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Summary

Vancouver city, as a North American city, has faced a rise in its active modes of transport share in recent years, as a result of implementing the Green Transport plan. One of the targets of this plan was to "Make the majority of trips (over 50%) by foot, bicycle, and public transit" by 2020. Several instruments were implemented to achieve this target. As a result, in 2019, the share of walking, cycling, and public transportation reached 54%, which is 4% more than the target value (City of Vancouver, 2020c). While the City of Vancouver has been successful in achieving its transportation target, it is not clear how each implemented instrument influences this achievement. There is a lack of empirical study on how to explain the meaningful instrument implementation in practice towards a successful green transportation system. In this study, four instruments including transportation safety, network expansion, greenways, and bicycle sharing program were selected to explain their influence on the achieved target. So, this study aims to explain the extent to which the transportation safety, network expansion, greenways and bicycle sharing program developed by the Vancouver city municipality has influenced the achievement of the proposed green transport target. This explanatory research was conducted by collecting and analysing both qualitative and quantitative data, through semi-structured interviews, questionnaires, and secondary data.

The findings of the research conclude that not all of the studied measures have been fully implemented in the studied area. Transportation safety measures still require improvements and in the studied period, they have slightly influenced the achievement of the target. This is while the multiple regression coefficient of this variable is not significant, which highlights the most limiting factor of this study, the small sample size. Expanding the network in Downtown and West End Vancouver, has also been influential in achieving the green transport target, although the cycling network is still under further developments. The greenways have influenced the achievement of the target positively, but their main function as recreational destinations must be taken into account. The bicycle sharing programs had a moderate influence on the achievement of the target, however, the statistical findings do not confirm this finding, as they are biased by the low sample size. To conclude, the identified instruments influence the achievement of the target by 14%, highlighting the existence of external influential variables, and the moderate influence of the studied variables.

Keywords

Green Transport, Transportation safety, Network expansion, Greenways, Bicycle sharing program,

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Abbreviations

IHS	Institute for Housing and Urban Development Studies
AAA	All Ages and Abilities
NMT	Non-Motorized Transport
TOD	Transit-Oriented Development

Table of Contents

List of Figures

List of Tables

Chapter 1 : Introduction

1.1 Background Information

Cities are home to more than half of the world's population (Steinberg & Lindfield, 2012). The rapid urbanization in the 20th century impacted urban forms based on motorized vehicles movement. So, transportation in cities is now dependent on fossil fuels. The motorized vehicle travels, make residents more vulnerable to diseases, exposes them to poor air quality, and makes them less physically active. It is also worth mentioning that 70% of the global greenhouse gas emissions are emitted from cities (Steinberg & Lindfield, 2012).

With the rapid growth of the urban population, the transportation demand increases. This growing demand could force cities to provide more motorized vehicle infrastructure. But the urban landscape is limited, and citizens are aware of the environmental hazards and adverse effects of traffic congestion caused by motorized vehicles. Notably, urban transport contributes to 33% of total urban carbon emissions (Wright, 2012). Such problems put policymakers under pressure to reconsider the transportation system to create a shift in transportation mode share. So, several long-term and short-term solutions, concepts and theories emerge.

One of the solutions is the green transport concept, which focuses on non-motorized transport and public transport (Faherty & Morrissey, 2014). It aims to reduce the environmental impact of the transport sector. In general, this concept provides the infrastructure for Non-Motorized Transport (NMT), while prohibiting or restricting motorized vehicle usage (Wright, 2012). It includes several dimensions and requires implementing different policies and measures. Non-motorized transport is mainly defined by walking or cycling between urban destinations. Non-motorized modes of transport could also be used as a part of a daily trip to public transit stations.

To implement the green transport concept, an adjustment in citizens behaviour is required. Providing adequate and safe infrastructure, setting regulations for green modes of transport, connectivity, and expansion of the green transport network, and making the green modes of transport more convenient and attractive by utilizing new technologies could lead to a shift to green transportation modes. To achieve a significant change in travel behaviour, all dimensions of green transportation must be taken into account, including land use, integrated transport system, quality of transport infrastructure, and advanced technologies (Bongardt, Breithaupt, & Creutzig, 2011).

In this regard, various instruments are being implemented in cities. These include the extension of the walking and cycling network and enhancing its safety, encouraging people of all ages and abilities to walk and cycle, bicycle-sharing programs, car-free areas or days, and building high-quality public spaces, such as greenways, for promoting walking and cycling. However, since the transportation field is related to different fields of urban planning, it is not clear which instrument contributes more to a shift in citizens behaviour towards green modes of transport.

1.2 Problem Statement

Vancouver city's plan, developed in the 19th and 20th centuries, was based on private motorized vehicles and low-density housing. However, the city has a long history of shifting to greener solutions. Since the 1970s, the city has been a pioneer in taking traffic calming actions and shifting to greener modes of transport (City of Vancouver, 2010).

The former transportation plans of Vancouver addressed different aspects, i.e., land use, walking and cycling network, and promoting non-motorized transport strategies. So, the integration of the plans resulted in increased walking and cycling rates, with 3% cycling and 27% walking in 2005. However, to address the gaps, make use of new technologies and approaches, and increase the share of green transport modes, a new plan was required.

In 2009 the Vancouver city initiated the "greenest city 2020 action plan", intending to make Vancouver the greenest city in the world by 2020. This plan is in line with the target of making at least two-thirds of the trips on foot, bike or by transit in 2040. The focus of this study is on the green transport field, with the goal to "Make walking, cycling and public transit preferred transportation options". To clarify the transportation goal, two targets were defined (City of Vancouver, 2020a):

1. "Make the majority of trips (over 50%) by foot, bicycle, and public transit" by 2020.
2. "Reduce distance driven per resident by 20% from 2007 levels" by 2020.

The active transportation budget was allocated to this goal. Also, the municipality and its partners were allowed to use up to 2% of the Capital Budget for active transport corridor and sports improvement. This made the total budget approximately equal to $150,000 annually (City of Vancouver, 2016a). The municipality of Vancouver in partnership with Translink, HUB cycling, and Better Environmentally Sound Transportation (B.E.S.T) worked towards achieving the green transport goal (City of Vancouver, 2021c).

The targets were achieved in the proposed time frame. But the focus of this study is the first target. To reach this target, several instruments were implemented. The selected instruments are:

- Transportation safety:

The municipality believes that by improving road safety, more people are encouraged to walk or cycle, especially children and the elderly. In the long-term plan, the Vancouver municipality's goal is to reach zero traffic-related fatalities by 2050 (City of Vancouver, 2015a). In this regard, the number of cyclists involved in crashes decreased to 970 in 2020, from 1500 in 2015 ((Insurance Corporation of British Columbia), 2021). Reaching this number has been done by:

  - Speed limit:
    A speed limit of 30 km/hr in bike routes and 40 km/hr on non-arterial streets was implemented (City of Vancouver, 2009) (City of Vancouver, 2015b).
  - All Ages and Abilities (AAA) guideline:
    The AAA guideline defines rules, regulations, and design guidelines to make cycling convenient and safe for all ages and abilities, through improving cycling routes based on the guideline (City of Vancouver, 2017a). In 2019 approximately 25% of the cycling routes were classified as AAA (HUB Cycling & TransLink, 2020).

- Network expansion:

The cycling and walking network was extended to improve connectivity. The cycling network was 370 km long in 2015 (City of Vancouver, 2015c) and expanded to 710 km (HUB Cycling & TransLink, 2020). It was planned to build six new bikeways in the Mainland area, and upgrade four existing routes (City of Vancouver, 2015a). By 2020, three of the cycling routes was utilized and four existing got upgraded (City of Vancouver, 2020d).

- Greenways:

Greenways are urban corridors with greenery that serve multiple purposes, including mobility between inner-city destinations (Wright, 2012). Vancouver city's greenway network plan states that the greenway network must be within 25 minutes of walk or 10 minutes of cycling from every resident (City of Vancouver, 2013). To reach this objective in downtown Vancouver, two greenways were built till 2020. The Comox-Helmcken Greenway is an east-west connection in downtown Vancouver. Section 1 of this project was completed and section 2 is under construction (City of Vancouver, n.d.-a). The seaside Greenway, which is a 28km walking and cycling route, crossing all along with central Vancouver was built (City of Vancouver, n.d.-b).

- Bicycle sharing programs:

To encourage citizens to cycle, a bicycle sharing program has been developed by the municipality. The Mobi bicycle sharing app was developed in 2016 and expanded its service areas in the coming years. The plan envisioned providing 2000 bicycles and 200 stations which were utilized by 2020 (City of Vancouver, 2021a) (Vancouver Bike Share Inc, 2021b).

Implementing the instruments resulted in the achievement of the first green transport target, in the proposed timeframe. In 2019, the share of walking, cycling, and public transit reached 54%, which is 4% more than the target value (City of Vancouver, 2020c). Vancouver now is well-known as the greenest city in Canada and one of the greenest cities in the world.

While the City of Vancouver has been successful in achieving its transportation target, it is not clear how each implemented instrument influences this achievement. There is a lack of empirical study on how to explain the meaningful instrument implementation in practice towards a successful green transportation system. Although Vancouver City has been monitoring transportation changes through panel surveys (McElhanney Ltd. & Mustel Research Group, 2020), implementation of the instruments and tracking their progress is not done in relation to the transportation monitoring, leading to unclear evidence on transportation trends. This study tries to explain the influence of the selected implemented instruments on the achieved target. Several other instruments of the green transport plan are not taken into consideration in this study. Instead, the influence of the selected instruments on the plan is highlighted. The selected instruments are related to walking and cycling modes, so public transport mode is not discussed in this study. Furthermore, the external factors influencing this study are recognized, however, they are not taken into consideration. An example of the external factors is the climatic condition which could adversely affect the safety of pedestrians and cyclists.

1.3 Relevance of the research topic

The City of Vancouver had developed several plans in the past 50 years to make a shift in the transportation behaviour of the residents. The most recently finished plan, the greenest city action plan, was successful in achieving its green transport target. This achievement has been done by implementing several instruments and taking various actions. The City of Vancouver has monitored the progress of each instrument but there is no evaluation done to see how each instrument influences the target. This could be problematic for the future plans of the city, as the emphasized instruments in the plan might not lead to the expected outcome. So, this study expands knowledge on green transport instruments in the area. Elaborating the impact of the selected instruments highlights how they are effective and addresses the distinct gaps of the plan, namely the expected change in the green transportation share after implementation of the instruments.

From an academic perspective, the majority of studies focus on the relationship between land use and population density on transportation trends. This is while other green transport instruments are widely implemented globally. So, the findings of this study provide insight into transportation safety, network expansion, greenways, and bicycle sharing instruments, which require more attention.

It is worth mentioning that this research is limited to the transportation instruments in the Downtown Vancouver neighbourhood. So, the provided insights are mainly based on North American downtown areas.

1.4 Research Objective

This study aims to explain the extent to which the transportation safety, network expansion, greenways and bicycle sharing program developed by the Vancouver city municipality has influenced the achievement of the proposed green transport target.

Green Transport target: Making the majority of trips (over 50%) by foot, bicycle, and public transit by 2020.

1.5Main Research Question and Research Sub-Questions

Main Research Question:

To what extent the transportation safety, network expansion, greenways and bicycle sharing program developed by the Vancouver city municipality has influenced the achievement of the proposed green transport target in Downtown Vancouver?

Variables and Sub-Variables:

Transportation safety (variable) is composed of two sub-variables:

- *Speed limit*
- *AAA guideline*

Sub-Questions:

- How do the speed limit and AAA guideline influence the achievement of the proposed green transport target?
- How does network expansion influence the achievement of the proposed green transport target?
- How do greenways influence the achievement of the proposed green transport target?
- How does creating a bicycle sharing program influence the achievement of the proposed green transport target?

Chapter 2 : Theory Review

2.1 Introduction

The urban transportation sector has a wide impact on the greenhouse gas emissions of a city, noting that motorized vehicles contribute to 25% of fossil-based CO_2 emissions. Within the rapid rate of urbanization and the increasing transportation demand, different transportation strategies are implemented in cities. However, the limited urban land resources and concerning environmental issues, highlight the need for greener transport systems (Wright, 2012) (Faherty & Morrissey, 2014).

In this study, the green transport concept was adapted to explain the increase in non-motorized transport trips. Four green transport instruments are identified and further studied in the following sections, including transportation safety, network expansion, greenways, and bicycle sharing program. Transportation safety consists of two sub-variables, i.e., speed limit and AAA guideline. This chapter provides the theoretical background of the mentioned variables and sub-variables.

The last section of this chapter is the conceptual framework which shows the relationship between the variables.

2.2 Green Transport

In this study, the green transport concept is adapted. It is the underlying concept of the target of the Vancouver green transport plan and its implemented instruments. This concept aims to reduce the environmental impact of the transport sector. In general, it provides the infrastructure for non-motorized transport, while prohibiting or restricting motorized vehicle usage (Wright, 2012). It includes several dimensions and requires implementing different policies and measures.

The green city concept emerged, as the rate of urbanization and the number of motorized vehicles rapidly rose in cities, resulting in poor air quality, road accidents, congestion, and several other issues. To highlight, it is estimated that the transport sector will be the world's largest greenhouse gas emitter in 2035 (Wright, 2012).

On the other hand, the need for urban transportation is increasing, as the urban population rapidly increases. Cities have various solutions for answering this demand. One solution is providing more infrastructure for private motorized vehicles; however, this solution adversely affects the environment and is not popular in today's modern society. Also, cities have limited land resources. So, the second and the more environmentally friendly solution is creating the infrastructure for greener modes of transport, namely walking, cycling and public transport (Wright, 2012) (Faherty & Morrissey, 2014).

In this regard, the green city concept concentrates on improving people's movements by non-motorized transport, efficient public transport, compactness and connectivity (Brilhante & Klaas, 2018). The green transportation instruments make cities car-free or implement restricting regulations for car use. It provides the infrastructure for non-motorized transport. Non-motorized transport is mainly defined by walking or cycling between urban destinations or for reaching public transit stations (Wright, 2012). Green transportation elements are divided into four categories, as follows (Bongardt, Breithaupt and Creutzig, 2011) (Brilhante and Klaas, 2018):

- Mixed-use lands that provide shopping and leisure amenities close to people
- Integrated long-distance public transportation system to the city centre that is accessible and affordable

- Good quality public transport integrated with non-motorized transport infrastructure as alternatives to private vehicle
- Advanced alternative fuel technologies

To move from a motorized vehicle transport mode to green transport, an alteration in citizens' behaviour is needed (Vogl, 2012). Changes in the transportation system, such as improving transport conditions, safety, and technology change human behaviour (Goldman & Gorham, 2006). But it is not possible to ban motorized vehicle usage in an instant and make cities car-free. So gradual steps are taken to start the shift from motorized vehicles, as shown in Figure 2.1. Restricting private vehicle movements and implementing speed control are the initial steps. Traffic calming and shared space strategies, firstly implemented in the Netherlands in the 1970s, are innovative strategies that improve pedestrian safety and remind the residents that streets are public spaces and do not only belong to automobiles. The strategy engages drivers with their surroundings by removing traffic signs and priorities in shared urban spaces (Wright, 2012). Creating shared spaces in cities where cars, pedestrians, and cyclists coexist equally brings safety, improves traffic, makes social interaction possible, and encourages active transportation modes (Goldman & Gorham, 2006).

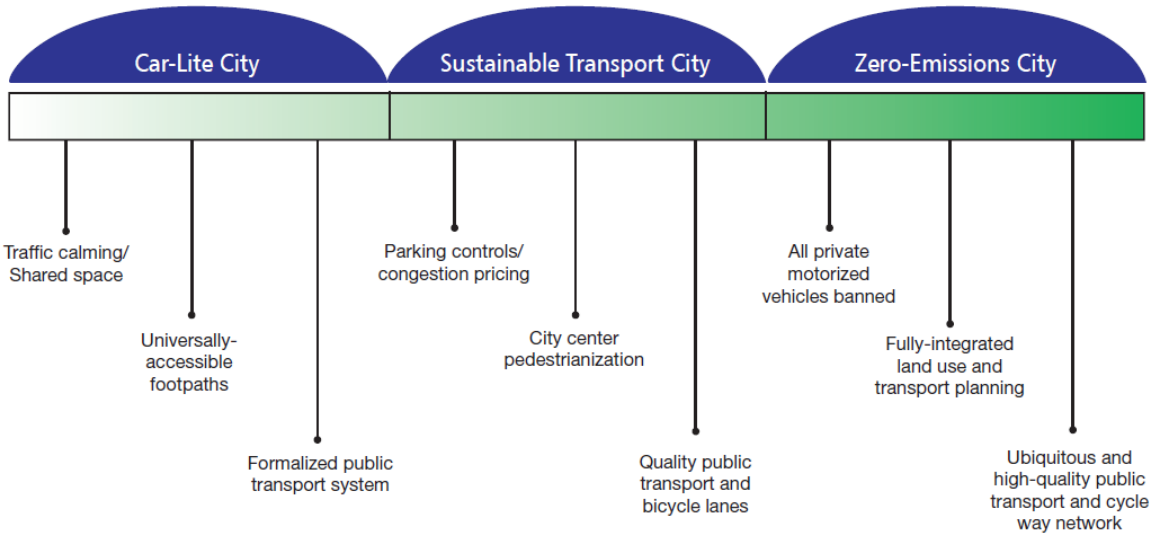

Figure 2.1 - Possible transportation strategies spectrum to reach the green transport target (Wright, 2012)

In the next steps, to move towards green transport car-free days are events that remind citizens of other modes of transport. It gives the chance to see what cities look like in the near future. Also, car-free housing provides a living environment without noise and less pollution where children can play without the fear of accidents. These communities are usually built around accessible public transportation systems and bicycle paths (Wright, 2012).

In short, as mentioned before, several different actions and instruments in various dimensions contribute to improvements in NMT share. These instruments consist of a wide range of factors, related to different urban fields. In the following, these instruments are explained.

2.3 Green transport Instruments

To reach the green transport target and minimize the carbon emissions from the transport sector, actions must be taken in all dimensions simultaneously (Bongardt et al., 2011). The avoid-shift-improve formula explains the need to avoid lengthy trips, to shift to cleaner modes of transport, and to improve the energy efficiency of the modes of transport (Steinberg & Lindfield, 2012) (Bongardt et al., 2011).

- Avoid
  The first priority is implementing the avoid strategies in which information and communication technologies and land use policies are improved to reduce or avoid travel. Solutions such as the Transit-Oriented Development (TOD), defined as commercial and residential investment around public transport stations, that reduces trip lengths and eliminates trips are developed to avoid trips (Wright, 2012).
- Shift
  Shifting to cleaner modes of transport could be done through managing transport demand and using public transport or non-motorized transport (NMT) (Bongardt et al., 2011). Public transport systems could be a more environmentally friendly alternative to private vehicles. But a series of measures are needed to make them become car competitive, including an integrated network, enhanced and convenient stations, and a proper fare collection system. NMTs, on the other hand, are essential modes of transport, especially for reaching the public transport system. They are economically viable transport options. Non-motorized vehicles make trips shorter compared to walking. Improving pavements, providing street lighting, providing security, improving amenities such as street furniture and public toilets, safe crossings, and wayfinding information could increase the number of pedestrians and cyclists. Car-free and pedestrianized streets also encourage people to walk and create a shift in transportation modes (Wright, 2012).
- Improve
  Improve strategies include transportation management and control, switching to other fuels and improving vehicle design, and setting regulations and standards, such as speed limits (Bongardt et al., 2011) (Wright, 2012).

The literature provides three approaches for a greener transport system, this study mainly focuses on the shift approach. As mentioned above, the shift approach consists of several instruments. Transportation safety, network expansion, greenways, and bicycle sharing programs are the instruments selected in this study and will be further explained in the following sections.

2.3.1 Transportation Safety

Road accidents are responsible for a great number of human and material losses. Approximately 1.3 million fatalities and 50 million injuries and disabilities are a result of road accidents each year. This is while pedestrians and cyclists are more vulnerable to vehicle accidents since they are less protected, compared to motorized vehicle drivers. Inadequate safety and comfort in non-motorized transport and public transport services result in more private-vehicle usage and ownership (Wright, 2012). In this regard, transportation safety is the safety of roads to reduce accidents and make residents feel safe. In this study, transportation safety is studied as one of the measures taken to make transportation green.

Many diverse factors, make walking and cycling uncomfortable and unsafe, including lack of pedestrian pavements, poor pavement quality, no physical separation for high levels of traffic and high-speed traffic, noise and air pollution, no infrastructure for crossing streets and intersections, obstructed pavements, lack of street lighting, lack of protection for climatic conditions, pedestrian overcrowding, and high levels of crime (Wright, 2012). So, action needs to be taken to address these issues. Setting speed limits, building separate bicycle and pedestrian lanes, installing traffic signals are some of the suggested actions in the literature (Hail & McQuaid, 2021) (Bongardt et al., 2011). Two transportation safety instruments, i.e., speed limits and AAA guideline, are further explained in the following.

- Speed limit

Speed limit measures restrict motorized vehicle movement. This can be done through implementing different regulations or strategies, such as designing low-speed zones or installing speed bumps (Wright, 2012). Based on a study conducted in London, by implementing 32 km/hr speed zones, the number of pedestrians who were killed or seriously injured was reduced by 34.8%. This regulation was more beneficial for children between 0-15 years, as it decreased the chance of collisions leading to fatality or serious injury by 44%. Another study on New Delhi showed that pedestrian incidents decreased after installing rumble strips (Boase et al., 2018). Studies also show that implementing speed limits makes streets more pleasant for pedestrians and cyclists and enhances their level of safety (Canterbury District Health Board, 2016).

- AAA guideline
  The AAA guideline highlights the importance of providing cycling routes safe for all ages and abilities. Scholars believe that transport policies are fair if they reduce inequality by prioritizing vulnerable groups and making roads safe for all citizens. The vulnerable groups include the elderly, people with disabilities, ethnic minorities, children, women, and financially disadvantaged people (Hail & McQuaid, 2021).
  Women's travel pattern differs from men and women are at higher risk of being the victim of crime or violence. Studies show that women are more concerned with injury while using active transport modes (Marolda, Dupont, & West, 2014), and they avoid dark and quiet streets (City of Sydney & C40 Cities, 2020), highlighting the need for gender-sensitive transportation planning (Kebeck, Mark, & Bonn, 2017). This is while women use the active modes of transport more than men. So, social control is needed in designing safe walking and cycling paths (Marolda et al., 2014).
  To make walking and cycling safe for all ages and abilities, various actions could be taken. Based on the literature some of these actions include: adding street lighting, making crossings and intersections safe, separating cycling and walking lanes from car lanes, and providing high-quality roads and pavements (Kebeck et al., 2017) (Hail & McQuaid, 2021).

2.3.2 Network Expansion

To enable the shift to green modes of transport, a network of walking and cycling routes is required. Based on the literature, network expansion refers to the linear extension of the walking or cycling network and could be measured in meters or kilometres (Houde, Apparicio, & Séguin, 2018). Different approaches are defined for extending the networks, some focus on the connectivity of the network, while others focus on reducing the travel time and adding redundant routes (Natera Orozco, Battiston, Iñiguez, & Szell, 2020). Extending the cycling network, increases the accessibility of different parts of a city, minimizing the inequality caused in low-accessible areas that could lead to problems such as low employment rate in low access areas. Residents access the network more easily when they spend less time reaching it (Hail & McQuaid, 2021).

To measure the network expansion, the length of the cycling network per square kilometre of the surface area for the studied area could be calculated. Also, the length of the cycling network divided by the road network length gives an overview of the network extension (Houde et al., 2018).

Another indicator, related to network expansion is connectivity. The more the network is connected, the lower the travel time is. Also, a high quality integrated network connects different parts of the city (Houde et al., 2018).

2.3.3 Greenway

Greenways are pedestrianized corridors with green landscapes. In many cities, they are routes to key inner-city destinations. NMTs, including bicycles, non-motorized tricycles, carts, pedicabs, etc., are allowed in most of the greenways (Wright, 2012). Urban greening in the greenways, including shadow trees, lakes and rivers, encourages walking and cycling, rises the number of people using the greenways and the frequency of each person's visit (Bongardt et al., 2011). So, based on the literature, easily reachable greenways, are instruments for promoting non-motorized transport.

To study greenways, the distance of the citizens with the greenways, or the time they spend reaching it, indicate how accessible they are. The world health organization recommends building 9 square meters per capita green spaces that are within 15 minutes of walking distance from residents (Steinberg & Lindfield, 2012). A Study states that residents that have a distance of 300 m or lower to a greenway are more likely to use the greenway for utilitarian (transport) cycling, highlighting the recreational function of greenways for other residents (Frank, Hong, & Ngo, 2021).

2.3.4 Bicycle Sharing

Bicycle sharing programs provide bicycles for people who are not willing to invest in bicycles, thus extending bicycle usage (Wright, 2012). They were first implemented in the Netherlands in 1965 and are getting upgraded with rapidly changing technology (Hail & McQuaid, 2021). The scholars state that the advantages of the sharing programs could be a commitment to more sustainable transport modes, increasing public awareness of the benefits of cycling, and providing equal transportation to disadvantaged communities (Hail & McQuaid, 2021). The mentioned advantages are in line with the dependent variable of this study.

Bike-sharing programs have different regulations and fare prices. Some need monthly subscriptions and membership. Others could be paid based on distance or time of travel. There are docking stations, where passengers could pick up or drop off the bike. Recent updates in the programs are making bicycles 'free-floating', allowing the users to find bicycles with a smartphone (Hail & McQuaid, 2021).

On the other hand, using shared bicycles is not equally accessible to all citizens. High fare prices and lack of knowledge to work with the bicycle sharing applications could make them less accessible to financially disadvantaged people and people with low education levels. Also, some of these programs only work with debit or credit cards, only allowing people with bank accounts to pay. Moreover, in many cases using these programs are impossible for people with children. Another barrier for some cyclists could be the size of the shared bike (Hail & McQuaid, 2021).

2.4 Conceptual Framework

This study focuses on instruments implemented to promote walking and cycling modes of transport in Downtown Vancouver. The conceptual framework was prepared using the main concept of the research, that is the green transport concept, as defined by (Brilhante & Klaas, 2018) and (Wright, 2012). The conceptual framework, as shown in Figure 2.2, is comprised of two parts: the causes (independent variables) and the problem (dependent variable). The independent variables are each used to explain the dependent variable. Several other independent factors might explain the dependent variable, however, in this study, only four are selected.

The independent variables are transportation safety, network expansion, greenways, and the bicycle-sharing program. It is worth mentioning that the sub-variables of the first variable are

speed limit and AAA guideline. The dependent variable is the achievement of the proposed green transport target.

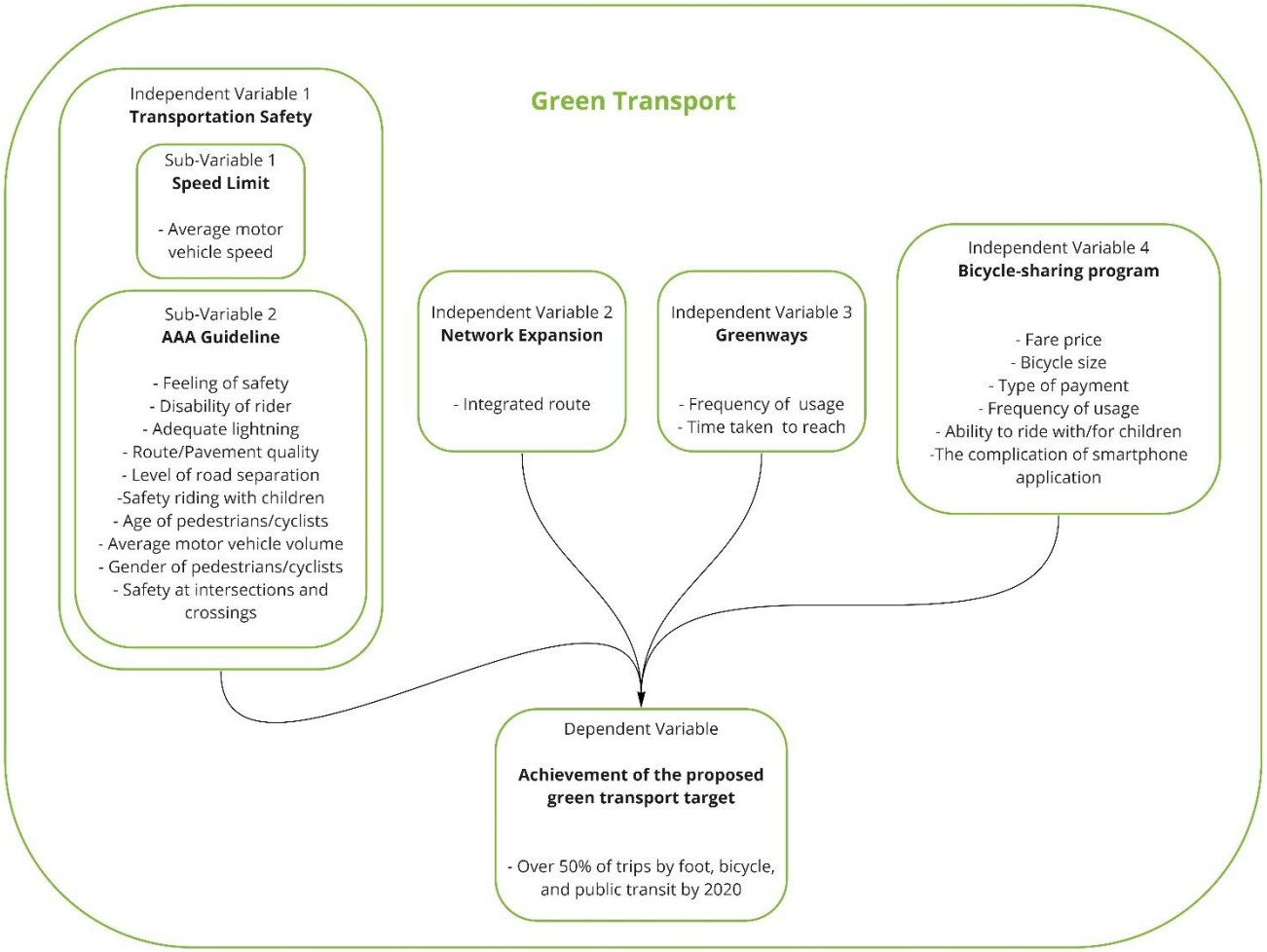

Figure 2.2 – Conceptual Framework

Chapter 3 : Research Design and Methods

Chapter 3 starts with the definition of the proposed concept, variables, and sub-variables. Then the variables and sub-variables are operationalized into measurable indicators. It describes the employed research type and strategy in detail. In addition, the data collection methods, the selected research instruments and approaches, and the sample and its size are explained. The challenges of conducting the research in terms of validity and reliability, and how the challenges were addressed is also explained. The last part focuses on data analysis methods.

3.1 Operationalization

3.1.1 Definition of Theory, Variables, and Indicators

Green Transport Concept

The Green Transport concept, adapted from (Wright, 2012) is defined as making cities car-free or implementing restricting regulations for car use. Green transportation provides the infrastructure for non-motorized transport.

Transportation safety (Independent Variable)

Transportation safety as defined by (Wright, 2012) is the safety of roads to reduce accidents and make residents feel safe. In this study, safety refers to the safety of pedestrians and cyclists.

Speed Limit (Independent Sub-Variable)

The speed limit measures are measures that restrict motorized vehicle movement. This can be done through implementing different regulations or strategies (Wright, 2012).

AAA guideline (Independent Sub-Variable)

A guideline that was developed for the City of Vancouver for identifying cycling routes that are safe, convenient, and comfortable for all ages and abilities (City of Vancouver, 2017a).

Network Expansion (Independent Variable)

The network expansion refers to the measured linear extension of the walking or cycling network in Kilometres (Houde et al., 2018), making the walking and cycling paths of the city connected in a network.

Greenways (Independent Variable)

Greenways, routes to inner-city destinations, are pedestrianized corridors with green landscapes (Wright, 2012).

Bicycle sharing program (Independent Variable)

Bicycle sharing programs provide bicycles for people who are not willing to invest in bicycles, thus extending bicycle usage (Wright, 2012)

Green Transport Target One (Dependent Variable)

The first target of the green transportation plan is to “Make the majority of trips (over 50%) by foot, bicycle, and public transit” by 2020 (City of Vancouver, 2020a).

3.1.2 Operationalization

Table 3.1 - Operationalization table

Concept/ Theory	Variable	Sub- Variable	Indicator	Data Type/ Analysis	Data Collection Method	Data Source
Green Transport	Transportation safety	Speed limit	Average motor vehicle speed	Quantitative & Qualitative	Documents Questionnaire Interviews	City of Vancouver Residents Experts
		AAA guideline	Age of pedestrians/cyclists	Quantitative & Qualitative	Documents Questionnaire Interviews	City of Vancouver Residents Experts
			Gender of pedestrians/cyclists	Quantitative & Qualitative	Documents Questionnaire Interviews	City of Vancouver Residents Experts
			Safety riding with children	Quantitative & Qualitative	Questionnaire Interviews	Residents Experts
			Disability of rider	Quantitative & Qualitative	Questionnaire Interviews	Residents Experts
			Average motor vehicle volume	Quantitative & Qualitative	Documents Questionnaire Interviews	City of Vancouver Residents Experts
			Safety at intersections and crossings	Quantitative & Qualitative	Documents Questionnaire Interviews	City of Vancouver Residents Experts
			Feeling of safety	Quantitative & Qualitative	Documents Questionnaire Interviews	City of Vancouver Residents Experts
			Route/Pavement quality	Quantitative & Qualitative	Documents Questionnaire Interviews	City of Vancouver Residents Experts
			Level of road separation	Quantitative & Qualitative	Documents Questionnaire Interviews	City of Vancouver Residents Experts
			Adequate lightning	Quantitative & Qualitative	Questionnaire Interviews	Residents Experts
Green Transport	Network Expansion		Integrated route	Quantitative & Qualitative	Questionnaire Interviews Documents	Residents Experts City of Vancouver
Green Transport	Greenways		Frequency of usage	Quantitative & Qualitative	Questionnaire Interviews	Residents Experts
			Time taken to reach	Quantitative & Qualitative	Questionnaire Interviews	Residents Experts
Green Transport	Bicycle sharing programs		Fare price	Quantitative & Qualitative	Documents Questionnaire Interviews	City of Vancouver Residents Experts
			Type of payment	Quantitative & Qualitative	Documents Questionnaire Interviews	City of Vancouver Residents Experts
			Frequency of usage	Quantitative & Qualitative	Documents Questionnaire Interviews	City of Vancouver Residents Experts
			Bicycle size	Quantitative & Qualitative	Documents Questionnaire Interviews	City of Vancouver Residents Experts
			Ability to ride with/for children	Quantitative & Qualitative	Documents Questionnaire Interviews	City of Vancouver Residents Experts
			The complication of the smartphone application	Quantitative & Qualitative	Documents Questionnaire Interviews	City of Vancouver Residents Experts

Green Transport	Achievement of the proposed green transport target	Over 50% of trips by foot, bicycle, and public transit by 2020	Quantitative	Questionnaire Interviews Documents	Residents Experts City of Vancouver

3.3 Research Type and Strategy

This is explanatory research as it explains the influence of selected green transport instruments in the achievement of the green transport target. It identifies the extent to which the implementation of the selected instruments results in the achievement of the proposed target.

The nature of the selected topic resulted in selecting a single case study with a focus on Downtown and West End neighbourhoods in Vancouver, Canada. The case study method is a suitable strategy for this research since it enables conducting an in-depth analysis of the case and the influence of the selected four instruments on the achieved target. Also, the study is context-based. Only one case study is selected because the green transport plan was implemented only in Vancouver. Utilizing the case study method for a real-life phenomenon results in improving the solutions to similar problems. If the same plan gets implemented in other locations, it will generate different results. However, it helps in identifying influential instruments in implementing green transport plans in cities (van Thiel, 2014).

3.4 Data Collection and Sampling Instruments

Questionnaires

To obtain data from the residents of Downtown and West End Vancouver, online questionnaires were prepared. Vancouver residents were asked in community social media to answer the questionnaire. The questions are based on the operationalization table. They are mainly close-ended questions on a Likert scale. Collecting data through the questionnaires, made cross-referencing the findings possible. The first part of the questionnaire consists of general questions. In the second part, questions about transportation safety are asked on a Likert scale. Part 3 and 4 focus on network expansion and greenways. The last part's questions are about the bicycle sharing program and must be answered on a Likert scale. A copy of the questionnaires can be found in Annex 1.

Semi-Structured Interviews

The semi-structured interviews enable gathering in-depth qualitative data (van Thiel, 2014). They were conducted online, through the Zoom application, to gather information from experts involved in the planning and implementation process. The open-ended questions are based on the operationalization table. The interview manual, provided in Annex 1, gives an overview of the topic of the interview and guides the interview to obtain relevant information.

Desk Research

To complete the data collection process and enhance the validity of the study, the secondary data was collected from reports, municipal panel surveys, and reports related to the plan (van Thiel, 2014). This data provided valuable information about the planning process.

3.5 Unit of Analysis

The green transport goal was developed for Vancouver city, but this research is only conducted on the central area, which is the Downtown and West End neighbourhoods in Vancouver, Canada. Since the Downtown and West End are the central areas of the city, and

many people travel there for work or recreation, the questionnaire respondents are residents of Vancouver city. So, the research population is the residents of Vancouver and experts involved in the plan.

The studied transportation plan was issued in 2009 and its targets were set for 2020. This study focuses on the last five years of the implementation of the plan, from 2015 till the end of 2019.

3.6 Sample size and selection

Questionnaires

The research population of the questionnaire respondents is equal to the population of Vancouver residents with 18 years of age or older, which is 549,948 based on the 2019 panel survey (McElhanney Ltd. & Mustel Research Group, 2020). For questionnaires, based on probability random sampling, with 95% of confidence interval level, 5% marginal error, and 20% of population portion, based on Van Thiel, a sample size of 246 people were selected (Maple Tech. International LLC, 2021) (van Thiel, 2014). To gather the data using the random sampling approach, after preparation of the questionnaire, the questionnaire was shared in social community groups, such as the neighbourhood Facebook groups and Twitter profiles and also on community newsletters. So, the residents were able to access the online questionnaire through social media. Due to the pandemic limitations, the survey was distributed only online, so the number of respondents decreased to 66. The characteristics of the respondents are provided in Chapter 4.

Semi-Structured Interviews

The semi-structured interviews were conducted to gain in-depth information from the involved experts. The interviewees were chosen by purposive sampling. The respondents were selected from the green transport group of the greenest city action plan. The respondents were contacted through email with an interview request. The characteristics of the chosen five interviewees are listed in Table 3.2. Selecting the interviewees was limited to the experts who were working at the City of Vancouver during the time frame of this study. In addition to the listed interviewees, the Transportation Design Manager of the city of Vancouver was contacted for an interview, but due to their long-term absence, the interview did not take place.

Table 3.2 - Interview respondents' characteristics

Respondent	Department	Role
R1	Transportation Planning Branch	Active Transportation Engineering Assistant
R2	General Office	Engineering Manager
R3	Transportation Planning Branch	Transportation Planning Engineer
R4	Transportation Design Branch	Manager
R5	Transportation Division	Director

3.7 Fieldwork and Data Collection

The fieldwork of this study took place fully online, as a result of the COVID-19 pandemics. As the first step, the interview requests and questionnaire links were sent to the potential respondents. Next, the interviews were being conducted online, starting in August and ending in November. After each interview, the interview was transcribed and coded. The questionnaire data was also collected till the end of November.

3.8 Validity

Internal validity refers to the degree to which the study answers the research question. In other words, research is internally valid if the relationship between the dependent and the independent variable is clearly established, and the variables are adequately operationalized. In this study to double-check the collected data and research results, more than one research method was used. The data was collected through semi-structured interviews, questionnaires, and when possible secondary data sources. In addition, interviewing experts involved in the green transport plan that are members of different departments in the municipality, contributes to internal validity. So, internal validity was gained through data triangulation. Moreover, the variables were properly operationalized into measurable indicators based on academic literature (van Thiel, 2014).

The external validity is the degree to which the data can be generalized. Since a single case study is selected for this research and a small number of people are involved, it is challenging to generalize the results. The generated information and theoretical findings of this study could only be generalized for the selected case study within the specific context.

3.9 Reliability

Reliability refers to the extent to which the instrument is measuring what is supposed to be measured and if the study is replicable. To enhance the reliability, notes were taken of every step of the research in a log, which makes replication easier. The interview and survey questions are formulated based on the literature review and are clear. Furthermore, the data is collected from different sources, i.e. residents and experts, making triangulation possible and increasing reliability (van Thiel, 2014). In addition, to check the internal consistency of the questionnaire, a Cronbach's Alpha test was carried.

3.10 Data Analysis Methods

After conducting each interview, the interview was transcribed. Since this study is deductive research, using the Atlas.ti software, the data was coded based on the operationalization table (Table 3.1). To find relationships between the codes, the co-occurrence and network function of Atlas.ti software was used. The co-occurrence table shows how frequently the co-occurrence happens. Then the query tool was used to observe whether there is a relationship between the dependent and independent variables. The final outcome was visualized in tables.

To analyse the quantitative data collected from the questionnaires, through descriptive statistics, Excel software was used. The data was coded to generate the percentage of responses for each indicator, showing the frequency of each response. Then the mean and standard deviation of responses was calculated. To do a reliability test, the variables were analysed using the Cronbach Alpha test. The values range from 0 to 1 and values higher than or close to 0.7 are considered reliable (van Thiel, 2014). To analyse the relationship between the dependent and independent variables, inferential statistics were used. The relationship between each independent variable and the dependent variable, questioned in the sub-research questions, was analysed using Pearson correlation. To answer the main research

question multiple regression analysis was utilized. In this analysis, the value of the R-square presents the percentage of the independent variable that explains the dependent variable, if the R-square is significant at a 95% confidence interval. Lastly, the results were illustrated in graphs and tables.

Chapter 4 : Research Findings

In this chapter, the research findings are presented. In the first sections, the case and the respondents' characteristics are described. In the following sections, the collected data from the mentioned data collection methods are analysed separately for each research sub-question. In the end, the statistical analysis was conducted based on the questionnaire and interview data.

4.1 Description of the case

This research is based on the Green Transport Plan of Vancouver city, with a focus on Downtown and West End. The objective is to study the influence of the selected factors on the achievement of the proposed green transport plan target.

The transportation plan of Vancouver was first implemented in 2009. Since 2009, the walking and cycling rates have gradually increased and the target was achieved in 2014, instead of the projected year, 2020. This number reached 54% in the year 2019. Regarding this achievement, the municipality of Vancouver has constantly improved the walking and cycling conditions based on the plan. The plan covered different aspects of walking and cycling infrastructure and environment, but there is no evidence on the influence of each instrument on the target achievement. Thus, data gathered through online interviews with transportation experts and survey responses of Vancouver residents were triangulated to study each instrument.

4.2 Respondent Characteristics

4.2.1 Interview Respondents' Characteristics

As described in chapter 3, for selecting the online interviewees, purposive sampling was applied. The selected interviewees consist of the key decision-makers involved in the green transport plan in the 5-year time frame of the study, as discussed in Chapter 3. All five interviews were recorded with the consent of the respondents, and then transcribed and coded. The low number of interview respondents is due to the limitation of this study, as only experts involved in the plan during the five-year time frame of this study were contacted for interviews.

4.2.2 Questionnaire Respondents' Characteristics

For the questionnaire, the residents of Vancouver were asked to fill out the survey. First, the intention of this study was to collect responses from Downtown and West End Vancouver residents, however, during the data collection process, it was found that other Vancouver residents travel to Downtown and West End for recreational walking and cycling, and also a large portion of the population work in the studied area. Therefore, the questionnaire was shared in different neighbourhood community groups and local newsletters, as all the residents with 18 years of age or more were considered eligible for responding.

Through random sampling, 66 responses were collected. This number is lower than the projected number in Chapter 3, since, during the data collection process, the travel restrictions of the COVID-19 pandemic made it impossible for the researcher to travel to the area of the study. So, the data was collected fully online and through social media. This low number of collected responses imposes implications on the representativeness of the sample size and thus the statistical analysis.

As illustrated in figure 4.1, about half of the respondents are Downtown and West End residents. Also, 27% and 30% of the respondents are between 20-30 and 30-40, respectively. Two of the respondents preferred not to say their gender, while 41% and 53% of the

respondents claimed as female and male, respectively. Only two of the respondents belong to the non-binary/third gender group.

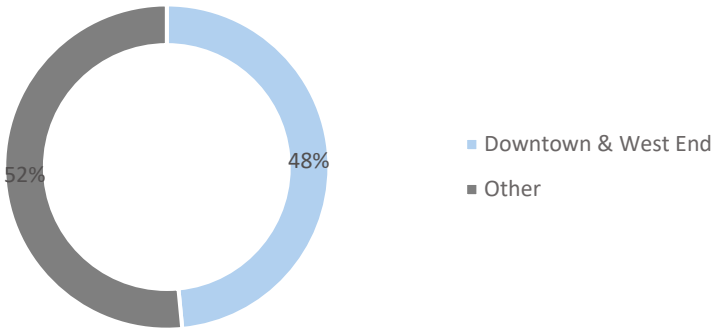

Figure 4.1 - Questionnaire respondent's place of residence. Number of respondents (N=66)

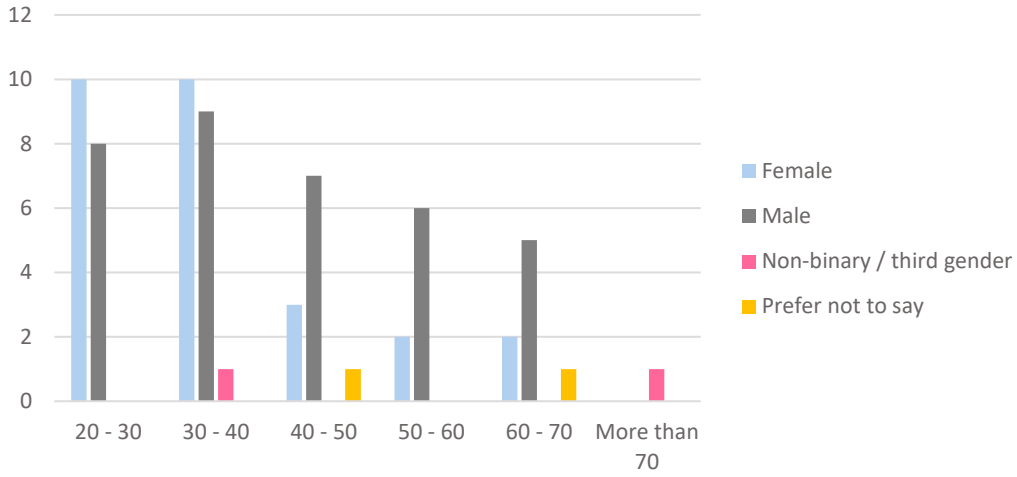

Figure 4.2 - Questionnaire respondents' age and gender. Number of respondents (N) =66

To gain a better understanding of respondents' mode of transport, their response to the frequency of usage of the active modes of transport are summarized in Figure 4.3. 67% of the respondents walk on a daily basis and about 50% cycle on a daily or weekly basis.

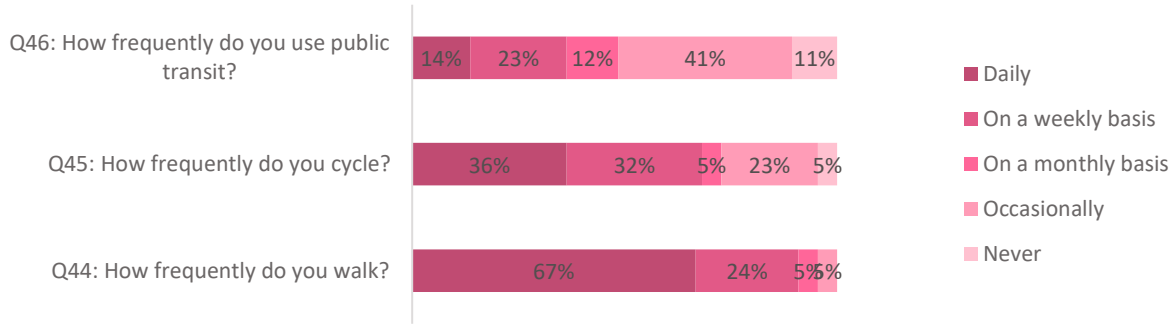

Figure 4.3 - Questionnaire respondents' transportation choice. Number of respondents (N) =66

4.3 The influence of Transportation Safety on the Achievement of the Proposed Green Transport Target

In the following parts, the results of the interviews and questionnaire are analysed for each sub-variable. First, the interview findings are summarized in tables, then the questionnaire results are analysed. To compare the results of this research with other sources, secondary data are included, when applicable. Furthermore, the results of interviews, questionnaires and secondary data are compared with the literature.

4.3.1 Sub-variable speed limit

Average motor vehicle speed

Table 4.1 - Summary of the interview response for the sub variable speed limit

Sub-variable	Indicator	Response Summary	Frequency
Speed limit	Average motor vehicle speed	Only a few streets have a 30 km/h speed limit and that is around school zones, parks, and where bikes and cars share the same road.	3
		Where implemented, the speed limit has made streets feel safer and more comfortable and thus contributed to more people cycling, but that is not the only influential factor.	5
		The geometrical constraints of the road guide drivers to lower their speed, not the traffic signs.	3
		Where bikes and cars share the same route, there is a 30 km/h speed limit.	5
		Most of the streets in Vancouver have a speed limit of 50 km/h.	5

Number of respondents (N) = 5

Three of the five interview respondents, as presented in Table 4.1, stated that the 30 km/h speed limit has only been implemented in a few streets, where there is a school, park, or there is no separate bikeway. They believe that in general, the 50 and 30 km/h speed limits are making the walking and cycling experience safer. This is while the questionnaire results show that nearly 50% of the respondents are annoyed by the speed of the cars passing, bringing about the possibility that this factor could be a barrier to walking and cycling.

The questionnaire responses in Figure 4.4 show that more than 35% of the residents were to some extent annoyed by the speed of the cars passing when cycling. This is while more than 20% of the respondents gave a neutral answer. Responses to the same question for walking depicts similar results with less than a 10% difference in the strongly agreed choice.

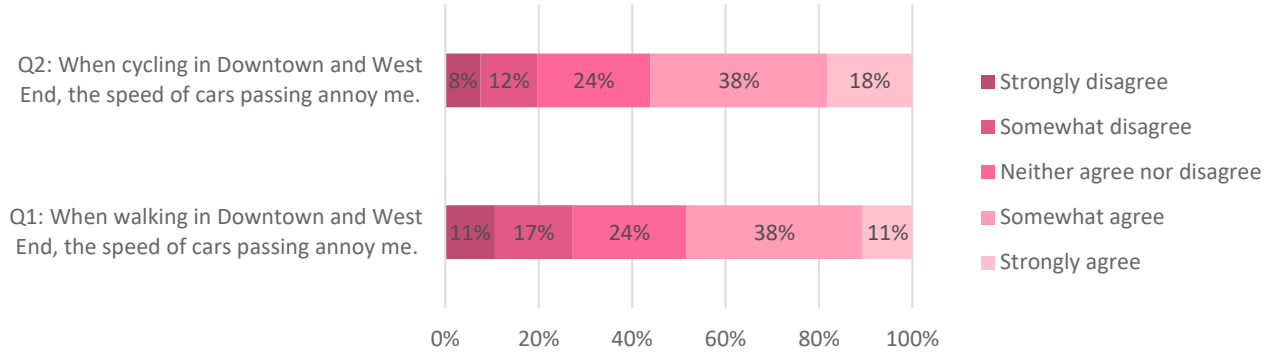

Figure 4.4 - Questionnaire results on vehicle speed. Number of respondents (N) =66

Vancouver municipality's data show that 75% of residents believe that lowering the vehicle speeds will help prioritize walking and cycling in slow streets (City of Vancouver, 2020b). Literature also indicates that the speed limiting measures shall be an integrated part of the urban design (Canterbury District Health Board, 2016), confirming Vancouver municipality's view, reflected in R2, R3 and R4 responses. The survey results show residents are still annoyed by the vehicle speed; even though the maximum speed in streets with a protected bike lane is at 50 km per hour. So, more action has to be taken to further implement the speed limits and enhance the transportation safety of pedestrians and cyclists.

4.3.2 Sub-variable AAA Guideline

Table 4.2 - Summary or the interview response for the sub variable AAA guideline

Sub-variable	Indicator	Response Summary	Frequency
AAA guideline	Age of pedestrians/cyclists	Seniors are more safety conscious, and the feedbacks and demographics show that now they are cycling more.	3
		The measures implemented to limit the speed and volume of cars passing has also contributed to more elderly cycling.	1
		With the e-bikes coming to Vancouver, there will be a boost in the number of seniors cycling.	1
	Gender of pedestrians/cyclists	Providing safe and protected (AAA) cycling routes has made more women cycle.	5
		Valuing places like day cares and schools in the network extension contributes to more women cycling.	1
		Providing adequate lighting in the cycling routes makes women feel safer.	1
	Safety riding with children	Families with their children are cycling more on the AAA bike lanes and greenways. It is not the same with the Street routes.	4
		By reducing the number of cars passing, families started cycling with their children on a specific route.	1
		By providing fully separated intersections, families are more confident to allow their	1

		children to cycle.	
		There is no parent and child tandem bike in British Columbia.	3
	Disability of rider	People with disabilities are feeling more comfortable cycling.	3
	Average motor vehicle volume	Implementing vehicle restrictions on some streets resulted in a sudden rise in the number of people cycling.	3
		The AAA guideline is still valid in Vancouver and the number of vehicle limits has not been implemented in many locations.	3
	Safety at intersections and crossings	Fully separated intersections were implemented in Vancouver, where bicycles movement is fully separated from vehicles. This has made people feel really safe.	5
		The fully protected intersections have not been implemented at every crossing in Vancouver. One of the reasons is the lack of space.	4
	Feeling of safety	General feedback from the public and also more people cycling on the AAA routes shows that people are feeling safer.	4
		People feel safe on the separated routes and Vancouver still has a long way to make all routes safe.	2
		The number of collisions is decreasing, while the number of people cycling is increasing.	1
	Route/Pavement quality	There is a priority map that shows the high-quality routes.	2
		The cycling routes in Downtown and West End are in good shape.	2
		Quality and safety go hand in hand.	1
	Level of road separation	The fully separated routes have allowed elderlies and children to cycle.	3
		Not all the routes are separated. It is important to increase the number of places people can reach on a separate route.	3
		Separating walking routes from cycling routes has made the sidewalks safer for people with disabilities.	1
	Adequate lightning	In some parts of the Downtown and West End routes the lighting has been improved, but there is a plan to upgrade it to LED lightning in the near future.	3
		The contribution of lighting to safety is being studied in Vancouver.	1

Number of respondents (N) =5

Age of pedestrians/cyclists

Seniors are more vulnerable and safety conscious when cycling, as 3 of the 5 interviewees mention and their cycling rates have risen. Based on interviewee R1's perception, elderlies are now cycling more and lowering the volume of cars passing contributes to this rise. Also, respondent R6 believes that in the near future, e-bikes are going to contribute to a huge rise in cycling numbers, especially for seniors.

In answer to the question that "my cycling experience is not affected by my age", as shown in Figure 4.5, most of the respondents either agree or somewhat agree that their age is not affecting their cycling experience. 75% percent of the 60- to 70-year-old respondents strongly agree that their age does not affect their cycling experience.

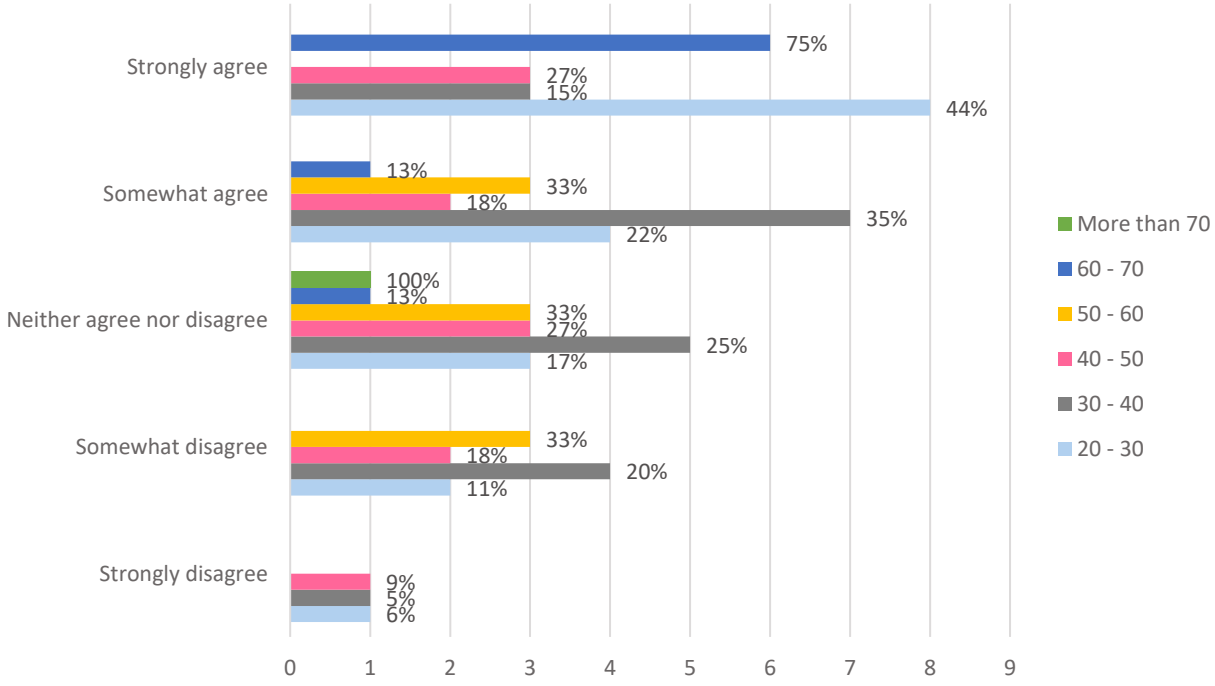

Figure 4.5 - Questionnaire results on the statement "My cycling experience is not affected by my age". Number of respondents (N) = 66

Vancouver municipality's 2019 data indicate that only 4% of people aged 65 years and more cycle (McElhanney Ltd. & Mustel Research Group, 2020). For 45 to 65 years old, this number reaches 11% (McElhanney Ltd. & Mustel Research Group, 2020), with a 4% growth from 2015 (City of Vancouver, 2015c). Studies state that cycling in North America has been dependent on age, as it is a marginal mode of transport and not safe and convenient for all ages and abilities (Pucher & Buehler, 2008). However, the experts interviewed believe that Vancouver has been successful in rising the number of elderly cycling and the studied survey sample, albeit the low number of senior respondents, also indicate the same result.

Gender of pedestrians/cyclists

All of the interviewed experts stated that the AAA guideline has improved the safety of the cycling routes, so, more women are cycling. Interviewee R3 pointed out lightning as an important factor for women cycling rates.

Figure 4.6 shows responses to the question “I believe my gender has no effect on my cycling experience”. Of the 27 female respondents, only 8 somewhat disagreed with this statement. 17 female respondents agreed or somewhat agreed with the statement.

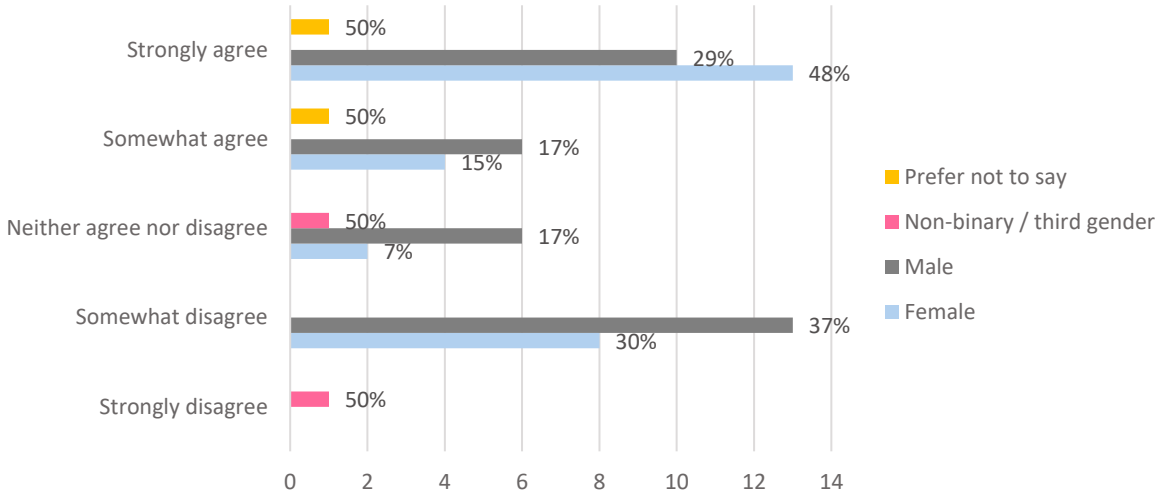

Figure 4.6 - Questionnaire results on the statement "I believe my gender has no effect on my cycling experience". Number of respondents (N) = 66

Vancouver municipality transport planning group, believe women rates of cycling as a good indicator for cycling infrastructure safety. Based on the City of Vancouver’s panel survey, 93% of the women had no safety issues and also 90% of them felt comfortable when travelling in the city. In their studied sample, 7% of women cycle and 29% walk (McElhanney Ltd. and Mustel Research Group, 2020). The questionnaire results admit that cycling in Downtown and West End is not a gendered experience in the view of most of the residents. In contrast to the panel survey, literature manifested that inadequate safety measures make women cycle less in North America (Pucher & Buehler, 2008). But the interview results indicate that women cycling rates have increased in Vancouver after improving safety and the city’s panel survey approve it, as there was a 2% rise in women’s cycling rates from 2015 to 2019, as illustrated in Figure 4.7 (McElhanney Ltd. and Mustel Research Group, 2020). It is worth noting that despite the increase in rates, the cycling rate difference between males and females is remaining the same (McElhanney Ltd. and Mustel Research Group, 2020). This gap between the rates of men and women cycling could be translated into interviewee R1’s belief that transportation planning is more male-dominated and trips to day care and schools are undervalued, as still in Canada women are dealing more with caregiving than men.

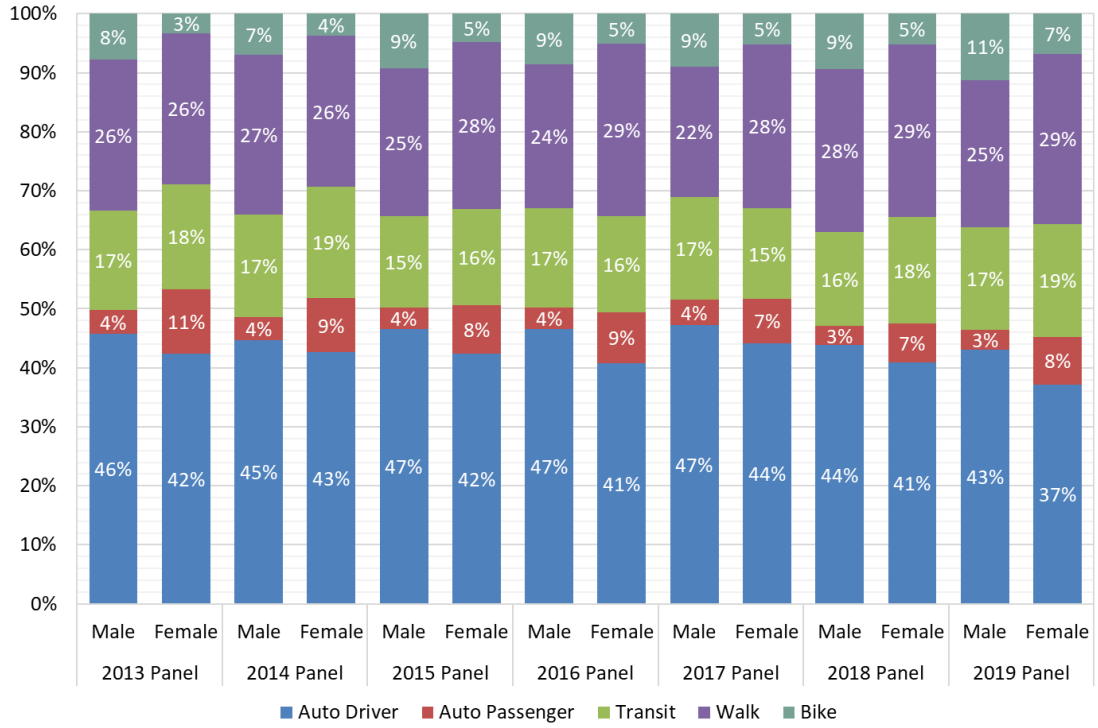

Figure 4.7 - Mode share trip by gender, from the City of Vancouver's Panel Survey. The number of respondents of the study was 2653 (McElhanney Ltd. and Mustel Research Group, 2020).

Safety riding with children

Four out of five interviewees believed that more families are now cycling in the protected bike lanes. One respondent claimed the protected intersections as a contributing factor. Another interviewee emphasized the relation between decreasing the traffic volume and more children cycling. The interview data show that there is no child and parent tandem bicycle in Vancouver. Families use cargo bikes instead to carry their kids.

From the questionnaire respondents, 14 respondents had children under the age of 18. As the questionnaire results show in Figure 4.8, more than 40% of the respondents strongly or somewhat feel unsafe when their child is cycling independently. It is not the same when they are riding with their child, as only 14% of the respondents to some extent feel unsafe.

The interviewees stated that an improvement in children cycling rates has occurred in the protected routes, but the parents answering the questionnaire deny feeling safe and comfortable when their child is cycling. This could be due to the insufficient number of protected bike routes in the area.

There is a 64% neutral answer to the question on cycling with children. This could be due to the reason that there is no parent and child tandem bike in Vancouver, as mentioned in the interviews. It is also good to note that Vancouver municipality has not been recording the rates of children cycling.

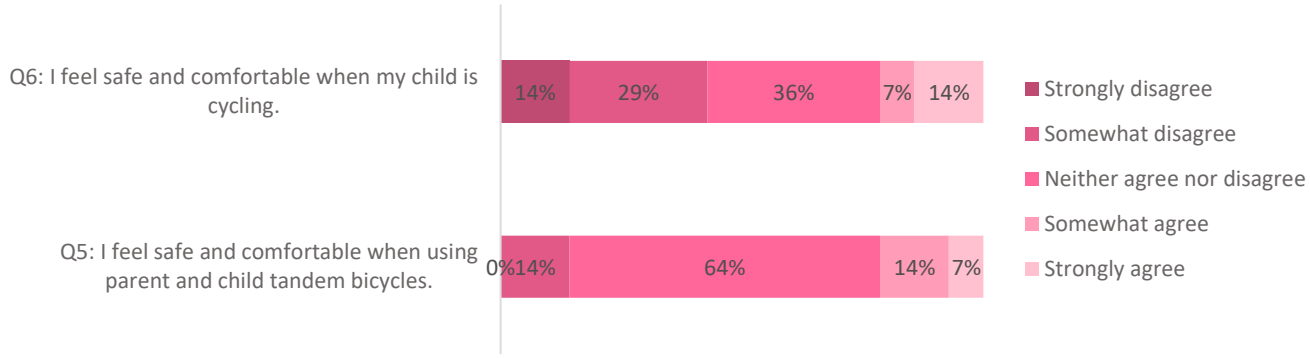

Figure 4.8 - Questionnaire results on children cycling. Number of respondents (N) = 14

Disability of rider

From the five interviewees, three believed that people with disabilities feel safer when cycling. From the questionnaire respondents, only 10 respondents claimed to have a physical disability. Although the intention of this research is not to study how different types of physical disabilities are related to cycling, Figure 4.9 shows which aspects of the cycling infrastructure need further improvements. Responses from respondents with sight and walking problems do not indicate a clear outcome, as the responses are equally distributed between the different options. But respondents with communication disorders clearly believe that their disability is a barrier to riding a bike.

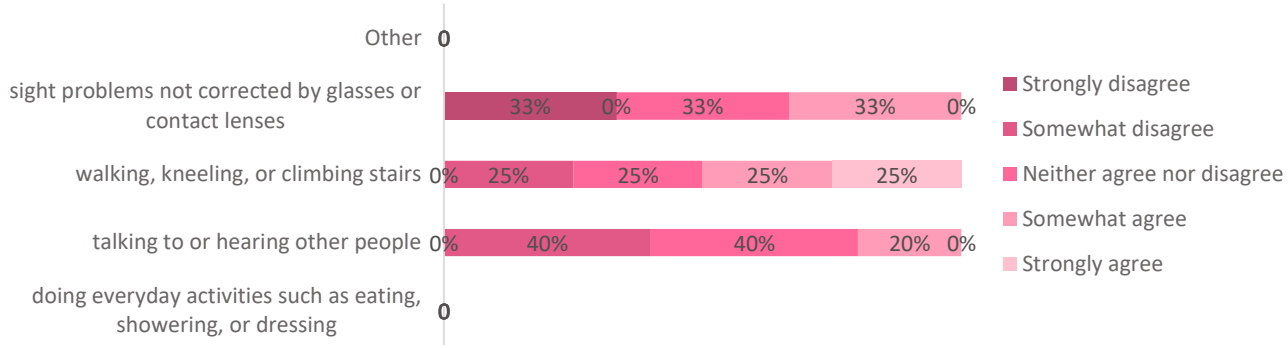

Figure 4.9 - Questionnaire results on the statement "My physical disability does not affect my cycling experience". Number of respondents (N) = 10

The total aggregated response from people with disabilities to this question also illustrates an equal distribution between the choices. To gain a better understanding of this group's cycling experience, their response to question 10 was separately analysed. As shown in Figure 4.10, 50% of the disabled respondents, do not feel safe when cycling in Downtown and West End and only 25% feel safe to some extent. This is while 3 of the interviewees believed that people with disabilities are now feeling safer while cycling. Based on the secondary data (City of Vancouver, 2020b) and interviewee R2, the municipality has been asking for advice from the Persons with Disabilities Advisory Committee for the transportation plan. However, the questionnaire data do not show achievements in this field and the municipality has not recorded the data on this matter. The literature also suggests that there is a lack of proper legislation in British Columbia to support vulnerable groups (*Cycling for Everyone*, 2011).

So, with the contradictory results and lack of secondary data, no specific outcome could be considered for this indicator.

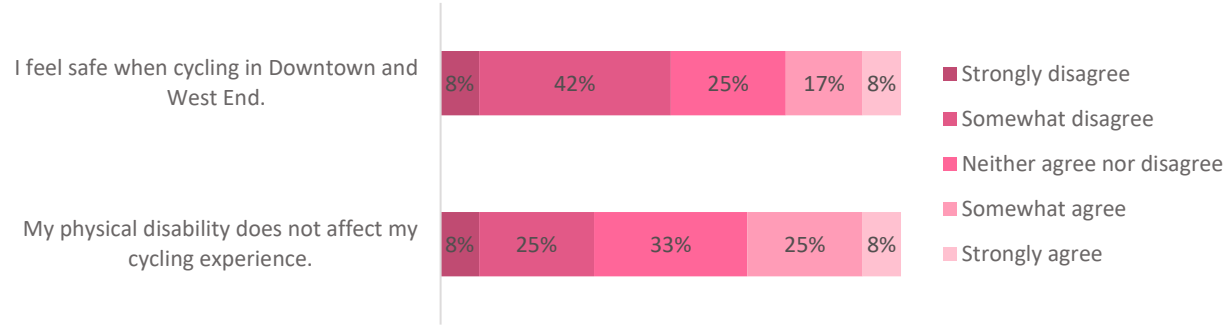

Figure 4.10 - Questionnaire results on disabled respondents feeling towards cycling. Number of respondents (N) =10

Average motor vehicle volume

There had been streets in Vancouver where the car volume limit was implemented, and referring to interviewees R1, R2, and R3, a great increase in cycling rates was observed. However, respondents R2, R3, and R5 stated the AAA guideline is still valid in Vancouver and based on it, still, more work needs to be done to limit the traffic volume. This has been reflected in questionnaire responses, Figure 4.11, with 49% positive responses to the annoyance of vehicles passing.

In a study conducted on Metro Vancouver, roadways with less than 2000 vehicles per day are classified as comfortable for most people. This category consists of 46% of the metro Vancouver roadways and the remaining 54% is only comfortable for some, few or very few people (HUB Cycling & TransLink, 2020). So, the implemented motor volume limits had a positive impact on the rates of cycling, but still, a great portion of the population view the vehicle volume as a nuisance and further actions must be taken in this regard.

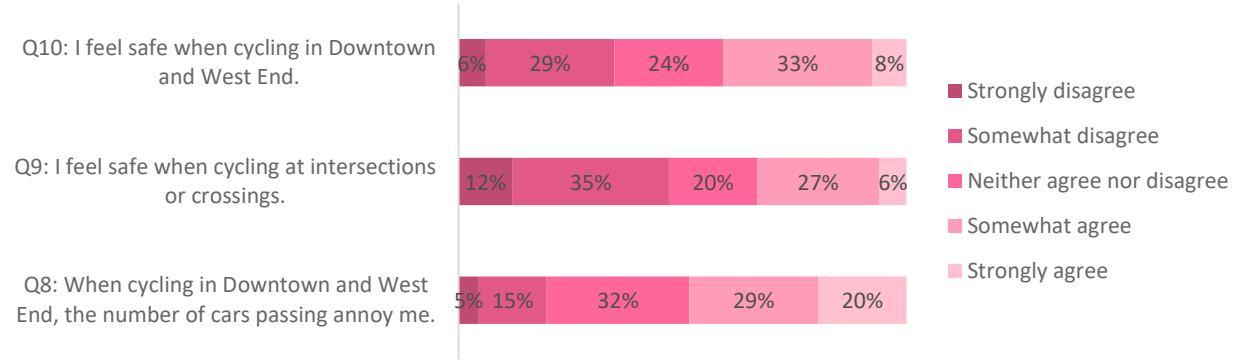

Figure 4.11 - Questionnaire results on three indicators: average motor vehicle volume (Q8), safety at intersections and crossings (Q9), and feeling of safety (Q10). Number of respondents (N) = 66

Safety at intersections and crossings

All the interviewees believed that the protected intersections have been successful in Vancouver. It provides a completely safe and prioritized crossing for cyclists. Despite that,

there are many non-protected intersections remaining. Questionnaire responses also support this fact. As illustrated in Figure 4.11 (Q9), only 33% of the respondents had a safe experience at crossings, while 47% felt the opposite.

Secondary data sources (City of Vancouver, 2017b) indicate that improvements in the intersections have been implemented, as an example at the intersection of the Burrard Bridge. However, studies still believe that more improvement has to be made (Hamre, 2018) (City of Vancouver, 2018), explaining the 47% of the respondents feeling unsafe and also admitting four of the five interviewees points of view.

Feeling of safety

Four out of five interview respondents believed that cyclists are now feeling safer and the growth in the number of cyclists is the evidence. More than 40% of the questionnaire respondents (Figure 4.11, Q10) also gave a positive response to the feeling of safety while cycling. Vancouver municipality's data show that despite the increase in cycling rates during the five-year period, the number of traffic-related fatalities has decreased (City of Vancouver, 2021b); this was also mentioned by respondent R1, confirming the enhanced level of safety.

Two of the interviewees declared that not all the roads are safe. This could be related to 35% of the respondents who were not satisfied with the level of safety. To explain it more in detail, interviewee R2 stated that cyclists' perception of safety is location dependent. If this question is asked on a non-protected bike route, the answer would probably be negative. Nevertheless, in a benchmarking report, 76% of Downtown Vancouver's cycling network is classified as comfortable for most (HUB Cycling & TransLink, 2020). The report defines comfortable for most routes as where the bikeways are fully protected from vehicles, if not the vehicles have a maximum speed of 30 km/h and a volume of fewer than 2000 vehicles per day (HUB Cycling & TransLink, 2020).

Route/Pavement quality

Two of the interviewees mentioned that the cycling routes have good quality. Interviewee R4 also believed that safety and quality go hand in hand. These, however, are in contrast with the 41% questionnaire dissatisfaction responses upon the route quality, as illustrated in Figure 4.12 (Q11).

In a study conducted by Translink in 2011, flat cycling routes was ranked as the fourth positive factor for cycling in Vancouver, while the icy or snowy road was the first contributing factor to not cycling. This is in line with interviewees R1 and R5's responses to this question. Interviewee R3 pointed out that Vancouver municipality has recently invested in vehicles to clear the cycling routes, to address what the Translink study also mentions (*Cycling for Everyone*, 2011).

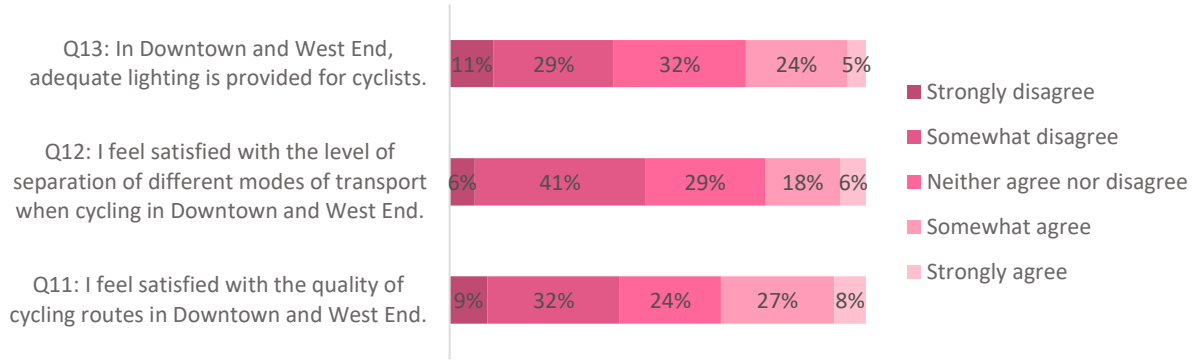

Figure 4.12 - Questionnaire results on three indicators: average motor route/pavement quality (Q11), level of road separation (Q12), and adequate lightning (Q13). Number of respondents (N) = 66

Level of road separation

Three of the interviewees stated that not all the cycling routes in Downtown and West End provide the required level of separation between vehicles and bikes. This is reflected in the questionnaire results in Graph 4.14 (Q12), as 47% of the respondents strongly or somewhat disagree that the level of route separation is sufficient. There is no data available on Downtown and West End bikeways, but data on Vancouver show that 26.8 km of bikeways are fully protected and 412 km are on shared roads (HUB Cycling & TransLink, 2020).

Children and elderlies' bike more on the fully protected bikeways, as three of the five interviewees, stated. Studies also admit that separating bikeways enhances safety and allows vulnerable groups to cycle (Pucher & Buehler, 2008). However, this factor needs further improvements in the studied area.

Adequate lightning

The lightning of the bikeways has been improved as a part of enhancing the walking and cycling infrastructure, but some parts need further improvements to LED lightning as three interviewees mention. 32% of the questionnaire respondents have no opinion towards the level of lightning, and in total 29% percent are satisfied and 40% are not satisfied with the current level of lightning, as shown in Figure 4.12 (Q13). So, the questionnaire responses are nearly equally distributed between the choices.

Interviewee R3 mentioned that there has been a research project on the relationship between lighting and safety in Vancouver. Another study, conducted by the University of British Columbia in Vancouver shows that to support travellers' safety, the first priority tactic is to provide lightning in a small part of the Seaside bikeway and sidewalk (Craig, Farías, Pagnucco, & Park, 2021) which is located in the neighbourhood studied in this research. This could shed light on the 40% dissatisfaction rate with the level of lightning.

To summarize, based on the analysis done on sub-question 1, implementing a speed limit in the studied area was not an influential factor during the studied period. The results also indicate that the municipality has been successful in encouraging seniors to cycle, however, the number of senior respondents of the questionnaire is relatively small. Moreover, the survey shows that most of the women respondents believe that their cycling experience is not affected by their gender, highlighting the success of the AAA guideline in this field. In contrast, there is still the need for improvements to raise the number of children cycling. Based on the survey, the respondents are mostly dissatisfied with the volume of motor vehicles, the safety measures at intersections and crossings, the level of road separation, and the lighting of the cycling routes. So, the municipality has taken actions to enhance walking

and cycling safety, and this has increased the rates of walking and cycling, but still, further improvements are required.

4.4 The influence of Network Expansion on the Achievement of the Proposed Green Transport Target

Integrated Route

Table 4.3 - Interview finding on sub-question 2

Indicator	Response Summary	Frequency
Integrated route	The walking network in Downtown and West End is complete.	3
	The pedestrian network is almost (99%) complete.	2
	There are a few gaps in the pedestrian network, for example in Pacific Boulevard, which is getting fixed.	1
	Extending the cycling network beside the sidewalks has made pedestrians feel safer and increased the walking rates.	2
	Although the cycling network in Downtown and West End has expanded, it is not complete.	4
	The AAA cycling routes are not well connected.	4
	The cycling network still lacks key connections.	2
	New bike lanes are only installed when they are connected to the network.	2

Number of respondents (N) = 5

Three of the interviewees agreed upon the fact that the pedestrian network of Downtown and West End is complete, and every street has a sidewalk. R2 and R3 stated that the network is almost complete, R2 also mentioned that there are a few gaps, for example in Pacific Boulevard. This is also depicted in the questionnaire responses (Figure 4.13), as 50% believe that most of the time it is possible to reach every part of the neighbourhood when walking and 42% believe that the pedestrian routes are integrated. Research also approves the completeness of the walking network in Downtown and West End Vancouver (Hamre, 2018).

Based on the interviews, the cycling network is not complete. Two of the interviewees pointed out that the network is still missing key connection points, they also explained the network extension process, that installing orphan pieces of protected bike lanes is avoided, so new bike lanes are only installed if they are connected to the network. This has been clearly reflected in the questionnaire responses. As illustrated in Figure 4.13, 33% of the respondents, believed that most of the time the bikeways are integrated. However, as interviewee R2 stated, the bikeways classified as AAA, are not completely connected, as old bike lanes were upgraded to AAA when the streets were upgraded, regardless of their connection to the network. The 41%, 23%, and 17% respondents (Figure 4.13 Q4) who believed that most of the time, half of the time, or sometimes it is possible to reach every part of Downtown and West End through the cycling network, reflect two of the interviewee's statement, that although the network has expanded, there are key connections missing.

A benchmarking report on Vancouver shows that the cycling network grew from 370 to 710 km, with a connected grid network. In the centre of the Downtown, there are network gaps in the east-west (HUB Cycling & TransLink, 2020), confirming the interview and questionnaire

findings. Literature states that the incomplete cycling network in Vancouver is a great barrier for cyclists (Hamre, 2018).

It is worth noting that 9% (6 respondents) of the questionnaire respondents think that it is never possible to reach every part of the Downtown and West End cycling and 3% (2 respondents) believe that the cycling routes are never integrated. These responses could be considered as outliers, as their response is in contrast with what the literature, secondary data, and interviews show.

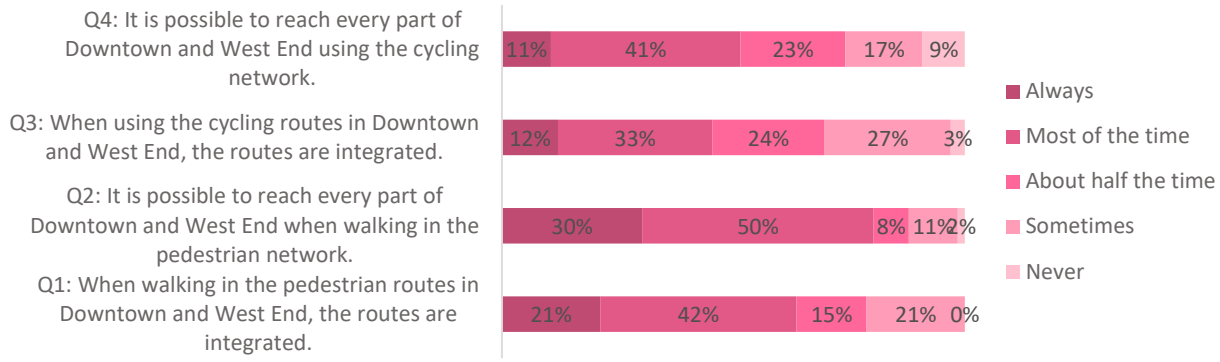

Figure 4.13 - Questionnaire findings on questions related to the Network Expansion variable. Number of respondents (N) = 66

In summary, the walking network of the Downtown and West End Vancouver is integrated. The cycling network covers most of the neighbourhoods but still needs to be further expanded to provide an integrated network of cycling routes. Within the network extension in the previous years, the contribution of the network extension to the achievement of the proposed green transport target could not be neglected.

4.5 The influence of Greenways on the Achievement of the Proposed Green Transport Target

Frequency of Usage

Table 4.4 - Interview findings on sub-question 3

Indicator	Response Summary	Frequency
Frequency of usage	The residents are using the greenways a lot and the greenways get busy.	5
	Once the greenways were connected to the walking and cycling networks, the frequency of usage rose.	2
	The green environment and high-quality facilities of the greenway encourage people to walk and cycle.	5
	The greenways serve both as a high-quality route for reaching destinations and a recreational destination on their own.	2
	During summer 2020, 10000 people used the greenways on average, with the maximum reaching 14000 a day.	1
	Mixing the recreational and travel function of greenways has disappointed the people using the greenways for daily travels.	1

Time taken to reach	The Seaside greenway surrounds the Downtown, so it is within a maximum 1000 km distance from the origin.	1
	The greenways plan was based on accessibility.	2
	Greenways are easily accessible in the Downtown and West End, so people use them.	2

Number of respondents (N) = 5

The interviewees all agree upon the popularity of the greenways that is a result of its high-quality facility and green environment. Interviewee R2 stated that there was a huge rise in the number of people using the greenways, with 10000 people using it on average in summer 2020. The greenways connectivity to the walking and cycling network also contributes to more people using it, as two of the interviewees stated. In addition to the commuting function of the greenways, they are recreational destinations by themselves, as interviewees R3 and R5 affirm. Interviewee R5 also mentions that mixing the recreational and utilitarian function of the greenways has resulted in dissatisfaction of the people using the greenways for their daily travels.

The questionnaire responses show that the walking and cycling rates in greenways are almost similar. More than 50% of the respondents walk in the greenways less than once a week, and approximately 40% of them cycle in the greenways less than once a week, reflecting the recreational trips as mentioned by the interviewees. As depicted in Figure 4.14 less than 20% of the respondents never walk or cycle in the greenways.

A study conducted on Vancouver greenways by the University of British Columbia also explains that greenways are organized as recreational destinations that provide public amenities alongside natural scenic landscape and community gathering spaces. It also highlights the popularity of greenways among residents (Craig et al., 2021). The City of Vancouver's panel survey states that the greenways have contributed to the rise in cycling rates (McElhanney Ltd. & Mustel Research Group, 2020). So, based on the interview, literature and questionnaire results, greenways are more popular as recreational destinations than commuting routes.

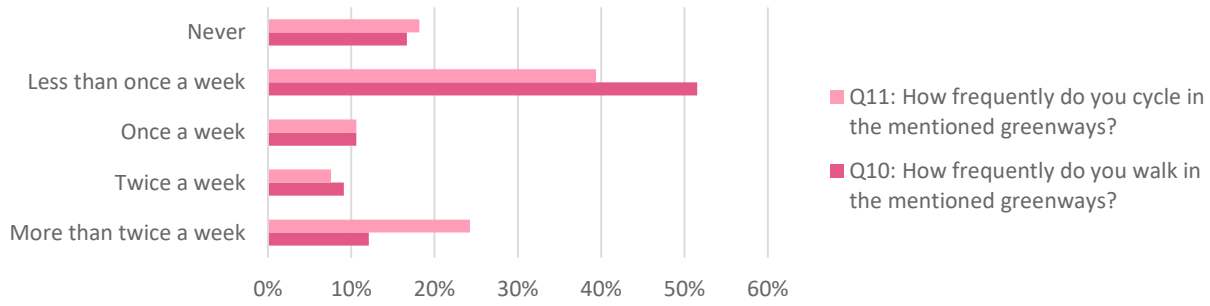

Figure 4.14 -Questionnaire findings on sub-question 3, part 1. Number of respondents (N) = 66

Time taken to reach

Interviewee R2 mentioned that the Downtown dimensions are about 1.5 km in 2 km, so within the Seawall surrounding the Downtown, each person would be in less than 1 km distance from the Seawall. This has made greenways easily accessible in the area of study. Interviewees R1 and R3 also mentioned that the greenway plan of Vancouver was designed based on accessibility.

Based on the questionnaire, nearly 50% of the respondents declared that it takes them less than 5 minutes to reach the greenways by bicycle. As illustrated in Figure 4.15, the frequency of responses decreases, as the time reaching the greenway by bicycle increases. On the other

hand, more than 30% of the respondents stated that it takes them more than 20 minutes to walk to the greenways. This is while it takes less than 5 minutes to walk to the greenways for almost 30% of the respondents.

Based on the literature, the greenways were planned in 1995, in a way to be accessible (Craig et al., 2021). This was also stated by interviewees R1 and R3 and confirmed by the questionnaire results. So, the greenways are within easy reach of the Downtown and West End residents, as the interview, questionnaire, and literature show.

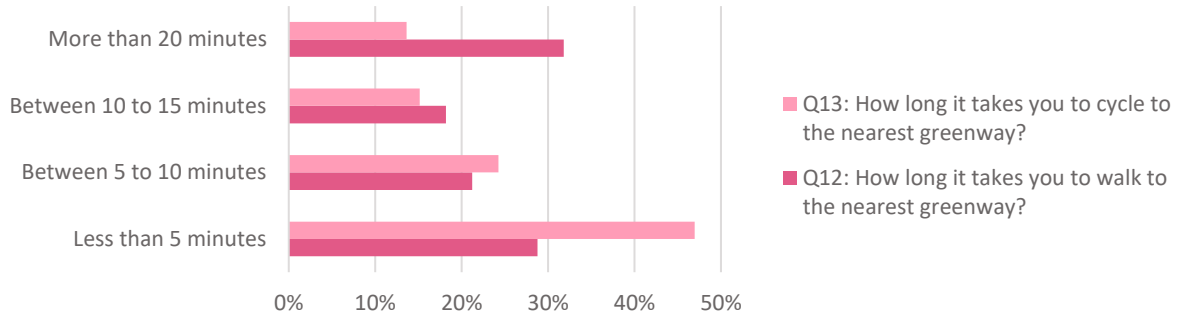

Figure 4.15 - Questionnaire findings on sub-question 3, part 2. Number of respondents (N) = 66

To summarize, the greenways of Downtown and West End are popular among the residents mainly as recreational destinations rather than commuting paths. They are within easy reach of the Downtown and West End neighbourhoods. So, their contribution to the achievement of the green transport target could not be neglected, but it must be noted that this contribution is relatively low, in comparison to the recreational function of the greenways.

4.6 The influence of Bicycle Sharing Program on the Achievement of the Proposed Green Transport Target

Table 4.5 - Interview findings on sub-question 4

Indicator	Response Summary	Frequency
Fare price	The membership fees are reasonable (around $120.00 per year)	4
	The equity pass program in partnership with VanCity offers low-income people the membership for $20- $30. This program was really successful, encouraging people to use Mobi.	5
	Mobi's equity share program has also been successful in enabling people to reach work with a relatively low travel cost, thus providing them better job opportunities.	1
	The equity program is very targeted.	1
Type of payment	For the normal membership (not the equity program) a credit card is needed.	3
	For the equity program, it is possible to pay in community centres.	2
	In the case of very disadvantaged people, the social workers pay for them.	1
Frequency of usage	The Mobi bike-sharing application is really popular, and it	5

	has constantly grown since it was launched.	
	Users use Mobi less during winter.	1
Bicycle size	Children 12 years and older are allowed to use Mobi.	1
	The bikes are offered in one size, so the bike size could be a barrier for very tall or short people or families.	4
Ability to ride with/for children	There is a minimum age requirement of 12 for using Mobi.	2
	Cyclists must cycle single file in British Columbia.	2
The complication of the smartphone application	Transit apps are used more than the Mobi app itself because it gives information about Mobi bikes as well as public transit.	2
	The bikes can be used with a card that has the pin, instead of the smartphone application.	2
	The application works fine.	2

Number of respondents (N) = 5

Fare price

Four out of the five interviewees admitted that the Mobi fees are reasonable. Moreover, they all mentioned the low-income subscription of the bike-sharing application, which allows low-income groups to use Mobi with a relatively low subscription fee. Although the mentioned equity program is very targeted (R1), it has been successful in providing cheap means of transport for low-income working members and thus provided them with job opportunities (R3).

Based on the questionnaire findings, only 14% of the respondents were to some extent dissatisfied with the Mobi fees (Figure 4.16). This is while 11% strongly and 43% to some degree believe them to be reasonable.

In 2018, Mobi conducted a survey on its users. 43% of the users claimed Mobi as a cheap means of transport (Winters, Therrien, McKeen, & Hosford, 2019), which matches the findings of the questionnaire and interviews. Mobi's survey also shows that only 15% of the respondents belong to the low-income group, confirming respondent R1s quote that the equity share program is really targeted. The report also indicates that the purpose of 42% of Mobi trips is work, highlighting Mobi's role in commuting to work (Winters et al., 2019), as mentioned by respondent R3.

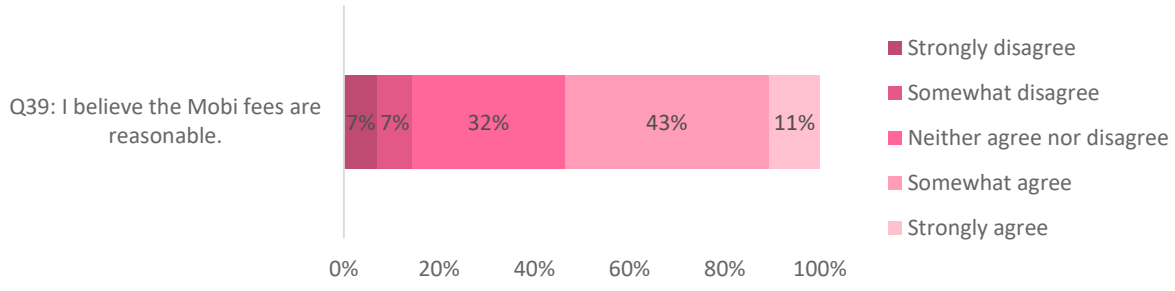

Figure 4.16 - Questionnaire findings on the statement "I believe the Mobi fees are reasonable". Number of respondents (N) = 28

Type of payment

Three of the interviewees explained that to pay for the normal subscription of Mobi, a credit card is needed. However, two of them mentioned that the equity share program provides

other payment options. Interviewee R2 said that in the case of very disadvantaged people, the social workers pay for them.

More than 50% of the questionnaire respondents have a positive opinion towards Mobi payment methods, while only 22% have the opposite opinion, based on Figure 4.17. Secondary data show that the cash payment option in the equity share program was the most used option (Daniel, 2020). So based on the results and secondary data (Daniel, 2020), it could be concluded that the equity share program has eliminated the payment issue of the targeted low-income group and the rest of the users are less likely to deal with this issue.

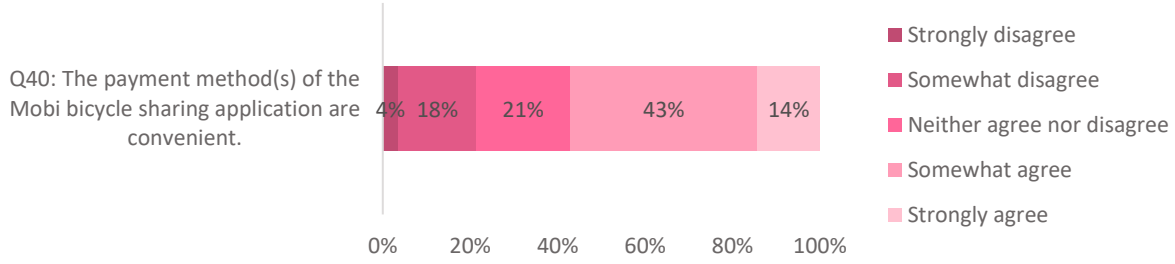

Figure 4.17 - Questionnaire findings on the statement "The payment method(s) of the Mobi bicycle sharing application are convenient". Number of respondents (N) = 28

Frequency of usage

All the interviewees agreed that the Mobi program is popular, and its users have grown since it was launched, during the studied timeframe. Interviewee R1 mentioned that Mobi usage rates drop in winter.

More than half of the questionnaire respondents are not Mobi users. This group of respondents were discarded from all the bike-sharing questions data analysis. As illustrated in Figure 4.18, 11% of Mobi user respondents use Mobi bikes for daily use, 25% use them weekly, 21% use them monthly, and 43% use them occasionally.

Based on the municipality's data, overall, 4% of Vancouver residents had a Mobi subscription in 2019; of Downtown and West End residents, 11% and 6% had a subscription, respectively (McElhanney Ltd. & Mustel Research Group, 2020). In 2019, 1% of the bicycle trips were done by Mobi (McElhanney Ltd. & Mustel Research Group, 2020). To explain Mobi's growth in the 5-year timeframe, the number of Mobi trips increased more than 500% from 2016 till 2019, reaching 865772 trips in 2019 (City of Vancouver, 2021b) (City of Vancouver, 2016b). So, despite the fact that a minority of people are using Mobi as the questionnaire results and secondary data show, Mobi has grown significantly, based on the secondary data, confirming interview results on Mobi's growth.

Mobi's survey in 2018 shows that weather conditions were a barrier for 43% of the studied sample (Winters et al., 2019). Also, Mobi's data indicate that during fall and winter the number of Mobi trips decrease significantly (Edwards, 2017), confirming R1s response.

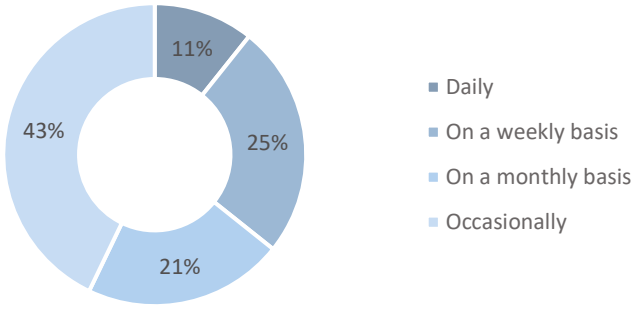

Figure 4.18 - Questionnaire findings on the frequency of Mobi usage by Mobi users. Number of respondents (N) = 28

Bicycle size

Interview data indicate that Mobi only offers one type of bicycle, the same as other bike-sharing systems commonly used in the world, that its seat height could be adjusted, so it might not be comfortable for very tall or very short people. Also, one of the interviewees pointed out that Mobi users must be older than 12-years, limiting the population group.

The size of Mobi bikes is a strong barrier only for 7% of the respondents. More than 50% of the respondents to some degree have no problem with the bicycle size, as illustrated in Figure 4.19.

In Mobi's 2018 survey, only 6% of the respondents claimed that the bike size is a barrier for them (Winters et al., 2019). So, the interview, questionnaire results and secondary data show that bicycle size is a barrier to a minor number of Mobi users, although the program offers a single type of adjustable bike.

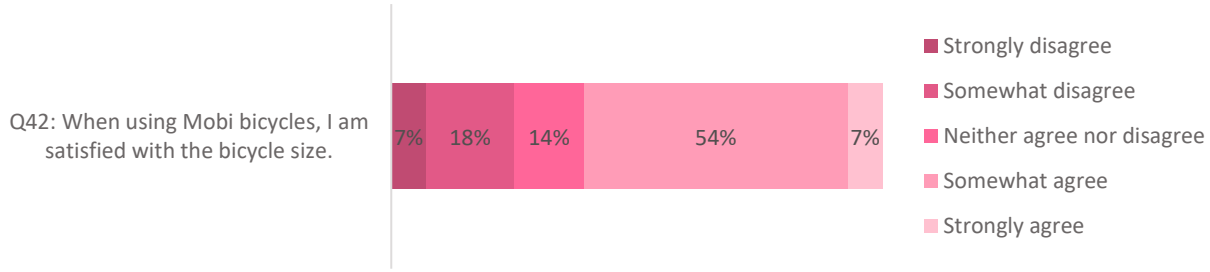

Figure 4.19 - Questionnaire findings on sub-question 4, the statement "When using Mobi bicycles, I am satisfied with the bicycle size". Number of respondents (N) = 28

Ability to ride with/for children

Interview analysis only shows that Mobi users are limited to children older than 12 years and that riding a tandem bike is not allowed in British Columbia.

The respondents answering this question are limited to Mobi users who have children, which is equal to 9 people. The questionnaire results (Figure 4.20) indicate that parents are strongly dissatisfied with Mobi, as in their opinion it could not be conveniently used with/by children.

Secondary data from Mobi's survey in 2018 indicate that 15% of respondents considered the lack of ability to ride with children a barrier to using Mobi (Winters et al., 2019). The higher rate of dissatisfaction of questionnaire respondents in comparison to Mobi's survey could be due to the fact that in this study the respondents to this question were only parents. Ultimately, Mobi is not designed for this purpose, as interview respondents mentioned.

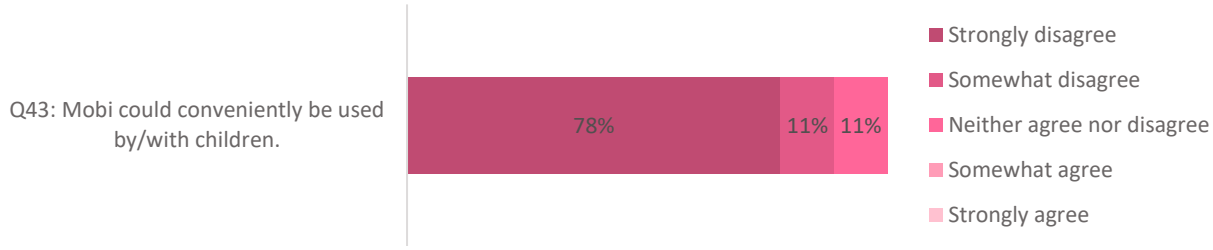

Figure 4.20 - Questionnaire findings on sub-question 4, the statement "Mobi could conveniently be used by/with children". Number of respondents (N) = 9

The complication of the smartphone application

Interviewees R1 and R4 mentioned that the smartphone application works fine. Two of the interviewees state that Mobi bikes could be used without the smartphone application and also other transit applications could be used instead, as the Mobi application only shows the available bikes and their location.

More than half of the questionnaire respondents have a positive view of the smartphone application, however, 25% of the respondents somewhat disagree with this term, as depicted in Figure 4.21.

Mobi's 2018 survey reflect that 31% of the respondents think that the general functionality of the application could be improved (Winters et al., 2019), reflecting the 29% dissatisfaction rate, as illustrated in Figure 4.21. However, most of the questionnaire respondents believed that the smartphone application is easy to use, which admits interviewee R1 and R4's views. The 18% neutral response to the question, could be translated to the fact that Mobi users could use other smartphone transportation applications instead, as the interviewees stated. So, to conclude, the smartphone application could not be a barrier for using Mobi bikes.

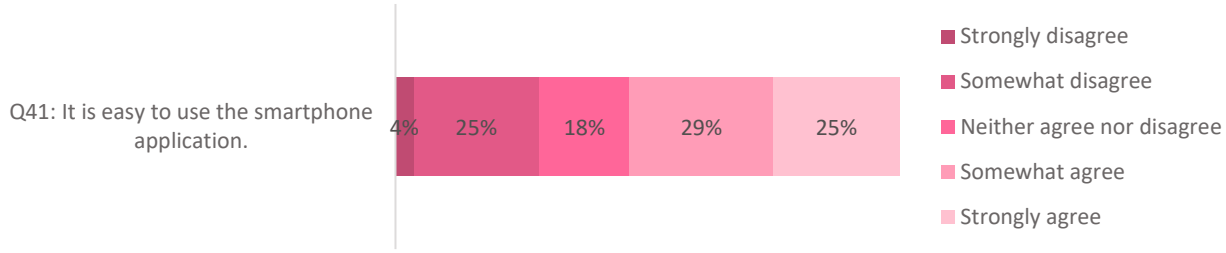

Figure 4.21 - Questionnaire findings on sub-question 4, the statement "It is easy to use the smartphone application". Number of respondents (N) = 28

In summary, the Mobi program is not widely used by Vancouver residents, but its users have grown significantly in the studied period. The program was launched in 2016 (Vancouver, 2014) and grew its fleet to nearly twice more in the studied timeframe (Vancouver Bike Share Inc, 2021a). Based on the findings, it offers affordable bikes with an easy payment system and its smartphone application is almost convenient to use. The limited size of the bike is not a barrier to most of the respondents, and the program is not designed for children. So, based on all the findings, the bicycle sharing program did influence the achievement of the target, with its high growth rate.

4.7 Statistical Analysis

To check the internal consistency of the questionnaire, the Cronbach's Alpha test was carried out in excel. Cronbach's Alpha test shows the reliability of the scale and it ranges from 0 to 1 (van Thiel, 2014). Cronbach's Alpha coefficients close to or higher than 0.7 are acceptable (Saris & Gallhofer, 2014). As the results presented in Table 4.6 show, all of the network expansion, greenways and bicycle sharing program's coefficients are higher than 0.7 and the transportation safety's coefficient is close to 0.7, approving the internal consistency of the questionnaire.

Table 4.6 - Cronbach's Alpha test result

Dependent variables	Cronbach Alpha
Transportation Safety	0.623
Network Expansion	0.735
Greenways	0.752
Bicycle Sharing Program	0.741

After analysing the questionnaire and interview results, to investigate the relationship between the independent variables and the dependent variable the average response of each respondent to each variable was calculated. In calculating the average response to a variable, the positivity or negativity of the question was taken into account. Then, a Pearson correlation test was conducted.

The Pearson test results for the four independent variables are significant at the 0.01 level, as summarized in Table 4.7. Transportation safety has a low and negative correlation coefficient. This could be due to the small sample size that makes the results biased. Network expansion has a weak positive linear relationship with the dependent variable, meaning that if the value of one of the variables increases, the value of the other variable would decrease relatively. The independent variable greenways has a moderate positive linear relationship with the dependent variable. So, the higher the value of the greenways variable is, the stronger the achievement of the proposed green transport target. The correlation of the bicycle sharing program with the achievement of the target is low. Meaning that the lower the value of the bike sharing program, the stronger the achievement of the proposed green transport target would be. However, based on the data and literature, this correlation value is not coherent. This could be due to the small sample size.

Table 4.7 - Pearson correlation results

Dependent variables	Pearson Correlation	P-value	N
Transportation Safety	-0.05	Correlation is significant at 0.01 level (two-tailed)	66
Network Expansion	0.184	Correlation is significant at 0.01 level (two-tailed)	66
Greenways	0.248	Correlation is significant at 0.01 level (two-tailed)	66
Bicycle Sharing Program	-0.211	Correlation is significant at 0.01 level (two-tailed)	28

Correlation tests do not depict the causal relationship between the variables. So, a multiple regression was used to investigate how the independent variables explain the dependent variable. As depicted in Table 4.8, except for the transportation safety variable, the three other variables could significantly explain the achievement of the target, considering that greenways are almost significant. Studies suggest that a reason for the insignificance of an independent variable could be the correlation between this variable and other independent

variables (Smith, 2012). So, the insignificance of the transportation safety variable could be due to its correlation with other independent variables. The correlation between the independent variables was studied and the results are included in Annex 2. The results indicate that the transportation safety variable is significantly correlated with network expansion, greenways, and bicycle sharing program. Other than the correlation of the independent variables, another reason for the insignificance of the transportation safety variable could be the format of the questions in the questionnaire relating to this variable. Based on Table 4.6, this variable has the least Cronbach's Alpha test value, making it less reliable.

Table 4.8 – Multiple regression coefficient table

Dependent variables	Coefficient	Standard Error	t Stat	P-value
Intercept	-0.005	0.487	-0.010	0.991
Transport safety	0.097	0.141	0.690	0.492
Network expansion	0.128	0.055	2.327	0.023
Greenways	0.060	0.030	1.974	0.052
Bicycle sharing program	-0.088	0.039	-2.268	0.026

Number of respondents (N) = 66

The multiple regression shows that the significant variables network expansion, greenways, and bicycle sharing program explain the achievement of the proposed green transport target by an adjusted R square of 0.142. This value shows the portion of the dependent variable that is explained by the independent variables. So, network expansion, greenways, and bicycle sharing program explain the achievement of the target by 14%. This indicates that there are other factors that contributed to the achievement of the proposed green transport target in Vancouver. The standard error value is not close to 1, showing that multicollinearity exists between the independent variables. The correlation between the independent variables, as listed in Annex 2, shows that the only insignificance variable, transportation safety, is correlated with the other three independent variables. This correlation was further examined in the interview data, using the co-occurrence table and query tool of Atlas.ti software, and it was observed that also in the interview data, this variable is related to the other independent variables (Annex 3).

Table 4.9 – Multiple regression results

Multiple R	R square	Adjusted R square	Standard Error
0.441	0.195	0.142	0.351

Number of respondents (N) = 66

To link the statistical findings with the interview, questionnaire, and secondary data, different findings on the transportation safety variable demonstrate contradictory results. Researchers view, based on the questionnaire, interview and secondary data is that the actions taken to make transportation safe in Downtown and West End Vancouver were not sufficient, but they had a moderate effect on the rates of walking and cycling. This is in contrast with the statistical findings, that are biased for this variable. As explained before, the reason could be the inappropriate structure of the questionnaire, the low number of survey respondents, and the correlation of this variable with other independent variables.

The statistical tests show that an increase in the network expansion variable moderately leads to an increase in the achievement of the target. The questionnaire, interview, and secondary data also admit it, as the cycling network in Downtown and West End Vancouver have

expanded, but still needs improvements, and the walking network has not faced major changes during the years of the study.

The results present the positive influence of greenways on the achievement of the proposed green transport target. Other research findings demonstrate that the greenways have been very popular for recreational purposes in the studied area, and they are easily within reach. The reason behind the low contribution of this variable to the dependent variable could be the function of the greenways as recreational destinations, and also the format of the questionnaire that only asks about the frequency of usage and the time taken to reach, while the purpose of travel to the greenway and the mode of transport used for reaching it is important.

The statistical analysis shows that the bicycle sharing app influences the achievement of the target negatively. The findings of the questionnaire, interview, and secondary showed that a very low number of the residents use Mobi, and thus this program could not have a great influence on the proposed target. However, this is different from the statistical findings. This could be due to the low number of questionnaire respondents that biased the statistical results.

Chapter 5 : Conclusions and recommendations

In this chapter based on the findings of the study, a conclusion is provided. The main purpose of this research is to study to what extent transportation safety, network expansion, greenways, and bicycle sharing programs has influenced the achievement of the proposed green transport target in Downtown and West End Vancouver. In the following, the sub-questions are answered based on the research findings and the literature. In addition, the limitations of this study and suggestions for future research are explained.

5.1 Main Findings of the Research

5.1.1 Sub-question 1

How do the speed limit and AAA guideline influence the achievement of the proposed green transport target?

The actions taken to limit the speed and volume of the vehicles passing and protect the intersections and cycling lanes, although still incomplete, have strengthened transportation safety and contributed to a positive influence on the achievement of the proposed green transport target.

Regarding the speed limit variable, the literature state that there is a strong link between safety and vehicle speed limit (Canterbury District Health Board, 2016) (Wee, 2018). Although the speed limit has not been fully implemented in the studied area and the majority of respondents found the speed of the vehicles passing annoying, the positive influence that implementation of the speed limit had in the few streets could not be neglected.

Moreover, based on the literature, safety is the most crucial factor for improving non-motorized transportation rates, and in this regard, providing fully segregated bike lanes is of great importance (Wee, 2018). In the case of Downtown and West End Vancouver, more protected bike lanes have been provided in the studied time frame, although the plan is yet to be completed. Other findings of the research show that municipality's actions to reduce the number of cars passing, to make cycling safer for all ages, abilities and genders, to improve the quality of the cycling infrastructure and enhance the lighting have been insufficient from the residents' point of view (HUB Cycling & TransLink, 2020). Although residents' opinion towards the actions taken in this field is not positive, the implemented measures were to some extent implemented and had influence on the achievement of the target.

Based on the interview findings, the municipality's actions towards implementing the speed limit and the AAA guideline are still in progress and was not fully achieved during the years of the study. As the questionnaire results show, the majority of the respondents are not fully satisfied with the actions taken in line with the two sub-variables. Although findings confirm that the implemented transportation safety measures in the studied timeframe had positively influenced the achievement of the green transport target, no specific indicator of this study could be selected as the most influential factor on this positive impact. So, the aggregation of improvements in each factor positively influenced the achievement of the proposed green transport target.

The statistical analysis results of this sub-research question are biased, as explained in Chapter 4, so the answer to this question is not linked with the statistical findings.

5.1.2 Sub-question 2

How does network expansion influence the achievement of the proposed green transport target?

Research findings suggest that the extension of the network has influenced the achievement of the target positively. Other than extending the network, Vancouver municipality has also communicated the new cycling routes with its residents.

To answer this question, the walking and cycling networks of Downtown and West End were studied. It was found that the walking network is complete, so it is possible to reach every part of the studied area when walking. Although the network has been completed before the time frame of this study (McElhanney Ltd. & Mustel Research Group, 2020), its contribution to the rates of walking could not be neglected.

Based on the results, the cycling network has expanded in the studied period, but there are still some gaps remaining in the network, making it impossible for cyclists to reach every destination. The approach that the municipality has taken in extending the network does not optimize the directness but improves the connectivity of the network. Literature states that the advantage of this approach is promoting cycling (Natera Orozco et al., 2020). The secondary data approve the literature's statement, as the length of the cycling network was more than doubled in the studied time frame (HUB Cycling & TransLink, 2020), contributing to the rise in the cycling rates.

The statistical results of this study also demonstrate that a change in the network expansion variable has a significant positive influence on the walking and cycling rates. To conclude, the cycling network still lacks some key connecting points, but it has extended with a focus on its connectivity. So, the extension of the networks has contributed to more walking and cycling.

5.1.3 Sub-question 3

How do greenways influence the achievement of the proposed green transport target?

Research findings confirm that greenways were influential in the achievement of the target, but they had a moderate influence. The findings from the interview and questionnaire show greenways popularity among the residents and their reachability. They also highlight the greenways main function, as recreational destinations. Although based on the literature, improving the greenways results in an increase in the perceived access to bike routes (Frank & Ngo, 2016), the research findings demonstrate that in the case of Downtown and West End Vancouver, greenways main function is not a high-quality walking and cycling route and the majority of the questionnaire respondents walk or cycle in the greenways less than once a week. So based on the interview and questionnaire, it could not be concluded that the greenways influence the achievement of the target strongly. The statistical analysis also shows that the greenways are moderately correlated with the achievement of the target.

5.1.4 Sub-question 4

How does creating a bicycle sharing program influence the achievement of the proposed green transport target?

The research findings demonstrate that launching a bicycle sharing program in Downtown and West End Vancouver has influenced the achievement of the target positively.

As explained in the literature, bicycle-sharing programs could serve as cycling facilitators, if they comply with specific conditions. A number of these conditions include easy access by everyone, and reasonable fare or subscription prices (Médard de Chardon, 2019). Based on the findings, the studied bicycle sharing program, Mobi, which is the only bike sharing program in Downtown and West End Vancouver, offers reasonable fare prices, convenient smartphone application, and different payment methods for underprivileged groups of people. Its bikes are only offered in one adjustable size, but this is not a concern to the developers, as

their target group are not kids younger than 12 years old, and research findings show that the users are to a good degree satisfied with the bike size.

On the other hand, the questionnaire results and secondary data indicate that the Mobi bike-sharing app is still not used by the majority of the people, however, its users have grown since its launch in 2016. So, since the number of users had increased and the level of user satisfaction is acceptable, it could be concluded that Mobi does slightly influence the achievement of the proposed green transport target. This however is not reflected in the statistical results, due to the low number of questionnaire respondents, which makes the statistical analysis unrealistic and biased.

To conclude, the bike sharing program has moderately influenced the achievement of the proposed green transport target. Future improvements in the system could increase the number of users and make the program more influential on the cycling rates.

5.1.5 Main Research Question

"To what extent the transportation safety, network expansion, greenways and bicycle sharing program developed by the Vancouver city municipality has influenced the achievement of the proposed green transport target in Downtown Vancouver?"

Based on the research findings, transportation safety, network expansion, greenways, and bicycle sharing program developed by the Vancouver city municipality, moderately influenced the achievement of the proposed green transport target in Downtown and West End Vancouver.

The results of the interview, questionnaire, and secondary data demonstrated that although Vancouver has been successful in achieving its target and improving all the selected variables, the variables did not have a strong influence on the achievement of the proposed green transport target. There are other variables and factors that in line with the studied factors, influenced the achievement of the proposed green transport target. Litman defines land use patterns, social norms, and several other factors in addition to the studied factors, as influential factors on non-motorized transport rates (Litman, 2016). This has been reflected in the multiple regression analysis, as the combination of the independent variables, explain the achievement of the proposed green transport target by 14%. The city of Vancouver defined two targets for its green transport plan. The first target was to "Make the majority of trips (over 50%) by foot, bicycle, and public transit" by 2020 and the second target was to "Reduce distance driven per resident by 20% from 2007 levels" by 2020. The second target was not in the scope of this study. So, the four selected dependent variables, transportation safety, network expansion, greenways, and bicycle sharing program, could have strongly influenced the achievement of the second target, rather than the first target.

In line with the findings from the first sub-research question, transportation safety has a moderate influence on the achievement of the target, while it is correlated with the other three dependent variables. This highlights the importance of transportation safety, that implementing measures to enhance the safety could increase walking and cycling of different groups of people (Hail & McQuaid, 2021), through different methods such as using the greenways or bike sharing programs. However, it was found that the transportation safety measures were not fully implemented and until 2019, 76% of the cycling routes were considered as comfortable for most people. So, further improving the transportation safety measures, would intensify its influence on the walking and cycling rates.

Network expansion in Downtown and West End Vancouver improved connectivity and thus positively influenced the achievement of the target, but still, the cycling network lacks key

points. Vancouver municipality's approach in extending the network did not take into account the travel time and directness of the paths. Literature states that this approach would create bottlenecks in the future if new links are not added to the network, however it is an important step towards completing the network (Natera Orozco et al., 2020).

Findings on sub-research question 3 demonstrated that although the greenways are popular in Vancouver, their main function as recreational destinations must be taken into account. So, based on research findings and literature, their main field of impact is not utilitarian walking and cycling, and thus they have a moderate influence on walking and cycling trip rates.

The bike sharing program has been successful in terms of providing satisfactory services to the residents and has contributed to the rise in cycling rates. However, its low number of users adversely affected the statistical analysis of this study, as less than 50% of the respondents were users of the program. As demonstrated in the research findings, further improvements of the cycling infrastructure and transportation safety could increase the number of Mobi users as well.

To conclude, Vancouver municipality has been successful in increasing the walking and cycling rates and reaching the target of making 50% of the trips by foot, bike, or public transit. The factors studied were influential factors in reaching this target, however, several other factors have also contributed to the achievement of this target.

5.2 Limitations

Firstly, the study was conducted during the COVID-19 pandemic and was affected by the travel and working restrictions of that time. So, the data collection process was done online, and the researcher's perception of the studied area was limited to previous observations and understanding of the neighbourhoods which could have biased the results of this research. This also made the data collection process more time consuming and resulted in a small sample size. The small sample size imposed implications on the statistical analysis so that the statistical analysis results on transportation safety and bike sharing program were biased and in contradiction with other research findings.

Secondly, it was found that the variable transportation safety, was correlated to other studied variables. This posed an implication on the statistical analysis, meanwhile, it was out of the scope of this study to further investigate the correlations and the reasons behind them, since for example the reasons behind the correlation of transportation safety and greenways is not related to the studied target.

Thirdly, as a part of the green transport plan, the Vancouver municipality implemented several measures to reach the proposed green transport targets. But in this study, it was not possible to take into account all the implemented measures and also the second target of the municipality.

Finally, the results of this research could not be generalized, as it was conducted on the two neighbourhoods of Downtown and West End in a five-year time frame starting from 2015.

5.3 Recommendations

This study offers new insight into measures contributing to cycling and walking rates and could serve as a benchmark for the municipality of Vancouver to evaluate its progress towards achieving its target. The researcher also hopes that findings could help the municipality in defining its future transport targets and adjusting the long-term green transport targets of 2040. The researcher suggests the municipality add a bypass route to the

greenways to enhance their multi-functional structure, define specific areas as family cycling routes to normalize kids cycling, and record the transportation behaviour of the disabled residents to further increase the rates of walking and cycling.

Future research could be done to expand the sample size and make the statistical results more reliable. Also, doing an observatory study on the area to better understand residents' behaviours and their transportation experience, enhances data triangulation and results in a more reliable study.

Each of the studied variables has the potential to be studied individually and in more detail to resolve the correlations between the independent variables. The results could serve as a good metric for the municipality of Vancouver in each relevant field.

Furthermore, future research could take into account more factors and measures, such as proximity, urban form, and e-bikes, and explain their influence on the achievement of the green transport target. Studies could also focus on the influence of the four independent variables of this research on the second green transport target, proposed by the municipality of Vancouver. Finally, future research could be conducted on other case studies, so that general results could be concluded on this topic.

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Annex 1: Research Instruments and Time schedule

Questionnaire

Institute for Housing and Urban Development Studies (IHS)

Erasmus University Rotterdam, The Netherlands

Questionnaires

Introduction: Hi! My name is Fatima Marashi. I am currently a masters' student at the Institute of Housing and Urban Development of the Erasmus University of Rotterdam, in the field of Urban Management and Development. I want to thank you for your participation. For my thesis, I am studying the green transportation plan in the Downtown and West End Vancouver neighbourhoods. I would like to gather information about the influence of the specific implemented instruments, as a part of the green transportation plan from 2015 to 2020.

Your participation in this survey should help me fulfil my masters' degree. This survey will take 15 to 20 minutes of your time.

Thank you for your participation.

Part 1: General Information

1	How old are you?	☐ <20 ☐ 20-30 ☐ 30-40 ☐ 40-50 ☐ 50-60 ☐ 60-70 ☐ >70
2	What is your gender?	☐ Female ☐ Male ☐ Other
3	Do you live in Downtown or West End?	☐ Yes ☐ No
4	What is your main mode of transport?	☐ Walking ☐ Cycling ☐ Transit ☐ Private Car ☐ Car sharing ☐ Other
5	Do you have children?	☐ Yes ☐ No

6	Do you have difficulty …	☐ doing everyday activities such as eating, showering, or dressing ☐ talking to or hearing other people ☐ walking, kneeling, or climbing stairs ☐ sight problems not corrected by glasses or contact lenses

Part 2: Transportation Safety

Please circle the number that express the degree of your agreement to the statements below:

		1. Strongly disagree	2. Disagree	3. Neutral	4. Agree	5. Strongly agree
7	When walking in Downtown and West End, the speed of cars passing annoy me.	1	2	3	4	5
8	When cycling in my Downtown and West End, the speed of cars passing annoy me.	1	2	3	4	5
9	My cycling experience is not affected by my age.	1	2	3	4	5
10	I believe my gender has no effect on my cycling experience.	1	2	3	4	5
11	I feel safe and comfortable when using parent and child tandem bicycles. *	1	2	3	4	5
12	I feel safe and comfortable when my child is cycling. *	1	2	3	4	5
13	My physical disability does not affect my cycling experience. **	1	2	3	4	5
14	When cycling in Downtown and West End, the number of cars passing annoy me.	1	2	3	4	5
15	I feel safe when cycling at intersections or crossings.	1	2	3	4	5
16	I feel safe when cycling in Downtown and West End.	1	2	3	4	5
17	I feel satisfied with the quality of cycling routes in Downtown and West End.	1	2	3	4	5
18	I feel satisfied with the level of separation of different modes of transport when cycling in Downtown and West End.	1	2	3	4	5
19	In Downtown and West End, adequate lighting is provided for cyclists.	1	2	3	4	5

* Please answer this question only if your answer to question 5 was ‘Yes’.

** Please answer this question if you selected one of the answers of question 6.

Part 3: Walking and Cycling Network Expansion

20	When walking in the pedestrian routes within my neighbourhood, the routes are integrated.	1. Always	2. Very Often	3. Sometimes	4. Rarely	5. Never
21	It is possible to reach every part of the neighbourhood when walking in the pedestrian network.	1. Always	2. Very Often	3. Sometimes	4. Rarely	5. Never
22	When using the cycling routes within my neighbourhood, the route is integrated.	1. Always	2. Very Often	3. Sometimes	4. Rarely	5. Never
23	It is possible to reach every part of the neighbourhood using the cycling network.	1. Always	2. Very Often	3. Sometimes	4. Rarely	5. Never

Part 4: Greenways

24	How frequently do you walk in the Downtown and West End greenway paths?	1. More than twice a week	2. Twice a week	3. Once a week	4. Less than once a week	5. Never
25	How long it takes you to walk to the nearest greenway?	1. Less than 5 minutes	2. Between 5 to 10 minutes	3. Between 10 to 15 minutes	4. Between 15 to 20 minutes	5. More than 20 minutes
26	How frequently do you cycle in the Downtown and West End greenway paths?	1. More than twice a week	2. Twice a week	3. Once a week	4. Less than once a week	5. Never
27	How long it takes you to cycle to the nearest greenway?	1. Less than 5 minutes	2. Between 5 to 10 minutes	3. Between 10 to 15 minutes	4. Between 15 to 20 minutes	5. More than 20 minutes

Part 5: Bicycle Sharing Program

Please continue answering the questions if your answer to question 28 is not choice 5.

28	How frequently do you use the Mobi bicycle sharing application?	1. Daily	2. On a weekly basis	3. On a monthly basis	4. Occasionally	5. Never
29	I believe the Mobi application fees are reasonable.	1. Strongly disagree	2. Disagree	3. Neutral	4. Agree	5. Strongly agree
30	The payment method(s) of the Mobi bicycle sharing application are convenient.	1. Strongly disagree	2. Disagree	3. Neutral	4. Agree	5. Strongly agree
31	It is easy to use the smartphone application.	1. Strongly disagree	2. Disagree	3. Neutral	4. Agree	5. Strongly agree
32	When using Mobi bicycles, I am satisfied with the bicycle size.	1. Strongly disagree	2. Disagree	3. Neutral	4. Agree	5. Strongly agree
33	Mobi could conveniently be used by/with children. *	1. Strongly disagree	2. Disagree	3. Neutral	4. Agree	5. Strongly agree

* Please answer this question only if your answer to question 5 was ‘Yes’.

Part 6: Achievement of the proposed green transport target

34	How frequently do you walk?	1. Daily	2. On a	3. On a	4.	5. Never

			weekly basis	monthly basis	Occasionally	
35	How frequently do you cycle?	1. Daily	2. On a weekly basis	3. On a monthly basis	4. Occasionally	5. Never
36	How frequently do you use public transit?	1. Daily	2. On a weekly basis	3. On a monthly basis	4. Occasionally	5. Never

Do you have any comments?

Thank you for your participation. The information you provided would be of great help for my research. If you wish to receive the results, please let me know your email address so that I can the results with you. The thesis will be submitted to the school and a copy will be deposited in the IHS library.

Interview Guide

Introduction: Good morning/ Good afternoon! My name is Fatima Marashi. I am currently a masters' student at the Institute of Housing and Urban Development of the Erasmus University of Rotterdam, in the field of Urban Management and Development. I would like to your time for conducting an online interview to answer 28 open-ended questions, through Zoom.

I am conducting this interview for my masters' thesis that is about the influence of transportation safety, network expansion, greenways and bicycle sharing programs on the achievement of the green transportation target, which is "making the majority of trips (over 50%) by foot, bicycle, and public transit" by 2020, proposed by the City of Vancouver.

I want to assure you that this interview would remain anonymous, and your data would be kept confidential and protected. May I ask for your informed consent and may I record the interview? (If the interviewee replies no, then the interview will end.)

I would also like to mention that you could pause, take a break, or stop the interview whenever you want. And please feel free to tell me if you do not want to answer a question.

Part 1: Transportation Safety

Please choose the number that expresses the degree of your agreement to the statements below.

1	A speed limit of 30 km/hr is developed for motorized vehicles. How do you explain the relationship between this limit and pedestrians' perception of safety?					
	When walking in Downtown and West End, the speed of cars passing annoy me.	1. Strongly disagree	2. Disagree	3. Neutral	4. Agree	5. Strongly agree
	Please explain your answer?					
2	How do you think this speed limit makes cyclists feel safe?					
	When cycling in Downtown and West End, the speed of cars passing annoy me.	1. Strongly disagree	2. Disagree	3. Neutral	4. Agree	5. Strongly agree
	Please explain your answer?					
3	The AAA guideline is about safe and comfortable cycling for all ages. How would you explain elderlies experience of cycling in Downtown and West End Vancouver, after implementing the plan?					
	My cycling experience is not affected by my age.	1. Strongly disagree	2. Disagree	3. Neutral	4. Agree	5. Strongly agree
	Please explain your answer?					
4	The aim of the AAA guideline is to make cycling possible for everyone. How would you explain the experience of different genders when cycling, after implementing the plan?					
	I believe my gender has no effect on my cycling experience.	1. Strongly disagree	2. Disagree	3. Neutral	4. Agree	5. Strongly agree
	Please explain your answer?					
5	Based on the AAA guideline, adequate infrastructure should be provided to make cycling comfortable for all. How would you explain parents' perception of comfort when riding parent and child tandem bicycles?					
	I feel safe and comfortable when using parent and child tandem bicycles.	1. Strongly disagree	2. Disagree	3. Neutral	4. Agree	5. Strongly agree
	Please explain your answer?					
6	How would you explain parents' perception of comfort and safety when their child is riding bicycles individually?					

	I feel safe and comfortable when my child is cycling.	1. Strongly disagree	2. Disagree	3. Neutral	4. Agree	5. Strongly agree
	Please explain your answer?					
7	How would you describe the cycling experience of people with disabilities?					
	My physical disability does not affect my cycling experience	1. Strongly disagree	2. Disagree	3. Neutral	4. Agree	5. Strongly agree
	Please explain your answer?					
8	Based on the AAA guideline, the volume of cars passing from streets must be limited to below 500 cars per day. How does this regulation affect cyclists?					
	When cycling in Downtown and West End, the number of cars passing annoy me.	1. Strongly disagree	2. Disagree	3. Neutral	4. Agree	5. Strongly agree
	Please explain your answer?					
9	Based on the AAA guideline, how would you explain cyclists feeling of safety when passing the intersections and crossing?					
	I feel safe when cycling in intersections or crossings.	1. Strongly disagree	2. Disagree	3. Neutral	4. Agree	5. Strongly agree
	Please explain your answer?					
10	How do you explain cyclists feeling of safety when cycling?					
	I feel safe when cycling in Downtown and West End.	1. Strongly disagree	2. Disagree	3. Neutral	4. Agree	5. Strongly agree
	Please explain your answer?					
11	Based on the development of the AAA guideline, how do you explain the quality of cycling routes?					
	I feel satisfied with the quality of cycling routes in Downtown and West End.	1. Strongly disagree	2. Disagree	3. Neutral	4. Agree	5. Strongly agree
	Please explain your answer?					
12	Based on the development of the AAA guideline, how do you explain the level of separation for cycling routes?					
	I feel satisfied with the level of separation of different modes of transport when cycling in Downtown and West End.	1. Strongly disagree	2. Disagree	3. Neutral	4. Agree	5. Strongly agree
	Please explain your answer?					
13	How would you explain the lightning of the cycling routes?					
	In Downtown and West End Vancouver, adequate lighting is provided for cyclists.	1. Strongly disagree	2. Disagree	3. Neutral	4. Agree	5. Strongly agree
	Please explain your answer?					

Part 2: Walking and Cycling Network Expansion

14	Regarding the expansion in the pedestrian's network, how do you explain the level of network integration?					
	When walking in the pedestrian routes within my neighbourhood, the routes are integrated.	1. Always	2. Very Often	3. Sometimes	4. Rarely	5. Never

	Please explain your answer?					
15	How do you explain the connectivity of the pedestrian network?					
	It is possible to reach every part of the neighbourhood when walking in the pedestrian network.	1. Always	2. Very Often	3. Sometimes	4. Rarely	5. Never
	Please explain your answer?					
16	Regarding the expansion in the cycling network, how do you explain the level of cycling network integration?					
	When using the cycling routes within my neighbourhood, the route is integrated.	1. Always	2. Very Often	3. Sometimes	4. Rarely	5. Never
	Please explain your answer?					
17	How is the cycling network connected to other cycling routes? How do you explain its connectivity?					
	It is possible to reach every part of the neighbourhood using the cycling network.	1. Always	2. Very Often	3. Sometimes	4. Rarely	5. Never
	Please explain your answer?					

Part 3: Greenways

18	How would you explain the resident's frequency of walking in the greenways?					
	How frequently do you walk in the Downtown and West End greenway paths?	1. More than twice a week	2. Twice a week	3. Once a week	4. Less than once a week	5. Never
	Please explain your answer?					
19	Regarding the aim of the greenways, how do you explain the required time for reaching the greenway when walking?					
	How long it takes you to walk to the nearest greenway?	1. Less than 5 minutes	2. Between 5 to 10 minutes	3. Between 10 to 15 minutes	4. Between 15 to 20 minutes	5. More than 20 minutes
	Please explain your answer?					
20	How would you explain the resident's frequency of cycling in the greenways?					
	How frequently do you cycle in the Downtown and West End greenway paths?	1. More than twice a week	2. Twice a week	3. Once a week	4. Less than once a week	5. Never
	Please explain your answer?					
21	How do you explain the time taken to reach the greenway when cycling?					
	How long it takes you to cycle to the nearest greenway?	1. Less than 5 minutes	2. Between 5 to 10 minutes	3. Between 10 to 15 minutes	4. Between 15 to 20 minutes	5. More than 20 minutes
	Please explain your answer?					

Part 4: Bicycle Sharing Program

22	With the expansion of the Mobi program, how do you explain the frequency of its usage by the residents?					
	How frequently do you use the Mobi bicycle sharing application?	1. Daily	2. On a weekly basis	3. On a monthly basis	4. Occasionally	5. Never
	Please explain why?					

23	How are the fees set for the Mobi bicycle sharing application reasonable?					
	I believe the Mobi application fees are reasonable.	1. Strongly disagree	2. Disagree	3. Neutral	4. Agree	5. Strongly agree
	Please explain why?					
24	How convenient is the payment method(s)?					
	The payment method(s) of the Mobi bicycle sharing application are convenient.	1. Strongly disagree	2. Disagree	3. Neutral	4. Agree	5. Strongly agree
	Please explain why?					
25	How convenient is the Mobi smartphone application for users?					
	It is easy to use the smartphone application.	1. Strongly disagree	2. Disagree	3. Neutral	4. Agree	5. Strongly agree
	Please explain why?					
26	The size of the bicycle could be a challenge for the users. How are the Mobi shared bicycles comfortable for different people?					
	When using Mobi bicycles, I am satisfied with the bicycle size.	1. Strongly disagree	2. Disagree	3. Neutral	4. Agree	5. Strongly agree
	Please explain why?					
27	One of the challenges of cycling for parents is taking their children with them. How does the Mobi bicycle sharing program provide bicycles that could be used with children? Or children could use them individually?					
	Mobi could conveniently be used by/with children.	1. Strongly disagree	2. Disagree	3. Neutral	4. Agree	5. Strongly agree
	Please explain why?					

Part 5: Achievement of the proposed green transport target

28	The first target of the green transportation plan is to make over 50% of the trips by foot, bicycle, or transit. How would you explain the achievement of this target? What were the main takeaways from the process of achieving this target?					
	How frequently do you walk or cycle?	1. Daily	2. On a weekly basis	3. On a monthly basis	4. Occasionally	5. Never
	How frequently do you cycle?	1. Daily	2. On a weekly basis	3. On a monthly basis	4. Occasionally	5. Never
	How frequently do you use private vehicle?	1. Daily	2. On a weekly basis	3. On a monthly basis	4. Occasionally	5. Never
	Please explain why?					

Do you have any comments?

Thank you for your participation. The information you provided would be of great help for my research. If you wish to receive the results, please let me know your email address so that I can the results with you. The thesis will be submitted to the school and a copy will be deposited in the IHS library.

Annex 2: Statistical Test Results

Pearson correlation between the independent variables

	Transportation safety	Network expansion	Greenways	Bicycle sharing program
Transportation safety	1	-0.289	-0.118	0.296
Network expansion	-0.289	1	0.252	0.06
Greenways	-0.118	0.252	1	0.237
Bicycle sharing program	0.296	0.06	0.237	1

All the correlations are significant at the 0.01 level (2-tailed)

Number of respondents (N) = 66

Annex 3: Atlas.ti Query Tool Results

A summary of the results of the query tool on the transportation safety variable with the other independent variables is presented in this part.

The reason behind women cycling less could be a problem of safety and a problem of the network. Since the network development is more male-dominated.	Transportation safety and network expansion	R1
You cannot reach all your destinations through the safe, protected cycling network.	Transportation safety and network expansion	R1
When the greenways as protected routes that provide more safety, are connected to the network, a sudden rise happens in cycling rates.	Transportation safety, network expansion, and greenways	R1
The municipality communicates with the residents that with the cycling network which routes are safe and for example could be used by families.	Transportation safety and network expansion	R2
Through the developments made to extend the cycling network, not all the added intersections are protected.	Transportation safety and network expansion	R3
We want to expand the network so that everyone is within a reasonable distance from the AAA cycling facility.	Transportation safety and network expansion	R4
We need to expand the network and improve the safety along it to see a rise in numbers. I think the biggest contributor is just making sure you have a connected network of comfortable facilities for cycling, I think that's been the biggest contributor in terms of improving cycling volumes, is this improving the number of opportunities for separation and the number of places people can get on a separated bike route.	Transportation safety and network expansion	R4, R5
Many parents take out their kids for cycling along the greenway or the protected bike lanes. But they may be hesitant to cycle on local streets with kids.	Transportation safety and greenways	R3
Greenways as nice streets with trees and vegetation provide fully separated bike lanes and low vehicle volume, so they can encourage people to walk and cycle.	Transportation safety and greenways	R4, R5

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