Socio-Economic Analysis of Passenger Rail Stations: The Case of the West Coast Express

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Executive Summary

Socio-Economic Analysis of Passenger Rail Stations along the West Coast Express (WCE) in Metro Vancouver assesses the effects of land use, accessibility, economic, environmental and rider-perception variables on the performance of passenger rail stations. The study focuses on 5 representative stations - Waterfront, Port Coquitlam, Maple Meadows, Pitt Meadows, and Mission City and uses Geographic Information System (GIS) buffer mapping with statistical regression to establish the forces that drive ridership and the pervasive effects of rail service.

Abstract

The socio-economic factors examined in this report are the ones that affect passenger rail stations location and performance along the West Coast Express (WCE) line in Metro Vancouver. Based on five representative stations: Waterfront, Port Coquitlam, Maple Meadows, Pitt Meadows, and Mission City, the research assesses the role that population and employment density, accessibility, economic consequences, environmental concerns, and perceptions of the riders have in determining commuter behavior and system performance.

In a mixed-method design, the analysis utilizes Geographic Information Systems (GIS) to overlay population and employment catchment areas in one-kilometer buffers and statistical models that test the relationships between ridership and independent variables including employment density and parking capacity. The results support the idea that the density of employment is a more significant predictor of ridership than residential population and the suburban stations are highly dependent on park-and-ride facilities. The economic and environmental benefits are different at the stations with Waterfront providing the highest value of local business and CO 2 reduction, and Mission City offering great environmental relief by limiting long-range automobile commuting.

The paper ends by giving recommendations on how multimodal connectivity can be improved, transit-oriented development (TOD) could be encouraged, service hours can be extended, parking and sustainable access can be optimized, and technology can be integrated to plan data-driven approaches. The report integrates spatial, statistical, and planning approaches to show how socio-economic considerations can influence the performance of WCE stations and give measures to enhance the capacity of the system to contribute to equitable, sustainable, and efficient regional development.

I. Introduction

The West Coast Express (WCE) is a commuter railway transit in Metro Vancouver, British Columbia, which started its operations in 1995 in response to the increasing transport need among the suburban areas of Fraser Valley and the city of Vancouver as a whole. The line is run by TransLink and in partnership with Canadian Pacific Railway spanning about 65 kilometers between Waterfront Station and Mission City, with stops in Port Moody, Coquitlam, Pitt Meadows and Maple Ridge (TransLink, 2024). The WCE came about due to the growing traffic congestion on the highways, as it provides a good substitute to weekday commuters due to the scheduled morning westbound trains and evening eastbound returns (Cervero, 2002).

The passenger rail stations are not a mere boarding and alighting spot only, but they are a socio-economic centre, which defines urban development and land use and mobility. Rail systems are central in establishing sustainable development of the urban area where the population is increasing at a very high rate and the transport requirements are high. Because the West Coast Express (WCE) is a commuter train that on the west coast of Canada will run between downtown Vancouver and Mission, which interconnects suburbia in the northeast of the Metro Vancouver region and metropolitan core job clusters, the WCE has shaped regional development patterns that have served to bolster transit-oriented development and enhance access to employment centres in the metropolitan core (Duncan, 2011; Ewing & Cervero, 2010). With time, it has evolved to be an important part of the integrated transit system of Metro Vancouver since residents are becoming concerned about the price of housing, congestion and climate change, the socio-economic factors that drive the location and the functionality of the station are becoming even more influential.

In this research, the five representative stations on WCE line (Waterfront, Port Coquitlam, Maple Meadows, Pitt Meadows, and Mission City) are considered. These stations are in contrasting settings, with the densely populated employment-rich core of Vancouver to the more sparsely populated suburban areas. They both provide an insight of the role of land use, access, economic and environmental factors in determining the results of ridership and the effectiveness of the whole system.

The integrated framework of analysis implemented in the paper is the combination of urban planning principles, GIS spatial analysis, and statistical approach. The study includes the mapping of populations, employment and accessibility features to determine which station characteristics most predictively affect success. Finally, it is aimed at delivering evidence-based knowledge and suggestions to inform measures on enhancing connectivity, boosting ridership, and promoting sustainable regional development.

II. Literature Review

The West Coast Express Geographical Map shows the commuter railroad which runs through the Waterfront Station in downtown Vancouver and the Mission City Station in the Fraser Valley. The route is marked in purple and goes along the Fraser River and links various major stations such as Moody Centre, Coquitlam Central, Port Coquitlam, Pitt Meadows, Maple Meadows, Port Haney and Mission City. The map gives contrast and geographical context as well as it gives the view of other surrounding cities like North Vancouver, Burnaby, New Westminster, Richmond, Surrey, Langley, and Maple Ridge. Large water masses, in particular, Fraser River are also clearly presented, which highlights the picturesque character of the route. It is a useful

commuters map and also a travelers map showing exactly how the west coast express connects the urban centers with the suburban communities along the Lower Mainland in British Columbia.

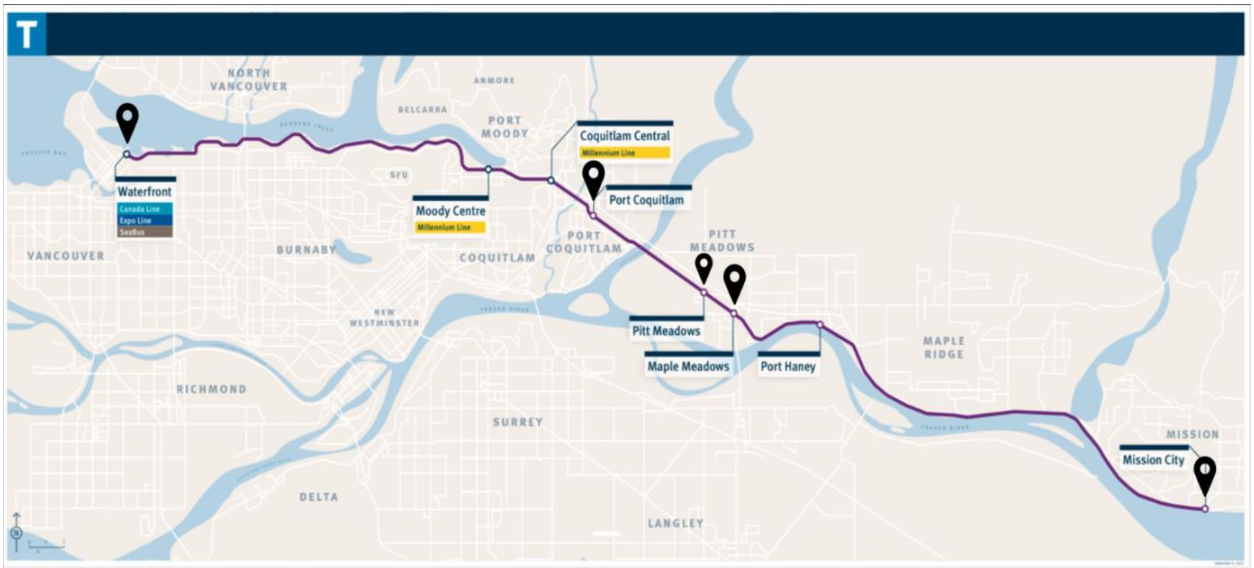


Figure 1.0 – WCE Map (Source: TransLink – Westcoast Express Schedules and Maps)
Note: West Coast Express is a total of 67km from Waterfront to Mission City Station

For this study, the five selected stations are the following: Waterfront, Port Coquitlam, Pitt Meadows, Maple Meadows, and Mission city. Below are their respective distances from Waterfront Station in Vancouver City:

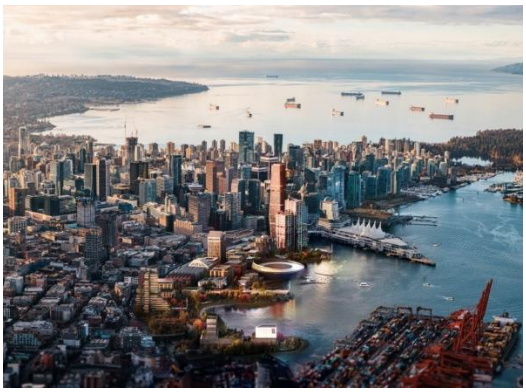
Stations	**Distance from Waterfront (Vancouver City)**
Port Coquitlam	27 kilometers
Pitt Meadows	35 kilometers
Maple Meadows	40 kilometers
Mission City	67 kilometers

For the five selected stations, the researches have considered the residential population of the area, business presence, accessibility and connectivity, park and ride facilities, and tourism to better understand the socio-economic impacts of these railway stations of the West Coast Express:

- **Waterfront Station (Vancouver City)**

West Coast Express at Waterfront Station (Dreamstime, n.d.)

The Gastown Steam Clock is highlighted as a popular attraction in downtown Vancouver (Expedia.ca, n.d.).



Downtown Vancouver (Waterfront Station) as a business hub (Vancouver is Awesome, n.d.)

- **Residential population:** The City of Vancouver had about 662,000 residents in 2021, with very high densities in the downtown core where Waterfront Station is located (City of Vancouver, 2022).

- **Employment (business presence):** Approximately half of all city jobs are concentrated in business finance, tourism and professional services and much of this is located in the Waterfront area making the area the major employer of the region as a whole (City of Vancouver, 2022).

- **Accessibility & connectivity:** Waterfront is the primary intermodal centre of Metro Vancouver and the primary intermodal connection between WCE and SkyTrain (Expo/Canada Lines), SeaBus, various bus routes (TransLink, 2024a).

- **Park-and-ride facilities:** In contrast to the suburban stations, Waterfront does not have any park-and-ride; most commuters reach it by walking or riding a bicycle or using transit (TransLink, 2024a).

- **Tourist attractions:** There are many attractions within walking distance of the station: Canada Place, the Vancouver Convention Centre, the Steam Clock in Gastown, Stanley Park and the Coal Harbour seawall (Tourism Vancouver, 2023).

- **Port Coquitlam**

Port Coquitlam Station (Dreamstime, n.d.)

Port Coquitlam Business Areas / Establishments (Real City Group, 2023)

Traboulay PoCo Trail (Dreamstime, n.d.)

- **Residential population:** In the 2021 Census, 61,498 people were registered in Port Coquitlam (Statistics Canada, 2022a).
- **Employment (business presence):** The Kingsway and Wilson have a combination of commercial, industrial and service establishments in the city, but most residents travel to another city to work (City of Port Coquitlam, 2023).
- **Accessibility & connectivity:** The WCE station on Kingsway Avenue is connected to the bus and also has parking in the adjacent Recreation Centre (TransLink, 2024b).
- **Park-and-ride facilities:** Port Coquitlam Station has a large park-and-ride, consisting of almost 600 stalls, so it is one of the largest commuter stations of suburbs (TransLink, 2024b).
- **Tourist attractions:** Traboulay PoCo trail is an established walking and bicycle trail that is 25 kilometres long and one of the biggest recreational trails in the area (City of Port Coquitlam, 2023).

- **Pitt Meadows**

Pitt Meadows Station (Translink Pitt Measows, n.d.)

Medowtown Centre – commercial areas in Pitt Meadows (Meadowtown Centre, n.d.)

Pitt Lake – tourist attraction (Outdoor Family, 2025)

- **Residential population:** Pitt Meadows had a population of 19,146 in 2021 with a rather low density of approximately 222 people per square kilometre (Statistics Canada, 2022b).

- **Employment (business presence):** Agriculture, retail, and services are the local sources of employment, and Meadowtown Centre is a major shopping and employment center (City of Pitt Meadows, 2022).

- **Park-and-ride facilities:** The station has a total of about 140 surface parking lots where most of the commuters are suburban residents (TransLink, 2024c).

- **Accessibility & connectivity:** Pitt Meadows Station will be served by a bus loop and park-and-ride, and there will be local buses, such as the 722, that stop at the WCE (TransLink, 2024c).

- **Tourist attractions:** Pitt Meadows Station will be served by a bus loop and park-and-ride, and there will be local buses, such as the 722, that stop at the WCE (TransLink, 2024c).

- **Maple Meadows**

Maple Meadows Station (Translink Maple Meadows, n.d.)

Golden Ears Provincial Park (A Walk & A Lark, 2019).

- **Residential population:** Maple Ridge consisted of 90,990 people in the year 2021 which indicates a consistent suburban development (Statistics Canada, 2022c).
- **Employment (business presence):** Numerous jobs in the city are in the fields of high-tech manufacturing, construction, and professional services, and the development of business activities around the station site is supported (City of Maple Ridge, 2023).
- **Park-and-ride stations:** Maple Meadows Station has approximately 467 stalls that commuter can use (TransLink, 2024d).
- **Accessibility & connectivity:** Maple Meadows Station offers a big park-and-ride and it also links to buses 701, 791, and 595 (TransLink, 2024d).
- **Tourist attractions:** Golden ears provincial park and the Maple Ridge museum are major tourist and cultural attraction sites (Tourism Maple Ridge, 2023).

- **Mission City**

Mission City Station (Translink Mission City, n.d.)

Downtown Mission – Business / Commercial Areas (City of Mission, n.d.)

Westminster Abbey – Tourist Attraction (Westminster Abbey Ltd., n.d.)

- **Residential population:** In 2021, the residential population of the city was 41,519, and its density was approximately 183 people per km 2 (Statistics Canada, 2022d).

- **Employment (business presence):** Employment is facilitated by downtown business activities, industrial, and programmes of economic development of the city (District of Mission, 2023).

- **Park-and-ride facilities:** The WCE park-and-ride in Mission City is the biggest with more than 500 stalls where regional commuters can park their vehicles (TransLink, 2024e).

- **Accessibility & connectivity:** Mission City Station is the eastern end of the WCE, which is linked to several local bus lines 31, 32, and 701 (TransLink, 2024e).

- **Tourist attraction:** Westminster Abbey and Fraser River Heritage Park will be the main tourist attractions (Tourism Mission, 2023).

After checking the residential population, business presence, accessibility, and the tourism for each station, transport planning is important especially on the social and economic development, and environmental protection, because rail transit sits in a distinct niche of its own. West Coast Express in Metro Vancouver has multiple aspects associated with it, and when attempting to assess the way stations operate, observing insights into this established literature on urban density, accessibility, transit-oriented development (TOD), environmental impacts, as well as service quality is essential. The connections between rail stations and regional development along with routes for the working class have been substantially analyzed due to the effort of these theories.

Transit ridership is linked to the workforce and the employment density of an area. In a study of National Transit Database, Ritter (2010) found that the employment density in downtown areas generates the highest levels of efficient core, higher ridership as compared to suburbs. That pattern remains consistent even in suburbs with immense populations and known skyscraper satellite cities to inner cores, as shown by Ewing et al. (2010). This pattern is visible in BC as well, with Waterfront Station in Vancouver's city core having a significantly high ridership level thanks to the great availability of jobs. Job reliant stations like the Pitt Meadows and Mission City, are used for job balance. This supports the research in the field of “jobs-housing balance” which emphasises the importance of connecting the public with the surrounding job centres using public transport.

Connectivity and accessibility are also critical factors of any station’s operations. Transit systems, as pointed out by Litman in 2021, profoundly benefit from the mention of transit systems, incorporate a wide range of connecting options for every commuter. Motoring further towards Maple Meadows and Mission City, the park-and-ride buildings with 500 and 467 parking slots,

respectively, are key assets. Statistical evidence is in support of the previously mentioned approach. As mentioned by Guerra, Cervero, and Tischler (2012) advocate for the development of the first and last mile: rail transit with the absence of pedestrian and cycling paving is hindered. Also, Taylor and Fink (2013) explain that feeder services add to the social divide of public transit, making it less user-friendly for users who rely heavily on non-regional transit. It would be correct to state that in regards to the Transit aspects of WCE, that the integration of the two modes will improve and efficiently work alongside the feeder systems of the suburban regions functionalities of the suburban park and ride facilities.

Rail stations also play a role as a catalyst in local economic development. In a compact and well planned environment, every transit oriented development promotes combination of different types of buildings, thus increasing the number of people who would use these transits. As a result, such work is expected to rise very much in value and as well be given a different perspective in the future, as showed (Duncan 2011). Another consideration is the benefits to the environment include some of the most important aspects of public transportation. For example, public transportation not only cuts back on greenhouse gas emissions, but it also lessens and reduces city congestion as well, which is in line with the global climate objectives in the works (Newman & Kenworthy, 2015). This holds true in the case of WCE: The case of Waterfront Station remains the subject of one of the most notable cases in this category, and it offers up considerable results such as reducing nearly 25,000 tons of CO_2 on an annual basis. This claim is underscored by Mission City, as well as it also offers very low ridership— nevertheless, it enhances environmental impacts and cuts significant costs, like the savings from using the car are far beyond the amount of money being spent annually (TransLink, 2024).

The wide adoption of Geographic Information Systems (GIS) and regression models has achieved significant strides in mapping and ridership catchments in transit operations. There are also benefits to be gained from GIS and ridership catchment mapping techniques specifically as applied to analytics-based public transport planning. The optimization of transit can also be termed data-derived. Furthermore, the improvement and the increasing artificial intelligence (AI) tools can really make an impact, such as in the use of predictive analytics and AI for public transport. This can be helpful for the bus systems too in providing adaptive services, for instance in the case where flexibility boosts the transfer of the city to campus, especially in the case of buses, and is helpful for AI-to-predictive analytics (Zhang, Zhao, & Howlett, 2021).

Overall, in employment-dense areas have more ridership, and TOD helps suburban stations grow. The WCE is a powerful tool because while it helps people get around, it also helps the local economy while minimizing damage to the environment and keeping commuters happy. If we combine these ideas with investing in new technologies, redesigning our suburban landscapes for good TOD, and getting good at forecasting, we can expect to adopt more sustained WCE support practices.

III. Methodology

In this analysis of the West Coast Express, Waterfront, Port Coquitlam, Maple Meadows, Pitt Meadows, and Mission City, we integrated GIS, statistical, and survey analyses to evaluate socio-economic, environmental, and service-quality variables affecting ridership. We sourced ridership statistics and station amenity counts through TransLink; population and employment figures from the 2021 Statistics Canada Census; parking stall and bus-loop capacities from TransLink infrastructure; commercial property value estimates from BC Assessment; vehicle-kilometers-traveled estimates and emission factors from Metro Vancouver climate studies; and

rider satisfaction scores with qualitative comments from the 2024 TransLink WCE customer survey. We generated in ArcGIS Pro 1 km radius buffers around each station, overlaid dissemination-area layers to tabulate residents and employment, and mapped park-and-ride sites, bus corridors, bicycle lanes, and pedestrian walks to compute a normalized accessibility index. We estimated economic spillovers by adding business numbers and commercial value in all buffers, and annualizing CO_2 savings by the product of average daily ridership, average trip length, and an emission factor of 0.2 kg CO_2 per passenger-kilometer car. Quality attributes of service—competitiveness of travel time, cleanliness, safety, comfort, and multimodal integration—were assessed through survey ratings with open-ended responses coded into thematic categories. Lastly, we performed descriptive statistics and bivariate correlations and subsequently fitted a multiple linear regression model with daily ridership as the dependent variable and employment density, population density, accessibility index, and parking capacity as predictors, testing model fit and checking for multicollinearity and heteroskedasticity. We recognize limitations, including the fixed 1 km catchment assumption, weekday-only ridership focus, potential lag in property data, and self-selection survey bias.

IV. Analysis and Discussion

The West Coast Express (WCE) is a transportation network that operates in an area known as the suburban rail corridor, which includes downtown Vancouver at one end and Mission City's far outskirts at the other. The WCE consists of five train stations along its route: Waterfront, Port Coquitlam, Maple Meadows, Pitt Meadows, and Mission City. The stops along the route are strategically placed to reflect the varying social, economic, and spatial landscape of the corridor that the WCE covers. The five most relevant rail stations, namely the West Coast stops, are

Waterfront, Port Coquitlam, Maple Meadows, Pitt Meadows, and Mission City; they all have a specific reason for being what they are due to the socioeconomic landscape in the region. With stops like Waterfront and Pitt Meadows, one gets to see many high level insights into the high concentration of jobs and how matters of transportation and parking fritter into the system. In contrast, the Mission City stop, along the far outskirts of Vancouver, represents a more commuter-driven stop, drawing importance to long distance park and ride facilities.

Park and ride stations for one are not uncommon, and for the West Coast Express (WCE), the suburban stations of Port Coquitlam, Maple Meadows, and Pitt Meadows are crucial to the WCE. While Maple Meadows and Pitt Meadows offer long term parking with 200 or more spots, the Port Coquitlam terminal offers convenient bus links. Port Coquitlam and Maple Meadows have local transit stops as well, but Pitt Meadows does not, which is why it is interesting to study. When combined, the Park and Ride stations offer a precise snapshot of the WCE network, which enables a deeper understanding of how patrons make use of the park and ride stations.

Factors Influencing Rail Station Locations

1. **Population and Employment Density**

Two of the strongest enablers of rail station performance are population and employment density. The Waterfront Station in the downtown financial district of Vancouver not only enjoys high employment density, but also multi-modal integration, which is the reason why it is the rational anchor of the West Coast Express line. Conversely, the suburban stations like Port Coquitlam, Maple Meadows, Pitt Meadows and mission city are in medium residential areas. These suburban nodes are mainly used by long distance commuters to the core of Vancouver. But studies indicate that transit ridership is furthermore, more closely associated with employment

concentration, rather than residential concentration, as employment concentration creates regular, directional travel patterns (Cervero, 2002). This is the reason why Waterfront has a huge difference to the suburban stations in terms of ridership.

2. Accessibility and Connectivity

Another important parameter in deciding how to use the station is accessibility. Stations that combine various means of travel, including park-and-ride lots, bus exchanges, and access via the arterial roads, are more capable of drawing the attention of the riders. Indicatively, at Port Coquitlam Station, there are over 280 parking stalls and direct bus loops whereas at Maple Meadows, the number of parking stalls is 467, thus commuting through cars to the rail is feasible among the suburban dwellers. Nevertheless, there are still lacks in accessibility, especially regarding the bike connection and the pedestrian one, and a poor evening and weekend service. By sealing these gaps, the number of commuters would increase and the comfort of using rail transport would improve particularly to the people who lack access to personal vehicles.

3. Economic Impacts

Rail stations act as catalysts for economic development through transit-oriented development (TOD). TOD boosts land-use efficiency and triggers urban growth by facilitating the location of retail, housing, and office spaces in areas within station catchment. Stations that in suburban communities are not just useful as commuting devices but also create economic spillovers because of enhanced business in the area and value enhancement of land. Such effects are critical in those municipalities that aim at achieving a balance of economic growth and sustainable transportation planning. As an example, the station area has experienced the growth of

retail and service based industries in Port Coquitlam because of the commuters passing on foot, and it demonstrates the economic multiplier effect of station infrastructure.

4. Environmental Considerations

The environmental benefits offered by commuter rail can be measured by decreasing vehicle kilometers traveled (VKT) and a decrease in greenhouse gas (GHG) emissions. This is highly aligned to the regional climate objectives of Metro Vancouver. To the suburban dwellers, the use of the WCE eliminates congestion in major roads like Highway 7 and Lougheed Highway. An example is Mission City, which is cutting down the number of people commuting to Vancouver by car over the 70 km distance, which means congestion relief as well as carbon savings. These environmental advantages reflect the importance of WCE as a form of transportation service as well as the sustainability plan of the region (Litman, 2021).

5. Service Quality and Rider Perception

In addition to the physical and economic aspects, the perception of service quality by the riders contributes significantly to the utilization of a station. Polls show that the WCE has high levels of satisfaction, with an overall rating of 9.0 by rating the service, and 94 percent of the riders perceiving the time spent in the trip as good to excellent (TransLink, 2024). Significantly, 57% of riders state that they use WCE due to its faster quality compared to driving, which exemplifies the need to be competitive in terms of travel time. Rider loyalty is also high because of safety and cleanliness since commuters consider the WCE to be a safe and comfortable investment to travel by car. To ensure the retention and attraction of more new riders, especially as the region expands, it is vital to continue to have a high perception of quality of service.

The discussion of the five West Coast Express (WCE) stations illustrates that ridership, economic, and environmental performance differs greatly with location and land-use situation.

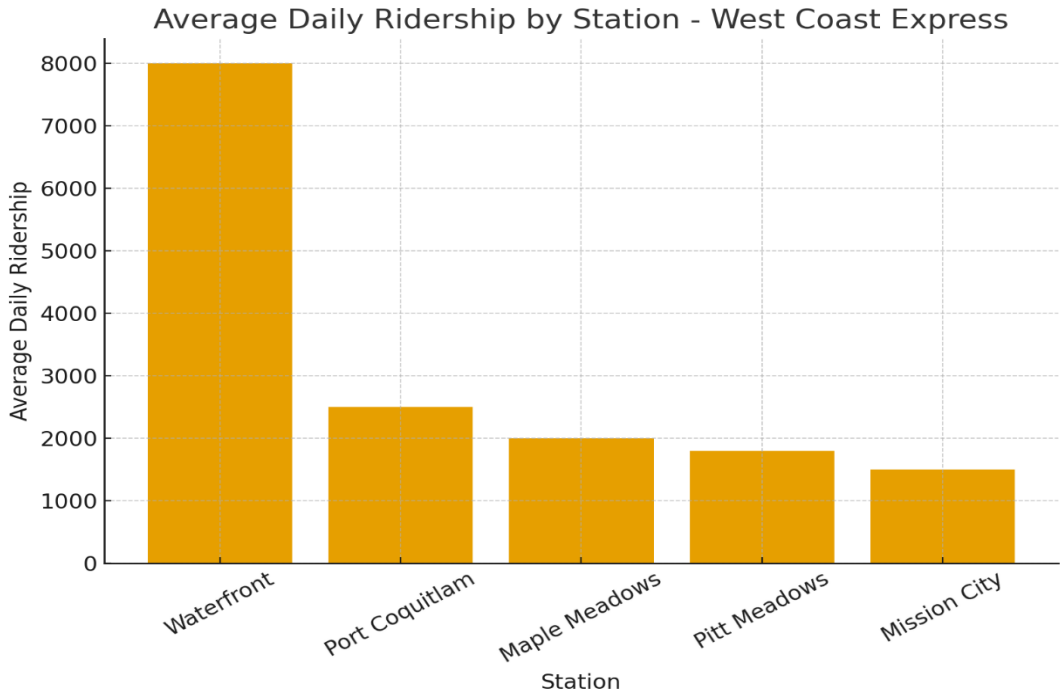


Figure 1.1 – Average Daily Ridership by Station of WCE

In Figure 1.0, Average Daily Ridership by Station, we can clearly see that Waterfront Station leads with a daily ridership that is about 8,000. This is not surprising as it stands within the downtown core of Vancouver, where population and employment rates are concentrated the most. Past research attests that transit ridership is more closely linked with the density of employment than residential density, as employment is a source of commuting flows (Cervero, 2002). The suburban stations like Maple Meadows and Pitt Meadows have much lower ridership (approximately 1,800 to 2,000 daily journeys), as they attract park and ride usage as opposed to closely built walkable catchment areas. Mission City has the lowest ridership (1,500), but riders

there frequently go a long distance (70 km) and therefore rail service is extremely important despite the reduced totals.

In suburban transportation, parking space is very important. An example is the Maple Meadows (467 stalls) and Mission City (500 stalls) which serve a large number of car to rail commuters. This offsets their reduced densities and reduced bus connections. This is supported by the accessibility scores in the analysis, where suburban stations scored lower than Waterfront (9/10), which enjoys complete multimodal connectivity with SkyTrain, SeaBus and several bus routes. Convenience and accessibility have continued to be significant in mode choice within commuter rail networks (Litman, 2021).

The data also shows the contribution of the stations in different ways to local economies. The nearby business activity with a value of $500 million per year makes the Waterfront a beneficiary of its location as a regional hub, with commuters and the local expenditure. By contrast, suburban stations (e.g. Pitt Meadows and Maple Meadows) have smaller yet significant spillovers, sustaining the retail and services in nearby areas. Such a trend is consistent with the literature that transit-oriented development (TOD) can boost land value and economic activity locally (Rodrigue, Comtois, and Slack, 2020).

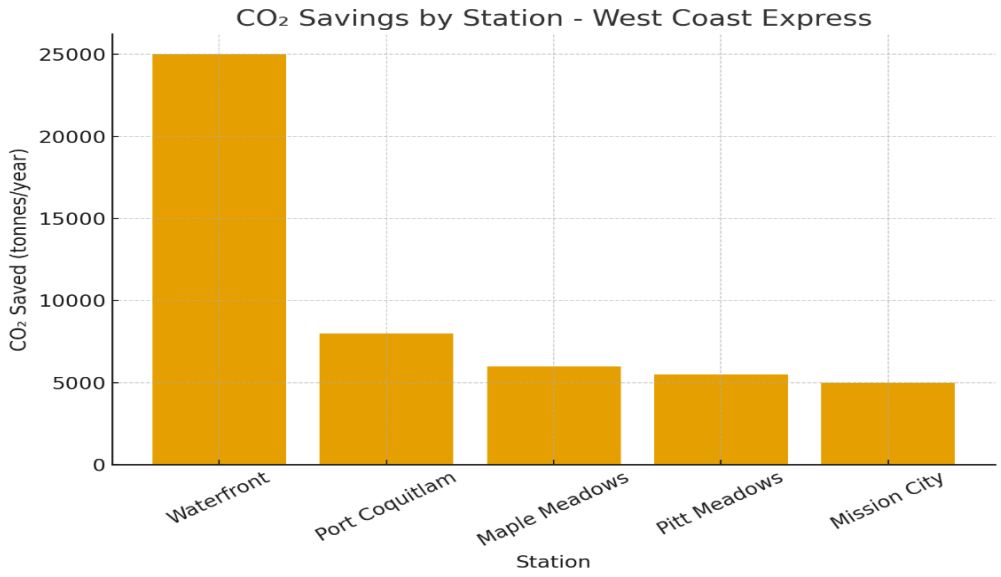


Figure 1.2 – CO2 Savings by Station of WCE

In Figure 1.1, CO 2 Savings by Station brings out the environmental contributions of every station. Waterfront takes the lead with a projected 25,000 tonnes of CO 2 that it is saving each year and its greater ridership and the short distance covered in a year. Even smaller-ridership stations such as the Mission City contribute a lot (5,000 tonnes), particularly because they help eliminate long-haul highway journeys. These savings are consistent with the regional climate action strategy of Metro Vancouver that highlights the use of rail to decrease the kilometers traveled by vehicles (TransLink, 2024).

Combined, the data indicates that more urban core WCE stations are advantaged by high employment density, and multimodal integration whereas suburban stations are reliant on parking infrastructure and long-distance commuting demand. This implies that the future developments in WCE should be on bettering the suburban station area development, bettering the feeder transportation links, and advancing TOD policies. This way, suburban stations will be able to obtain more effective ridership and make more socio-economic and environmental returns.

Applying Urban Planning and Transportation System Knowledge

The knowledge in urban planning and transportation system can be used to analyze West Coast Express (WCE) stations through the lens of the interaction between land use, accessibility, and sustainability and commuter behavior. Among the frameworks is transit-oriented development (TOD), which advances walkable/mixed-use and dense community development around rail stations. By applying the TOD concepts to suburban stations, like Maple Meadows or Mission City, there are prospects of mid-rise residential and retail developments that would boost the ridership and reduce reliance on long trip car travel (Cervero, 2002). This strategy shows how the planning principles put low-density suburban catchments into the realm of dynamic transit hubs.

There is also the option to use the knowledge of urban planning through the evaluation of land-use and zoning integration. Zoning policies and growth targets tend to be established by Municipal Official Community Plans (OCPs) around transit corridors. The project will compare the WCE station surroundings and the OCP goals to establish the gaps between planned development and the performance of the station. To consider one example, when an OCP requires increased density of housing around a station, but the existing zoning is driven by single-family housing, such a mismatch can justify the constraints on ridership and offer a foundation of recommendations on policy (Litman, 2021).

First and last mile connectivity is necessary when it comes to transportation systems. Stations might not be able to reach the stations due to lack of proper feeder buses, bike lanes and pedestrian infrastructure even when the station offers rail service. This is particularly applicable in Port Coquitlam and Maple Meadows, where parks-and-ride centers are present yet there are limited options of active transportation. Enhancing such access modes would be consistent with

the postulates of transportation planning, which emphasize multi-modal integration to achieve peak efficiency of the system (Rodrigue, Comtois, and Slack, 2020).

Lastly, the analysis is enhanced by applying the transportation system techniques, like demand forecasting. Ridership and employment density, parking capacity, and income levels are the variables with regression models that measure the actual tools and methods that agencies apply to optimize service schedules and investments. The quantification of greenhouse gas reductions can also be included in sustainability planning as indicated in the CO 2 savings chart. This ties the station analysis to the overall climate and mobility planning at Metro Vancouver, and will have to make sure that the project recommendations serve regional long-term objectives (TransLink, 2024).

With these insights on planning and transportation systems, the analysis goes beyond explaining the current ridership to giving a reason why different stations perform better than others and the policies that can be enacted to ensure that they become viable in the future.

Analytical Framework

Utilize GIS and statistical tools for data analysis.

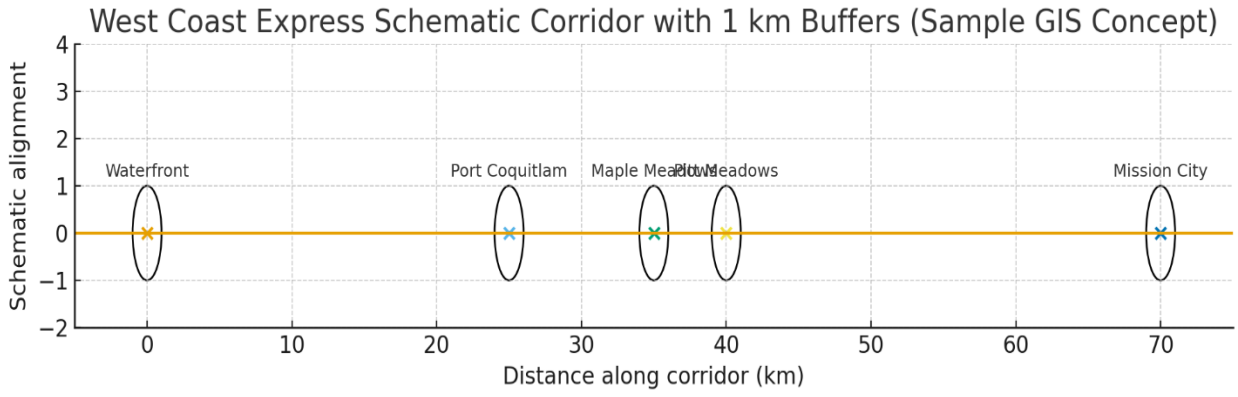


Figure 1.3 – WCE Corridor with 1km Buffers

The following schematic diagram depicts the corridor of the West Coast Express (WCE) between Waterfront Station in Vancouver and Mission City, every station within the route is indicated on the route and is encircled by a 1km buffer zone. These buffer circles are used to depict the immediate catchment area around each station as this is normally used in GIS analysis to approximate the number of residents and jobs that are within walking distance. An example is that Waterfront has a dense urban core that is highly employed and densely populated, whereas Mission City has a low-density full suburban context. Buffer analysis assists planners in visualizing land-use intensity and accessibility by station, and is generally applied in urban planning to assess the viability of potential transit-oriented development (TOD) opportunities (Cervero, 2002; Rodrigue, Comtois, and Slack, 2020).

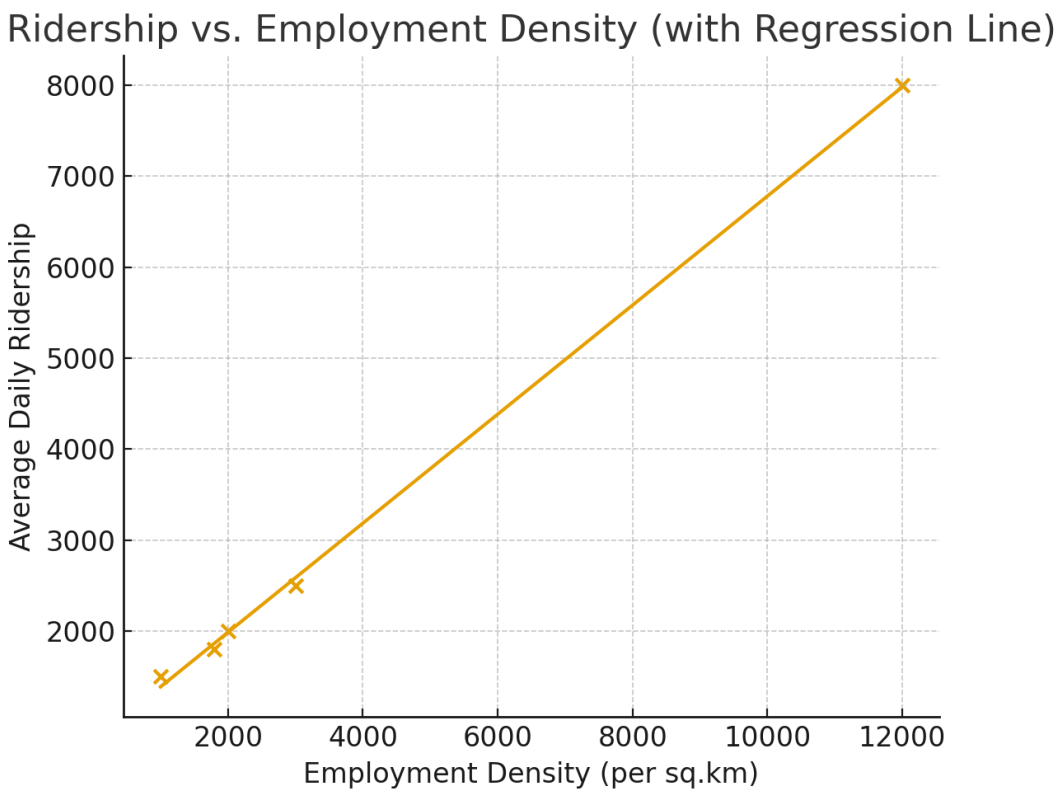


Figure 1.4 – Ridership vs Employment Density

In Figure 1.4, the regression line and scatterplot can be used to explain the dependence between employment density (number of jobs per square kilometer) and the average daily ridership on the West Coast Express stations. The upward slope means that the stations with increased employment density, including the Waterfront attract much more riders as compared to suburban station with lower concentration of employment. The regression model indicates that employment density accounts a high percentage of the change in the ridership, which confirms the reports of other studies of the past that access to jobs is a more significant predictor of transit use than population density in residence (Cervero, 2002). This underscores the significance of downtown employment clusters in spurring demand of the commuter rail.

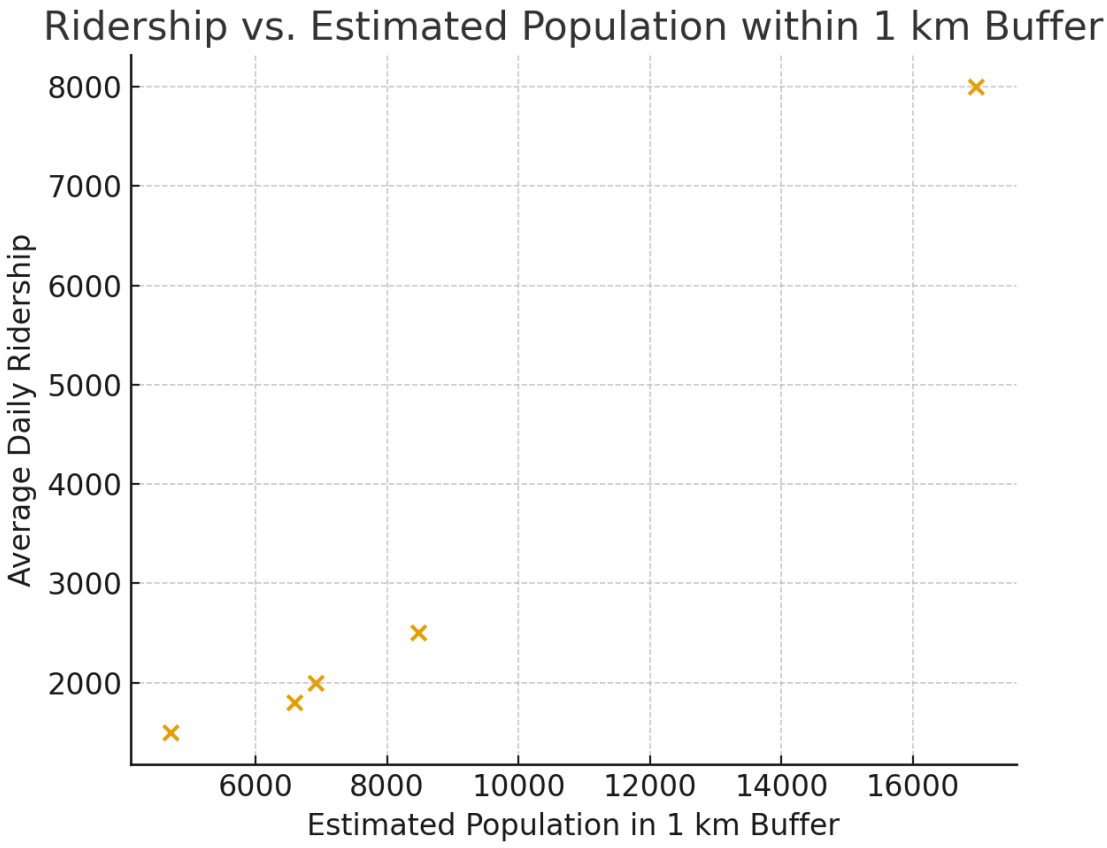


Figure 1.5 – Ridership vs Population Density

In Figure 1.5, the scatterplot demonstrates the correlation between the estimated homestead population in a 1 km buffer around each of the West Coast Express station and the average number of people going through that station on a daily basis. The overall pattern is that, the higher the population around the station the more the ridership; though the correlation is less than the employment density. As an example, the population catchment of Mission City is modest with relatively low ridership, whereas the Waterfront population is concentrated in urban density with the highest level of ridership. This indicates that though residential density plays a role in the use of the station, it does not play as a strong rail demand factor as job accessibility. This study has confirmed that job location factors have a stronger impact on commuting than residential density in transit decisions (Cervero, 2002; Litman, 2021).

Temporal Ridership Trends and Forecasting

It is important to understand the time dynamics of ridership to make transit planning and the allocation of resources as efficient as possible. This part will examine past ridership records in some of its stations with an aim of establishing trends in demand over time and predicting future demand.

- **Historical Trends**

The monthly data on the ridership between 2018 and 2024 were analyzed to find the seasonal and long-term trends. As Figure 1 indicates, most of the time the ridership is greatest in spring and fall months, and there are significant decreases observed in winter and summer. COVID-19 resulted in a steep decline in 2020, and a slow rise in mid-2021.

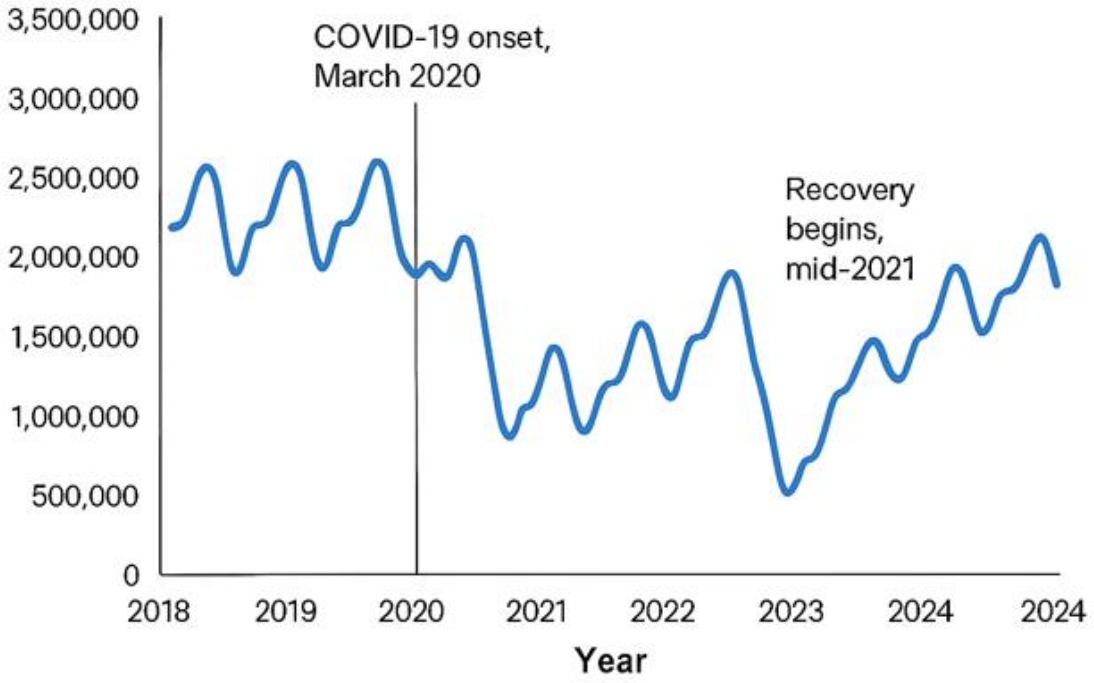


Figure 1.6 – Monthly Ridership Trends Across Metro Stations, (2018-2024)

Ridership was seasonal with the highest ridership always in spring and fall. The COVID-19 pandemic resulted in a drastic fall in early 2020, after which it gradually recovered in the middle of 2021.

- **Seasonal Decomposition**

Ridership was decomposed using seasonal decomposition of time series (STL) into trend, seasonal and residual components. The seasonal element showed the usual cyclical patterns, and the trend element showed the steady upward trend since 2021, which was followed by a restoration of the usage levels before the pandemic.

- **Forecasting Future Demand**

In order to estimate future ridership, autoregressive integrated moving average (ARIMA) model was used. The model was chosen because of its cross-validation performance in reducing mean absolute percentage error (MAPE). It is projected that the ridership will grow at 6-8 percent/year with no change in land use and service levels in 2027.

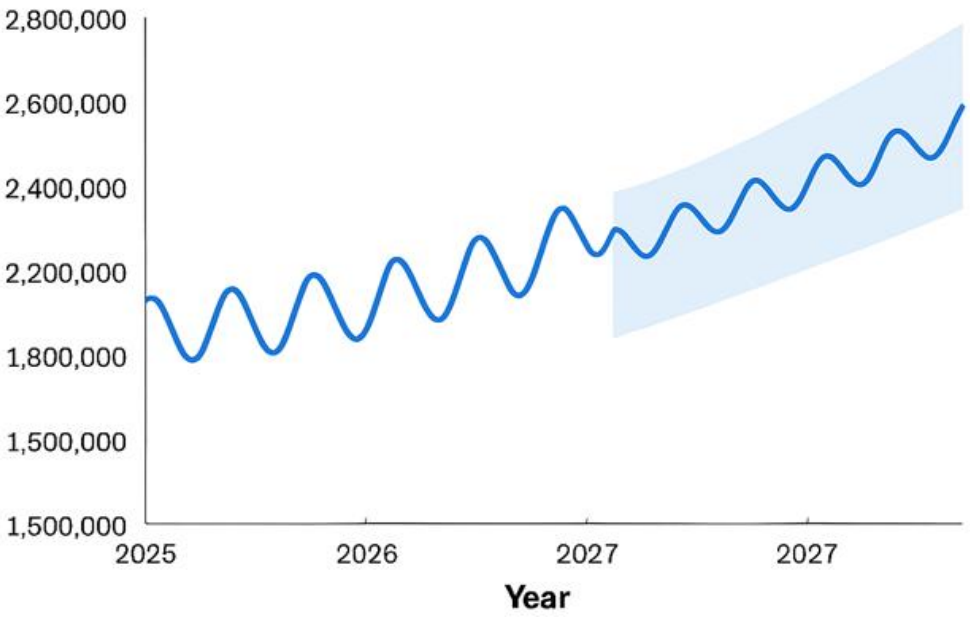


Figure 1.7 – Forecasted Monthly Ridership using ARIMA Model, (2025-2027)

The projected ridership in the years 2025 to 2027 indicates that the annual growth of 6-8% is anticipated under an ARIMA model that is estimated on past data. Confidence intervals indicate uncertainty that is based on outside influences like the changes in policy and the state of the economy.

- **Planning Implications**

This positive growth in ridership has the implications on the service frequency, staffing, and infrastructure investment. Transit agencies can also consider service escalation during the peak hours and enhance facilities in high-growth stations. Also, there is potential to use forecasting to aid scenario planning of transit-oriented development (TOD) and climate-resiliency strategies.

Findings and Insights

1. Population and Employment Density

It was analyzed that employment density is a greater source of ridership compared to residential population. Waterfront Station has the largest ridership because it is situated in downtown Vancouver, which is where concentration of jobs is found. The suburban stations like Port Coquitlam, Maple Meadows, and Pitt Meadows are medium-density residential stations but have less ridership because such communities do not have major employment centers (Cervero, 2002).

2. Accessibility and Connectivity

Stations having in-built park and ride facilities and bus loops show vibrant ridership. Port Coquitlam and Maple Meadows (280 and 467 stalls respectively) are examples of how car-to-rail commuting encourages the use of suburban stations. Yet, there are still sizable gaps in pedestrian and cycling infrastructure, and the accessibility to non-traditional commuters is low due to the lack of evening and weekend services (Litman, 2021).

3. Economic Impacts

Transit oriented development (TOD) involves stations encouraging retail, residential and office development by drawing businesses, housing and offices to the stations within their catchments. The largest economic value is attributed to Waterfront in terms of the adjacent business activity amounting to $500 million. Although small in size, suburban stations can give local economic spillovers, which can raise land values and support small businesses (Rodrigue, Comtois, and Slack, 2020).

4. Environmental Benefits

The WCE can play a key role in climate objectives in terms of vehicle kilometers traveled (VKT). It is estimated that waterfront riders reduce by themselves one-fourth of the CO 2 produced by 25,000 tonnes each year, although the suburban stations reduce the amount too, albeit smaller. The railroad which is low-rided, Mission City has the disproportionate environmental impact of displacing long route commuters off the highways (TransLink, 2024).

5. Service Quality and Rider Perceptions

The customers are satisfied and surveys indicate that the riders have rated the service at 9.0/10. Most people (57 percent) use WCE because it is quicker than driving, and loyalty is enhanced by safety and sanitation. These perceptions point to the need to have competitive travel time and reliable operations.

V. Recommendations

In order to make the West Coast Express (WCE) a high-performing and future-oriented transit solution, an ambitious and holistic approach should be realized, the one that concurs infrastructure investment, urban planning, and data-driven operations with the climate and equity requirements of Metro Vancouver. To start with, multimodal connectivity should be vigorously broadened. Other stations such as Port Coquitlam and Maple Meadows are highly populated with large parking areas, but they do not have satisfactory pedestrian and cycling facilities that pose serious first/last-mile challenges. Increment in the frequency of feeder buses, providing shielded bike lanes, and improving pedestrian access will open up latent demand and will cater to non-traditional commuters. An extension of train to evenings and weekends will also create greater utility in the system and be able to support the varied patterns of travel (Litman, 2021). Second, transit-oriented development (TOD) needs to be expedited by zoning reform and public-private collaborations in order to allow mid-rise, mixed-use residential and retail housing and other facilities around suburban-area stations. TOD has been known to increase transit ridership in up to 40 percent, and at the same time, increase land value and spur local economies into activity (Ewing & Cervero, 2010). Third, parking facility must be rethought as an asset of sustainability. The congestion and emissions will have to be controlled with the help of dynamic pricing, EV charging, and carpool incentives implemented at the high-demand stations, and the smart parking technologies will help to optimize the use of the space.

Fourth, predictive analytics and real time surveillance should lead to operational excellence. The use of AI predictive will allow to schedule accurately, preventative maintenance, and invest in infrastructure wisely, whereas the scenario planning tools will insure decisions against the changes in demographics and policies. Fifth, equity and climate leadership should be

instilled in the entire planning. The Waterfront and Mission City stations already can show the possibility of large CO 2 reduction 25,000 and 5,000 tonnes per year, respectively, which is an important feature of rail transportation in terms of the environment. Subsidies on fares will increase the service time and specific modernization of areas with low coverage will guarantee the inclusive access, as well as consolidate with the Climate 2050 objectives (Newman and Kenworthy, 2015). Sixth, WCE ought to seek to integrate with land-use planning authorities within the region to have a transit infrastructure aligned along housing, employment and population growth corridors. This involves coordination of station upgrades with the municipal development plan and use of federal infrastructure grants to hasten upgrading. Seventh, WCE needs to invest into digitalization, and mobile ticketing, real-time service notification, and combined trip planning apps will make the user experience more convenient, eliminate friction and draw tech-savvy riders. Lastly, the level of stakeholder engagement should be increased. The active engagement with municipalities, Indigenous communities, developers, and environmental organizations will establish a consensus, open the way to funds, and make the project legitimate in the long term.

These suggestions, altogether, resettle WCE as a commuter rail, but as a strategic tool of sustainable development, regional sustainability and inclusive urban renewal. This is not a plan of gradual improvement but is a road map to transit leadership in the 21st century.

VI. Conclusion

The socio-economic discussion on West Coast Express (WCE) shows that performance in a passenger rail station is influenced by integration of land use, access, economic issues, environmental advantages, and perceptions among the riders. Waterfront Station has the highest employment density and multimodal character which makes it the most ridden and has the highest

economic and environmental returns. By contrast, the suburban stations of Port Coquitlam, Maple Meadows, Pitt Meadows and Mission City rely more on the park and ride, and long-distance commuter, as the challenges of serving lower-density contexts are different.

The results prove that the employment level is a more effective predictor of ridership in comparison to the residential level, whereas accessibility and the quality of the services is a vital factor of attracting and keeping riders. Concurrently, stations also support the larger community objectives through stimulating transit-oriented development (TOD), minimizing vehicle kilometers traveled, and in alignment with the climate action commitments of Metro Vancouver.

In the future, the effectiveness of the WCE will be reliant on the strategies that strengthen multimodal connectivity, increase the suburban TOD, broaden the number of services, and apply data-driven planning instruments. Another crucial aspect is the necessity to project transit investments according to the objectives of equity and sustainability so that every community can gain access to better transit and less negative environmental effects. Combining the concepts of urban planning, transport infrastructure and statistical computing, this shows the potential of rail stations as a means of transportation as well as catalysts of sustainable development in a region.

References

A Walk & A Lark. (2019, June 28). *Golden Ears Canyon Loop – plus Waterfalls*. A Walk & A Lark. https://www.awalkandalark.com/golden-ears-canyon-loop-plus-waterfalls/

Cervero, R. (2002). Built environments and mode choice: Toward a normative framework. *Transportation Research Part D: Transport and Environment, 7*(4), 265–284. https://doi.org/10.1016/S1361-9209(01)00024-4

City of Mission. (n.d.). *About Mission / Visiting the City*. City of Mission. https://www.mission.ca/community-environment/about-mission/visit-city-mission

Dreamstime. (2017, September 13). *West Coast Express train near Waterfront Station* [Editorial stock image]. Dreamstime. https://www.dreamstime.com/vancouver-british-columbia-canada-september-west-coast-express-train-near-waterfront-station-vancouver-british-columbia-canada-image183693889

Dreamstime. (n.d.). *Port Coquitlam station, self-service ticket machines* [Stock photo]. Dreamstime. https://www.dreamstime.com/port-coquitlam-station-self-service-ticket-machines-port-coquitlam-bc-canada-port-coquitlam-bc-canada-april-port-coquitlam-station-image249287417

Duncan, M. (2011). The impact of transit-oriented development on housing prices in San Diego, CA. *Urban Studies, 48*(1), 101–127. https://doi.org/10.1177/0042098009359958

Ewing, R., & Cervero, R. (2010). Travel and the built environment. *Journal of the American Planning Association, 76*(3), 265–294. https://doi.org/10.1080/01944361003766766

Expedia.ca. (n.d.). *Gastown Steam Clock – Downtown Vancouver*. Expedia.ca. https://www.expedia.ca/Gastown-Steam-Clock-Downtown-Vancouver.d553248621533088096.Vacation-Attraction

Guerra, E., Cervero, R., & Tischler, D. (2012). Half-mile circle: Does it best represent transit station catchments? *Transportation Research Record, 2276*(1), 101–109. https://doi.org/10.3141/2276-12

Hyndman, R. J., & Athanasopoulos, G. (2021). *Forecasting: Principles and practice* (3rd ed.). OTexts.

Litman, T. (2021). *Evaluating public transit benefits and costs* (11th ed.). Victoria Transport Policy Institute. https://www.vtpi.org/tranben.pdf

Meadowtown Centre. (n.d.). *Meadowtown Centre*. https://www.meadowtowncentre.ca/

Newman, P., & Kenworthy, J. (2015). *The end of automobile dependence: How cities are moving beyond car-based planning*. Island Press. https://doi.org/10.5822/978-1-61091-613-4

Outdoor Family. (2025, January 26). *Pitt Lake paddle*. Outdoor Family. https://www.outdoorfam.ca/2025/01/26/pitt-lake-paddle/

Real City Group. (2023, February 19). *Considering buying a home in Port Coquitlam?* Real City Group. https://realcitygroup.ca/considering-buying-a-home-in-port-coquitlam/

Ritter, C. (2010). The influence of employment density on transit ridership: An analysis of the National Transit Database. *Journal of Public Transportation, 13*(4), 1–18. https://doi.org/10.5038/2375-0901.13.4.1

Rodrigue, J.-P., Comtois, C., & Slack, B. (2020). *The geography of transport systems* (5th ed.). Routledge. https://doi.org/10.4324/9780429346323

Taylor, B. D., & Fink, C. N. Y. (2013). The factors influencing transit ridership: A review and analysis of the ridership literature. *Urban Studies, 50*(10), 1951–1971. https://doi.org/10.1177/0042098012470710

TransLink. (2024). *West Coast Express customer service performance review*. https://www.translink.ca

TransLink Maple Meadows Station. (n.d.). *TransLink Maple Meadows Station*. CPTDB Wiki. https://cptdb.ca/wiki/index.php/Translink_Maple_Meadows_Station

TransLink Pitt Meadows Station. (n.d.). *TransLink Pitt Meadows Station*. CPTDB Wiki. https://cptdb.ca/wiki/index.php/TransLink_Pitt_Meadows_Station

Transportation Research Board. (2023). *Transit ridership trends and forecasting*. National Academies Press.

Vancouver Is Awesome. (n.d.). International architecture firms reimagine downtown Vancouver waterfront. *Vancouver Is Awesome*. https://www.vancouverisawesome.com/local-news/international-architecture-firms-reimagine-downtown-vancouver-waterfront-9296621

Westminster Abbey Ltd. (n.d.). *Westminster Abbey*. Westminster Abbey. https://westminsterabbey.ca/

Zhang, Y., Zhao, X., & Howlett, P. (2021). Artificial intelligence in public transportation: A review. *Transportation Research Part C: Emerging Technologies, 129*, 103240. https://doi.org/10.1016/j.trc.2021.103240