Technical Assistance to Improve Bus Transport Operation and Infrastructure in Himachal Pradesh and Andhra Pradesh

"Fleet Planning and Terminal Infrastructure development support for Andhra Pradesh Road Transport Corporation and Himachal Pradesh Road Transport Corporation"

FINAL REPORT

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1 Introduction

Bus based public transport is the backbone of road based mobility in our country. It is estimated that over 7 lakh buses operate in India of which more than 1.5 lakh are operated by more than sixty road transport undertakings. These buses operate from more than 3000 bus terminals and are maintained at nearly equal number of depot facilities. Though public transport buses alone undertake more than 12.1 billion kilometers every year, there has been no significant and noticeable growth in these numbers. This is attributed mainly to significant deterioration of bus operations and related infrastructure i.e. depots and terminals. This generates the need to support to STU's in identifying the existing gaps and put in enablers which would allow a service quality focused approach towards improving bus transport system planning, in terms of :

- Fleet up-gradation planning – To meet the current and projected demand of the STU's.
- Bus transport operations and Infrastructure planning – To make the bus transport system efficient and attractive

To address this, STUs have (after addressing fleet requirements) started focusing on improving bus infrastructure including bus stops, terminals and depots. However there exists a considerable capacity gap in the country to address these deficiencies. As a part of national efforts and to deal with these issues, Association of State Road Transport Corporation (ASRTU) has developed bus terminal and depot design guidelines. Additionally, Ministry of Road Transport and Highways (MoRTH) has initiated a support program for assisting STUs to upgrade bus terminal facilities through PPP route.

In order to upgrade infrastructure for bus based public transport, Shakti Sustainable Energy Foundation (SSEF) has taken the initiative to support Himachal Pradesh Road Transport Corporation (HRTC) and Andhra Pradesh Road Transport Corporation (APSRTC) and appointed SGArchitects as consultants to render their active support for improving the bus operations and infrastructure of the city. The exercise envisioned to contribute to an internal capacity building of the STUs which leads to an overall increase in ridership and improvement in the efficiency of the existing bus system.

2 Aim, Objectives and Methodology

Himachal Pradesh, famous as the tourist center of India is visited by travelers throughout the year. Also, due to its high altitude geographical settings the bus system in the state has been the lifeline of the transportation in the state. These factors underscore the need for a more modern and efficient bus service in the state. To achieve this, Himachal Pradesh Bus Stand Maintenance and Development Corporation (HPCTBSMDC)/Himachal Pradesh Road Transport Corporation has shown interest in receiving multi-pronged expert assistance to address various operational, quality of service and capacity issues affecting the current bus services in the state.

In line to this, Himachal Road Transport Corporation (HRTC) has aligned its institutional mechanism to take up bus terminal development and upgradation in the State. Himachal government has set up the Himachal Pradesh City Transport and Bus Stands Management and Development Authority (HPCTBSMDA). This authority is responsible for development of all bus passenger infrastructure (including bus stops and terminals) in the state. HPSCTBSMDA has divided the terminal facilities in to three categories – A, B and C. A category terminals are terminals at district headquarters such as Kangra and Shimla Terminal. B category terminals are regional terminals such as Parwanoo and Nurpur. C category terminals are local terminals (with no overnight parking requirement, and with no route starting/terminating points) such as Jhalog, Baroh and Bijrara.

The STU has also undertaken extensive investments in improving bus operations, through integration of ITS systems. Additionally, to boost bus operations in the state HRTC is also actively looking forward to addressing any deficiencies in bus fleet requirement.

2.1 Aim and Objectives

The main objective of the project is to contribute to an enabling framework which leads to an overall increase in ridership and improvement in the efficiency of the existing bus system in Himachal Pradesh. To achieve this objective following support is proposed:

1. Providing hand holding support for planning and design of bus terminals under the three categories of bus terminals in Himachal Pradesh.
2. Advisory support and assistance in reviewing the designs submitted to HPBSMDC by bidders under the PPP terminal development initiatives.
3. Undertaking an evaluation of the shortcoming of bus operations under the Shimla Division and suggesting infrastructure and operational interventions at an identified depot to address the same, in addition to supporting establishment of preventive bus maintenance practices for HPBSMDC.
4. Provide policy level estimation of bus fleet requirement at Himachal Pradesh along with recommendations on addressing the gap in a phased manner.

These objectives and tasks have been identified based on the meeting held between Himachal Pradesh Bus Stand Maintenance and Development Corporation (HPCTBSMDC)/HRTC office, and Shakti Sustainable Energy Foundation.

2.2 Scope of the Project

The project promises to achieve the said objectives, through support on three broad bus service components, these are:

a) Bus Terminal template design development.
b) Bus Operations Support
c) Development of a bus fleet upgradation plan

The scope of the project classified under these three components has presented below.

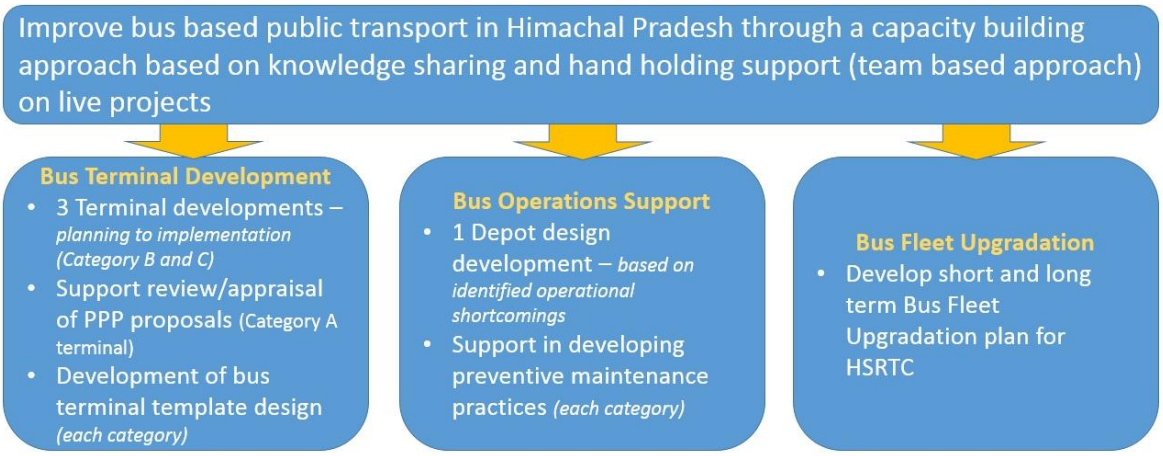


Figure 1: Scope of Work

2.3 Methodology

The project intends to improve the quality, image, operations of buses and their infrastructure provisions in the state of Himachal Pradesh. To achieve its objectives, the project methodology is detailed for each of the three components mentioned in the scope of work. The following flowchart presents the components and the activities required to be undertaken for each component.

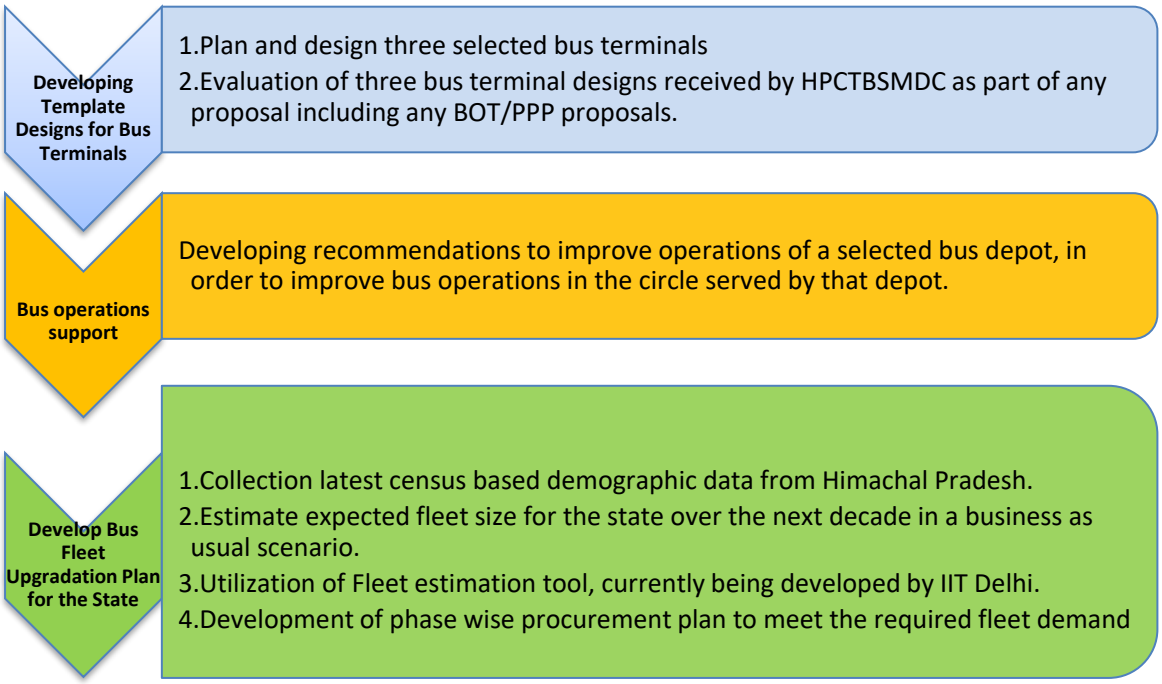


Figure 2: Methodology

3 Infrastructure support for HRTC and APSRTC

The project initiated on October 20, 2016. Based on the decided workplan and timeline, the tasks to be performed were distributed under three identified components (refer Section2.2). Each of these components had a specific approach and methodology. This chapter of the report elaborates the activities performed under each respective component.

3.1 Developing Template Design for Bus terminals

Been the first component - Developing template design for bus terminals; two sections of activities were assigned under this. Section1, included site-specific bus terminal template designs. Section 2, comprised of evaluation of three bus terminal designs as part of any proposal including any BOT/PPP proposals.

Himachal Pradesh road transport corporations (HRTC) categorizes bus terminals in to three types. These are nominated as:

1. A category i.e. Large terminal,
2. B category i.e. Medium scaled terminals and
3. C category i.e. Small terminals.

Thus, HRTC assigned B and C category terminals for site-specific bus terminal template design development whereas suggested A category bus terminal for review and evaluation. HRTC also expressed their concern for a prototype, cost effective bus shelter design for Himachal Pradesh.

Although, bus shelter design was not mentioned in the project scope of work but been part of bus facility improvement exercise; bus shelter design was also included as part of task to be performed under this component. The detailed inventory of activities performed are explained below sub sections:

3.1.1 Bus Shelter Design

Asper the requirements of HRTC, a bus shelter design proposal with cost estimates was developed. The design proposed, a pre- cast concrete bus shelter structure with 4.5 m in length and 2.5 m in width. Considering the climatic conditions of Himachal Pradesh corrugated steel sheet resting over mild steel section was used for roofing the bus shelter. The approximate cost for this bus shelter design was estimated to be 1 lakh (plus minus 10%). The bus shelter design and costing details are presented below in Figure 3,Figure 4 and **Table 1** respectively.

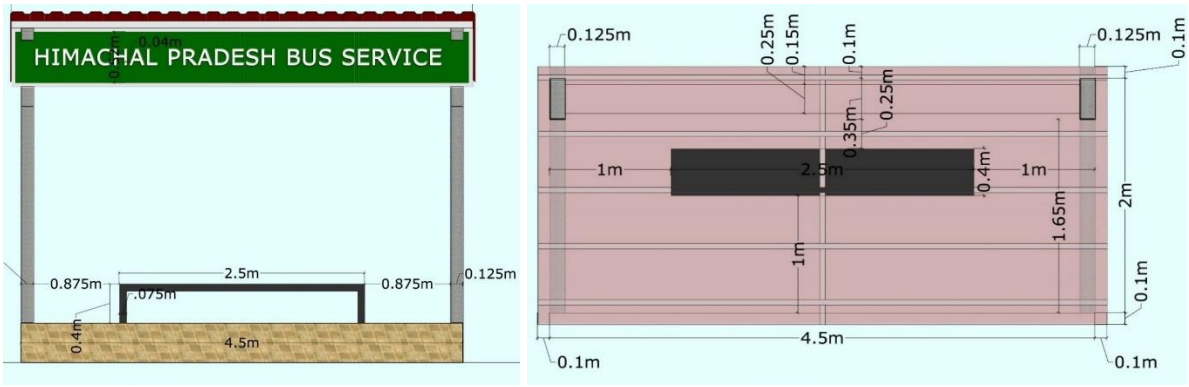


Figure 3: Elevation /Plan – Bus Shelter

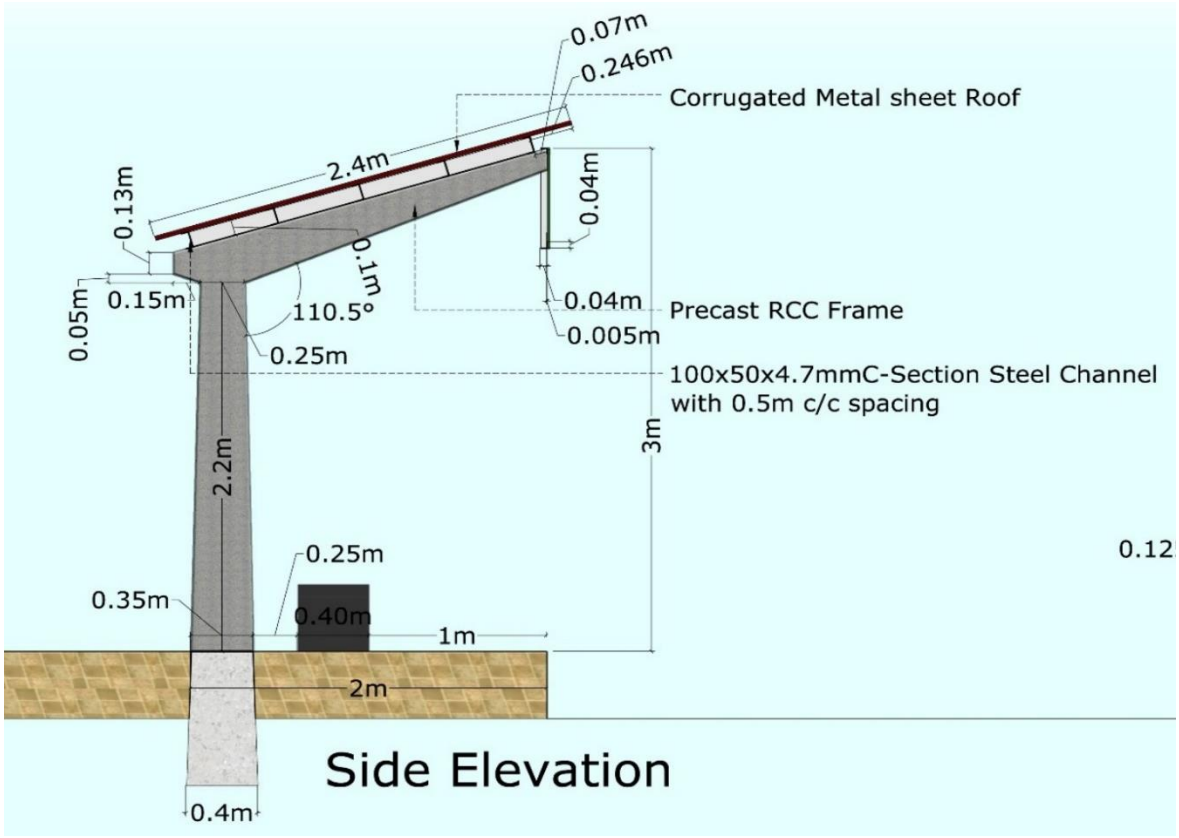


Figure 4: Sectional Detail – Bus Shelter

Table 1: Cost Breakup – Bus Shelter Design

Item	Area/Weight	Unit Cost	Unit	Total (Rs.)
Plinth and flooring	11.25	4000	Sqm	45,000
Precast concrete structure	0.4	25000	Cum	10,000
Bench	0.1	20000	Cum	2,000
Roof metal sheet	11.5	600	Sqm	6,900
L-Section - 40x40x5mm	0.280	6750	QTL	1,890
C-Section - 100x50x7.5	2.16	6750	QTL	14,580
Miscellaneous	1	20000	Each	20,000
TOTAL				**1,00,370**

3.1.2 B and C category bus terminal template designs

As a part of section 1 activities; two potential sites for development of terminal designs were selected. These were:

1. Jhalog – Site selected for C category bus terminal.
2. Nurpur – Site selected for B category bus terminal.

Site visit was conducted with HRTC official and design team for Jhalog (Figure 5), whereas the base drawing for Nurpur site was provided as secondary data.

Jhalog – Site for C category **During the site visit**

Figure 5: Site Visit Jhalog

A design brief was framed based on the standard requirements provided by HRTC specifically set up for B and C category terminals. These are listed below:

3.1.2.1 Requirements for C Category terminal

- 20 buses in a day
- One storey structure having tin shed.
- 1Toilet (2 units each for both ladies and gents)
- 1 Booking Counter
- 1Waiting area (open benches)
- 2 shops / dhaba (for tea coffee having size of 8x8 & 8x10)
- 2-3 buses will haul at night
- Haul time – 6 to 10 min
- 2 terminating bays
- 1 room for driver/conductor having attached toilet

3.1.2.2 Requirements for B Category terminal

- 5 bays
- Crew Restroom
- Booking Counter & terminal in charge (8'x8' room)
- 4 shops having 1 ATM (8'X8')
- 1Toilet (10 units each for both ladies and gents)

Based on the data collection, photographic documentation and discussions with the HRTC officials design recommendations were worked out for selected sites. As the authority, showed their interest in developing cost effective prototype designs, two design options

comprising of both B and C category requirements for each site were developed including costing implications. The designs are being elaborated in the below sections.

A. Jhalog

Jhalog is a brown field contoured site identified by HRTC for terminal development (Figure 6). It stretches over an area of 2189 Sq.mt. The site is approachable from three sides. HRTC identified this site for development of C category bus terminal however, the design interventions for both C and B categories have been developed for this site. Both the design options have been presented in the sections below

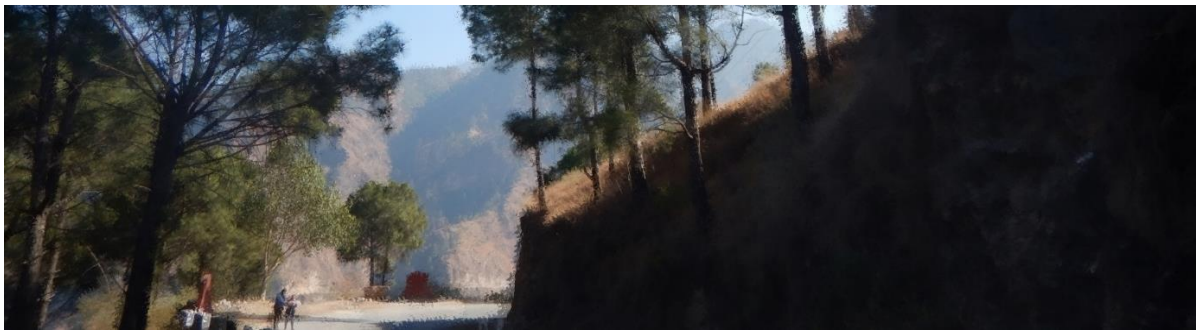


Figure 6: Jhalog – Selected Site for Bus Terminal

3.1.2.3 C Category Bus Terminal Development – Option 1

Based on given design brief (*Refer – Section 3.1.2.1*), typical Design of C- Category Terminal proposal is developed at Jhalog utilizing an area of only 645 Sq.mt (Figure 7) which is 30% of total site area. The design of the terminal is worked out using existing access road along the site stretching over less than 70m in length. The Terminal is designed such that no internal circulation space in a closed terminal building is required. The approximate estimated cost for the design proposal sums up to be 30 lakhs (plus minus 10%).The detailed cost break-up is presented in

Table 2.

The proposal is outlined considering the cost effectiveness as the remaining site need not be levelled. Site area released by such planning approach may be utilized to raise additional finances (PPP options may be explored). The design proposal, schematic views and costing details are presented below:

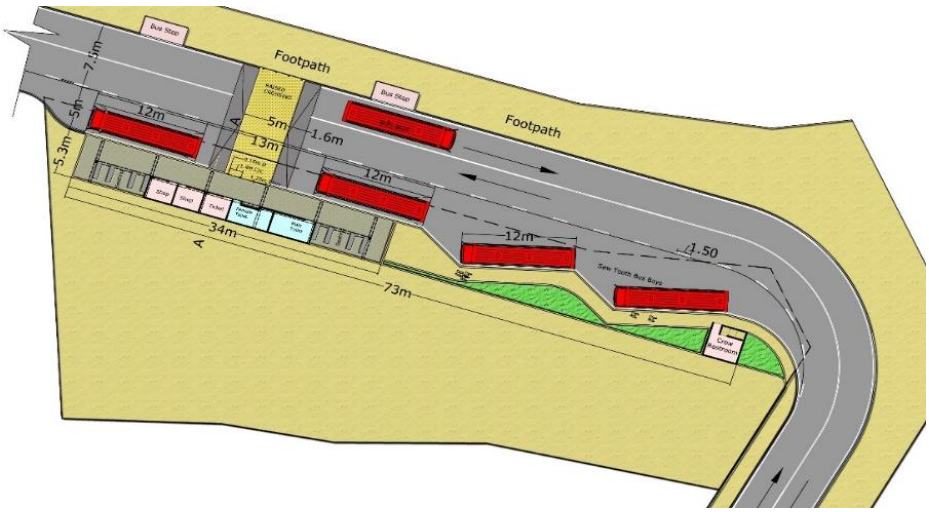


Figure 7: Design Proposal – Bus Terminal C category – Jhalog

Figure 8: Site Views – Bus Terminal C category – Jhalog

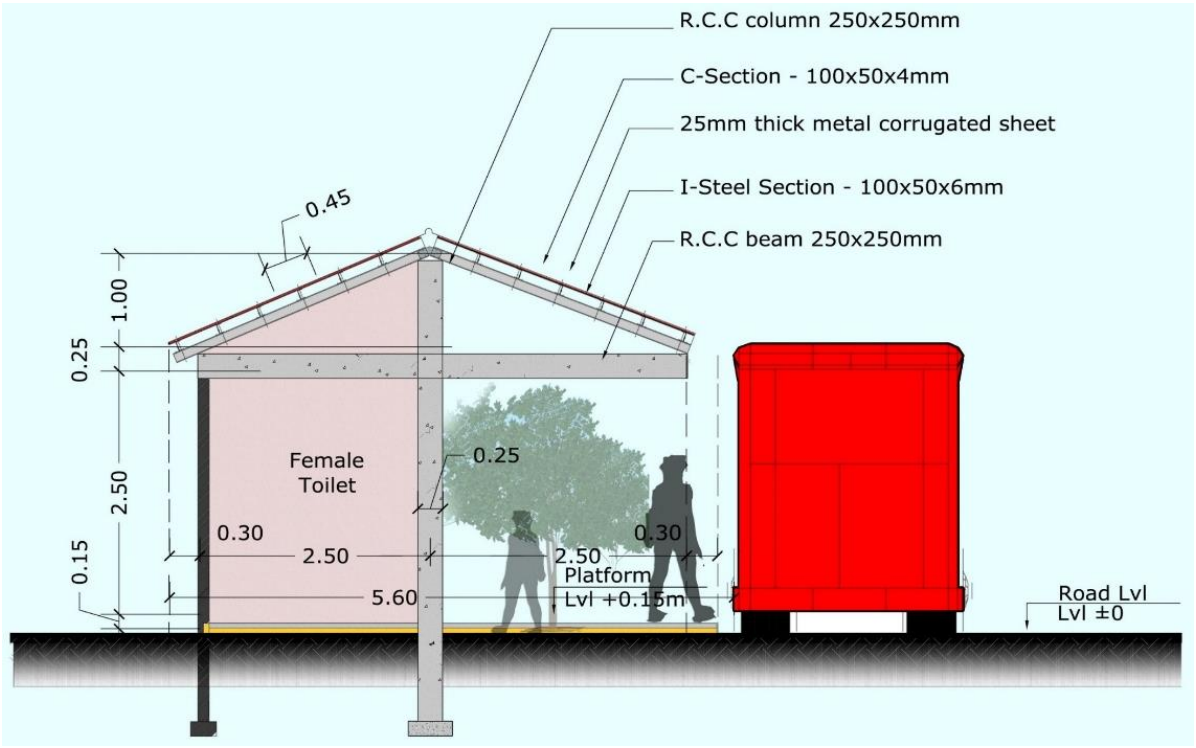


Figure 9: Terminal building Sectional Detail – Bus Terminal C category – Jhalog

Table 2: Cost Breakup – C category Bus terminal – Jhalog

Bus Terminal 'C 'category	Area/weight	Unit Cost	Unit	Total (Rs.)
Open Area	385	3000	Sqm	11,55,000
Landscape Area	64	409.5	Sqm	26,208
Plinth and flooring	196	4000	Sqm	7,84,000
Brickwork and finishes	61	8000	Sqm	4,88,000
Roof	204.68	600	Sqm	1,22,808
Bench	0.54	20000	Cum	10,800
Electrical	1	40000	each	40,000
Miscellaneous	2	80000	each	80,000
Structure	0.7728375	-	Cum	1,00,427
Cleat - 40x50x3mm	0.1	6750	QTL	675
C-Section - 100x50x4mm	29	6750	QTL	1,95,750
I-Section - 100x50x4mm	2.7	6750	QTL	18,225
TOTAL (excluding bus shelters)				**30,21,893**

3.1.2.4 B Category Bus Terminal Development – Option 2

Similarly, typical Design of B- Category Terminal is also developed at Jhalog (Figure 10). Planned with design brief for B category (*Refer – Section 3.1.2.2*) the requirements tend to be on higher side compared to C category requirements.

B category terminal is proposed covering an area of 1071 Sq.mt with site length of approximately 100m and width 10.3m. Existing access road is used for circulation whereas the internal circulation space is kept open. The proposed design is likely to release more than 2/3rd of current site such that remaining site need not be levelled or developed. It can be rather used to strengthen HRTC finances through PPP initiatives. The approximate estimated cost for the design proposal sums up to be 50 lakhs (plus minus 10%). The detailed cost break-up is presented in Table 3.The design proposal, schematic views and costing details are presented below:

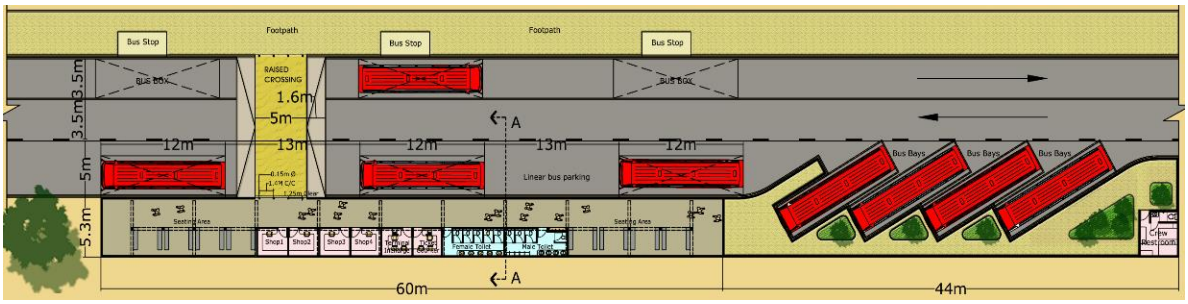


Figure 10: Design Proposal – Bus Terminal B category – Jhalog

Figure 11: Site View – Bus Terminal B category – Jhalog

Table 3: Cost Breakup – B category Bus terminal – Jhalog

Item	Area/weight	Unit Cost	Unit	Total (Rs.)
Open Area	680	3000	Sqm	20,40,000
Landscape Area	57	409.5	Sqm	23,342
Plinth and flooring	334	4000	Sqm	13,36,000

Brickwork and finishes	95	8000	Sqm	7,60,000
Roof	363.2895	600	Sqm	2,17,974
Bench	1.272	20000	Cum	25,440
Electrical	1	60000	each	60,000
Miscelaneous	1	120000	each	12,0000
Structure	1.0990875	-	Cum	1,38,332
Cleat - 40x50x3mm	0.1265	6750	QTL	854
C-Section - 100x50x4mm	47.14325	6750	QTL	3,18,217
I-Section - 100x50x4mm	4.52	6750	QTL	30,510
TOTAL (Excluding Bus shelters)				**50,70,668**

B. Nurpur

Alike Jhalog, terminal template design development exercise was conducted for Nurpur. HRTC identified this site for development of B category bus terminal. Due to inferred (travel) constraints, site visit to Nurpur could not be done. However, design proposal for both C and B categories were worked out based on the secondary data provided by HRTC. The secondary data included a site plan Figure 12, area and site dimensions along with the standard design brief.

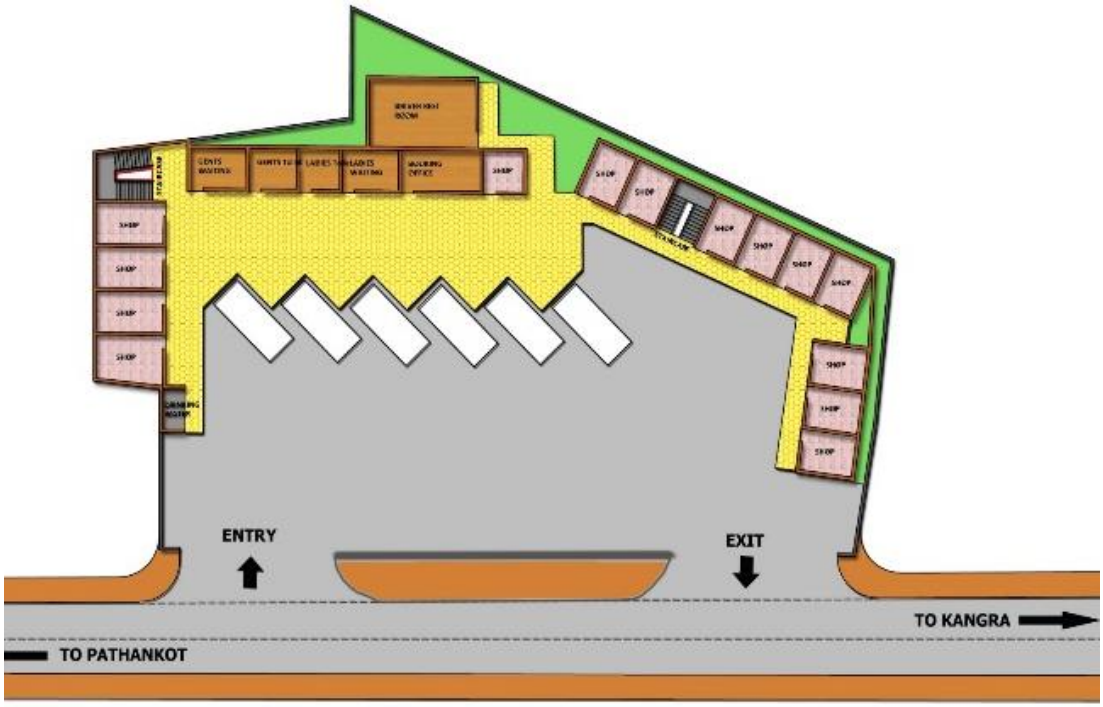


Figure 12: Nurpur Site Plan - HRTC

The site plan revealed, the area of the terminal site was 1179 Sq.mt. The site is located along National highway - 154 connecting Pathankot and Kangra. This served as the only approach to the site. Below sections explains the design proposal suggested for both C and B category terminals in Nurpur.

3.1.2.5 C Category Bus Terminal Development – Option 1

Following the design brief (*Refer-Section 3.1.2.1*), a C category terminal design was planned at Nurpur (Figure 13). The terminal is designed covering an area of approx. 1196 Sq.mt. This constituted 70% of the total site area including terminal facility and circulation. Besides being irregular in shape and having only single approach i.e. through NH 154, the site also had length constraint in the frontage. Thus, the length of site along the main road (NH-154) was planned as the passenger pickup area i.e. boarding bays along with the other requirements such as ticket counter, waiting concourse, shops etc. The rare side was designed as idle parking of the buses. All the facilities at the frontage were developed leaving the main road edge so that there is minimal maneuvering of the buses to the boarding bays and safe merging in the passing traffic while exiting. The approximate cost for this design proposal is estimated to be 50 lakhs (plus minus 10%). The detailed cost break-up is presented in Table 4.

Two additional bus shelters on the opposite direction were also included in the proposal for passenger moving reverse direction. To connect both the sides a raised crossing is being proposed for safe pedestrian crossing and traffic calming in front of the boarding areas. The cost of these additional features will get added to the total estimated cost. The remaining 30 % of site area left may be utilized to raise additional finances for HRTC. The proposed design, schematic views and costing details for Nurpur C category bus terminal are presented below:

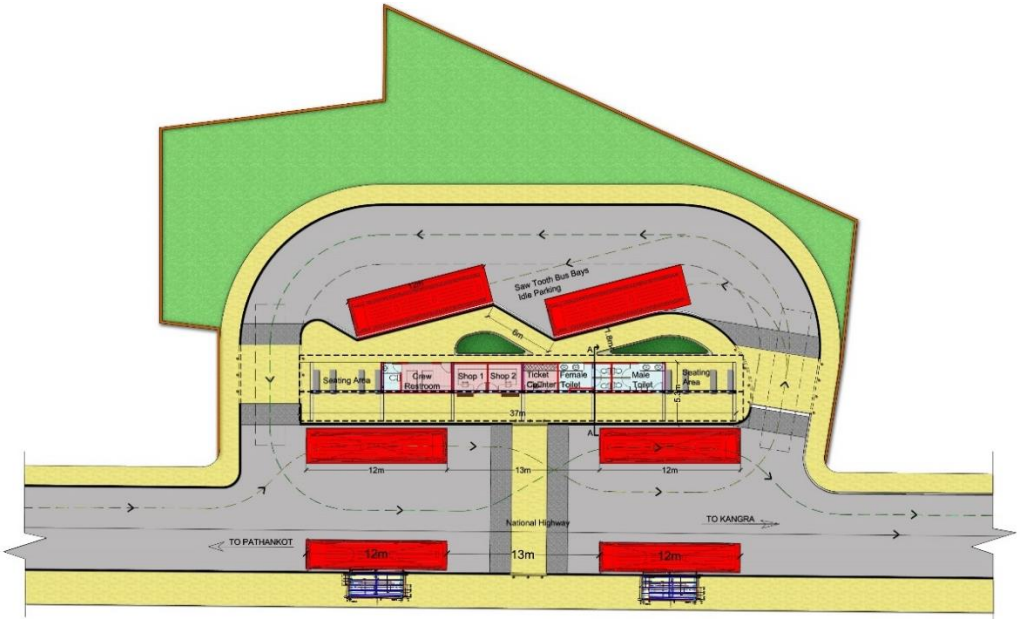


Figure 13: Design Proposal – Bus Terminal C category – Nurpur

Figure 14: Site View – Bus Terminal C category – Nurpur

Table 4: Cost Breakup – C category Bus terminal – Nurpur

Bus Terminal 'C 'category	Area/weight	Unit Cost	Unit	Total (Rs.)
Open Area	983	3000	Sqm	2,949,000
Landscape Area	16	409.5	Sqm	6,552
Plinth and flooring	197	4000	Sqm	788,000
Brickwork and finishes	64	8000	Sqm	509,280
Roof	241	600	Sqm	144,433
Bench	0.636	20000	Cum	12,720
Electrical	1	40000	each	40,000
Miscellaneous	1	80000	each	80,000
Structure	0.97	-	Cum	125,168
Cleat - 40x50x3mm	0.1	6750	QTL	652
C-Section - 100x50x4mm	36	6750	QTL	2,41,818
I-Section - 100x50x4mm	3.3	6750	QTL	22,491
SUB TOTAL				49,20,115
Total No. of Bus Stops	2	100,370	Each	2,00,740
Total				51,20,855

3.1.2.6 B Category Bus Terminal Development – Option 2

B category terminal was planned at same site. A proposal was developed with an area of approx. 1345 Sq.mt (Figure 15). This constituted 78% of the total site area including terminal design and circulation. The remaining 22 % of site area left may be utilized to raise additional finances for HRTC.

Except for the modifications needed as per B category design brief the concept and design principles were retained like C category proposal. The approximate cost for this design proposal was estimated to be 61 lakhs (plus minus 10%).The cost includes four additional bus shelters i.e. three on the opposite direction for passenger moving reverse direction and one bus shelter for buses picking up passengers while exiting out from the idle parking. The detailed cost breakup is presented in Table 5. The proposed design, schematic views and costing details for Nurpur B category bus terminal are presented below:

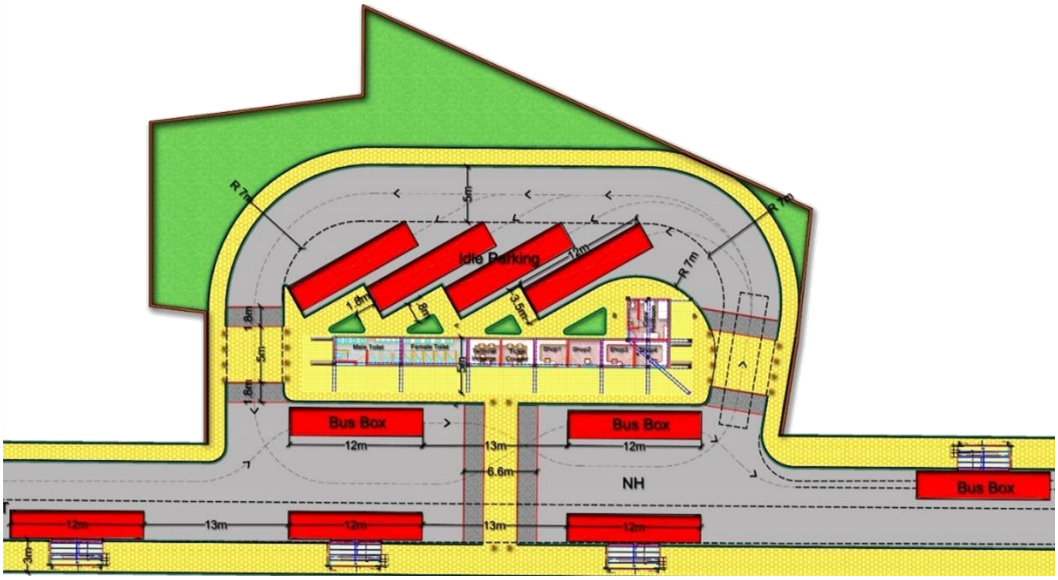


Figure 15: Design Proposal – Bus Terminal B category – Nurpur

Figure 16: Site View – Bus Terminal C category – Nurpur

Table 5: Cost Breakup – B category Bus terminal – Nurpur

Bus Terminal 'B' Category	Area/weight	Unit Cost	Unit	Total (Rs.)
Open Area	1136	3000	Sqm	34,08,000
Landscape Area	12	409.5	Sqm	4,914
Plinth and flooring	197	4000	Sqm	7,88,000
Brickwork and finishes	94	8000	Sqm	7,52,000
Roof	248	600	Sqm	1,49,007
Bench	0.3975	20000	Cum	7,950
Electrical	1	60000	each	60,000
Miscellaneous	1	1,20,000	each	1,20,000

Structure	1.22	-	Cum	1,33,355
Cleat - 40x50x3mm	0.1	6750	QTL	994
C-Section - 100x50x4mm	36	6750	QTL	2,41,520
I-Section - 100x50x4mm	4.4	6750	QTL	29,576
SUB TOTAL				56,95,315
Total number of Bus Stops	4	100,370	Each	401,480
TOTAL				60,96,795

To ensure that all passenger and user requirements are met as per best practice functional and spatial arrangement, the terminal proposal development undertaken is based on the newly available Bus Terminal Design Guidelines developed by ASRTU and Shakti Sustainable Energy Foundation.

3.1.2.7 Design intervention of Nurpur bus terminal site.

HRTC liked the planning process and appreciated the design options but it was suggested that the design team should firstly conduct a site visit and accordingly workout a design option because the HRTC design proposal was already under construction and been partly executed at the site. Therefore, HRTC wanted a hybrid design option considering no demolition of the structure which had already been erected at the site. HRTC also recommended to re-measure the site dimensions and scrutinize it with the dimensions provided in their proposal.

Following the inputs received from HRTC, Nurpur site visit was conducted on 16th Feb 2017. The Site visit was conducted by Mr. Satyajit Ganguly (Transport planner- SGArchitects) and Mr. Shaaambir Singh (Architect- SGArchitects) under the guidance of Mr.Dariyal R.M – Pathankot HRTC. Figure 17 presents the pictures of Noorpur Site.

Figure 17: Nurpur Bus Terminal Site

The site dimensions were re-measured and scrutinized on -site (as shown in Figure 18) and were found to be correct as provided on the HRTC design proposal.

Figure 18: Nurpur Bus Terminal Site – Re- measurement

Based on the recorded site observations and photo documentation, a new hybrid design option (Figure 19) was planned for Nurpur bus terminal site. This proposal was designed as a combination of the initial design proposal submitted and the HRTC design proposal. The design proposal retains the commercial area provided in the HRTC proposal (as it was already under construction). Bus circulation, provision of boarding and idle bays, terminal administrative building including public amenities, pedestrian infrastructure and linkages are retained according to the Initial proposal.

During the site visit, it was also observed that their existed an unavailability of space on the opposite side of the site due to presence of commercial land use. Therefore, instead of bus stops as proposed in the initial proposal, in the hybrid proposal only drop off bays are provided for buses heading towards Pathankot. Thus, passing buses need not enter the terminal area and shall only enter once at night for idle parking. Figure 19 presents the Hybrid option developed for Nurpur.

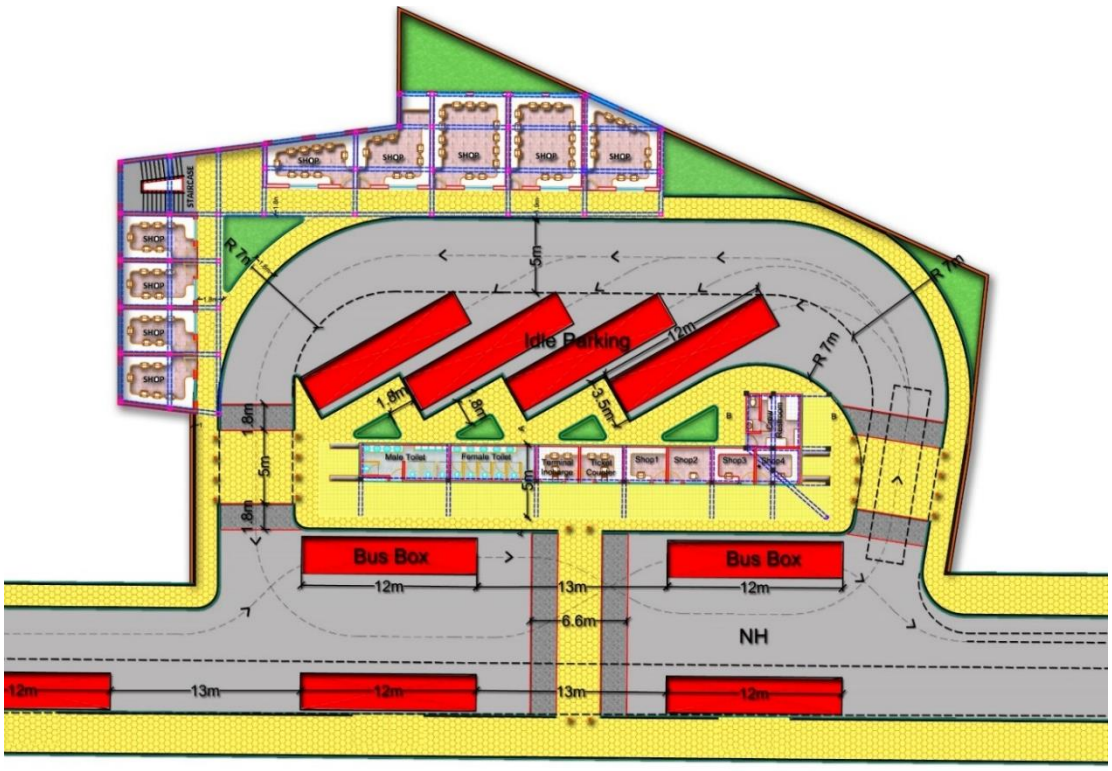


Figure 19: Nurpur Bus Terminal Hybrid Proposal

Although no alterations were made in the provisions of amenities. The proposal followed the original design brief requirement provided by HRTC. Thus, the proposal comprised of 4 Idle parking bays, 2 Boarding bays, Toilets (2 units each), 1 Driver restroom with toilet,1 Booking Counter, 1 Drinking Water point, 1 Terminal in-charge room and 13 Shops (commercial area as proposed in HRTC proposal).

The new hybrid design proposal intended:

1. Cost-effective design template with minimum utilization of available space
2. No internal circulation space in a closed terminal building is provided. Lay by bays has been provided to minimize the circulation.
3. Due to lack of space, opposite direction pickup/drop off, designated painted bus bay locations are provided on the either side
4. Terminal cost is reduced by using existing access road for circulation and painted pickup and drop of locations.
5. Advantageous on narrow streets where buses cannot enter/ exit terminals at sharp angles.

3.2 Evaluation of Existing bus terminals

Andhra Pradesh state transport corporation (APSRTC) showed their interest and desired to improve the passenger facilities at the major bus terminals of the state. In this context, APSRTC proposed to seek assistance for retrofitting of four bus terminals.

This task aimed at bus terminals evaluation based on current situation and demand followed by a study of ground situation, assessment of alternate solutions, leading to analysis and recommendations. Four bus terminals (mentioned in Table 6) were selected for the purpose. In this process, the generic steps followed for evaluating all the four terminals were:

1. Site visits for all the three selected terminal sites were conducted. Mr. Sandeep Gandhi – SGArchitects and Mr. Puskhar Dhawale did the site visits. The details of the site visit held are presented in the Table 6.

Table 6: Site visit Details - Andhra Pradesh

Date of site visit	Terminal	Place	Type
31st January 2017	Pandit Nehru bus station	Vijaywada – Andhra Pradesh	Interstate/Local
20 March 2017	NTR bus Station	Ghuntur – Andhra Pradesh	Interstate/Local
21 March 2017	Tirupathi Bus station	Tirupati - Andhra Pradesh	Interstate/Local/Rural
22 March 2017	Dwarka Bus terminal (DBS)	Vishakapatnam - Andhra Pradesh	Interstate/Local

2. Required secondary data for evaluation was collated from the STU. This included the terminal site plan with dimensions and drawings, daily and peak hour bus flow data, passenger flow and accumulation data, total area of the site including breakup like concourse area, parking area, bay area etc and the inventory of the existing amenities.
3. Issues were recorded through activity mapping for the entire terminal complex including streets leading up to it. This created a real-time activity plan of the terminal with informal activities shown on the site plan along with formal/fixed structures and boundaries.
4. Traffic flow data at the junction is collected using sample video recordings during peak hour. Data collected is mode and direction wise, to allow analysis of circulation pattern and directional load.

Analysis of the data collected and provided from APSRTC, observation of site conditions, activity mapping and traffic data was used to create a complete understanding of all issues at the terminals. Based on the detailed understanding of all issues and requirements desired by APSRTC, the assessment of the bus terminals was worked out. Two design options were recommended for each of the selected bus terminal. The terminal wise evaluation and its respective suggested proposals have been discussed in the following sections.

3.2.1 Evaluation of Pandit Nehru Bus Station, Vijayawada

Pandit Nehru bus terminal – Vijayawada was selected as the first case study for this evaluation exercise (Figure 21). The terminal is operated by APSRTC. It is a combined land parcel with a

total area of 22.2 Acres which accommodates an ISBT (18.64 Acres), City Bus Terminal (3.56 Acres) and APSRTC Bus Depot (5.66 Acres).

Figure 20: – Pandit Nehru bus terminal – Vijayawada

The necessary documents required for evaluation such as site plan, drawing of the terminal (Figure 21), traffic numbers and photo documentation were shared by APSRTC. The intention was to develop suggestions for improving terminal infrastructure, passenger amenities, vehicular and passenger circulation in the terminal, etc.

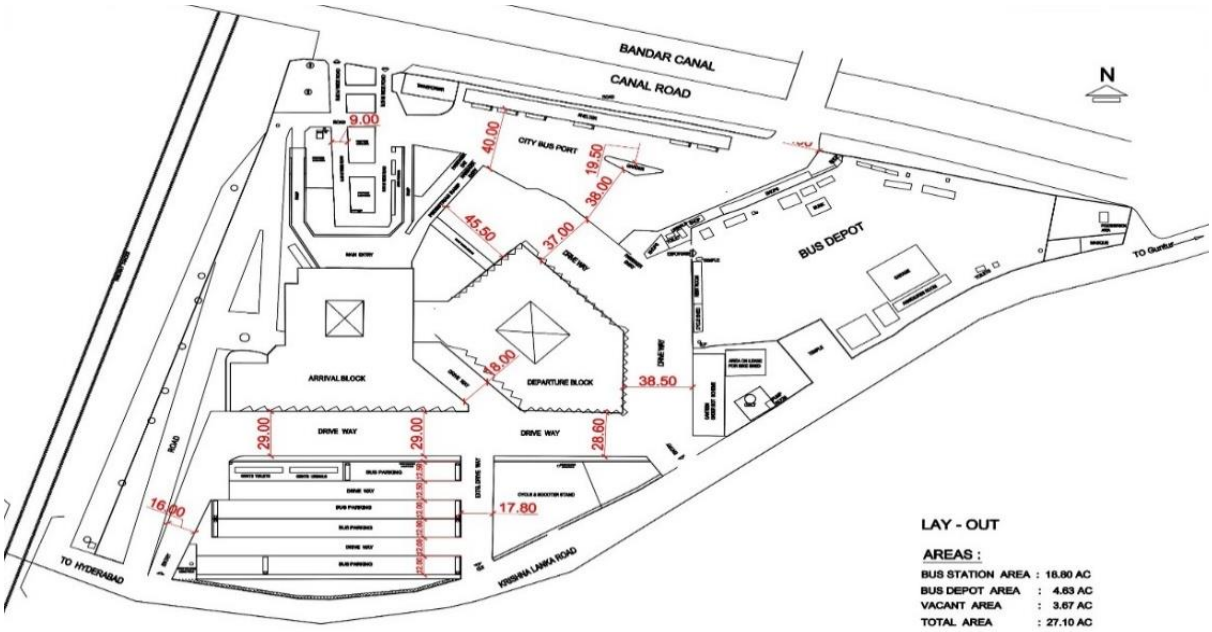


Figure 21: – Existing Plan (Pandit Nehru bus terminal – Vijayawada)

3.2.1.1 Key Observations

The observation made during the site visit of Pandit Nehru Bus terminal are listed below:

a. **Approach and Accessibility –** This station acts as the best road transport connector with each town and city in the state of Andhra Pradesh. The station is surrounded by

major roads on three sides. The Guntur – Hyderabad highway is adjacent to the terminal site. The terminal has to two entrances for the buses. The interstate buses access through whereas the local buses approach the terminal from Canal road. The arriving passengers approach the bus terminal mainly via local buses.

b. **Infrastructure and Geometry –** This station has 62 platforms with two terminals (local and ISBT). The bus station has a departure terminal with 48 platforms and arrival terminal with 14 platforms. Current bus bay width is 3.3-3.5m, with no passenger boarding lip
c. **Circulation (Bus and Vehicles)-** Presently, vehicular circulation and access to all functions is well planned.
d. **Passengers -** Terminal has all amenities required for passenger security and comfort. However, passenger wayfinding (signages) are missing.
e. **Parking Infrastructure-** Limited defined parking for terminal staff, commercial/office staff and passengers
f. **Feeder service -** Informal TSR boarding happens on the highway and not inside the terminal complex.
g. **Services -** Lighting levels (day time) can be increased to desired lux levels to enhance passenger comfort and security. Green concepts such as rain water harvesting and solar roof top are not yet included at the terminal. However, it does include a sewage treatment plant

3.2.1.2 Identified Issues

Issues identified during the site visit of Pandit Nehru Bus terminal are listed below:

1. Terminal access for pedestrians is not planned.
2. No defined pick-up and drop of bays exist (for private vehicles and IPT).
3. Desired roadway geometry for better space use and conflict management does not exist.
4. Access to local bus station is not clearly identified. It is more than 200m away.
5. Arrival block includes functions such as waiting area, recreational spaces, eateries etc. These relate more to waiting passengers which is related to departure function.
6. Departure block lacks adequate capacity to handle peak hour demand
7. Rear gate and baggage area are mostly accessible due to absence of boarding lip.
8. Grade separated pedestrian infrastructure is grossly underutilized.
9. Informal parking scattered in terminal area
10. Due absence of defined private vehicle drop-off/pick-up area, arriving passengers spread in different directions to access different modes
11. Feeder services are not integrated with bus terminal.

3.2.1.3 Actionable Recommendations

a. Current arrival concourse can be used as secondary departure concourse because:
b. It currently accommodates all amenities for departure concourse

c. The large area is not suitable for arrival as it impedes efficient dispersal of arriving passengers to feeder modes.
d. Departure function in any case requires additional bays, which are available at the current arrival block.
e. Arrival concourse requires less than 900 sqm (no waiting passenger function) – this can be developed next to local bus terminal along with feeder pick-up and drop off infrastructure, to maximize efficient dispersal and minimize passenger inconvenience and conflicts
f. Adding minimum of 17 more departure bays.
g. Re-design bus bays with 3.0m bay width and 1.8 to 2.0m wide passenger boarding area or lip. This shall also facilitate access to rear door and cargo bay in the bus.
h. Provide defined and streamlined pedestrian infrastructure along the desire lines
i. Provide well defined and conflict free pedestrian access from both edges to departure block. Where required at grade pedestrian crossings should be provided as raised cross-walk designs, to enhance safety and manage conflicts.
j. Roadways shall be developed with well- defined geometry and clear edges, to maximize space usage, and streamline vehicular movement.
k. Provide pvt. Vehicular parking to cater to parking demand from passenger, staff and commercial/office block/floors.
l. Add clear passenger wayfinding signs through the terminal and along the passenger circulation. The signs shall repeat information at each turn/bend for the same destination points (City Bus Terminal, TSR Bays, etc.)
m. Lighting systems may be added to enhance lighting (even during the day). Lighting designs may confirm to Lux levels prescribed in the guideline
n. Terminal energy costs and ecological footprint may be reduced by adding roof top solar panels and by including rain water harvesting systems.

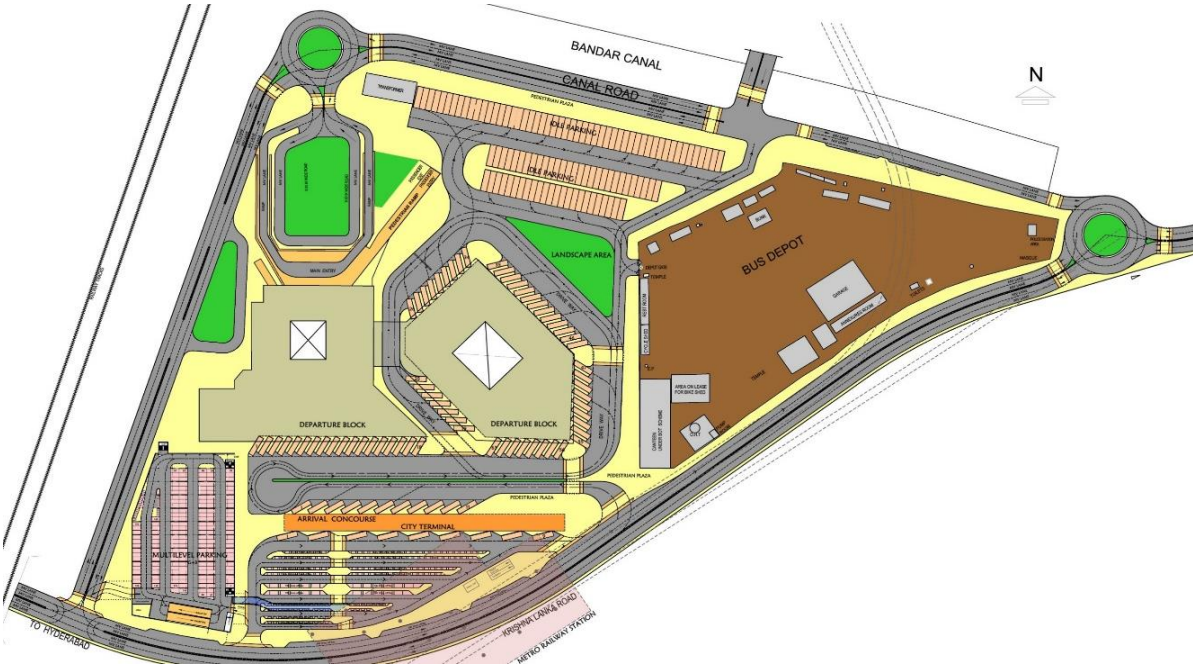
3.2.1.1 Design Proposals

Based on the observations and actionable recommendations, two design options involving limited redevelopment (mainly of circulation and parking/boarding areas) has been proposed. These are:

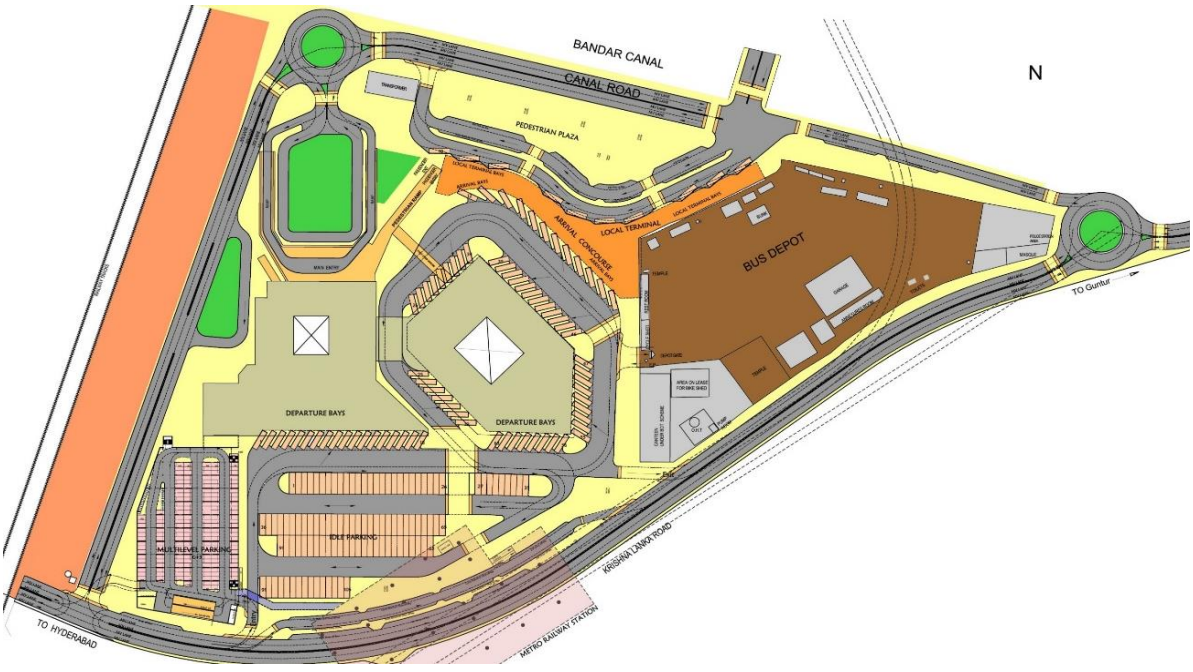
- **Option 1 –** Arrival concourse and private vehicle parking is added along with integrated feeder infrastructure, however exit for ISBT buses and location for Idle parking is shifted towards the canal road and local bus terminal and feeder infrastructure is brought where current Idle parking exists.

- **Option 2 –** Access to local bus terminal remains from the canal road and access to ISBT remains from the highway, however arrival concourse and private vehicle parking is added along with integrated feeder infrastructure.

The detailed design plans of Option 1 & 2 are shown in Figure 22



(Option – 1)



(Option – 2)

Figure 22: – Design Proposal (Pandit Nehru bus terminal – Vijayawada) – Option 1 (up) & Option 2(Down)

3.2.2 Evaluation of Dwarka Bus Station (DBS) – Vishakhapatnam

The Dwarka Bus Station (DBS), popularly known as RTC Complex is a bus terminal operated by Andhra Pradesh State Road Transport Corporation (APSRTC). It is one of the major bus stations in Andhra Pradesh. The terminal is located in the city of Visakhapatnam (Figure 23).

Figure 23: – Dwarka Bus Station (DBS- Vishakhapatnam)

The terminal operates both inter district and local bus services from the terminal. The total area of the bus station is 2.74 Hectare (6.77 Acres). 20% of site has been used for commercial development. Figure 24 presents the existing detailed site plan provided by APSRTC.

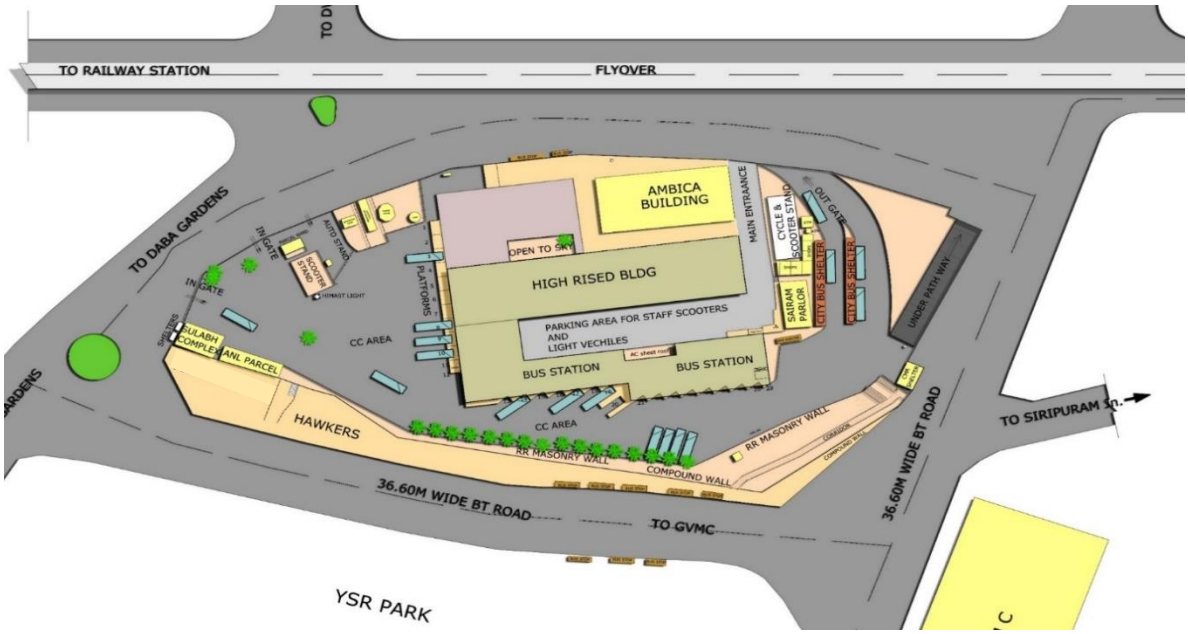


Figure 24: – Existing Plan (Dwarka Bus Station)

3.2.2.1 Key Observations

The observation made during the site visit of DBS are listed below:

1. **Approach and Accessibility -** Dwarka bus terminal site is surrounded by major roads on all four sides. The Telegu-Tali Flyover is adjacent to the terminal site. The site is

directly connected to Rama talkies road for exiting (Inter-district) buses in the direction towards NH- 16 through an underpass. Local terminal is located on the southern edge of the terminal while the rest of the terminal is devoted to inter- district operations.

2. **Infrastructure and Geometry –** DBS terminal infrastructure is presently inadequate. It lacks defined arrival bays and idle bays with poor bus way geometry. However, current number of boarding bays are sufficient for inter-district operations but local bus bays are grossly insufficient. Current bus bay width is 3.5-3.6m, with no passenger boarding lip.

   Rest the terminal infrastructure includes most of the functions, recommended for any terminal of this size. The terminal includes PIS systems, CCTV cameras, Crew restrooms, admin office, etc. However, passenger infrastructure and wayfinding (signages) were observed missing.
3. **Circulation (Bus and Vehicles) -** Internal bus circulation for both inter-district and local buses is one way i.e. entering from Seethammapetha Road and exiting from Waltair Station approach road. The terminal building segregates bus way from private vehicle movement.

   Private vehicle access to the terminal is from the side of Telugu Talli flyover. Due to 5.2m level difference between the site and Jail road and RTC complex road, the vehicular access to the site is limited to Waltair Station Approach Road and Seethammapetha Road.
4. **Bus Parking -** Inter-district buses currently dock at an angle which ranges between 30 and 90 degrees. Buses are observed to be parked at 90 degrees towards the north edge of the terminal.
5. **Passengers -** Passengers on foot, access the terminal from all directions except for Jail road. Pedestrians also access the terminal from a narrow opening between the compound wall and the commercial complex along the Telegu-Talli flyover – however this is not a very pleasant access.
6. **Feeder service -** Feeder infrastructure is not integrated with bus arrival area/concourse – Auto rickshaws crowd the Seethammapetha Road near the entrance. An autorickshaw parking exists near the north edge of the terminal building and caters to passengers getting off in the vacant space between the entrance and the terminal block.
7. **Parking Infrastructure-** Parking area requirement is not sufficient as per existing passenger demand. Parking facility for commercial functions developed at the site are absent and visitors to these functions (Ambika Building) park on the carriageway.
8. **Services -** Lighting levels (day time) can be increased to desired lux levels (as listed in the guideline) to enhance passenger comfort and security. Green concepts such as rain water harvesting and solar roof top are not included at the terminal. Fire- fighting systems have not yet been installed.

3.2.2.2 Identified Issues

The issues identified at DBS are listed below:

a. Current site area is insufficient to cater to current demand in any developmental scenario. It requires an addition of about 0.8 hectares.
b. Due to unavailability of defined bus-way and arrival bus bays, buses were observed to dropping passengers in the middle of a large open space between the entrance and the terminal building – leading to criss-crossing of bus way by arriving passengers.
c. Due to absence of defined idle bus bays buses were observed to be parked in the undesirable locations. This also led to a difficult manoeuvring of the buses.
d. Insufficient provisions of bus bays (local) caused many buses/routes to operate from outside the terminal creating confusion for boarding passengers impacting the operations and efficiency of the terminal.
e. Poor geometrical and design issues such as bus bays with no passenger boarding lip making rear gate and baggage area not accessible to the passengers while boarding.
f. Due to unavailability of pedestrian crossing facilities, passengers were observed crossing the bus way at unmarked and unplanned crossings at least 3 locations – leading to conflicts with bus traffic.
g. Parcel booking office located near the entrance was observed used by tempos and trucks for loading and unloading parcels over the bus way. Thus, improper placement of the passenger amenities and undefined busway collectively causing vehicular conflicts inside the terminal.

3.2.2.3 Actionable Recommendations

a. Off-loading bays need to be located on site and integrated with feeder/IPT bays to ensure quick and efficient dispersal of arriving passengers
b. The vacant space between terminal building and site entrance (on the northern side) may be utilised better by providing additional bays along with additional drop-off bays.
c. Bus circulation area and roadway geometry may be planned, to better utilize left over space as planned idle parking bays.
d. Passenger access should be provided from all directions along the desire line. Where required at grade raised pedestrian crossings should be provided.
e. Level difference at RTC complex road may be utilised by providing first floor level connection to passengers between the terminal building and local bus stops/stations on that road
f. Multilevel parking shall be provided to accommodate required parking demand – ideally located on the edge facing Telegu Talli Flyover
g. Lighting systems in station buildings may be upgrade to more efficient lighting, with sensors and actuated switches to provide the desired lighting levels by additional artificial lighting – augmenting day lighting where required.
h. Passenger way finding signs may be added.

i. Firefighting systems should be added to bus station building.
j. Green concepts may be incorporated by including roof top solar and rain water harvesting systems.
k. Staff canteen facilities and wi-fi may be added for the convenience of staff.

3.2.2.4 Design Proposals

Based on the observations and actionable recommendations, two design options involving limited redevelopment (mainly of circulation and parking/boarding areas) has been proposed. These are:

- **Option 1 –** Retained the existing building of Dwarka Bus complex. Segregated offloading bays and boarding bays (designed at 60-degree angle). Multilevel private vehicle parking is added along with integrated feeder infrastructure. Designated Pedestrian infrastructure is provided on all the possible entry locations. Local terminal is designed on the outer edge of site on upper side.

- **Option 2 –** Complete development of entire site excluding Ambica (commercial) Building area.

The detailed design plans of Option 1 & 2 are shown in Figure 25 & Figure 26 .

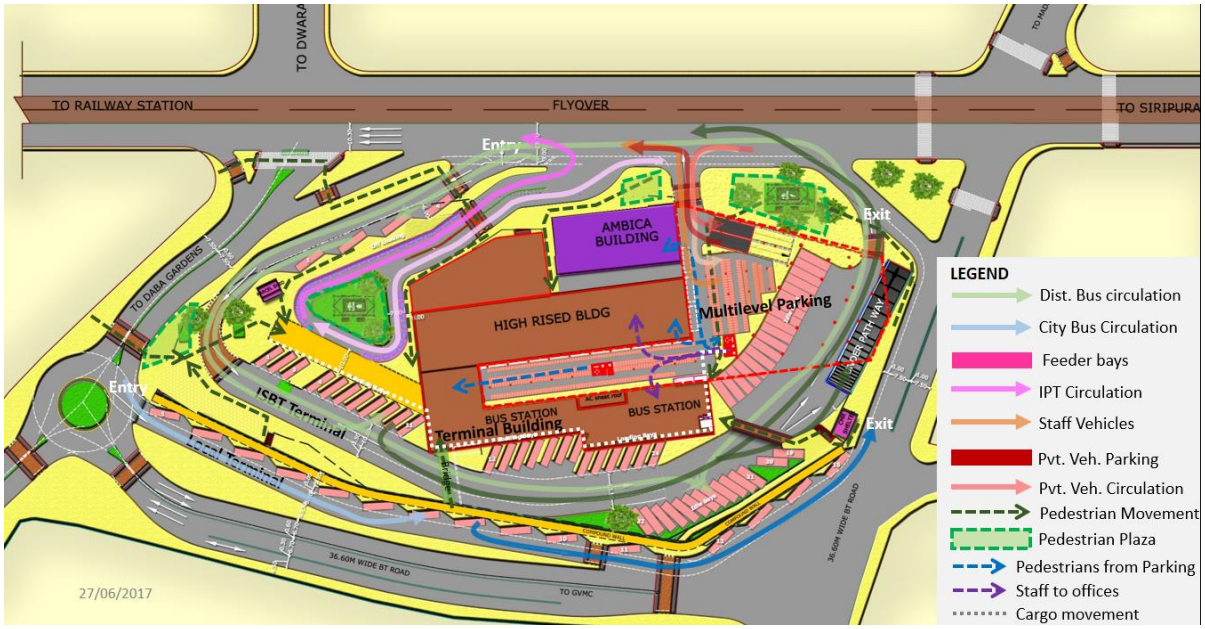


Figure 25: – Design Proposal of Dwarka Bus Station Option 1

Figure 26: – Design Proposal of Dwarka Bus Station Option 2

3.2.3 Evaluation of NTR Bus Station – Guntur

The NTR bus station at Guntur (Figure 27) is operated by Andhra Pradesh State Road Transport Corporation (APSRTC). The bus station serves both the local and district services in Andhra Pradesh as well buses from neighbouring states of Karnataka, Tamil Nadu and Telangana.

Figure 27: – NTR Bus station Guntur

The total area of the bus station is 3.79 Hectare (9.37 Acres). The size of inter district bus station is medium whereas the size of local bus station is small, both operating on fixed routes having layover time of 20 minutes and 10 minutes respectively. Figure 28 presents the existing detailed site plan provided by APSRTC.

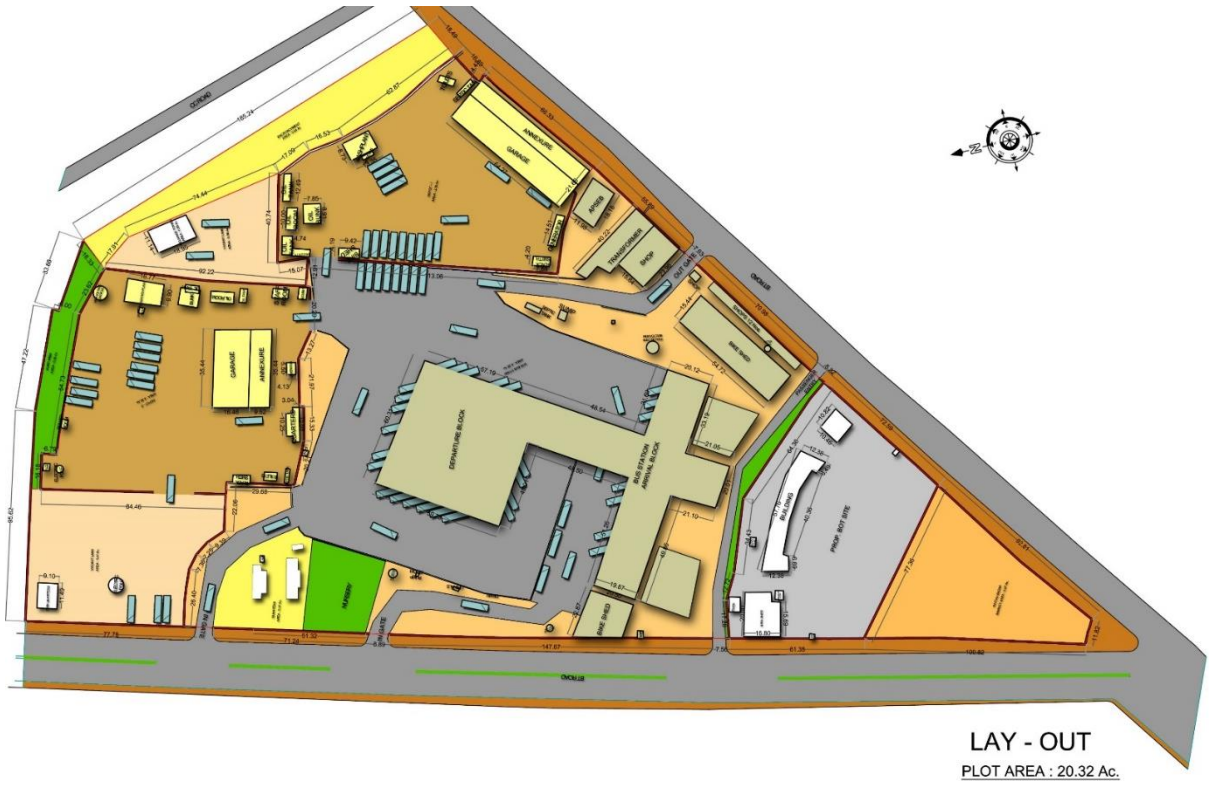


Figure 28: – Existing Plan (NTR Bus Station)

3.2.3.1 Key Observations

The observation made during the site visit of NTR bus station are listed below:

1. **Approach and Accessibility -** The terminal lies on the busy Grand Trunk Road and all bus traffic to the facility comes from and departs to this road. The terminal site is about 2.0 to 2.5m below the adjoining road level. The location of the depot is such that two different un usable land parcel are created totalling more than 2 acres in area.
2. **Infrastructure and Geometry –** NTR terminal site has four components i.e., two depots, a bus terminal and a site earmarked for commercial development. The bus terminal mainly caters to inter district and rural buses only. Local bus operations are very limited (14 departures per hour). The terminal serves a significant passing bus traffic. It is estimated that 2/3rd traffic consists of terminating buses while nearly 1/3rd are passing buses. Bus way geometry and idle parking bays are not defined. Apart from wayfinding signage, majority of required functions for both local and inter district operations exist.
3. **Circulation (Bus and Vehicles) -** Entry to the terminal is from GT road while buses exit on the Nandivelugu road, returning to roundabout from GT road from where they turn towards any direction on the highway. There exists an unsignalised crossing/median break on GT road allowing right turning buses to the terminal. This creates vehicular conflict at the entrance. However, vehicular circulation inside the terminal is streamlined and the one-way movement minimises bus to bus conflicts. The terminal is designed with two separate blocks for arrival and departure functions. These blocks

are connected with grade separated crossings (subway and overpass) cross the bus way.

4. **Bus Parking -** Current bus bay width is 3.5-3.6m, with no passenger boarding lip. This also means that rear gate and baggage area may not be accessible.
5. **Passengers -** Terminal generates significant crossing pedestrian traffic, however there exists no safe pedestrian crossing on the GT road. Passengers access and egress from the terminal to at least 3 different sides crossing the bus way in the absence of safe at-grade crossing infrastructure.
6. **Feeder service -** Feeder service infrastructure is not integrated with bus arrival area/concourse – a prepaid three-wheeler stand exists however informally parked rickshaws attract more passengers.
7. **Parking Infrastructure-** More than 600 two wheelers (250 ECS) are parked at the site at three locations.
8. **Services -** Lighting levels (day time) can be increased to desired lux levels (as listed in the guideline) to enhance passenger comfort and security. Green concepts such as rain water harvesting and solar roof top are not included in the terminal. Fire-fighting systems have not yet been installed.

3.2.3.2 Identified Issues

The issues identified at DBS are listed below:

a. The terminal building appears as an island in a large bus circulation area and generates a lot of unusable negative spaces.
b. Existing site area is sufficient to cater the required capacity however the current layout results in more than 1 hectare site area to remain unutilized.
c. Both depot gates are adjacent to each other and are accessed from the terminal bus way.
d. Current depot operations require buses to be fuelled by the service driver before he ends his day. This leads to stacking of buses in the bus way, disrupting operations between 9 to 10pm.
e. Passenger wayfinding (signages) are missing.
f. Because multiple passing buses, the average layover time for buses at the terminal is low at about 20 minutes.
g. Part of the arrival block is used as a parcel booking office. However, parcels are loaded from the back of the buses on the bus driveway creating conflicts.

3.2.3.3 Actionable Recommendations

a. To avoid right turning buses across GT road, entry and exit to the terminal may be reversed – allow entry from Nandivelugu road and exit from GT road – unsignalised vehicular crossing in front of terminal entry can be closed.
b. In the current form, the terminal building cannot accommodate more than 45 to 50 bus bays. To address additional demand – buses from routes with passing service only

may be catered to at transfer stops on the external edge – bringing down the peak hour flow of inter district buses through the terminal from 230 to 150.

c. Bays may be re-designed with boarding lip – to accommodate additional width the angle of docking may be changed from 45 to 60 degrees.
d. Bus way geometry may be re-designed to accommodate designed space for 20 to 25 idle parking bays outside depot 2.
e. To allow easy dispersal of passengers – off loading bays may be provided on the external edge, before entering the terminal – these may be integrated with IPT bays and local bus stops.
f. For passenger legibility, all departure functions may be shifted to existing departure building – expanding it along the GT road to add additional bays.
g. Existing arrival block may be used for parcel service and terminal offices.
h. For passenger convenience, comfort and safety, designed infrastructure for arrival and departure of passengers from both GT and Nandivelugu road should be planned.
i. Unused terminal land along the Nandivelugu road to be used as drop –off/ pick-up bays
j. Provide dedicated loading and unloading area for goods vehicles.
k. On the edge adjoining the GT road, old structures between the terminal and GT road may be removed and the space developed as feeder pick up/drop-off bays and multi-level car parking.
l. Provide defined and streamlined pedestrian infrastructure along the desire lines – connecting drop-off/pick-up bays on both GT and Nandivelugu road to the departure concourse through traffic calmed at grade crossings across the bus way.
m. Relocate the entry for depot 1 towards GT road in order to avoid vehicular conflict between terminal and depot buses at night.
n. Current vacant land between depot 1 and GT road may be developed as a holding space for buses as they wait to enter the depot 1.
o. Vacant land between Depot 1 and 2 may be developed as holding space for buses waiting to enter depot 2.
p. Commercial/real estate development may be proposed on the upper levels on vacant land adjacent to GT Road – this may be linked to floor levels to the multi-level car parking proposed along GT Road.
q. Mezzanine level cargo loading platforms (connected with corridor) connected with lift to cargo godown are recommended for efficient handling of cargo
r. Lighting systems in station buildings may be upgrade to more efficient lighting, with sensors and actuated switches to provide the desired lighting levels by additional artificial lighting – augmenting day lighting where required.
s. Passenger way finding signs may be added.
t. Firefighting systems should be added to bus station building along with CCTV cameras.

u. Green concepts may be incorporated by including roof top solar and rain water harvesting systems.
v. Staff canteen facilities and wi-fi may be added for the convenience of staff and passengers.

3.2.3.4 Design Proposals

Based on the observations and actionable recommendations, a design option involving limited redevelopment (mainly of circulation and parking/boarding areas) have been proposed.

In the design proposal, retained the existing building of Guntur Bus complex. The option designed is based on 150 inter-district terminating buses, 80 passing buses and 14 local buses during peak hour. Arrival concourse for 8 bays (divided at two locations i.e. 4 on each side) and Multilevel private vehicle parking is added along with integrated feeder infrastructure. Passenger entry planned from both roads - designated pedestrian infrastructure is provided on all the possible entry locations. The detailed design plan is shown in Figure 29.

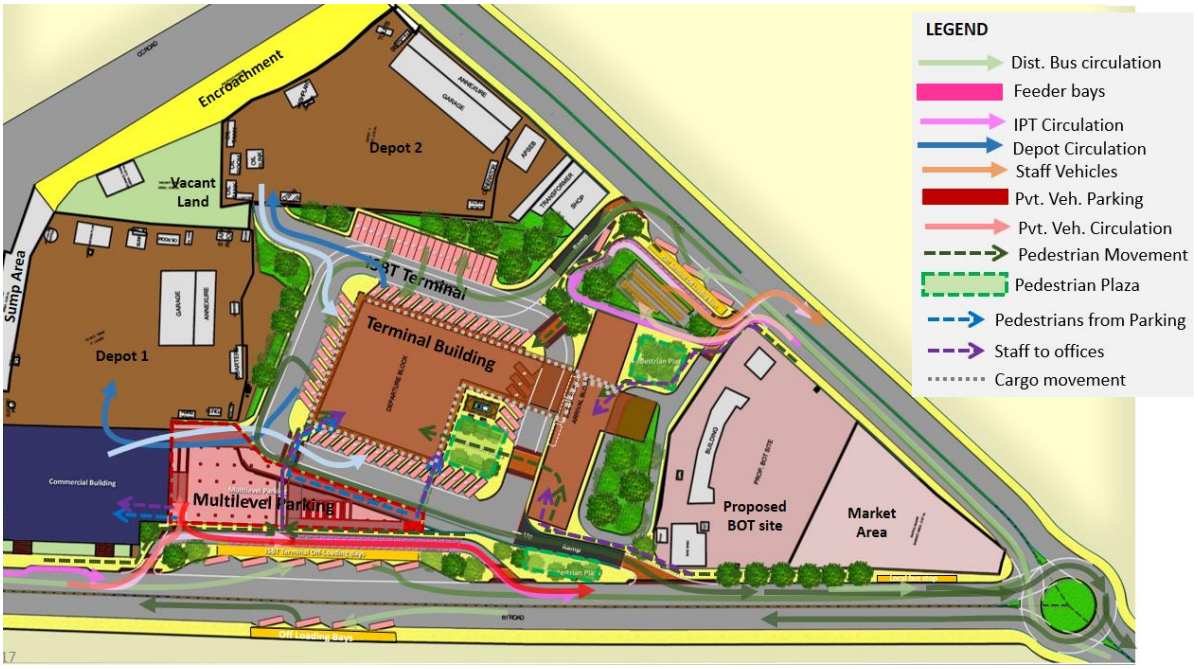


Figure 29: – Design Proposal of NTR Bus Station

3.2.4 Evaluation of Tirupati Bus Station

Tirupati bus station is in Tirupati city of Andhra Pradesh (Figure 30). It is owned by Andhra Pradesh State Road Transport Corporation (APSRTC). The Tirupati central bus station complex is operated from three separate buildings namely, Srihari bus station, for eastern services, Srinivasa bus station for west-bound destinations and the Yedukondala bus station for services to Tirumala.

Figure 30: – Tirupati Bus Station

Tirupati bus station complex is a combined land parcel with a total area of 5.35 Hectares (13.22 Acres) which accommodates bus station having an area of 4.38 Hectares or 10.82 Acres (including RM's office & Shopping Complex) and APSRTC bus depot having an area of 0.97 Hectares (2.4 Acres). The existing daily passenger flow in the complex is 1.20 lakhs (total).
The size of inter district bus station and local bus station is medium whereas the size of rural is small, all operating on fixed routes having layover time of 40 minutes each. Figure 31 presents the existing detailed site plan provided by APSRTC.

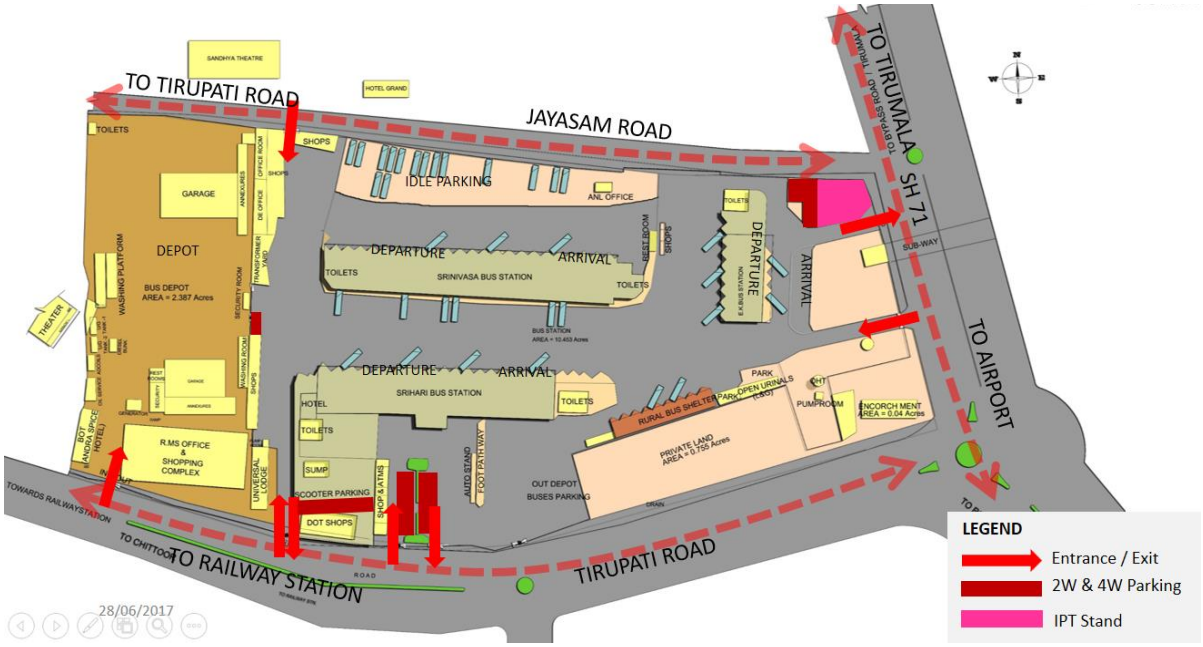


Figure 31: – Existing Plan (Tirupati Bus Station)

3.2.4.1 Key Observations

The observation made during the site visit of NTR bus station are listed below:

1. **Approach and Accessibility -** Tirupati bus terminal acts more like a transit hub than a traditional terminal catering to origin/destination traffic. It is accessed from three sides by pedestrians, while vehicular access/egress is limited to SH 71 and Tirupati Main Road.
2. **Infrastructure and Geometry -** Srihari bus station building is very old and requires major repairs. Majority of required functions for both rural and inter district operations exist. Terminal buildings have most of the amenities required for passenger and staff/crew security and comfort. Bus circulatory area and parking geometry is not clearly defined – terminal buildings appear as islands in a large bus circulation area.
3. **Circulation (Bus and Vehicles) -** Entry Bus circulation and access to all functions is well planned and minimal bus to bus conflicts observed.
4. **Bus Parking -** Current bus bay width is 3.7-3.8m at 45 deg. angle, with no passenger boarding lip. This also means that rear gate and baggage area may not be accessible.
5. **Passengers** – Transiting passengers need to walk between buildings crossing bus driveway through unsafe crossings at multiple locations – creating passenger to bus conflicts
6. **Feeder service -** Feeder service is provided in the station complex but it's not well integrated.
7. **Parking Infrastructure-** Formal/defined private vehicle parking area is not sufficient as per existing capacity – informal parking both by staff and passengers is observed throughout terminal.
8. **Services -** Lighting levels (day time) can be increased to desired lux levels (as listed in the guideline) to enhance passenger comfort and security. Green concepts such as rain water harvesting and solar roof top are not included in the terminal.

3.2.4.2 Identified Issues

The issues identified at Tirupati bus station are listed below:

a. No defined offloading bays – arriving passengers dropped near the entrance on SH 71
b. Tirumala bus terminal requires 19 additional bays to cater to peak hour traffic – Interstate bus terminal has 6 additional bays (over current demand)
c. Idle parking of buses is not defined in the terminal and during peak hours stacked bus parking is observed.
d. Lack of integration of IPT services with Pedestrian infrastructure
e. Passenger walkways, safe crossings and wayfinding (signages) are missing.
f. Some critical safety requirements such as fire detectors as well fighting equipment; CCTV cameras have not yet been integrated in the buildings
g. Waiting space for Tirumala pilgrims (with dining hall and toilets) is missing.
h. Staff canteen and wi-fi facilities are missing.

i. Overall - existing site area is not sufficient enough to cater the required capacity in real estate development scenario.

3.2.4.3 Actionable Recommendations

a. Srihari bus station building is old, while Tirumala bus station building is too small for its demand – these may be demolished, to create room for better planning of the terminal
b. Srinivasa bus station building may be extended and additional bays added on the south side (currently has dead wall) to create continuous passenger area – minimising conflicts for transiting passengers.
c. Alternately the space between Srinivasa bus station and Tirumala Bus Station can be built as terminal with additional bays on both sides.
d. Bus way geometry should may be clearly defined as separate from parking and boarding area and pull-off/pull-in ways.
e. Segregated boarding and off-loading bays may be provided to improve operational efficiency and passenger convenience.
f. 40 additional Idle parking bays and 6 additional boarding bays may be added to meet the current peak hour demand.
g. Partial or complete re-planning of depot space may also be taken up (along with terminal re-development) to carve out common parking space for buses.
h. Additional 3137 Sq. m. may be added to the current passenger concourse area – with a total area of 10,714 sq.m. – including both arrival and departure concourse.
i. Re-design bus bays with 3.0m bay width and 1.8 to 2.0m wide passenger boarding area or lip. This shall also facilitate access to rear door and cargo bay in the bus.
j. Provide well defined access for pedestrians from all three roads along with defined and streamlined pedestrian infrastructure along the desire lines.
k. Provide designated space for feeder and private vehicles i.e., pick-up bays near off-loading area and drop off bays near boarding area should be provided.
l. Cargo booking office and loading area should be located to allow conflict free access to trucks and to allow easy transfer of cargo between buses and booking office/godown.
m. Mezzanine level cargo loading platforms (connected with corridor) connected with lift to cargo godown are recommended for efficient handling of cargo.
n. Limited possibility of developing commercial real estate floor space at upper levels may be considered, along with ground level access either from Tirupati road or SH 71.
o. Multilevel parking shall be provided to accommodate required demand for staff, passengers and real estate development.
p. Lighting systems in station buildings may be upgrade to more efficient lighting, with sensors and actuated switches to provide the desired lighting levels by additional artificial lighting – augmenting day lighting where required.
q. Firefighting systems should be added to bus station building along with CCTV cameras.

r. Green concepts may be incorporated by including roof top solar and rain water harvesting systems.
s. Resting space along with some dining facilities and toilets may be provided near Tirumala boarding platforms – for the convenience of pilgrims.

3.2.4.4 Design Proposals

Based on the observations and actionable recommendations, two design options have been proposed. The detailed design plan is shown in
Figure 32 and Figure 33. These are:

- **Option 1** – Retained the existing building of Tirupati Bus complex (Srihari). Arrival concourse for 6 bays and Multilevel private vehicle parking is added along with integrated feeder infrastructure. Designated Pedestrian infrastructure is provided on all the possible entry locations.

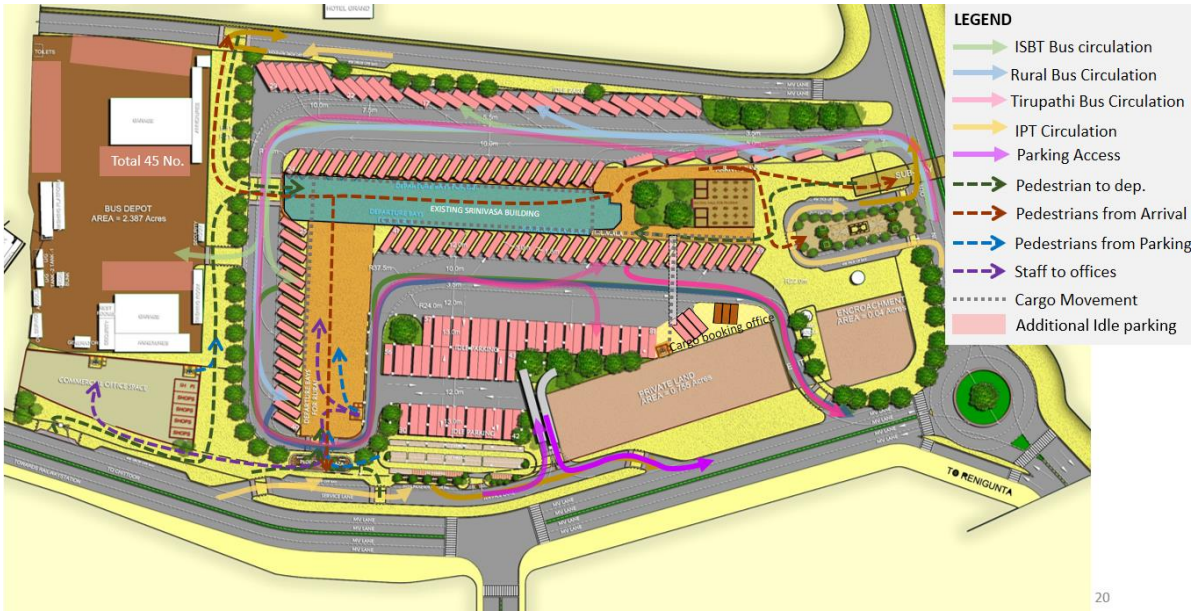


Figure 32: – Option 1 - Design Proposal of Tirupati Bus Station

- **Option 2** – Complete development of entire site including the depot area.

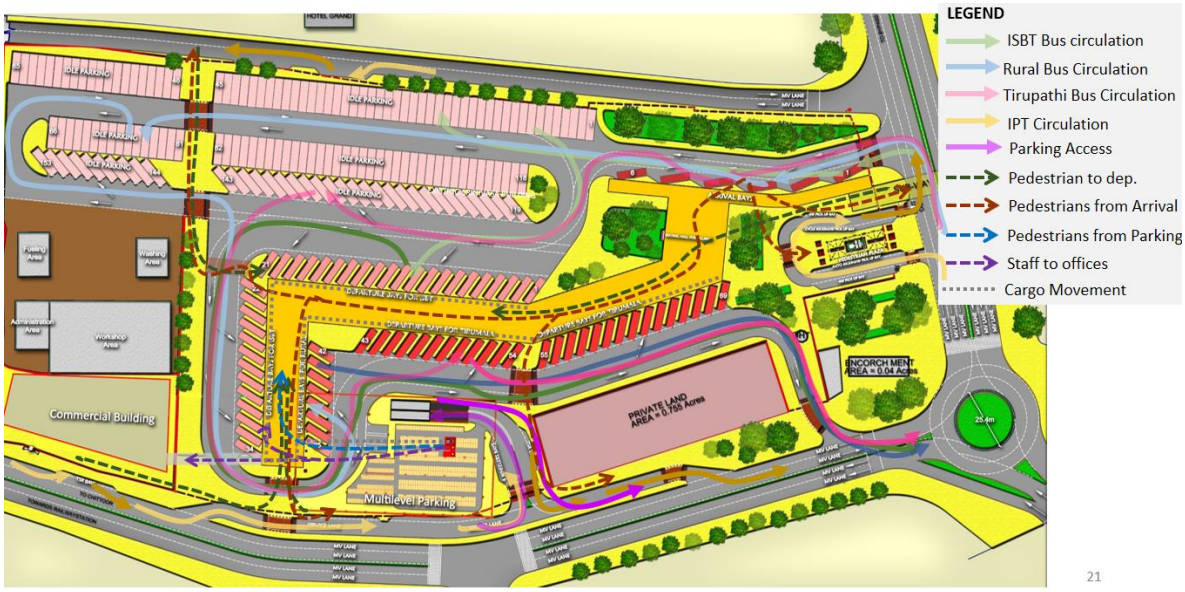


Figure 33: – Option 2 - Design Proposal of Tirupati Bus Station

3.3 Bus operation Support

The reliability of bus operations is largely dependent on the regular preventive maintenance strategy adopted by the serving depot. Thus, under bus operations support, the project intents to study and address limitations and shortcomings in bus operations through proposed interventions in depot operations and infrastructure. For the purpose, HRTC suggested Dhalli bus depot to be taken up for the design intervention.

3.3.1 Dhalli Bus Depot

Dhalli is an area situated 6 km's from Shimla city. It comes under Shimla municipal corporation limits and houses a bus depot distributed in two units – urban and rural which presently handles 82 buses and 182 buses respectively. Directed by HRTC, work was initiated for Dhalli bus depot. As part of plan of action, the following steps were taken in the chronological order. These are:

1. To develop a clear understanding of the present situation, depot functioning, infrastructure condition and bus operations a site visit was conducted at Dhalli bus depot. During this site visit, general observation, data collection and photographic documentation was carried out.
2. Based on the newly available bus depot guidelines developed by ASRTU and Shakti Sustainable Energy Foundation a depot requirement checklist was framed and the same was used to gather information from the depot officials.
3. Discussions with HRTC officials and depot managers regarding the specific requirements, infrastructure improvements and suggestions that can be incurred for depot development.

As per above mentioned tasks, a design brief for the depot was developed. The highlights of this design brief are as follows:

1. Based on the checklist provided to the depot officials, an inventory of requirements was framed. This inventory constituted following requirements:
2. Trainee room
3. Pollution & inspection room
4. Engine maintenance shop
5. Electrical shop
6. Gear shop
7. Tool room
8. Service room
9. Washing and Cleaning area
10. Junk yard
11. Store area
12. Change room
13. Supervisor room
14. Work manager room

1. A comparative infrastructure assessment list presented in Table 7, was prepared based on the depot design guidelines and real-time data collected. The list revealed the immediate short comings of the depot.

Table 7: Comparative assessment of the Depot Facilities

S.no	Components	Existing	Status
2	Internal Bus parking	Yes	Available but not organised
3	External parking	No	Not available
4	Fuelling	Yes	Available
5	Cleaning /washing	Yes	Non – functional
6	Workshop	Yes	Inadequate
7	Storage	Yes	Inadequate
8	Administrative facilty	Yes	Inadequate

2. No evident base map available for the site, therefore, the depot area was calculated with aid of google earth and assumed to be 10,166 sq.mt.

Based on the above findings, design brief and bus depot guidelines a design proposal for Dhalli bus depot was developed. It was observed at Dhalli bus depot had existing capacity for 40 bus parking at a time and the demand raised was for 180 buses. But as per Depot design guidelines, it needed 27140 Sq.mt site area for 180 buses whereas existing site area of bus depot was presumed to be 10,166 sq.mt (asper google earth). Thus, due to area constraint, the depot has been proposed for the parking of 49 buses but all other services have been designed considering catering capacity of 80 buses. The other planning considerations that were taken in design are as follows:

1. About 50% buses to be parked outside the depot.
2. All buses shall access the depot on alternate days.

3. Arrangements for night parking of buses not accessing the depot shall be made locally.
4. Dry cleaning, air filling and fuelling of these buses may be undertaken at night under arrangement with local fuel station.

The design proposal and schematic views worked out for Dhalli bus depot are presented below:

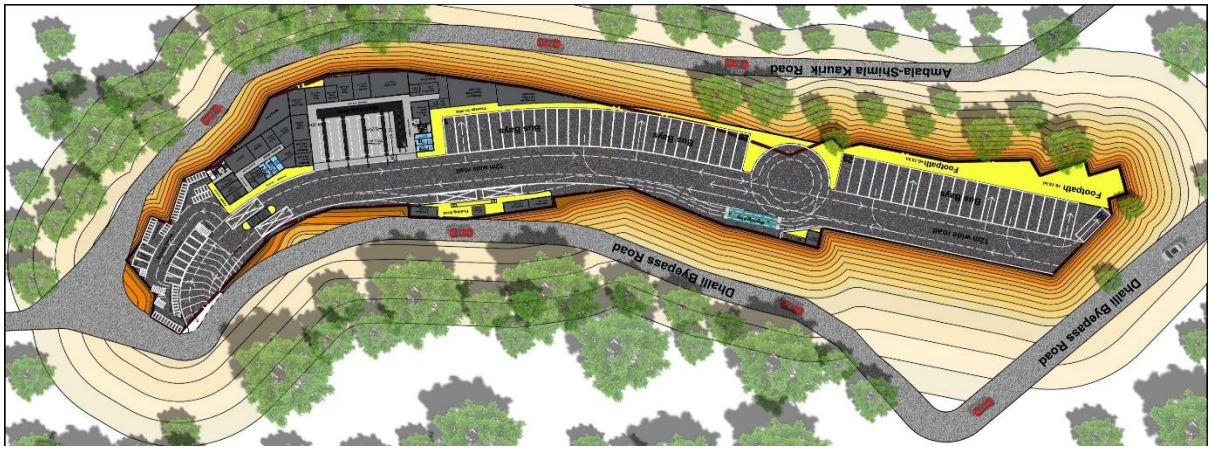


Figure 34: Design proposal Site Plan – Dhalli Bus Depot

Figure 35: Design proposal Site View – Dhalli Bus Depot

Entry / Exit

Workshop area

Administrative area

Bus parking Area

Washing area | Fuelling area

Figure 36: Other Depot Provisions – Dhalli Bus Depot

Figure 37: External parking – Dhalli Bus Depot

4 Bus Fleet Upgradation Planning

The third component of the project was to develop a Bus Fleet Upgradation Plan for the Himachal Pradesh state. The purpose of undertaking such exercise was to identify the gaps in fleet requirement to meet current and projected demand.

'Fleet Estimation tool' aims to assist STU's in forecasting demand in different scenarios and allow planning for financing and meeting the projected demand in these scenarios. It can be used to prepare a potential base for short medium and long- term strategy planning approach for the STU's.

The tool developed is spread sheet based model (Figure 38) and is expected to be used to propose current and projected (over next 10 years) fleet requirement for Himachal Pradesh.

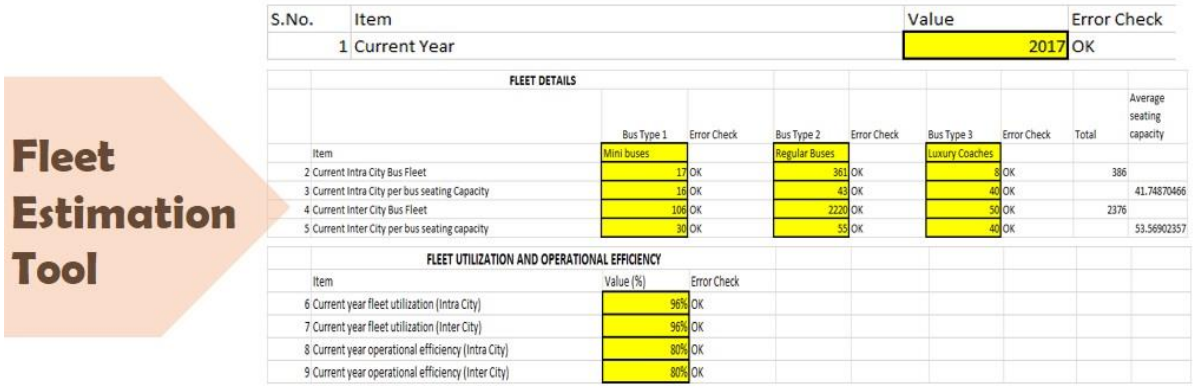


Figure 38: Fleet estimation Tool – Architecture

4.1.1 Methodology and basis of estimation

The tool estimates a total of 31 outputs (ranging from annual fleet requirement to annual budgetary requirements using 69 inputs and 115 default values. The user is required to insert the data in the dash board tab and can obtain the results under output tab. The default tab, includes a list of (editable by the user) default values or assumptions used in estimating the output values. These include target mode shares, annual rates of change, fleet and infrastructure development cost, etc. The tool uses a series of validated algorithms to input values and the default values to generate output for each successive year. Each year estimates form the input for successive year estimates, thereby generating annual output values for 33 successive years. Figure 39 presents a diagrammatic representation of the tool working and methodology

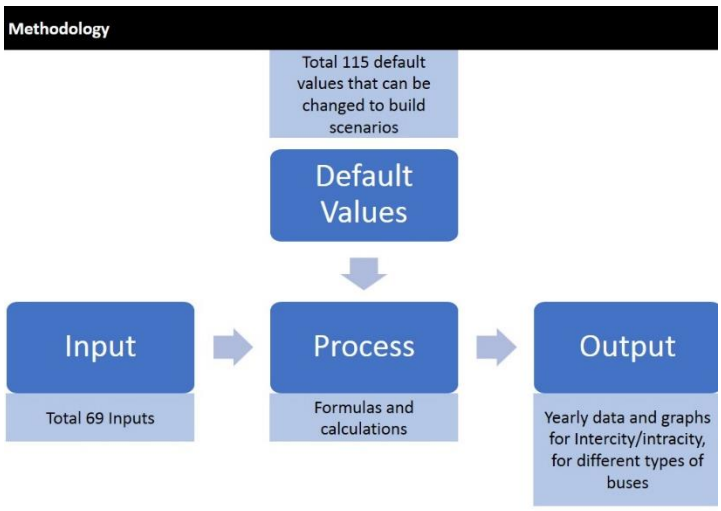


Figure 39: Fleet estimation Tool –Working and Methodology

The Fleet estimation tool generates the outputs based on the fleet size. This includes staff requirements, Infrastructure requirements, land and budget. The fleet size is estimated based on population (urban and rural) of the state, growth rate trend applied (urban rural and tourist) and the total trips (non- work, work and leisure) catered. presents basis of the fleet estimation and the components and data inputs involved in the process. Figure 40 presents the scientific formulation which forms the basis of fleet estimation.

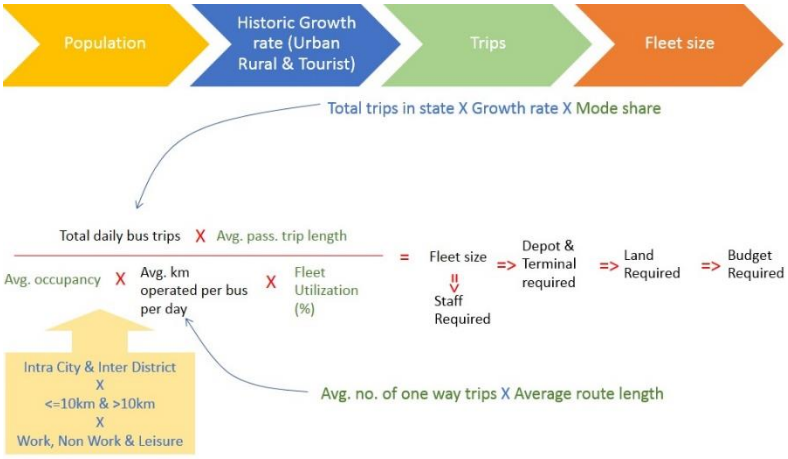


Figure 40: Fleet estimation Tool –Basis of estimation

4.1.2 Model Dissemination

The tool was presented along with projections (results generated by the tool) for Himachal Road Transport Corporation (HRTC) in a meeting held at the HRTC office in Shimla on 27th March 2017. In this meeting, the development of the tool and the scenario building were explained to the concerned HRTC officials by Mr. Satyajit Ganguly – SGArchitects and Ms. Kanica Gola - SGArchitects.

The list of the HRTC officials participated in the meeting is presented in Table 8 while Figure 41 presents the glimpse of the meeting.

Table 8: List of HRTC officials who attended the meeting on March 27, 2017

Name	Designation	Organization
Mr. Ashok Tiwari	Chief Executive Officer/Managing director	HRTC, Shimla
Mr. Pankaj Singhal	Civil Divisional Manager	HRTC, Shimla
Mr. Raghubeer Singh Chowdhury	Chief General Manager	HRTC, Shimla
Mr. Pavan Mahajan	Divisional Manager,Traffic	HRTC, Shimla

Figure 41: Images of meeting held on March 27, 2017

4.1.3 Tool Validation

The inputs received from HRTC during this meeting were used in improving the tool. HRTC suggested to validate and calibrate the model based on the HRTC's past trend and use the calibrated model for projections. For validation, the calibrated model was to replicate the HRTC performance indicators in terms of ticket sales, fleet size, utilization, etc. for the years 2007 to 2017. HRTC also provided historic data over the past 10 years. This data was used to validate the tool. For validation, the Calibrated model was used to project data from 2007 up to 2040 (33-year projection). This was compared with recorded data from 2007 up to 2017 as well data projected based on trend generated (using data from 2007 to 2017) for period between 2017 and 2040.

The outputs from the calibrated model when compared with recorded data – including projections based on recorded data, suggested that the model closely replicates the historic indicators including current estimates based on that data.

4.1.4 Scenario Building

The calibrated tool was used to undertake long range planning for HRTC. To achieve this fleet, budgetary, operational, staffing and infrastructural requirements were compared under three different scenarios. These were:

- **Business as usual scenario** – To develop this scenario, 10-year historic data from STU was collected and used to generate future trends (forecasting). This trend was used to derive default values such as target mode share and growth rates, etc. Additionally, insights from interactions with HRTC officials were applied to generate a guestimate of mode share in horizon year between different trip types. For example, it is expected that in the current scenario, private operators (and competing STU's) may continue to

gain share of trips on more profitable intercity routes, while HRTC (as a government operator) may need to increase its mode share on less attractive (to private operators) intra city routes. These set default values when used with Himachal and HRTC base data from 2016, generated output in a business as usual scenario.

The tool projections revealed that by 2050, in a business as usual scenario, HRTC fleet strength and mode share will increase by 4 times of the present fleet size but the vehicle utilization will continue to decrease up to 47%. This shall also result in an overall mode share increase of 50%. This is contributed mainly by expected increase in intra city mode share (along with increase in the share of intra city trips) which compensates the expected decline in the mode share of intercity trips.

- **Current Mode share scenario** - Under this scenario, model projected the fleet, budgetary, staffing, operational and infrastructural requirements for HRTC, based on a scenario where the current HRTC mode share remains constant up to 2050. Current mode share derived from HRTC and census data, was input as target mode share in the default values tab.

  It was observed that projections up to 2050 in scenario 2 generated similar results/requirements (for HRTC) as in scenario 1 i.e. business as usual scenario. The tool projections revealed that by 2050 HRTC fleet strength will need to be increased to four-fold of the present fleet size - with a reducing vehicle utilization (as per current trend), to maintain the current mode share (for each trip type).
- **Aggressive scenario** - This scenario assumes a policy support from the Government of Himachal Pradesh, in favour of sustainable transport. This is likely to result in overall increased mode share of both public and intermediate public transport (IPT). The scenario is based on a vision that HRTC shall expand operations and commit funds to attract most trips in the state. These trips are projected to be attracted both from other bus operators and other modes.

The target mode share inputs in the default value tab defining each of the mentioned scenarios is presented in Table 9.

Table 9: Targeted Default values used in all three Scenarios

Target Values (Defaults)	Business as usual	Current Mode Share	Aggressive
Achievable target mode share (Intra City Trips) - IPT for less than 10km trip length	6.00%	3.00%	15.00%
Achievable target mode share (Intra City Trips) - STU Bus for less than 10km trip length	18.00%	18.00%	35.00%
Achievable target mode share (Intra City Trips) - Other Bus for less than 10km trip length	5.00%	25.00%	15.00%
Achievable target mode share (Intra City Trips) - IPT for more than 10km trip length	4.82%	7.00%	15.00%
Achievable target mode share (Intra City Trips) - STU Bus for More than 10km trip length	12.00%	29.00%	50.00%

Achievable target mode share (Intra City Trips) - Other Bus for More than 10km trip length	54.86%	39.00%	25.00%
Achievable target mode share (Inter City Trips) - IPT for less than 10km trip length	4.88%	1.00%	10.00%
Achievable target mode share (Inter City Trips) - STU Bus for less than 10km trip length	10.00%	13.00%	30.00%
Achievable target mode share (Inter City Trips) - Other Bus for less than 10km trip length	8.10%	26.00%	20.00%
Achievable target mode share (Inter City Trips) - IPT for More than 10km trip length	5.24%	4.00%	5.00%
Achievable target mode share (Inter City Trips) - STU Bus for More than 10km trip length	9.00%	30.00%	75.00%
Achievable target mode share (Inter City Trips) - Other Bus for More than 10km trip length	83.46%	61.00%	18.00%
Targeted average Occupancy	57.07%	57.07%	57.07%
Targeted Fleet utilization	98%	98%	98%
Operational Efficiency	80%	80%	100%
Staff ratio	3.1%	3.1%	3.1

4.1.5 Comparative Analysis

A comparison of the projections between the three scenarios suggests that in the best-case scenario the current trend of fleet acquisition (even though increasing) should just about be able to keep pace with the growing demand and will help HRTC retain its market share. However, at between 19 to 22% (mode share of HRTC in Himachal) this market share is low, and needs to be expanded. The aggressive scenario generates the fleet acquisition demand for a scenario where HRTC market share (of total trips in Himachal) to close to 50% in 2050. This more than doubles market share in the business as usual scenario in 2050. To achieve this HRTC will need to improve the fleet utilization, fleet efficiency and operational efficiency. Even with these improvements the annual fleet acquisition and infrastructure development rate will need to be doubled, nearly doubling the annual budgetary requirement. Table 10 and Figure 42 to Figure 44 below presents a comparative view of the three scenarios.

Table 10: Targeted Default values used in all three Scenarios

Scenario Comparison 2050	Business as usual	Current Mode Share	Aggressive
Mode-share (Overall) - HRTC	21.14%	22.32%	47.41%
HRTC Trips per day in Lakhs	28.2	29.8	63.5
Fleet Strength	11405	12,415	24,678
Fleet utilization	98%	98%	99%
Efficiency	47.3%	47.3%	80.6%
Staff ratio	5.4	5.4	5.4
Average Occupancy (Intra and Inter)	57.07	57.07	74.5
Total Routes	6736	7184	14846

Total Buses to be Procured in year	1906	2024	3801
Total Buses to be Scrapped in year	1161	1210	2169
Number of terminals to be developed annually	190.00	205.00	446.00
Total Bus Terminal in year	12.00	14.00	29.00
Number of Depots to be developed annually	114.00	121.00	247.00
Total Bus Depot in year	8.00	8.00	17.00
Annual Land to be developed in Hectares	16.24	17.78	41.19
Annual Budget in Crores	641	684	1300
Annual Staff requirement	61967	65986	134085

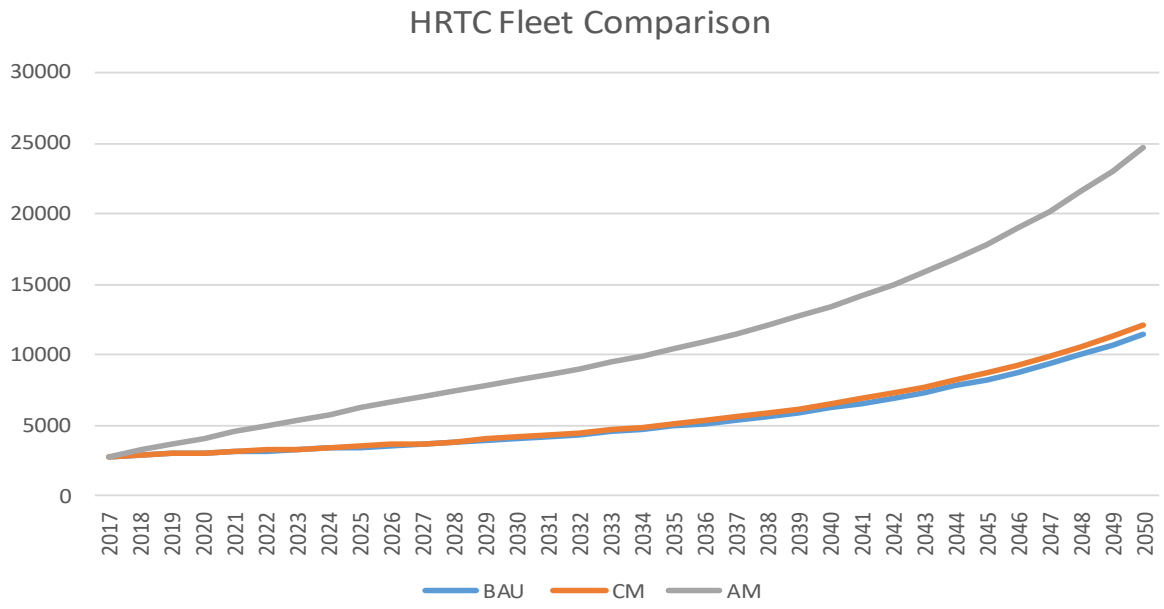


Figure 42: HRTC Fleet Graph for all three scenarios

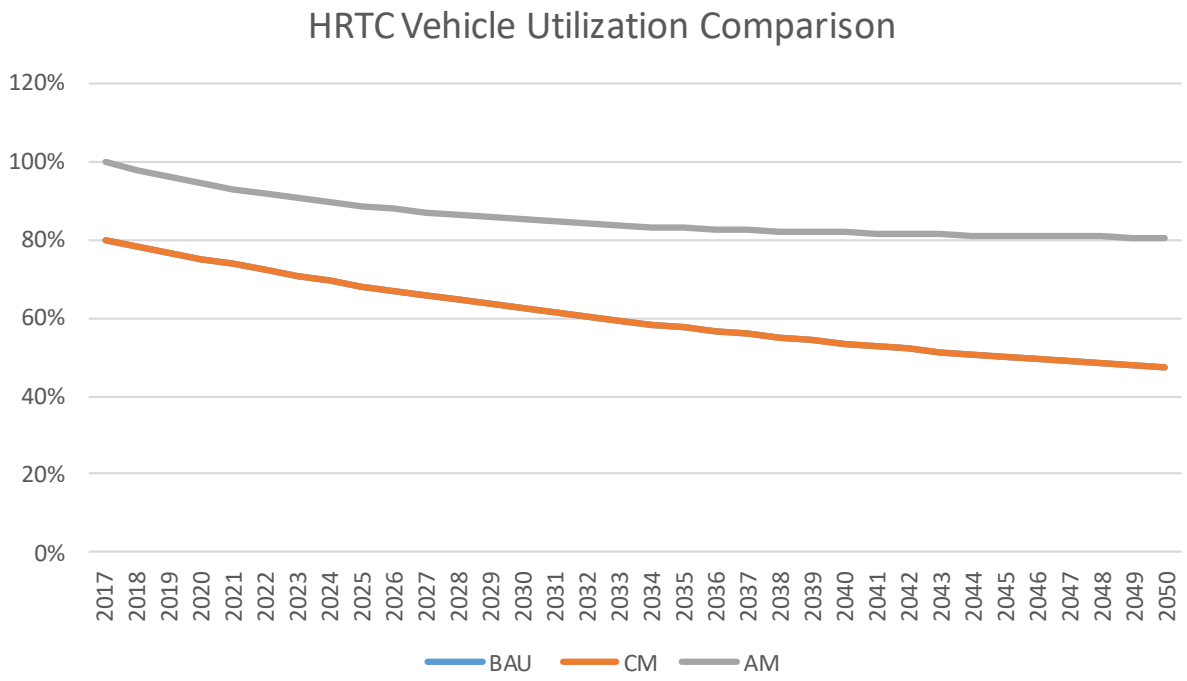


Figure 43: HRTC Fleet Graph for all three scenarios

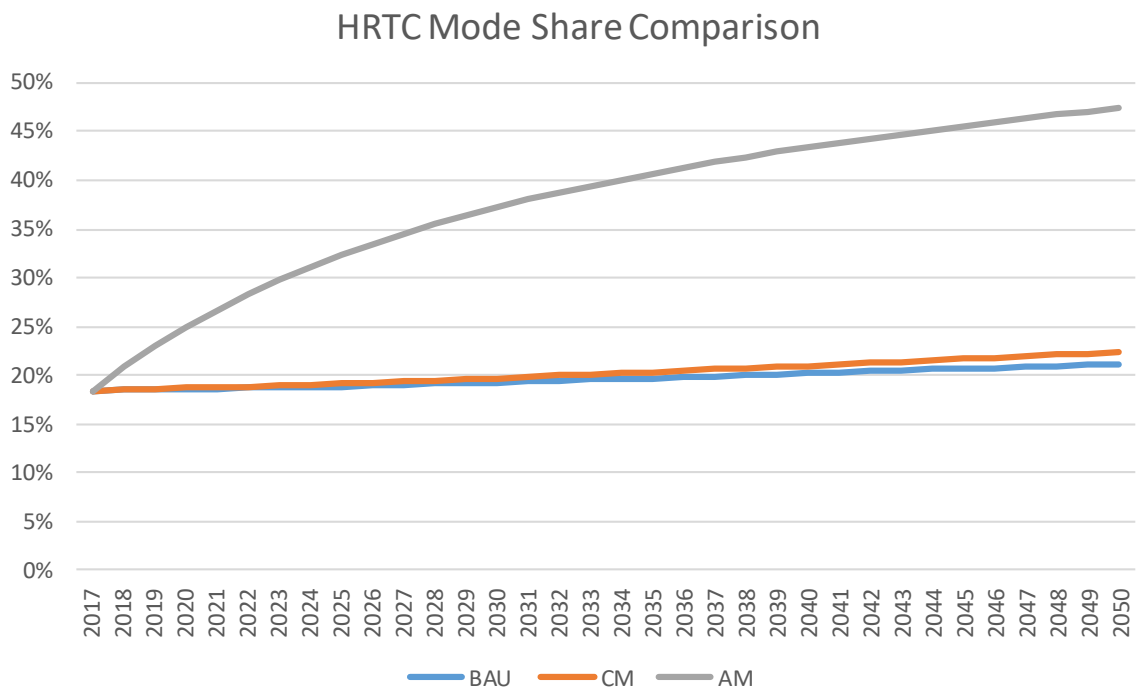


Figure 44: HRTC Fleet Graph for all three scenarios

All the above - discussed sections are elaborated and compiled in a separate report developed for fleet estimation tool. The report showcases step by step tool development and validation process along with findings of the validated for different HRTC service projection scenarios. The report has been submitted to Shakti sustainable energy foundation and HRTC.

5 Training and Capacity Development

All the above-mentioned works and design exercises, undertaken for the project were discussed through a series of discussion with the concerned HRTC and APSRTC officials belonging to civil and operations departments. The objective was to discuss and present the designs, plans and guidelines to contribute to the internal capacity building. For the purpose, three detailed training sessions were conducted. The list of these training sessions has been presented in Table 11.

Table 11: Training Session List

S.no	Venue	Date
1	HRTC office, Shimla, Himachal Pradesh	1st February 2017
2	APSRTC office, Vijayawada, Andhra Pradesh	31st January 2017
3	APSRTC office, Vijayawada, Andhra Pradesh	8th May 2017

The details of each training session have been discussed in the following sections.

5.1.1 Training session -1 at HRTC office Shimla

The training session was addressed by Mr. Sandeep Gandhi – SGArchitects. The design team, shared the process of design development followed so far. Additionally, the principles and design process was also detailed out during the training session. Figure 45 presents the glimpse of the training session held with HRTC officials.

Figure 45: During Training - for implementation of proposed terminal design -HRTC

The participants of the meeting are listed in the Table 12.

Table 12: List of Participants

Name	Designation	Organisation
Mr. Ashok Tiwari	Chief Executive Officer/Managing director	HRTC, Shimla
Mr. Pankaj Singhal	Civil Divisional Manager	HRTC, Shimla
Mr. Raghubeer Singh Chowdhury	Chief General Manager- Operations	HRTC, Shimla
Mr. Gurubachan	HRTC official	HRTC, Shimla
Mr. Rana	HRTC official	HRTC, Shimla

5.1.2 Training session -2 at APSRTC office Vijayawada

In the process of evaluating APSRTC bus terminals, a training session was undertaken at APSRTC office Vijayawada on 31st Jan 2017. This included power presentation on bus terminal designs for HRTC, terminal design approach and the bus terminal design guideline; by Mr. Sandeep Gandhi – SGArchitects. The presentation elaborated on the applicability of the bus terminal design and planning guidelines for planning and evaluating APSRTC bus terminals. The views shared were well accepted by APSRTC. The participants of the meeting are listed in the Table 13.

Table 13: List of Participants – APSRTC

Name	Designation	Organisation
Dr. Malakondaiah	Managing Director	APSRTC
Mr. D.S.N Raju	Executive Engineer – Vishakhapatnam	APSRTC
Mr. V.V Subramanya Sastry	Chief Civil Engineer	APSRTC
Mr. K.Varadaraju	Architect Planner	APSRTC
Mr.Narsimha Rao	Executive	APSRTC

5.1.3 Training session -3 at APSRTC office Vijayawada

On 8th May 2017 in Vijaywada - Mr. Sandeep Gandhi, Principal Architect - SGArchitects and Mr. Puskhar Dhawle, Urban and regional planner – SGArchitects; held a training-session regarding the assessment of the bus terminals. The training session comprised of presentations addressing assessment of the 3 selected bus terminals along with the recently developed fleet estimation tool. The presentation highlighted the two different design options, identified problems, issues and solutions that can be opted to improve the present condition of all the selected terminals. This training session was addressed to all the APSRTC's concerned officials mentioned in Table 13 and the engineers from other various related departments. Figure 46 presents the glimpse of the training session held with HRTC officials.

Figure 46: During Training – Assessment of terminal design – APSRTC

APSRTC also presented design evaluation of four different bus terminals (i.e. Raja Mohendravarnam bus terminal, Ongole bus station complex, Kurnool Bus station and Kadapa bus station) based bus station on the Bus terminal planning and design guidelines.

5.1.4 Capacity Development

SGArchitects supported in capacity building effort for the cities of Himachal Pradesh and Andhra Pradesh under this project. This included advising and supporting executives and engineers, participation in meetings, presentations and workshops. In the workshop's the support work undertaken by SGArchitects for improving bus transport operations and infrastructure was presented for the benefit of other officials from various other departments and levels present at the event. This included terminal design templates for HRTC and APSRTC, bus shelter design, bus depot planning and fleet upgradation planning tool. Context specific design analysis and development of selected sites terminal sites were undertaken in close co-ordination with the HPSCTBSMDA and APSRTC civil division respectively. SGArchitects has also been advising the in-house team to effect capacity building of local staff in implementing the tasks listed in the proposal.

6 Conclusions and Recommendations

This study has been helpful in generating critical insights in to the limitations of the STUs in gearing towards meeting the increasingly complex and varied user requirements. It can be concluded that though STUs in India vary in their size, market share and competence, they all would need to evolve in to the new and evolving requirements from a public bus system. The STUs had so far limited their role to availability as well operations of buses. They have neither developed capacity nor systems to monitor and ensure the quality of service. This was acceptable so far because the potential recipients of bus services were captive commuters, and there was a ready clientele for whom the provision of service was enough and the quality did not matter. However as public transport tries to become more self-sustainable, and fares grow higher than operating costs of two wheelers, the captive client base is shrinking (as they shift to other modes), at the same time the service quality is not up to the mark to capture the attention of other potential and choice commuters.

To adapt to this changing scenario, STUs need to evolve and adapt to address a new vision and changing commuter requirements. They now need to focus on quality of service, and not just provision of the same. This includes focusing on passenger friendly infrastructure - bus stations, etc., better quality and cleaner passenger experience in the bus - which requires upgraded and well-maintained fleet, and a more reliable service - which requires improved service and operational planning as well monitoring. This means that STUs need to evolve in to commuter specific planning role, which requires them to widen their scope and capacity from the current operations limited role.

To achieve this transition, the following steps are recommended:

1. STUs need to draft a vision statement. This should be the base for framing the scenario to achieve that vision.
2. STUs should undertake long range planning with annual goals, to achieve the targets in the developed scenario. This includes road map for fleet size expansion, fleet upgradation, infrastructure development, land acquisition for bus infrastructure, budgetary requirements cum planning, manpower requirements, etc.
3. STUs need to urgently invest in upgrading current passenger amenities and infrastructure to be competitive against other modes (especially private motorised modes).
4. STUs need to spend planning energy to improve the efficiency and quality of existing infrastructure in terms of capacity, space use, passenger as well crew amenities provided, etc.
5. Upgrading bus maintenance facilities so as they are planned to include functions and equipment in line with the best practice and fleet type specific service requirements. This requires attention on depot planning efforts.
6. STUs need to tap additional revenue sources. This includes tapping the land as a resource and re-developing depots and terminal to monetize available FSI.

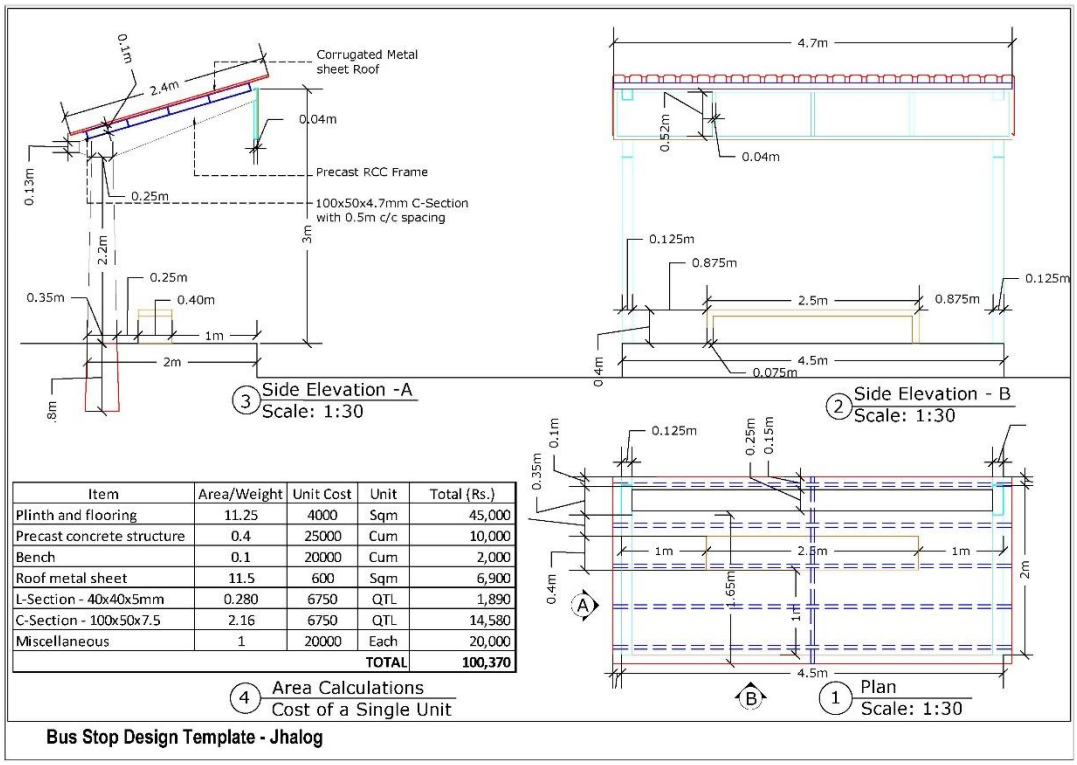
7. STU also need to explore financial efficient operations and maintenance strategies. This includes, KPI based depot MIS modules which allow monitoring of fleet maintenance in line with defined benchmarks. This in turn promises, lower maintenance and operational costs.
8. Additionally, STUs should explore innovative (in terms of being more cost effective and efficient) fleet maintenance approaches such as third-party depot operations and bus management contracts which allow sharing of depot space with other/private operators during off peak hours.

Resources developed and refined as an outcome of this exercise are expected to be helpful in assisting STUs to achieve the said transition. These resources include long range fleet and infrastructure planning tool, terminal design guidelines and depot design guidelines

7 Annexure

Following are the detailed drawings of all the interventions which were suggested to HRTC for bus stop design and design templates for improving the functionality of their bus terminals and depots.

1) Bus stop design template

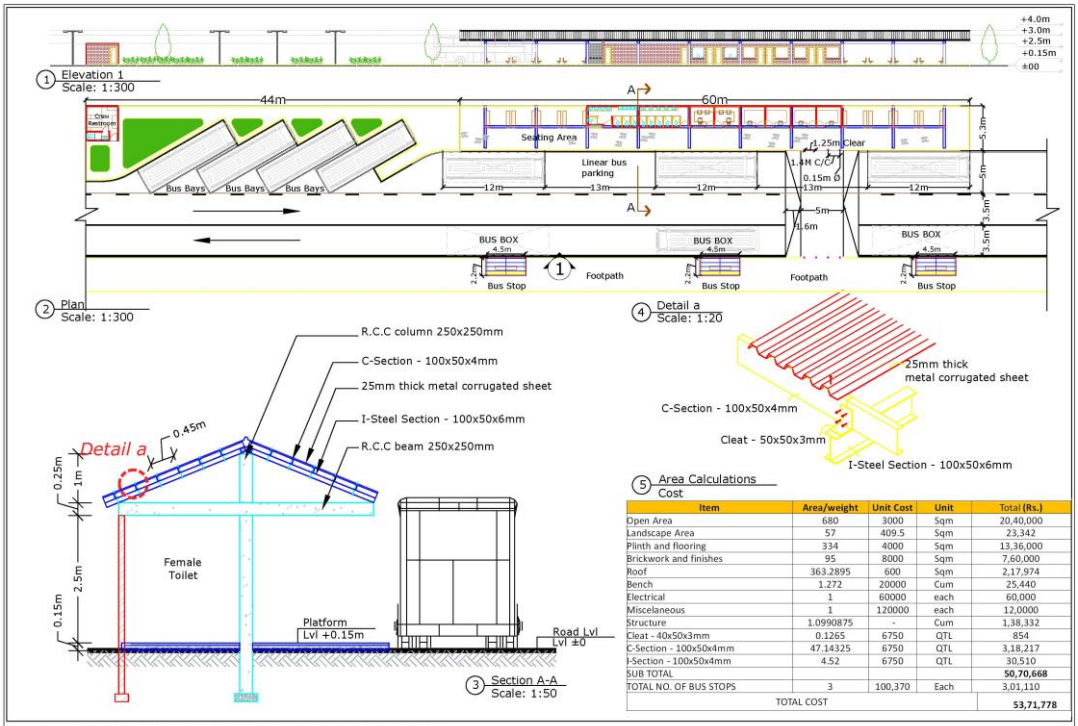


Item	Area/Weight	Unit Cost	Unit	Total (Rs.)
Plinth and flooring	11.25	4000	Sqm	45,000
Precast concrete structure	0.4	25000	Cum	10,000
Bench	0.1	20000	Cum	2,000
Roof metal sheet	11.5	600	Sqm	6,900
L-Section - 40x40x5mm	0.280	6750	QTL	1,890
C-Section - 100x50x7.5	2.16	6750	QTL	14,580
Miscellaneous	1	20000	Each	20,000
			TOTAL	100,370

Area Calculations
Cost of a Single Unit

Bus Stop Design Template - Jhalog

2) B-Category bus terminal design template

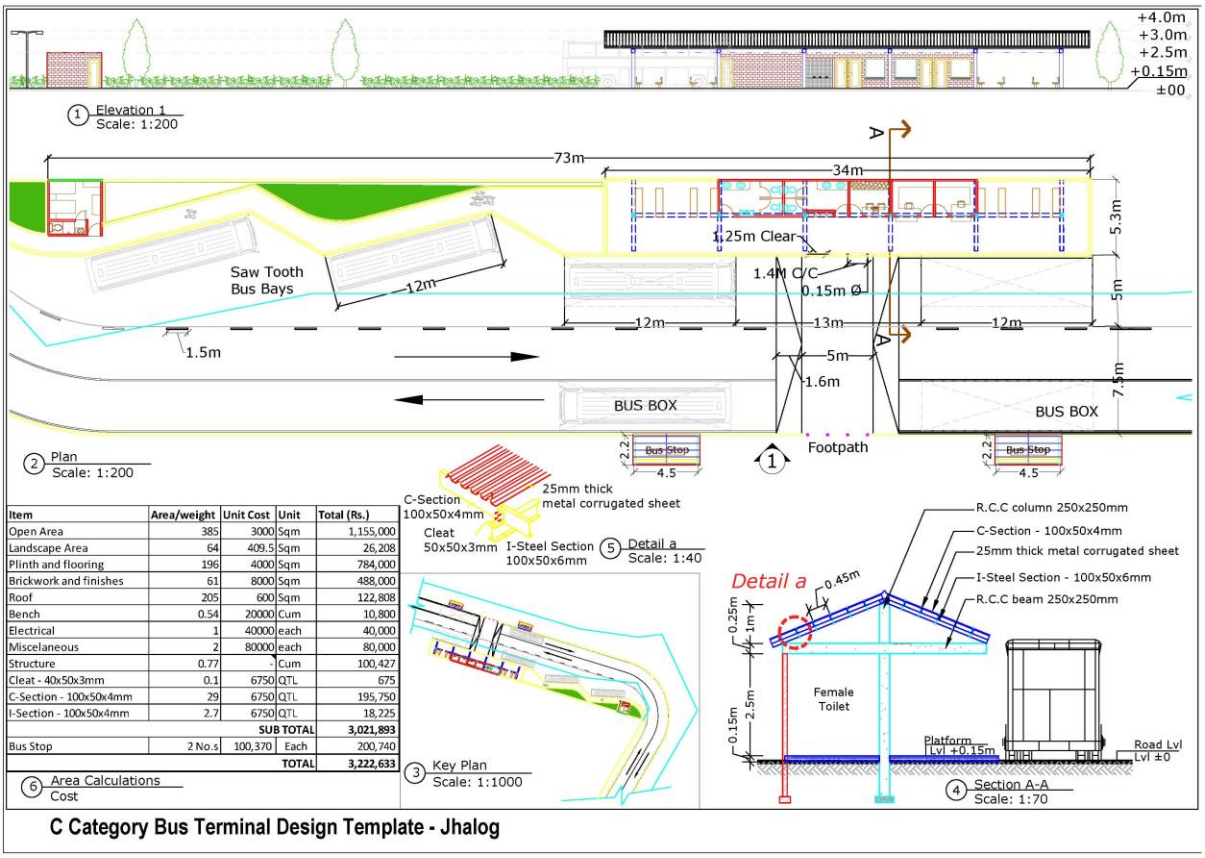


Area Calculations
Cost

Item	Area/weight	Unit Cost	Unit	Total (Rs.)
Open Area	680	3000	Sqm	20,40,000
Landscape Area	57	409.5	Sqm	23,342
Plinth and flooring	334	4000	Sqm	13,36,000
Brickwork and finishes	95	8000	Sqm	7,60,000
Roof	363.2895	600	Sqm	2,17,974
Bench	1.272	20000	Cum	25,440
Electrical	1	60000	each	60,000
Miscelaneous	1	120000	each	12,0000
Structure	1.0990875	-	Cum	1,38,332
Cleat - 40x50x3mm	0.1265	6750	QTL	854
C-Section - 100x50x4mm	47.14325	6750	QTL	3,18,217
I-Section - 100x50x4mm	4.52	6750	QTL	30,510
SUB TOTAL				50,70,668
TOTAL NO. OF BUS STOPS	3	100,370	Each	3,01,110
TOTAL COST				53,71,778

B Category Bus Terminal Design Template - Jhalog

3) C-Category bus terminal design template

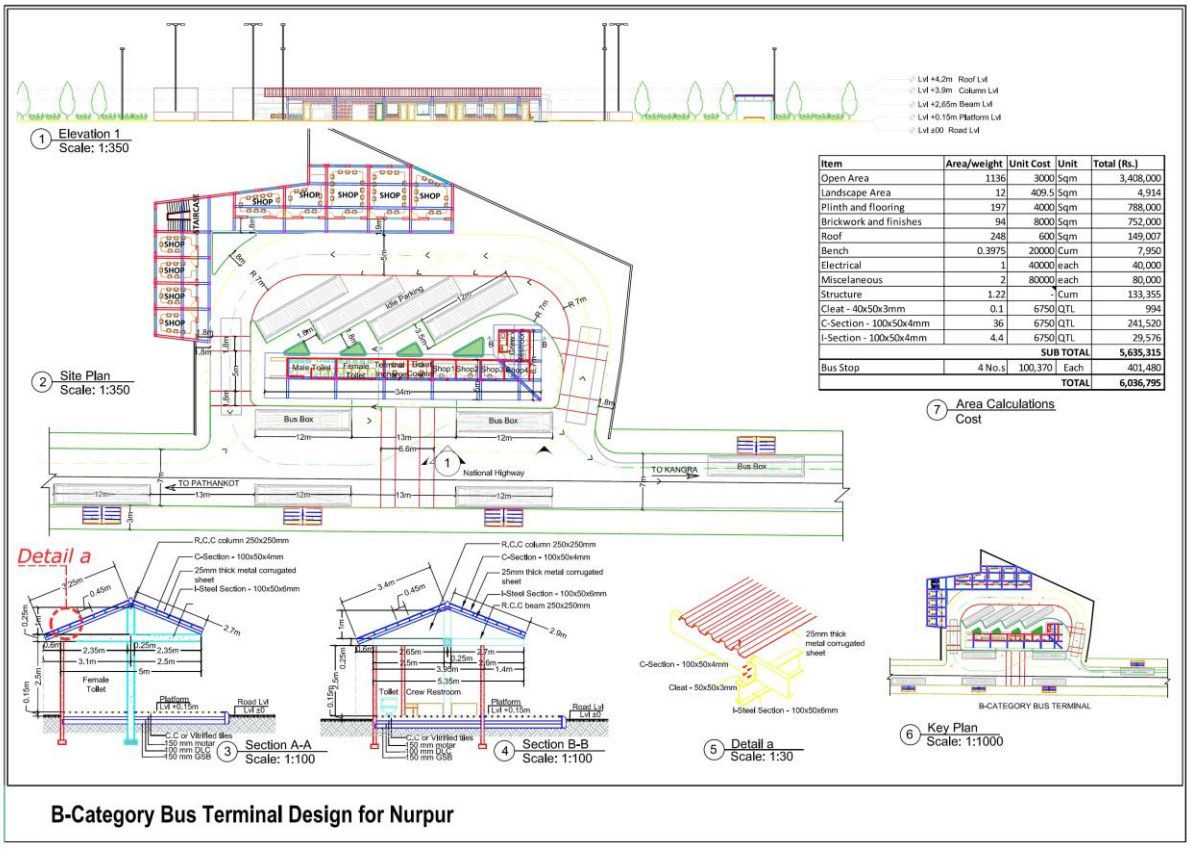


Item	Area/weight	Unit Cost	Unit	Total (Rs.)
Open Area	385	3000	Sqm	1,155,000
Landscape Area	64	409.5	Sqm	26,208
Plinth and flooring	196	4000	Sqm	784,000
Brickwork and finishes	61	8000	Sqm	488,000
Roof	205	600	Sqm	122,808
Bench	0.54	20000	Cum	10,800
Electrical	1	40000	each	40,000
Miscelaneous	2	80000	each	80,000
Structure	0.77	-	Cum	100,427
Cleat - 40x50x3mm	0.1	6750	QTL	675
C-Section - 100x50x4mm	29	6750	QTL	195,750
I-Section - 100x50x4mm	2.7	6750	QTL	18,225
			SUB TOTAL	3,021,893
Bus Stop	2 No.s	100,370	Each	200,740
			TOTAL	3,222,633

6 Area Calculations
Cost

C Category Bus Terminal Design Template - Jhalog

4) B-Category bus terminal design - Nurpur (Option 1)

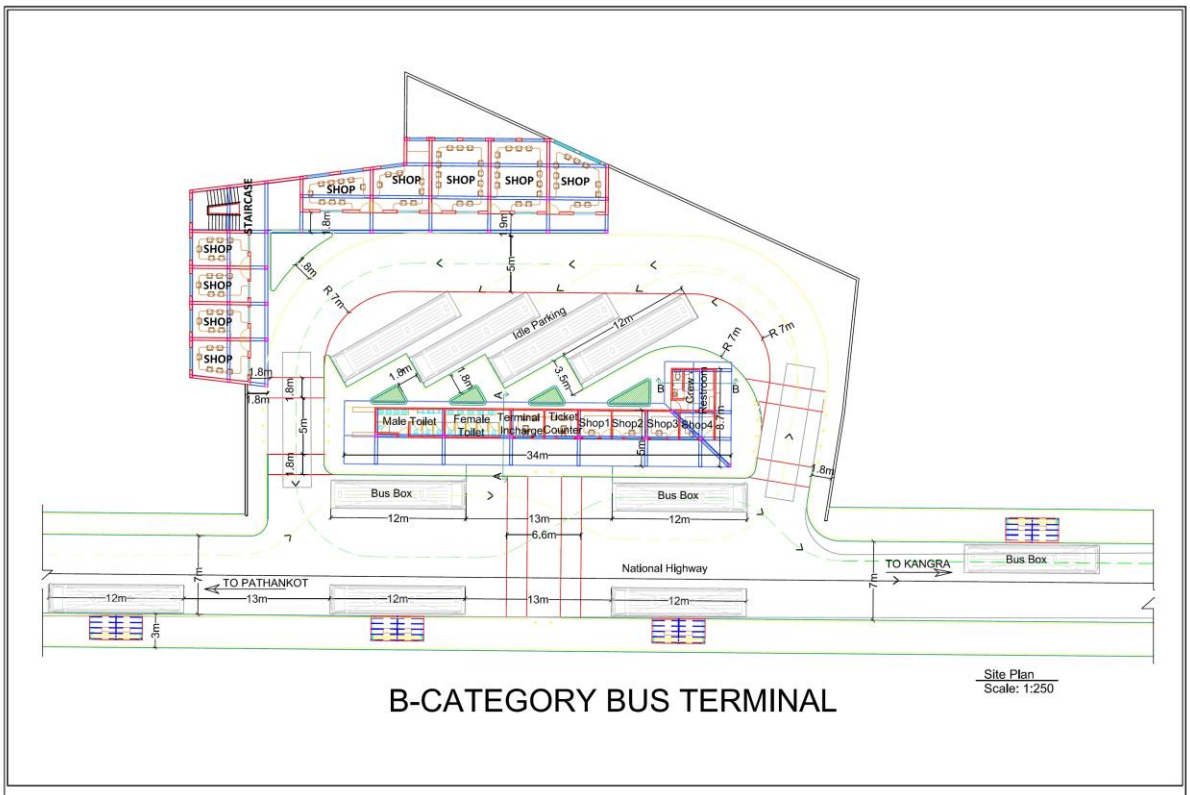


Item	Area/weight	Unit Cost	Unit	Total (Rs.)
Open Area	1136	3000	Sqm	3,408,000
Landscape Area	12	409.5	Sqm	4,914
Plinth and flooring	197	4000	Sqm	788,000
Brickwork and finishes	94	8000	Sqm	752,000
Roof	248	600	Sqm	149,007
Bench	0.3975	20000	Cum	7,950
Electrical	1	40000	each	40,000
Miscelaneous	2	80000	each	80,000
Structure	1.22	-	Cum	133,355
Cleat - 40x50x3mm	0.1	6750	QTL	994
C-Section - 100x50x4mm	36	6750	QTL	241,520
I-Section - 100x50x4mm	4.4	6750	QTL	29,576
			SUB TOTAL	5,635,315
Bus Stop	4 No.s	100,370	Each	401,480
			TOTAL	6,036,795

7 Area Calculations
Cost

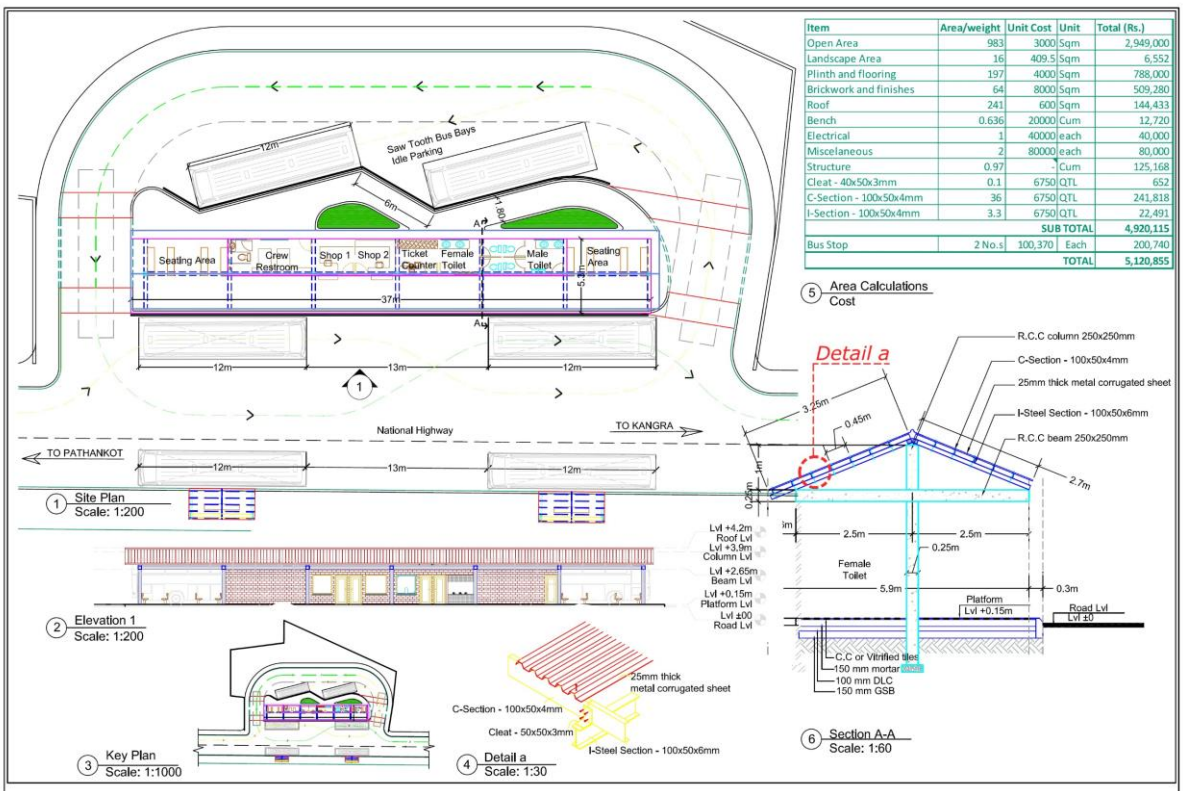
B-Category Bus Terminal Design for Nurpur

1) B-Category bus terminal design - Nurpur (Revised proposal)



B-Category Bus Terminal Design for Nurpur

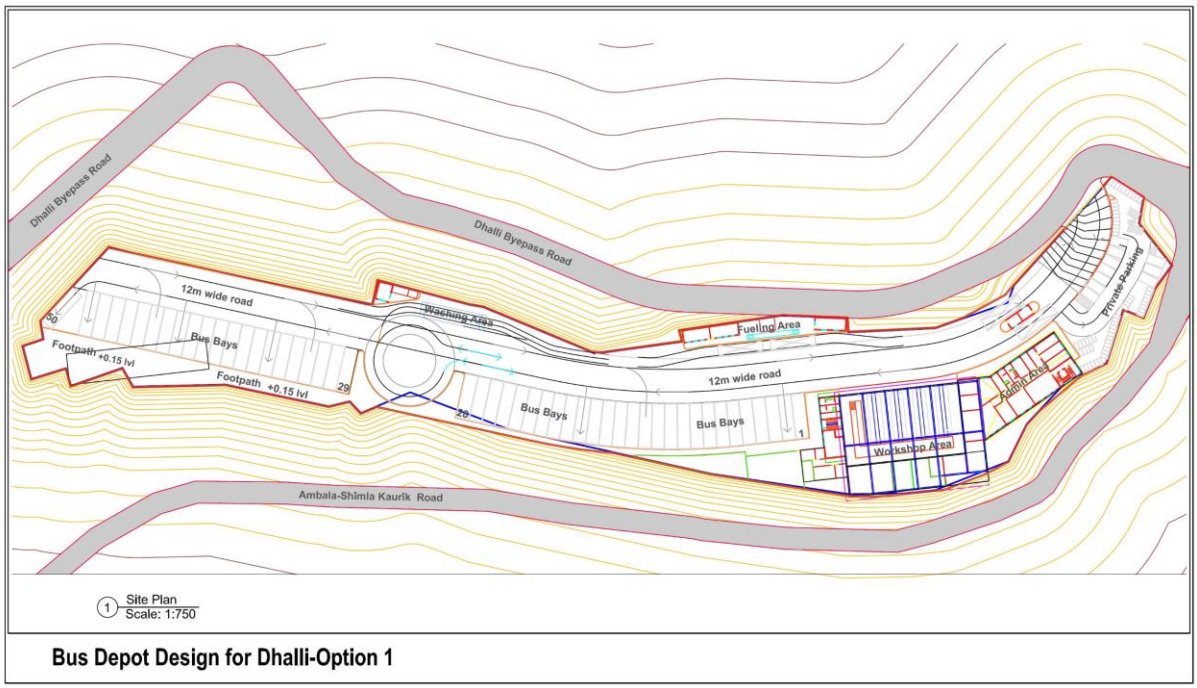
2) C-Category bus terminal design - Nurpur



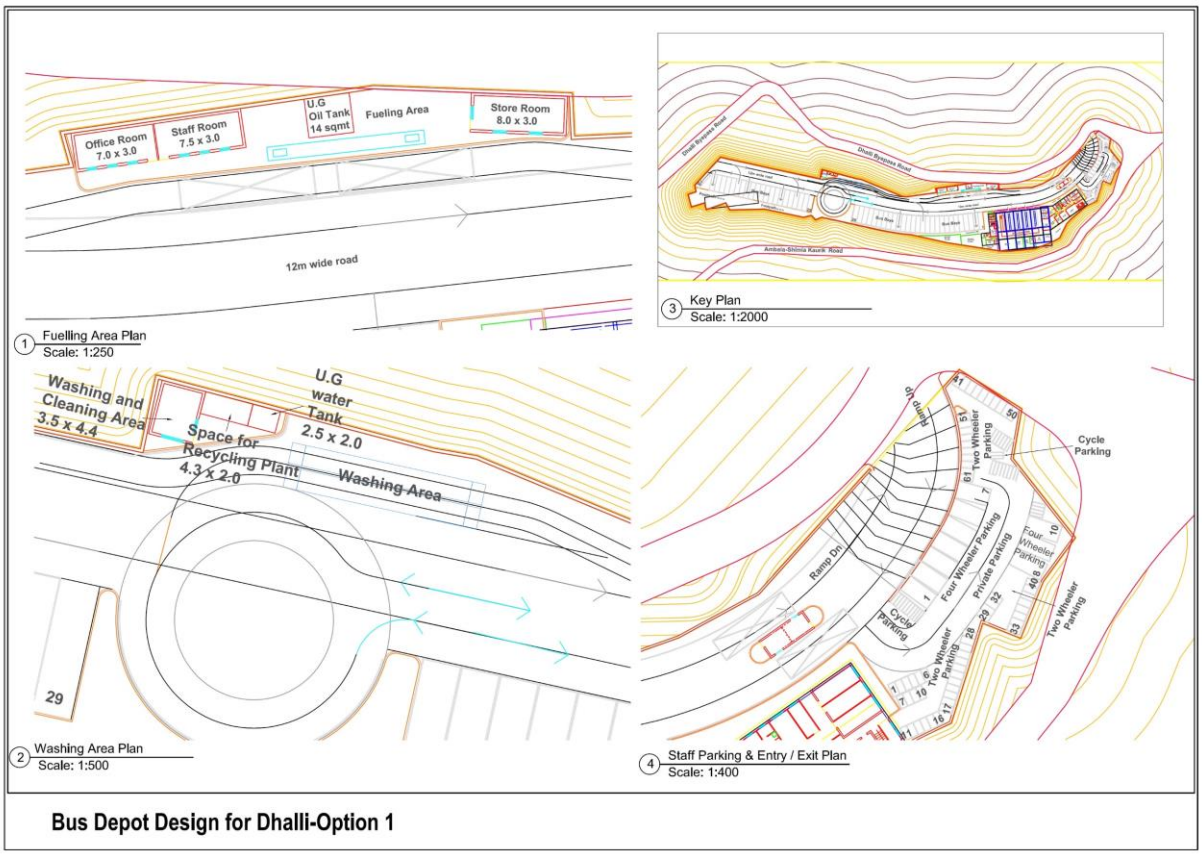
Item	Area/weight	Unit Cost	Unit	Total (Rs.)
Open Area	983	3000	Sqm	2,949,000
Landscape Area	16	409.5	Sqm	6,552
Plinth and flooring	197	4000	Sqm	788,000
Brickwork and finishes	64	8000	Sqm	509,280
Roof	241	600	Sqm	144,433
Bench	0.636	20000	Cum	12,720
Electrical	1	40000	each	40,000
Miscelaneous	2	80000	each	80,000
Structure	0.97	-	Cum	125,168
Cleat - 40x50x3mm	0.1	6750	QTL	652
C-Section - 100x50x4mm	36	6750	QTL	241,818
I-Section - 100x50x4mm	3.3	6750	QTL	22,491
			SUB TOTAL	4,920,115
Bus Stop	2 No.s	100,370	Each	200,740
			TOTAL	5,120,855

C-Category Bus Terminal Design for Nurpur

3) Dhalli bus depot – Option 1

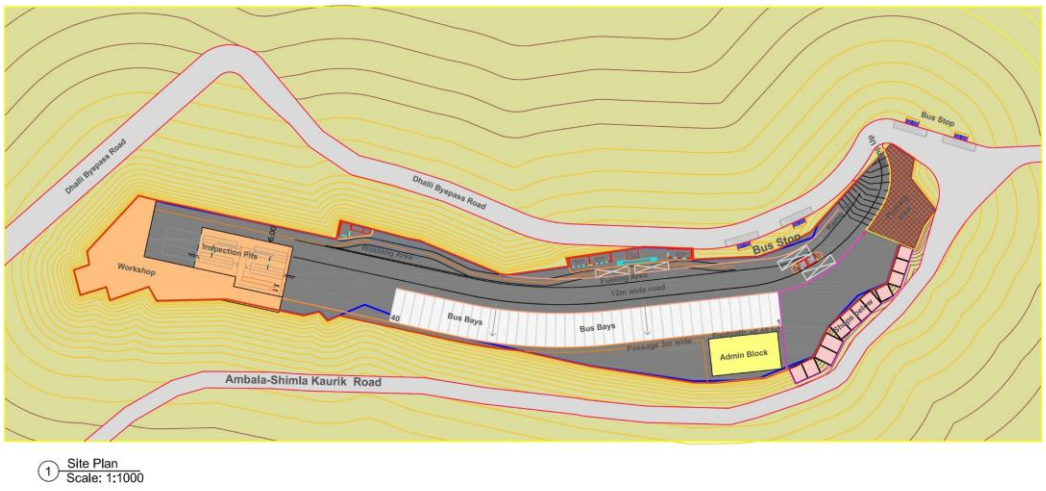


Bus Depot Design for Dhalli-Option 1



Bus Depot Design for Dhalli-Option 1

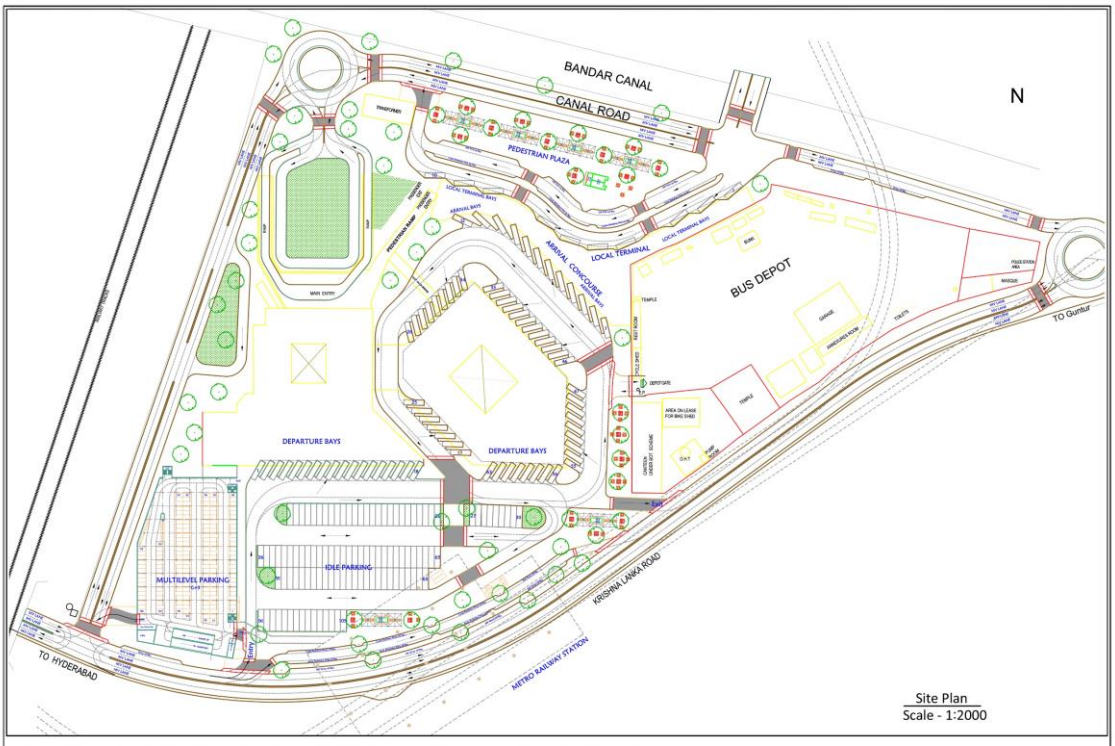
4) Dhalli bus depot – Option 2



Bus Depot Design for Dhalli-Option 2

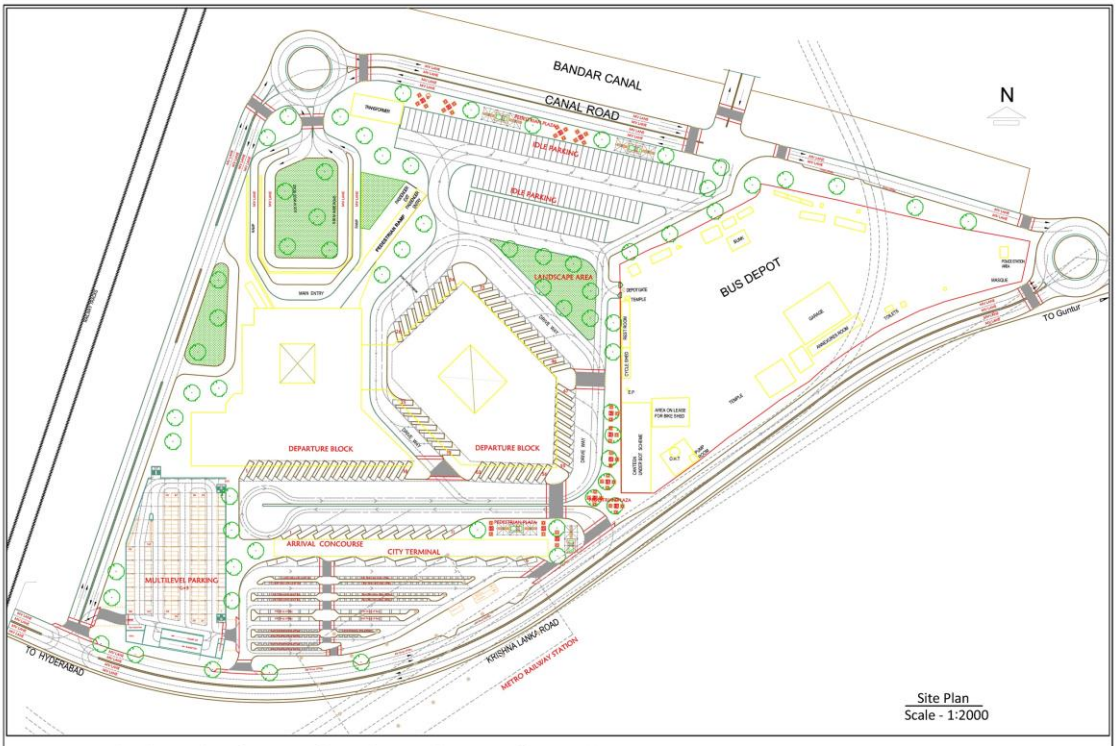
Following are the detailed drawings of all the interventions which were suggested to APSRTC for improving the functionality of their bus terminals

1) Vijayawada bus terminal – Option 1



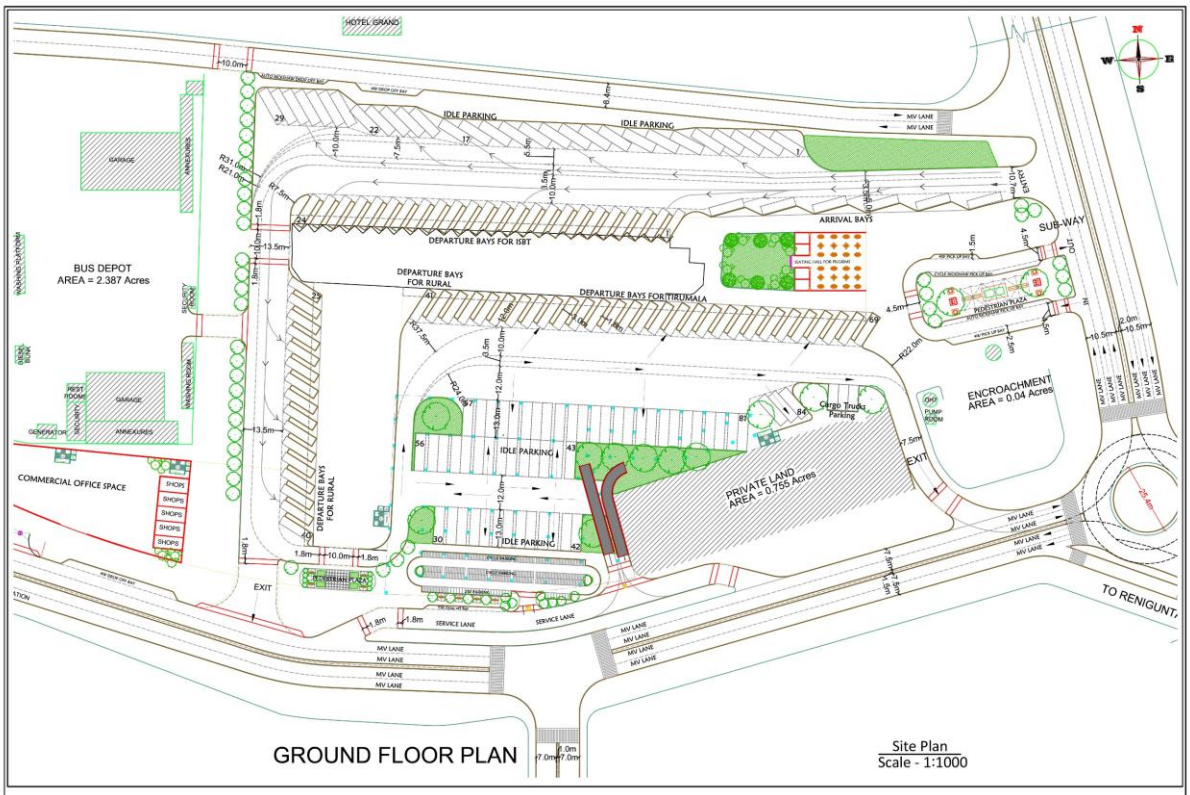
Bus Terminal Design for Pandit Nehru, Vijayawada, Option 1

2) Vijayawada bus terminal – Option 2



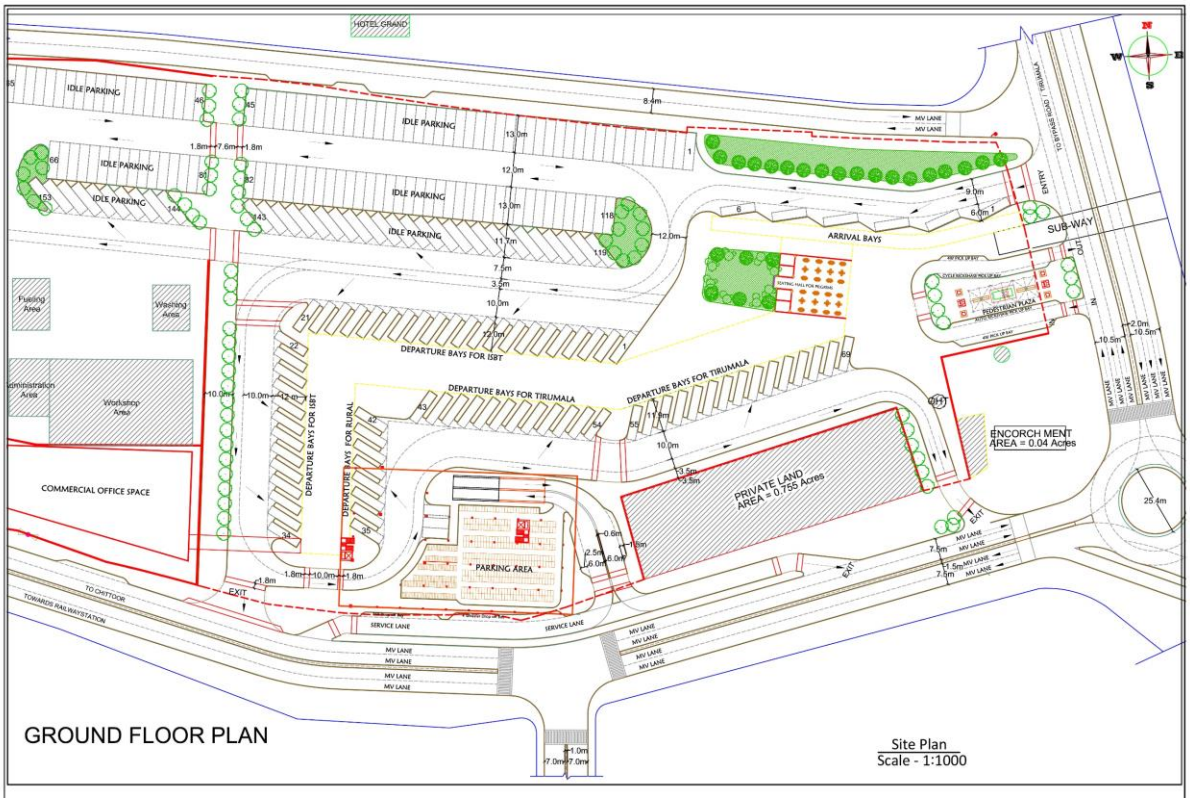
Bus Terminal Design for Pandit Nehru, Vijayawada, Option 2

3) Tirupathi bus station – Option 1



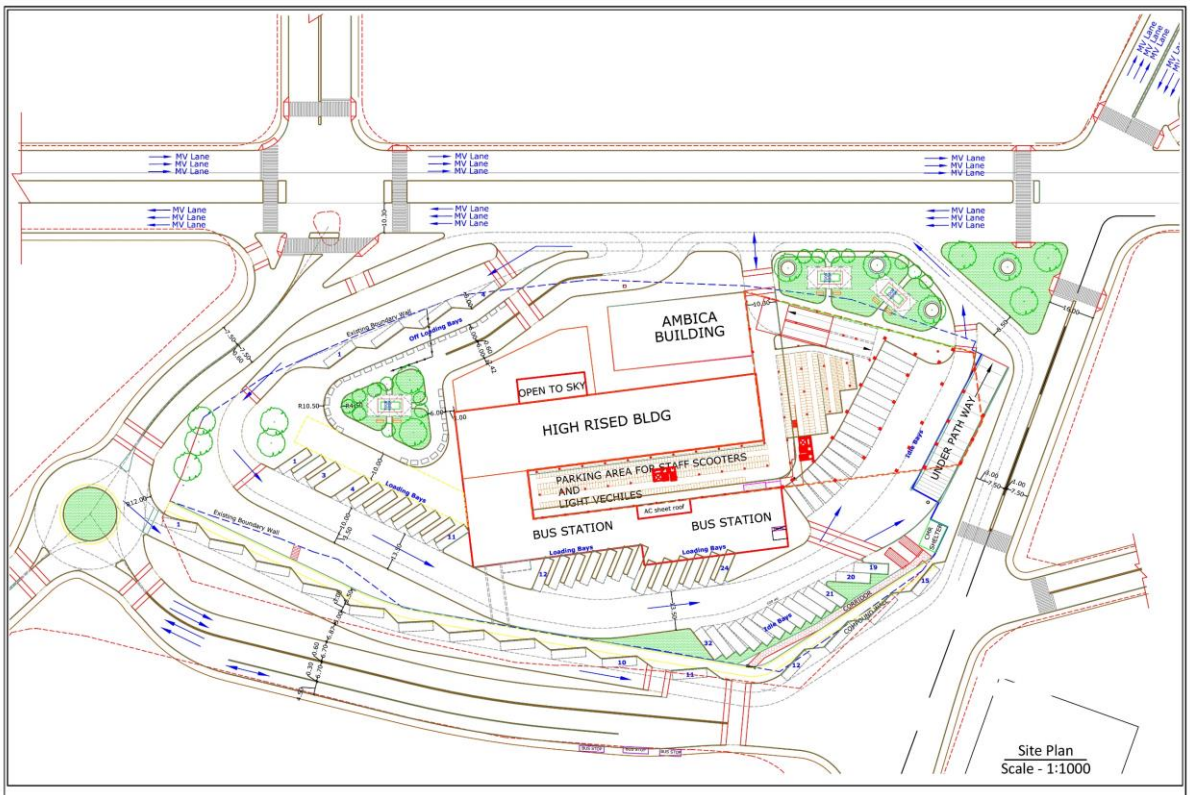
Bus Terminal Design for Tirupathi, Option 1

4) Tirupathi Bus Station – Option 2



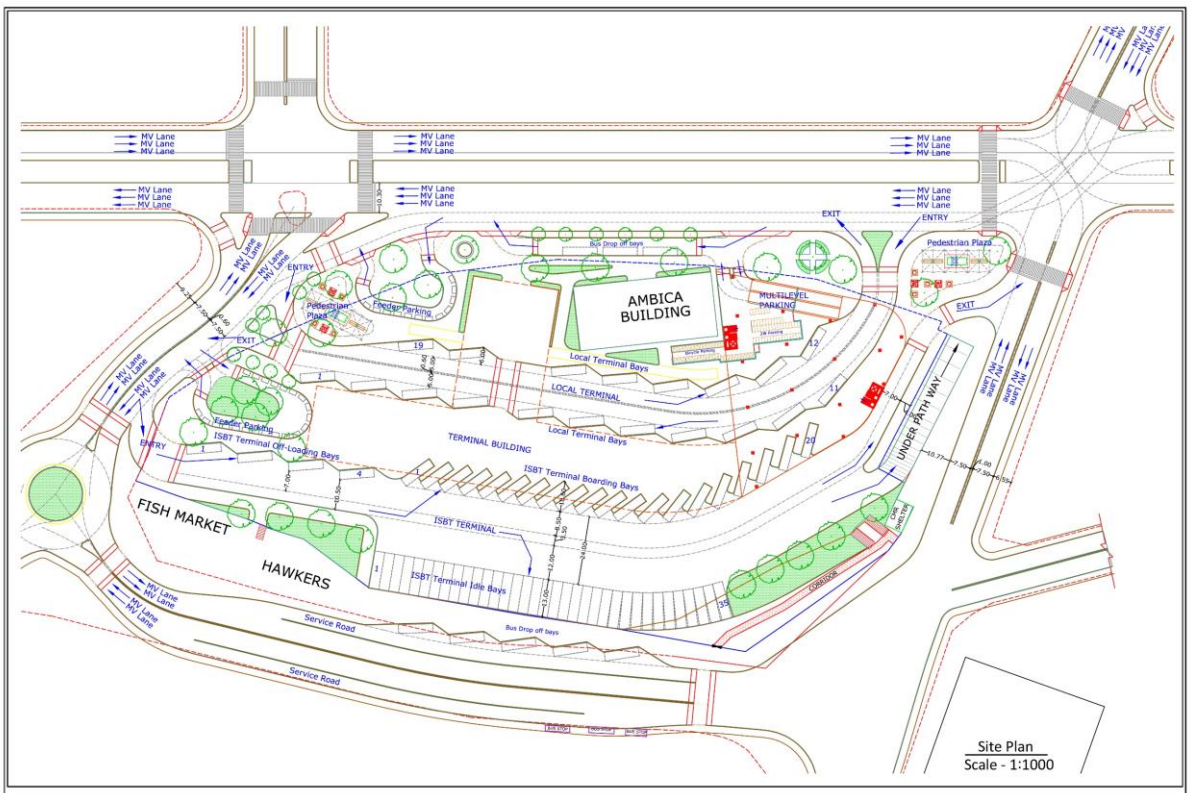
Bus Terminal Design for Tirupathi, Option 2

5) Dwarka Bus Station – Option 1



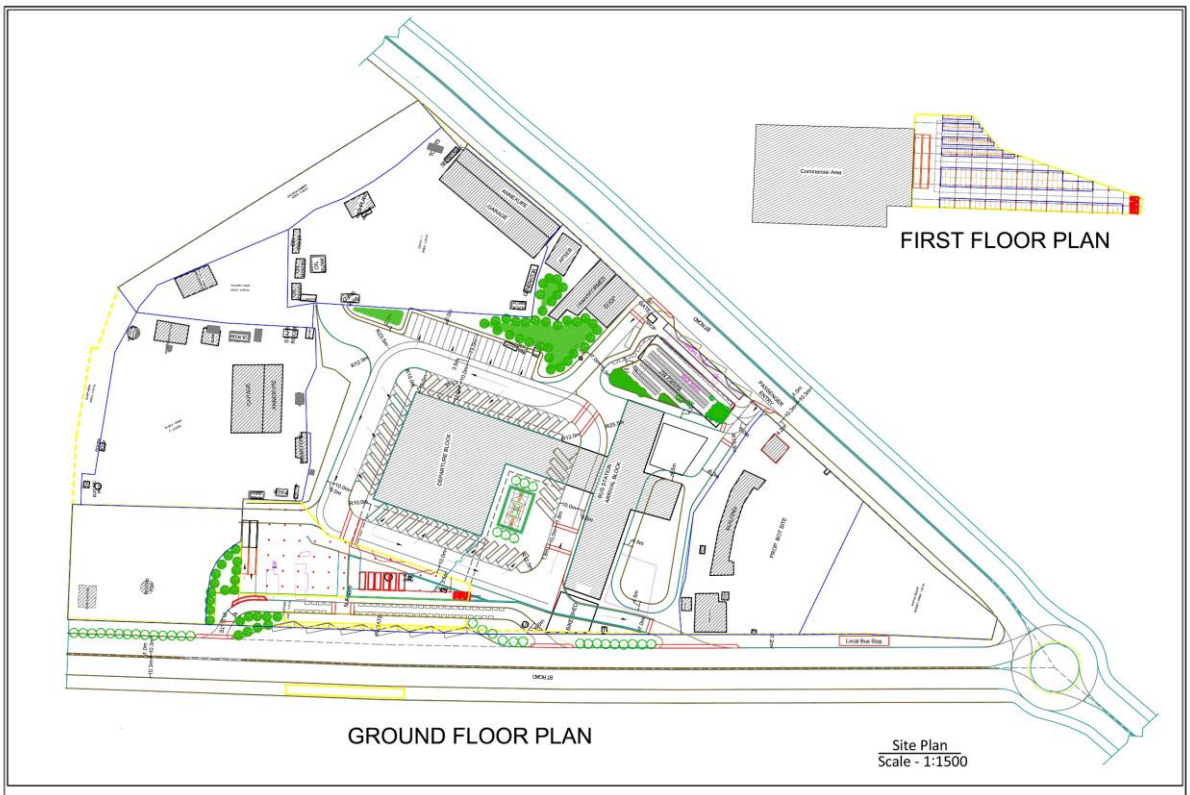
Bus Terminal Design for Dwarka, Vishakhapatman, Option 1

6) Dwarka Bus Station – Option 2



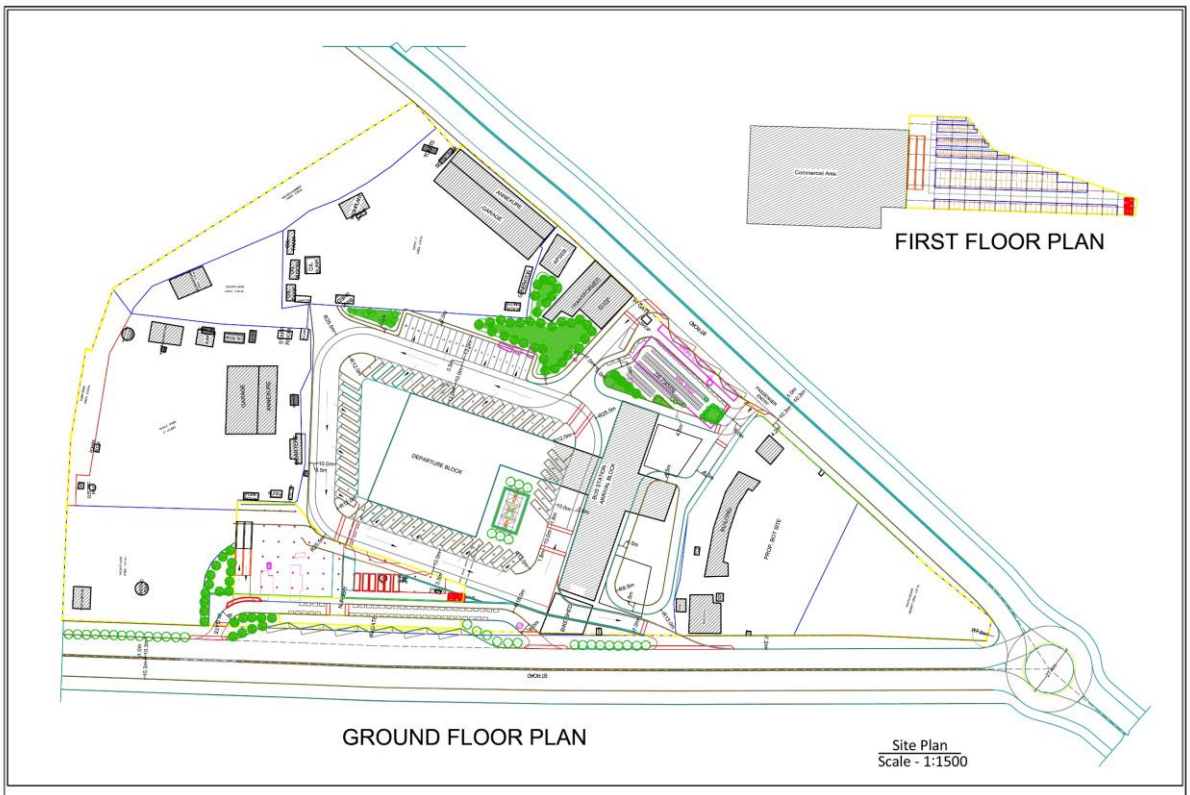
Bus Terminal Design for Dwarka, Vishakhapatman, Option 2

7) Guntur Bus Terminal – Option 1



Bus Terminal Design for Guntur, Option 1

8) Guntur Bus Terminal – Option 2



Bus Terminal Design for Guntur, Option 2