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Identifying Best Practices for Mobility Hubs

Prepared for TransLink

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Executive Summary

The project, Identifying Best Practices for Mobility Hubs, explores the concept of mobility hubs in an effort to implement strategies and initiatives that prioritize low emission transportation modes in the long term.

In existing research, mobility hubs are often defined as areas where a variety of sustainable transportation modes connect seamlessly. As such, hubs present an opportunity to integrate mobility options that utilize new transportation technology to help enhance user experience and travel resiliency to help cover first and last mile travel. Based on these existing definitions, the core components of mobility hubs include being near a major transit station, providing a variety of sustainable transportation options, and being surrounded by areas with high residential and employment density.

Common hub typologies distinguish mobility hubs by their function within the transportation system such as a major transfer or gateway point, or a destination stop. Other typologies focus on the urban context which determine the scale of the hub. Within mobility hubs, different combination of elements are offered that respond to the local context and needs, and enhance user experience. In this project, ten elements were explored related to accessibility, safety, furniture, weather protection, information, services, placemaking, car interface, bike interface, and enhanced operations. The implementation of mobility hubs often involves several partnerships that can be categorized within four main themes of planning, services and elements, land development, and funding. Across these themes, these partnerships involve various stakeholders including public agencies, private mobility services, technology companies, private developers, and business improvement associations.

As a result of this research, the grounding framework for how mobility hubs can be defined and addressed in the Metro Vancouver context was established. Following the background research and case study review, three key next steps were identified to further understand this concept and its implications. Firstly, further research on key elements are recommended to understand the challenges and needs regarding the implementation of key elements. Additionally, the objectives and implementation methods will require refinement to align further with TransLink's current goals, capacity, and organizational structure. Lastly, it is recommended to plan for how mobility hubs will be incorporated into the current policy work, existing design guidelines, and planning station upgrades. This will help identify key opportunties to incorporate mobility hubs in new developments and future projects.

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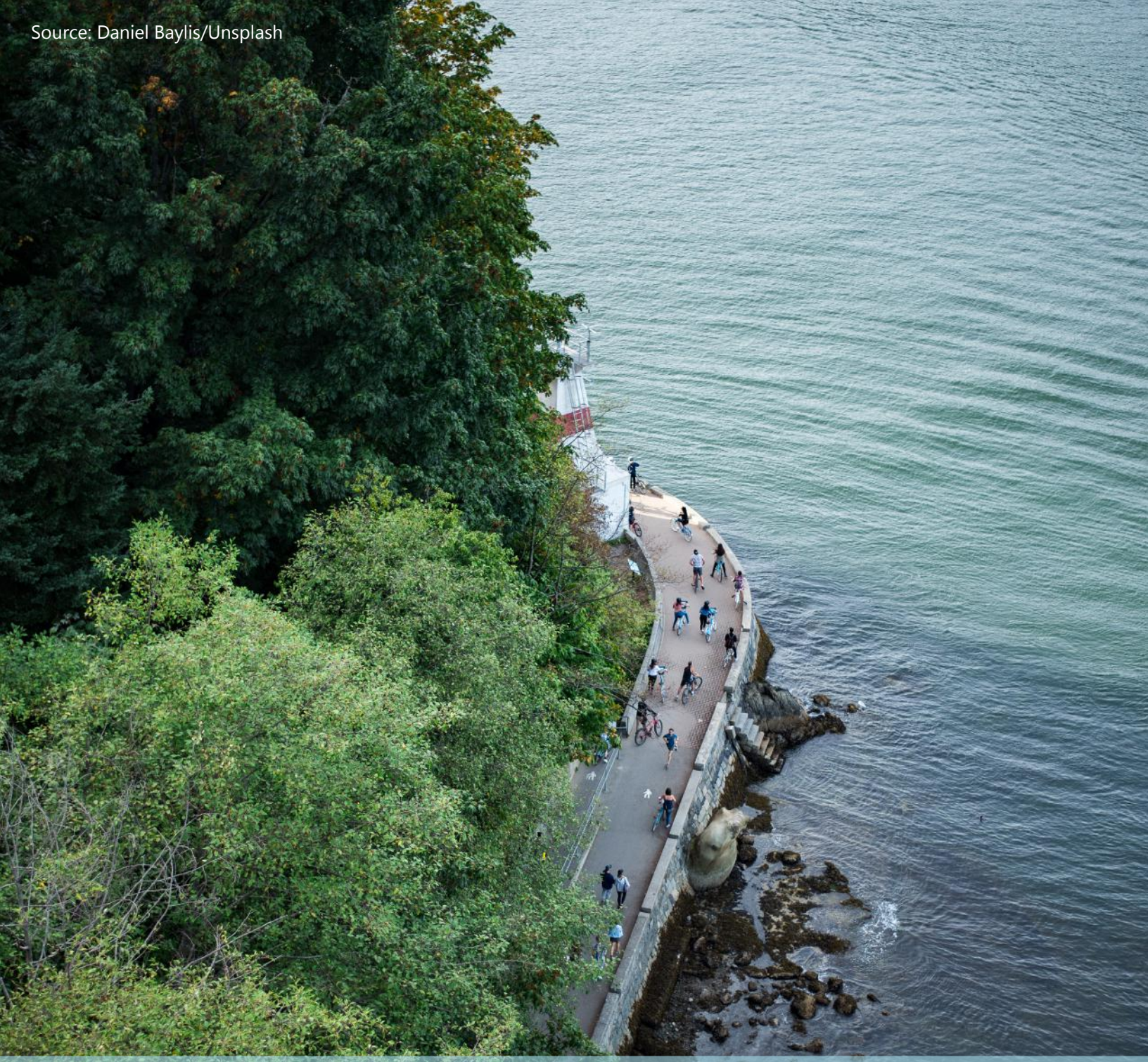
Introduction

In a time where transportation services, infrastructure, and amenities are evolving rapidly, mobility hubs present an opportunity to integrate different sustainable transportation options to enhance connectivity across the region. This project aims to explore this opportunity in Metro Vancouver by understanding the core elements that constitute a successful mobility hub that meet the objective of fostering a seamless integration of public and private mobility services that enhance user experience and travel resiliency. As a region that has aimed to protect the environment and support sustainable transportation choices, mobility hubs have the potential to become a catalyst to prioritize low emission transportation options that support existing regional goals and embrace future changes in the urban form.

Study Purpose

The overarching aim of this research project is to explore the concept of mobility hubs in an effort to implement strategies and initiatives to prioritize low emission transportation modes in the long-term. To achieve this goal, the project explores three different components related to mobility hubs.

1. Common definitions and objectives of this concept are explored to understand why it should be implemented in Metro Vancouver given their current transportation strategies and trends.
2. Essential hub elements, implementation methods, and challenges of mobility hubs are explored through case study research to form considerations for implementation.



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Section 1. Background Review

Overview of Mobility Hubs & Corridors

Definition of a Mobility Hub

The existing definitions of mobility hubs follow common themes and keywords that encompass a seamless transition of different transportation modes in areas where there is a high concentration of urban activity. These hubs are often perceived as areas where new transportation technology and services can be integrated and utilized to enhance user experience and increase transportation options for first and last mile travel.

"A place where different sustainable transportation modes are integrated seamlessly to help promote connectivity"

For the purposes of this research, the definition of mobility hubs will follow the common characteristics identified in these existing definitions. As such, mobility hubs are defined as a place where different sustainable transportation modes are integrated seamlessly to help promote connectivity, and are usually located in centralized areas. Based on the different types of mobility hubs explored later in this section, hubs can also be located in lower dense areas that have potential for development. In summary, mobility hubs provide sustainable transportation and shared mobility services, often clustered around a major transit station to help cover first and last mile travel and provide a sense of travel resiliency to customers.

Definition of a Mobility Corridor

Compared to mobility hubs, mobility corridors remain to be a lesser known concept. However, this concept is similar to mobility hubs in that it provides easy access to major transit areas. Additionally, as key corridors that connect major parts of the city, they are often highly congested with traffic. However, mobility corridors aim to integrate a variety of transport modes to promote the uptake of sustainable transportation options. Thus, the aim of mobility corridors is to prioritize transit, walking, and cycling options to and within urban centres. Some early initiatives to implement mobility corridors have focused on incorporating smart technology to explore the potential for autonomous vehicles and innovative infrastructure.

"Mobility corridors aim to integrate a variety of transport modes to promote the uptake of alternative transportation options"

"Mobility hubs are places of connectivity where different modes of travel – walking, biking, transit, and shared mobility – converge and where there is a concentration of employment, housing, shopping, and/or recreation. They provide an integrated suite of mobility services, amenities, and technologies to bridge the distance between high-frequency transit and an individual's origin or destination." – SANDAG (n.d.)

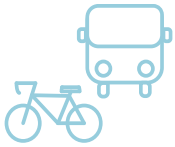
"A mobility hub is a place of connectivity, where different modes of movement, from walking to high speed rail, come together seamlessly. A mobility hub is a place in the urban region in which there is an attractive, intensive concentration of employment, living, shopping and enjoyment around a transit interchange." – Metrolinx (2008)

"Mobility Hubs provide a focal point in the transportation network that seamlessly integrates different modes of transportation, multi-modal supportive infrastructure and place-making strategies to create activity centers that maximize first-mile last mile connectivity. An integrated suite of mobility services are provided at defined locations around existing and new transit stations, allowing transit riders to seamlessly access other modes of transportation once they arrive at the station." – Los Angeles Urban Design Studio (2016)

"A mobihub (mobipunt in Dutch) is a transport hub based at a neighbourhood level, where different sustainable and shared transport modes are linked. It is designed to enable and promote multimodal transport on a local level and can be tailored for different neighbourhoods. Multiple 'hubs' could be spread across various neighbourhoods within a city and can easily be integrated into route planning facilities as each hub would have its own name." – Share North (n.d.)

Mobility Hub Components

Based on these common definitions and classifications, there are recurring core components that are required for an area to be considered as a mobility hub.



Surrounds a major transit station
A significant component of a mobility hub is that it has one or more modes of higher order transit that serves as its core. This core is surrounded by a larger area of influence – also referred to as the catchment area – that benefits from the services provided at the hub. Residential and employment areas are located within this catchment area to support the uptake of the services offered at the core.

Provides sustainable transportation options
Mobility hubs include services and destinations that are available within a 5 minute walk, cycle, and drive. When discussing mobility hub elements, many existing guidelines include walking, bike sharing, bicycling, car-sharing, ride hailing, and micro-transit in addition to major rapid transit services. Therefore, vehicle sharing options are highlighted as a key component to incorporate into mobility hubs. Metrolinx provides target metrics that assign a target mode share for transit and active transportation. For example, in primary hubs located within urban centres, Metrolinx assigns a target of 60% transit modal spilt and a 30% share of active transportation (Metrolinx 2011).

Area with high residential and employment density
As expressed in many existing definitions, the presence of urban activity is a key component of mobility hubs which is achieved from the surrounding residential and employment density. Although thresholds that determine the appropriate residential and employment density are not specified in the existing literature, Metrolinx provide target density metrics for different mobility hub types. For example, primary hubs have target metrics that range between 200 to over 400 people/jobs/ha (Metrolinx 2011). Meanwhile, secondary hubs are assigned a target metric of approximately 200 people/jobs/ha (Metrolinx 2011).

Objectives of Mobility Hubs

Based on these common definitions, mobility hubs are presented as a strategy to enhance sustainable and active modes of transportation through a user-oriented lens in dense urban centers. Preliminary research regarding the definitions of mobility hubs helped inform the objectives of mobility hubs that can address core transportation needs and help guide their development. These resulting objectives are based on existing literature surround themes that improve travel experience through safety and placemaking initiatives, embrace future changes through flexibility, support sustainable transportation options, and allow for partnership opportunities in the transportation realm.

1. Provides **efficient and seamless integration** of sustainable transportation options

2. Focuses on improving **user experience** of different transportation options

3. Ensures **safety** and **security** for all travelers

4. Creates a **sense of place** through effective and meaningful placemaking strategies

5. Allows for **flexibility** to embrace technological innovations and foster resiliency

6. Addresses **equity** by considering accessibility to and availability of transportation options in different neighbourhoods

7. Creates opportunities to form **effective partnerships**

1. **Provides efficient and seamless integration of sustainable transportation options**

A prominent goal of mobility hubs is the reduction in private automobile use and its resulting emissions. This can be obtained by ensuring a seamless and frictionless integration of different private and public mode options. Therefore, by connecting sustainable transportation options, mobility hubs aim to minimize the ecological footprint in the region. This notion can be extended to goods movement, where sustainable alternatives to delivery services are made available at these hubs.

2. **Focuses on improving user experience of different transportation options**

Mobility hub elements relevant to enhancing user experience aim to help residents, commuters, and visitors use these hubs with ease and comfort. These services include legible wayfinding, universal payment systems, and comfortable passenger waiting areas. Given the intermodal nature of these hubs, it is essential to consider services that help customers plan their trip using a variety of sustainable modes.

3. **Ensures safety and security for all travelers**

As a place with high pedestrian activity, the design and infrastructure within mobility hubs need to foster a sense of safety for passengers. Following this, safety in the mobility hub context refers to pedestrian oriented design, where passenger movement is protected from surrounding vehicle traffic. Safety should also be considered across all ages and abilities as well, allowing people of different abilities and familiarity with mobility services to travel and use a variety of services easily. The perception of safety can also be enhanced through implementing security measures that help reduce crime in these areas. Security also refers to addressing bicycle theft by implementing secure storage facilities to promote cycling to and from the hub.

4. **Creates a sense of place through effective and meaningful placemaking strategies**

Mobility hubs have the potential to become the source and destination for urban activity. Therefore, fostering a sense of place is vital to solidify the hub as a place where people belong and their values as a community are exemplified. This sense of belonging can be created by ensuring a mix of activities within the hub and building an attractive and interactive public realm.

5. **Allows for flexibility to embrace technological innovations and foster resiliency**

Mobility hubs aim to prioritize low emission transportation options by incorporating newer transportation technology. However, the shift away from private automobiles is still a developing concept. In particular, newer sustainable technologies and services such as ride-hailing, electric bike sharing, and autonomous vehicles are emerging modes that are still in its early stages of adoption. Therefore, as technology in transportation continues to evolve, the success and sustainability of mobility hubs will be contingent on its ability to modify, expand, and adapt to these changes. As a result, these unprecedented changes in transportation must be considered in the design and infrastructure incorporated at mobility hubs. As such, designs should be flexible to accommodate for future growth and changes in transportation technology. The ability for mobility hubs to adapt to technological changes will foster a sense of resiliency that will contribute to its viability in the long term.

6. **Addresses equity by considering accessibility to and availability of transportation options in different neighbourhoods**

As the overarching goal of mobility hubs is to reduce greenhouse gas emissions resulting from private automobile use across different municipalities and regions, it is essential for mobility services to be available across different neighbourhoods. Therefore, as mobility hubs become increasingly common, the location of mobility hubs and the service area of hub elements must be accessible by residents from different neighbourhoods. As a result, mobility hubs need to consider services that will help cover first and last mile travel for residents who reside outside the hub's area of influence, where there is a lack of service options. Equity also entails ensuring mobility hubs are located in areas with various densities and are not conglomerated in urban cores. Another facet related to accessibility is the cost of these services. In order for mobility services to be viable for individuals across the social gradient, fare subsidizing programs and initiatives should be considered.

7. **Creates opportunities to form effective partnerships**

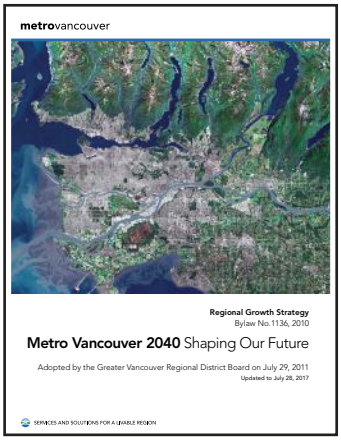
In terms of implementing mobility hubs, partnerships between the public and private sector are vital to allow for a seamless integration between different mobility services. These partnerships allow for opportunities that make traveling more convenient and unified such as integrated payment services and comprehensive data-sharing systems. Moreover, partnerships may vary between the real estate sector, commercial sector, private mobility services, and public transit providers and operators. These partnerships can help optimize land value by creating opportunities for economic development at these hubs.

Mobility Hubs in Metro Vancouver

Policy Context

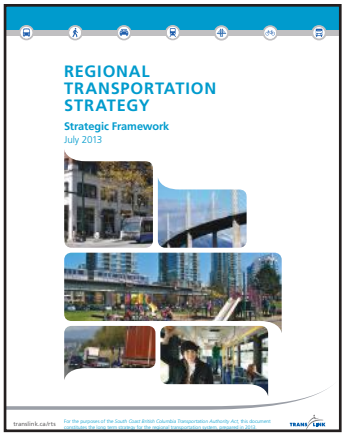
To understand the need of mobility hubs in Metro Vancouver, relevant regional plans and policies were reviewed to draw connections between existing policies and the potential for mobility hubs to meet the addressed targets, policies, and strategies.

The following documents were reviewed:



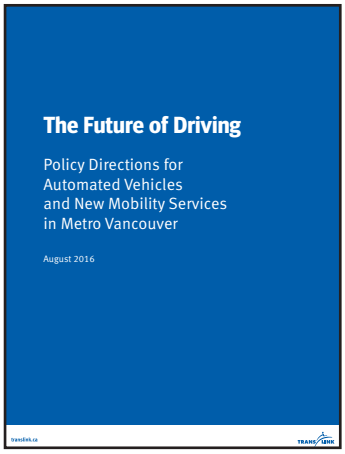
Regional Growth Strategy (2011)
Metro Vancouver

Strategy that represents the collective vision of Metro Vancouver municipalities on how to manage and foster growth and meet goals related to urban development such as the regional economy, transportation, housing, and climate change.



Regional Transportation Strategy (2013)
TransLink

Long-range plan that sets out the vision, goals, and targets for how people will travel in Metro Vancouver and outlines strategies and investment priorities to help meet these goals. This document relates to the 10-Year Vision, which specifies the actions and implementation details of the strategies outlined in the RTS.



The Future of Driving (2016)
TransLink

Recommends policy directions regarding the adoption of automated vehicles and new mobility services in Metro Vancouver.

Regional Growth Strategy (RGS)

The Regional Growth Strategy lists specific actions under each of the five goals that have been identified for the region. These goals reflect five main values of containing development within urban areas, supporting a sustainable economy, protecting the environment from climate change impacts, developing complete communities, and enhancing sustainable transportation options. Therefore, aligning the goals and actions of this document with the intended impacts of mobility hubs will help understand how mobility hubs can address regional values that extend beyond transportation. Table 1 summarizes whether each action that fall under each respective goal is addressed through the implementation of mobility hubs.

Based on this review, the implementation of mobility hubs in Metro Vancouver help address actions related to creating a compact urban area, developing complete communities, and supporting sustainable transportation choices. This is largely attributed to the fact that the aim of mobility hubs is to create concentrated areas of urban activity, travel, and related services to allow for growth in urban centers and frequent transit development areas. Moreover, sustainable transportation choices are provided through the integration of different modes for different uses. Although mobility hubs do not directly address the protection of agricultural land and conservation areas, the concept of these hubs are intended for areas within the urban containment boundary to allow for concentrated development in and around key transit areas.

Table 1. Strategies and Actions Listed in the Regional Growth Strategy

1. Create a Compact Urban Area	Contain urban development within the Urban Containment Boundary	🟢
	Focus growth in Urban Centres and Frequent Development Areas	🟢
	Protect rural areas from urban development	🟡
2. Support a Sustainable Economy	Promote land development patterns that support a diverse regional economy and employment close to where people live	🟢
	Protect the supply of industrial land	🔴
	Protect the supply of agricultural land and promote agricultural viability with an emphasis on food production	🔴
3. Protect the Environment and Respond to Climate Change Impacts	Protect conservation and recreation lands	🔴
	Protect and enhance natural features and their connectivity	🟡
	Encourage land use and transportation infrastructure that improve the ability to withstand climate change impacts and natural hazard risks	🟢
4. Develop Complete Communities	Provide diverse and affordable housing choices	🟡
	Develop healthy and complete communities with access to a range of services and amenities	🟢
5. Support Sustainable Transportation Choices	Coordinate land use and transportation to encourage transit, multiple occupancy vehicles, cycling and walking	🟢
	Coordinate land use and transportation to support the safe and efficient movement of vehicles for passengers, goods and services	🟢

🟢 = Achievable 🟡 = Potential to achieve 🔴 = Not addressed

Source: Metro Vancouver. (2010). Metro Vancouver 2040 Shaping Our Future. Retrieved from http://www.metrovancouver.org/services/regional-planning/PlanningPublications/RGSAdoptedbyGVRDBoard.pdf

Regional Transportation Strategy (RTS)

The Regional Transportation Strategy takes into consideration the five goals listed in the RGS. In response, this Strategy focuses on the existing transportation trends in Metro Vancouver to set targets and strategies that align with the region's values and will help meet the region's goals. The listed strategies focus on investment strategies to expand the transportation system, managing an efficient and user-focused transportation system, and achieving transportation goals and targets through partnerships. Therefore, as a guiding policy document for the regional transportation system, it is pertinent to analyze how and to what extent mobility hubs can help achieve the listed actions.

Targets

1. **Half of all trips to be made by walking, cycling, and transit**

By definition, mobility hubs are intended to provide a seamless transition between transit, cycling, and walking networks. Additionally, as mobility hubs are located in areas with a high demand for residential and employment uses, it offers opportunities for individuals to work and live in close proximity. These two factors combined can help increase the use of these three key modes. As a result, the implementation of mobility hubs across the Metro Vancouver region has the potential to support the achievement of the first target.

2. **Reduce the distance people drive by one-third**

The convenience of multimodal transportation provided by mobility hubs can be a catalyst for transit oriented development. This type of development will minimize the need for individuals to commute to and from work using an automobile. Additionally, the provision of first and last mile travel through the availability of bike and car sharing options at transit stations can help create a frictionless trip schedule that does not require a private automobile, helping to not only reduce the distance people drive, but the need to use an automobile at all.

RTS Strategy 1 - Invest strategically to maintain and grow the transportation system

As mobility hubs require a variety of infrastructure suitable for transit, cycling, and walking, the implementation of hubs will require investment in both existing and new walkway and bikeway networks, especially within Frequent Transit Networks. As a result of improving connectivity to and from major transit stations through these networks, mobility hubs are intended to increase transit ridership and thus, will require higher service levels in these high demand areas. As mobility hubs focus largely on pedestrian prioritization and placemaking, there is less opportunity for initiatives that focus on goods movement. However, as a concept that invites new transportation methods, there is capacity to incorporate goods movement through newer technologies (i.e. autonomous vehicles, electric cargo bikes, off-peak loading hours) in and around mobility hubs. Additionally, mobility hubs often require high density areas with high demand for transit by definition. Therefore, although low demand neighbourhoods may not be directly addressed by these hubs, they are intended to provide a variety of mode options that cover first and last mile travel to reach different neighbourhoods.

Table 2. RTS Strategy 1 - Invest strategically to maintain and grow the transportation system

Strategy 1	Actions	Addressed by mobility hubs
Invest strategically to maintain and grow the transportation system	Maintain what is needed in a state of good repair	🟡
	Make early investments to complete the walkway and bikeway networks	🟢
	Invest in the road network to improve safety, local access and goods movement	🟡
	Make investments in the transit network to increase ridership	🟢
	Ensure the continued provision of coverage transit services in low-demand neighbourhoods	🟡

🟢 = Achievable 🟡 = Potential to achieve 🔴 = Not addressed

RTS Strategy 2 - Manage the transportation system to be more efficient and user focused

This strategy to manage the transportation system to be more efficient and user focused aligns best with the intent and objectives of mobility hubs. Firstly, as mobility hubs are intended to be driven by high quality customer service, there is an emphasis on safety and security through designs and initiatives that create a sense of place and foster safety. Secondly, a prominent element of mobility hubs include shared mobility services and amenities that make travelling easier across all ages and abilities, while reducing the need for automobiles. Lastly, efficiency is addressed in a number of ways through mobility hubs such as implementing a universal payment system for different travel services, providing parking for active and shared modes of travel, and incorporating future-proof designs to accommodate for low-carbon self-driving automobiles.

RTS Strategy 3 - Partner to make it happen

Based on the review of the Regional Growth Strategy, it is evident that the concept of mobility hubs respond to the existing regional land use objectives of containing development in urban centres and frequent transit development areas. Although the common objective of mobility hubs is to foster effective partnerships, this is reliant on the efforts made by both the private and public sector to adopt a similar agenda regarding user-oriented sustainable transportation modes and its implementation methods. Moreover, the actions listed under this strategy highlight the need for mobility hubs to incorporate qualities and amenities that attract investment and funding from both sectors (see Table 4).

Table 3. RTS Strategy 2 – Manage the transportation system to be more efficient and user focused

Strategy 2	Actions	Addressed by mobility hubs
Manage the transportation system to be more efficient and user focused	Make travel safe and secure for all uses	🟢
	Make travel easy and attractive for all users	🟢
	Optimize roads and transit efficiency, safety and reliability	🟢
	Use integrated mobility pricing for fairness, efficiency and revenue	🟢
	Manage parking for fairness, efficiency and revenue	🟢

🟢 = Achievable 🟡 = Potential to achieve 🔴 = Not addressed

Table 4. RTS Strategy 3 - Partner to make it happen

Strategy 3	Actions	Addressed by mobility hubs
Partner to make it happen	Support regional land use objectives	🟢
	Ensure effective coordination through strong partnerships	🟡
	Establish funding that is stable, sufficient, appropriate and influences travel choices	🟡
	Monitor progress towards our desired outcomes	🟡

🟢 = Achievable 🟡 = Potential to achieve 🔴 = Not addressed

The Future of Driving

The Future of Driving is a relevant policy document for the implementation of mobility hubs as it explores the impacts of future technology on the existing transportation system. This document has three main policy recommendations that are intended to help TransLink and other government bodies promote and adopt autonomous vehicles. Therefore, this document provides initial discussions regarding the potential transformation in the transportation system given the current understanding of automated vehicles. As hubs present an opportunity to incorporate newer technologies and services such as autonomous vehicles and ride hailing, it is essential to explore how the implementation of mobility hubs in Metro Vancouver can help support the recommendations outlined in this report.

Recommendation 1: Update transportation policies and regulations to promote shared automated vehicles in support of regional objectives

Firstly, mobility hubs are an avenue to incorporate new technological advances in transportation as a way to increase available mode options that are suited for a wide diversity of customers. Thus, shared automated vehicles are a viable mode option to consider implementing in mobility hubs. The integration of similar technological advances such as an automated micro-transit system can help increase transportation options to major transit stations as well.

Recommendation 2: Proactively position TransLink to navigate rapid change while maintain the resiliency of transportation operations and improving the customer experience

Secondly, mobility hubs can enhance travel resiliency as the integration of several sustainable transportation modes surrounding major transit areas is intended to increase transit ridership and emphasize public transit as a vital component of urban travel. Moreover, common service amenities provided in mobility hubs aim to enhance customer experience by making sustainable transportation a convenient option and allowing individuals to navigate through different modes efficiently.

Recommendation 3: Create opportunities for government, industry and experts to explore and test innovative ideas to harness the positive benefits of automated vehicles and new mobility services

Lastly, mobility hubs can create an avenue for public-private partnerships to explore new and innovative ideas in transportation that help enhance the integration of different mobility options to cover first and last mile travel. These partnerships are vital in creating a frictionless system for amenities such as trip planning and fare payment.

Background Context

To fully encompass the potential of mobility hubs in responding to the travel behavior patterns and changes facing Metro Vancouver, the current trends in transportation were examined. The majority of this data was obtained from the most recent Metro Vancouver Regional Trip Diary Analysis Report produced by TransLink as a result of their 2011 travel survey. The following section summarize broad trends related to travel behavior that are relevant to the impact of mobility hubs. Therefore, trends that could be improved or could be enhanced even further by the implementation of mobility hubs to meet the outlined regional targets are explored. In regards to emerging trends in transportation – such as ride hailing, electric bikes, and autonomous vehicles – how these existing trends can be supported by mobility hubs are also identified in this section.

General Trends in the Region

The highest number of trips was related to **commuting** either to work or to post-secondary education.

Significant increase in the share of **non-home based trips** since 2008, meaning there is greater efficiency in travel through trip-chaining.

Increase in **transit (+1%)** and **bike (+0.3%)** mode share, while the share of **automobile driving (-1%)** decreased.

Transit trips had the highest average trip length and also showed a significant **increase in average transit trip length**

(2011 Metro Vancouver Regional Trip Diary Analysis Report, 2013)

Based on these regional level changes in travel patterns, there seems to be a general trend towards increasing transit and cycling use. Despite automobiles remaining as the dominant mode share, these changes align with the targets outlined in the Regional Transportation Strategy to increase the number of trips taken by sustainable modes of transportation. Mobility hubs present an opportunity to advance this transition by connecting transit to several other mobility services.

Population and Ridership Changes by Region

Population

Transport 2040 published by Translink in 2008 outlines the projected population growth in different regions within Metro Vancouver between 2006 to 2040. As a region that is rapidly growing, all the identified areas show a significant increase in population growth, with the Surrey/Delta/White Rock region having the highest projected growth of 56% from 2006, resulting in an increase of 835,000 residents. Although growth will be smaller in the Vancouver/UBC region of 18%, due to the large existing population, this is equivalent to an additional 730,000 residents. This is followed by an increase of 420,000 residents in the Burnaby/New Westminster region which translates to a 53% percentage increase.

In general, it is estimated that by the year 2031, the median age in Metro Vancouver will be 46, compared to a median age of 39 in 2006. Additionally, one quarter of the population is estimated to be over 65 years old in 2040. In the context of mobility hubs, this signifies the growing need to accommodate seniors in public and private mobility services to help this age group transition smoothly from private automobiles to sustainable modes of transport. Additionally, Transport 2040 notes that almost 40% of Metro Vancouver's population were born outside of Canada. Thus, indicating the importance of transportation and customer services to address language barriers so these services remain accessible and reflect the diverse community in the region.

(Data Source: Transport 2040, TransLink)

Transit Ridership

Bus ridership

The 2017 Transit Service Performance Review by TransLink indicate detailed changes in bus ridership by bus route and region as a result of service changes. In regards to bus ridership in Metro Vancouver, there has been a dramatic increase in annual bus boardings of 9% in the Ladner/South Delta/Tsawwassen region from 2016. More specially, the number of annual bus boardings increased by 216,000. This can be attributed to the 7% increase in service hours. Other regions that show a notable increase in annual bus boardings include the South of Fraser region and Richmond. Annual bus boardings in the South of Fraser increased by 8% (equivalent to 3,311,000 additional boardings) from the previous year, while bus boardings increased by 6% (equivalent to 1,088,000 additional boardings) in Richmond. On the other hand, the number of bus boardings in the Northeast Sector decreased by 23%. This is largely attributed to the opening of the Millennium line extension. It should be noted that despite these changes in bus ridership, the number of annual bus boardings in Vancouver/UBC remain the highest with 140.6 million boardings, followed by the South of Fraser (43.3 million boardings) and New Westminster (36 million boardings).

(Data Source: 2017 Transit Service Performance Review, TransLink)

SkyTrain ridership

The 2017 Transit Service Performance Review also ranks

SkyTrain stations by average weekday boardings. Based on the information provided, stations within the downtown core (i.e. Waterfront, Burrard, and Granville) are among those that have the highest average weekday boardings. This can be largely attributed to the high employment density of the downtown core. Moreover, the stations with the highest average weekday boardings both serve as an important interchange between different transit modes and lines. Firstly, Waterfront station has the highest average weekday boardings of 37,500 and is a major transfer station between the SeaBus, the Canada line, and the Expo line. This is followed by Commercial-Broadway station with 24,900 average weekday boardings. This station serves as a key interchange between the Expo line, Millennium line, and the 99 B-Line. Once the average weekday boardings were calculated by municipality, Vancouver had the highest number of boardings of 254,938, followed by Burnaby with 152,981. Therefore, the number of boardings is higher in municipalities that are closer to Vancouver and have a large number of stations.

(Data Source: 2017 Transit Service Performance Review, TransLink)

Travel Behavior by Population Characteristics

By age

The Metro Vancouver Regional Trip Diary Analysis from the 2011 trip diary survey found that about 65% of trips made by the young adult group (ages 18 to 24) were primarily for commuting purposes to work or school. This age group also had the highest transit mode share out of all other age groups. However, it should be noted that auto mode share was the highest for all groups excluding the youngest age group of ages 5 to 17.

Additionally, there is an interesting trend regarding driver licensing as there has been a decrease in the proportion of young adults who own a driver's license from 1999 to 2011. The Analysis Report attributes this trend to the incorporation of the U-Pass program and a general shift in travel behavior and attitude. This trend towards the prioritization of alternative travel modes other than the automobile can be supported by mobility hubs through its effort to make transit a viable and convenient travel option. Additionally, through the integration of other modes such as buses and bike shares combined with an improved walking experience, mobility hubs can help foster door-to-door travel using non-auto modes. Therefore, mobility hubs can support the lifestyle of individuals without a driver's license to operate their daily tasks and commute through several alternative modes efficiently.

By life stage

Another notable finding is that individuals with a full time employment status were most likely to use automobiles as their primary mode for their trips, and were least likely to either walk or be an auto passenger. In response, mobility hubs demonstrate two main ways to incorporate other sustainable modes in commuting trips. Firstly, by fostering concentrated development where there is both high employment and residential demand, the concept of mobility hubs can create opportunities where people live and work in close proximity. Secondly, by providing shared mobility services that can cover first and last mile travel at ease combined with implementing parking management strategies, there is greater incentive for individuals to utilize these services for their commute over private automobiles.

Travel Behavior by Household Characteristics

Income

Travel patterns across different household incomes indicate that auto driver mode share increases with increasing household income, however, transit mode share decreases with increasing household income (TransLink 2013, 26). This trend presents an opportunity for mobility hubs in Metro Vancouver to level the use of sustainable transportation modes across the social gradient. As the functions and services of mobility hubs become common practice, there is potential for sustainable transportation options to become a useful, efficient, affordable, and convenient alternative to automobiles for all income levels.

Housing type

For housing type, single family, townhouse/rowhouse, and apartment/condo were distinguished as three categories to find relationships with travel behavior. As a result, individuals in higher density housing types had a higher share of trips made by modes other than automobiles (TransLink 2013, 27). Therefore there is potential for success in implementing mobility hubs as major hubs — based on its existing definition — will presumably be located in centralized urban areas. Thus, as the use of other modes are more common in these housing types, this indicates that there is potential for high uptake of alternative mobility services other than the automobile in these urban centres.

Shared Mobility

Although there is limited information regarding the usage and uptake of private shared mobility services, the increase and expansion of these services can help identify its popularity in Metro Vancouver.

Car share

Car sharing is becoming a prominent option in the City of Vancouver as it has the largest car sharing fleet in Canada of 3,000 vehicles (Vancity 2018). This is largely attributed to the fact that there are currently four different companies that operate car sharing services: Evo, Car2Go, Modo, and Zipcar. Research conducted by Vancity indicate that membership is growing rapidly as out of more than 4,000 members, "one in three signed up less than a year ago and two in three joined within the last two years" (Vancity 2018, 2). Aside from Vancouver, some car sharing services are expanding to surrounding municipalities like New Westminster, Burnaby, and North Vancouver (Vancity 2018).

However, the proportion of these car share vehicles out of all registered vehicles remain relatively low at around 0.5% (Vancity 2018).

Car2Go in Vancouver (David Horemans/CBC)

In regards to the impact of car sharing on travel behavior, this study found that the availability of car share services influenced private vehicle ownership. Firstly, 25% of their survey respondents disposed at least one private vehicle after adopting car sharing as a viable transport option (Vancity 2018). Secondly, 53% of survey respondents indicated that they would have purchased a private vehicle if car sharing services were unavailable (Vancity 2018). Therefore, the incorporation of car sharing services at mobility hubs will be integral in reducing the use of private automobiles and promoting environmental efficiency and sustainability.

Lastly, this research highlighted the reasons why respondents used car sharing services. Respondents across all age groups agreed that its convenience was an important factor that contributed to utilizing car share. Similarly, most respondents across all age groups valued the benefit that car sharing services provided more options for getting around. Therefore, allocating space for car sharing services in and around mobility hubs can enhance these identified benefits of having a convenient option to complete trips.

Bike share

Mobi Bike Share, City of Vancouver

Mobi bikeshare is a public bike share system implemented in Vancouver and operated by Vancouver Bike Share Inc. This bike share service was implemented in summer 2016 and has resulted in 125 stations, over 1200 bikes, and over 650,000 trips by fall 2017 (City of Vancouver n.d.). Although the service area was initially limited to the downtown area with Arbutus Street, Main Street, and 16th Avenue as its boundaries, it has then been expanded to Commercial Drive, resulting in an addition of 25 stations (Mahichi 2018). Thus, this expansion can be interpreted as a sign of growing demand in other areas of the City (Benning & Little 2017). Additionally, this also signifies a potential for uptake if implemented as an amenity in mobility hubs, especially around urban centres.

Mobi Bikes in Vancouver (Amy Do/The Global Grid)

One notable initiative taken by the City of Vancouver and Mobi bikes is their one year pilot program aimed to make the Mobi passes more affordable. This program allows eligible individuals to obtain a yearly pass to the bike share service for $20, as opposed to the standard yearly rate of $159 through a Vancity Community Pass (Mahichi 2018). This program is also available for individuals who either have a subsidized Compass Card, obtain a referral through a community non-profit, or are part of the Leisure Access Pass (Mahichi 2018). These efforts to make shared services more accessible directly address the common objective of mobility hubs to consider equity in accessing different transportation options.

U-Bicycle, City of Victoria

U-Bicycle is a dockless bikesharing system that was implemented in Victoria as a pilot project in October 2017 (Times Colonist, 2017). As a result of their pilot, the company has added 250 bikes to their fleet from an initial fleet of 150 bikes. Although the uptake of the program is unclear, their program is expected to expand to Port Moody, Port Coquitlam, and Richmond in 2018. Thus, there seems to be municipal interest in incorporating this bikeshare system to promote sustainable modes of transport.


U-Bicycles in Victoria (Adrian Lam/Times Colonist)

Dropbike, University of British Columbia (UBC)

Recently, the University of British Columbia implemented a 12-month pilot program for a bike share system on campus (UBC Campus + Community Planning n.d.). Although the initial fleet comprised of 200 bikes, the program aims to increase their fleet to 2000 bikes. Similar to U-Bicycle, Dropbike utilizes a dockless system, where bikes can be parked at any location where bicycle parking is permitted. The program has shown early signs of success with "over 6,000 rides in less than five weeks" according to company CEO, Qiming Weng (Wilson 2018). This pilot program indicates the potential of hubs to succesfully promote bike sharing services in key destinations with a large population such as universities, hospitals, and corporate campuses.

Ride hailing

Ride hailing services are yet to be adopted in BC. However, the provincial government has indicated their plans to introduce these service in 2019. Therefore, although the usage, uptake, and impacts of ride hailing services in BC are currently unavailable, there is existing research that focuses on the impacts of ride hailing services in major US cities. For example, research conducted by Clewlow & Mishra (2017) identify the impacts of ride hailing services on transportation systems and travel behavior from seven major US metropolitan areas. Firstly, this research found that out of all surveyed service users, 24% used ride hailing on a weekly or daily basis (Clewlow & Mishra 2017). Meanwhile, a majority of 41% utilized these services 1 to 3 times a month, and 34% used them less than once a month. Therefore, based on these results, ride hailing services seem to only replace particular trips and do not affect every travel such as commuting. This is further supported by responses that indicate most trips made via ride hailing were for going to bars and parties, followed by restaurants and cafes.

In regards to the impacts of ride hailing on transportation mode share, 9% of respondents indicated that they were able to dispose at least one household vehicle, while 91% indicated the use and availability of ride hailing services had no impact on their personal vehicle ownership. For vehicle miles traveled, 29% of service users indicated that their distance travelled by their vehicle decreased by at least 10 miles. However, Clewlow & Mishra (2017) suggest that the net change in vehicles miles travelled (VMT) is unclear as the reduced distance driven by personal vehicles may have been made via ride hailing services instead. Moreover, there has been an increase in unoccupied taxi and ride hailing hours between 2013 to 2017, which may result in an increase in VMT from "deadhead" miles (Brown et al. 2018). Additionally, Clewlow & Mishra (2017) found that 49% to 61% of ride hailing trips would not have been made at all or would have been made by walking, biking, or transit.

Clewlow & Misha (2017) also found that a majority of ride hailing users indicated that the availability and usage of these services did not impact transit use. For respondents that indicated that their transit usage were impacted, public bus trips were replaced to the greatest extent with a 6% net reduction, followed by a 3% net reduction in light rail use (Clewlow & Misha 2017). Meanwhile, there was a 3% net increase in commuter rail use, indicating that ride hailing services can be used to complement this particular mode (Clewlow & Misha 2017).

Self-driving Uber cars (Jared Wickerham/AP)

Based on these findings, it is essential for mobility hubs to allow for easy transitions between ride hailing and public transit services to ensure that ride hailing complements existing transit services instead of replacing them. Additionally, mobility hubs must provide viable alternatives to ride hailing in the form of bike sharing and safe pedestrian walkways to help reduce VMT by both privately owned vehicles and ride hailing services.

Emerging Technology

Electric bikes

Electric bikes ("e-bikes") have recently become an emerging mode of transportation in North America. This increase in uptake extends beyond private use as bike share services have increasingly incorporated e-bikes into their fleet. Despite this increase in usage, data regarding e-bike sales in Canada remains limited. However, it was reported in 2016 that local e-bike firms in Canada have seen a 100% to 500% growth in sales (Shore 2016). Additionally, it is estimated that the number of sales in North America as a whole was about 300,000 that year (Shore 2016). Based on these recent figures, it can be expected that the uptake of e-bikes will continue to increase, resulting in an increasing need for e-bike charging stations in public areas like mobility hubs.

In terms of accommodating e-bike infrastructure, there have been efforts by the City of Vancouver to accommodate for e-bikes through their parking bylaw, which now requires each two of Class A bicycle spaces to have an electrical outlet (City of Vancouver 2016). Class A bicycle spaces refer to bicycle parking designed and used for long-term parking. As e-bike uptake and usage increases in Metro Vancouver, it may become essential for mobility hubs to consider implementing similar standards for shorter-term bicycle parking to promote e-bike usage for a variety of trip types.

Electric vehicles (EVs)

The EV Technology and Market Overview provided by Powertech Labs Inc. in 2016 summarize the usage and potential uptake of electric vehicles in BC. This document reports that in 2014, there was a total of 1,700 electric vehicles in BC alone, and 1,200 of these vehicles were registered in the Lower Mainland (Powertech Labs Inc. 2016). This signifies that the environment and infrastructure in the Lower Mainland is perceived to be appropriate to accommodate for electric vehicle use relative to other regions in BC.

There is also potential for growth as the EV market in Canada is less diversified compared to other countries. Thus, as newer EV models infiltrate the Canadian market, there may be an increase in demand for these vehicles. This assumption is supported by research conducted at Simon Fraser University regarding electric vehicle sales in BC. Their research found that having a diverse range of electric vehicle models in the market is vital to promote EV adoption (Powertech Labs Inc. 2016). Based on their research, it is suggested that the EV market share of new vehicle purchases will range between 6% to 16% in 2024, and will increase to range between 20% to 23% by 2030 (Powertech Labs Inc. 2016).

This report also summarizes findings published by Navigant Research regarding EV adoption in Canada. Their research found that under a conservative scenario, EV adoption in Canada will have a compound annual growth rate of 22.8%, while under the aggressive scenario it will reach 25.7% (Powertech Labs Inc.). This translates into approximately 74,000 to 91,000 EV sales by 2024 (Powertech Labs Inc.). Once applied to the context of British Columbia, this results in 39,000 to 47,000 forecasted EV sales by 2024. The forecasted increase in EV sales signify the potential and need for EV accommodating infrastructure in BC. This extends to mobility hubs, as electric vehicle use is a sustainable transportation option that users may value and utilize to connect their trips. Moreover, the inclusion of this transportation option will help achieve the overarching aim of mobility hubs to reduce greenhouse gas emissions.

Autonomous vehicles

Autonomous vehicles often refer to fully automated, self-driving vehicles that are estimated to enter the market in the next 20+ years. These automated vehicles are classified across 5 levels that range between no automation to full automation. Currently, the market is between partial and conditional automation, where functions such as steering, accelerating/decelerating, and monitoring the driving environment is nearing towards automation (PPSC 2018). As a growing industry, the incorporation of automated vehicles through safety and regulatory policies is being explored by different levels of government. As a result, pilot testing of automated vehicles has been allowed in certain regions like Ontario to understand the potential impacts of AVs in the transportation system.

Autonomous vehicle in France (Sean Lee/The Star)

The common benefits of automated vehicle ownership and sharing include:

- Reduced human-induced traffic accidents
- Increased human productivity during travel time
- Increased basic mobility for individuals who cannot or prefer not to drive

The potential challenges of automated vehicle ownership and sharing include:

- Increase in vehicle kilometer travelled (VKT) resulting from increased AV trips and trips to avoid parking fees
- Reduced transit and active transportation trips
- Additional risk to other road users (e.g. pedestrian and cyclists)
- Increased infrastructure costs

Based on these potential impacts, it is essential for mobility hubs to enhance the benefits of AV technology, while mitigating the potential challenges and conflicts. Given that many cities have begun pilot testing the role and incorporation of AVs, it is important for mobility hubs to accommodate this new technology as it becomes increasingly adopted. Therefore, although the incorporation of AV technology in Metro Vancouver is still uncertain, mobility hubs need to consider flexible design and infrastructure that will allow for the incorporation for AVs in the future.

Source: Aditya Chinchure/Unsplash

Section 2. Case Study Review

Mobility Hub Typologies

Some of the existing literature distinguishes between different types of mobility hubs. These distinctions are essential in understanding mobility hubs as a multifaceted concept, where the local context shapes the hub typology. Additionally, these existing typologies can help inform how to classify hubs in Metro Vancouver in a way that suites the local transportation network.

Gateway and Anchor Hubs

One method of categorization is by their role in the transportation network. This categorization is utilized by the Regional Transportation Plan (RTP) for the Greater Toronto and Hamilton Area created by Metrolinx.

Gateway hubs are located in a major transit station area that is a point of interchange between two or more current or planned regional rapid transit lines (Metrolinx 2008). As major transit areas, gateway hubs must have a forecasted density target of 10,000 people and jobs combined within 800 metres (Metrolinx 2008).

Anchor hubs are located at major transit stations in an urban growth centre as outlined within Metrolinx's RTP. Anchor hubs also include transit areas that serve as international gateways, such as airports and railway stations. In summary, anchor hubs are major regional destinations that have the potential to accommodate new growth.

Urban Context & Transportation Function Typologies

Another way to classify mobility hubs is through the urban context and the transportation function the area serves, used by Metrolinx. Classifying hub locations through these two factors helps identify specific needs and characteristics of the area.

Urban Context

- City Centre: These areas are dense regional centers that have multiple destinations, attracting a large number of jobs and people. As a major destination, there is already a multi-modal environment with a high quality walkway network. Due to the dense environment, there is limited developable land, and most development will occur through infill development.
- Urban Transit Nodes: These areas refer to both major and local centers that have moderate to high densities and mixed use development (Metrolinx 2011).
- Emerging Urban Growth Centers: Unlike City Centres and Urban Transit Nodes, these areas have potential for development as more land is available. Compared to the previous two area types, these areas are generally more auto-oriented.
- Historic Town Centres: Smaller city centers with low to medium density development (Metrolinx 2011). These areas offer mixed development and a walkable street network.
- Suburban Transit Nodes: These areas show potential for development due to a growing demand for mixed-use development and greater land availability (Metrolinx 2011). Similar to Emerging Urban Growth Centres, these areas are generally auto-oriented.
- Unique Destinations: Similar to the destinations typology identified under Gateway and Anchor Hubs, these areas draw and generate a lot of activity and travel. As such, areas under this category include universities and airports.

Transportation Function

- Entry: Stations that have a large share of outbound trips in morning peak hours. These areas are often local transit terminals that provide commuter car parking and bicycle parking (Metrolinx 2011).
- Transfer: These areas are points of transfer within the regional rapid transit network. Transfers may be between rapid transit lines or other services provided by various service operators.
- Destination: As opposed to entry areas, destination areas have a large share of inbound trips in morning peak hours. These areas are major destination areas that have a high concentration of employment, recreational, and institutional uses (Metrolinx 2011). As a result, they are often served by a large number of rapid transit lines.

Neighbourhood, Central, and Regional Hubs

The LA Urban Design Studio (2016) uses three typologies to classify mobility hubs which include neighbourhood, central, and regional hubs. These typologies identify requirements for both the surrounding urban context and hub elements.

Neighbourhood

Neighbourhood hubs are smaller stations in lower density neighbourhoods. Basic hub elements are offered at these hubs along the street.

Central

Central mobility hubs are located in the urban context with more amenities like car and bike shares. These amenities are available throughout the intersection and integrated in the neighbourhood.

Regional

Regional mobility hubs are the largest in scale and are in dense urban areas. As key areas that connect to other regional transit providers, these hubs offer most hub elements which are built into the station itself.

E-Mobility in Amsterdam, Nijmegen, Leuven, and Manchester

The Future Mobility Network developed different mobility hubs that focuse on e-mobility. These 'eHubs' offer electric mobility and accommodating infrastructure to residents, commuters, and tourists. Under their model, there are four main eHubs that vary by size, location type, and services offered. The idea behind these four types is that the hub services match the existing demand for transportation at that location. As such, the four eHubs are defined as minimalistic, light, medium, and large.

Minimalistic
This category is a small-scale hub, where there is a minimum of one mode offered. Therefore, the aim is to utilize existing infrastructure that has minimal physical impact. This hub features elements that are easy to install or move, and are suitable for demonstration projects.

Light
Similar to minimalistic eHubs, hubs under this category are relatively easy to install or expand. However, these hubs require at least two mode options.

Medium
These hubs cover a variety of modes and have more of a permanent character through mobility infrastructure that has a high physical impact. Additionally, greater space is required to accommodate for different modes.

Large
This is a large-scale hub that also covers different modes but to a greater extent than hubs under the medium category. Hubs under this typology target commuters and visitors.

Examples of Mobility Hubs

This section outlines existing examples of mobility hubs. Some of these examples are places that were planned and implemented as “mobility hubs”, while others are places that exemplify elements and factors that are required to be considered as a mobility hub.

The following examples are explored in this section:

1. Kipling Mobility Hub (Toronto, ON, Canada)
2. Union Station (Denver, CO, USA)
3. Millennium Station (Chicago, IL, USA)
4. Mobil.punkt Stations (Bremen, Germany)

Kipling Mobility Hub in Ontario

Summary/Description

The Kipling Station in Toronto is a new development that only begun construction this year and is estimated to be completed in 2020. As a station that was proposed to become a mobility hub, the plans include implementing infrastructure that supports different public transit services along with safe pedestrian and bike pathways. The plan for this station has three main aims of fostering integration, connection, and growth. Firstly, integration refers to providing seamless transit trips by becoming a station that serves as an access point for regional and local services. Secondly, this station aims to foster connections across the region by becoming a regional transit network that includes bus routes and rail lines provided by various transit providers. Lastly, this mobility hub is intended to spur economic growth and development in the area by creating job opportunities in the surrounding neighbourhood.

Rendings of the proposed Kipling Transit Hub (Strasman Architects/Urban Toronto)

Mobility Hub Elements

- **Several transit services:** The expansion of Kipling Station will integrate several public transit services including the subway, GO train, GO buses, and MiWay buses. Therefore, a large component of the station's transformation is the addition of a new bus terminal that will serve inter-regional and local bus services which will connect to the station's subway and regional GO rail services.
- **Pedestrian priority:** The development considers pedestrian access and movement through pedestrian oriented designs and facilities. These facilities include an elevated pedestrian bridge and an underground tunnel that are intended to help pedestrians move from one transit facility to another with ease and safety.
- **Bike networks:** The development of this mobility hub extends to the entire neighbourhood as the nearby streets have been planned for a redesign as well. This redesign incorporates wider sidewalks with street furniture and dedicated bike lanes leading to the station. In addition, there is space dedicated for bike parking at the station. These designs can improve bicycle access to the station which help increase cycling trips for first and last mile travel.
- **Potential for surrounding development:** The location for this development has already realized its potential for growth as 2000 new residential units have been built over the past 5 years (SvN n.d.). Additionally, given the forecasted transformation into an regional interchange point, the plan for this hub is to create opportunities for jobs both in the neighbourhood and across the Greater Golden Horseshoe area (Metrolinx n.d.).
- **Environmentally sensitive practices:** The station proposes a green roof for the bus terminal to incorporate natural storm-water management at the site (SvN n.d.). Moreover, the station plans for improved landscaping to incorporate natural features around the station and enhance user experience when entering and exiting the hub.

Union Station in Denver, Colorado

Summary/description:
Union Station in Denver has transformed into a major regional transportation and mobility hub. This transformation was made possible by the availability of 20 acres worth of rail yards that was converted into an urban transit district that accommodates light, commuter, and intercity rail, as well as bus routes, bike infrastructure, and pedestrian walkways (Skidmore, Owings & Merrill LLP n.d.). The station itself is a historical landmark as it is a significant station that provided railway services which contributed to Denver's economic growth in the 1880's (City and County of Denver 2004). Therefore, this station has been one of the downtown area's significant landmarks for over 120 years.

The Train Hall at Union Station (Robert Polidori/ArchDaily)

Pedestrian promenade at Union Station (Robert Polidori/ ArchDaily)

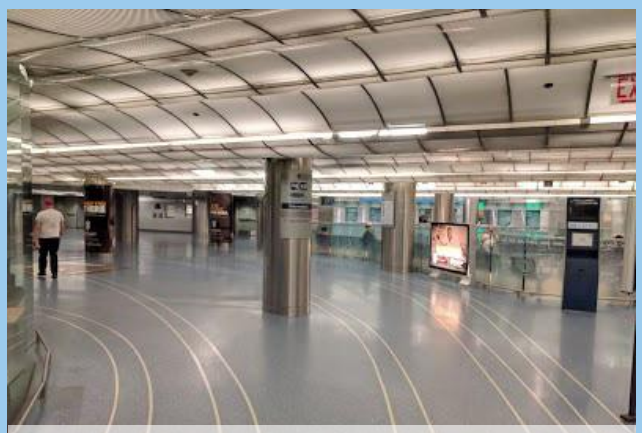
Mobility Hub Elements

- **Several transit services:** As mentioned, this transit station serves as a hub that provides major regional and local connections through several sustainable transportation methods. In terms of public transit, this station provides access to commuter rail, light rail, and regional buses. As such, the railway facility accommodates commuter rails and Amtrak and Ski Train services. Each of these facilities are well connected to allow for seamless transitions between different modes.
- **Integration with the surrounding area:** As part of the station's services, free shuttle bus rides are provided along a major commercial street from the station. This service, known as Free MallRide, runs every day and connects Civic Center Station with Union Station. These shuttle buses have recently converted into battery-powered electric buses. For commuters that work in the downtown area, a similar service known as Free MetroRide is provided which serves a different route between Civic Center Station and Union Station. The aim of this service is to provide free bus service during weekday rush hours for downtown commuters.
- **Public spaces:** The upgrade of this station incorporated several public spaces such as plazas, gardens, and pavilions to integrate the station into the surrounding neighbourhood, known as LoDo (Lower Downtown). These public spaces also contribute to the creation of an enhanced pedestrian pathway network that improves customer service when users are transferring between different modes.
- **Architectural design:** As part of the redevelopment, new architectural designs were incorporated to help the facilities and services stand out as a major regional transportation hub and provide functionality for everyday users. For example, the railway facility was built as an open-air Train Hall which allows an open concept while providing weather protection through a tensioned canopy. Additionally, the bus concourse utilizes vivid colors and natural lighting to help users navigate themselves among the different transit services (ArchDaily 2014).
- **Mixed-use development:** The station itself expands as a multi-use development through the incorporation of retail and commercial services in the Great Hall, a historic building that has become an architectural feature that represents the station. Within this space, different restaurants and eateries are available, making the station more than a transient space for transportation, but a destination for recreational activities. Moreover, the Wynkoop Plaza is designed to hold concerts and festivals. Lastly, the historic Union Station building was transformed into a hotel to accommodate for visitors in the downtown Denver area.
- **Free Wi-Fi:** Although this is a large-scale development, free Wi-Fi services are provided at the bus concourse to enhance user experience.

Millennium Station in Chicago, Illinois

Summary/Description

Millennium Station can be considered as a major destination given its location under the Millennium Park. This station serves as a major commuter rail terminal that also connects to several bus routes in downtown Chicago. The rail services include the South Shore Line and the Metra lines, while the bus services available nearby include both Pace buses and CTA buses.



Inside Millennium Station (PlacesMap.net)

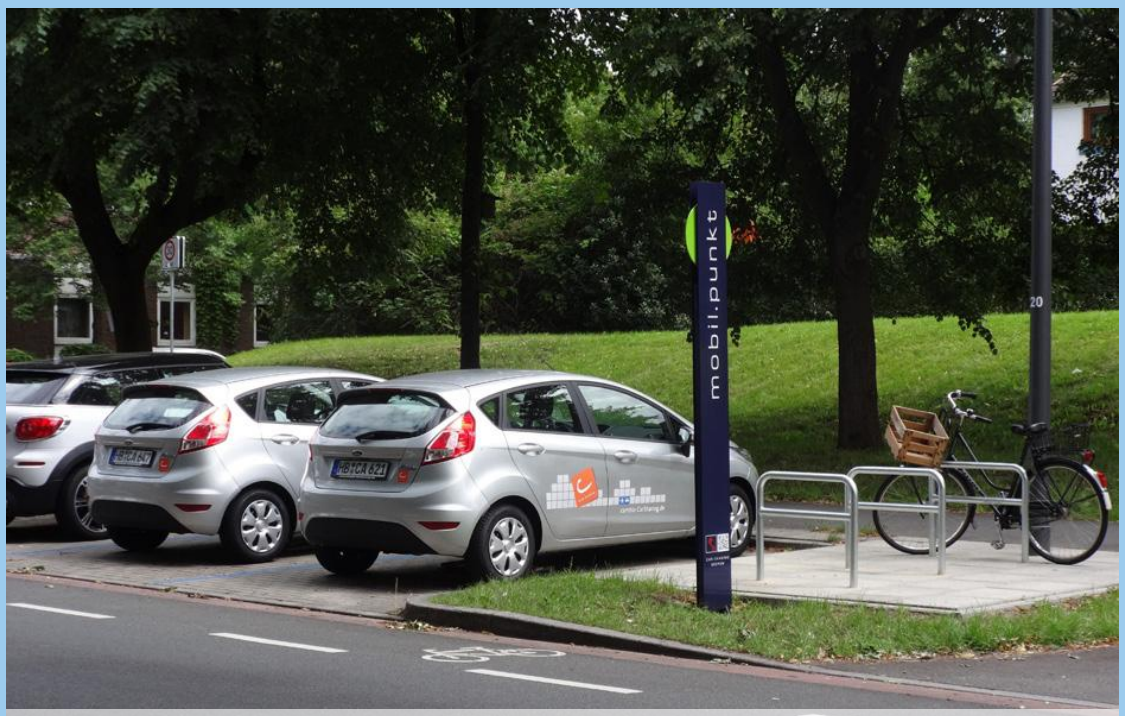
Millennium Park in Chicago (City of Chicago)

Mobility Hub Elements

- **Bike station:** One of the defining mobility hub features of this station is the Millennium Park Bike Station (also known as McDonald's Cycle Center), located outside the Millennium Station. This bike station offers several bike amenities include secured bike parking, bike rentals, bike repairs, and end-of-trip facilities. This multi-use bicycle center promotes cycling to and from the station as it accommodates both short- and long-term bike uses and parking needs. This bike station is explored further as part of the elements under the Bike Interface amenity in the following section (see page 30).
- **Bike share:** As a station located in a major destination, there is a bike share service available outside the station. This bike share service, known as Divvy, utilizes docking stations that provide different payment options for both visitors and residents of the area.
- **Pedways:** Underground pedways that are available at this station allow for easy transfers between the Metra lines and nearby CTA lines. These pedways connect to several other commercial, residential, and office destinations within the area. At Millennium Station, these pedways are located underground, allowing passenger protection from extreme weather conditions. As a completely pedestrian-oriented walkway, these pedways offer safe and efficient movement that is free from vehicular traffic.
- **Retail/Commercial:** Retail and commercial uses are often embedded within pedways. These services add a sense of convenience to passengers who wish to access retail services during their commute. Additionally, it helps establish the station as a destination where services extend beyond transportation.
- **Lighting:** As a major underground station, the interior design utilizes several lights and illuminating features to create a vibrant space indoors. The idea behind the lighting design was to transform a dark, underground space into a light cloud-like atmosphere (SOM n.d.). The floors also use subtle white lines that guide passengers to the train platforms (SOM n.d.).

Multi-modal transit hub (Bremen, Germany)

Summary/description:
The City of Bremen in Germany has implemented an integrated mobility strategy which allows for seamless integration between different transportation modes. This strategy promotes mobility on a city-wide level through "mobil.punkt" stations, which offer car sharing vehicles, accessible cycling and walking infrastructure, and public transport across the city. The prominent service of these stations is car sharing which is offered on public street spaces. Therefore, these stations implement the concept of mobility hubs on a smaller scale, however, are highly accessible across inner-city neighbourhoods with a station being available at approximately every 300m. As of 2017, there were 80 car sharing stations that offered more than 300 cars in total to 14,000 clients in Bremen (n.d.).



A mobil.punkt station in Bremen (Freie Hansestadt Bremen/VCD)

Moblity Hub Elements:

- **Car sharing:** The defining component of mobil.punkt stations in Bremen is the availability of car-sharing services. As these stations were intended to respond to parking management issues and decrease private automobile use, on-street car sharing services that are easily accessible were implemented. Therefore, each station has several car sharing vehicles.
- **Near bus and train stops:** To allow users to transition from public transit trips to car sharing services, many mobil.punkt stations are located near local public transport stops. Moreover, to enhance integration with public transportation, public transport subscribers receive discounts for the car sharing services offered at these stations.
- **Bike parking:** To ensure access to these car sharing services, public bike racks are often provided at the station. Charging infrastructure for e-bikes have also been planned for a few pilot stations in downtown locations (VCD n.d.).
- **Smartcard:** Smartcards are used as the main way to access the services offered at mobil.punkt stations. These smartcards unlock the car sharing vehicle and provide access to bike storage facilities (Dillon Consulting 2017). According to Dillon Consulting (2017), this smartcard can be used for fare payment for over 30 operators.
- **Information services:** To increase uptake of the different modes offered within and near these stations, the stations have computerized information booths that help users plan their trips. Station users can also connect to a call center where staff can book taxis and car share vehicles (Shared Use Mobility Center 2017).

Examples of Mobility Hub Elements

This section explores the different hub elements that are considered necessary to meet the outlined objectives of mobility hubs. Although not all elements and amenities are required, this review will help understand the different forms a mobility hub can take. Therefore, existing case studies of each element are considered under this section. The considerations for implementing each amenity group were found from existing guideline documents and research regarding mobility hubs. As such, these considerations are a brief overview of what is found in existing research and are meant to guide the development of complete guidelines.

These mobility hub elements are categorized under the following topics:

1. Accessibility
2. Safety
3. Furniture
4. Weather Protection
5. Information
6. Services
7. Placemaking
8. Car Interface
9. Bike Interface
10. Enhanced Operations

Accessibility

Accessibility measures refer to ensuring the services and infrastructure within and around mobility hubs remain accessible to people of all ages and abilities. Therefore, elements and efforts to increase accessibility often include following universal design guidelines and incorporating responsive and inclusive street and transit elements. As a foundational element that is already considered by many transit organizations, the provision of accessible elements in mobility hubs do not differ greatly from what is provided at existing transit stations.

Considerations

- Consider incorporating facilities and services that assist transfers between different mobility services for people with disabilities (Metrolinx 2011)
- Coordinate arrival and departure times between transit services and accessible transit services (Metrolinx 2011)
- Prioritize space in a way that minimizes the distance between accessible transit pick-up/drop-off locations and other transit services
- Minimize interception of other mode shares (e.g. cycling pathways, vehicular traffic, heavy pedestrian traffic) in pathways that connect accessible transit services to transit stations

Existing and common practices

- Wheelchair accessibility
- Barrier free access
- Priority shelter areas
- Universal fare gate access
- Tactile information
- Tactile walking surfaces and guideway

Security

Security is an important factor in mobility hubs as it is integral in helping passengers feel comfortable travelling and using the available services during all service hours. The elements under this group aim to prevent transit stations and mobility hubs from becoming crime prone areas. Additionally, proper security measures are necessary for bike parking facilities to reduce bicycle theft and promote cycling to and from these hubs.

Existing Practices

- Transit Police
- Surveillance cameras and footage

Considerations

- Monitor and review the current conditions of transit stations in terms of their safety and security (Metrolinx 2011)
- Ensure pedestrian and cyclists facilities are visible and have natural surveillance from surrounding areas during all hours of the day (Metrolinx 2011)
- Provide consistent lighting throughout areas of the mobility hub
- Promote mixed-use development within and around the hub as a way to enhance “eyes on the street” (LA Urban Design Studio 2016)

Existing and common practices

- Transit Ambassador programs
- Lighting
- Designated waiting areas
- Emergency telephones
- First Aid Stations

Furniture

Street furniture often refers to any objects that are placed in public spaces for a variety of purposes. Most commonly, these objects are intended to enhance pedestrian mobility by providing useful functions such as benches, litter cans, and lighting. At mobility hubs where different modes are interconnected and pedestrian movement is prioritized, the implementation of functional and aesthetic street furniture that respond to the needs of the community will influence pedestrian movement in a way that is safe and efficient.

Considerations

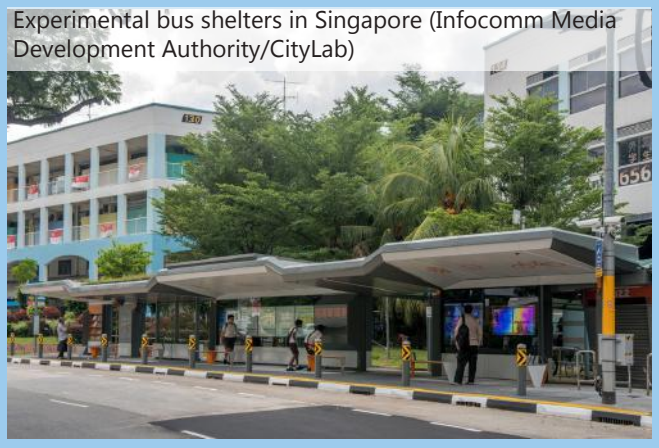
- Infrastructure should be flexible to change to accommodate for changes in transit demand and pedestrian activity
- To ensure usage and uptake, the number of furniture amenities should match the amount of foot traffic and transit demand of each area
- Seating furniture should be implemented in long walkways within and to/from transit stations to accommodate seniors
- Furniture design should follow universal design guidelines and principles to ensure accessibility for all users (LA Urban Design Studio 2016)
- The implementation of furniture should consider incorporating artistic design to contribute to meaningful placemaking
- Furniture should provide a buffer between pedestrian activity and vehicle traffic (LA Urban Design Studio 2016)
- The placement of furniture should avoid posing conflict for pedestrians in the walkway as well as for passengers loading and unloading from transit (LA Urban Design Studio 2016)

Case Studies

Bus shelters

Multi-purpose bus shelters (Jurong, Singapore)
This innovative bus shelter in Singapore features a variety of amenities that enhance customer experience while waiting for the bus. The bus stop provides sheltered seating, bicycle parking, collection of books, local art, bicycle parking, and a green roof (Kirk 2017). This bus shelter also incorporates technological features where travelers can download e-books through a QR code and charge their phones. Digital interactive boards are also installed that provide local news and weather information, and allows users to obtain real-time bus arrival information and plan their trip.

Experimental bus shelters in Singapore (Infocomm Media Development Authority/CityLab)



Seating

Bus shelter kits (Los Angeles, USA)
Big Blue Bus shelters in LA were designed to accommodate bus stops in the transit system with a limited budget. The designers of these bus shelters realized that a one-size-fits-all approach was not appropriate nor economically viable as different stops had different ridership volume, shading, and available space (Walker 2016). As a result, a kit of different parts was proposed that can be assembled into different clusters (Walker 2016). These parts also utilize reclaimed and locally available materials to lower the cost as much as possible (Nikdel 2014). To accommodate the needs of seniors, armrests and back supports were added on from the original design. Their design also addressed the concern of nearby storeowners who submitted concerns that large benches and shelters could block their storefronts (Walker 2016).

Bus shelter kits (Lawrence Anderson/Curbed)

Seating (cont'd)

Solar powered benches

The Soofa is a solar-powered public bench equipped with outlets to allow users to charge their phones using solar energy. These benches have been installed in several US cities and have most recently entered the Canadian market. These benches also collect anonymous information on Wi-Fi enabled services to help monitor and inform the municipality on the usage of these public spaces (Town of Newmarket 2018).

A Soofa Bench (Soofa)

Bus cubes (New York, NY, USA)

In Rochester, a demonstration project utilized simple blocks for seating at bus stops that didn't have benches. As a result of searching for a simple and inexpensive solution to the lack of seating, these bus cubes were designed which had positive results from the public. Given the compact design of these cubes, this strategy may be suitable for bus stops with relatively less ridership and for areas with limited space.

Bus cubes in Rochester (Reconnect Rochester)

Leaning rail and bench

Another alternative for seating is a leaning rail, which allow passengers to lean while waiting for transit. The benefits of these leaning rails is that it requires less space and allows more room for pedestrian movement.

Lighting

Terminal lighting (Anaheim, CA, USA)

The Anaheim Regional Intermodal Transportation Center (ARTIC) uses energy-efficient LED lights that change colors to light up and activate the centre in the evening.


The ARTIC (Tim Worden/tworden)

Underpass & furniture lighting (Minneapolis, MN, USA)

The Metro Station in Minneapolis is a landmark for the Target Field and is home to a center of different modes including light rail transit, bus service, and commuter trains (iLight Technologies 2016). To activate the pedestrian underpass at the station, color-changing light effects were used with the intention that this space could be used for public events like concerts, festivals, and movie nights (iLight Technologies 2016). The station also utilizes lights under public benches to help light up the walkway to the transit hub and enhance safety.


Target Field Metro Station (iLight Technologies)

Weather Protection

As a large pedestrian-oriented space, mobility hubs need to be convenient across different times, seasons, and climate. As a result, weather protection is vital to ensure street furniture, information services, and placemaking initiatives remain viable and active throughout the year. The provision of weather protection provides an opportunity to incorporate innovative designs that is both attractive and practical.

Existing Practices

- Bus shelters

Considerations

- Consider incorporating design initiatives that contribute to placemaking
- Walkways that connect different available mode options should be partially or completely covered to make movement within the hub easier (Metrolinx 2011)
- Canopies and street covers should provide adequate ventilation and shade
- Utilize design features and elements that help reduce environmental impacts resulting from heavy rain and snow (Metrolinx 2011)

Case Studies

Bus shelters

Heated bus shelters

As part of advertising strategies, heated bus shelters or street furniture is often utilized by advertisers during the winter time (JCDecaux 2012).

Heated bus shelters in the US (JCDecaux)

Air Conditioned Bus Shelters (Singapore)

In Singapore, a cooling technology was trailled at a local bus stop. This bus stop utilized a cooling unit that converts warm air in the atmosphere into cool air streams for waiting passengers. In addition, as a way to mitigate air pollution, the cooling unit also included filters to help purify the surrounding air from harmful pollutants.

Bus layover shelters (Curitiba, Brazil)

The Bus Rapid Transit system in Brazil stands out as a prominent example of a successful and efficient transportation system, partly due to their tube stations. These stations are waiting areas for the bus service which passengers must pay the bus fare to enter. As the tube station is raised, they are equipped with stairs and wheelchair lifts to accommodate for people with disabilities. The buses are designed to have wider doors with ramps so passengers can load and unload at the same level. The cylindrical and clear design of the tube provides a protected and safe shelter for passengers.

Inside the bus shelter in Curitia, Brazil (Weng Xinyand/Xinhua)

Green shelter roofs (Philadelphia, PA, USA)

In Philadelphia, the first green roof bus shelter in the city was implemented as part of the Water Department's Green Cities Clean Waters initiative. These roofs, which were created by Roofmeadow, are prefabricated and can be used to install on standard bus shelters (Liggett 2011). Due to its absorptive surface, these roofs can help mitigate storm water runoff that can build up quickly on impermeable city surfaces.

Green shelter roofs in Philadelphia (inhabitat)

Canopies

Bus station canopy (Aarau, Switzerland)
This canopy was implemented at a major bus exchange station where many commuters transfer from the railway station. This cover provides passengers with protection from rain and snowfall. The gap in the center of the canopy and the semi-transparent material exudes a sense of openness in the area.


Aarau bus station canopy (Niklaus Spoerri/ArchDaily)

Transit center canopy (Detroit, USA)
This roof canopy at the Rosa Park Transit Center was built to cover the drop-off and waiting area for passengers while they switch their mode of transport (ArchDaily 2009). The canopy was designed to utilize natural light while providing sufficient weather protection.

Canopy at Rosa Parks Transit Center (ArchDaily)

Information

Information services are vital to support the functions provided at mobility hubs. These services often provide information on transit schedules, wayfinding, and service availability to assist with route planning that utilizes different modes. As such, different information channels are explored in this section which are intended to help travelers make informed choices on which mobility service is most efficient and convenient for their trip. Additionally, the provision of real-time information on transit and other services can help improve user experience. These information services also relate to accessibility, as it can help provide children, seniors, and people with disabilities the same level of access to mobility hubs as other users (LA Urban Design Studio 2016).

Existing Practices

- ID Sign and Bus Marker
- T Branded Markers
- Static Bus Schedule
- SkyTrain Attendants (STAs)
- TravelSmart program

Considerations

- Wayfinding and information boards need to consider universal design standards to provide access for people with disabilities (Metrolinx 2011)
- Transit information should include arrival times, service changes, delays and other information that will help users travel efficiently and conveniently (Metrolinx 2011)
- Real-time information should be provided in different areas of the hub so users can make informed decisions about which travel mode option is most convenient before entering the transit station (Metrolinx 2011)

Case Studies

Dynamic Real Time Information

Real Time Passenger Information (Dublin, Ireland)
In Dublin, a real time passenger information system was implemented which updates passengers with expected arrival times of the bus. This system is updated every 30 seconds and calculates the expected arrival time by recording how long each bus takes to travel between stops (McCarra 2011). This helps inform passengers on which bus route they should take and how long the waiting time is until the service arrives.

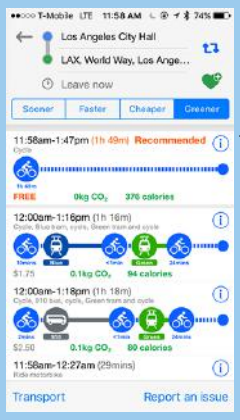
Real time passenger information in Dublin (sociable)

Service Announcements (Brookyln, NY, USA)
In New York, many subway stations went under renovation to install several station upgrades. One notable upgrade was installing service announcements at the station entrance and countdown clocks near the kiosks. This real-time information helps inform passengers on when to expect the train and its related service status before entering the platform.

Improved real time information services in NYC (6sqft)

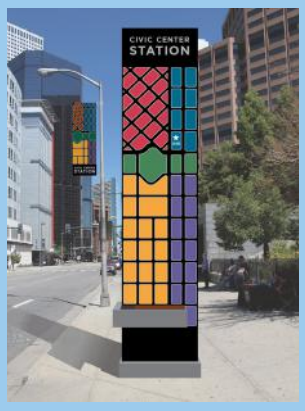
Live Chat (Metro Vancouver, BC, Canada)
Recently, TransLink implemented a live chat feature where passengers can access to speak to the Customer Information team directly. This allows passengers to receive the most up-to-date information on the available services or any general inquiries regarding TransLink's transit services.

Journey Planning Information
Multi-modal Trip Planner (Los Angeles, USA)
The city of Los Angeles launched a journey planning app in partnership with Xerox. The Go LA app allows users to explore the shortest, cheapest, or greenest option for their trip (Susan 2016). The app provides options for several modes to complete a trip including, ride hailing, ride sharing, walking, bicycling, driving, parking, public transit, and taxi options (Susan 2016).



The Go LA App (Planetizen)

Wayfinding
Branding and Wayfinding (Denver, CO, USA)
These wayfinding signs at the Civic Center Station offer clear wayfinding for travelers. Their design utilizes a distinctive color palette to help passengers orient themselves within different neighbourhoods (Noble Erickson Inc n.d.). These color distinctions are also used in signs, pedestrian crossings, and public art as part of their wayfinding system (Noble Erickson Inc n.d.).




Wayfinding displays at Civic Center Station (Noble Erickson Inc)

Wayfinding Sign System (Calgary, AB, Canada)
The City of Calgary underwent an extensive planning process to install wayfinding signs with an integrated design in City Centre that encompassed the objectives and goals of different stakeholders. Extensive wayfinding is essential for Calgary's City Centre as it is bordered by two major transportation corridors, has mixed use development, and is home to historical landmarks. The City's objectives for their wayfinding program was to enhance pedestrian movement, facilitate transit movement, promote local tourism, and encourage street-level activity (Gerylo & VanderKlipp 2013). Additionally, their wayfinding system followed three main principles:

- Having a pedestrian-oriented lens
- Utilizing terminology that reflects the language and logic of locals
- Integrating signs in different centres of activity to help people decided whether to drive, take public transit, or walk

These signs were located strategically along pedestrian walkways and away from curbs to enhance safety and reduce damage from the spray of snow and slush (Gerylo & VanderKlipp 2013). Additionally, to enhance the functionality of these wayfinding signs, service staff at the City and nearby hotels were trained to help visitors understand how to use the wayfinding system.

Integrated wayfinding at Calgary's City Centre (Signmedia)

Staff on Site

Transit Ambassador Program (Indianapolis, IN, USA)

The IndyGo Transit Ambassador program is a volunteer program to help passengers feel more comfortable riding transit as they can ask volunteers for information on how to use transit. Volunteers are trained to be knowledgeable about the existing routes, service changes, and upcoming projects on the IndyGo transit system (IndyGo n.p.). Through this program, transit ambassadors can also help relay direct feedback from transit users regarding existing routes and route changes to the transit organization.

The Transit Ambassador Program by IndyGo Transit (IndyGo)

Information Kiosk

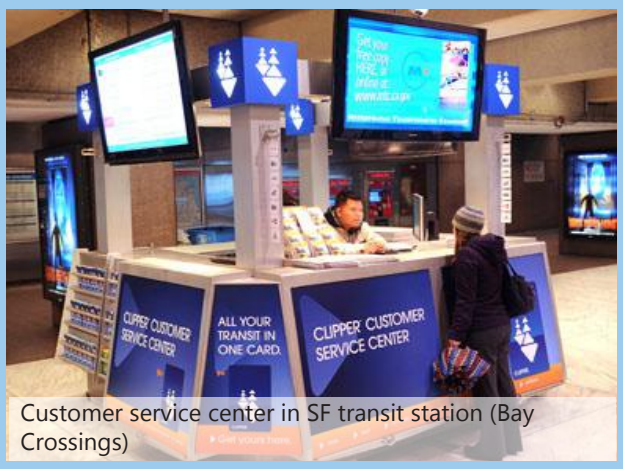
Interactive Kiosks (New Jersey, USA)

In a partnership with Intersection, a smart cities technology and media company, NJ Transit implemented interactive information kiosks at several rail and light rail stations (Metro Magazine 2018). These kiosks provide wayfinding services, real-time service information, and maps to help visitors and commuters travel with ease. The use of advertising at these kiosks help provide these services at no cost for both NJ Transit and transit users (Metro Magazine 2018).


Interactive kiosk at train station (Intersection/Metro Magazine)

Customer Service Center (San Francisco, CA, USA)

The customer service center at transit stations in downtown San Francisco offer several services that help passengers using public transit. These services include issuing new or replacing damaged Clipper cards, charging Clipper cards, and providing information regarding the functions and uses of the Clipper card. This center also allows customers to obtain senior and youth Clipper cards, without having to go to a transit agency ticket office (Kahn 2011).



Customer service center in SF transit station (Bay Crossings)

Services

Services at mobility hubs often refer to amenities that provide support services that make travelling via the offered mobility services efficient and convenient. Therefore, certain service amenities listed in this section aim to make the transfer between different mobility options seamless. These services also help transform mobility hubs into an area that extends beyond a transportation hub, as it considers amenities such as storage lockers, retail uses, delivery services, which help emphasize mobility hubs as a multi-use space.

Existing Practices

- Retail kiosks
- Wifi on transit

Considerations

- Ensure each service element promotes safety and security for all users
- Prioritize elements that operate sustainably or incorporate sustainable features (LA Urban Design Studio 2016)
- For services that require technological devices, consider incorporating different options to access these services for customers that do not have access to smartphones

Case Studies

Storage lockers

Coin lockers (Japan)

At most train stations in city centers, storage lockers are available that can be used to store baggage. These lockers are available at different sizes and can be paid using cash or the local transit card.

Storage lockers at a train station in Japan (Navitime Travel)

Luggage Storage (Florence, Italy)

A luggage storage center is available near the train station in Florence. These self-service lockers are charged on an hourly basis and allow visitors and residents store their baggage during their trips within the city center.

Luggage storage near a train station in Florence (Stow Your Bags)

Washrooms

Hands-free, self-cleaning bathroom (Atlanta, GA, USA)

Lindbergh Center Station implemented public station bathrooms that were designed to enhance security to increase usage by passengers. These bathrooms use a virtual restroom attendant that monitors the bathroom from outside. Passengers that wish to use the bathroom have to buzz in and have access provided by the virtual attendant (Jaffe 2015). Monitoring is used to ensure only one user enters at a time, unless users need assistance (Jaffe 2015). While inside, users are limited to 10 minutes within the restroom, although more time can be requested for those who need assistance. Sensors are also used to detect for any lack of movement for safety reasons (Jaffe 2015). In terms of the hands-free and self-cleaning component, the

sink is completely sensor-controlled and the walls use graffiti-resistant coating (Jaffe 2015).

Self-cleaning bathroom in Atlanta (MARTA/Citylab)

Portland Loo (Portland, OR, USA)
Portland has successfully installed public washrooms that respond to the common concerns and problems of public toilet use. These bathrooms are designed with bars at the top and bottom of the structure as a way to increase the perception of visibility and reduce crime. It is also made of steel with graffiti-proof coating so it can withstand any damage (Metcalfe 2012). Lastly, these toilets have a minimalist theme as they do not provide any sinks or mirrors within the structure, instead, a faucet is provided outside.

The Portland Loo (City of Portland/CityLab)

Commercial Kiosk/Retail
Mobile Retail Services
Food trucks (San Francisco, CA, USA)
Food trucks are a prominent feature of the new Salesforce Transit Center. Known as food truck lane, this area of the center features several food vendors every day. Food trucks are also available on the rooftop park to emphasize this transit center as a multi-purpose space.

Food trucks in front of Salesforce Transit Center (Skift)

Retail services
Retail and commercial services can also be operated in mobile trucks and vans. These mobile retail services can utilize and activate open plazas near major transit stations to invite pedestrian activity.

Mobile Hair Salon (Sterlings Mobile)

STERLINGS Mobile Salon (San Diego, CA, USA)
Mobile hair salon that offers haircuts at several locations.

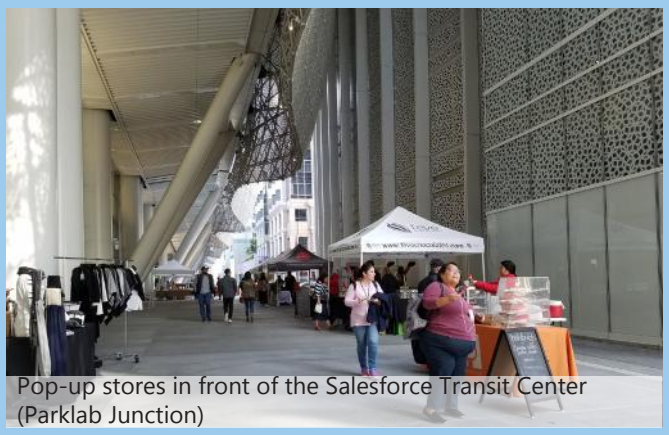
Fashion mobile trucks (Vancouver, BC, Canada)

Fashion mobile trucks (Vancouver, BC, Canada)
Mobile trucks can also be used to sell fashion items in a mobile truck. Although limited in operation due to licensing constraints, this Vancouver Fashion Truck can be found at various events and fairs.

Markets

Pop-Up Market (San Francisco, CA, USA)

At the Salesforce Transit Center, a pop-up market is hosted every week that features local vendors. This pop-up market is located near the entrance of the transit center to increase activity around the station.



Pop-up stores in front of the Salesforce Transit Center (Parklab Junction)

Outdoor Market (Toronto, ON, Canada)

Outside of Union Station in Toronto, an outdoor market event is held every summer. This market uses the plaza space available in front of the station and features local food vendors and arts and cultural organizations. Therefore, this event also hosts musical and cultural events to help celebrate the community's talent and culture.

Summer Market at Union Station (Vince Talotta/Toronto Star File Photo)

Market (Chicago, IL, USA)

MetraMarket is a street-level market located in Metrarail's Ogilvie Transportation Center. This market features several restaurants, shops, boutiques, and a Chicago French Market (Black 2015). Given its location in a major transportation center, this market has approximately 115,000 commuters walk by twice a day, and up to 10,000 pedestrians (Black 2015). As a market that is open to both pedestrians and transit users, this design helps connect the transportation center to the surrounding neighbourhood.

French market inside MetraMarket (Martha Williams/Time Out)

Mail/Courier Service

Amazon lockers and hubs

In some areas, Amazon offers a delivery service to a secure locker for customers that do not want their package left unattended at home (Ballew 2017). This service delivers the package to a designated Amazon locker that customers set up when they check-out. Customers are informed by the company on when the package is available and are given a code to the locker to access their package. These lockers can be located in convenient and accessible locations such as major transit stations so customers can pick up packages according to their schedule.

Amazon lockers (Bill Gurley/Business Insider)

Packcity (Tokyo, Japan)

Similar to Amazon lockers, Packcity Japan offers drop-off lockers where delivery companies can leave packages for customers to pick up. Different delivery and courier companies in Japan are able to use these lockers. However, these companies must pay a fee to utilize these lockers. The concept behind these lockers is that customers are able to pick up their packages during their commute or while running errands. As such, these lockers are strategically located at places where people frequent such as train stations, supermarket, and drugstores (Nagata 2018).

Delivery lockers in Tokyo (Satoko Kawasaki/The Japan Times)

Refrigerated lockers by Fresh St. Market (PNG/ VancouverSun)

Smart lockers (University of British Columbia)
Recently, smart lockers were implemented at the UBC campus. These lockers allow students to have their online shopping orders delivered to a designated location to pick-up at their convenience. These lockers can also be used for short-term storage for students to store their baggage on campus. To use these services, students can sign up through their Google mail account and pay either $0.25/hr for storage, or $1/order (UBC Lockers n.d.).


UBC Smart Lockers (UBC Lockers/DailyHive)

Grocery collect service
Similar to courier services, some grocery stores have implemented a pick-up service for groceries in select locations. These pick-up services are provided through refrigerated lockers. Fresh St. Market, a grocery store chain in Canada, has trialled a pick-up service where customers can order groceries online and pick up their order at select lockers. Although the locker location was limited to Fresh St. Market's parking lots during the trial period, it planned to expand service locations at remote sites where commuters would find more convenient.

Multi-use space
Multi-use plaza (SeaTac, WA, USA)
The Angel Lake Transit Station and Plaza is a prime example of a transit station that incorporated multi-use plazas in its design. As a multi-level, mixed-use facility, that has two levels partially underground and five levels above ground, the plaza is accessible from the third level (Rinaldi 2017). This level includes a 1-acre plaza that provides a protected walkway to the station, a drop-off area, retail space with bike storage, and parking (Rinaldi 2017). This plaza is intended to be used as community event space to connect the transit station with the surrounding neighbourhood.


Plaza at Angel Lake Transit Station (Ben Benschneider/A As Architecture)

Multi-use bus shelter (Paris, France)
In Paris, an interactive bus shelter known as Osmose was implemented that serves multiple uses. On top of bus shelter and seating, this shelter provides interactive information screens, a library, a make-up area, a cafeteria, and a charging station for electric bikes (id created, Inc. 2012). These different services allow bus shelters to be utilized for both passengers and non-passengers throughout the day. Moreover, these shelters feature lighting that changes throughout the day and the walls use decorative glass that is heated to increase passenger comfort (id created, Inc. 2012).

Osmose bus shelter (id created)

Wi-Fi

Wi-Fi Hubs (New York City, USA)

In 2016, through a program known as LinkNYC, several defunct pay phones were converted into Wi-Fi hubs across New York (Warerkar 2016). These hubs provide free internet service along with several other services related to safety, real-time information, and wayfinding. For example, the hub displays real-time bus arrivals and maps, local news and weather information, and alerts form the Office of Emergency Management (Wiggers 2018). Additionally, these hubs allow people to make calls within the country for free, and are designed to have buttons that directly connect to 911 (Wiggers 2018). The screens of these Wi-Fi hubs often display content provided through collaborations with different organizations and government agencies (Wiggers 2018).

LinkNYC (Venture Beat)

Universal Transportation Account

Whim (Helsinki, Finland)

Whim is a service that serves as a universal transportation account. As such, through the Whim app, customers are able to plan and pay for their trips across different transportation modes such as public transit, bike shares, car shares, car rentals, and taxis. Therefore, the aim of this service is to replace car ownership by providing access to several alternative options through one app and payment system. In terms of the payment system, users are enabled access to this service by paying a monthly fee. However, users have options to change their membership fee based on how often they use the service. Therefore, membership is organized as follows (Maas Global Oy n.d.):

- Whim To Go: Free membership and users pay as they use these services
- Whim Urban: 49 Euros/month and provides unlimited transit ride and bike share access, and subsidized taxi and car rental fees
- Whim Unlimited: 499 Euros/month and provides unlimited rides of each transportation service

In terms of the operation of this app, Whim negotiates with individual mobility providers to earn a small commission of the booked trips (Zipper 2018).

The Whim App (Fleet Europe)

The Mobility Shop (Hannover, Germany)

The Mobility Shop in Hannover is another example of Mobility as a Service (MaaS). This pilot program allows users to plan, book, and be invoiced for several transportation modes including public transit, car-sharing, and taxis (UITP 2016). This service provides real time information of each service to help with trip planning. Through the app, users can sign up for which multimodal service they would like to subscribe to and pay tariffs based on how much they use each service (i.e. single tickets vs. annual passes, basic vs. heavy user tariffs for car-sharing, etc.) (Rohrleef 2017). Additionally, if customers plan trips using multi-modal options, all the services available on the app are booked and the customer gets an invoice that is automatically charged to their registered bank account (Rohrleef 2017).

Placemaking

A strong sense of place is essential in mobility hubs, where users can feel safe and comfortable being in the space and using its amenities. As a mixed-use area, having an attractive public realm through interactive and engaging practices can help create a place where people feel comfortable to work, play, live, and travel. Placemaking is a key strategy that can help build a localized hub that integrates community values and neighbourhood characteristics through artistic design and expressions. Having a collection of public spaces and pedestrian-oriented uses can help attract the community to utilize the proposed services and activate the space.

Existing Practices

- Public art
- Art on Transit

Considerations

- Incorporate the local community's input to reflect community values, vision, and history
- Create opportunities for local artists to contribute to the placemaking of mobility hubs
- Install initiatives and art that can become a landmark for the station
- Incorporate natural features and environmentally friendly practices to create a space that is green and sustainable
- Foster a sense of openness to invite people to use the space and to create a sense of safety
- Consider active uses of public space that support pedestrian activity such as enhanced curb designs and parklets

Case Studies

Landscaping

Landscape buffers (Philadelphia, PA, USA)
On streets with heavy vehicular traffic, landscaping can be used to create a buffer between pedestrian and cyclist pathways. These planted mediums also have the benefit of providing storm water management.

Example of buffers made through landscaping (City Center District/Visit Philadelphia)

Public Art

On-site public art (San Francisco, CA, USA)
The Salesforce Transit Centre in San Francisco is a hub that connects public and private bus services, commuter rail and high speed rail (Tedford 2018). This centre features several different artists throughout the hub. The art installations are diverse as it celebrates local artists and history, while others incorporate natural features. The integration of these art pieces can help passengers enjoy and experience the space.


Public art at the Salesforce Transit Center (SFAC/KQED)

Art-based bus shelter (New Westminster, BC, Canada)
In New Westminster, public art was utilized in the form of a bus shelter. The art was inspired by the local landscape and aims to provide functionality by providing accessible seating for all ages and abilities.


Bus stop at City of New Westminster (City of New Westminster/604 Now)

Stoplet (Halifax, NS, Canada)
In Halifax, a pilot project was implemented where a stoplet was created to activate the street. A stoplet is a parklet that is extended to incorporate a bus stop (Woodford 2018). Parklets are often created by removing on-street parking spaces to extend the sidewalk to create small public spaces. The new

platform uses colorful design to create an interactive, playful, and pedestrian-oriented space. By extending the sidewalk at the bus stop, it also provided passengers more room when waiting for the bus.

Stoplet on Spring Garden Road (Zane Woodford/StarMetro)

Transit Bulb-outs

Transit bulb-outs are similar to parklets, however are dedicated solely for on-street transit purposes. Therefore, instead of fostering public activity, it aims to improve the waiting and boarding experience at bus stops (Bialick 2015). By dedicating more space for passengers that doesn't conflict with pedestrians, it allows loading and unloading to occur smoothly, especially for individuals who require the use of deployabale ramps (Bialick 2015). Additionally, these bulb-outs allows buses to move easily as they no longer need to move in and out of traffic to access the bus stop.

AC Transit bulb-out (Aaron Bialick/Streets Blog)

Curb designs

Pedestrian Enhancement (Jersey City, NJ, USA)

As a demonstration project, temporary curb extensions were implemented in Jersey City. These enhancements used colorful paint and designs to help emphasize the curb extensions and improve the safety of pedestrians. Planters were also used to ensure these curb extensions were visible from ongoing traffic.

Curb extension design (Street Plans)

Car Interface

Although mobility hubs aim to increase the use of sustainable modes of transportation, car services maintain an important role of covering first and last mile travel. These services often take the form of shared mobility services so travelers are not required to own a private automobile, but instead can utilize car services on-demand. Moreover, the automobile realm presents several opportunities to incorporate infrastructure that will accommodate new and innovative technologies such as electric vehicles and autonomous cars.

Existing Practices

- Park and ride
- Car share parking spaces

Case Studies

Car parking

Considerations

- Parking structures should consider future uses and adopt flexible and adaptable designs to respond to changes in parking demand
- A portion of parking should accommodate for electric vehicles to support cleaner vehicles (Metrolinx 2011)
- Parking should be designed as structures that are integrated with the surrounding development (Metrolinx 2011)
- The expansion of surface parking lots dedicated for commuting trips near major transit stations should be limited to allow space for hub development
- Incorporate environmentally sensitive practices and features in parking design to minimize negative environmental impacts (Metrolinx 2011)

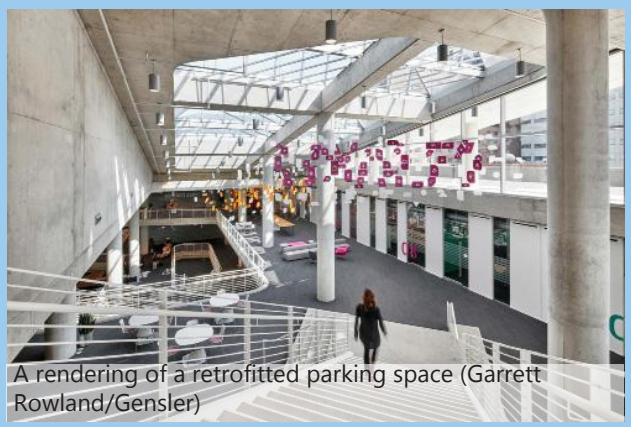
Reallocating parking space (Toronto, Canada)
In Islington Station in Toronto, the existing park and ride space located near the existing bus terminal was downsized and relocated. The space was relocated along the existing rail corridor but still remained within walking distance to the station (Metrolinx 2011). This relocation allows for a greater land space to allocate for future development of the transit station.

Allocated parking space at Islington Station (Metrolinx 2011, p.76)

Repurposable parking (Ohio, USA)
The 84.51 Centre building in Cincinnati was built with the expected changes in parking demand in mind. Although the building has three levels of parking, they are adaptable as they were designed to be converted into office spaces as needed (Walker 2017). Thus, the parking levels were built using an exterior that matches the rest of the building.


Mid-level parking in Cincinnati (Gensler/Forbes)

Gensler, the architecture firm behind this design, has created potential designs that treat above ground parking garages as a temporary use and envision a future where they will be transformed for other uses. As such, the MOD is a hypothetical design that incorporates designs such as level floors between ramps, modular walls and ceilings, and ample lighting so it can be retrofitted for office or retail uses (Walker 2017).


A rendering of a retrofitted parking space (Garrett Rowland/Gensler)

Mixed use parking
Mixed use parking allows to minimize the presence of parking in comparison to surface level parking lots. Having parking allocated to above ground levels in mixed use buildings also has an added benefit of preserving street level uses for retail and commercial services.

Miami Beach Parkade (Miami, FL, USA)
The Miami Beach Parkade dedicates three storeys of a seven storey building to parking. To create parking that is permeable, the ground floor is used for retail and one side of the parking lot has space for a boutique, and the top floor is intended to be used as a multi-use event space (Turner 2012).


Miami Beach Parkade (Xavier de Jaureguiberry/

Bordeaux Car Park (Bordeaux, France)
In Bordeaux, a multi-storey, mixed-use car park was proposed. This particular design proposes retail at the ground level, housing with a communal ground on the top floor, and 4 levels of parking in between. The intention of the designer was to create a parking space that remained active after business hours through the implementation of retail and housing units. The parking levels are visible from the street and have colorful ceilings to transform the concept of parking into a vibrant space.


Bordeaux car park (dezeen)

Smart parking
Demand based parking (San Francisco, CA, USA)
San Francisco launched a program that utilizes demand responsive parking prices on all parking spaces on public streets. This means that parking prices fluctuate based on parking demand, resulting in different parking rates depending on the day (weekend vs. weekday), time, and area. This system is partnered with a phone app that provides information on parking availability. This mechanism encourages drivers to park their cars in underutilized parking spaces, balance occupancy across different blocks, and reduce the time vehicles spend driving to find parking.

Electric vehicle parking
Electric vehicle parking stations are often equipped with charging technology so users can recharge their vehicle while their vehicle is parked. The charging technology varies in level, with the lowest level (level 1) being similar to a standard household outlet. Thus, this level takes the longest to charge a vehicle and is suited for long-term parking areas. Meanwhile, level 2 offers a shorter charging time and is commonly found in public parking spaces.

Electric vehicle charging station at Portland International Airport (The Manufacturer)

Car sharing
Considerations
- Parking spaces should be allocated for car share services so users can easily access and park the car from the transit station
- To encourage car share use, financial incentives like discounts could be considered for individuals that use bike share or transit services to connect their trips (SANDAG n.d.)
- Consider car share services that utilize clean energy (SANDAG n.d.)
- A group of car share vehicles should be available at each parking location to increase its availability for customers (LA Urban Design Studio 2016)
- The pick-up/drop-off or parking areas should be clearly visible and accessible from the transit station through wayfinding initiatives (LA Urban Design Studio 2016)

Different car share models
In Vancouver and other municipalities in Metro Vancouver, there are already four prominent car share services that utilize different operating structures.

1.Round trip car share
Modo is a round-trip car share system where users must return the vehicle to the pick-up location. The user is charged hourly for their trip and have the option to pay an upfront refundable deposit ($500) or a monthly membership fee ($8).

2. One-way car share
Zipcar is a one-way car share system as their vehicles are available from a designated Zipcar parking space. Similar to Modo, members are charged on an hourly basis for their trip on top of either am annual or monthly membership fee.

3. Free-floating car share
Evo and Car2Go both follow a free-floating car share model, where vehicles are available for pick-up and drop-off within the service area. For drop-off, vehicles are limited to specific parking areas that permits car share vehicles. The service charges the user through their registered payment information on a per minute basis. Both services require a smartphone app where users can reserve and end their trip.

Car sharing options in Vancouver (CTV News)

Neighbourhood Electric Vehicles (NEVs)
NEVs are an emerging transportation mode that are similar to electric cars. These vehicles are smaller than common electric cars and are often classified as a low-speed vehicle. These vehicles are intended to be a sustainable and supplementary alternative to a typical automobile. Additionally, due to their small size, it is often used for shorter trips.

Neighbourhood Electric Vehicle Plan (Coachella Valley, CA, USA)
The Coachella Valley Association of Governments published a NEV Plan in 2016 with the aim to outline suitable infrastructure to accommodate the growth of NEVs. This plan was also created in conjunction to the CV Link development, which is a transportation and recreation pathway that is expected to be used by NEVs, among other mobility devices (Alta Planning + Design 2014). The NEV Plan gives consideration to several implementation components such as the integration with existing bike and golf cart networks, different path designs, parking designs, and charging infrastructure.

Small Electric Car Sharing (Seattle, WA, USA)
It has recently been reported that Lime – a bike and scooter share operating company – is planning to launch small electric car rentals in Seattle. Unlike existing car share services, these small electric cars are built to seat one passenger only. However, these rentals will operate similarly to car share services as they can be parked at any permitted car parking spaces.


Model of a small electric car (Electrek)

Ride hailing
Considerations
- These services should be considered for neighbourhoods with low demand for transit or limited accessibility to convenient transit routes.
- The fare structure should follow a similar system used for transit with different fares for seniors, students, low income individuals, and people with disabilities.
- Safe and convenient pick up and drop off areas for these services are essential near transit stations to foster safe and seamless transition between modes.

On demand ride service
Uber
In the ride hailing industry, Uber stands out as one of the prominent service providers along with other companies like Lyft. This service works by users reserving a ride to and from their desired location through a smatphone app. The service provides upfront pricing and offers different options such as carpooled rides.

Uber in Innisfil, Canada
Although Uber is a growing ride hailing service that

started in the US, the company partnered with the Town of Innisfil to create Innisfil Transit. This service offers flat fare rides to popular destinations and their major transit station for a fee that ranges between $3 to $5 (Heath 2018). This partnership showcases the flexibility of certain ride hailing service to cater to specific transportation needs for a municipality or region. Moreover, this partnership helps create trips that connect to existing transit services rather than replacing them.

On-demand microtransit (California, USA)
SmaRT Ride (Sacramento, CA, USA)
SmaRT Ride is an on-demand microtransit service implemented by the Sacremento Regional Transit District. The aim of this program was to help residents travel in less densely populated areas and also connect them to rapid transit services (Sacramento Regional Transit District 2017). This service allows customers to request a ride from an app to and from their desired location that is within service boundaries (California Transit Association n.d.). As the service is not set to a fixed route, operators can pick up and drop off several passengers through a suitable route. Due to their initial success from the pilot program, the service has expanded to include additional towns and communities and has increased their operating hours.

Transloc's SmaRT Ride (Business Wire)

Chariot (San Francisco, CA, USA)
Chariot is an app-based shuttle service that operates during rush hours. This service operates on fixed routes and commuters can book a ride to be picked up and dropped off at designated locations. Although these services may replace some transit trips, it also works to complement mobility hubs by providing an on-demand travel service to cover a commuter's first and last mile to/from these hubs.

A Ford Chariot vehicle (The Globe and Mail)

Pick up & drop-off locations

Considerations

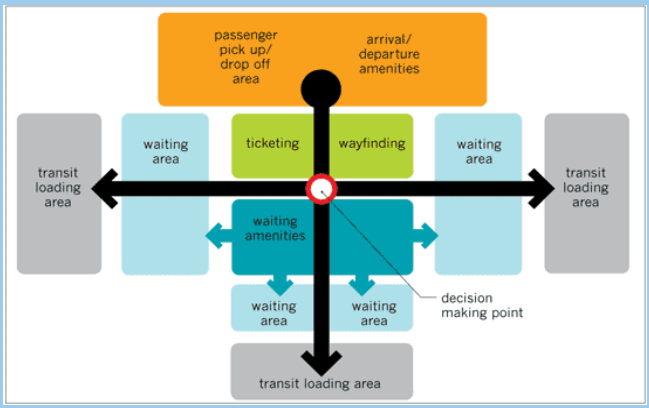
- These zones must be highly visible from mobility hubs to ensure safe access from other modes and services (LA Urban Design Studio 2016)
- These zones can be located in close proximity that is walking distance from the station. However, proper walkway networks are required to make sure the pedestrian experience in accessing the pickup and drop-off zones is safe and convenient.

QueueY
QueueY is an imagined pickup and drop-off location for autonomous vehicles in corridors surrounding transit hubs. The design converts curbside parking areas into areas of pickup and drop-off zones. In the proposed design, the waiting area is weather protected and are equipped with solar powered lights to enhance safety and easy wayfinding.

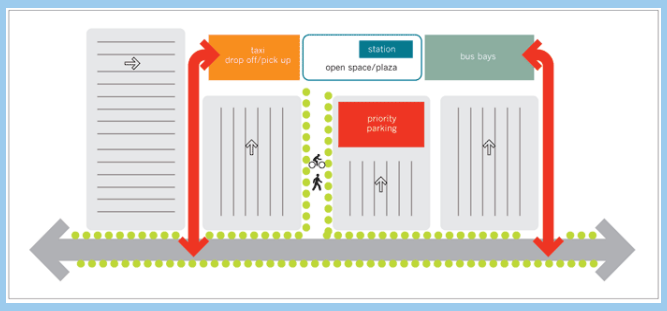
Rendering of QueueY's pick up and drop off area (6sqft)

Transit-Supportive Guidelines on Pick-up/Drop-off Areas
Ontario's Ministry of Transportation provides guidelines for the design of transit stations. In their particular guideline regarding the location of different amenities, the passenger pick up and drop off area is clearly segregated from transit loading areas, yet provide direct access to "a decision making point" where passengers are connected to different transit services. The rationale behind this design is that passengers encounter very few decision making points from their

point of arrival (or drop-off) to help navigate their way through the station easily and efficiently (Government of Ontario 2016).



Design guidelines for pick-up and drop-off areas near a transit station (Ontario Ministry of Transportation)



In areas with large surface parking, their guidelines also suggest dividing lots into smaller modules and locating pick-up and drop-off areas closest to the station. This way, passengers being dropped off have direct access to the transit station.

Bike Interface

Bicycles are a prominent mode of transportation that can prove essential to transit networks if integrated properly and efficiently. This integration requires facilities such as parking and end-of trip facilities and services like bike share systems to be available near the transit station. Bike facilities must consider additional factors such as security and accessibility so users can use these facilities with comfort and ease.

Existing Practices

- Bike lockers at SkyTain stations
- Bike parkades at SkyTrain stations
- Mobi bike share at certain SkyTrain stations

Case Studies

Bike parking

Considerations

- Consider increasing bicycle options including but not limited to electric-assist bikes, cargo bikes, and trikes
- Bicycle parking should be accessible from existing or planned bikeway networks
- Bike parking facilities should be equipped with information on how to properly secure a bike to reduce theft
- Parking options for both short-term (e.g. bike racks) and long-term (e.g. bike lockers) parking uses will help users utilize bikes for multiple trip purposes
- A universal payment system that allows users to ride transit and utilize secured bike parking can help increase the convenience of these services
- Additional security measures such as surveillance cameras, preventive designs, and on-site staff may be required in areas where there is a higher risk of theft (Metrolinx 2011)
- Consider bike racks and storage designs that contribute to placemaking initiatives

Indoor bicycle parking facility (Utrecht, Netherlands)
The indoor bicycle parking facility located around Central Station in Utrecht is intended to accommodate 4,200 bicycles (Bicycle Dutch 2014). The facility is designed to have ample light and uses electronic systems to signal users of how many spaces are available in each aisle. This parking system can be utilized through a public transport card.

Underground parking structure in Utrecht (Bicycle Dutch)

Automated underground parking (Japan)
In this underground parking facility, once the bike enters from the ground level entry/exit, it is sent to an underground storage system that is computer automated and activated by an IC tag attached to the bicycle (Neira 2017). As an underground and computer automated system, this facility eliminates theft and allows for more public space.

Automated underground parking in Japan (designboom)

Offstreet parking facility (Oxfordshire, UK)
Below is a two-tiered covered bicycle parking implemented at Didcot Parking Station. The tiered design allows for more parking spaces in a smaller space.

Example of an off-street bicycle parking facility (Broxap Design & Build)

Onstreet parking facility (Kamloops, BC, Canada)
Cyclehoop specializes in creating innovative solutions for bike parking and infrastructure (Cyclehoop n.d.). One of their initiatives is an on-street bike parking infrastructure that allows 10 bikes to park in one car parking space. Known as the Car Bike Port, this innovative design has been implemented in Kamloops.

On-street bike parking (SUBMITTED/Infotel)

Cargo bike parking (Copenhagen, Denmark)
This innovative cargo parking design is dedicated specifically to cargo bikes which are often suitable for shopping trips. Although this design has not been implemented, it considers diverse and emerging cycling options and proposes safe and secure options for cargo bike users.

Off-street cargo bike parking (Copenhaginze Design Co.)

This on-street cargo bike parking is designed to provide bike parking in a space usually dedicated to cars. This design allows for four cargo bikes to be parked in a protected structure and has hooks for riders to store their cycling gear.


On-street cargo bike parking (Copenhaginze Design Co.)

End of trip & supportive facilities

Considerations

- Depending on the context of the mobility hub, full bike centers or hubs may be necessary (LA Urban Design Studio 2016). For areas where cycling is not a dominant mode, components of supportive facilities may be more appropriate than full service bike centers.

The Cycle Centre (Chicago, IL, USA)
This facility, known as the Cycle Centre in Chicago, is a three-storey cycling facility that provides 300 bike parking spaces, day use lockers, a bicycle rental and repair station, and private shower stalls (ArchDaily 2009). To increase a sense of safety and security, the building also houses Chicago's bicycle patrol (ArchDaily 2009).


McDonald's Cycle Center (ArchDaily)

Metro Bike Hubs (Los Angeles, CA, USA)
Similar to the Cycle Centre, the Metro Bike Hub is a multi-purpose cycling facility where secure parking for 200 bikes are provided along with other cycling-related services. These services include on-site staff, bicycle repair, and sale of bike accessories (Metro 2017). To attract non-commuters, the Metro Bike Hub also offers bike rentals to encourage non-commuting trips as well.

Metro Bike Hub (Metro)

E-bike parking and charging stations (Oregon, USA)
The Oregon Museum of Science and Industry implemented a solar canopy charging station for electric vehicles, including e-bikes (Maus 2010). This station provides a charging locker where e-bike riders can charge their battery in a secure place. Additionally, bike racks with a weather protected outlet are also available for cyclists who wish to park their e-bike with the battery attached.

Bike charging lockers (Scott Ewing/BikePortland.org)

Electric bike parking facility (BikePortland.org)

Integrated bike share

Considerations

- A common fare payment system is recommended, where transit users can utilize their transit pass to also reserve and use the available bike share system
- For bike shares with docking stations, these stations should be flexible and easy to change locations so it can accommodate future changes in infrastructure
- Bike share models that incorporate different bike models (e.g. electric bikes, step-through bikes, cargo bikes) should be considered to ensure people of all ages and abilities can make use of the service
- The objectives of the bike share system should be clearly defined to help with the process of selecting a suitable bike share system
- The bike share system should be accessible from both the bikeway network and transit, with little interface with pedestrian and vehicle traffic (LA Urban Design Studio 2016)

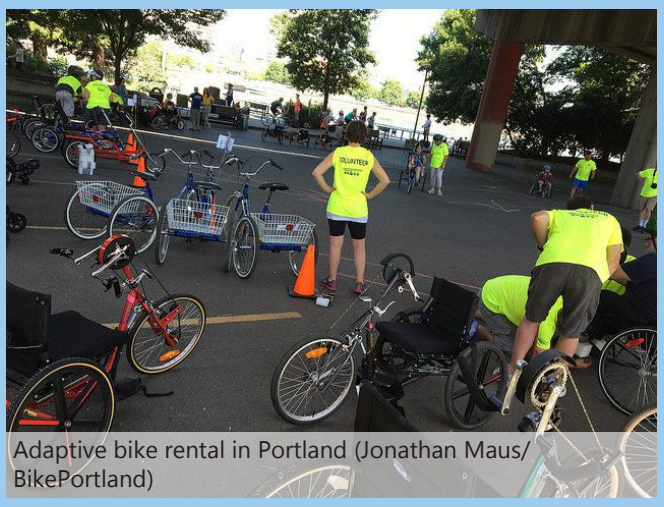
Bike share with docking stations
Metro Bike Share (Los Angeles, CA, USA)
Unlike bike shares that are either privately operated or public operated by municipalities, Metro Bike Share is a bike sharing service that is operated by the county transit agency in LA. This bike share system operates using docking stations which users can access by enrolling in either a monthly, annual or day pass. However, recently, the fares for this bike share were reduced and additional passes were introduced such as a single ride pass and transfer passes. A single ride pass would equate to the same fee for a Metro bus or train ride, while transfer passes mean bike share riders get a free transfer to any Metro bus or rail trips that accept payment by TAP cards (Linton 2018). TAP cards are a payment device that passengers can use for their bus and rail trips in LA County. Therefore, there have been efforts by Metro to unify the bike share with the transit system.

Metro Bike Share (The Transport Politic)

Blue Bikes (Ghent, Belgium)
Under the EU-wide Bike Train Bike program, one initiative that was highly successful was the Blue-bike bike share program implemented in Ghent, Belgium. This bike share system was designed to work in conjunction with train stations. As such, the blue bike share stations are available at 40 train stations across the country (Christiaens 2012). This bike share service follows a round trip model, meaning bikes must be returned to the station where they were rented out. Therefore, this bike share program aims to cover first and last mile travel to and from the station for every day commuters. All users pay an annual membership fee and are charged a maximum of 3.15 Euros per 24 hours (Blue-bike n.d.). This payment system allows users to keep the bike overnight to use the next morning for their departure to work.


Blue-bike station (CyCLO)

Adaptive Bike Rentals
Bicycling Pilot Project (Portland, OR, USA)
In Portland, an adaptive bike rental pilot program was implemented to provide cycling options that responded to the needs of people with disabilities or individuals unable to use two-wheeled bicycles (PBOT 2017). Through this program, tricycles, hand cycles, and side-by-side tandem bikes were available for rent for one to three hours (Cohen 2018). As these bikes must be picked up and returned to the same rental location, this program operates more as a bike rental program than a bike share. However, the Portland Bureau of Transportation is aiming to develop this program to operate similarly to a bike share system and encourage uses that extend beyond recreation.


Adaptive bike rental in Portland (Jonathan Maus/ BikePortland)

Adaptive MoGo Bike Share (Detroit, MI, USA)
The adaptive MoGo pilot project offer different bicycle types to respond to a variety of accessibility needs. This includes bikes that are not commonly available through bike share systems such as tandem bikes, cargo tricycles, and recumbent tricycles. These bikes are available to book online, and are picked up from a designated local bike shop. The payment system is similar to bike share systems as users have the option to purchase a single trip pass which allows for two hours rental for $12, or a seasonal pass which allows unlimited two hour rides for $30 (Runyan 2018).


Adaptive MoGo (MoGo Detroit/Better Bike Share Partnership)

Enhanced Operations

Enhanced operations refer to elements that help the transportation system operate smoothly and efficiently. This can encompass initiatives that help passenger board and exit out of transit vehicles easily and designs that help the transfer between different transit services occur seamlessly. As such, enhanced operations is an essential amenity that help passengers optimize their travel time and experience through mobility services that are well-intergrated.

Existing Practices

- Compass vending machines
- Passenger queuing

Considerations

- Clear and visible signage should be used to alert other vehicles of transit priority lanes
- Wayfinding and service information can help assist transfers between different platforms
- Designs and signages that clearly provide space for passengers alighting the vehicle can enhance efficiency and conflict between alighting and boarding passengers

Case Studies

Passenger Queues

Passenger queues can help increase efficiency for both passengers and bus operators when passengers board and alight the vehicle. Clear areas for passenger queues can also help minimize crowding on busy streets and avoid conflict with other pedestrians.

Marked passenger queue zones at Commercial Broadway station (Ellen M. Banner/The Seattle Times)

Transit Priority Measures

Queue Jumps

Queue jumps provide a priority green light to transit vehicles via a queue jump lane, that allows them to pass through vehicle traffic (Meyer 2016). This allow buses to operate on schedule through busy traffic and avoid service delays.

Transit Only Lanes

Similar to queue jumps, bus only lanes ensure that bus services remain on schedule during peak hours especially in areas where there is busy traffic. Having an efficient and reliable transit service can also help increase ridership, resulting in a reduction of greenhouse gas emissions in the long term. These transit priority lanes are often enforced through fines to avoid illegal use by standard vehicles.

Bus priority lane in Victoria (Darren Stone/Times Colonist)

Platform Designs

Dual Platforms

Dual platforms allow passengers to board and alight trains from both sides of the vehicle. These designs can help reduce overcrowding by allowing more space to passengers. Generally, each platform is dedicated separately for onboarding and alighting passengers to eliminate conflict pedestrian movement and allow for efficient foot traffic.

Dual platforms being built at Commercial-Broadway station (Kenneth Chan/Daily Hive)

Cross Platform Interchanges

Cross platform interchanges allow passengers to switch between different lines without having to change platforms. These designs can help minimize time spent travelling between different major lines. As an interchange point, train schedules need to be coordinated to foster safe and convenient transfers at these platforms.

Implementation of Mobility Hubs

This section explores existing implementation strategies of mobility hubs. Firstly, common planning phases used to plan for mobility hubs were reviewed and summarized to understand the initial phase of mobility hub implementation. Secondly, given the different agencies involved in the creation of mobility hubs, different partnerships and responsibilities involved in mobility hub creation – both internally and externally – are outlined under four main different topics of planning, services and elements, land development, and funding. Existing strategies were also explored to understand common approaches used by existing mobility hub studies. Lastly, other key considerations and common challenges found in mobility hub implementation were identified.

Common Planning Phases

1

Planning context
This step aligns with common planning strategies as it involves reviewing the existing planning framework of the mobility hub area. As such, essential city plans such as Official Community Plans and Master Transportation Plans are reviewed to find any relevant policies and objectives that the mobility hub should follow or target. This stage also involves referring to planning initiatives on both the regional and municipal levels to ensure the mobility hub complies with the vision outlined in these long-range planning documents. Lastly, local planning documents such as neighbourhood concept plans are essential to review in order for the mobility hub responds to the local community's values.

2

Study area
The following step involves researching the existing and baseline conditions of the planned hub site and its surrounding area. As such, the existing transportation network including street connectivity, cycling and pedestrian infrastructure, and public transit services are reviewed and analyzed. This review should also extend to factors such as land use, urban form, and neighbourhood character to fully encompass the site context. Additionally, redevelopment opportunities within and around the site are crucial to analyze in this phase to understand the potential of the mobility hub to promote transit oriented development. Lastly, constraints and opportunities of the site area should be discussed to guide which mobility hub elements will help respond to the site's existing challenges and enhance its strengths. In some mobility hub studies, this also takes the form of a SWOT analysis.

3

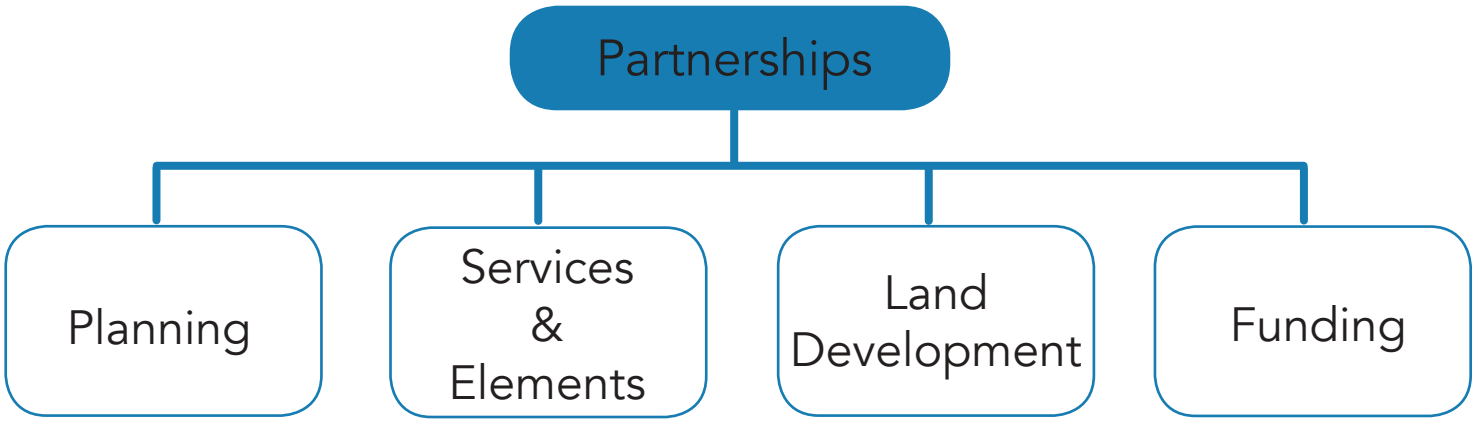
Guiding principles
Once the planning context has been established, guiding principles of the mobility hub are often listed in the form of an overall vision and its subsequent goals and objectives that are meant to help achieve the vision. These objectives can also be used to evaluate the mobility hub after implementation to ensure it is meeting the stated goals and to identify areas that require improvements. The previous stage of identifying opportunities and weaknesses along with this stage presents a prime opportunity to engage the community and the involved stakeholders to help realize a vision that is responsive to the community's and stakeholders' identified concerns, values, and vision for the neighbourhood.

4

Concept plan
Lastly, the concept plan for the mobility hub is created which outlines the recommended improvements and elements that should be incorporated in the particular hub. As such, specific designs of the streetscape and transportation network plans are included in this plan. The recommended built form of the area may also be incorporated to help envision the appropriate form of transit-oriented development in the respective neighbourhood. This is often followed by a phasing plan for implementation which outlines the responsibilities of key stakeholders and the timeline of action items for implementation.

Partnerships Involved in Hub Implementation

As a concept that involves several public and private services, a key element in mobility hub implementation is partnerships. Additionally, mobility hubs require an integration of land use, infrastructure, and services that benefit sustainable transportation modes and transit-oriented development. Therefore, several partnerships are often involved with municipalities and transit agencies leading the hub creation. The type of partnership and the stakeholders involved can vary across four main categories that are involved in mobility hub implementation. The following section outlines different roles and partnership examples that have been created in other mobility related projects.



Planning

Municipal government

Municipal government can help guide development around mobility hubs through different planning tools and incentives. This can include density bonuses in exchange for community benefits such as public spaces and facilities that encourage active transportation and transit use. Also, certain planning process can be streamlined to encourage development while reducing processing times as implemented by the City of Brampton (Metrolinx 2011). In Brampton, a Development Permit System (DPS) was implemented which combined zoning, site plan, and minor variance approals into one single procedure for an area downtown (Metrolinx 2011). Additionally, the planning phases used to initiate and develop a mobility hub plan are often undertaken by the city. Lastly, municipal government can also support mobility hubs by incorporating policies that promote mobility hubs and transit-oriented development in city-wide plans.

Public transit agencies (Transit operators, regional transportation agencies)

The role of transit agencies can be multifaceted depending on the amount of land that is owned by the agency. However, the main function of transit agencies often times involve increasing service levels and improving transit infrastructure in a way that enhances customer service. This includes accessibility, safety, furniture, service, and information elements that were previously reviewed. It is pertinent to coordinate schedules both among different transit services and with the surrounding employers and institutions so transfers are made easily and match employee schedules (BrookMcIlroy n.d.). Additionally, transit agencies can help address equity and accessibility by setting precedent for subsidized fare programs. This can help increase the uptake of transit services and increase the viability of mobility hubs. In terms of land use, transit agencies can reserve or create spaces in their station plans to lease for commercial and retail uses. Based on this multi-faceted and significant role of transit agencies, they are often involved from the planning phase and all other implementation phases of mobility hubs.

Services & Elements

On-demand rideshare agencies (Microtransit, ride-hailing companies)

Microtransit and ride-hailing agencies can form partnerships with transit agencies to encourage trips to and from major transit stations to ensure these services complement each other. An example is Uber in Innisfil as mentioned under the Mobility Hub Elements section. Another innovative partnership idea is to utilize ridehailing services to reduce parking demand, as done by the Town of Summit and Uber. Under their partnership, the City provided free Uber rides for commuters with parking passes as well as $2 trips to and from the station for all other

users (Hawkings 2016). This pilot program was initiated as a way to reduce the number of parking required at transit stations.

Car share services
Similar to on-demand rideshare agencies, shared mobility services can encourage transit use through partnerships with the local government and/or transit agencies. This is already implemented in certain SkyTrain stations in Metro Vancouver, where parking spaces are reserved for certain car share services. Additionally, car share services are increasingly gaining access to on-street parking and dedicating parking lots, also known as, drop zones in popular neighbourhoods. Another way to integrate shared mobility with existing transit services is through an integrated access card as done by Metro Transit and Hourcar. Hourcar is a car share service in Minneapolis. This particular partnership enables access to their car share service through Go-To transit cards which are used by commuters to switch between different Metro Transit systems. However, the card only enables access to the car share service and payment is still made separately. To further the integration and partnership of these two agencies, Metro Transit has also allowed Hourcar vehicles to park at certain light rail stations and transit centers (Harlow 2015).

Technology companies
Technology companies often refer to companies that can help produce and operate mobile payment or trip planning apps, such as Go LA or Whim. To launch the Go LA app, the City of Los Angeles partnered with Xerox, which allowed the Los Angeles Department of Transportation to obtain valuable travel data such as popular travel destinations and preferred travel modes, while also promoting a variety of transportation modes. Xerox also worked with both public and private transportation providers to incorporate as many transportation options into their app as well. Although the pilot program was offered without a fee from Xerox, the company will be using a fee-for-service model after the pilot period (Brasuell 2016).

Another example of a technology company that enhances transportation and user experience is Cubic Corporation. This corporation helps design and operate services that integrate payment and information technology for transportation services through their branch, Cubic Transportation Systems (PRNewswire 2017). Their mobile payment app service has been utilized in the UK, allowing users to charge their Oyster cards through their mobile device. They have recently partnered with Chicago Transit Authority to implement their app, Cubic Mobile for Travelers. This app provides information to the user regarding the available transit services near their location, while also acting as a mobile ticketing kiosk. As such, users are able to purchase transit passes or connect to existing mobilty payment services through the app (Anzilotti 2018).

Wi-Fi providers
As a prominent mobility hub element, Wi-Fi access is critical to enhance user experience during their travel. SANDAG outlines the major methods used to fund Wi-Fi service including direct sponsorships from advertising or technology companies, charging users for the Wi-Fi service, or partnering with service providers (SANDAG). For example, GO Transit implemented free Wi-Fi access through a partnership with IMA Outdoor, an advertising company. In their partnership, Wi-Fi access is provided by IMA Outdoor in exchange for advertising revenue (Kalinowski 2015).

Business Improvement Associations (BIA)
BIAs can help activate mobility hubs in a number of ways. Firstly, these organizations can ensure transit plazas are utilized by holding public events and festivals that support local artists and community culture. Additionally, BIAs can help maintain the area as a clean and safe place and contribute to placemaking through initiatives that promote safety and active street uses. This aligns with the common objectives of mobility hubs, where placemaking and safety are valuable elements for a successful mobility hub. There is potential for further partnerships with BIAs as mobility hubs present several elements that will help flourish local businesses such as shuttle services or on-demand ride hailing (SANDAG n.d.). As such, there are opportunities to collaborate with BIAs to fund certain hub initiatives.

Land Development

Private developers
Developers can help promote transit-oriented development by developing mixed-use buildings near mobility hubs. Moreover, by utilizing city incentives, developers can contribute to the incorporation of public art, public spaces, cycling or pedestrian amenities in new development. Additionally, public-private partnerships can help develop buildings that accommodate both private and public sector agencies to achieve a diversity in land use and achieve higher density (Metrolinx 2011). Public-private partnerships can also help connect public infrastructure with private buildings. For example, pedestrian access routes with weather protection that directly connect transit stations major buildings nearby can be formed through such partnerships (Metrolinx 2011).

Funding

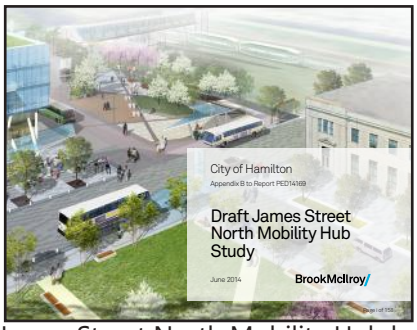
Federal/provincial government
Funding from the federal or provincial government can help cost-share transportation investments and capital projects. Metrolinx (2011) also recognizes the potential for senior levels of government to encourage development around mobility hubs by locating federal or provincial facilities near potential mobility hub locations.

Sponsors

Certain mobility services can earn corporate sponsorships that can help provide funding. Corporate sponsorships are common among bike share programs, where partnerships are made so sponsors provide payments to support the bike share system or components of the bike share program in exchange for branding on the bikes and stations. A local example is the Mobi bike share which is sponsored by Shaw Communications.

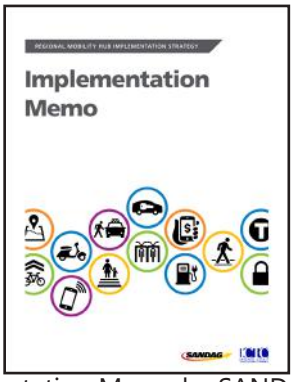
Mobility Hub Implementation Strategies

The following mobility hub studies and guidelines (listed below) are used as examples to show how mobility hub elements have been implemented in the past. Therefore, these strategies listed within these documents are meant to provide a general idea of how mobility hub elements have been planned and implemented in other areas. These are bound to change depending on the local context, the local jurisdiction of different agencies, the agencies involved in mobility hub creation, and the amount of property belonging to each agency.



James Street North Mobility Hub by BrookMcIlroy (n.d.)

Newmarket Go Station Mobility Hub by IBI Group (2018)



Implementation Memo by SANDAG (n.d.)

Cooksville Mobility Hub by Metrolinx (2011)

The following tables provide examples of actions that have been used in existing mobility hub studies which were then categorized into different themes related to the planning framework, partnerships. policy development, and facility planning. Implementation actions that are generally applicable across different mobility hub projects are listed in the following tables. Therefore, it is important to note that these actions will change depending on the specific needs and plans for the mobility hubs, however it is intended to provide a general idea of different implementation of mobility hub elements. 'Other stakeholders' refer to other mobility service providers, private sector developers, local community.

Table 6. Strategic Actions Related to the Planning Framework

Actions	Transit Agency	Municipality	Regional Government	Other Stakeholders
Finalize mobility hub study[1]	○	○		○
Establish mobility hub communications plan[1]	○			
Develop a project priority list[1]	○	○	○	
Undertake multi-modal transportation impact assessment[1]	○	○		
Create a comprehensive wayfinding strategy[1]	○	○		
Establish a Mobility Programming Strategy[1]	○	○		
Monitor implementation of mobility hub[1]		○		
Conduct street corridor and trails connection study[1]		○		
Review and update existing street standards[1]	○	○		

Table 7. Strategic Actions Related to Partnerships

Actions	Transit Agency	Municipality	Regional Government	Other Stakeholders
Establish partnerships between institu-tions, employers, transit agencies, and local artists[1]	○	○	○	○
Partner with private vendors to pilot different technologies and products that integrate mobility hub services[4]	○	○		○
Create a "Mobility Sandbox" to allow the private sector to develop pro-posals for demonstrating technology and services that solve mobility challenges[4]	○	○		○
Collaborate with the private sector to develop shared data agreements, and aggregate data on transportation modes and related travel to facilitate real-time trip planning across modes[4]	○	○		○
Explore opportunities for partnerships on streetscape and cycling facilities with the regional government[3]		○	○	

[1]BrookMcIlroy. (2014, June). Draft James Street North Mobility Hub Study. Retrieved from http://www2.hamilton.ca/NR/rdonlyres/C76A1926-F266-4A71-B4E7-CF3DBD21ABA7/0/JamesSNMobilityHubStudy.pdf
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[3]SANDAG. (n.d.-b). Implementation Memo. Retrieved from https://www.sdforward.com/docs/default-source/default-document-library/implementation-memo_12-13-17_final.pdf?sfvrsn=dad0f965_0
[4]Metrolinx. (2011a, September). Cooksville Mobility Hub Master Plan Study. Retrieved from http://www.metrolinx.com/en/regionalplanning/mobilityhubs/MH_Study-Cooksville.pdf

Table 8. Strategic Actions Related to Policy Development

Actions	Transit Agency	Municipality	Regional Government	Other Stakeholders
Commit to operational transit improvements (E.g. increasing transit service where appropriate)[3]	○			
Secure lands for station facilities and amenities[2]	○			
Official Plan and zoning amendments[1]		○		
Ensure the proposed pop-up and mobile business uses align with zoning bylaws and are permitted[2]		○		
Account for mobility hub improvements within Capital Improvement Programs (CIPs)[4]	○	○	○	
Pursue relevant federal and provincial grant programs[4]	○	○		
Incorporate mobility hubs as an eligible expenditure under existing funding streams[4]		○		

[1]BrookMcIlroy. (2014, June). Draft James Street North Mobility Hub Study. Retrieved from http://www2.hamilton.ca/NR/rdonlyres/C76A1926-F266-4A71-B4E7-CF3DBD21ABA7/0/JamesSNMobilityHubStudy.pdf
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Table 9. Strategic Actions Related to Facility Planning

Actions	Transit Agency	Municipality	Regional Government	Other Stakeholders
Undertake planning and design work for transit plaza[1]		○		
Implement public realm pilot projects[1]		○		
Dedicate parking space at transit stations for carpools, vanpools, and car-share[4]	○			○
Dedicate transit station space for bike services and amenities such as bikeshare and secure group bike parking[4]	○			○
Implement platform interventions that improve access between different transit services[3]	○			
Repurpose customer parking lot for other mobility hub elements[2]	○	○		
Allocate transit station curb space for loading and unloading passengers of on-demand shuttles, rideshare companies, and other shared services[4]	○	○		○
Establish the extension of streets that will lead to the station (including connections by cars, buses, cyclists, and pedestrians)	○	○		○
Undertake enhancements to cycling infrastructure on roads leading to the hub[2]		○	○	
Implement streetscape improvements on nearby streets[1]	○	○	○	
Continue to explore other opportuni-ties for improved pedestrians and cyclist connections within mobility hub[2]		○		

[1]BrookMcIlroy. (2014, June). Draft James Street North Mobility Hub Study. Retrieved from http://www2.hamilton.ca/NR/rdonlyres/C76A1926-F266-4A71-B4E7-CF3DBD21ABA7/0/JamesSNMobilityHubStudy.pdf
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Challenges of Mobility Hub Implementation

Parking demand

A prominent issue facing mobility hub creation that is recognized by Metrolinx is the pre-eminence of parking in employment areas. In particular, suburban areas often rely heavily on inexpensive and large parking areas which present challenges to creating a successful mobility hub in two ways. Firstly, large scale parking creates an environment that discourages active transportation modes. Secondly, dedicating large parcels of land to parking near transit areas can inhibit development as land is underutilized. As such mobility hubs must accommodate an adequate amount of parking space to continue to attract development in these auto-oriented areas, while also discouraging development that concentrates parking near the transit station (Metrolinx 2008).

Land ownership

Another barrier to mobility hub implementation that favours mixed-use development is land ownership patterns. Metrolinx identifies a problem with two common types of land ownership that are found in potential mobility hub locations. Firstly, where land ownership is held by large single users such as shopping centers or transit agencies, the common priority for land use is to provide parking for its users (Metrolinx 2008). Meanwhile, land that is divided through multiple ownerships often default to residential uses (Metrolinx 2008). Moreover, there is difficulty in developing mobility hubs along rail corridors as the land is often designated for industrial uses. In response, Metrolinx (2008) suggests the public sector take an interventionist role of securing land that is suitable for mixed-use development (Metrolinx 2008).

Misalignment between transit and development

In certain areas, key higher-order transit stations are located in areas that are not surrounded by commercial and residential activity. Instead, major land uses may be located in the catchment area of the mobility hub (Metrolinx 2008). This discontinuity between the transit station and surrounding development can pose a challenge for implementing cycling and pedestrian access to the transit station (Metrolinx 2008). In response, innovative solutions are necessary to increase user experience at these stations and serve better connections to resolve the discontinuity between transit services and major land uses.

Equity considerations

Firstly, mobility hubs must ensure equity for all users. As such, depending on the local context, hub elements that are beneficial to disadvantaged and vulnerable groups should be prioritized. The potential issues surrounding equity concerns are explored below:

Cost of services

Many of the mobility services offered at mobility hubs require payment through smartphone apps or credit cards which people may not always have access to (SANDAG n.d.). Additionally, Mobility as a Service and shared mobility services often utilize a subscription fee which many users may not be able to commit to. Therefore, subsidizing programs and payment structures that take into account low-income households will be beneficial to ensure mobility hubs remain accessible across the social gradient.

Language and cultural barriers

Firstly, all mobility hub services and elements should be responsive and inclusive to the surrounding community it is intended to serve. This may encompass including multilingual signs within the mobility hub or providing translation services. Moreover, SANDAG (n.d.) highlights that mobility services may have a lack of uptake in some neighbourhoods where communities are culturally unfamiliar with the offered mobility service, such as shared mobility models.

Accessibility

As mentioned previously, mobility hub elements and infrastructure must incorporate accessibility standards in their design and function to enhance access for seniors and people with disabilities. However, according to SANDAG (n.d.) private mobility services that are not publicly funded are not required to comply with accessibility standards such as the Americans with Disabilities Act (ADA). Therefore, it is recommended to assess accessibility barriers found in both the private and public modes offered at mobility hubs.

Source: Kyle Thacker/Unsplash

Section 3. Next Steps

Conclusion & Next Steps

The overarching aim of this research project is to explore the concept of mobility hubs in an effort to implement strategies and initiatives that prioritize low emission transportation modes in the long term. As a way to achieve this, the background and case study research is intended to provide a grounding framework of how mobility hubs can be defined and addressed in future research and related TransLink projects. Firstly, the background research found that the proximity to a major transit station, a mixture of multi-modal trips, and high surrounding densities or centralized locations are considered essential in characterizing a space as a mobility hub. Additionally, the case study research from this project highlights the importance of incorporating several mobility hub elements that respond to the transportation needs of the local context. As a result, a key component of implementing effective mobility hubs is partnerships between key stakeholders that can help realize the full potential of these hubs.

Based on this research, there are three potential next steps to guide future research and build onto the results of this project.

Further Research on Key Elements

Firstly, mobility hub elements present an opportunity for further research. Although this research explored general considerations and existing case studies of several hub elements, further research regarding implementation strategies will be essential to understand the challenges and needs regarding the implementation of key elements. This is recommended particularly for elements that will require partnerships between different stakeholders like integrated retail.

Refinement of Objectives & Implementation

Secondly, the listed mobility hub objectives and implmentation practices will need to be refined and adjusted to meet the current organizational structure, capacity, and goals of TransLink. As such, further refinement of mobility hub objectives and the role various teams within TransLink will have in hub implementation may be required to reflect the organization's vision for mobility hubs.

Future of Mobility Hubs

Lastly, given the broad framework of how mobility hubs can be addressed in Metro Vancouver provided in this project, a viable next step is to set the pathway for how mobility hubs will be integrated into future projects. This may entail planning how mobility hubs will be incorporated in the current policy development work, existing facility design guidelines, and planned station upgrades. Identifying existing opporunities in terms of station upgrades can also help identify key locations for pilot hub projects.

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