements for implementing the identified measures along the corridor																		
7	Development of a draft financial plan and action plan for implementing the selected measure																		
E	Co-ordinate and advise the international experts																		
F	Final Report																		Deliverable 3
G	Approval of Final Report																		Deliverable 4

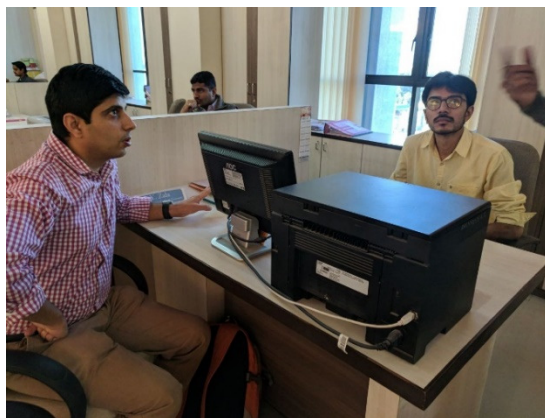
4 Initial Steps

The start date of this project is 15, November 2017. In line with the time line presented above, the project was scheduled to be concluded on March 15, 2018. However due to delays in data collection and site visit caused by elections in Gujarat, the timeline and accordingly the project conclusion date is likely to shift by 15 days to April 01, 2018.

The initial steps undertaken for the project include internal finalization of project approach as well strategy as well establishing contact with Rajkot BRTS operators and stake holders for initiating primary and secondary data collection.

The project approach and strategy included the methodology and time frame (presented above) has been finalized with ICLEI -SA team. This was achieved at a kick-off meeting which was held on 16th November 2017 at the ICLEI office, New Delhi. This meeting was attended by Mr. Ashish Rao Ghorpade, Mrs. Deboshruti Sadhukhan, Dr. Monalisa Sen, Mr. Vijay Saini from ICLEI. Mr. Nicolas Dr. Utpal Dekka, Mr. Rohit Garg, Mr. Ravi Gadepalli. Mr. Sandeep Gandhi and Mr. Pushkar Dhawale from S G Architects. The details of this meeting have been listed in meeting minutes included as a part of the Annexure to this report. The agenda of this meeting was to introduce the team, present the objectives, methodology and timelines of the project. In addition, the survey formats required to collect data through primary surveys has been prepared for the study 5.

4.1 Site Visits and Meetings



Apart from internal approach and methodology finalization, the project team has established contact with Rajkot Municipal Corporation (RMC) and Rajkot Municipal Transport Services (RMTS) officials. This was achieved through a site visit at Rajkot between December 12, 2017 to December 15, 2017. During this visit meetings held with the officials were used to introduce the team to city officials and to present the study objectives, scope and methodology with the concerned officials. During this visit, meetings were held with Mr. K L Zala (RMTS Traffic & Transport wing), Mr. R.R. Raiyani (RRL General Manager), Shri Banchhanidhi Pani (Commissioner, Rajkot Municipal Corporation), Mr. Chirag Pandya (GM Smart Cities), And Mr. Ankit Makvana, (ICLEI Senior Project Officer, Energy and Climate). The minutes of these meetings has been presented in Annexure 6.3.

4.2 Primary Data Collection



In addition, primary data collection was initiated during this visit. Data collection was undertaken by Mr. Sandeep Gandhi, Ms. Kanika Gola and Mr. Shyambir Singh from SGA and Mr. Jeet Thakkar and Ms. Kairavi Jani who were students locally hired for the study. The data collection included traffic volume survey (videos) on total 19 junctions and Origin – Destination (O – D) survey on total 10 junctions and 13 bus stops. Junction O-D data on the remaining 9 junctions and 5 bus stops was collected between December 18 and 21, 2017, by the selected students for this study.

A total of approximately 900. respondents have been surveyed for junction O-D survey and 180 respondents were interviewed for bus station O-D survey.

4.3 Secondary Data collection

To start with, the team has identified Passenger and Bus related secondary data requirements for BRTS buses and city buses. Required secondary data for BRTS and city buses is as following:

4.3.1 For BRTS buses

4.3.1.1. *Passenger data –*

- a. Daily or monthly Passenger trips with breakup as per trip length or ticket category, and journey start point (ticket sale point/station).
- b. Any one peak hour Passenger trips data with breakup as per direction, trip length or ticket category, and journey start point (ticket sale point).
- c. Any other BRT passenger related studies or data available, such as that which contains information on passenger and trip characteristics.

4.3.1.2. *Bus data –*

- a. No. of daily bus trips - with breakup of peak hour and off-peak hour frequency or headway - and/or total number of bus trips in a day - preferably with an hourly and direction wise breakup.

- b. Average operations speed achieved during peak and off-peak hours. If not try and get entire GPS data for one bus for 3 consecutive working days - say Tuesday to Thursday.
- c. Bus operational hours - start time from depot till end time in Depot. Also, information on layover time at terminals or end points of the corridor will be helpful - if available.
- d. Bus type information, including fuel type and seating and standing capacity.
- e. Current operational and total fleet size.
- f. Any other information, reports, etc.

4.3.2 For city buses

4.3.2.1. *Passenger data -*

- a. Daily or monthly Passenger trips on each route, with breakup as per trip length or ticket category, and journey start point (ticket sale point/station).
- b. Any one peak hour Passenger trips data on each route, with breakup as per direction, trip length or ticket category, and journey start point (ticket sale point)
- c. Any other city bus passenger related studies or data available, such as that which includes information on passenger and trip characteristics.

4.3.2.2. *Bus data –*

- a. Number of daily bus trips in each route - with breakup of peak hour and off-peak hour frequency or headway - and/or total number of bus trips in a day - preferably with an hourly and direction wise breakup.
- b. Average operations speed achieved during peak and off-peak hours, for each route. If not try and get entire GPS data for one bus for 3 consecutive working days - say Tuesday to Thursday.
- c. Bus operational hours - start time from depot till end time in Depot. Also, information on layover time at terminals or end points of the corridor will be helpful - if available.
- d. Bus type information, including fuel type and seating and standing capacity.
- e. Current operational and total fleet size as dedicated or assigned on each route.
- f. Route information, including total route length, route map, etc.
- g. Please also specify provide any Depot and terminal location.
- h. Any other information, reports, etc.

4.3.3 Secondary data collected

Secondary data collected till December 21, 2017, is presented in the Table 4.

Table 4: Secondary data and availability

Nos.	Data	Data collected so far
A.	For BRT buses	
1	Bus stop wise Ticketing information	Not collected yet
2	Bus stop wise Passenger information	Passenger information for 11 months were collected
3	Speed analysis report	Not collected yet
4	Daily route wise – station wise ridership	Not collected yet
5	BRTS time schedule	BRT time schedule for whole were collected
6	Passenger trip characteristic data	Not collected yet
8	Depot and terminal location	Not collected yet
B.	For RMTS buses	
1	Route wise Ticketing information	Data of 30 routes were collected
2	Speed analysis report	Speed analysis for 2 routes were collected
3	Daily route wise – station wise ridership	Data of 22 routes were collected
4	Route wise time schedule	Data of all routes were collected
5	Route wise Ridership information	Data of 46 routes were collected
6	Route wise fare matrix	Total data of 48 routes were collected
7	Passenger trip characteristic data	Not collected yet
8	Bus operational hours - start time from depot till end time in Depot. Also, information on layover time at terminals	Not collected yet
9	Bus type information – including fuel type and seating and standing capacity	Not collected yet
10	Depot and terminal location	Not collected yet

5 Way Forward

The collected data shall be analyzed over the next 2 to 4 weeks. In addition, missing secondary data will be sourced from RMTS and RRL. The analyzed data shall be compiled in a master data sheet (Figure 6). This data sheet shall be used to generate mode wise trip characteristics and demand on the BRT corridor along with a list of potential catchment areas for the BRT. This data shall subsequently be used identify potential feeder modes for BRT with their expected capacity (in terms of hourly trips catered).

S.no	Mode : _____(Two wheeler / Four Wheeler / Three wheeler/ Bus / Cycle / Cycle Rickshaw/ E - rickshaw/ Walk/ etc.)																		
	OD		Route		Average Distance on the corridor	Average Distance off the corridor	Average speed on the corridor	Average speed off the corridor	Average time on the corridor	Average time off the corridor	Average cost on the corridor	Average cost off the corridor	Total Journey Time	Total Journey distance	% of distance on the corridor	Average passenger speed	Change-over time	Total Journey Cost	Number of trips
1	L.H.S	R.H.S	L.H.S	R.H.S															
2																			
3																			
4																			
5																			
6																			
7																			
8																			
9																			
10																			
11																			
12																			
13																			
14																			
15																			

Figure 6: Master data sheet for analysis

6 Annexure

6.1 Kick-off Meeting Minutes

Technical Study of the existing BRTS corridor for the last mile connectivity and pre-feasibility of potential electrification of the corridor in Rajkot, Gujarat, India.

International Council for Local Environmental Initiatives (ICLEI)

Meeting: 17.11.2017

Attended by:

Mr. Ashish Rao Ghorpade, Deputy Director, ICLEI, New Delhi.

Mrs. Deboshruti Sadhukhan, Senior Programme Coordinator (Sustainability Management), ICLEI, New Delhi.

Dr. Monalisa Sen, Senior Programme Coordinator (Biodiversity), ICLEI, New Delhi.

Mr. Vijay Saini, Senior Project Officer (Urban), ICLEI, New Delhi.

Mr. Nicolas

Dr. Utpal Deka, Independent Consultant, New Delhi.

Mr. Rohit Garg, Project Manager, South Pole Group, New Delhi.

Mr. Ravi Gadapalli, Independent Consultant, New Delhi.

Mr. Sandeep Gandhi, SGArchitects, New Delhi

Mr. Pushkar Dhawale, SGArchitects, New Delhi

Venue: ICLEI office, Green Park, New Delhi.

Minutes:

- a. Dr. Monalisa Sen presented the presentation about CapaCITIES projects.
- b. Mr. Ashish Rao Ghorpade explained the Rajkot, Siliguri and Udaipur project background and deliverables for all three projects. He asked for queries and explained in detail.
- c. Dr. Utpal Deka presented the Siliguri project presentation and explained the project objectives and deliverables.
- d. Mr. Sandeep Gandhi explained the Rajkot BRTS project objectives, deliverables and methodology in detail. And then asked for queries.
- e. Mr. Ashish Rao Ghorpade said that Rajkot Municipal Corporation is very much interested in this project and expecting BRT ridership improvement solutions for implementation. He also asked to check the survey data from IIT Kharagpur.

- f. After the SGArchitects presentation, Mr. Ravi Gadapalli explained the Udaipur project presentations.
- g. Mr. Ashish Rao Ghorpade asked to start all the three projects from 15th November 2017 and requested to complete before this financial year.

6.2 Primary Survey Formats

6.2.1 O-D Survey form:

<i>"Technical Study of the existing BRTS corridor for the last mile connectivity and pre-feasibility of potential electrification of the corridor in Rajkot, Gujarat, India "</i>						
Origin - Destination Survey Form					Date -	Time -
Location/Junction:				Arm:		
S.no	Gender	Mode	Origin	Destination	Direction	Occupancy
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6.3 Minutes of Meetings

6.3.1 Site visit 1:

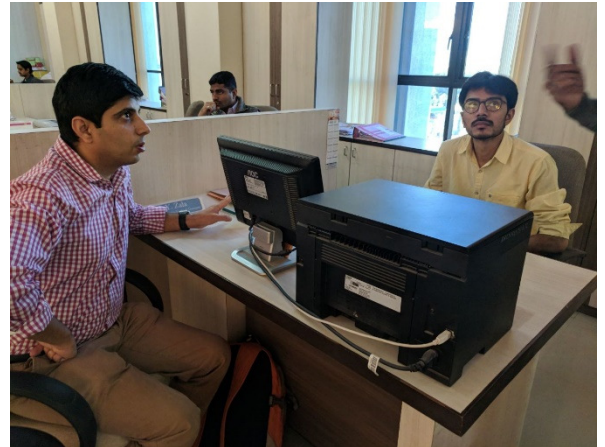
Meeting 1: 14.12.2017

Venue: RMC office - Traffic & Transport wing, Rajkot

Time: 04:45pm

Attended by:

- Mr. K L Zala, RMTS Traffic & Transport wing, Rajkot
- Mr. Ankit Makvana, Senior Project Officer (Energy and Climate), ICLEI, New Delhi
- Mr. Sandeep Gandhi, Transportation Engineer & Principal Architect, SGArchitects, New Delhi
- Ms. Kanica Gola, Architect & Infrastructure Planner, SGArchitects, New Delhi



Minutes:

- Mr. Ankit introduced SGA team to Mr. K L Zala mentioning the project and agenda of visit.
- Mr. Zala informed that RMTS buses efficiency is 99% and in case of any breakdown there is always a spare bus ready.
- About midi buses – seating capacity is 42 while average is 26.25 per km.
- Mr. Zala also explained that operations are being managed by third party and the charges (including diesel/ accident change) per person per shift is 12,300.

Meeting 2: 14.12.2017**Venue: RMC office - Engineering Department**

Attended by:

- Mr. R.R. Raiyani, General Manager (RRL), Rajkot
- Mr. Ankit Makvana, Senior Project Officer (Energy and Climate), ICLEI, New Delhi
- Mr. Sandeep Gandhi, Transportation Engineer & Principal Architect, SGArchitects, New Delhi
- Ms. Kanica Gola, Architect & Infrastructure Planner, SGArchitects, New Delhi

**Minutes:**

- Mr. Sandeep Gandhi gave brief introduction to Mr. R.R. Raiyani about the project and updated him about the data collection process.
- Mr. Gandhi informed Mr. Raiyani that SGA team is doing O-D surveys on junctions and BRTs with the help of traffic police and taking videos for traffic volume count.
- He appreciated our effort and suggested SGA team should carry the letter and id-card all the time for smooth movement and he also mentioned that all the support will be provided to SGA team regarding any data requirement.
- Mr. Gandhi informed Mr. Raiyani that SGA team will be coming back again after around three weeks with draft analysis and its findings to discuss with him.
- Mr. Gandhi also updated Mr. Raiyani regarding the Swiss team who are working on pre-feasibility of potential electrification of the corridor in Rajkot.
- Mr. Raiyani showed his concern whether the electrification is practical. Also, traction and operational feasibility is there.
- Mr. Raiyani also discussed with Mr. Gandhi how successful is hybrid bus and how much is the life of such a bus.
- Mr. Raiyani also discussed about Himachal e- bus and how is Delhi's e-bus/ e-rickshaw is doing.
- Mr. Raiyani was concerned with the source of electricity. Whether it is coming from non-conventional sources or not. He said that otherwise there is no point in shifting one problem to another. He was also concerned with the infrastructure cost of electrification.

- Mr. Gandhi clarified his concerns and explained the charging method and discussed the gross cost model.
- Mr. Raiyani discussed that the gross cost model is very successful. Under this model, there is no responsibility of RMC, all the maintenance/ driver related queries/ penalties etc. is operator's responsibility. Everything is up to date and public gets good service and safety. He also mentioned that bonus provision is also there after the tenure is finished. He said that corporation is not paying any GST.
- Mr. Raiyani said that the electrification should be economical, and he was more concerned with the life of electric bus.
- Mr. Raiyani also mentioned that they are planning to buy 3 more buses for BRTs but there is some issue with the operator's contract.
- Mr. Raiyani mentioned that more than 24000 people moves in a day, so they cannot convert all the fleet into electric at one go. Hence, firstly they will apply it on pilot basis. He said that till the time public is not habitual nothing can change.
- Mr. Raiyani also informed SGA team that currently Madhapar and Gondal junctions are very chaotic. He said that on these junctions, two buses cannot go together due to space constraint and heavy flow of traffic.
- Mr. Raiyani updated SGA team about the construction of ring road (on TOZ model) which will be used to move heavy traffic.
- Mr. Raiyani updated SGA team about their current services of RMTS which are plying. He said that there are 90 RMTS buses plying on 45 routes covering around 130 sq. km.

Meeting 3: 15.12.2017

Venue: Office of Commissioner, Rajkot Municipal Corporation, Corporation Chowk, Rajkot

Attended by:

- Shri Banchhanidhi Pani, Commissioner (I.A.S.), Rajkot Municipal Corporation, Rajkot
- Mr. Sandeep Gandhi, Transportation Engineer & Principal Architect, SGArchitects, New Delhi
- Mr. Ankit Makvana, Senior Project Officer (Energy and Climate), ICLEI, New Delhi

Minutes:

- Mr. Sandeep Gandhi explained the broad objective of the project, which is to look at improving last mile connectivity in order to improve BRT ridership and also to explore electrification possibility of BRT and/or feeder to BRTS. He elaborated on the teams involved in the project, the broad project methodology, project timelines and the tasks to be undertaken during the current visit.
- The commissioner RMC, pointed out that he is not so much interested in further improving the ridership of BRT, but is keen to see if the ridership of city buses operated by Rajkot Municipal Transport can be improved. He pointed out the Rajkot BRTS is carrying 20,000 passengers in a day while RMTS ridership is much lower even though the fleet is much bigger.
- Mr. Gandhi pointed out that the current scope of the project focuses on studying the BRT and its ridership and the study area is also just the catchment area of the corridor and hence any suggestions for RMTS route rationalization or ridership enhancement cannot be derived from the current study. Mr. Gandhi also pointed out that as a part of looking at the feeder options to the corridor, the project team is analysing data from around 30 RMTS routes which are crossing the BRT corridor. If some interesting findings arise from this data, which may help the RMTS to improve operations on this route, the team will be happy to share the same.
- Mr. Gandhi also mentioned that considerable secondary data for RMTS and RRL has been provided by Mr. Raiyan (G. M. RRL) and that his office has been very helpful in providing us the data required for the study.
- The commissioner re-iterated that all data required for the study shall be provided. He understood that the focus of the study shall be BRT corridor, but looked forward to any findings that came out of the study for improving city bus ridership.
- The commissioner mentioned that the three outputs that he looks forward to from the study are:
 1. Suggested measures to improve city bus ridership

2. Suggested plan for integrating non-motorized transport for improving last mile connectivity.
 3. Evaluating augmentation of BRTS network in to the ABD area for Rajkot under the Smart City initiative.
- The commissioner suggested that we have a look at the proposals to look at extending BRT corridor to smart city ABD and for that we should go and meet Mr. Chiragh Pandya, GM Smart Cities.
 - Mr. Gandhi conveyed to the commissioner that as a part of the study, options and possibilities of integrating NMT with BRT (as a feeder mode for last mile connectivity) will be explored. He also assured the commissioner that we will meet Mr. Pandya and provide him any advisory support he may require for the BRT augmentation to the ABD area.

Meeting 4: 15.12.2017

Venue: Office of Commissioner, Rajkot Municipal Corporation, Corporation Chowk, Rajkot

Attended by:

- Mr. Chiragh Pandya, GM Smart Cities, Rajkot
- Mr. Sandeep Gandhi, Transportation Engineer & Principal Architect, SGArchitects, New Delhi
- Mr. Ankit Makvana, Senior Project Officer (Energy and Climate), ICLEI, New Delhi

Minutes:

- Mr. Chiragh Pandya explained the proposal to extend the BRT corridor to the smart city ABD. He explained the proposed BRT network on the Rajkot City map. He also explained the limitations in right of way (RoW). He requested advise on one-way BRT to get around the limitations of RoW.
- Mr. Gandhi, requested Mr. Pandya to share a map/plan for the ABD area. He also agreed to look in to a possibility of BRT on a 24m wide road and suggest to him any options.
- Mr. Ankit pointed out that he may have the plan for the ABD area and agreed to share it with Mr. Gandhi.