

## Urban Design of On-Street Stops and Road Environments: A Conceptual Framework

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### ABSTRACT

Transit stops should be situated where they are convenient to use and the safety of passengers and alternative road users has been taken into consideration. A review of literature has indicated that there are some important factors that should be taken into consideration at the design and planning stage. These factors have been found to have the ability to influence the location of a transit stop and transit shelter. The underlying focus of this paper is that on-street stops and their connecting roads are viewed as a holistic environment, instead of an ordinary place or location for transit modes to make a stop. This environment includes elements such as: Accessibility through street connectivity, street and road design, and transit stop design. This paper develops a conceptual model that links the various variables together, highlighting how one affects the other and their impact on the overall ability to produce a good passenger experience, which is the fundamental goal of any successful on-street stop design. This paper concludes that transit stops are easier to locate when there is high street connectivity which determines to a large extent how transit passengers gain access to transit service. Also, proper design and configuration of on-street stops and connecting roads lead to increased safety, thereby leading to increased ridership and revenue and also impact how everyone on the street interacts with the transit system.

**Keywords:** Travel Behavior, Transit Stop Design, Street Connectivity, Transit Ridership, Road Network Design

### Introduction

The underlying focus of this research is that the on-street stops and their connecting roads are viewed as a holistic environment, instead of an ordinary place or location for transit modes to make a stop. This environment includes components such as: Accessibility through street connectivity, street and road design, and transit stop design. Transit stops should be situated where they are convenient to use and the safety of passengers and alternative road users have been taken into consideration. Enhancing road travel stops achieves a double strategic goal of making travel increasingly appealing, while at the same time carrying colossal advantages to openness and execution. Travel Stops are

frequently where existing and potential travel clients initially associate with a travel administration; stops offer basic data and the measure of solace and fulfillment riders infer is subject to the travel administration.

Stops can be updated utilizing between time configuration measures, however, consolidating top-notch travel stop structure and conveniences into capital activities can extend passerby limit and advance travel roads as an attractive spot in the urban condition. Making a basic, simple, and wonderful involvement with the travel stop develops the capacity of the whole framework, and may encourage rebuild travel from a fundamental inclusion

administration to an attractive portability choice.

Stops are utilized as an approach to pull in riders, improve operational proficiency and empower nearby financial advancement. Travel stops have been found to exist on a continuum, from negligible sign-and-shaft stops to totally shut in stations. Though money related requirements frequently limit the accessibility of stop components on existing courses, interests in great stops can change both the discernment and truth of travel administration and increment travel utilization rates.

The design, prominence, and comfort of a transit stop is the initial indication that users receive regarding their own potential experience as passengers. Stop elements and design have a control on all the key decision points during a transit trip, affecting whether or not a trip is taken by transit or a competitive mode, and even whether or not to make a specific trip at a specific time of day or in uncertain weather. Platforms enable faster boarding, good maps and signage make trips easier, and integrating stops with adjacent buildings or green infrastructure can dramatically enhance the streetscape.

### **Literature Review**

A researcher [1] deduced that the most significant determinant of client fulfillment with their travel stop or station had little to do with physical attributes of that specific stop or station. As per the exploration, client fulfillment had to do with its recurrence and dependable assistance in a domain of individual security. This implies most travel clients would incline toward short, unsurprising hangs tight for transports and prepares in a safe, if straightforward or even grim condition, over long sits tight for late-running vehicles in even the most complicated travel office, particularly if the issue of wellbeing is included. Travel clients allocated the most significance to variables

related to security and wellbeing, and beside components identified with network and trustworthiness. This analysis indicates that the most important factor affecting transit users' overall stop/station satisfaction is on-time performance, followed by presence of a security guard for safety, adequate lighting, adequate safety throughout the day, simplicity of getting around a facility, and good sign posts. Decisively, while comfortable, enlightening, and alluring stops and stations can make going by open travel progressively pleasing, what travelers truly need most as indicated by this exploration, is protected, regular, and solid assistance.

According to another research, [2] transit agencies believe that passenger safety and security are by far the most important determinants of a good stop or station. This finding was found to be consistent with the conclusion of another study [3]. While much of the literature on transit stops and stations had not distinguished the relative importance of passenger safety and security, the research findings are consistent with behavioral studies of the "out-of-vehicle" travel experience of transit users by [4] and [5]. While many of the findings reported in this research seemed to be generally discovered in transit user behavioral research, respondents' strong emphasis on functional attributes—safety/security, pedestrian/vehicle conflicts, schedule coordination, etc., suggests something quite important: that the tendency to focus on physical attributes in transit facility design [6] [7] is of limited use at best, and potentially misleading at worst.

A study [8] examined the evaluation of passengers on transit stops and stations, taking into consideration the level of importance passengers place on each factor, and the factors that influence passengers' evaluation of transit stops and stations using the five evaluation criteria categories which are: access, connection and reliability,

information, amenities, security and safety. An Importance-Satisfaction Analysis was carried out to identify the priority that the users place on improving transit stop and station attributes. Also, chi-square tests, correlation tests, and multiple regression analyses were used to examine which transit stop and station attributes measured in the inventory were related to the satisfaction level of transit users. While comfortable, educational and appealing stops and stations can, in fact, make commuting by open travel increasingly pleasant, what travelers truly need most is protected, incessant, and dependable service. The area surrounding any public area is equally important to its success as the design and management of the area itself. This goes for stations and stops as well.

Another examination [9] effectively applied both factual and spatial investigations to look at the connection between every one of the administrative regions, populace clients, cover regions, and opened neighborhoods. As far as spatial openness, most stations were seen as very much got to, while five significant basic causes were the impedances bringing about poor accessibility. Additionally, a few stations were found to have enormous territories of coverage, while some others with little cover regions. For stations with a limited quantity of administration region inclusion, an improvement in the density of street system was considered as one of the arrangements. The concept of accessibility was studied as it works for the interest of the users. Although the distance between stops is increased after stop consolidation, still these are kept within the convenient walking distance. It considers the user's perception of accessibility through the users' willingness to walk the maximum walking distance of the transit service.

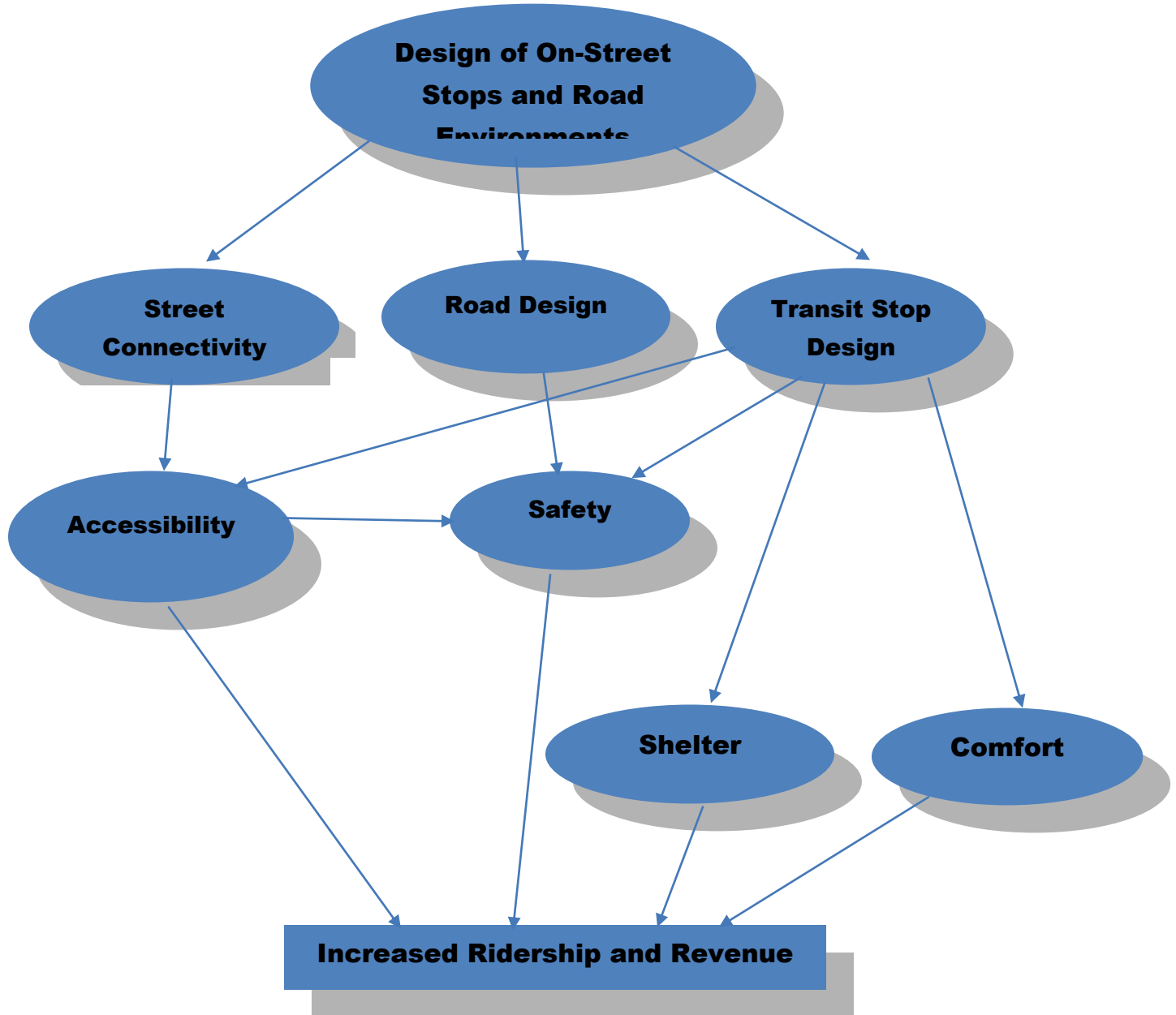
A research by [10] revealed that users' choice is influenced by the perception of the

time spent waiting, boarding, or riding, and research suggests that these perceptions depend on the amenities of the stations and vehicles. In other words, travelers are more likely to take transit if they can wait in a heated and sheltered station and get work done during the ride than if they must wait at an unsheltered bus stop and endure a cramped or otherwise uncomfortable ride. Thus, even if service frequency does not increase, more people can be attracted to transit by improving the attractiveness of the stations and vehicles. Overall, enhancing station and vehicle environments had a different effect on different kinds of transit users and ridership in general.

Another study [11] concentrated on the effect of separation to travel on movement mode decisions. Because of the way that the association between travel access and travel use is more straightforward than the association between travel access and Vehicle miles traveled (VMT), the assessed impacts for the previous were seen more uncertain as directed by different variables. Likewise, the assessed consequences for travel use cannot be straightforwardly converted into evaluated impacts on VMT for many reasons: not all travel excursions supplant a driving outing, and in any event, when they do, an individual's goal may change when his mode changes, prompting contrasts in the trip distance. If occupants who like to use travel will undoubtedly house areas inside the nearby separation of movement stations, their lower VMT would start from their movement tendency similarly as their closeness to the station. Guaranteeing movement availability is an indispensable assignment for practical urban improvement. Different examinations have likewise shown what number of individuals have generally simple access to public transit as far as both physical access and the degree of administration recurrence gave. These patterns attest to the desires in

public travel improvement and land use designs that all the more thickly rented urban zones would in all likelihood feature high-quality public transport.

Based on the major issues arising from literature review, a conceptual model of the design of On-street stops and Road environments is presented in Figure 1 below:



**Fig 1: Conceptual Model of On-Street stops and Road Environment Design**

The analysis of the conceptual framework in Figure 1 and the issues surrounding it are discussed below:

***Street Connectivity***

While the impacts of density and land-use on travel behavior have long been

**Analysis of Model**

acknowledged, street network design has received less attention. Thus, literature on network effects on travel is comparatively restricted. Design of street networks are shown to be significantly related to the decision to patronize transit and other non-motorized modes. Connectivity patterns and spatial structure of street networks bring origins and destinations nearer by providing comparatively direct routes. They also generate different densities of interface between streets and premises, thus different opportunities to combine a walk to/from the station with other activities. Finer-meshed urban grids are found to offer a variety of choices for meeting people's daily travel needs and creating more opportunities for shorter, purpose-driven walks. Thus, people are less likely to drive and more likely to use transit and walk for transit in well-structured and differentiated street networks. This is reflected in lower VMTs and higher non-motorized trip rates and ridership levels.

Various quantitative measures are steered by the urban-design literature to measure street connectivity. Block sizes, the density and pattern of intersections, and block face lengths among other factors have been employed to describe connectivity [12] [13]. Using such measures, several studies have reported significant relationships between transit and street network design. In a study [14], VMT for non-work trips was found lower in neighborhoods with higher proportion of 4-way intersections or quadrilateral-shaped blocks ratios. A study by [15] reported lower conveyance travel in areas with small blocks kind of like ancient grid pattern. A few studies utilized simulation models to forecast travel impacts of neo-traditional communities. Also, [16] used travel models to conclude that neighborhoods with one-dimensional street layouts was calculated to be an average of 43% lower VMT.

Using a comparative method, [17] examined two pairs of areas in Orange County, CA, one with grid street patterns, the latter with irregular street patterns. Results of bivariate and multiple regression analyses showed a strong relationship between bus ridership rates and pedestrian access, characterized by population density quantified for each catchment area based on the magnitude relation of street length within the area to the total street length within the census tract. Directional accessibility plays as vital a role as metric accessibility in influencing the proportion of riders walking for transit.

#### ***Accessibility through universal design***

Accessibility has been perceived as one of the most significant components that influence travel use. Travel availability alludes to the capacity of users to arrive at travel offices, including transit stops as well as rail stations [18]. Numerous elements add to accessibility, including sensible nearness from the root and the destination to the service; protected, wonderful, and open to strolling pathways and road network to travel offices; and adequate parks for vehicles or bikes, and so on. An individual may live near a bus station yet at the same time does not approach travel on the grounds that there are no avenues or strolling ways that interface the starting point and the stop, or there are some common or man-made boundaries, for example, channels, network dividers, or wall encompass an advancement that square access.

A significant condition for satisfactory travel is that the user must have the option to stroll between the travel stops and the travel starting point and destination inside a reasonable measure of time (5 minutes or  $\frac{1}{4}$  mile separation is an ordinary standard). In the event, that entrance to travel is via car, for example, in a recreation center and ride trip, at that point the park should be situated on the course to the stop point. Park and ride

outings will likewise require walk access toward one side of the travel. On account of auto travel, the vehicle must be situated inside sensible walk distance to both the trip origin and destination

A universal design is a design that caters for both the old and young, able and disabled, etc. A short, cozy stroll from a start or stop to a travel station might be a standard guideline for multimodal urban structure and development. Urban planners generally assume that individuals of all ages will easily walk approximately 400 meters (one-quarter mile) to get to transit stops or stations [19], [20]; as walking distance to transit increases, people will be less likely to use it if they need different travel alternatives [21]. Easy access to public travel is an establishment for neighborhood planning for users and travel-oriented plans. Riding transit requires a passenger to possess sufficient mobility for travel—by walking some or all of the way—between origins, destinations, and transit stops. The nearness of walkways and foot pathways expands the potential number of commute [22] and the probability of walking [23] [24] [25] [26]. The nature of a pedestrian area is a solid indicator of walking conduct and travel [14].

#### *Road Design*

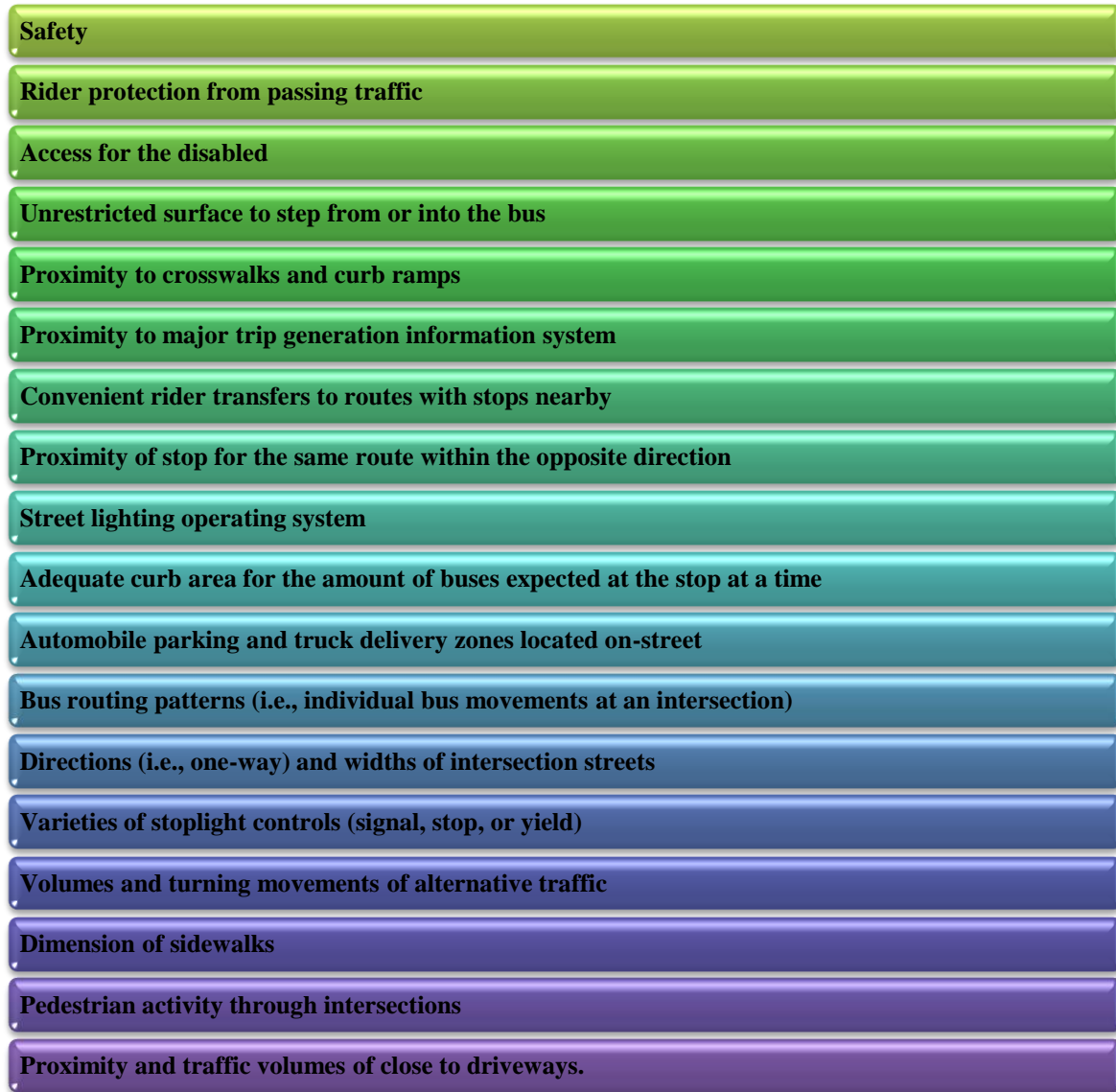
##### **PLACEMENT OF BUS STOP—Far-Side, Near-Side, and Midblock Stops.**

Choosing the correct area of travel stops includes settling on either far-side, close side, and midblock stops (see Table 1). The following factors should be carefully considered when choosing transit stop type: Adjacent land use and its activities, transit route (for example, is bus turning at the intersection), bus signal priority (e.g., far

A stop ought to be accessed by a walkway in great condition between the bus station and the nearest convergence. In addition, a safe, nearby street crossing with curb cuts for wheelchairs, is required; almost all riders will need to make round trips using a pair of bus stops. For denser areas where it is likely that many people visit multiple destinations in a single bus trip, priority should be given to making sure that there is an accessible path throughout the area. For bus stops which serve mostly a single destination, the focus can be on a path between that destination and the bus stop.

After ridership potential has been established, the foremost important factors in transit stop placements are safety and refrain from conflicts that may obstruct bus, car, or pedestrian flows. In choosing a site area for location of a bus stop, the need for future riders' amenities is a very vital thought. Possibly, the transit stop should be situated in an area where typical enhancements, such as a bench or a transit stop shelter, can be provided. The final resolution on transit stop location depends on a lot of safety and operative components that on-the-scene analysis. Vital elements in transit stop placement is shown in Figure 2 below:

side placement, impact on intersection operations, convergence transit routes, convergence geometry, parking restrictions and needs, passenger origins and their destinations, pedestrian access, as well as accessibility for handicap/wheelchair patrons, physical road margin constraints (trees, poles, driveways, etc.), presence of bus detour lane, traffic control devices.



**Fig 2: Vital elements in transit stop placement**

Figure 2 shows the merits and demerits of transit stop road types.

**Table 1: Merits and Demerits of Bus Stop Placement**

Transit Road Design	Merits	Demerits
<b>Far-Side Stop</b>	<ol style="list-style-type: none"> <li>1. It encourages pedestrians to cross behind the bus</li> <li>2. It minimizes conflicts between right turning vehicles and buses</li> <li>3. Bus drivers are able to take advantage of the gaps in traffic flow that are created at signalized intersections</li> <li>4. It minimizes conflicts between right turning vehicles and buses</li> </ol>	<ol style="list-style-type: none"> <li>1. It could result in traffic queued into intersection when a bus is stopped in travel lane</li> <li>2. It can cause a bus to stop far side after stopping for a red light, which interferes with both bus operations and all other traffic</li> <li>3. It could result in intersections being blocked during peak periods by stopping buses</li> </ol>

	<ol style="list-style-type: none"> <li>5. It creates a shorter deceleration distances for buses since the bus can use the intersection</li> <li>6. It minimizes sight distance problems on approaches to intersection</li> </ol>	<ol style="list-style-type: none"> <li>4. It could increase the number of rear-end accidents since drivers do not expect buses to stop again after stopping at a red light</li> <li>5. It could obscure sight distance for crossing vehicles</li> <li>6. It could increase sight distance problems for crossing pedestrians</li> </ol>
<b>Near-Side Stops</b>	<ol style="list-style-type: none"> <li>1. It eliminates the potential of double stopping</li> <li>2. It provides the driver with the opportunity to look for oncoming traffic, including other buses with potential passengers</li> <li>3. It minimizes interferences when traffic is heavy on the far side of the intersection</li> <li>4. It results in the width of the intersection being available for the driver to pull away from the curb</li> <li>5. It allows passengers to board and alight while the bus is stopped at a red light</li> <li>6. It allows passengers to access buses closest to crosswalk</li> </ol>	<ol style="list-style-type: none"> <li>1. It could cause sight distance to be obscured for cross vehicles stopped to the right of the bus</li> <li>2. It increases sight distance problems for crossing pedestrians</li> <li>3. It increases conflicts with right-turning vehicles</li> <li>4. It could block the through lane during peak period with queuing buses</li> <li>5. It could result in stopped buses obscuring curbside traffic control devices and crossing pedestrians</li> </ol>
<b>Mid-block Stop</b>	<ol style="list-style-type: none"> <li>1. It could result in passenger waiting areas experiencing less pedestrian congestion</li> <li>2. It minimizes sight distance problems for vehicles and pedestrians</li> </ol>	<ol style="list-style-type: none"> <li>1. It increases walking distance for patrons crossing at intersections</li> <li>2. It requires additional distance for no-parking restrictions</li> <li>3. It encourages patrons to cross street at midblock</li> </ol>

**Table 2: Merits and Demerits of Transit Stop Road Type**

Stop Road Type	Merits	Demerits
<b>Curb-side</b>	<ol style="list-style-type: none"> <li>1. It is easy to relocate</li> <li>2. It is simple in design</li> <li>3. It provides easy access for bus drivers and results in minimal delay to bus</li> </ol>	<ol style="list-style-type: none"> <li>1. It could cause drivers to make unsafe maneuvers when changing lanes in order to avoid a stopped bus</li> <li>2. It could cause traffic to queue behind stopped bus, thus causing traffic congestion</li> </ol>
<b>Bus bay</b>	<ol style="list-style-type: none"> <li>1. It allows patrons to board and alight out of the travel lane</li> <li>2. It minimizes delay through traffic</li> <li>3. It provides a protected area away from moving vehicles for both the stopped bus and the bus patrons</li> </ol>	<ol style="list-style-type: none"> <li>1. It is difficult and expensive to relocate</li> <li>2. It could present problems to bus drivers when attempting to re-enter traffic, especially during periods of high roadway volumes</li> </ol>
<b>Nub (or Curb Extensions)</b>	<ol style="list-style-type: none"> <li>1. It decreases the time and walking distance for pedestrians crossing the street</li> <li>2. It results in minimal delay for bus</li> <li>3. It removes fewer parking spaces for the bus stop</li> </ol>	<ol style="list-style-type: none"> <li>1. It costs more to install as opposed to curbside stops.</li> </ol>



	4. It provides additional side walk area for bus patrons to wait	
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Definitively, a few things ought to be viewed when structuring and finding a bus station on a roadway. The following ought to be checked on with each plan since it unites related issues that can significantly affect the sheltered tasks of the bus station.

**Regularization:** One of the most basic factors in the roadside plan and situation of a bus station includes regularization or consistency. Regularization is intriguing because of the way that it prompts less disarray for transport administrators, travelers, and drivers. Consistency in style, be that as it may, will be hard to acknowledge since traffic, parking loss, turning volume, neighborhood inclination, and political contemplations will impact the decisions.

**Intermittent Review:** An occasional audit of transport stops conditions (both roadside and curbside) is prescribed to guarantee the wellbeing of transport travelers. This will support the opportune recuperation of things like missing stop signs and poor asphalt pavement.

**Near Side, Far-Side, Midblock Placement:** Each kind of arrangement has focal points and detriments. All in all, every stop area ought to be assessed in a steady progression to pick the best area for the stop.

**Perceivability:** Transit stops ought to be anything but difficult to see. On the off chance that the stop is clouded by close by trees, posts, or structures, the transport administrator may have issues finding the stop. In any case, drivers and bicyclists may not comprehend its reality and will not have the option to play it safe when drawing near to, and passing the stop. Likewise, perceivability to pedestrians walking across a road is additionally a significant thought in territories that permit "right turns on red."

**Bike Lanes and Thoroughfares:** When a bicycle path and a travel stop zone are both present, the administrators should be in a situation to locate cyclists in the two headings when moving toward the stop. Adequate sight distance for cyclists to stop securely after halting is furthermore required.

**Stoplight and Signs:** Transit stops ought to be arranged so transports do not block the perspective on traffic flags and signs from different vehicles. Because of the way that all transport travelers, in the end, become people on foot when they alight, pedestrian signal markers ought to be introduced at close-by signalized crossing points.

#### *Transit Stop Design*

Configuration highlights may likewise influence ridership by making the accessibility state of transit stops pretty much alluring. A few investigations discovered that the road network had an essentially positive association with travel ridership. Some studies also concluded that bust stop amenities, such as having signs, shelters, schedules, lighting and paved landing areas were significantly and positively correlated with increased ridership; pedestrian/bicycle friendly design was positively associated with ridership and transit usage rates. It was likewise inferred that structures and stop territories planned with fascinating highlights are probably going to empower ridership. According to [27], there is a degree of variability in transit ridership from stop to stop, and a few studies apply inferential statistics to determine if observed changes in ridership are beyond what may be due to chance by this stop-to-stop variation in ridership.

Further research was carried out to ascertain what the riders really want, and what gives them satisfaction in their day to day use of

transit stops and also what their expectations are. This research was carried out by Shannon Mandel. At the point when study respondents were solicited to rank the significance from conceivable help upgrades, those identified with time, recurrence and cost took positioned most elevated, trailed by transport havens and continuous data. What positioned least was innovative 'additional items' like USB ports and free Wi-Fi scarcely enlisted with respondents. Restorative upgrades like new walkways and plants prompting transport stops likewise weren't viewed as significant. Some help variables didn't rank exceptionally either. The study proposes that riders are all the more, ready to acknowledge late transports and a more drawn out stroll to the bus station than they are eager to acknowledge long hold up times and moderate rides.

Since travel riders acknowledge upgraded transit service frequency and quicker travel times more than everything else, it is more astute to center improvement endeavors in these zones. This basically shows what matters to transit users and what does not. Toward the conclusion of the project, it was then presumed that course improvement can set aside organizations' cash by diminishing driver-hours. It can likewise profit riders by shortening trips, and when routes are shortened, the time that was spared can be utilized toward increasing service frequency on prevalent routes. A ton of riders likewise believes it's critical to have shelters at transport stops. This bodes well – who needs to hang tight outside for an extensive stretch of time without cover from the elements? Transport shelters can improve rider fulfillment, yet on the off chance that service frequency is improved, the significance of shelters might be decreased.

Travel clients additionally evaluated constant traveler information frameworks as being genuinely imperative. Traveler data

frameworks might be shown to riders by means of advanced signs at transport stops, or through a cell phone application or web-based interface. It likewise enables riders to diminish their hold up time by arranging their landing in the bus station for only a couple of minutes before the transport shows up. Applications were seen as valuable for this reason since riders can get to the apps while in a hurry. A recent report on New York City's transport framework found that throughout three years, ridership expanded by 2% on account of their new traveler data framework. This implied over \$6.3 million in included income over the three-year time frame. The stop itself serves many purposes: It signals the presence of transit service, it provides information about the transit service that is provided, it provides information about the surrounding destinations, it provides a place for passengers to wait comfortably and securely, it may provide a place to park a bicycle, it makes provision for a place for the transit vehicle to pause, it provides a surface for passengers to board the vehicle [28].

Enhancing road travel stops achieves a double effect, in that, the trip is increasingly alluring, while at the same time carrying huge advantages to accessibility and performance. Travel Stops are regularly where existing and potential travel clients initially connect with a travel administration; stops offer fundamental data and the measure of solace and fulfillment riders infer is subject to the travel administration. Stops can be redesigned utilizing break configuration measures, yet fusing top-notch travel stop structure and comforts into capital projects, can grow pedestrian limit and advance travel boulevards as an alluring spot in the urban condition. Making a basic, simple, and knowledgeable experience at the travel stop develops the capacity of the whole framework, and may encourage redesign

travel from an essential coverage service to an alluring mobility choice.

#### *Transit Stop Design Elements*

Stops are used as a way to attract riders, improve operational efficiency and encourage local economic development. Travel stops exist on a continuum, from negligible sign-and-post stops to totally shut-in stations. While fiscal limitations frequently limit the accessibility of stop components on existing courses, investments in excellent stops can change both the observation and truth of travel service and increase in travel utilization rates. The design, prominence, and comfort of a transit stop is the initial indication that users receive regarding their own potential experience as passengers. Stop elements and design have a control on all the key decision points during a transit trip, affecting whether a trip is taken by transit or a competitive mode, and even whether or not to make a specific trip at a specific time of day or in uncertain weather. Platforms enable faster boarding, good maps and signage make trips easier, and integrating stops with adjacent buildings or green infrastructure can dramatically enhance the streetscape.

Seating is among the foremost characteristics at transit stops. Seats are an opportunity to incorporate appealing structures and solid materials into a travel stop. Seats ought to be structured or chosen on the reason of solace comparative with expected hold-up time and loading up request at a stop. Giving cozy seating at or near travel stops significantly improves the solace of the client experience. It will likewise give important resting places whether or not there is a need to commute

#### *Assessment Tools*

1. *Safety*: In an overview of transport riders and affirmed by a few different studies, wellbeing, especially safety is deliberately stratified as perhaps the best need at

a stop. Without a sufficient degree of perceived safety, transit users will essentially decide not to utilize the bus station. Issues of security may result from crime or physical dangers, for example, high vehicular traffic or tricky surfaces, generally classified as Risk of Accident and Risk of Crime. To guarantee the security of transit users, sufficient pedestrian insurance must be given. Plans that have demonstrated effectiveness, incorporate more stoplights, crosswalks and boundaries between commute modes.

2. *Acoustic Comfort*: Several factors contribute to the high noise levels at stops and stations: The high speed of traffic on the freeway, the short distance between station platforms and freeway travel lanes, the presence of structures above the platforms like canopies and roadways that throwback noise onto the platform. Exposure to high levels of noise has both short and long term negative effects. Long term effects may include harm to human health: Potentially, continual exposure to high noise levels at these highway-centered stations may cause damage to transit riders' hearing and circulatory systems. There is a conclusive link between hearing loss and exposure to high ambient noise levels, and daily commuters who use stations in noisy highway medians over the course of many years may suffer from hearing loss. Much of the variation in noise levels is due to factors that cannot be controlled by the design and layout of the stops and stations. Nevertheless, some

design elements, particularly when used can reduce noise significantly.

The recommendations made are:

- a) Attempt to reduce noise levels at existing stations with additional benches. The large benches provide some noise reduction, albeit only 4 or 5 decibels. Large benches would prove ineffectual for noise reduction at the light rail stations, however, because the bench will only block noise from one side of the freeway, and so will have little or no reduction in the overall noise levels.
- b) Investigate ways to dampen or deflect noise that reflects back from canopies and overhead roadways. The shape of the canopies or the material used to construct them may help to reduce the amount of noise reflected back onto the platforms. At some stops, the canopies are curved, which reduces the amount of sound that reflects directly back onto passengers. Materials that absorb sound may also reduce these levels to a further extent.
- c) Install sound walls at stations. Clear materials such as Plexiglas can be used to build sound walls that do not have the effect of enclosing the station with dark material.
- d) Build enclosed but transparent waiting areas on platforms

3. *Thermal Comfort*: Transit stop amenities were characterized based on the capacity to provide relief from heat and correlated with transit ridership; the analysis conveys that stops with higher vulnerability to extreme heat (lack of greenspace and physical shade) serve a lower volume of passengers.

The recommendation made are:

**Vegetation:** The temperature of urban surface areas may be decreased through evapotranspiration by planting trees and vegetation. Shade provided by trees and vegetation in public spaces mitigate the effect of heat exposure. In addition, trees and vegetation reduce storm water runoff and protect soil from erosion.

**Cool and green pavement:** Cool pavements reflect solar radiation, lower the surface temperatures, and reduce the amount of heat absorbed into the pavement so that they stay cooler than the traditional pavements. The many benefits include energy savings, emission reductions, improved comfort and health, increased driver safety, improved air quality, reduced street lighting cost, reduced power plant emissions, improved water quality and slowed climate change

**Green roofs:** Green roofs or rooftop gardens reduce the heat exposure of the occupants. They not only help in reduce heat exposure but also contribute to improved human health. They help to reduce the urban heat island effect and reduce the greenhouse gases. They can be efficiently applied at the transit stops to reduce the temperature underneath.

The paper concluded that transportation infrastructures will be challenged in the future by more extreme heat events, increased overall temperatures, and more riders due to increasing populations. Extreme heat exposure is both a health risk for riders and threat to the operations of transits generally.

4. *Wind Protection*: Wind Protection: This paper sees if, and to what extent

wind injures conceivable travel mode decision, which incorporates riding open travel, bicycling, and strolling. A research project was accomplished for a half year at four territories in San Francisco, a city that has been found to progress viable travel mode choice yet experience high wind levels. It involved surveying pedestrians and recording of microclimate data on site using different kinds of instruments. In sum, the results suggested that wind discourages people from choosing sustainable transportation modes in San Francisco. Evaluation of the correlation between wind and discouragement for sustainable transit mode choice indicated that higher wind speeds are associated with riders being more discouraged to wait at transit stops and also from cycling. Research has shown that greater wind speeds cause a decrease in the number of transit journeys.

5. *Visual Comfort*: Visual comfort has been found to interact widely with other factors. Most strikingly, outwardly animating articles and even exercises in a zone can make up for a few undesirable traits, as drawn-out wait times and even elevated levels of clamor. Therefore, providing a visually comfortable and interesting transit stop environment is very helpful, because it will draw riders to and keep riders at a public space.
6. *Accessibility*: Results from research recommended that simple access to terminals and even availability to different stops affect existing riders' fulfillment with ridership. The outcome raised the profile that

despite the fact that transit users have just chosen to utilize Public Transit (PT), access to terminals and accessibility to different stops stay as compelling variables. It was prescribed that organizers place significance on expanding the straightforward entry to terminals and accessibility to different stops with the end goal that current patronage can be continued in the long haul.

7. *Mix*: Just as in any urban open zone, travel stops can be of incredible advantage by being melded with its surroundings in various manners. With collaboration from the region, travel organization, and contiguous land proprietors, it is conceivable to make transport stops that serve suburbanites, yet in addition, consistently associates with neighboring activities. The orientation of and amenities provided at the transit stop should be made compatible with the encircling establishments, whether or not it is providing additional surfaces for stops close to grocery stores or fitly sized seats for stops close to elementary schools. The design team should also be aware that transit stop use could differ between seasons. Therefore, it is fundamental that courtesies underused by workers are repurposed by local clients. Reconciliation is not just to serve the neighbors. Studies show that arranging a stop close to shops, providing food outlets, and organizations added to the engaging quality of the stop.

## Conclusion

Transit stops are easier to locate when there is high street connectivity which determines to a large extent how transit passengers gain access to transit service. Also, proper design and configuration of on-street stops and connecting roads lead to increased safety, thereby leading to increased ridership and revenue and also impact how everyone on the street interacts with the transit system. A legitimate plan ought to be simple on the eye, ought not to give culprits and loiterers a spot to defraud others out of general visibility, and should offer sufficient information. The psychological impact of paying attention to details while designing for proper transit stop shelter is such that it creates a big difference in people's perceived waiting time. These subtleties can cause the transports to appear to be quicker, regardless of whether there are no progressions to the genuine transport times. This implies it influences to what extent individuals think they are hanging tight for a mode of transport. This recommends it is imperative to give transport shelters at stops. Also, transit information and signage is as important as riders perceiving they are safe at stops. According to literature survey, in most cases, no shelter equals no transit information of any kind.

According [28] (direct quote), "There are no restaurants of any kind in my neighborhood. The nearest ones are in the Victory neighborhood. To get from my house to the nearest restaurant is a mile-and-a-half walk, which takes me about 30 minutes each way. To get to the same restaurant by bus, I must walk half a mile, then cross a heavily-traveled arterial street with no pedestrian protection to arrive at the nearest stop (it's unprotected) for a route that passes the restaurant. Once the bus arrives, I have to ask the driver where the bus is going, since there's no signage at the stop, pay the fare, and then watch as the bus stops six times in the remaining mile, all of those stops on the

same arterial street I just crossed to board the bus. It takes me 10 minutes to walk the half-mile to the bus stop, and according to the Met Transit schedule, it takes the bus another 20 minutes to negotiate the remaining mile to the restaurant, so walking or riding the bus are equivalent in terms of time spent. It's the sort of bus service that encourages people to drive a car instead."

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