Planning, Designing and Implementing City Bus Depots

Urban Mobility India Conference and Expo 2019

November 15, 2019
Basic Elements

Objectives

- Need of Depot
- Who are stakeholders and their involvement during various stages
- Criteria for Site Selection

Facilities Planning

- Determining the number and types of buses
- Horizon period
- Estimation of Infrastructure capacity
- In-house vs Outsourced activities

Implementation Structure

- Funding Source
Key Parameters Defining Layout of a Depot

- Number of buses to be maintained
- Dimensions of buses (length, floor height)
- Type of fuel (diesel, CNG, electric)
- Maintenance philosophy
- Movement of rolling stock, man and material
- Legal framework (environment, safety, green building etc.)
Present Indian Scenario
Types of Depots

Tier 1: Parking Bus Depots
- Night Parking
- Physical checking and minor on-site repairs
- Washing

Tier 2: Unitary Bus Depots
- Parking Bus Depots +
- Fuelling
- Battery Charging
- Minor and Scheduled Maintenance
- Capacity Building

Tier 3: Central or Regional Bus Depots
- Unitary Bus Depots +
- Major Maintenance and Accidental repairs
- Tyre Retreading
- Inventory and Waste Management
- Major planning of civil infrastructure required for parking and unitary bus depots

There can be different combinations of aforementioned activities depending on operational requirement & maintenance philosophy of the operator and size of land parcel available for the depot.
Maintenance Philosophy

- Minor repairs
- Preventive maintenance – KM based/ Time based
- Major maintenance, mid life-refurbishment, accidental repairs

**Maintenance Block**

- Bench-work and other activities
- Tyre Section
- Fuel Injection Pump
- Brake Testing
- Electrical Section
- Brake Overhauling Section
- Reconditioning of Major Aggregates
- Inventory and Material Handling
Types of Buses

Floor Height
- Low Floor Bus (400mm) – Stepless entry/exit
- Semi Low Floor Bus (650mm) - Entry + one step
- Standard Bus (900mm) - Entry + two steps

Length
- Standard Bus (12m)
- Midi Bus (9m)
- Mini Bus (6m)
- Articulated Bus (18m and/or 24m)

Fuel
- Diesel Bus
- CNG/ HCNG Bus
- Pure Electric/ Hybrid Bus

Deck
- Single Decker Bus
- Double Decker Bus

Rear Axle Configuration
- Single Rear Axle bus
- Multi Rear Axle bus
- Rear Axle Loads

Comfort
- Air-Conditioned Bus
- Non Air-Conditioned Bus

Impact
- Pit Depth
- Ramp Gradient
- Inspection, Maintenance, Washing

- Turning Radii
- Swept Path
- Fuelling, Washing, Maintenance, Parking, Circulation, Queuing

- Areas – Fuelling, Maintenance, Parking

- Height
- Fuelling, Washing, Maintenance

- Swept Path
- Fuelling, Washing, Maintenance, Parking, Circulation, Queuing

- Height
- Washing
Bus Depot Perspectives

Planners Perspective
- Location
- Activities
- Workflow

Depot Manager Perspective
- Operation
- Maintenance
- Environment & Safety
Process Flow

In-Shedding of buses
- Check for presence of major items
- Documentation of faults in bus by driver

Sequence of Fuelling, Washing, Parking and Maintenance activities is interchangeable

Fuelling
- Logging of Km

Washing

Parking

Maintenance
- Routine Checking and Minor Repairs
- Preventive Maintenance: KM Based/ Time Based
- Major Maintenance

Allocation of Buses
- Bus ready for out-shedding

Out-Shedding of buses
- Visual inspection by driver
Bus Driver Movement in a Bus Depot

Entry into bus depot
Vehicle Parking

Attendance in Admin block
Easy Access to Attendance System

Duty allocation
Easy Access to Allocation and Dormitory

Proceed to bus in parking area
(1) Pedestrian Access to bus Parking Area and
(2) Marked parking location

Completion of day's operation
Bus out shedding

Bus movement to Exit Gate
Open bus movement area

Visual Inspection of bus and Basic Checks
Movement area around the bus

Bus in shedding

Logging of bus complaints
Fast entry

Logging of km
Fast entry

Parking
Easy Access
Conductor Movement in a Bus Depot

Entry into bus depot
Vehicle Parking

Attendance in Admin block
(1) Pedestrian access to admin block and
(2) Easy Access to Attendance System

Duty allocation
Easy Access to Allocation and Dormitory

Bus out shedding

Bus boarding at Exit Gate
Pedestrian Access to Exit Gate

Collect tickets/ ETM
Min queue

Completion of day’s operation

Bus in shedding

Go to Cash and ETM Section
Min queue
Maintenance Staff Movement in a Bus Depot

Entry into bus depot

Vehicle Parking

Attendance in Admin block
(1) Pedestrian access to admin block and (2) Easy Access to Attendance System

Duty allocation in maintenance block
Easy Access to Allocation

Spares and other aggregate collection
Pedestrian Access to stores

Maintenance in maintenance area
Pedestrian Access to (1) Bus Parking Area and (2) various maintenance sections of workshop

Access to tools in maintenance block
Efficient design of maintenance bay and work stations
Material Movement in a Bus Depot

Entry into bus depot
(1) Stores Entry gate and (2) Unloading area

Inspection and Entry in MIS
Easy Access

Moves to Storage location
Proper Access to stores and handling equipment

Movement from maintenance block to old/ scrap store
Designated scrap yard

Used for maintenance and old/ scrap generated

Movement to maintenance block
Easy movement from stores to bus location

Old/ scrap store taken for reclamation

Scrap Dispose off as per policy
Manual Contents

- Site Selection
- Facilities Planning
- Safety & Security
- Utilities Planning
- Environment
- Depot Development Process
Evaluation of Multiple Sites

Site Selection – 2 Step Process

Step 1 - Preliminary Screening

1. Minimum size
2. Minimum width/ frontage
3. Ease of procurement
4. Land-use restrictions
5. Access to Approach roads
6. Mitigation measures for environmental issues/ sensitive neighbours
7. Low lying areas
8. Site preparation costs

Step 2 - Evaluation of Site based on Pre-Determined Parameters

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Sub-Criteria</th>
<th>Indicative Weightage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance from transit centre</td>
<td>Minimize dead mileage cost</td>
<td>20.0%</td>
</tr>
<tr>
<td>Access to Public Roads</td>
<td>Full movement access to site with limited traffic disturbance during the peak entry and exit periods</td>
<td>10.0%</td>
</tr>
<tr>
<td>Site capacity</td>
<td>Site acreage</td>
<td>10.0%</td>
</tr>
<tr>
<td></td>
<td>Minimum width/ frontage</td>
<td>10.0%</td>
</tr>
<tr>
<td></td>
<td>Shape of site</td>
<td>2.5%</td>
</tr>
<tr>
<td></td>
<td>Expandability</td>
<td>2.5%</td>
</tr>
<tr>
<td>Real estate issues</td>
<td>Ease of procurement</td>
<td>5.0%</td>
</tr>
<tr>
<td></td>
<td>Neighbourhood sensitivity issues</td>
<td>10.0%</td>
</tr>
<tr>
<td>Environmental issues</td>
<td>Geotechnical and Seismic issues</td>
<td>5.0%</td>
</tr>
<tr>
<td></td>
<td>Forest, wildlife, tree cutting, Wetlands, streams etc. issues</td>
<td>5.0%</td>
</tr>
<tr>
<td>Development Cost</td>
<td>Land Cost</td>
<td>10.0%</td>
</tr>
<tr>
<td></td>
<td>Site development cost</td>
<td>4.0%</td>
</tr>
<tr>
<td></td>
<td>Change in land use cost</td>
<td>3.0%</td>
</tr>
<tr>
<td></td>
<td>Mitigation measures for environmental issues</td>
<td>2.0%</td>
</tr>
<tr>
<td></td>
<td>Special design covenants that increase construction cost</td>
<td>1.0%</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>100%</td>
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</table>
Bus depot Site – to be reserved in Master plan of the city

- Comprehensive City Mobility Plan - for identification of suitable land for bus depots

- Identified land should be immediately procured to avoid escalations in price of land.

- Number of Depots - city bus operations plan and CMP
## Size of Land Parcel

Size of land parcel is assessed by evaluating the space requirement of individual facilities/components in the depot.

<table>
<thead>
<tr>
<th>Area</th>
<th>50 Bus Depot</th>
<th>100 Bus Depot</th>
<th>150 Bus Depot</th>
<th>200 Bus Depot</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>No</td>
<td>Area (sqm)</td>
<td>No</td>
<td>Area (sqm)</td>
</tr>
<tr>
<td>Fuelling Area</td>
<td>2</td>
<td>200</td>
<td>2</td>
<td>200</td>
</tr>
<tr>
<td>Washing Area</td>
<td>1</td>
<td>100</td>
<td>2</td>
<td>200</td>
</tr>
<tr>
<td>Maintenance Bays/Pits</td>
<td>4</td>
<td>7</td>
<td>11</td>
<td>14</td>
</tr>
<tr>
<td>Inspection Area</td>
<td>2</td>
<td>160</td>
<td>4</td>
<td>320</td>
</tr>
<tr>
<td>Workshop Area including stores</td>
<td>1100</td>
<td>1600</td>
<td>2000</td>
<td></td>
</tr>
<tr>
<td>Bus Parking</td>
<td>50</td>
<td>2500</td>
<td>100</td>
<td>5000</td>
</tr>
<tr>
<td>Admin Area</td>
<td>600</td>
<td>750</td>
<td>1100</td>
<td></td>
</tr>
<tr>
<td>Staff Parking</td>
<td>1000</td>
<td></td>
<td>1250</td>
<td></td>
</tr>
<tr>
<td>Scrap Yard</td>
<td>250</td>
<td>350</td>
<td>450</td>
<td></td>
</tr>
<tr>
<td>Sub Station</td>
<td>250</td>
<td>350</td>
<td>450</td>
<td></td>
</tr>
<tr>
<td>Green Area</td>
<td>600</td>
<td>950</td>
<td>1250</td>
<td></td>
</tr>
<tr>
<td>Circulation &amp; Queuing Area</td>
<td>5700</td>
<td></td>
<td>8200</td>
<td></td>
</tr>
<tr>
<td>Total Area</td>
<td>12,460</td>
<td></td>
<td>19,170</td>
<td></td>
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<tr>
<td>Land Area (acres)</td>
<td>3.08</td>
<td></td>
<td>4.74</td>
<td></td>
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<tr>
<td>Area per bus (sqm)</td>
<td>250</td>
<td></td>
<td>192</td>
<td></td>
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</table>
Shape of Land Parcel

- Level square or rectangular piece of land is particularly suited.
- Minimum frontage should be ensured for smooth depot operations.

<table>
<thead>
<tr>
<th>SN</th>
<th>Activity</th>
<th>Approx. Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Entry/ Exit Gate – 2 (including adjoining structures)</td>
<td>17 m</td>
</tr>
<tr>
<td>2</td>
<td>Staff/ Private Vehicles Entry Gate – 1 (including adjoining structures)</td>
<td>8 m</td>
</tr>
<tr>
<td>3</td>
<td>Other for circulation and segregation of vehicles and operational requirements</td>
<td>50 m</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>75 m</strong></td>
</tr>
</tbody>
</table>

~ 90 m of Minimum Frontage/ width is required
Major Activities in a Bus Depot

- **Entry/Exit**
- **Fuelling**
- **Washing**
- **Parking**

**Maintenance**
- Routine Maintenance
- Maintenance in bench work areas/machine shop
- Wheel and tyre activities
- Alignment testing
- Brake testing

**Administrative Block**
- Attendance of staff/crew
- Cash handling
- ETM handling and charging
- Staff/Crew amenities
- Administrative work
- Training & Development

**Inventory/Storage Work**

**Storage and Disposal of Scrap**
The layout of facilities is designed based on
- Work flow
- Minimal and conflict free movement of bus, personnel and material.
Entry and Exit
Traffic impact analysis needs to be undertaken to assess the impact of bus traffic on the main road and intersections need to be designed accordingly.
Entry/ Exit Gates

- Buses - 2
  - Segregated entry and exit for buses

- Staff Vehicles - 1
  - A single entry and exit for staff/private vehicles

- Inventory/ Supplies (stores/scrap/fuel/canteen stores)
  - Staff Vehicles Entry/ Exit Gate to be used

- Visitors
  - Staff Vehicles Entry/ Exit Gate to be used

- Pedestrians (staff and visitors)
  - A pedestrian entry and exit gate integrated with Staff Vehicles Entry/ Exit.
Bus Movement

- Movement of the bus within the bus depot should be unidirectional.
- Placement of facilities should facilitate unidirectional movement.
**Fuelling Area**

- **Diesel bus depots**, 2 fuelling bays with 4 nozzles for 100 buses.
  - Layout based on OMCs requirements.
- **CNG bus depots**, 2 CNG dispensers for 100 buses.
- **HCNG bus depots**, HCNG reformer plant is required.
- **Electric buses**, charging at the parking
  - Provision of a min 2m space for charging station and cable network.
Washing Area

- 2 washing bays for 100 buses.
  - 1 washing bay for additional 50 buses.

An automatic bus washing system based on OEM specifications.
Washing Area – Illustrative Layout

[Diagram showing the layout of the washing area with labels for ETP 3.0x3.0m, Grease trap, WRP 3.0x3.0m, PLAN, WASH MACHINE MOVEMENT PATH, BUS, BUS WASH MACHINE, FRONT ELEVATION, SIDE ELEVATION, and Ground level.]
Maintenance Area

- Space provisioning based on space requirement of equipment to be housed.

| Non-individual space | = informed estimates based on existing good practice or comparable examples + an additional factor for primary circulation |

Sections in the maintenance area

- Wheel & Tyre Section
- Battery Section
- Auto Electrical/Electronic Section
- General (Admin & Maintenance) Section
- Radiator Section
- Pits/ Bays & General Maintenance Area

Unitary Bus Depot

Central/ Regional Bus Depot

- Machine Shop
- Body Shop
- Fuel Injector Section
- Reconditioning of Major Aggregates Section

- Integrated bus depots – in smaller cities
Bus Parking Design & Illustrative Layout

- Parking to be designed to ensure minimum maneuvering for bus parking and retrieval and ease of circulation.
- Angular parking 60° is the preferred parking
- Thermosetting resins should be used for marking bus movement corridor.
- In case covered parking is planned than installation of solar plant should be considered.
Angular 30° Parking Configuration
Angular 45° Parking Configuration
Angular 60° Parking Configuration
Row Parking Configuration
Parking Configuration Options … 5

Inline Parking Configuration
Multi Level Depot

**Design Philosophy Tenets**

- Eliminating potential barriers in planning which might discourage conversion to multilevel depot, in future

- Seamless integration of the facility on different floors and corresponding bus circulation
- Minimising turnaround time per bus
- Development of associated infrastructure for ease of entry/exit
- Safety and security aspects

<table>
<thead>
<tr>
<th>SN</th>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Cost of procurement of additional land</td>
<td>A</td>
</tr>
<tr>
<td>2</td>
<td>Dead mileage for all the buses for the horizon period</td>
<td>B</td>
</tr>
<tr>
<td>3</td>
<td>Cost of construction of multilevel depot at the same site</td>
<td>C</td>
</tr>
<tr>
<td></td>
<td>Whenever, C is less than (A + B), the multilevel depot should be constructed</td>
<td></td>
</tr>
</tbody>
</table>
Staff Movement
Driver and Conductor Movement

Bus Driver Movement

- Staff Entry Gate
- Car & 2 Wheeler Parking
- Duty Allocation
- Duty Allocation ETM Machine
- To bus parking
- To Exit Gate

Bus Conductor Movement

- Staff Entry Gate
- Car & 2 Wheeler Parking
- Duty Allocation
- Duty Allocation ETM Machine
- To bus parking
- To Exit Gate
Maintenance Area – Illustrative Layout

Ground Level

- Service bay-3
- Wheel & Tyre Section
- Service bay With pit-1
- Over head service platform
- Service bay With pit-2
- Service bay With pit-3
- Service bay-2
- Service bay-1

- Inventory Storage

Basement Level

- Radiator Section
- Lockers
- General Admin & Maintenance Section
- Pits/ Bays & General Maintenance Area

- Inventory Storage

- 3M Clear Passage and 1.5M work area
- Work Area
- 3M Clear Passage and 1.5M work area

- Toilets
- Battery Section
- Auto Electrical/Electronic Section
- Work Area
Pits/ Bays & General Maintenance Area

For a 100 bus depot
- 8 Maintenance pits
- 3 Maintenance bays
- Wheel section – 1 pit and 2 bays
- One movable column lift
Inventory and Material Movement
Inventory Area

- Space provisioning based on
  - Number of buses in the depot
  - Number of days for which the inventory level is to be maintained as per the operational philosophy of the operator and availability of the spares in the local market
  - Lead time for the inventory

- Entry and exit from Staff Entry Gate.

- Storage gates - minimum width of 3 m

- Aisles – at least 2 m for smooth movement of forklifts
Inventory Area Illustrative Layout – Ground Floor

- Loading/ Unloading Bay
- Ground floor Mini store
- Tyre Section
- Storage for Huge Items
- Aggregate Section
- Lubricant Store
Administrative Staff Movement
Administrative Block Overall Layout – Ground Floor
Overall 100 Bus Depot Layout
Overall 100 Bus Depot Layout - Alternate Layout with Substation at front
Overall 100 Bus Depot Layout - Alternate Layout with Parking at back
THANK YOU