Bus shelter as an integral part of the urban transport system in low-income countries

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ABSTRACT: Bus shelters in Delhi have been neglected so much so that they are now referred as a conflict zones. Cyclists and waiting commuters occupy the bus lane, buses pick and drop passengers at random spots, on the road and hawkers "encroach" upon areas designated for pedestrians and commuters. Responding to these problems a design exercise has been initiated for the development of 88 bus shelters on the Northern Ring Road, Delhi. Systemic parameters and performance specifications have been defined based on the initial survey of 15 sites spread throughout Delhi. The bus shelter designs are site specific and based on the survey of each site. Post construction survey conducted at these sites are being used to update the systemic parameters and performance specifications and develop it into a manual.

1 INTRODUCTION

Most cities in low-income countries rely heavily on the use of buses. It is a major means of mobility, particularly for the low and medium income population. Here the interface between the commuter and the bus at the Bus Shelter seeks prime importance. Unfortunately this issue has been neglected by the government of Delhi, so much so that the interface i.e. the bus shelter is now referred as a conflict zone. Cyclists and waiting commuters occupy the bus lane, buses pick and drop passengers at any random spot, on the road and hawkers "encroach" upon areas designated for pedestrians and commuters. The new bus shelters, recently constructed by the authorities, too fail to cater basic requirements, like commuter and bus capacity, access to non-motorized modes, interface with other modes of passenger transportation, such as auto rickshaws and cycle rickshaws.

The rising concerns on safety of commuters and traffic congestion caused by parallel parking of buses at bus shelters has prompted the authorities to lay more stress on development of these facilities. Following this the Delhi Transport Corporation (DTC), who owns and maintains bus shelters in Delhi associated with Transportation Research and Injury prevention Program (TRIPP), IIT, Delhi initiated a project for developing a 'Bus Shelter System'. The design of this system has been based on the understanding that conflicts between different users at the bus shelter i.e. commuters, hawkers, cyclists, cycle rickshaws, Motorized three wheeled rickshaws (auto rickshaw) and buses can be eased by designing for an integrated infrastructure based on their specific needs.

2 SYSTEMIC PARAMETERS AND PERFORMANCE SPECIFICATIONS

Though the bus shelter is the most common piece of public architecture no one single design solution can be used to produce them all. This is because the nature and intensity of conflicts at a bus stop and the issues concerning its users are dependent on specific site conditions and land-use patterns, which vary across the length and breadth of our 'urban fabric'.

The bus shelter being an integral part of the, bus based urban transport system in Delhi, cannot be designed in isolation. Thus a detailed study of the transportation system (buses) and the issues concerning it's interface with commuters, becomes imperative. To achieve a true representation of all types of bus shelter sites in the study, a broad categorization has been drafted. This categorization is based on the logic that the density of commuter and bus traffic at a bus shelter is dependent on the generating factors such as land-use, intersection status and road right of way (R/w). All of these factors can be arranged in a hierarchy. This hierarchy can be arranged in a matrix to group similar locations in 10 different categories (see table 1 and 2).

A detailed study has been conducted at 15 different sites (minimum 1 site for each category). The survey includes observations as well bus, commuter,

cyclists, cycle rickshaw, auto rickshaw and hawker counts.

Table 1. Hierarchy of traffic volume generating factors at bus shelters.

A. Land-use	B. Junction Status	C. Right of Way
1). Terminals	1). Major Junctions.	1) 60M. right of way
2). Commercial	2) Straight Stretch	2) 45M. right of way
3). Institutions		3). 30M. right of way
4). Religious		4). 24M. right of way
5). High Density Housing		
6). Low Density Housing		
7). None - Desolate		

Table 2. Categorization of bus shelters based on the functional hierarchy of traffic volume generating factors*.

Land-use	Junction Status	60 m R/w (1)	45 m R/w (2)	30 m R/w (3)	24 m R/w (4)
Terminal	1).Junction	1	2	3	4
	2)Straight St	2	3	4	5
Commercial	1)Junction	2	3	4	5
	2)Straight St	3	4	5	6
Institutional	1) Junction	3	4	5	6
	2)Straight St	4	5	6	7
Religious	1). Junction	4	5	6	7
	2)Straight St	5	6	7	8
High Density Housing	1)Junction	5	6	7	8
	2)Straight St	6	7	8	9
Low Density Housing	1). Junction	6	7	8	9
	2)Straight St.	7	8	9	9

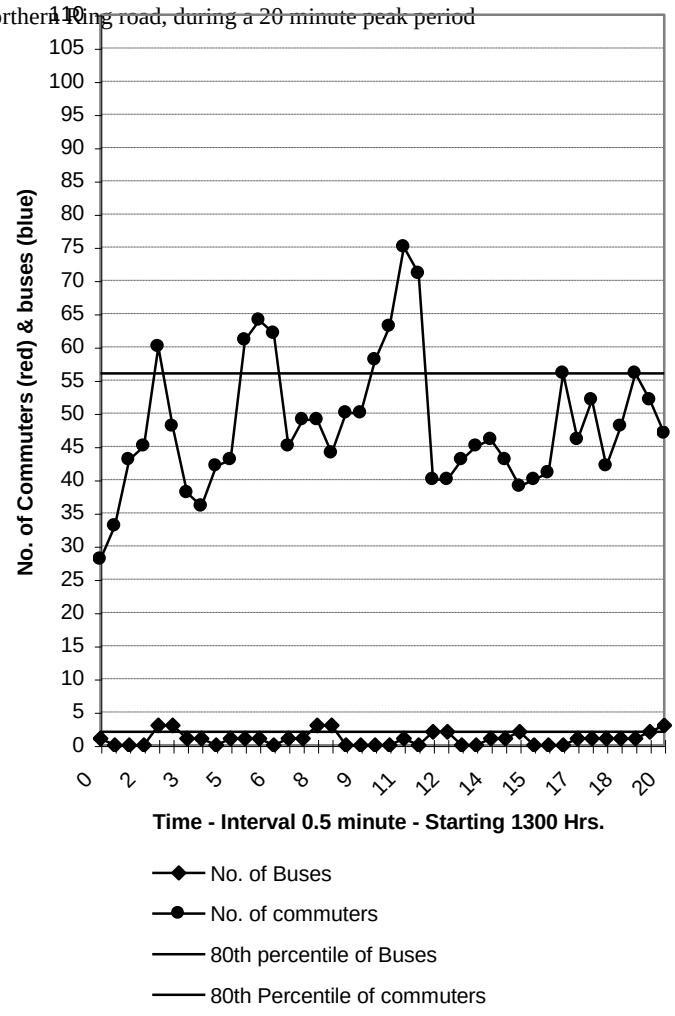
*Category 1 generates highest demand for traffic volume and category 10 generates lowest demand for traffic volume.

Commuter and bus counts comprised of 40 to 60 counts taken every 30 seconds (the time required by each bus to serve a bus shelter). Buses parking for periods longer than 30 seconds have been counted repeatedly over this quantum (to incorporate the effect of buses parking for extended an extended time period). The 85th percentile of these counts (taken at peak time) is used to define site-specific bus parking and commuter capacity requirement. The survey shows, that depending on the location of bus shelter in Delhi, the peak time commuter capacity requirement varies from 1 to 110 and bus capacity requirement from 1 to 4. Similarly auto rickshaws and cycle rickshaws counts have been recorded for each site to help design adequate parking facilities for comfortable inter-modal transfers at the bus shelter (see table 2 and figure 2).

The study of hawkers shelter reveals that the intensity and the nature of commercial activity generated at the bus shelter is directly proportional to the rate of flow of passengers which is represented by the bus parking demand (see figure 1 and 2). The study concludes, if the bus parking demand is less than 2 every 30 seconds, no separate infrastructure need be provided for hawkers (see figure 2). At locations where bus parking demand is 2 or more, space between two adjacent bus shelters can be developed for hawkers

In Delhi, no separate infrastructure exists for cyclists. Cyclists use the outermost or the curbside lane and thus conflict with buses entering or exiting the bus bay. This does not allow buses to park close to the bus shelters forcing the commuters to wait on the road.

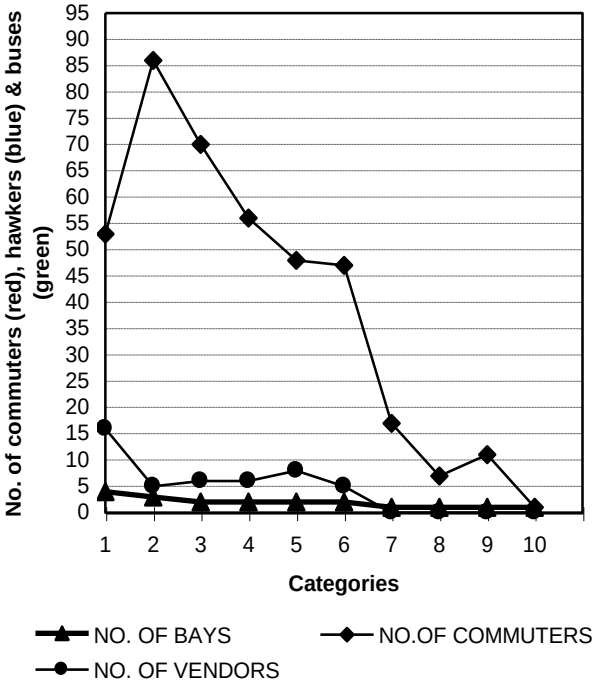
Figure 1. Buses and waiting commuters at Rajdhani College on Northern ring road, during a 20 minute peak period



.Based on these observations and the analysis of the survey results the following, ‘systemic parame-

ters and performance specifications have been drafted for bus shelters in Delhi:

– Bus shelter designs should be modular so as they can adapt to the varying commuter and bus traffic demands at different locations in the city.
– Provision for a separate cycle track should be made on roads where heavy bus traffic is expected (45m. and 60. Right of way roads).
– Standard road sections should incorporate space for 1.5m. to 2.5m. wide bus stops with a 1.0m wide boarding path in front.
– Space behind the bus shelters should include a minimum 1.5m. wide footpath for through pedestrian traffic and a 1.5m. to 2.5m. (for single or



both direction Non Motorized Vehicular (NMV) traffic.

Figure 2. Relationship between, hawker demand, bus bay requirements and commuter volumes.

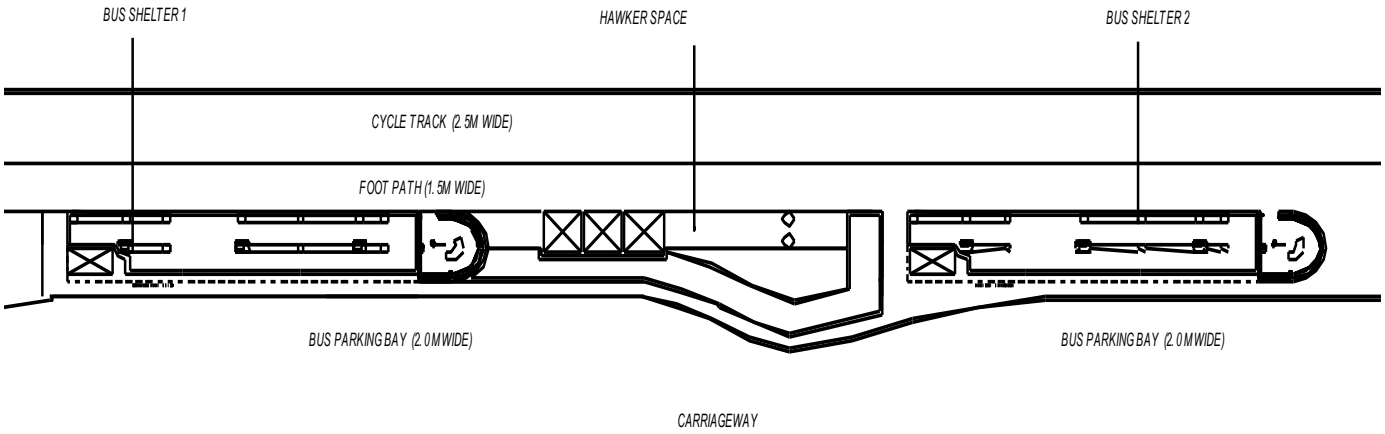
– Bus shelter designs on 45m. and 60m. right roads should incorporate a minimum 2.0m. wide bus bay between the bus shelter and the carriageway with designed bus entry turning radius for speeds no greater than 25km/h and exit speeds no greater than 10 km/h.

Figure 3. Layout plan for proposed bus shelters and hawker spaces on Northern Ring Road, Delhi

– For the comfort of commuters opting for change of travel direction at intersections, bus shelters should be located after the intersections. As transition lengths need not be incorporated for bus shelters to be placed after the intersection, they can be placed as close as 50m to the intersection, reducing the distance for the commuters.
– Bus Stops should be vandal proof, i.e. no part of the Bus Stop should be removable or damageable by miscreants.
– Bus Stops should be adequately lit, so that it could function properly at night. The light fixtures used should be completely vandal proof and easily maintainable.
– Bus Stops should provide adequate seating for waiting commuters. Since 30% of total work force in Delhi consists of women, a minimum of 30% of the total capacity should be seat able.
– All adequate and necessary information related to a Bus Stop location, should be displayed clearly at a Bus Stop.
– Wherever required, hawkers should be provided with a defined and designed paved space, so that they could conduct their business from that area without disturbing the flow of pedestrian and cyclist traffic.

3 BUS SHELTER DESIGNS FOR NORTHERN RING ROAD, DELHI

88 bus shelter sites are being developed for the DTC on the northern ring road (a 60m right of way road). These sites are being developed in 22 stages of 4 sites each, to allow assessment and further improvement at each stage. The design developed for DTC is a modular design, which can be arranged to cater to varying commuter and bus capacity requirements at different sites. The shelter design consists of two, three or four, 2.5m x 4.25m modules arranged, linearly (based on the commuter capacity requirements) to produce 8.5m x 2.5m, 12.75m x 2.5m or 17m x 2.5m bus shelters respectively. These bays



can be repeated at the same location if the survey results show bus-parking requirements as more than 1. For all such locations, a methodology for assigning bus routes to different shelters, based on the route frequencies and direction of travel has been worked out so as the commuters retains the freedom of route selection. The space between the shelters is proposed to be utilized as "Hawker Space", The hawker space brings together facilities for cart vendors, temporary stall operators and pavement based vendors so as they operate as mini bazaar providing for all possible commuter requirements from water to fresh fruits. The proposed bus shelter is, user friendly and efficient for all, including commuters, hawkers, bus operators and other vehicles using the road surface including cyclists. Other important characteristics of the proposed bus shelter designs are:

- External information display sizes have been worked to ensure their readability from and distance of upto 50m (refer figure 4).

Figure 4. Bus shelter at Wazir Pur Depot - I, view from carriageway

- Internal information display system consists of 0.4m x 1.1m route time table display (louvered to discourage sticking of bills) and 0.4m x 1.1m boards to display route chart, map of Delhi with route layout and local area map.
- Advertising space has been located to make it attractive for advertisers without cluttering the external information display (refer figure 4).
- The choice of construction material including that of light sources has been to keep it as far as possible vandalism and maintenance free, as well provide for a fast and industrial quality construction.
- Light sources have been located above each of the internal information display boards.
- Two rows of seats have been provided. These have been moulded in a curve so as they are not misused for sleeping and they occupy less floor area of the shelter.
- Buses have been provided with docking/parking space outside the main carriageway with kerbs designed for design speed of 25 km/h for entering turning radius, and 9 km/h for exiting turning radius
- Space has been provided for future display of latest bus information through electronic sign boards
- Space has been provided for ancillary services, such as ticket vending and police picket etc

Figure 5. Bus Shelter at Wazir Pur Depot - I, view from cycle track.

- Cyclists have been provided with a separate and segregated cycle track behind the bus shelter, so as they do not interfere with bus docking. To allow the cyclists on the carriageway an easy access to the cycle track, a 40 m, permeable stretch of the cycle track runs parallel to the cariageway before bending behind the bus shelter.
- Signposts have been provided to help all bus shelter users, identify facilities provided for them.

4 LESSONS LEARNT

The first set of four, bus shelter sites have been taken up for construction. Out of these, one site at 'Wazir Pur Depot - 1' has been declared operational. Here a 200m long, 2.5m wide cycle track, has been provided behind the bus shelter, connecting the carriageway on either side. A 1.2 - 1.5m wide footpath runs adjacent to the cycle track. Three bus shelter, each 12.75m x 2.5m in area have been arranged linearly along the carriageway, with 16m x 3.5m 'hawker

spaces segregating them. Each bus shelter has provision for a 0.9m wide boarding path followed by 2.0m wide bus parking bay in front. Parking space for 4 auto rickshaws has been provided at a distance of 10m from the last bus shelter.

The post construction study conducted at this site shows that the design achieved limited success in removing conflicts between various bus shelter users. Although signposts and information board demarcate in clear text and symbol, assigned circulation and functional spaces for hawkers, cyclists, auto rickshaws, commuters and buses (segregated route wise), the users avoid any order. Cycle track is encroached by pedestrians, hawker space by waiting commuters, bus bay by hawkers and auto rickshaws, and carriageway by cyclists and parked buses (refer figure 6).

Figure 6. View of Wazir Pur Depot - I Bus Shelter. Hawkers and auto rickshaws encroached the bus bay, before the 'user interaction exercise' was taken up by the project team.

A survey based on user interaction was taken up to identify the shortcomings of the system. The study identifies, design defects and lack of education/ interaction with the users as the route cause of the problem.

4.1 *Design Defects*

The following design defects have been identified in the system:

- The pedestrian footpath provided behind the bus shelter was found to be too narrow for the pedestrian traffic generated at this site. The footpath width requirement is estimated to be 1.8m (instead of 1.2 - 1.5m width, provided - refer figure 5).
- The bus parking bays, which have been designed for, safe entry and exit design speeds of 25 km/h and 10 km/h respectively, require a strenuous use of the steering wheel to complete the parking. Since the buses operating in Delhi are not equipped with 'Power Steering', the drivers avoid this maneuver. Buses park upto 4m. away from the bus shelter (bus shelters are set back from the carriageway by 2.0m wide bus bay) forcing the commuters to wait in this space and inviting hawkers and auto rickshaws to the proximity of their clients.

Following the study, design changes have been incorporated for other sites, under construction in the first phase of the project. Footpaths are being widened and bus bays are being made more gradual for entry at 35 km/h and exit at 15 km/h.

4.2 *Lack of Education*

The interviews conducted at the Wazir Pur Depot bus shelter reveal, that even though they use it every day, none of the users could relate to the new bus shelter or any of it's "user friendly" features.

Figure 7. Wazir Pur Depot - I, Bus Shelter. View of 'hawker space' from service lane, after the 'user interaction exercise' was undertaken by the project team.

Following this study, the project team, with the involvement of 'Lokayan' a local NGO, organized group meetings with the hawkers. This was met with a tremendous response from the vendors who have not only organized themselves within the confines of the two 'hawkers spaces' but also taken up the responsibility of cleaning and maintaining it (refer figure 7). This has also led to the reduction of cases of harassment by Police and Municipal authorities. These vendors now act as volunteers and direct, auto rickshaws, cycle rickshaws and buses to their demarcated parking spaces. The traffic police have been involved in directing the cycle traffic off the carriageway and on to the cycle track.

Commuter form a wide and varied bus shelter user group, therefore a direct interaction with them is unlikely to effect their behavior. To address them, a presentation of information regarding the user specific features of the bus shelter, on an announcement/ information board, installed at the site, is proposed.

4.3 *Conclusions*

This experiment is already showing positive results. Cycle and auto rickshaws, confine to there designated parking spaces (refer figure 8) and buses park opposite their respective bus shelters (though still outside the bus bay). Cyclists have started showing some enthusiasm towards the cycle track though it's use is limited. As most cyclists are long distance travelers, they refrain from using a 200m detour on 15 km journey. The cycle track facilities are now seen as a part of a long-term objective to provide a continuous cycle tracks on either side of the ring road.

Figure 8. Auto Rickshaw parking at Wazir Pur Depot - I, bus shelter. Orderly parked auto rickshaws after the 'user interaction exercise' was conducted.

Lessons learnt from the experiment show that though user specific design is crucial to the development of a safe and efficient bus shelter system it cannot work in isolation. Hence design, education and enforcement should necessarily follow each other in that order to ensure acceptability and efficient working of the bus shelter as an 'integral part of the urban transportation system in low income countries'.

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