Public Transport Safety

Sandeep Gandhi, Ph.D.
What we will cover ...

Outside the Vehicle
- Safe last mile access trips
  - Pedestrian pathways
  - Intersections
  - Pedestrian crossing
- Safe and accessible infrastructure
  - Safe and accessible stations
  - Safe depots

In the vehicles
- Safe design speeds
- Bus travel way

Contents
- Background
- Last mile access trips
- Safety in the stations
- Pedestrian crossing at stations – access
- PT lane and roadway
- PT Fleet
- PT Terminals and depot
Background and Context

Public Transport Safety
What is public transport safety?

• The physics of accidents – Injury is caused by transfer of kinetic energy from impacter to the receptor in a crash
• Injury/fatality can be reduced by reducing or eliminating the energy transfer – reduce the speed of impacter or eliminate the contact between impacter and receptor
• Planning and design interventions influencing speed control and conflict management in PT systems can improve safety.
• PT journey safety should cover passenger safety and safety of other road users from impacting PT vehicles
What is Transportation Safety planning in urban context?

Transportation safety relates to reducing risk of crashes, and reducing chances of injury and fatalities in Road based Urban Transport.

• Risk Reduction – Exposure Reduction
  • Reduced travel demand
  • Increase segregation

• Severity Reduction – Speed Reduction
  • Reduction in peak speed or lower speed limits
PT Journey Components

PT Journey = In-vehicle journey + Outside Vehicle Journey

Diagram showing various modes of transportation including walking, cycling, and different types of travel.
Public Transport Safety = Pedestrian safety mostly!

*Bus and Metro have Access and Egress, and in-vehicle time
60% Metro and 90% Bus access trips are pedestrian*

PT commuter safety includes boarding and alighting and vehicle interior design
Traffic risk in PT TRIP, Copenhagen

Last mile access trips

PT Safety
Planning principles for safe PT Access

Planning for safe PT access can be achieved by planning **safe streets**

- Exposure or level of segregation and speed reduction can compensate for each other for a safe street planning

What is wrong with planning high speed roads if high segregation can be achieved?
Feeder Access to PT

- PT is mainly dependent on Walk as feeder.
- 78% walk feeder involved in Metro trip chain - 43% walk directly to Metro.
- Almost 90% walk trips to access buses
- Current share of bicycle feeder trips to PT is 1%
Components of PT Access by NMT (walk/cycle)

Roadway system elements for safe PT access
• Pedestrian pathways (barrier free access)
• Bicycle infrastructure
• Intersections
• Lighting/services
Pedestrian pathway and cycle lanes

- Lack of dedicated NMT infrastructure forces NMT to mix with vehicles, increasing risk of crashes
- High quality, direct, continuous, even and shaded pedestrian and bicycle infrastructure required within 500m radius of transit stations.
- Poor footpath surface also increases risk of falls
- Public transport accessibility (PTA) toolkit can be used to plan, audit and evaluate the NMT infrastructure around transit stations
- PT access needs to be universally accessible
- Universal Access to Public Transport is not an option but a legal requirement
- Disability act of 1995 makes it mandatory for all Public Facilities to be barrier free for all.
1. Access and egress trips are an integral part of any type of public transport mode.

2. Making access and egress trip comfortable, easy and safe is key to improving attractiveness of public transport.

3. The system must be accessible and available to the community and its activity centers and connected with the rest of the transportation system.
PTA Audit Format

Separate sets of checklists have been provided depending on the public transport system and Road type

- **Metro Rail/ Mono Rail/ Closed BRT Systems**
  - Arterial/Sub arterial Roads
    - Checklist Set 1.1
  - Local/Collector Roads
    - Checklist Set 1.2

- **Regular city bus/ Open BRT Systems**
  - Arterial/Sub arterial Roads
    - Checklist Set 2.1
  - Local/Collector Roads
    - Checklist Set 2.2
For each PT system there are Eight Checklists are:

Check List 1:
Accessibility to Pedestrians

Check List 2:
Accessibility to Cyclists

Check List 3:
Accessibility to IPT Users

Check List 4:
Accessibility to MV Users

Check List 5:
Accessibility to Bus Users

Check List 6:
Driver Behaviour

Check List 7:
Pedestrian Behaviour

Check List 8:
Traffic volume

focus on infrastructural facilities and will help in rating the existing facilities through a scoring system. The final scores that are calculated with this check lists will help the city authorities in prioritizing the problem areas and devote funds accordingly.

Features used to study the environment in which the public transport stop or station is located. These checklists will study the behaviour of road users as well the traffic volumes on the roads. Studying environmental factors helps in understanding which areas require infrastructural intervention to improve accessibility.

### Access Mode Type

<table>
<thead>
<tr>
<th>Access Mode Type</th>
<th>Score(A)</th>
<th>%age (B) = Score x100</th>
<th>Weight(C)</th>
<th>(D) = (A) x (C)</th>
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</thead>
<tbody>
<tr>
<td>Pedestrian accessibility</td>
<td></td>
<td></td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Cyclist accessibility</td>
<td></td>
<td></td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>IPT User accessibility</td>
<td></td>
<td></td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Motor vehicle User accessibility</td>
<td></td>
<td></td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Bus User accessibility</td>
<td></td>
<td></td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td>3</td>
<td>19</td>
</tr>
</tbody>
</table>

**Recommendations**

- If the score is greater than 80% it is good.
- If the score is between 50 to 80% it is fair.
- If the score is less than 50% it is poor.
Results of PTA Audit for Sample Stops

**Overall Score**
- 0-0.2: 4%
- 0.2-0.4: 18%
- 0.4-0.6: 78%

**Comfort and Convenience**
- Pavement Type
- Width
- Height
- Cleanliness
- Amenities
- Disabled-friendly
- Obstructions
- Signage
- Overall

**Safety and Security**
- Buffer Zone
- Crossing Frequency
- Type of Crossing
- Time for Crossing
- Crossing for Access Roads
- Lighting
- Land-use
- Overall
PT Access issues and audit findings

- Discontinuous footpath
- Open drains
- Obstructions such as trees and poles on footpath
- High footpath
- No kerb ramps
- No tactile pavers for visually impaired
PT Access issues and audit findings

- High footpaths
- Trees on footpath
- Hawkers
- No tactile pavers

Photos showing the obstructions on footpath
PT Access issues and audit findings

- Temple
- Open Drainage line
- Open Drainage line
- Parking

2-wheeler Parking
PT Access issues and audit findings

- Missing kerb ramps at zebra crossing
- No raised crossings at minor junctions and free left turns
- No audible signals
- Unsafe – free left turns for vehicles
Barrier free pedestrian paths - solutions

- Raised crossing across cycle tracks
- Tactile pavers for visually impaired
- Veding spaces outside the footpath
- Use of tree pits with tree grates
Barrier free intersection- solutions

- Audible Signals
- Kerb ramps & barrier free access to traffic islands
- Raised crossings on free left turns
- Raised crossings at minor junctions
Services - Lighting and Drainage

- Planned drainage system to ensure flooding and resultant damage to NMT infra is avoided
- Conduits for services to avoid damage to surface during repair
- Lighting levels desirable 40lux with 40% uniformity for vehicular lanes and NMT infrastructure
- 50% higher lighting levels at intersections and pedestrian crossings.
- White light to ensure visibility of tactile surface by partially blind.
Safety at Station

PT Safety
Bus stop location
Close to intersection is convenient for commuters

- Signalized intersections are safe for pedestrian crossings
- Preferred distance to intersection <50m, maximum <80m, to encourage safe crossing behavior
- Near side or far side?
  - For BRT near side preferred to reduce delays.
  - For standard bus systems far side preferred to reduced distance to junction (ensure proximity to safe crossings)
- Preferred on all arms for convenient and safe interchange
- Shortest crossing distance for pedestrians at the zebra crossing
- Pedestrian delay reduced

Catchment Area for Bus users is on all four sides
Metro Station Accessibility

✓ Wheelchair Gates
✓ Tactile Pavers
✓ Lifts
✓ Visual Signs
✓ Audio Info
💰 Braille Signs

Image Source: Samarthyam
Bus/BRT Station Accessibility

✓ Ramps
✓ Tactile Pavers
✓ Visual Signs
✓ Hand rails
💰 Audio Info
💰 Brail Signs

Image Source: Samarthyam
Station boarding doors

High floor platforms require station boarding doors to prevent falls. Not necessary for low floor platforms (<400mm). All require 1:20 ramp access from at grade crossing.
Integration of IPT feeder modes at Stations

• IPT (auto rickshaw, e-rickshaw, cycle rickshaw) bays need to be planned outside the carriageway near the bus stations to avoid conflicting situation with accumulation of these modes near stations.

• IPT bays at bus stations will be near intersections ensuring safe access
Pedestrian Crossing at Stations – Safe Station Access

PT Safety
Safe NMT crossing types

1. Signalized Crossing
2. Half Underpass
3. Subway
4. FOB

Grade separated crossings may only be mandated at signal free, high speed, non-urban roads. To be avoided in urban setup.
Grade separated crossing access

1. At Grade
2. Escalator
3. Ramp
4. Steps

Elevators are required with all grade separated crossings – to ensure wheelchair access. It needs to be accompanied with other means to transition the grade to ensure capacity.
Pedestrian Crossing at BRT

All BRTS systems in the world include segregated bus ways – almost all of them are in the centre

- Physically segregated bus ways is a mandatory requirement of BRTS and safe/efficient arterial street design
- Left lanes cannot be physically segregated in urban areas - property access, side road access, parking access
- Central lanes are together - allow use of opposite lane for buses to escape through opposite lane in case of breakdown

HOW DO PEOPLE CROSS THE ROAD?

Image source - *Karl Fjellstrom, ITDP – China. **bikeblogs.org
BRT Station location for safe crossing

1. Near Side
2. Far Side
3. Common/Island
Pedestrian crossing at central and side bus lanes

Total of 12 lanes are crossed - 3 at a time

Total of 12 lanes are crossed - 2 at a time
PT Lanes and Roadway

PT Safety
Roadway Infrastructure Planning Principles and Features

• Roadway infrastructure design principles:
  • Transportation Safety – Minimize risk and severity of accidents
  • Efficient Roadway utilization – planned space for all functions and uses
  • Mobility Security – Ensure mobility by all modes.

• Roadway infrastructure design features:
  • Speed limit & design speed, no. of lanes, lane width, pedestrian infrastructure, cycle infrastructure, bus infrastructure, service lane, parking, location of services, location of service providers, intersection designs
# Roadway types and it’s elements

<table>
<thead>
<tr>
<th>Road Type (% of city network)</th>
<th>Speed Limit</th>
<th>Enforcement</th>
<th>ROW</th>
<th>No. of Lanes</th>
<th>Lane Width (excluding marking)</th>
<th>Segregation Type</th>
<th>Intersection Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arterial/Sub-arterial Road (10-15%)</td>
<td>50 km/h</td>
<td>Manual/Active</td>
<td>30-60m; 24 to 45m</td>
<td>4 to 6</td>
<td>3.1m for cars, 3.3m for buses</td>
<td>Median, <em>Bus Lanes</em>, <em>Service Lane</em>, Cycle Track, Footpath</td>
<td>Signalised junction, signalised roundabout (400 to 800m spacing)</td>
</tr>
<tr>
<td>Collector/Distributor Road (15-25%)</td>
<td>30 km/h</td>
<td>Traffic Calmed/Passive</td>
<td>15 to 30m</td>
<td>2 to 4</td>
<td>2.75m for cars, 3.1m for buses</td>
<td><em>Median</em>, Footpath</td>
<td>Roundabout, traffic calmed junctions</td>
</tr>
<tr>
<td>Local Road (60-70%)</td>
<td>15 km/h</td>
<td>Traffic Calmed/Passive</td>
<td>6 to 18m</td>
<td>1 to 2</td>
<td>2.75m</td>
<td><em>Footpath</em></td>
<td>Mini roundabout, raised crossing</td>
</tr>
</tbody>
</table>

*May not be provided at all locations*
Speed Limit & Design Speed

• Streets can be designed for planned speed limit – design speed should be the same as speed limits

• Currently streets are designed at 85% of observed speed which can be as high as 80km/h

• High efficiency and high utilization of current road space can be achieved by planning at speed limit
  • Sharper turning radius – narrower junctions
  • Lane width reduction by as much as 0.75m, carriageway width reduction by as much as 3.0m

• This leads to more space for pedestrians and cyclists – allows segregation without compromising space for cars

• Urban streets should be designed at posted speed limit. On Arterial roads this is 50km/h for general traffic. Bus speeds to be limited at 40km/h
Speed Control at Intersections: Issues and solutions

• Arterial/Sub Arterial Road – 50 km/h – Segregation is achieved in time using traffic signals – but what happens at night when no speed control or segregation/enforcement exist?

• Distributor/ Collector Road – 30 km/h – Lower volume and lower speed means passive measures such as roundabouts can be used.

• Local Roads – 15 km/h – Low volume and speeds, narrower junctions – raised crossings, mini roundabouts and raised junctions can be used
The role of Traffic Calming

Urban speed limits Enforcement: is it a burden on traffic police?
• Traffic police role only for active speed enforcement
• Only >=50km/h speed limit requires active enforcement.
• All speed limits < 50km/h can be enforced by passive measures – traffic calming.
• Arterial Roads are only 10-15% of city road network. Hence traffic calming is a viable solution for 85% streets in the city.
• Traffic calming is also desirable for speed control at intersection on arterial roads - especially for unsignalized intersections such as free left turns
Side effects of reserved bus lanes – Over speeding

• Over-speeding by buses in reserved lanes causes pedestrian fatalities
• Rumble strips can be installed at strategic locations in bus lanes
• Well placed safe pedestrian crossings
Accident Reduction Measures

Yearly Average Fatalities Before Construction on 5.8km Stretch of BRT Corridor, Delhi

- Cyclists: 4.6, 50%
- Motorist: 3.2, 35%
- Pedestrian: 1.4, 15%

Yearly Average Fatalities After Construction on 5.8km Stretch of BRT Corridor, Delhi

- Cyclists: 0, 0%
- Motorist: 0, 0%
- Pedestrian: 6, 100%

Comparison Between Accidents and Bus Speeding on BRTS Corridor, Delhi

No. of Speeding Incidents

- Fatal Accidents
- Major Accidents
- More than 70 Km/hr
- 60-70 Km/hr
- 50-60 Km/hr

No. of Accidents post installation of rumble strips in bus lane

- “ZERO”
BRT Eliminates Friction Ensures Safety
BRT Eliminates Friction Ensures Safety
PT Fleet

PT Safety
Boarding levels between vehicle and platform

Level boarding between vehicle and platform is necessary to ensure safety. Additional levels/steps in boarding increases risk of falls and reduces system capacity. It also renders the system inaccessible.
Universal Access to Bus – Possible with low floor bus

Level boarding at BRT

Wheelchair belt and space inside

Ramp to road level

Images Source: Samarthyam
Delhi Metro Vehicle Accessibility

✓ Level Boarding
✓ In-vehicle wheelchair belt and space
✓ Emergency escape ramp
✓ Platform level gates/access control to trains

Image Source: Samarthyam
PT Terminals/Stations and Depot

PT Safety
Passenger safety at bus terminal

Conflicts between passengers and buses to be minimized using min. 8m wide raised crossings, defined bus bays and boarding platforms.

1. Public amenities, reservation counter
2. Toilets
3. Footpath/static bus bays
4. Terminal office
5. Service bays/store
6. Uttam nagar metro station
7. Existing parking
8. TSR
9. Cycle rickshaw, bicycle parking
10. Gramin Seva
Staff safety at bus depot

Interaction between visitors, non-workshop staff and buses needs to be minimized through access control at administrative building.
Staff safety at bus depot

Interaction between visitors, non-workshop staff and buses needs to be minimized through access control at administrative building.
Thank you
sandeep@sgarchitects.in