Designing Bus Bulbs for People

Evaluating passenger behavior and interactions at bus bulbs to identify gaps and inform design.

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Image Source: City of Vancouver

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Disclaimer

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Executive Summary

In 2021, approximately 40% of Vancouver's carbon emissions were attributed to on-road transportation from cars and trucks. To address this issue, the City of Vancouver's Climate Emergency Action Plan has set a target of achieving two-thirds of all trips in Vancouver through active transportation and transit by the year 2030. This ambitious objective necessitates a comprehensive range of initiatives aimed at encouraging a shift towards more sustainable modes of transportation. Among these initiatives, bus priority measures play a crucial role in enhancing the efficiency and reliability of bus operations. Opting for buses over private vehicles can significantly reduce carbon emissions, with a single average trip avoiding nearly 2.3 kg of carbon emissions, reiterating the importance of bus transit in reducing carbon emissions.

The City of Vancouver collaborates with TransLink to implement various bus transit projects, and one notable bus priority measure is bus bulbs. While the operational benefits of bus bulbs in terms of bus speed and reliability are well understood, there remains a limited understanding of how passengers interact with the additional sidewalk space and bus stop amenities. To bridge this knowledge gap, my research involves in-person passenger observations and surveys at four bus bulb locations across the city. The aim is to provide recommendations for improving the design of bus bulbs, emphasizing the creation of human-centered public spaces.

This report answers some key questions that were further refined throughout the scope of work:

- Where do passengers choose to wait for the bus and do bus bulbs free up space on the sidewalk?
- What factors impact pedestrian behavior (e.g., weather, time of day, demographics)?
- How do people interact with bus bulbs?
- How do bus bulbs change perceptions of public transit?

Out of the total bus bulb locations in Vancouver, four were selected for analysis based on factors like amenities, daily boardings, and permanence of materials. To gain insights, a survey was conducted to gauge passengers' perceptions of safety, comfort, and the value they place on specific bus stop features at these locations.

Findings from the research include:

- **People tend to move towards the periphery of space,** whether the edge of the bus bulb or corner of the bulb.

- **People do not typically wait on the bus bulb**. They waited either on the sidewalk or in between the sidewalk and bus bulb, and step onto the bulb only once the bus approaches.

- In primary commercial high-street zones, it can be challenging to distinguish between passengers waiting for the bus and pedestrians using the bus bulb space as sidewalk space.
- My observations highlighted that bus bulbs **do not significantly free up space on the sidewalk.**
- The presence of a bus shelter significantly impacts pedestrian behavior. In locations without shelters, people seek shade and rain protection under commercial awnings.
- The **time of day does not generally impact one's waiting behavior**, though rush hour times are busier and often more chaotic.
- **Older passengers utilize shelter and benches more frequently** compared to younger passengers.
- Passengers feel more comfortable waiting in familiar areas with significant street activity, highlighting the importance of safety and comfort supported by active eyes on the street
- Some passengers often trip on the wood strip at temporary and interim bulbs, indicating the **importance of material safety at bus bulbs.**

From my analysis, I produced the following recommendations:

1. Install modular/temporary shelters at interim and temporary bus bulb locations.
2. Use consistent material elements and colors to create a clear look and feel.
3. Add green infrastructure to temporary and interim bulbs, including but not limited to green roofs, planters, and sidewalk vegetation.
4. Implement a communications campaign (social media and physical posters) to educate passengers on bus bulbs and support increased use of sidewalk extensions.
5. Integrate specific bus bulb locations with adjacent plazas to support pedestrianization and social connectivity.

My findings and recommendations will help the City of Vancouver target specific bus bulbs to focus design improvements, implement additional extensions or create permanent sidewalk extensions. By adopting these measures, the city can further its efforts towards creating a sustainable and efficient transportation system while reducing city-wide and regional carbon emissions.

Introduction

Convenient, reliable, and efficient public transit is crucial to meeting TransLink and Metro Vancouver's regional transportation and climate goals. Transit not only helps people get to essential services, jobs and educational opportunities but also significantly contributes to the reduction of greenhouse gas emissions and road congestion. What more, taking transit tends to be significantly cheaper than driving and is often the only option for those who cannot afford to drive or who live with disabilities.

To limit greenhouse gas emissions, the City of Vancouver's Climate Emergency Action Plan sets the target of having two-thirds of all trips to be by active transportation and transit by 2030 (Climate Emergency Action Plan, 2019). Currently, transportation accounts for almost 40% of city-wide carbon emissions. Therefore, addressing transit's role in contributing to climate change is a critical City of Vancouver priority. Meeting this objective requires a broad range of initiatives to encourage a shift to sustainable modes of transportation. One of these key initiatives is transit priority, particularly bus priority, which involves infrastructural and design measures that make bus transit operate more efficiently and reliably on city streets.

Across Metro Vancouver, buses are the "workhorses" of the regional transit system, and most people who use transit services in Metro Vancouver have or currently take the bus. In 2021, buses carried 63% of all TransLink customers, and this number continues to increase post-pandemic (Bus Speed and Reliability Report, 2023). However, as the region continues to grow towards population estimates of 3 million by 2050, so will the demand for already limited road space (Transport 2050). To meet the goals outlined in Transport 2050 and the City of Vancouver Climate Emergency Action Plan, changes to the street that prioritize buses and other higher capacity modes of transportation over personal vehicles are essential. With funding from TransLink, the City of Vancouver has and continues to implement bus priority measures that improve the travel times and reliability of bus routes across the city, thereby reducing congestion and carbon emissions. Some of these bus priority projects include bus bulbs, bus priority lanes, bus zone extensions, pavement markings and bus stop balancing (Transit Project Definitions, City of Vancouver). For the purpose of this research project, bus bulbs will be the area of focus.

Bus bulbs as commonly defined as "curb extensions that align the bus stop with the parking lane, allowing buses to stop and board passengers without ever leaving the travel lane" (National Association of City Transportation Officials). Combined with various amenities such as benches, shelter, greenery and public art, bus bulbs can enhance the overall bus transit experience and make bus travel more desirable. In the City of Vancouver, bus bulbs take different shapes and forms. Some bulbs are temporary, while others such as Commercial Drive and Alma St are permanent (to be discussed further).

Figure 1: NACTO bus bulb design

Bus bulbs contribute to improved bus speed and reliability by the following:

- Creating more space for people walking on the sidewalk and an area for passengers to wait.
- Allowing buses to stop in the travel lane and reduce delays from entering and exiting bus stops.
- Improving the comfort of a bus ride as buses would not need to change lanes to stop.
- May shorten the crosswalk if the bus bulb is located at an intersection.

While much is understood regarding the operational benefits of bus bulbs, there is a gap in understanding of how passengers utilize this additional space, how they interact with amenities and their movements and waiting tendencies. An enhanced understanding will help the City of Vancouver's Transit Integration and Projects team make better decisions on where to locate future interim bulbs, what improvements can be made to better the passenger waiting experience and inform how the City of Vancouver can transition them to permanent sidewalk extensions.

1. Background

1.1 Vancouver's Climate Context

Geographically, Vancouver sits on the Lower Mainland of British Columbia, uniquely situated between mountains, valleys, and the Pacific Ocean. Due to its location, the city generally experiences moderate weather, with rainy winters and hot, humid summers. However, climate change is and continues to alter Vancouver's landscape, exacerbating extreme weather events and sea level rise that threatens the livability of all Vancouver residents. By 2050, the City of Vancouver projects hotter, drier summers, wetter falls and springs, and warmer winters. What more, extreme weather events are projected to be more frequent and intense, with sea level rise anticipated to reach 1 meter by 2100 (Climate Change Adaptation Strategy). These climate projections will not only impact our natural environment, but also the built landscape and human health. Some examples of climate consequences include increased risk of health and safety impacts; new and existing buildings being maladapted to new climate norms; increased loss of trees and vegetation; and increased street, property and shoreline flooding.

Figure 2: City of Vancouver Climate Adaptation Strategy Infographics

In 2018, the City of Vancouver drafted its second iteration of its Climate Change Adaptation Strategy in response to the 2018 Intergovernmental Panel on Climate Change report which now famously stated that "limiting global warming to 1.5°C would require rapid, far-reaching and unprecedented changes in all aspects of society" (IPCC). The second version built upon the 2012 strategy which proposed 50 initiatives across the city to prepare for an adapt to climate change impacts.

1.1.1 Climate Emergency Action Plan

In recognition of the gravity of the climate crisis and IPCC climate projections that the world is on track to warm up to 3-4 degrees Celsius by the end of the century, the City of Vancouver declared a climate emergency in 2019. In doing so, Vancouver set ambitious climate targets to rapidly cut carbon emissions by 2030. Since 2007, Vancouver has just scratched the surface of lowering its carbon emissions, with a sole 10% decrease from 2007 to 2021. The new 2030 goal seeks to hastily lower carbon emissions by 50% by 2030 via the sectors that contribute most to pollution: buildings and transportation (Climate Emergency Action Plan, 2019).

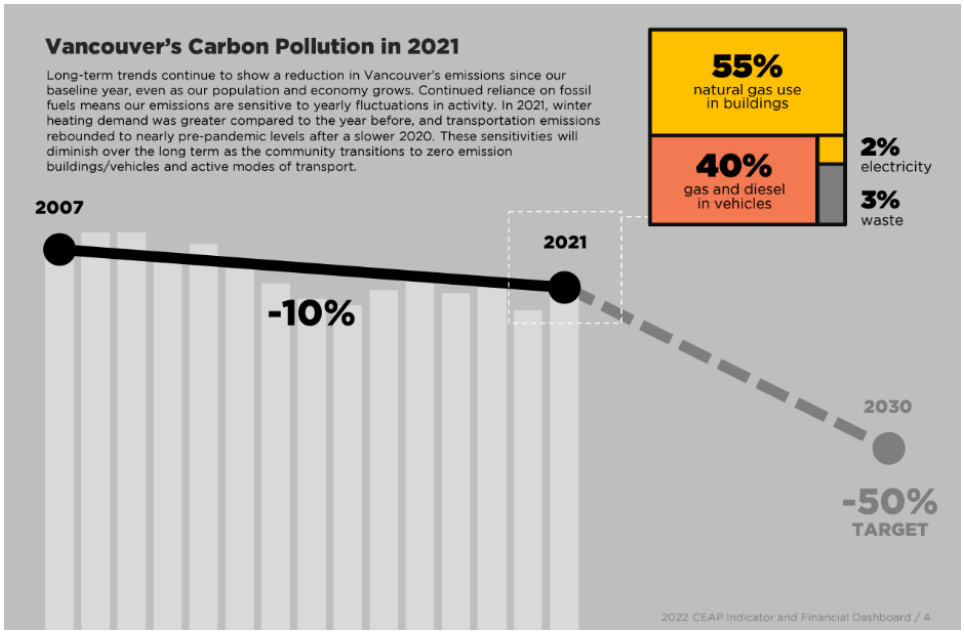


Figure 3: CoV Climate Emergency Action Plan Infographic

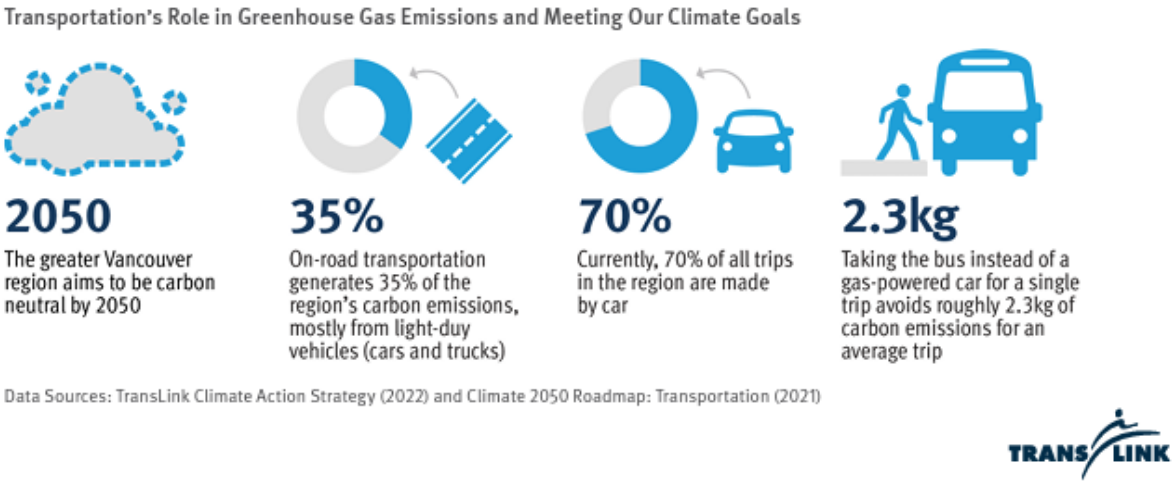


Figure 4: TransLink Bus Speed and Reliability Report Infographic

As shown in the graphics, nearly 40% of Vancouver's carbon pollution in 2021 stemmed from on-road transportation . To address this statistic, Vancouver aims to have two-thirds of all trips by active transportation and transit by 2030. A significant component of this goal is promoting public transportation, a critical element being improving bus speed and reliability. As illustrated, taking the bus can avoid nearly 2.3 kg of carbon emissions for a single average trip- this statistic reiterates the importance of sustainable transit, particularly bus transit, in reducing carbon emissions (Bus Speed and Reliability Report, 2023).

1.2 Vancouver's Transportation Context

1.2.1 TransLink and Transport 2050

Transit service is essential to accessible transportation in Metro Vancouver, and maintaining a convenient, reliable, and sustainable transit system not only attracts riders but complements the entire regional transportation system. As Metro Vancouver's integrated, regional transportation authority, TransLink operates and maintains the region's transit network in alignment with 21 Metro Vancouver municipalities, the City of Vancouver included, local Indigenous Nations and the Province of BC. Governed by provincial legislation, TransLink supports the Metro Vancouver Regional Growth Strategy which sets long-term growth goals for the region (Metro 2050). In conjunction with Metro 2050, TransLink released Transport 2050 as the region's long-term transportation strategy in alignment with the Mayor's Council on Regional Transport, Metro Vancouver municipalities, various stakeholders, and Indigenous Nations. This plan identifies key transportation objectives to meet larger regional goals of

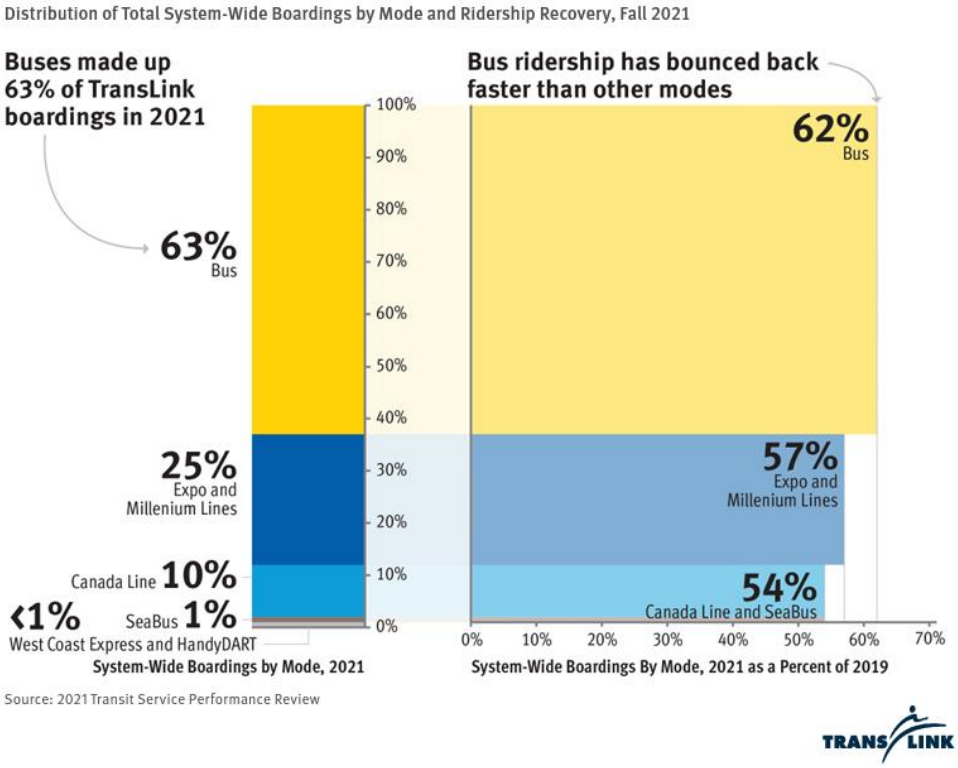
reconciliation, equity, affordability, congestion mitigation and climate change mitigation and to ensure transportation access for all. These objectives include providing transportation that is convenient, reliable, affordable, safe, and carbon-free (Transport 2050).

The report proposes 10 transformative actions across its operations. The action most pertinent to this research project is "Prioritizing the Movement of Transit" through dedicated bus transit lanes, priority at intersections, and bus bulbs. These measures will enable passengers to efficiently get to their destinations and minimize road congestion (Transport 2050). A key action to making bus transit more reliable for users is to provide transit priority through bus priority measures such as bus bulbs and dedicated lanes to reduce delay times. TransLink aims to have passengers spend 20% less time in congestion by 2050 compared to today – it's Bus Speed and Reliability Report delves deeper into the specific actions necessary to meet this goal.

1.2.2 Bus Speed and Reliability

Across the region, buses are critical to the operational efficiency of the transit network, serving more than 60% of all transit riders. As illustrated in the graphic below, buses made up the majority of TransLink boardings in 2021, with almost three-fourths of all transit trips made by bus for at least a part of the trip. Since the end of British Columbia's COVID-19 pandemic restrictions when TransLink saw a steep decrease in overall transit ridership, bus ridership recovered by 62%, more than any other TransLink transit mode. Buses carry a significant number of people in the region, and at peak travel times buses play a critical role in how and when people get to key destinations. Therefore, reliable bus service is essential to maintaining and supporting a growing regional transit network (Bus Speed and Reliability Report, 2023).

Figure 5: Bus Speed and Reliability Report, 2023: Boardings data



However, road delays and congestion continue to significantly impact the efficiency and reliability of the bus network. TransLink found that 80% of bus routes had gotten slower over the past 5 years, due to road congestion (Bus Speed and Reliability Report, 2023). These delays not only make transit less attractive for riders but also increase the cost TransLink must provide to maintain bus service across the region. When buses are delayed by traffic, it reduces people's confidence in taking the bus and pushes them further towards choosing to drive a car. As congestion slows down bus service, TransLink generally has two options at its disposal. It can either add more buses (costing money) to a route to increase frequency or accept the reduction in service. Currently, 15% of TransLink's bus operating costs stem from traffic delays; yearly, TransLink adds $2 million to maintain service levels in the form of more buses (Bus Speed and Reliability Report, 2023). As traffic congestion increases, buses spend additional time waiting at stops, have difficulty finding spaces to change lanes, and take longer to accelerate and decelerate. Although delays vary by time of day and surrounding commercial uses, constrained sidewalks and on-street parking significantly impact delay times for buses. To help ameliorate congestion for buses and increase the speed and reliability of the network, TransLink and the City of Vancouver work together to implement bus priority measures such as bus bulbs.

1.2.3 Bus Priority Infrastructure and Bus Bulbs

At a municipal level, the City of Vancouver collaborates with TransLink on bus stop design, bus bulbs and other bus stop infrastructure to improve city-wide bus speed and reliability. The City of Vancouver has and continues to partner with TransLink to implement various bus transit projects to improve bus travel times. Included in this toolkit are bus bulbs, bus priority lanes, bus stop balancing, bus stop relocation, bus zone extensions, red pavement markings, right turn pockets and turn restrictions (Transit Project Definitions, City of Vancouver). As illustrated below, bus bulbs are indicated as a measure both under TransLink and City of Vancouver authority.

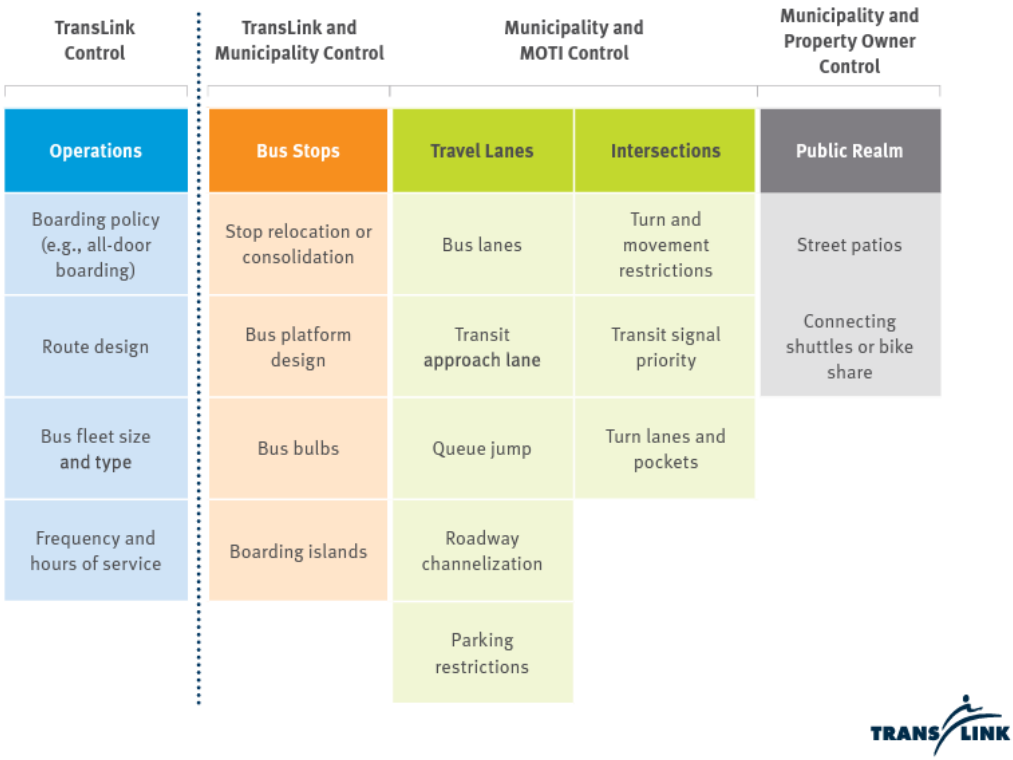


Figure 6: Bus Speed and Reliability Report, 2023

Bus bulbs are commonly defined as extensions that bump out of the bus stop into the parking lane. Bus bulbs contribute to bus speed and reliability by providing the following:

- Creating more space for people walking on the sidewalk and an area for passengers to wait
- Allowing buses to stop in the travel lane and reduce delays from entering and exiting bus stops
- Improving the comfort of a bus ride as buses would not need to change lanes to stop
- May shorten the crosswalk if the bus bulb is located at an intersection.

Image 1: Bus bulb, Robson and Bute: City of Vancouver

Bus bulbs typically result in around a 7% increase in bus speed at bus stops, reduce well times by 15-30 seconds per stop, allow for more stop amenities such a shelter and benches, provide additional space for passengers to wait, and reduce vehicle conflicts with cars, bicycles and pedestrians (Transit Priority Toolkit, TransLink). Bus bulbs also enhance street life by providing an additional public space for passengers to wait and mingle. The City of Vancouver has implemented bus bulbs across the city, many of the recent bulbs constructed out of interim and temporary materials such as asphalt and wood. As a relatively new measure, the city is looking to add additional interim bulbs at new locations that would benefit from increased bus speed and reliability and increased pedestrian waiting space on sidewalks.

The city's interim, temporary and permanent bus bulb locations:

*This list is not exhaustive and does not include some of the permanent bus bulbs

- Westbound Robson and Burrard
- Westbound 4th and Yew
- Eastbound 4th and Yew Street
- Westbound 4th and Burrard
- Eastbound 4th and Maple

- Eastbound Robson and Bute
- Westbound Robson and Bute
- Eastbound 4th and Balsam
- Northbound Main and 14th
- Northbound Commercial and 6th
- Westbound 4th and Maple
- Southbound Commercial and 6th
- Fraser St and 5th
- West 10th Ave and Alma

These locations are a mix of permanent, temporary and interim bulbs with varying material.

2. Literature Review

There is a significant gap in transportation planning literature on how passengers interact with transit stop design elements, and how available space influences passenger waiting behavior. Moreover, very few studies have examined how critical bus stop attributes are to overall rider satisfaction during waiting. This literature review will examine the existing literature on effective bus stop design and delve into the few existing studies on passenger waiting behavior at bus stops. Understanding the knowledge gaps surrounding bus stop design and human behavior at bus stops will help align my project methodology and results within the existing literature.

2.1 Bus Stop Design

2.1.1 Transit Passenger Facility Design Guidelines

TransLink's 'Transit Passenger Facility Design Guidelines' is a collaborative document that provides a framework for successful transit facility and environment design that supports long-term priorities such as the 2040 target of having two-thirds of all trips by active transport and transit. The goal of the guide is to provide recommendations on designing transit spaces that are comfortable, safe, and accessible for all ages and abilities. This document defines transit stops as "facilities, usually on-street, that serve one or more road-based bus routes" and are separated into different design elements: usability, operations, placemaking, environment and accountability. Usability encompasses the passenger experience and designing of transit facilities that prioritize passenger needs through the provision of safe, secure, and accessible environments. It is further divided into movement and capacity; legible spaces; wayfinding; physical accessibility; safety and security; comfort, and amenities (Transit Passenger Facility Design Guidelines).

Movement and capacity design considerations focus on removing barriers for movement. This can entail minimizing pedestrian conflicts, providing clear lines of sight and ensuring consistent wayfinding and lighting. Similarly, providing legible spaces involves limiting any visual obstructions at transit locations and including consistent materials, colors and surfaces.

Wayfinding considerations entail integrating passenger information and wayfinding infrastructure into the facility design needs while ensuring this information is safe and accessible to those with disabilities. Physical accessibility considerations must ensure transit facilities are obstacle free and that people with disabilities can access the location on ramps and with a wheelchair.

Safety and security are of critical importance, especially in Metro Vancouver where rainy and slippery weather is frequent. Design must consider anti-slip flooring, high quality lighting and effective positioning of street furniture to limit obstructions and to maximize passenger space. The other

component of security is passenger comfort; integrating weather protection not only improves safety but also improves the overall comfort levels of passengers in various weathers.

Lastly, amenities such as shelter, benches, trash bins, public art and greenery improve overall passenger comfort, safety, and experience. Amenity considerations are usually decided based on various factors such as available road space, surrounding commercial uses, material availability, and financial constraints.

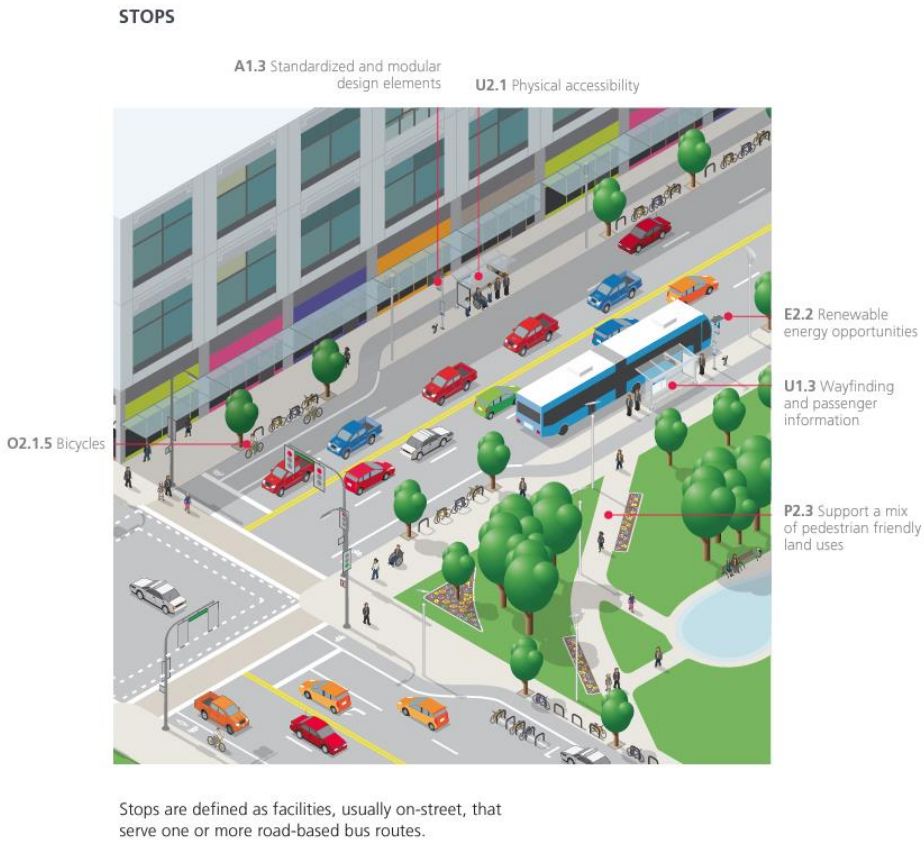


Figure 7: 'Transit Passenger Facility Design Guidelines' stop design considerations

2.1.2 NACTO Design Guidelines

The National Association of City Transportation Officials' 'Transit Street Design Guidelines' and 'Urban Street Design Guidelines' provide additional context around bus stop designs and principles. NACTO is a coalition of North American city Departments of Transportation that aims to support cities and create sustainable, equitable and safe transportation choices for all.

The Transit Street Design Guide provides guidance for the development of street transit facilities and stops and is primarily based on North American design practice. This guide builds upon the Urban Street Guide and focuses on stations and stops and their corresponding design principles. The guideline defines stations and stops as "introductions to the transit system," gateways to movement and interaction. Special attention must be given to how sidewalks and surrounding buildings interact, as comfortable stops with various features and amenities "anchor" the stop into the pedestrian realm and improve perceptions of public transit. Moreover, stops should be critically designed for safety and equitability, so that people of all ages and abilities can comfortably and safely reach stops and their destinations. The guideline specifically mentions that platform design (Ie. where passengers board the bus on the street) is an important component to stop design, as integration of the platform, street and vehicle allow for more accessible and quicker boarding times and reduced delays (NACTO Transit Street Design Guidelines). Curb level boarding (supported by bus bulbs) may be preferred when there is limited space to provide ramps or slopes onto a higher platform. Boarding bulb stops create an in-lane stop by aligning the transit vehicle with the stop. The report explains that boarding bulbs have an opportunity to become a focal point of public space and create a pedestrian zone with amenities without having to encroach on sidewalks.

The Urban Street Design Guide varies slightly from its sister report, and although written primarily for US cities, the bus bulb section of the report outlines in more detail specific design considerations for bus bulbs worldwide. For one, bus bulb length is determined by the boarding area necessary for the expected number of buses or types of buses dwelling at a given moment but should be at least long enough to serve all doors of at least one bus. The width of each bulb should reflect the need for traffic maneuvering and inclusion of bus shelters, at least 6 feet but preferably 8–10 feet. The report recommends that cities should collaborate with transit agencies to determine the clear width necessary to deploy a wheelchair accessible lift onto the bus bulb. In terms of amenities, the report states that bulbs are more effective when equipped with shelters; shelters make transit more attractive and provide necessary shelter from various weather conditions. Optional amenities include wayfinding maps, plantings, and trees to enhance the overall transit user experience (NACTO Urban Street Design Guidelines).

Figure 8: NACTO visual design for bus bulbs

2.1.3 Role of Transit Amenities and Vehicle Characteristics in Building Transit Ridership

This 1999 Transportation Research Board and National Research Council Handbook was sponsored by the US Federal Transit Administration and identifies passenger amenities and transit vehicle characteristics that attract ridership. In Part 2 of the study, the National Research Council conducted surveys, focus groups and discussion sessions to understand the effect of recently implemented transit passenger amenities. The key methodology for this research was a "trade off" survey. In this gamified survey, passengers were presented with a broad catalogue of amenities from which to choose, making passengers consider the importance of one amenity over another. The survey then asked passengers about how the provision of their chosen amenities would affect their frequency of ridership, and whether they would keep the amenities or rather reduce the transit fare. Bus stop amenities included weather protection, seating, passenger information, lighting, trash baskets, newspaper vendors and pay phones. The research findings strongly suggested that transit stop amenities have numerous impacts on customer perception and behavior and play a role in instilling rider comfort, confidence, and safety. The studies point to the importance of quality amenities and customer opinion in helping make decisions about facilities design. Knowing what amenities passengers want most and determining their willingness to pay for them can help an agency determine which amenities to offer (Transportation Research Board, 1999).

The report identified key elements of an effective amenity program. The first is addressing customer concerns; understanding passenger dynamics and reactions is key to the design decision making process. The second element is using a transit design game (such as the one provided in this study) to elicit passenger concerns and opinions about amenities. The third recommended element is making a

commitment to quality, which consequently creates a positive image of transit. Quality amenities include effective design, placement, visibility, comfort, and long-term maintenance of the amenities. The final recommendation is minimizing costs. The report emphasizes the importance of transit agencies finding the balance between providing passenger amenities, but not spending too much money on these. Community partnerships and transit stop advertising are effective ways of reducing costs.

2.1.4 Exploring the asymmetric influences of stop attributes on rider satisfaction with bus stops.

Using 2019 data from Harbin, China, this study by Shan Sung and Dewei Fang employed an importance-performance analysis to identify the associations between bus stop amenities and overall rider satisfaction within the bus waiting area. Their goal was to evaluate stop attributes that influence rider satisfaction with the waiting environment and identify design priorities. The researchers collected data from a two-page survey conducted in Harbin in May-July 2019. Harbin, located in Northeast China. They had passengers report their satisfaction levels of 11 bus stop attributes: shelters, lights, security cameras, trashcans, benches, information signage design, route information, real time information, comfort while waiting, safety while waiting, and advertisement infrastructure. Passengers responded to each attribute question on a seven-point scale.

Survey analysis was conducted via IPA and three-factor theory to evaluate bus stop amenities/attributes significant to passenger waiting satisfaction. IPA classifies attributes into four quadrants based on importance and performance of attributes, from self-reported satisfaction levels.

Results concluded that trashcans and shelters are the most important amenities that contribute to overall rider satisfaction. As the waiting environment is generally passengers' first impression of bus transit, trash on the ground and the poor conditions could generate immediate feelings of dissatisfaction. Moreover, shelter is a basic infrastructure that protects passengers from exposure to weather such as sunshine and rain. (Sung and Fang, 2019).

2.1.5 Extreme weather, public transport ridership and moderating effect of bus stop shelters

Qing Miao et al (2019) examined how extreme weather conditions influence public transit ridership, specifically the role of bus stop shelters, and builds upon existing research of the impact of transit characteristics on ridership. Using data from the Salt Lake City metro area, the researchers found that extreme weather such as rain and heatwaves reduce overall transit ridership, while bus stop shelters have a small effect on decreasing ridership losses from these conditions. The moderating effect of shelters is more pronounced on weekdays, and for bus stops with lower service frequency and fewer transfers.

To measure extreme weather conditions, the researchers focused on four distinct seasons: a hot summer, a cold winter and two wet transition seasons. Weather conditions were coded as binary variables that could

be categorized into extreme weather days and normal weather days. The team then established a "fixed effect model" to investigate the impact of extreme weather and the effects of bus shelter on bus ridership.

Questions the paper attempted to answer: (1) what factors influence the installation of bus shelters; (2) whether bus stops equipped with shelters have higher ridership under extreme weather conditions compared to exposed stops; and (3) whether the moderating effect of shelters differs depending on other stop-level characteristics such as service frequency and accessibility. Results indicated that sheltered bus stops see slightly higher ridership numbers compared to unsheltered bus stops during extreme low and high temperatures and heavy precipitation. This can indicate that transit stops with shelter may be more valued by more frequent bus riders or those exposed to weather conditions longer. Another interesting finding suggests that bus stop shelters may attract additional bus riders in bad weather conditions; this result can be used by transit agencies to support plans to respond to increased extreme weather due to climate change.

2.2 Bus Bulb Design and Case Studies

2.5.1 ZICLA

Multiple cities around the world have implemented bus bulbs or similar bus extension infrastructure to improve bus speed and reliability. Of the various cities researched, San Francisco, Seattle and Portland provide interesting case studies to analyze Vancouver's bus bulb program.

Unlike the City of Vancouver that uses asphalt and other interim materials to construct its bus bulbs, New York and Oakland utilize the ZICLA platform system. ZICLA is a relatively cheap plastic platform, in comparison to other applications, that allows cities to install bus priority extensions in hours, compared to concrete installations that may take weeks. Oakland, California built a bus stop platform along a protected bikeway on Telegraph Avenue using ZICLA. Before the ZICLA installation, this corridor was a highly dangerous route for bicyclists who rode next to buses that pulled into the bike lane to pick up passengers. After the ZICLA platforms were installed on Telegraph Avenue in 2018, the city saw a 40% reduction in bike/vehicle collisions and an average of 35% reduction in bus travel times (ZICLA). The city is considering more widespread implementation of its ZICLA bulbs at more locations across the city where bus and bicyclist conflicts are high ZICLA products are also mentioned twice in the NACTO "Transit Street Design Guide."

Image 2: ZICLA modular platform on Telegraph Avenue in Oakland, California

Case studies such as Oakland and New York point to the success of ZICLA in providing an interim solution with a quick-build implementation and low costs. For Vancouver, products such as a ZICLA should be considered for temporary and interim bulbs at locations that would benefit from quicker builds and lower costs. An additional advantage of ZICLA is its ability for the product to be re-used in theory. The ability to re-use product allows for testing and interim application and would also support overall cost savings.

2.5.2 Evaluation of Bus Bulbs

Kay Fitzpatrick et al (2000) conducted a study for the Transit Cooperative Research Program as part of the National Research Council's Transportation Research Board, investigating the benefits of bus bulbs on both transit and pedestrian operations. The study provides enlightening insight into the benefits bus bulbs have on pedestrians, with its pedestrian field studies targeting bus bulbs on Mission St in San Francisco, California. The study's design objectives were to determine if bus bulbs increase available pedestrian space, if bus bulbs improve walkway width effectiveness, and how boarding characteristics change with the additional sidewalk space. In doing so, it compared bus bays and bus bulbs on the nearside intersection of Mission St and 30th St and evaluated pedestrian space, sidewalk level of service, and boardings. During this study, pedestrians and passengers were counted in different intervals in and

around the bus shelter before and after the bus bulb was constructed (Fitzpatrick, Evaluation of Bus Bulbs on Transit, Traffic, and Pedestrian Operations).

Results:

- Before the bus bulb design was present, the area next to the bus shelter operated at a C level (defined by researchers).
- Once the bus bulb was constructed the bus stop space utilization improved by 20%, with passenger space improving by 2.3 sq meters.
- The widening of the sidewalk from the bus bulb had a significant impact in reducing the number of people passing between the bus stop shelter and the curb.
- During the four highest 15-minute periods of pedestrian activity near bus stops, pedestrian flow increased by approximately 11%.

The conclusion assumes that the bus bulb provided essential space for pedestrians and thereby improves the condition of the adjacent sidewalk. Board and alighting data concluded that bus bulbs provided more space for boarding, whereas a traditional stop results in some pedestrian flow disruptions on the sidewalk. Bus bulbs allow pedestrian congestion to move away from the sidewalk altogether.

In another iteration of this study, the authors conducted a multi-city bus bulb evaluation, focusing on the West Coast cities of San Francisco, Seattle, and Portland in 1999. Each of the chosen cities were selected due to their high population densities, well-developed transit corridors and high transit passenger numbers.

San Francisco

In San Francisco, the idea to implement bus bulbs was conceptualized in the early 1970's as part of a city-wide program to envision more transit friendly streets. Bus bulb locations were initially chosen by frequency of service, ridership numbers, presence of existing transit infrastructure and bus conflict rates. Key to deciding where to place bulbs were locations that presented high congestion levels and bus re-entry conflicts. After the implementation of bus bulbs on Mission Street in 1999, the city saw bus waiting space expand by 64% and resulted in space for each passenger by 132%. The City of San Francisco's 2019 Better Streets Plan created a set of consistent design standards to streamline how to design and build pedestrian environments, such as bus bulbs. Some key bus bulb design standards included far-side stop placement and full-length corner bulbs. The city prioritized bus bulbs on rapid network lines and major transfer points; locations where the existing sidewalk is too narrow to accommodate shelter; locations where pedestrian travel is constrained; and locations where transit performance is slowed due to delays of traffic flow. Bus bulbs should be considered on all streets except those with peak period towaway lanes,

and near side stops with heavy right turn movements. City-wide bus bulb amenities should include wayfinding signs, new trees, leaning bars and bus shelters.

Image 3: San Francisco, CA bus bulb: NACTO

Seattle

The City of Seattle implemented bus bulbs to ameliorate frequent bus re-entry problems. Bus bulbs were commonly placed on isolated streets with high pedestrian volumes and areas with a "neighborhood feel." The preferred location for bus stops in Seattle is the far side intersection. In 2021, the city implemented two bus bulbs as part of its RapidRide bus program, choosing to place bulbs where bus drivers could easily stop in the travel lane and where sidewalks are too narrow to serve many waiting passengers. Common features of all bus bulb locations were large, well-defined pedestrian crosswalks at intersections. After installation of the University Way bulb, the curb extended to approximately 80 ft in length in order to consolidate bus stops, have two articulated buses and to add parking. A key issue of this project was drainage; water on the sidewalk could often freeze and pose safety issues to pedestrians. This is an issue present in the City of Vancouver as well.

King County Metro's 2021 Speed and Reliability Guidelines includes bus bulbs in its toolbox for reducing bus reentry delay and predictability. It references its E John Street and 10th Avenue bulb and Olive Way and Summit Ave bulb, pointing to additional customer amenities such as shelter.

Image 4: Seattle, WA bus bulb: NACTO

Portland

In Portland, bus bulbs were initially installed for reasons other than transit, and rather part of traffic calming measures to reduce pedestrian crossing times.

Rationales for bus bulb installation included:

- Bus bulbs create a shy zone for cyclists who use the curbside parking lane as a travel lane.
- Bus bulbs potentially forces bicyclists to use the general-purposes lanes to pass around the bulb—hence, the 2-ft (0.6-m) zone and the 6-ft (1.8-m) bulb width.

Design considerations include:

- Length of bus bulbs is variable and dependent on width of street, amount of parking.
- Nearside placement of bus bulbs is preferred.

Image 5: Portland, OR bus bulb: NACTO

Conclusions emphasized that bus bulbs are suitable in areas with high density development, high pedestrian and transit activity, low road vehicle operating speeds and bus re-entry problems. Conditions that may be ill-suited for bus bulbs are two lane streets, high bicycle traffic, complex drainage problems and business concerns (Fitzpatrick, Evaluation of Bus Bulbs). Above all, the key characteristic that reinforced Seattle, Portland and San Francisco as appropriate bus bulb cities is urban form; each of these cities support pedestrian-friendly streets and transit-oriented development.

2.3 Human Behavior and Transit Studies

2.3.1 Social Life of Small Urban Spaces

In 1980 while working for the NYC Planning Commission, William Whyte conducted one of the preliminary studies on human interaction within urban spaces. With the publication of "The Social Life of Small Urban Spaces" and its additional film in 1980, the world could visualize through observation and interviews how planners could make spaces more livable. Whyte's longitudinal observational study laid a foundational understanding of why some public spaces "work" and why others fail in their aims. While the study was predominately focused on parks and plaza, it still provides a background understanding of the historical literature on this topic and some basic design considerations for all human public spaces, transit stops included (Whyte, 1980).

Some key results from Whyte's studies applicable to this research:

- Sitting space should ideally 6-10% of overall space.
- Women and men interact with urban spaces differently.

- People tend to look for edges or move towards the edge of a small space.
- Trees and greenery not only provide shade and shelter but support a larger social scene. They should be placed close to sitting spaces.
- In the absence of seating, people improvise and sit anyway adapting to the obstacle placed.
- People are attracted to spaces with other people and generally congregate in the center.

2.3.2 Human movement behavior in urban spaces: implications for the design and modelling of effective pedestrian environment

Alexandra Willis (2004) conducted an "agent-based model of pedestrian movement" that sought to understand which human behaviors were most appropriate and "normal" in various conditions through a predictive model. Willis prefaces that research in this area is very limited, historically focused on movement rather than behavior. The research was primarily conducted via video observations of various intervals at three locations in York and Edinburgh, United Kingdom. A total of 2613 pedestrians "took part" in the video survey.

Early reports suggested that:

- People prefer to maintain a buffer zone of around 0.45 m between themselves and the edges of buildings (for example, Ciolek, 1978; Fruin, 1971).
- A smaller distance (approximately 0.1 m) to stationary items of street furniture (Habicht and Braaksma, 1984).
- A larger distance (around 0.8 to 0.9 m) between themselves and other pedestrians (Dabbs and Stokes, 1975).
- People like to maintain a distance of around 0.75 m between themselves and their companion(s) when walking (Burgess, 1983).
- Most pedestrians walked within pavement areas at the edge of spaces, on the margins. This could be due to pedestrian perception of pavement space and that it did not provide adequate room.
- Walking speeds varied between locations, based on the presence of vehicular traffic and the amount of space available for pedestrians.

2.3.3 Style versus Service? An Analysis of User Perceptions of Transit Stops and Stations

Hiroyuki Iseki and Brian D. Taylor's (2010) research on passenger perceptions at transit stops took place across a selected dozen transit stops in metropolitan Los Angeles. The researchers designed a 46-question survey to collect data on passengers' perceptions of various transit stop categories: 1) access, 2) connection and reliability, 3) information, 4) amenities, and 5) security and safety. They specifically asked passengers to assess the level of importance of multiple amenities and their level of overall level of

satisfaction at the bus stop on four-point scale from “very important” to “not important” and “strongly agree” to “strongly disagree.” The researchers used an I-S analysis method to evaluate survey results. After calculating I-S ratings for each of the attributes across the dozen facilities surveyed, we ranked each attribute from 1st to 16th. Results demonstrated that transit passengers tend to care more about safety and frequent, reliable service than the physical condition of transit stops and stations. In other words, given a choice between benches, shelters, and off-street stations, or safe, frequent service, the findings suggest that most passengers will opt for the latter (Iseki & Taylor, Style verses Service? An Analysis of User Perceptions of Transit Stops and Stations).

These findings are applicable to the Vancouver context and will be discussed in more depth in the results section. The question this research poses is whether the City of Vancouver and TransLink’s bus service at a high enough level of efficiency and frequency where passengers even care about additional amenities such as benches, shelters and greenery. Would the addition of amenities improve bus transit use overall or would it be a waste of financial resources? These critical questions must be considered before implementing any design solution.

2.3.4 City of Vancouver and Happy City “Well-Being Assessment: Pavement to Plaza Program”

Happy City conducted this study on behalf of the City of Vancouver for the city’s VIVA Pavement-to-Plaza program in 2019. The goal of the study was to evaluate how public space can improve human well-being, and how various designs influenced pedestrian perceptions of safety, sociability, inclusion, and place attachment. For the purposes of this report, I was interested in looking at the research methodology undertaken for this study, as it is one of the City of Vancouver’s sole behavioral studies focused on design’s impacts on peoples’ use of space, well-being, and perception (Happy City & City of Vancouver, 2019).

The research methodology consisted of a brief 12 question survey presented to the public electronically on digital tablets. The study staff chose six plazas on three different Vancouver streets. Surveys were conducted at three different times, on days of varying weather, at each plaza location: weekday mornings, weekday afternoons and weekend days. 703 people responded to the survey. Results were presented via charts made from each question response and into a score-based system of analysis. Because the study’s participants were engaged randomly in a public setting, the team opted for a brief survey rather than a longer and more rigorous series of questions within a standard academic scale. Recognizing the limited amount of time that people are willing to spend answering questions during an intercept, the survey focused on VIVA Vancouver’s key areas of interest: sociability, safety, trust, inclusion, and place attachment. Overall scored results and individual plaza results are shown below:

Appendix A: Average Score at Study Sites

	Overall		Main		Bute		Davie	
	Overall Plazas	Overall Control	Main 14th Plaza	Main 10th Control	Bute Robson Plaza	Cardero Robson Control	Jim Deva Plaza	Thurlow Davie Control
3. This is a place where I would like to meet new people.	3.80	3.30	3.85	3.28	3.71	2.99	3.79	3.51
4. If you were to lose your wallet in this spot today, how likely do you think it would be for a stranger to return it to you?	3.04	2.79	3.39	2.83	3.07	2.76	2.80	2.78
5. I would like to return to this place again.	4.40	4.14	4.44	4.08	4.36	4.21	4.39	4.16
6. If I noticed a piece of litter here, I would pick it up and throw it out in a nearby trash receptacle.	3.76	3.44	3.73	3.37	3.83	3.20	3.75	3.65
7. This place reflects my community.	4.02	3.68	4.08	3.57	3.81	3.72	4.06	3.77
8. Rate your happiness in this moment.	4.43	4.33	4.46	4.25	4.38	4.30	4.42	4.43
9. This is the kind of place I would choose to meet with friends.	4.23	3.66	4.34	3.54	4.22	3.40	4.17	3.94
10. I feel safe when I visit this place alone.	4.36	4.19	4.56	4.16	4.26	4.27	4.27	4.18
11. I would be upset if someone vandalized this space.	4.40	4.34	4.36	4.24	4.21	4.31	4.49	4.47
12. How often do you come to this place?	4.07	4.28	4.04	4.33	3.83	4.01	4.18	4.38
13. I feel people here can be trusted.	3.80	3.81	3.95	3.73	3.92	3.87	3.66	3.87
14. I feel welcome in this place.	4.32	4.09	4.34	4.01	4.30	3.97	4.31	4.25
Total	4.05	3.84	4.13	3.78	3.99	3.75	4.02	3.95

5 = Strongly positive response
3 = Neither positive or negative response
1= Strongly negative response

Positive Difference of 0.5 or more
Positive Difference of 0.1 or more
Statistical tie

Pavement-to-Plaza Well-being Assessment // **Appendix A** 25

Figure 9: Happy City survey results

Results indicated that most people felt positive about sociability, safety, trust, inclusion, and place attachment to the plazas in question. The plaza with the lowest overall score was the Bute Robson Plaza (interestingly, nearby one of this report's bus bulbs) and the highest overall score was Main and 14th (also nearby one of this report's bus bulbs).

3. Research Methodology

3.1 Scope and Rationale

My research and analysis followed three key steps:

- Conduct in-person site visits at various bus bulb locations across Vancouver.
- Consolidate data:
    - Identify key themes from surveys and observations.
    - Conduct descriptive statistics where applicable to quantify survey results.
- Recommend modifications to the design and spatial layout of bus bulbs to improve how people use the bulb and sidewalk.

Some high-level questions the research sought to answer:

- Where do passengers choose to wait for the bus?
- Do bus bulbs free up space on the sidewalk?
- What factors impact pedestrian behavior (e.g., weather, time of day, age demographics)?
- How do people interact with bus bulbs (sidewalk space and amenities)?
- What are riders' perceptions of safety and comfort at bus bulbs?

Before conducting my primary data analysis, I considered the following questions that helped ground my research in a result-oriented approach.

What kind of information is this research seeking?

This research seeks to understand how passengers interact with bus bulbs (extra sidewalk space, amenities, other passengers, commercial spaces), how they perceive bus transit, and the importance of bus bulb extra sidewalk space amenities in fostering one's decision to take bus transit.

What types of information are particularly important?

For the survey, the team is interested in age group demographic data. Sentiments of comfort and safety at a particular bus bulb are also important, alongside passenger perceptions of the importance and satisfaction of various bus bulb amenities and features (i.e. benches, shelter etc.).

For the observations, behavioral and habitual information will be most critical. As the survey covers passenger sentiments, the observations will supplement by observing how passengers take up space, congregate alongside others and interact with surrounding features.

How will this information be used?

The information gathered will be used to produce recommendations on gaps that exist in the design of bus bulbs in terms of amenities and space, and how passengers of differing ages utilize the extra sidewalk space and/or interact with their surroundings. The information will also be used to understand how the City of Vancouver can better plan and design future bus bulbs at future locations.

3.2 Bus Bulb Prioritization

Due to time constraints and operational feasibility, it was agreed amongst the project team that I would focus my primary data gathering on a select few bus bulb locations across the city. To prioritize specific bus bulbs for in person observations and surveying, I created an Excel tool to target specific bus bulbs that would provide me with the most effective and varied data.

Each bus bulb location was categorized by different indicators, and certain indicators were given scores on a point system. These scores were then added up into a final score out of 10.

- Amenities (**1 point each**)
    - Shelter
    - Seating
    - Greenery
    - Passenger wayfinding/information
    - Trash bins
    - Public art
    - Street lighting
- Permanence
    - Temporary (**1 point**)
    - Interim (**2 points**)
    - Permanent (**3 points**)
- Bus stop number
- Bus route number
- Daily boardings
    - <1,000 (**1 point**)
    - 1,000-2,000 (**2 points**)
    - >2,000 (**3 points**)
- Adjacent commercial uses

Generally, the more amenities a city provides at a bus bulb, the more effective the space is overall at providing a comfortable waiting experience for passengers. Therefore, each amenity was given a score of 1. In terms of permanence, temporary bus bulbs constructed of wood and asphalt are less comfortable and visually appealing than permanent concrete bulbs. Therefore, permanence was scored, with temporary bulbs given a score of 1, interim bulbs given a score of 2 and permanent bulbs given a score of 3. Additionally, busier bus stops with higher passenger numbers were scored as more boardings contributes to more bus bulb use overall; bulbs with daily alignments greater than 2,000 were given a score of 3.

These scores are not indicative of a location being more "effective" than the other, as there are various land use and density considerations as to why a bus bulb may be utilized more frequently than others, or why a particular amenity was included or omitted. The scorecard system was simply created to establish an easier way to categorize the bus bulb locations for analysis.

After adding up each score, I selected bulb locations of various scores (which consequently varied amenities and busyness) from 1-13 to provide the most wide-ranging and robust understanding of the bus bulb infrastructure across the city. The final chosen locations were Westbound 4th Ave and Burrard, Northbound Commercial and 6th Ave, Westbound Robson and Burrard, and Northbound Main St. and 14th Ave. I will delve into the characteristics of these specific bus bulbs in the next section.

3.3 Primary Data Collection: Surveys and Observations

The primary data collection methodology was a cross-sectional longitudinal study including surveys and observational analysis. Taking lessons learned from literature reviews and human behavioral studies, I scheduled my observations and surveying into three blocks: peak-period weekday mornings (8am-9am), peak-period weekday evenings (5-6pm), and weekend days (12-1pm). In order to better understand how passengers interact with the bus bulb in various weather conditions, I ensured I conducted my analysis on both sunny and rainy days.

3.3.1 Survey

Consisting of 10 questions and one demographic question, the survey was designed to provide the most useful information that could be obtained during an interaction that lasted three minutes or less (while passengers waited for their bus to arrive). Questions included in the brief survey were rooted in standard instruments. After review, the project team and I agreed that the most effective survey format would be an interview style; a more conversational approach would hopefully elicit transparent responses and provide a more nuanced understanding of passengers' perception of bus stops and their opinions on safety and comfort. The goal was to attain ten responses at each of the four bus bulb locations from various age demographics, for a total of 40 responses.

As the City of Vancouver has specific data privacy regulations, I ensured minimal demographic data was obtained. The survey was noted as anonymous and the age-range question as optional. I printed and provided official City of Vancouver survey information sheets to interested participants that detailed the research objectives and data collection goals.

After a week of surveying passengers, it became clear that the survey questions did not elicit the robust responses desired. For example, many passengers answered the open-ended questions with very limited responses. Furthermore, with the short time constraints required to survey passengers before buses arrived, many surveys were left unfinished. Therefore, the project team and I reviewed our initial survey and made some changes to accommodate for the lessons learned in the first iteration.

This second phase of surveying achieved its goal of eliciting detailed information regarding the importance and satisfaction of specific bus bulb features. The results of both iterations of the survey will be discussed in the results section of this survey.

3.3.2 Observations

Observations were undertaken at the four bus bulb locations before I surveyed passengers. The goal of the observational analysis was to assess and analyze passenger waiting behaviors and movements that surveys are unable to effectively record. Whereas surveys elicited data on passenger perception of various bus stop attributes and their overall levels of safety and security, observations produced a more nuanced understanding of how passengers interact with space, amenities, and each other at a higher level.

Key questions I attempted to answer during my observations:

- Are passengers standing on the sidewalk, on the bus bulb, somewhere in between the sidewalk and bulb, or under the awning.
- How are people with disabilities/mobility aids/strollers interacting with space?
- What is the ratio of passengers sitting vs standing?
- How, if at all, are passengers talking/interacting to each other?
- Are passengers queuing up or dispersed?
- If there is shelter available, are passengers utilizing it, or standing underneath awnings of businesses? How does weather (sun vs rain) impact this?
- Are passengers interacting with the businesses around the stop while waiting?

The results of passenger observations will be discussed in the results section of this report.

3.4 Limitations

With any human study or primary data gathering, there are limitations when it comes to interacting with people and gathering enough effective data for analysis. My methodology had some limitations, none of which were major, but that impacted project development and timing. For one, some passengers were unwilling to participate in the survey at all, requiring me to take more time than expected to find willing participants. Moreover, many respondents were not fully aware of their reasoning for providing a given survey response due to either lack of knowledge on the subject matter, lack of memory, or disinterest in the subject. Therefore, conformity bias was a limitation in that those providing robust answers to survey questions may likely be frequent transit users who may have a particular bias that differs from less frequent transit riders.

Lastly, selection bias was avoided by choosing participants from varied age rangers to elicit a more wide-ranging and robust analysis.

4. What I Found

4.1. Northbound Main St. and 14th Ave

4.1.1 Background

Prioritization score: 6

Amenities: Street trees, trash bin

Permanence: Temporary (wood and asphalt)

Weekday Boardings: 1,147 (TransLink System Performance Review, Fall 2022).

Route characteristics: One local route

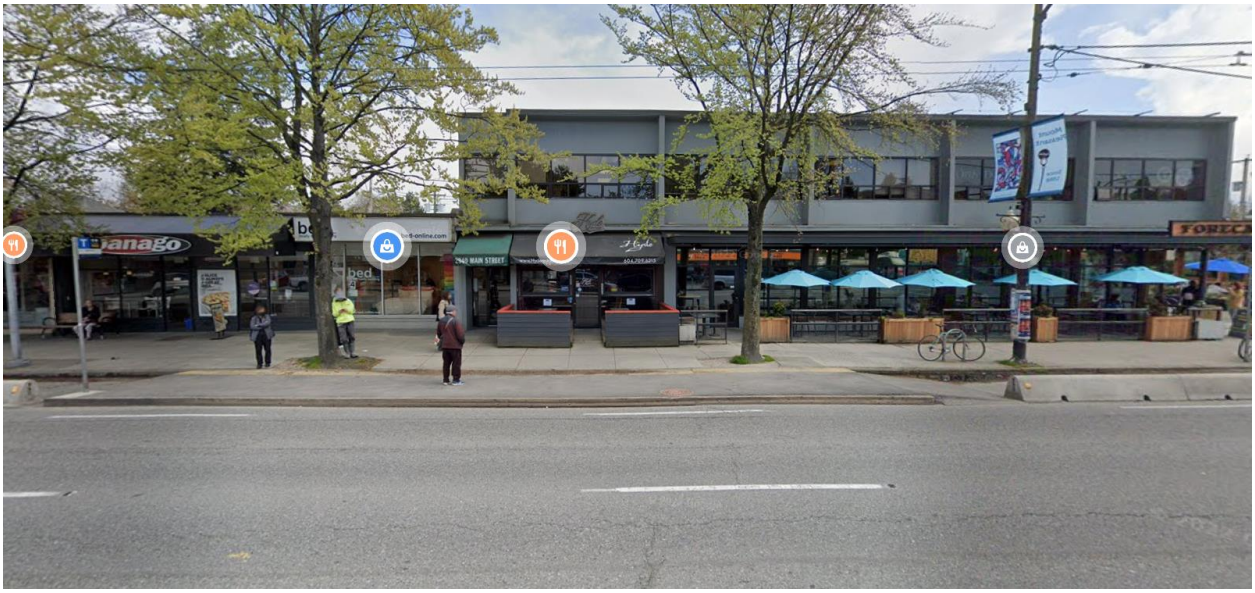


Image 6: Main + 14th bulb: Google Street View

This bus bulb is located on the northbound far side intersection of Northbound Main St and the east side of 14th Ave. There are 2 sidewalk trees at both ends of the bulb, however there are no benches, shelter, or trash bins in immediate proximity. The bulb itself is short, but wide, due to the limited sidewalk space available because of adjacent patios. Besides the small bike rack on the south end there are no other bulb amenities.

This bus stop is in Mount Pleasant, on an intersection with two plazas and coffee shop patios. Mount Pleasant is a young, family-oriented neighborhood that encompasses Main Street, its core street, up to East 16th to the south, Clark Street to the east, and False creek to the north. It's locally known for its youthful, hipster vibe, with a great restaurant and cafe scene, and various thrift and antique shops. This section of Main Street is generally quite busy on both weekends and weekdays, with pedestrians flocking to the area for its coffee shops, restaurants, and bars. Directly adjacent to the bulb is a restaurant and

coffee shop (both with sidewalk patios) and a bedding store (City of Vancouver, Mount Pleasant Neighborhood Social Indicators).

4.1.2 Survey Results

"This is a very safe neighborhood."

"There are always a lot of people around with the patios and stuff, so it feels lively."

"During the day I feel very safe waiting for the bus alone here, but at late at night when there are people drinking and it feels rowdier, I feel unsafe on my own."

Age Ranges	Average Level of Comfort	Average Level of Safety
<65 (n=2)	8	7
50-65 (n=1)	7.5	7.6
35-50 (n=2)	7.5	7.5
20-35 (n=3)	6	8.8
<20 (n=2)	8	5.5
Grand Total	**7.1**	**7.7**

Figure 10: Main + 14th Survey results

From the people I surveyed, it looks like the youngest and oldest participants felt most comfortable at this bus stop, but less safe, compared to participants in the 20–50-year-old range.

4.1.3 Observational Results

- Most passengers were solo riders.
- The majority of people I observed stood on the wood strip between the sidewalk and bus bulb.
- Most people congregated on the northside of the stop, near the bus ID pole and tree. Often, people would lean against the tree or stop pole.
- Those who did not stand directly on the bulb or the wood strip stood on the sidewalk under the commercial awnings.
- Little to no interpersonal conversation or interactions took place.
- Most people waiting were looking down at their phones and occasionally stepping forward to look towards the bus.

- If there was a queuing order, people waited on the bulb in line in order of arrival and boarded upon that corresponding order.
- On rainy days, those without umbrellas waited under the commercial awnings. The nearest awning was in front of the bedding store, and it appeared that most people standing here blocked the storefront of this business. I would assume this could be detrimental for the local business owner, though I did not have time to interview local business owners as part of this research.
- As buses became visible on the street, people stepped out from under shelter towards the bulb to board.

4.2 Westbound Robson St and Burrard St

4.2.1 Background

Prioritization Score: 6

Amenities: Bench, Trash bin

Permanence: Temporary (wood and asphalt)

Weekday boardings: 2,744 (TransLink System Performance Review, Fall 2022).

Route characteristics: One local route

Image 7: Robson + Burrard bulb: Google Street View

This bus bulb is a temporary bulb located on the very busy intersection of Robson and Burrard, in Downtown Vancouver. As the bulb is located on the direct far side of the intersection, stopping buses habitually causes intersection traffic blockages. The bulb and sidewalk are both quite wide, giving ample room for pedestrians and passengers in a busy commercial zone. The bulb has no greenery nor shelter, there is however a bench and trash bins nearby.

Where Robson St meets Burrard Ave is a busy intersection located in central Downtown Vancouver, part of the West End neighborhood. Robson Street has historically been a key commercial destination and remains today as the best-known shopping district. The west end of Robson Street buts against Stanley Park, while the east end is home to BC Place Stadium. Directly adjacent to the stop is a Roots clothing store and lingerie store (Bizmap.com & City of Vancouver, Robson Street).

4.2.2 Survey Results

"It's a really busy street so I don't feel that comfortable waiting on the bus bulb."

"To be honest, this isn't the most visually appealing place to wait. I would love to see more greenery added to add to the overall experience."

Age Ranges	Average Level of Comfort	Average Level of Safety
<65 (n=1)	8	8
50-65 (n=2)	9	8
35-50 (n=2)	8.3	8.2
20-35 (n=3)	8.2	8.3
<20 (n=2)	8	8
Grand Total	**8.2**	**8.2**

Figure 11: Robson + Burrard survey results

All age ranges at this location felt similarly in terms of comfort and safety levels.

4.2.3 Observational Results

- Most passengers were solo riders.
- Many passengers were sitting on the available bench.
- One person sat on the barrier structure on the westside of bulb when the bench was occupied.
- Additional passengers waited underneath the store awnings and walked up to the bulb when they saw the bus turn the corner. As it started to rain, the individuals waiting on the sidewalk or bulb moved back under the store awnings.
- Like the bus bulb on Burrard and 4th, it was oftentimes difficult to discern who was a passenger versus a pedestrian lingering around the bus stop. This is because the street life around the bus bulb is very active and lively due to the commercial storefronts and restaurants.
- To differentiate the two groups, I paid attention to those who were stationary for longer periods of time (generally waiting) and who were more physically active engaging in activities such as meandering around storefronts or talking on the phone (generally pedestrians).
- Compared to the other bus bulbs, there was a larger ratio of older folks. They were more likely to be sitting down on the available bench compared to the younger people, and if a younger person was on the bench, he or she would often give up their seat for an older passenger or those with mobility

devices. This may be because there are two retirement homes near the bulb. This also highlights the importance of seating and limited seating at bus bulbs to fulfill passenger demand.

4.3 Westbound 4th Avenue and Burrard Street

4.3.1 Background

Prioritization Score: 9

Amenities: Bench, street trees, trash bins

Permanence: Interim (Asphalt and concrete)

Weekday boardings: 1,407 (TransLink System Performance Review, Fall 2022)

Route characteristics: Three local and one express route

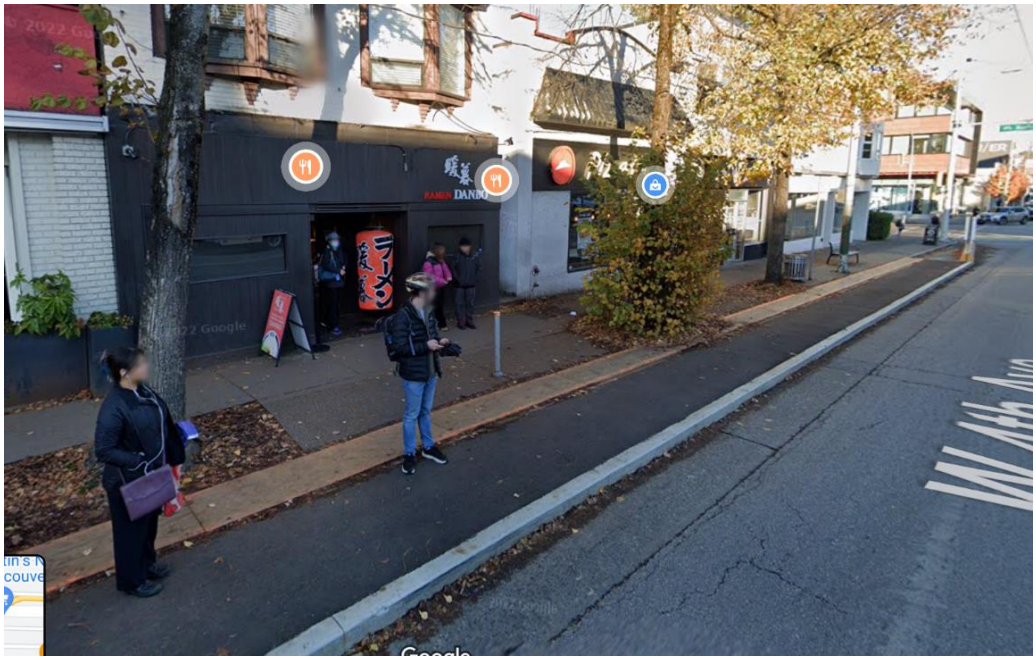


Image 8: Burrard + 4th bulb: Google Street View

No shelter is available, however there are quite a few trees that provide some respite from the sun or rain. There is one bench at the eastern end of the bulb and a sittable barrier at the western end. The bus bulb is quite long and provides ample room for passengers to wait in a generally very busy pedestrian zone.

This bus stop is located on the eastern border of the residential neighborhood of Kitsilano. Kitsilano is a highly sought after neighborhood due to its proximity to beaches, commercial activity and the University of British Columbia Vancouver campus. Compared to the City of Vancouver overall, Kitsilano has a proportionally larger population of people in their 20s and 30s and a smaller seniors and child population. Kitsilano contains primarily multi and single-family zoning districts as well as commercial uses concentrated along West 4th Ave and West Broadway. 4th Avenue and Burrard is a very busy intersection that frequently sees congestion due to cars entering and leaving Downtown over Burrard Street Bridge.

Surrounding commercial uses include large sports good stores, car dealerships, a very popular restaurant that sees customers flood onto the sidewalk, as well as a gas station that also increases congestion and dwell times (City of Vancouver, Kitsilano Neighborhood Social Indicators Profile).

4.3.2 Survey Results

"I often trip on the wood."

"The bush blocks my view of the buses approaching and should be trimmed!"

"It's often uncomfortable waiting here with all the people outside of Ramen Dambo. The bus bulb definitely adds extra necessary space."

Age Ranges	Average Level of Comfort	Average Level of Safety
<65 (n=1)	8	8.5
50-65 (n=2)	7	8
35-50 (n=3)	7.5	6
20-35 (n=2)	7.7	9
<20 (n=2)	9	9
Grand Total	**7.8**	**8.1**

Figure 12: 4th and Burrard survey results

The <20 participants felt the safest and most comfortable at this location. The 25-50 age group felt the least safe, and the 50-65 age group felt the least comfortable.

4.3.3 Observational Results

- Most passengers were solo riders.
- Due to how physically long this bus bulb is compared to the others, a higher ratio of passengers "queued" in a relative line. At this stop, most people I observed stood on the wood strip between the sidewalk and bulb.
- Additionally, most people congregated closer to the stop and wood barrier on the west side of the platform.
- Like Robson and Burrard, discerning between passengers and pedestrians/people waiting in line at the adjacent Ramen Danbo proved difficult at times; however, once the bus approached, those waiting under the commercial awnings or sidewalk made their way forward to the bus bulb. After some time

and multiple days observing passengers, I was able to detect the passengers by their physical, more stationary movements.

- People sitting on the west side barrier indicated there could be more seating for such a busy and long bus stop.
- The large bush in the middle of the bus bulb made it difficult to observe the opposite side of the bus bulb if I was standing on either side; for those passengers waiting on the west side of the bulb or sidewalk and looking towards the street for approaching buses, the bush acts as a visual obstruction. Green space design will be further discussed in the recommendations section of this report.

4.4 Northbound Commercial Drive and 6th Ave

4.4.1 Background

Prioritization Score: 8

Amenities: Bench, shelter, street trees, trash bin

Permanence: Permanent

Weekday Boardings: 863 (TransLink Performance System Review, Fall 2022).

Route characteristics: One local route

Image 9: Commercial + 6th bulb: Google Street View

This bus bulb is located on the northbound corner of Commercial Drive and 6th Ave. It is the only permanent bulb I observed; the permanent concrete material physically extends the sidewalk and gives off a perception of more pedestrian space. There is lots of litter on the ground in this section of Commercial Drive. Both 6th Ave bulbs have permanent shelters and seating on the sidewalk, as well as trash bins and newspaper stands. The northbound bulb has two street trees, whereas the opposite side of the street does not. As it extends directly from the sidewalk, this bus bulb looks more like a curb bulb-out and does not have the same "temporary" look that the other bus bulbs possess.

This bus stop is located on the major street of Commercial Drive, in the Grandview-Woodland neighborhood just east of Downtown. Commercial Drive is a street packed with small local shops and has been a significant part of Vancouver's commercial landscape for nearly a century for its ethnic

diversity. Known locally as "The Drive", the street is lined with everything from trendy coffee shops, bars, restaurants, and ethnic centres. Compared to city averages, the neighborhood of Grandview-Woodland has a higher ratio of low-rise apartments compared to single detached or high-rise housing. The corner of Commercial and 6th Ave is surrounded by various restaurants, bars, a bowling alley, a Royal Canadian Legion branch, and a Canada Post Office (City of Vancouver, Grandview-Woodland Neighborhood Social Indicators Profile).

4.4.2 Survey Results

"The bus bulbs are very bare and not very inviting."

"It's quite dirty around here so it doesn't feel like the most comfortable place to wait."

"Sometimes you have to be careful in this neighborhood."

Age Ranges	Average Level of Comfort	Average Level of Safety
>65	7	6.5
50-65	7.5	8.5
35-50	7.5	7.5
20-35	7	7
<20	5	5
Grand Total	**7**	**7.1**

Figure 13: Commercial and 6th survey results

The <20 group felt the least comfortable and least safe at this location; the score of 5 is the lowest score present across all locations. The 50-65 age group felt the most safe and comfortable. Across all ages and locations, Commercial and 6th produced the lowest scores for safety and comfort overall. This is an interesting finding, as this is the only permanent bus bulb and only bulb with permanent shelter. As my sample size was relatively small (only 10 people), I would be interested to see if this trend was consistent across larger sample sizes, times of year and weathers.

4.4.3 Observational Results

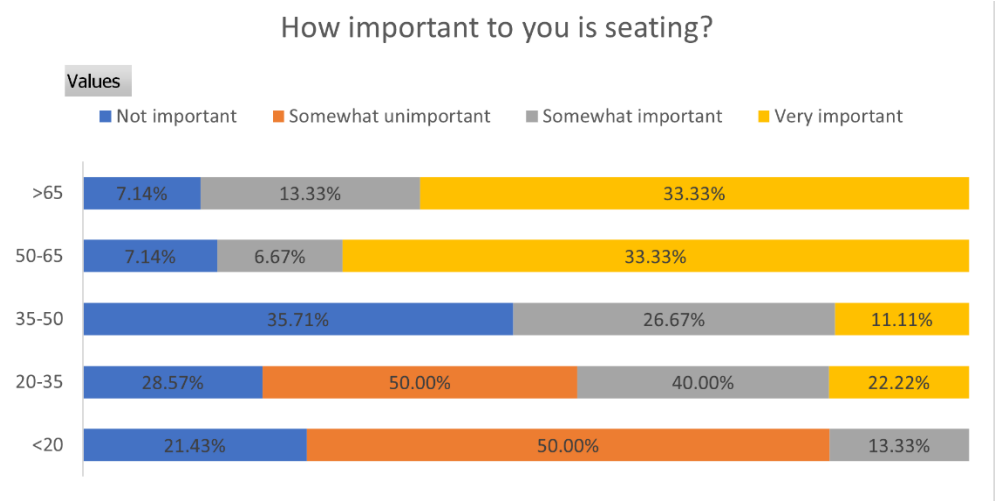
- This is the only selected bus stop that had shelter and corresponding bench, alongside being the older permanent extension.
- Most people who waited here either stood under the shelter or sat down on the bench.
- During the weekday morning hours, this stop was much less busy than expected; it was quite empty, with only 4 or so individuals waiting for the northbound bus.
- Weekend observations proved much busier, as more people flocked to the street for daytime activities and nightlife. My weekend observations provided a more robust understanding of passenger behavior at this bus bulb.
- The permanence of the bus bulb and visual consistency of sidewalk material made it so that many more pedestrians walked in front of the bus shelter and onto the bulb space, as if it was the regular street sidewalk. Unlike the other bus bulbs that looked physically separate than the sidewalk, this bus bulb blended in naturally and people used the space consequently.
- Due to the proximity to the Expo Line SkyTrain, people may be less inclined to use this stop going in the Downtown direction as the SkyTrain provides a quicker and more frequent service.

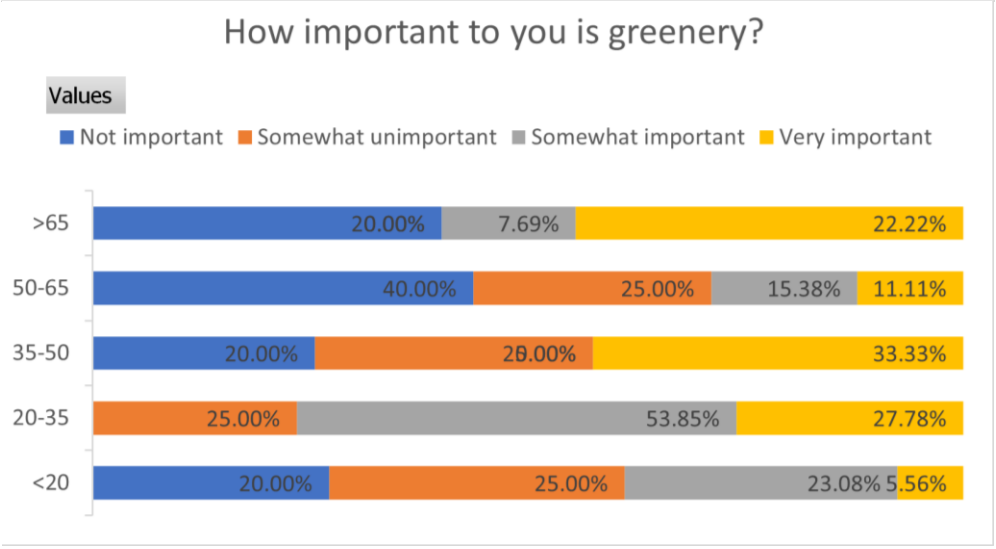
4.5 Overall Findings

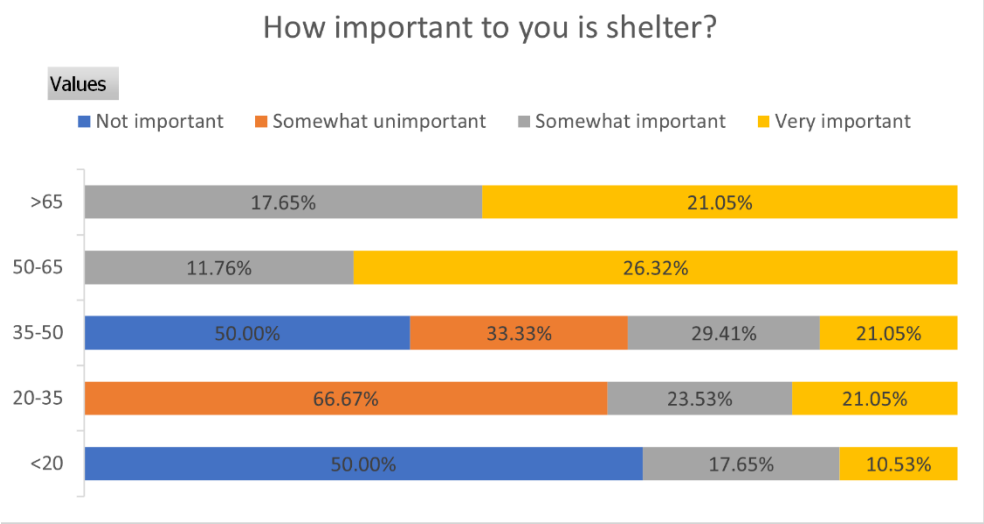
Most people I surveyed were frequent bus riders, with the majority of participants taking the bus every day and using the bus bulbs they were surveyed at more than 3 times a week. While most passengers felt generally quite comfortable and safe across all four locations, there were some participants who highlighted specific concerns related to violence, drug use and unsafe street traffic.

The following bar charts highlight passenger value and satisfaction of seating, shelter and greenery amongst all 40 participants, across the five age ranges.

4.5.1 Value/Importance of Amenities



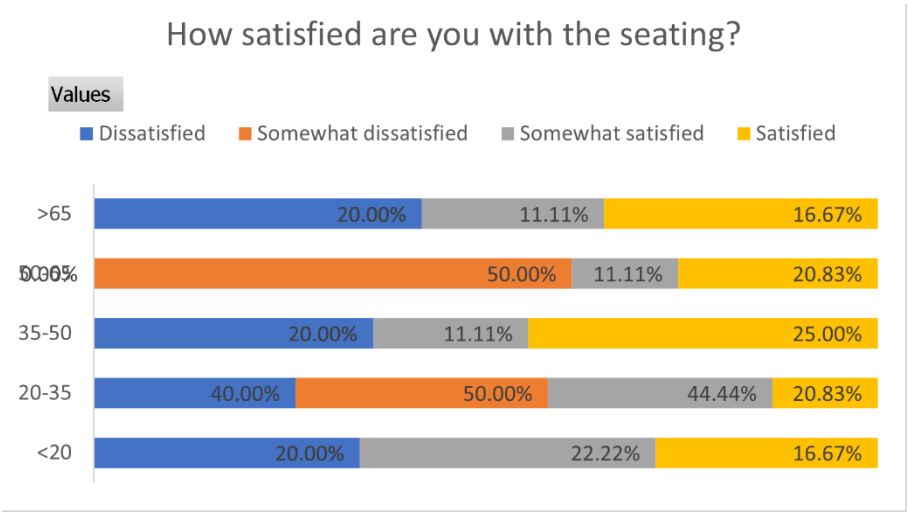


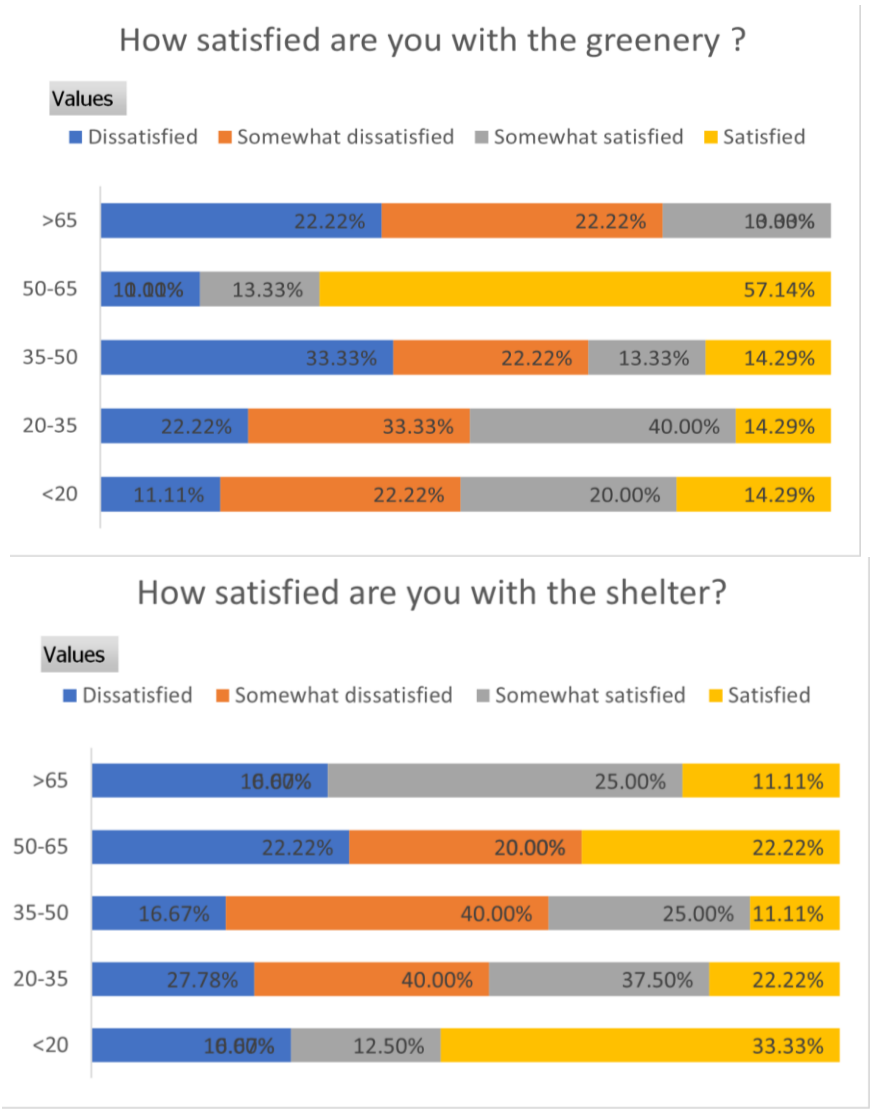


Figures 15: Overall survey results: Value/importance

Interestingly, there is quite an even mix of responses from participants across all age ranges. seating, it appears as though the older participants get, the more they care about seating. The ratio of "not important" or "somewhat unimportant" responses gets greater the higher the age. Less than half of all total participants see seating as "very important." For shelter, the same phenomenon seems to happen. The older the age of participant, the more they seem to care about shelter. However, the split between those who find shelter "very important" and "not important" is also quite even. For greenery, those aged 35-65 see greenery as less important compared to those aged 20-35 who view greenery as very important overall.

4.5.2 Satisfaction of Amenities





Figures 16: Overall survey results: Satisfaction

For seating, those aged 30 and higher seemed to be less satisfied with the seating than those younger than 30. For shelter, those younger than 35 appeared to be overall more satisfied with the level of shelter at bus bulbs, compared to older participants. Those aged 50-65 were the least satisfied with the level of shelter. For greenery, results were quite mixed. More than half of all participants were somewhat dissatisfied to dissatisfied with the amount and level of greenery at bus bulbs, with the 50-65 age group the most satisfied and the 35-50 age group the most dissatisfied overall.

There appears to be a slight negative correlation between one's valuation of amenities and passenger satisfaction of that amenity at a particular bus stop. For example, the age ranges that saw shelter and greenery as important were overall less satisfied with that same amenity, and vice versa. Although my sample size was small, I presume that these results would be similarly representative across a larger

demographic and bus bulb locations. A limitation of this result is that most passengers surveyed are frequent bus riders. Therefore, an intrinsic selection bias may exist in that those who frequently take the bus may be more inclined to value bus stop amenities than less frequent bus riders.

Where do passengers choose to wait for the bus?

- **People tend to move towards the periphery of space,** whether the edge of the bus bulb or corner of the bulb. This correlates to William Whyte's observations on pedestrian behavior in public spaces.
- At locations with no shelter, **people tend to use the commercial awnings for shelter** and wait for the bus, more than initially expected.
- At locations with shelter, **those who arrive first tend to use the shelter and bench.**
- **People do not typically wait on the bus bulb**. They waited either on the sidewalk or in between the sidewalk and bus bulb, and step onto the bulb only once the bus approaches.

Do bus bulbs free up space on the sidewalk?

- On busier streets, it seems like **people are still hesitant to use the extra space** and **many people stand directly next to and adjacent to the bulb.**
- For bus bulbs that are in primary commercial zones, it is **often difficult to decipher who is a passenger waiting for the bus versus who is a pedestrian using the bus bulb space as sidewalk space.**
- My observations highlighted that bus bulbs **do not significantly free up space on the sidewalk.**

What factors impact pedestrian behavior (e.g., weather, time of day, age demographics)?

- The presence of a **bus shelter greatly impacts how pedestrians behave in space**. At locations without shelter, many individuals utilize commercial awnings for shade and rain protection in various weather conditions.
- The **time of day does not generally impact one's waiting behavior**, though rush hour times are busier and often more chaotic.
- At busier peak travel period, people tend to randomly congregate rather than form queuing patterns.
- **Older passengers utilize shelter and benches more frequently** compared to younger passengers.

What are riders' perceptions of safety and comfort at bus bulbs?

- People tend to feel **unsafe waiting alone later in the night in more rowdy areas**.
- People tend to feel **uncomfortable waiting on super busy traffic streets** with no seating.

- People tend to feel more comfortable waiting in areas they are familiar with and that have a lot of street activity, **indicating the importance of eyes on the street supporting safety and comfort.**
- Some passengers often trip on the wood strip at temporary and interim bulbs, indicating the **importance of material safety at bus bulbs.**

5. Recommendations for City of Vancouver

Recommendations are intended to support the development of a human-centered approach to bus bulb design. While the current design of City of Vancouver bus bulbs was initially devised from an operational perspective with secondary passenger benefits, I propose a reevaluation of the human design elements necessary to provide a comfortable, safe and socially connected waiting environment at bus bulbs.

My recommendations consider the temporary nature of many of the bus bulbs, considering interim solutions that can be integrated to support future permanent bulbs, alongside low cost and easy to install materials.

5.1 Consider implementing temporary shelters bus bulb locations.

A trend present throughout my passenger analysis is that many people highly value shelter at bus stops; as all temporary and interim bulbs do not currently support shelter, passengers are left to use commercial awnings as protection from weather. A key constraint in installing bus shelters across the city at temporary locations is the material nature of bus shelters. Traditional shelters must be installed on a concrete foundation and bolted firmly into the ground. Unfortunately, the bus shelters that exist in the City of Vancouver's toolkit cannot be installed in asphalt or wood. To account for the temporary permanence of bus bulbs, new types of bus shelters should be installed to create permanent weather protection across all locations. I have selected an example from Los Angeles, California that demonstrates a unique modular bus shelter design.

Courtesy of Tranzito-Vector

Image 10: Tranzito-Vector

This bus shelter is the City of Los Angeles's new winning design by Tranzito-Vector. This "smart shelter" offers shade protection with overhead solar panels, integrated lighting, earthquake early warning systems, lighting, phone chargers, real time bus arrivals and city information. It is a high visible and open design concept which is attached to a modular curb extension system like ZICLA.

As current bus shelters cannot be installed on the temporary materials present at temporary bus bulbs, the City of Vancouver should consider alternative shelter designs and materials that can more easily be installed on asphalt, wood or ZICLA systems. The inclusion of shelter at all temporary and interim bus bulb locations would not only improve the overall passenger waiting experience at these locations but support the overall use of bus transit. As my literature reviews illustrated, people value shelter and will feel more inclined to use bus transit over their car in bad weather conditions.

An additional solution is to collaborate with businesses behind the bus bulbs to construct an extendable awning that would open and retract depending on weather conditions; this option would eliminate the need for a structured shelter to be constructed or installed. The benefit of this solution is that bus bulbs and their surrounding businesses would have a stronger relationship, supporting place-making and community connections with local businesses. More research would need to be done to understand how to best support this type of extendable shelter and gaining approval from businesses on installation.

5.2 Use consistent material elements and colors to support a clear look and feel.

The current design of temporary and interim bus bulbs across the city is disjointed. There lacks a consistent look and feel that distinguishes these spaces from traditional bus bulbs. Moreover, my observations demonstrated that most passengers are hesitant to use the bus bulbs; most people stood either on the wood beam separating the sidewalk from the bulb or did not step foot on the bulb until the bus pulled into the curb. These results may indicate that people intuitively feel a sense of separation between the sidewalk and the bulb, not understanding visually what differentiates the sidewalk and the extension, and not knowing how to utilize this space. I believe that the material design and look play a key role in this overall hesitancy.

One constraint critical in bus bulb design is drainage issues; the wood slat separating the sidewalk and the street allows for street water drainage and leaf collection. Anything that cuts into the curb without a space underneath would restrict the essential movement of water and debris. One way to solve this problem would be to paint the wood beam a color more consistent with the concrete sidewalk or asphalt bulb. Another option is painting the street edge of the bus bulb a higher contrast color so that subconsciously, the sidewalk wood slat does not look like a barrier.

Another solution for supporting material consistency is using new materials and colors such as the ZICLA Vectorial system for both temporary and interim bulbs. Utilizing a consistent design and material would allow for a universally recognized bus bulb design and support the increased use of the sidewalk extension. Moreover, ZICLA allows for adequate rainwater drainage.

There is a fine line between deterring passengers from standing on the sidewalk and pulling people onto the bus bulb; the aesthetic look of the bus bulb is a key reason to why people might utilize the bus bulb space more frequently and with less hesitation.

5.3 Upgrade or implement green infrastructure.

Greening bus shelters provide a myriad of benefits to human health and climate change mitigation. Bus stops can be transformed into inviting green spaces by adding planters and other types of greenery such as green roofs. Greening bus stops can help to reduce the heat island effect brought on by climate change by providing shade and cooling effects from plants. Greenery can also improve air quality in urban areas and busy transit zones, while providing a pleasant waiting environment for passengers. Greenery has been scientifically proven to lower stress and anxiety levels and may improve peoples' perception of bus transit if their waiting environment is more visually calming and aesthetic to look at.

With greening bus stops, considerations must be made in terms of adequate shade and weather protection as well as any visibility issues that plants may pose for passengers waiting for oncoming buses.

Green roofs:

Image 11: Green roof: NACTO

This bus stop shelter in Sheffield England contains a simple green roof. The tops of bus shelters provide an ideal surface for greening and filter pollution to protect the health of passengers.

Planting behind shelter:

Image 12: Green roof: NACTO

This bus shelter in Bialystok, Poland contains both a green roof and climbers on the sides and back of shelter that produce a rain capture system and a visually aesthetic design.

Planting into sidewalks, medians and curbs

Image 13: Bioswale in Portland, Oregon: NACTO

Stormwater bus stops contain bioretention cells that are physically incorporated into the bulb design to improve the passenger waiting experience and overall aesthetic feel of the bus stop.

Biofiltration planters such as the above are an alternative method utilized in cases where physical material constraints or native soils prevent infiltration; walled planters such as these support water drainage that collect and filter runoff through the soi land into underground pipes.

Street Stormwater Trees

Image 14: Stormwater Tree: NACTO

5.4 Implement a communications campaign to educate the public on bus bulbs.

Although most passengers I interviewed during my surveying phases were aware of newly installed bus bulb infrastructure, they were not knowledgeable about the benefits bus bulbs bring nor why the city installed them at certain locations. I believe that bus bulbs would see more passengers utilizing the extra space if more people were educated on bus bulb infrastructure and its passenger benefits.

Posters located on the bus id could effectively explain how bus bulbs operationally improve bus speed and reliability, why that specific bus stop was chosen for the upgrade, and how bus bulbs are intended to provide additional space for passengers. These posters must be strategically placed to not create issues with passenger visibility and ensure people are drawn to the information.

Image 15: Auckland Transport

Image 16: Transport for Greater Manchester

As social media is used extensively across most age groups, a collaborative and targeted social media campaign via City of Vancouver, TransLink and local news networks would reach the furthest audience. Sites like DailyHive Vancouver routinely post transportation updates that link to longer articles; a visually stimulating post that links to a City of Vancouver and TransLink article about bus bulb infrastructure would go a long way. Moreover, the city could collaborate with local video stars like Utae Lee who create videos about Vancouver's urban framework; this type of informational and social media marketing would reach many more people than simply putting up a poster at a bus stop. However, both physical and media communication strategies should be simultaneously implemented.

5.5 At temporary and interim locations with corner street plazas, merge spaces to create a pedestrian zone.

At bus bulb locations with corner plazas such as Main and 14th, and Robson and Bute, there is an opportunity to integrate both spaces into a larger pedestrian zone with unified public space amenities. Currently, bus bulbs and adjacent plazas at corner intersections are divided; people waiting for the bus and interacting with the plazas are physically separated, although close together in proximity. Instead, the City of Vancouver should physically combine these public spaces to create one unified public plaza with a bus bulb as a key feature. This integration will likely improve street life via increasing the overall happiness of passengers and thereby increased utilization of bus bulbs. This would ideally be a partnership between the City of Vancouver, TransLink and neighborhood businesses and BIAs.

This integration can be implemented at temporary and interim bulbs via pavement markings and street barriers, while including low-cost moveable street furniture and planters.

Image 17: Pop up street furniture in Seattle, WA designed by LMN Architects: Trevor Dykstra

At permanent bus bulbs with no adjacent street plaza, the same type of moveable street furniture and unique designs can be integrated to the sidewalk extension.

Image 18 + 19: Interim public plazas:NACTO

Plazas should be designed with a strong edge and defined using a combination of striping, bollards, and larger fixed objects, such as granite rocks and/or planters. Corners and other areas of a plaza subject to encroachment by errant or turning vehicles should be reinforced using heavy objects and bollards that alert drivers of the new curb line (NACTO).

Both interim, temporary and permanent bulbs can be combined with public plaza space to enhance public life and improve passenger perception of bus transit. Including public art, vendors and performances can improve its identification as a public space while engaging the local community and adjacent businesses.

6. Conclusion and future methodology

Currently, bus bulbs across the City of Vancouver are visually inconsistent, minimalistic, and often underutilized. If the City of Vancouver would like to see increased usage of and interest in the additional sidewalk waiting space bus bulbs provide to passengers, design considerations must shift towards a more human-centered approach. My research presented interesting findings that support future bus bulb design considerations that prioritize human comfort, safety and social connectivity, alongside operational benefits such as travel time savings and reliability.

Not only did the primary data present findings that resulted in design recommendations, but highlighted how this type of survey and observational methodology can be improved upon and potentially utilized at other bus bulb locations and public spaces across the City of Vancouver going forward. For one, the limited time frame available for collecting primary research restricted the number of passengers that could be observed and surveyed at each bus bulb location. A larger sample size of passengers and bus bulb locations would elicit more robust and nuanced results and allow for a more in-depth analysis. Although my sample size of 40 participants was as many people as possible that could be interviewed in time limit and scope, it is simply not large enough to understand the larger Vancouver transit rider demographic.

If the City of Vancouver is to consider implementing this type of human observational and behavioral analysis at transit stations or bus stop locations in the future, I recommend the following:

- Expand the sample frame to include more temporary, interim and permanent bus bulb locations.
- Consider comparing observational and survey results to non-bus bulb stops to understand behavioural nuances between passengers waiting at bus bulbs vs regular bus stops.
- Consider a larger sample size of at least 100 participants across all locations.

As a whole, this research elicited interesting findings about how passengers behave at and interact with bus bulbs that can applied to future research and design implementations. The results underscore the need to “human-proof” bus bulb infrastructure – that is, design bus bulbs to act more like pedestrianized public spaces where passengers can interact with amenities and each other in a way that improves overall happiness, well-being and desire to take bus transit. With my proposed recommendations, the City of Vancouver is hopefully better equipped to improve its bus bulb infrastructure and design to support the overall passenger experience and make bus transit more accessible and attractive for all.

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8. Appendices

Survey Phase 1:

1. What is your age range?
    a. <12 years old
    b. 12-20 years old
    c. 20-35 years old
    d. 35-50 years old
    e. 50-65 years old
    f. >65 years old
2. How frequently do you take the bus?
    a. Once a day
    b. Once a week
    c. A few times a week
    d. A few times a month
3. How frequently do you use this particular bus stop?
    a. Once a day
    b. Once a week
    c. A few times a week
    d. A few times a month
4. Before taking this survey, were you aware that this bus stop was a temporary bus stop extension/bus bulb?
    a. Yes
    b. No
5. On a scale of 0-10, how safe do you feel at this bus stop?
6. On a scale of 0-10, how comfortable do you feel at this bus stop?
7. In your opinion, what could be changed, added or removed to make waiting at this bus stop better for you? (open response)

Survey Phase 2:

1. What is your age range?
    a. <12 years old
    b. 12-20 years old
    c. 20-35 years old
    d. 35-50 years old
    e. 50-65 years old
    f. >65 years old
2. How frequently do you take the bus?
    a. Once a day
    b. Once a week
    c. A few times a week
    d. A few times a month
3. How frequently do you use this particular bus stop?
    a. Once a day
    b. Once a week
    c. A few times a week
    d. A few times a month
4. Choose the level of importance of seating at bus stops?
    a. Very important
    b. Somewhat important
    c. Neither important nor unimportant
    d. Not important
5. Choose the level of importance of shelter at bus stops?
    a. Very important
    b. Somewhat important
    c. Neither important nor unimportant
    d. Not important
6. Choose the level of importance of trees/greenery at bus stops?
    a. Very important
    b. Somewhat important
    c. Neither important nor unimportant
    d. Not important

7. Choose your level of satisfaction of the seating available at this bus stop?
    a. Extremely satisfied
    b. Somewhat satisfied
    c. Somewhat dissatisfied
    d. Extremely dissatisfied
8. Choose your level of satisfaction of the shelter available at this bus stop?
    a. Extremely satisfied
    b. Somewhat satisfied
    c. Somewhat dissatisfied
    d. Extremely dissatisfied
9. Chose your level of satisfaction of the greenery available at this bus stop?
    a. Extremely satisfied
    b. Somewhat satisfied
    c. Somewhat dissatisfied
    d. Extremely dissatisfied