How innovative city planning can aid healthy aging in place

Evaluating the success of the Comox-Helmcken Greenway under the aspect of age-friendly community planning

by

Stephan Zimmermann

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Examining Committee:	**Chair:** Tyler Carlson Master of Resource Management Candidate

Sean Markey
Senior Supervisor
Associate Professor

Meghan Winters
Supervisor
Assistant Professor
Faculty of Health Sciences

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Ethics Statement

The author, whose name appears on the title page of this work, has obtained, for the research described in this work, either:

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Abstract

Canada’s aging population will require retrofitting our communities to become age-friendly communities that encourage active aging. In this research project a subset of data from the ‘Active Streets, Active People’ research study was analyzed to evaluate the success of the Comox-Helmcken Greenway in downtown Vancouver, B.C. I compared three days of coupled GPS/Accelerometry data for 111 study participants aged > 60 from prior and post construction of the greenway. The construction did not lead to increased levels of active transportation among the study participants, however our data suggests that the improvements along the corridor elevated the neighbourhood street to a more valuable public space. The findings revealed increased use of Comox Street as a walking corridor, and confirmed implementation of many age-friendly features. This research highlights the significance of interdisciplinary research to community planning and calls for more research evaluating the links between older adults’ well-being and the built environment.

Keywords: Comox-Helmcken Greenway; Aging in Place; Age-friendly; Sustainable Community Planning; Active Transportation

Dedication

This research project is dedicated to my wonderful wife for always believing in me and constantly pushing me forward by supporting me through her love, positive attitude in life and genuine interest in my work.

I also would like to dedicate this work to my hard-working and ever supporting parents, who despite 'losing' their son to another continent, always encouraged everything I wanted to pursue with trust, love, and support.

Lastly, I dedicate my research work to the many progressive city planners around the world that put human well-being and active transportation for all ages and abilities into the focus of their daily work.

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List of Acronyms

ASAP	Active Streets, Active People (Research Study)
AARP	American Association of Retired Persons
BC	British Columbia
SWEAT-R	Seniors Walkability Environment Audit Tool-Revised
GIS	Geographic Information System
GPS	Global Positioning System.
WHO	World Health Organization
WCED	(United Nations) World Commission on Environment and Development
OCP	Official Community Plan
T1	Time period of data collection prior to construction of the greenway
T2	Time period of data collection post construction of the greenway

Glossary

Active transportation	Active transportation refers to any travel mode that encompasses some form of physical activity. Generally this would be walking, cycling and transit as it includes walking to/from transit stops. It can also include alternative travel methods, such as running, kayaking, skiing, uni-cycling etc.
Age-friendliness	Age-friendliness is a term used to describe features of the built environment or policy environments that are designed to consider the needs and demands of older adults. The design of age-friendly features however benefits all ages and often improves accessibility for people of all abilities.
Comox-Helmcken Greenway	The Comox-Helmcken Greenway is a multi-modal transportation corridor in Vancouver, B.C. The proposed route of the greenway would connect the False Creek seawall in the southeast of the downtown peninsula with Stanley Park in the northwest of the city. The first section of the greenway was constructed in July 2013, and the second section via Helmcken Street is not yet constructed.
Walkability	The term walkability is commonly used to describe an areas' or neighbourhood's level of facilitating walking as the common mode to accomplish tasks and errands of daily life. In the context of this research paper, walkability is referred to by implicitly focusing on the street level and built environment features that make a neighbourhood walkable.

Chapter 1.

Introduction

Worldwide, the proportion of people aged 60 and over is growing faster than any other age group, and the World Health Organization (WHO), projects two billion people at the age of 60 and over by 2050 (World Health Organization, 2002).WHO and many other international institutions are warning politicians, policy makers, community planners, and the general public to prepare for a changing demographic.

Consequently, the aging population will require policy makers, planners and municipal governments across the globe to change their mindset and focus on making our communities age-friendly. In order to lead and initiate policy changes in countries affected by an aging population, the WHO introduced the “Active Ageing” and “Age-friendly cities” frameworks in 2002, outlining the key issues related to the development, research, and implementation of policies for making our communities age-friendly. The government in British Columbia was influential in the development of these frameworks, and in 2008 developed a provincial ‘Healthy Living Framework’ to address the anticipated increase in the proportion of BC’s population of people older than 65 (25% of BC’s population will be 65 years or older by 2031 based on estimates) (British Columbia Ministry of Healthy Living and Sports, 2008; Plouffe et al., 2012).

On a regional scale, many communities including the City of Vancouver have realized that city planning and policies need to take into consideration the changing demographics, and plan for the challenges and opportunities that result from an aging population (City of Vancouver, 2012a).

In 2002, the city council of Vancouver passed the Downtown Transportation Plan (City of Vancouver, 2002), and started developing the Comox-Helmcken Greenway, a multi-modal transportation corridor through Vancouver’s residential neighbourhoods -

West End and Yaletown - and the downtown core. In June 2013, the City of Vancouver finished construction on the first phase of the Comox-Helmcken Greenway. The greenway route was designed to improve neighbourhood accessibility, connectivity and street aesthetics, and enable the safe use of multiple transportation users – cyclists, pedestrians and car traffic. The Comox-Helmcken Greenway was planned to “encourage people of all ages and abilities to explore their city by foot, bicycle, wheelchair and stroller” and “provide places to sit, rest and socialize” (City of Vancouver, 2015).

The construction of the greenway provided a rare opportunity to evaluate the real life impacts of substantial changes to the built environment. Capitalizing on this natural experiment, the Centre for Hip Health and Mobility initiated an innovative three-year longitudinal study – Active Streets, Active People (ASAP) - to study the links between the built environment, mobility and healthy aging.

Being part of the ASAP research team, I developed the idea to use data derived from the ASAP study to explore and evaluate the impacts of the greenway construction on older adults living along the greenway, and assess the greenway’s influence on the neighbourhood’s age-friendliness. From an age-friendly community planning perspective, this research project aims to evaluate the success of the first phase of the Comox-Helmcken Greenway in improving the lives and mobility of older adults in the West End. The project aims to evaluate whether the improvements on the corridor enabled and/or motivated older adults in the neighbourhood to use alternative modes of transportation. The study will evaluate potential changes in the transportation behaviours and route choices of older adults living near the greenway route. Based on a literature review and by assessing the city plans for the greenway, I will evaluate how the greenway design implemented measures of age-friendliness.

In chapter two, an extensive literature review explores the foundations of sustainable community planning and age-friendly community planning, presenting the significance of the built environment to our health overall, and even more so to the well-being of older adults in our society. Specifically, I will explain why older adults prefer to age in place and how the psychological phenomenon of place attachment is highly influential to planning livable communities that focus on human well-being. Further, the chapter explores the links between the built environment and physical and mental health.

Chapter three highlights Vancouver's sustainable transportation planning agenda and its efforts in promoting active transportation and building sustainable communities. It also provides a detailed look at the plans for the Comox-Helmcken Greenway. This chapter will introduce the West End neighbourhood which most of the participants in the ASAP study call home, and that is being traversed by the Comox-Helmcken Greenway. An overview of the ASAP study, its key purpose and hypotheses, as well as an explanation of the mixed-method approach used in the study is meant to highlight the original research project at the Centre for Hip Health and Mobility. Then I will introduce you to my own research project, its key hypotheses and methodology. In this research project I analyzed 3 days of GPS and accelerometry data for each of 111 older adults residing in the West End neighbourhood. The study participants wore GPS units and accelerometers at their hips for about one week each for a study period in fall 2012, prior to the construction of the greenway, and again in the fall of 2014, after the greenway had been constructed. All collected data was processed following protocols of the ASAP study research team, and individual data were extracted for the purpose of providing information on number of trips, trip modes and durations for each of the 111 study participants.

In chapter four I present the findings of my work by introducing results of street audits done by researchers of the ASAP study team before giving you an overview of the results of my individual research project. The chapter presents detailed results, categorized in trips taken vs. mode share for both T1 and T2, as well as results from a traffic volume mapping exercise for Comox Street and Barclay Street, are presented. A quick overview of the weather, mean daily temperature and total daily precipitation, during the study period are meant to provide the necessary context for the subsequent analysis section.

Chapter five presents the discussion section, which highlights and analyses the key findings from this research project and puts my findings and research hypotheses into context with findings from the extensive literature review. In this chapter I will discuss how the changes to the built environment along the corridor improved the walkability and age-friendliness of the area through traffic-calming measures and improving the attractiveness of Comox Street. The term walkability is commonly used to describe an areas' or neighbourhood's level of facilitating walking as the common mode to accomplish tasks and errands of daily life. The walkability of an area is defined by features and elements of the built environment, as well as the availability of nearby services and amenities. Often the term 'walkscore' is used to rate the walkability of an area. In the context of this research paper, walkability is referred to by implicitly focusing on the street level and built environment features that make a neighbourhood walkable

This section will explore levels of active transportation uptake of our study participants prior and post construction of the greenway, and provide a detailed look at how different sections of Comox Street are being used by the participants of the ASAP study.

The final conclusion highlights the importance of age-friendly community planning now and in the future, and how interdisciplinary research work between planners, policy makers and public health researchers can contribute significantly to the livability of our communities and the well-being of older adults in our society.

Chapter 2.

The Nexus of Aging in Place and Sustainable Community Planning – A Literature Review

2.1. Sustainable Community Planning

Sustainable Community Planning refers to the concept of planning sustainable development in our communities. Sustainable development is meant to achieve an appropriate balance between the three key pillars of sustainability: environment, economy and society (Meadowcroft, 2007; Roseland, 2012). For the concept of sustainable development this means that environmental considerations must be entrenched in economic policy making. Further, in economic terms, development should not just refer to growth in quantitative measures, but should also have a commitment to social equity (Roseland, 2012).

In the past century, the concept of sustainable development has been recognized as a tool to solve the conflict between environmental protection and economic growth (Roseland, 2000). However, there is no clear definition of sustainable development to date that may effectively guide politicians, policy makers, or planners as the term is open to contradictions (Holden, Linnerud, & Banister, 2014; Roseland, 2012). For example, the terms *sustainable growth* or *sustainable use* do not relate to the idea of sustainable development per se (Roseland, 2012), but are often mistakenly associated with sustainable development. Roseland argues that "sustainable development represents a "historic compromise" between the ideology of capitalism and its environmental critique" (Roseland, 2000, p. 76).

The term 'sustainability' originates from ecological science, and was first framed in a planning and policy context through the Brundtland report (1987), commissioned by the UN World Commission on Environment and Development (WCED). In its essence, the term 'sustainability' was developed to express the conditions that must be present for the ecosystem to sustain itself over the long term (Holden et al., 2014). The Brundtland report defined sustainable development as "development that meets the needs of the present without comprising the ability of future generations to meet their own needs'' (World Commission on Environment and Development, 1987, p. 43).

Untangling the definition by the WCED reveals four key dimensions that are relevant to sustainable development: long-term ecological sustainability, satisfying basic human needs, and promoting intragenerational and intergenerational equity. The Brundtland report also refers to several secondary dimensions of sustainable development, namely: preserving nature's intrinsic value, promoting the protection of the environment, promoting public participation and satisfying aspirations for an improved quality of life (Holden et al., 2014).

Sustainable Community Planning targets these dimensions by trying to achieve 'whole' and 'livable' communities that promote sustainable practices and enhance human well-being. Sustainable Community Planning centres around the concept of planning places where people want to live and work, "meeting the diverse needs of existing and future residents", places that are "sensitive to their environment and contribute to a high quality of life", and places which are "safe and inclusive, well planned, built and run, and offer equality of opportunity and good services for all" (Wong, Sadler, & Rogerson, 2010, p. 506). In the context of practicing sustainable community planning, Roseland states that "sustainable development requires fundamental economic and social change", and that it must be "a proactive strategy to develop sustainability" (Roseland, 2012, p. 7). He argues that sustainable community development shall be achieved by strengthening community capital, and developed the community capital framework to help planners and policy makers in planning sustainable communities (Roseland, 2012)[1].

The Ontario Institute of Planning defines sustainability in the context of community planning as relating to some forms of community capital, such as: *Urban Form*, *Transportation Services,* and *Infrastructure* (Horton, McKibbon, & Pavan, 2007). Good *urban form* is meant to be functional, economically and environmentally sustainable, and liveable in a way that it promotes public health. Planning communities with good urban

[1] A detailed description of Roseland's community capital framework is outside of the scope of this research project. Refer to Roseland's book "Towards Sustainable Communities: solutions for citizens and their governments" (Roseland, 2012)

form means planning complete, compact communities that have a clear structure of neighbourhoods, defined by centres, nodes, and multi-modal corridors. *Transportation services* need to accommodate alternative ways of transportation, as an automobile centred transportation system is seen as unsustainable. *Infrastructure* needs to be kept up to date and support a sustainable urban form, as the infrastructure of a community can be seen as the foundation upon which a sustainable community is built. (Horton et al., 2007)

At a policy level, governments across the globe are increasingly realizing the opportunities and the need to plan our communities sustainably. In 2009, governments in the US and Canada recognized Sustainable Community Planning nationally, implementing the 'Partnership for Sustainable Communities' in the US, and the 'EQuilibrium™ Communities' Initiative in Canada, with the intention of promoting sustainable development in their communities by improving access to affordable housing and public transportation, and funding research for sustainable development and sustainable community planning (Roseland, 2012). In the United Kingdom, policies for sustainable community development focus on higher-quality urban design, environmental awareness and social well-being as key elements, reaffirming the WCED sustainability dimensions of promoting the protection of the environment, promoting public participation and satisfying aspirations for an improved quality of life (Wong et al., 2010) .

The latter two dimensions play a key role in age-friendly community planning, which will be explored in the following chapter of this research paper. Planning for age-friendly communities is part of a trending stream of recent planning initiatives in North America that bring people and their well-being into the centre of planning theory and practice (Menec, Means, Keating, Parkhurst, & Eales, 2011). Planning initiatives such as smart growth, healthy communities, and livable communities are all part of this new era in planning. In the following sections I present literature on aging in place and age friendly planning, which narrows and refines the conceptual lens of the research related to sustainable community planning.

2.2. Aging in place: Age-friendly community planning

2.2.1. Aging in place and place attachment

The concept of Aging in Place has been common in gerontological health research for the past 30 years (Matlo, 2013), and through an increasing focus of public health research on age-friendly design and health promoting environments, it has emerged within other disciplines, such as Sustainable Community Planning, Urban Planning, and Urban Design. Aging in place constitutes people's desire to remain in their communities while they age, while maintaining their mobility and independence (which contributes to their overall physical and mental well-being) (Webber, Porter, & Menec, 2010).

Researchers, policy institutes, health care providers, planners, and many other professionals agree that many older adults want to age in place. A study by the policy Institute of the American Association of Retired Persons (AARP) reports the majority of respondents aged 50 and older, wanted to remain in their current homes or communities (71 percent of respondents), and that the desire to age in place only increases with age (Harrell, Lynott, Guzman, & Lampkin, 2014). Survey results by MetLife, an American life insurer, confirm these findings (MetLife Mature Market Institute, 2013). Planners in both the United States and Canada realize the necessity to re-evaluate the design of our communities, as the aging "baby boomers" are looking to retire in their existing communities, and prefer to age in place (Buffel et al., 2012; Hodge, 2008; Matlo, 2013; Michael, Green, & Farquhar, 2006; Scharlach & Report, 2009).

Harrell et al. (2014) and Matlo (2013) refer to Aging in Place as the ability to live in one's home and community safely, independently, and comfortably — regardless of age, income, or ability level. Matlo (2013, p. 24) describes optimal aging in place is attained when "an individual is able to remain in their environment of choice, regardless of physical and cognitive changes with the responsive economic and social environmental resources available to them". The interaction between the social (social network of family, friends, and neighbours) and built environments (urban form, infrastructure and transportation) in these environments of choice support the changing needs of the individual and helps to maintain their autonomy, sense of continuity, and independence.

Aging in Place is inherently linked to the phenomenon of place attachment (Matlo, 2013; Scharlach & Report, 2009). Place attachment, or 'attachment to place' as it is often referred to by geographers, is a psychologically driven phenomenon referred to as **"**one's socio-culturally mediated emotional connection to a particular physical location, and the ongoing effort to create and preserve meaning through place-centered activity" (Scharlach & Report, 2009, p. 7). Attachment to place centers on the concept that familiar places represent geographies of well-being, safety, intimacy, and memories. Attachment to place needs time to develop, but the time factor alone does not constitute an attachment to a particular place. Rather, factors such as sense of belonging, autonomy, independence, and sense of self need to exist in order to build an attachment to place (Buffel et al., 2012). Place attachment is highly influenced by the social well-being. There is a reflexive relationship between 'attachment to place' and mental well-being. 'Attachment to place' influences one's personal identity – which thus affects well-being – and at the same time a person's own identity, self- and social awareness stimulates attachment to place (Franke, Tong, Ashe, McKay, & Sims-Gould, 2013).

Gardner (2011) examined the importance of neighbourhoods, and so-called natural neighbourhood networks through face-to-face interviews with older adults in Toronto and found out that 'third places', public places such as malls, parks, or community centres in the neighbourhood, were significant contributors in maintaining social well-being among older adults. The strong feelings of comfort and a sense of belonging contributed to the place attachment of these older adults. Findings from a study in Auckland, NZ confirmed the significance of the role of one's neighbourhood for successful aging in place (Gardner, 2011). A sense of community enables people to draw meaning, security, and a sense of identity. As well, attachment to place facilitates successful adjustments in old age, helping seniors to feel secure and 'grounded'(Wiles et al., 2009), when shrinking social spaces can cause issues of poor mental health, and subsequently affect physical health (Buffel et al., 2012; Gardner, 2011; Wiles et al., 2009).

Aging in Place and Sustainable Community Planning are intertwined issues as both ultimately seek the same goal: planning inclusive, sustainable communities that enhance human well-being. Both concepts also focus on a holistic, integrated approach to achieve these goals (Franke et al., 2013; Wong et al., 2010).

The concept of Aging in Place drives the idea of designing our communities in an age-friendly way, by planning communities after principles akin to key components of Sustainable Community Planning. Thompson & Kent (2014) stress the importance on how the built environment can promote healthy aging in place by promoting active transportation, facilitating connective communities, and ensuring equitable access to food.

In the following sections I will define the concept of age-friendly community planning, highlight how the built environment contributes to age-friendliness, and what factors of the built environment should be considered when planning age-friendly communities.

2.2.2. Planning for age-friendly communities

In 2006 the WHO launched the global Age-friendly Cities project, a concept developed out of the Active Ageing framework from 2002 (Menec et al., 2011). Since then, the age-friendly community program has been a growing movement, yet there is no universally accepted definition to date (Novek & Menec, 2013). The WHO defines age-friendly cities as cities that establish policies, services, settings and structures that support active aging. The concept of active aging is tied closely to the concept of Aging in Place, as it describes a "process optimizing opportunities for health, participation and security in order to enhance quality of life as people age" (World Health Organization, 2007, p. 5). The links between the three concepts, Active Aging, Aging in Place, and Age-friendly communities, become clear with Matlo's definition of age-friendly communities. An age-friendly community simply defines a community that is optimal for Aging in Place (Matlo, 2013), and encourages active aging. The concept of age-friendly communities focuses on the built environment and its effect on older adults' ability to age in place, with the goal of enabling and optimizing the mobility of older adults. Yet, age-friendly communities should also encompass policies and programs promoting a healthy social environment, such as promoting social and civic engagement, minimizing effects of isolation, and enabling mental well-being (Novek & Menec, 2013).

As mentioned above, age-friendly communities are places that facilitate aging in place by encouraging active aging. There is a wide range of factors that facilitate age-friendliness, and many of these can be addressed by planning the built environment to include features which are age-friendly. The built environment affects the social and physical activities of people, and older adults in particular, in constraining or supporting their mobility (e.g., the ability to move around in one's neighbourhood and maintain independence (Webber et al., 2010; Winters et al., 2014)).This chapter will explore the significance of physical activity and social activity to the wellbeing of older adults, and how we can design our built environment to facilitate successful aging in place.

Health benefits of physical activity

Physical activity greatly benefits the health of older adults. The link between the built environment and its influence on physical activity and health has been recognized as an important issue of public health (Carlson, Aytur, Gardner, & Rogers, 2012; Kaczynski, Potwarka, Smale, & Havitz, 2009; Winters et al., 2014). Physical activity improves and strengthens the physical and mental health of older adults, thus it is one of the key strategies of active aging (World Health Organization, 2007; World Health Organization, 2002).

In cross-sectional studies, more walking has been associated with lower body fat, more favorable cholesterol and glucose levels (Ward Thompson, Curl, Aspinall, Alves, & Zuin, 2012), higher aerobic capacity (Wong et al., 2010), and less likelihood of metabolic syndrome (J. Kerr, Rosenberg, & Frank, 2012). Furthermore, walking as a form of physical activity is known to improve or prevent a variety of health conditions among older adults, such as osteoarthritis, diabetes, colon cancer, hypertension, and dementia (J. Kerr et al., 2012). On the contrary, sedentary behavior is associated with several health concerns, independent of physical activity levels, including weight gain, metabolic syndrome, diabetes, and heart disease (J. Kerr et al., 2012). “Given the well established associations between physical inactivity and chronic disease risk, well designed neighbourhoods may ultimately influence one’s health” (Winters et al., 2014, p. 8).

Physical activity also affects the mental health of older adults by utilizing their resourcefulness and boosting their personal self-esteem. Interviews with older adults in downtown Vancouver showed that older adults use physical activity as a means to cope with, and conquer, personal challenges (Franke et al., 2013). In effect, being physically active has positive impacts on their overall well-being, self-efficacy, and overall life adaptability (Franke et al., 2013). More active individuals are less depressed and anxious, have higher ratings of quality of life, and are generally more social (J. Kerr et al., 2012).

Significance of social activity to well-being

Social activity is a significant component to well-being, and especially for older adults it is highly influential to their overall well-being. Thompson & Kent (2014) characterize social connectedness in the neighbourhood and social interaction - such as "the commonplace meeting and greeting of different people who occupy, and pass through the same places at the same time" - as small-scale exchanges that "strengthen the connection between people" and induce a care for each other. This in turn highly influences perceptions of safety in a neighbourhood, which is one of the key features of an age-friendly neighbourhood (Franke et al., 2013; Harrell et al., 2014; MetLife Mature Market Institute, 2013).

Social activity and interaction in one's neighbourhood creates a 'natural neighbourhood network' of communal support, which often can substantially contribute to the overall well-being of older adults by adding to an existing support network of family and close friends, or even partially replacing a family support network (Gardner, 2011). Social activity highly influences feelings of 'attachment to place' and can also be seen as an expression of place attachment itself (see 2.2.1). A built environment that supports social activity by offering meeting places, accessible services, and recreation opportunities, will in turn contribute to the well-being of older adults.

How we can facilitate successful aging in place by designing our built environment in ways that enable older adults to be physically and socially active will be explored in the following sections.

Built environment and physical activity

One of the key components of creating age-friendly communities is to encourage and facilitate physical activity, both for transportation and recreation (British Columbia Ministry of Healthy Living and Sports, 2008; Mahaffey, 2010; World Health Organization, 2007; Plouffe et al., 2012; Public Health Agency of Canada, 2012; World Health Organization, 2002). Research in the transportation, urban planning, and public health fields indicates that people are more active in accessible neighborhoods with mixed land uses, high street connectivity, and greater population density (Hanson, Winters, Ashe, & McKay, 2012; Michael et al., 2006; Thompson & Kent, 2014; Winters et al., 2014). King et al. (2011) found that those living in walkable neighborhoods with even the lowest levels of function still walked more than people in unwalkable neighborhoods. This indicates the significant role of a well-designed built environment in getting people active. There are several factors of the built environment, the part of the physical environment that is constructed by human activity (Saelens & Handy, 2008), that promote physical activity among older adults. These factors can be categorized into five key issues: access to public transportation, access to amenities and services, street connectivity and neighbourhood safety, parks and greenspaces, and aesthetics and scenery (Harrell et al., 2014). Also, perceptions and the weather may be significant factors affecting physical activity levels among older adults.

Access to public transportation

Public transportation can be considered as a form of active transportation, due to the fact that people have to walk to and from bus stops to get to their destinations. Findings by Franke et al. (2013) and Winters et al. (2014) showed that many older adults in Vancouver's downtown neighbourhoods use public transportation. Surveys in the United States revealed the high value placed upon affordable and accessible transportation by seniors (Harrell et al., 2014; MetLife Mature Market Institute, 2013).

Access to amenities and services

Access to amenities and services is one of the key facilitators of age-friendliness that promotes physical activity (Franke et al., 2013; Hanson et al., 2012; Kerr, Rosenberg, & Frank, 2012; Winters et al., 2014). In a literature review Saelens & Handy (2008) found sufficient evidence to conclude that the accessibility of amenities is influenced by the distance to such destinations. There seems to be a correlation between distance to amenities and transportation walking. The walkability of a neighbourhood is a key component of modern day real estate assessments; and the WalkScores®, calculated based on the distance to shops and amenities, such as banks or libraries, are commonly used in practice and research. Researchers have developed walkability indices for neighbourhoods and cities in North America using parcel-level information. Frank et al.'s walkability index, rated the walkability of the built environment using four components: residential density, access to amenities (malls, grocery stores), land-use and zoning, and street connectivity (Frank et al., 2010). Further, the accessibility of nearby amenities and services is not only an important factor contributing to physical activity, but also a key component of the social space for older adults (Gardner, 2011). Older adults like having places to stop and rest while walking (J. Kerr et al., 2012), which may encourages walking to retail-based destinations (Franke et al., 2013).

Street connectivity and neighbourhood safety

Personal safety and traffic safety, as well as street connectivity are key barriers or facilitators for mobility among older adults. These issues are key considerations for choosing whether and where older adults will walk; and they are re-occurring themes in survey results, content analyses, and other studies (Franke et al., 2013; Gardner, 2011; Harrell et al., 2014; MetLife Mature Market Institute, 2013; Strach, Isaacs, & Greenwald, 2007; Wiles et al., 2009). In a UK study with older adults, Carlson, Aytur, Gardner, & Rogers (2012) concluded that the strongest associations with destination walking were found for sidewalks and connectivity. Survey respondents who mentioned that there were few places to walk safely, reported walking to significantly fewer locations and less often (Carlson et al., 2012). In general, aspects of the built environment such as uneven sidewalks, slippery or uneven surfaces, hills, cars parked on sidewalks, cleanliness, traffic noise, and air pollution are key barriers to physical activity among older adults (Franke et al., 2013), as these issues influence feelings of traffic safety and the potential for falls and injuries. The elimination of such mobility barriers enhance age-friendliness by enabling physical activity among older adults (Hanson et al., 2012; Novek & Menec, 2013; Webber et al., 2010). In a content analysis of interviews with older adults in the United States, infrastructure was the most common category identified to encourage physical activity; specifically, well-maintained sidewalks, bike paths or lanes, and traffic control (Strach et al., 2007). Michael et al. (2006) concluded that "for older adults, maximizing the attractiveness or safety of a walking path is more important than minimizing the distance to a destination" (Michael et al., 2006, p. 738).

Parks, Greenspaces and Street Aesthetics

Both in the field of planning and public health, it is well known that parks and greenspaces provide many benefits to city dwellers. Based on recent research, parks are an important community setting for physical activity (Kaczynski et al., 2009). A study with older adults in a mid-sized Canadian city revealed that 32 percent of participants' physical activity happened in their own neighbourhood, and 18 percent of these activities in a park. Access to well-designed green spaces makes the experience of walking more pleasant (Kaczynski et al., 2009). Particularly for older adults, connected greenspaces facilitate neighbourhood walking and physical activity as well as benefit mental health (Franke et al., 2013; Novek & Menec, 2013). A study with older adults in Portland, Oregon confirmed the hypothesis that physical activity is strongly associated with the size and number of green spaces in the neighbourhood. Participants living closer to a greater number of parks were more physically active. Furthermore, the bigger the park was resulted in more time being spent by the participants in the park, generally pursuing physically active recreation (Fisher, Li, Michael, & Cleveland, 2004). By providing walking trails, public parks, and other recreational open spaces, the built environment can regulate access to facilities for planned physical activity (Thompson & Kent, 2014).

The aesthetics of a neighbourhood also play important roles in encouraging older adults to be ‘out and about’ in their neighbourhood, exploring on foot or bike, or walking to destinations. Qualitative research highlights older adult’s pleasure of exploring their neighbourhood to inform themselves of new happenings, or to look at neighbourhood gardens and flowerbeds (Michael et al., 2006; Strach et al., 2007). Gardens, interesting things to see, and attractive areas add to the walking enjoyment (Franke et al., 2013; J. Kerr et al., 2012).

Perceptions

Destination walking, health, and the built environment are likely related in a non-linear, complex way. A walkable built environment may be seen as a risk regulator, offering the opportunity for walking, which may then result in a healthier population than might be found in a non-walkable neighborhood (Carlson et al., 2012). This reflects the significance of perceptions as a facilitator of physical activity and is a key factor that needs to be considered when developing policies to encourage active aging. Perception of the built environment often acts as a mobility barrier in itself. Many recent studies have shown that perception, as distinct from actual physical attributes of the built environment, may impact the decision to walk. “Perception of walkability can be influenced by the physical attributes of a neighborhood, as well as local culture, crime or crime reporting, traffic accidents, and other non-physical attributes, and should be understood as being potentially distinct from physical attributes” (Carlson et al., 2012, p. 272). Furthermore, perceived (rather than actual) proximity and density of recreation facilities, and presence of malls, and other destinations have been consistently related to physical activity among older adults (J. Kerr et al., 2012; Michael et al., 2006; Thompson & Kent, 2014).

Weather

Finally, the weather is an important factor affecting outdoor activity levels for older adults. Poor weather may act as a key barrier to physical activity. Franke et al. (2013)

noted that, features of the environment such as weather, particularly rain, wind, and cold temperatures, are some of the more frequently mentioned barriers to walking by older adults. Bad weather does not only affect the desire of going outside, but also influences perceived and actual safety, as wet or icy surfaces may present an increased risk of falling and slipping, and decreased visibility for drivers and cyclists affect traffic safety.

Social activity and the built environment

The built environment constitutes a key facilitator of social activity and mental well-being among older adults. As Gardner (2011) pointed out, neighbourhoods are extremely important places of aging and essential to the well-being and self-identity among older adults. There are a variety of factors of the built environment that promote social activity and social interaction of older adults, which together form a "natural neighbourhood network" of so-called ***third places*** and ***transitory zones*** (Gardner, 2011; Thompson & Kent, 2014).

Third places are "located outside of the home (first place) and work (second place) and share several essential features: they are on neutral ground, they act as 'levelers', conversation is the main activity, they are accessible, 'regulars' spend time in them, they are physically plain and unassuming, the mood is playful, and people feel like they are 'home away from home'" (Gardner, 2011, p. 266). Third places are locales in a neighbourhood that facilitate and encourage social interaction mainly by being accessible and open to the public, and can be indoors - such as malls, restaurants or community centres – or outdoor facilities, for example parks or beaches.

Parks and greenspaces are some of the most important ***third places***, and beneficial to both physical and mental well-being among older adults. A participant participating in a study about older adults' social networks among residents of a downtown Toronto neighbourhood illustrated the significance of a nearby park to her mental well-being: "Regardless of the weather, every morning I walk to the off-leash dog run in the park near my home. On 'Dog Hill' I talk to the dogs and (sometimes) their owners, delighted in watching the animals play, and laugh with the others when the dogs performed funny antics" (Gardner, 2011, p. 268). In another study, discussions with older adults about their social spaces indicated outdoor green spaces as a major contributor to age-friendliness (Novek & Menec, 2013). Respondents to the AARP survey revealed that the majority of them 'connect' with other people in parks and other outdoor facilities (27%), as well as religious institutions (42%) (Harrell et al., 2014). Parks and green spaces provide various health benefits and improve, as well as maintain, mental well-being by promoting the development of social connections, and provide opportunities for interactions with nature and personal reflection (Kaczynski et al., 2009).

Transitory zones are public places that connect first, second, and third places and often act as the key locale of unplanned social interaction, enabling encounters with strangers. Gardner(2011) defines ***transitory zones*** as places which are not destinations, but places we pass through during the course of our daily public lives. Accessible streets and safe walking environments facilitate, and encourage residents to be 'out and about' and thus increase the opportunity of unplanned social interaction. In cities across the UK, Ward Thompson, Curl, Aspinall, Alves, & Zuin (2012) found that a lack of barriers and perceived nuisances, as well as good paths and cycleways and enjoyable routes to local open space are consistently associated with time outdoors, and with general health and well-being among its older adults. Beautified, walkable streets and greenways present strong transitory zones encouraging both social activity and physical activity. Research by Franke et al. (2013) confirmed the theory that access to well-designed green spaces makes the experience of walking more pleasant, and that connected greenspaces facilitate neighbourhood walking and physical activity as well as benefiting mental health.

In the upcoming chapter, I will present Vancouver's active transportation agenda and the city's main planning objectives in relation to providing livable communities for the future.

Chapter 3.

Research Context and Design

3.1. Policies for age-friendly communities in British Columbia

In 2008, the Provincial government in British Columbia developed the "Healthy Living Framework" to guide municipalities in the development and implementation of age-friendly communities. The overall goal is to work with local governments and other partners to promote and implement age-friendly practices in communities throughout British Columbia. The framework sets out the provincial goal of adapting successfully to B.C.'s aging population by asking municipalities to implement strategies for age-friendly communities into the respective municipal planning documents, generally referred to as Official Community Plans (British Columbia Ministry of Healthy Living and Sports, 2008). In response, the Union of British Columbia Municipalities (UBCM) developed guidelines on how communities can be planned by implementing strategies of age-friendliness into Official Community Plans (OCP's) (Mahaffey, 2010). Five key guidelines form the backbone of UBCM's strategy to implement policies, goals, and visions for age-friendly and disability friendly communities into OCP's: 1) Include a commitment to accessibility and inclusion into the overall vision or mission section of the OCP, 2) Actively invite the participation of people with disabilities and older people into the development or revision of the OCP, 3) Include goal statements in the OCP on key topics that have been shown to positively influence the quality of life of people with disabilities and older people, 4) Complete an age-friendly and disability-friendly assessment of your community, 5) Commit to having a local government committee that can continue to provide feedback and direction to elected officials and staff on aging and disability issues (Mahaffey, 2010).

Cities across British Columbia and Canada started to include strategies for age-friendliness in their official community plans to advance the progressive ideas of the Public Health Agency of Canada (Plouffe et al., 2012) and Vancouver, long promoting sustainable planning practices and liveability(Scerri & Holden, 2013), developed its own plans to make the city a more liveable place for people of all ages and abilities.

When planning for age-friendly communities, Menec et al. (2011) suggests that older adults must be involved in identifying areas of need, prioritizing key issues, and ensuring appropriate implementation; and notes that engagement and consultation of older adults would be essential to planning and implementing age-friendly communities. This somewhat reflects policy recommendations by the British Columbia government, as outlined in the Healthy Living Framework, that call upon municipalities to provide opportunities for employment and civic participation that cater to the interests and needs of older persons. From a planning perspective, Hodge (2008) suggests meeting the four following principles in planning age-friendly communities: 1) understanding of seniors' independence; (2) a broad scope of administrative involvement; (3) a technical base of knowledge of the seniors' population; and (4) active involvement of seniors from the community in the planning process. Ideally, when planning age-friendly communities, one should focus on areas where elderly are spatially concentrated, and also evaluate the comparative effect of programs to promote physical activity and improvements in walkable and unwalkable environments (J. Kerr et al., 2012).

3.2. The Comox-Helmcken Greenway and Vancouver's sustainable transportation agenda

In Vancouver, B.C. the municipal government developed the Greenest City Initiative in 2009 and initiated the idea to build greenway corridors in the city which would provide safe and pleasant access for residents of all ages and abilities to its many greenspaces. The Comox-Helmcken Greenway, which will be evaluated in this research study, was part of a transportation planning process for Vancouver's downtown core. It was to form one of the greenway corridors to connect important greenspaces in the area and provide an important active transportation link.

3.2.1. Transportation plans

In the City of Vancouver Transportation 2040, outlines the city's goal to implement many strategies for age-friendly communities, with goals to eliminate mobility barriers and address many factors of the built environment that affect older adults' ability to age in place. The city recognizes that in the next 30 years, the number of Vancouver residents aged 65 and over will more than double (City of Vancouver, 2002, 2012b) over the 82,000 seniors in 2011 (Statistics Canada, 2012). Transportation 2040 includes the goal to promote active lifestyles for all ages through education and promotion programs, and to encourage active transportation.

The City of Vancouver is trying to promote and encourage active transportation and active living for all ages by formulating goals such as making streets pedestrian and rain friendly, by improving street connectivity, evening out sidewalks, implementing traffic-calming measures in various neighbourhoods and installing/encouraging roofed walkways along commercial areas (City of Vancouver, 2012b). If implemented successfully, the City of Vancouver would meet recommendations by researchers of aging in place and age-friendly community planning. Specifically, changes such as adjusting the timing of lights to create safer crossings or widening sidewalks to create a safer and more enjoyable pedestrian environment are recommendations of researchers and the City of Vancouver alike (British Columbia Ministry of Healthy Living and Sports, 2008; Carlson et al., 2012; City of Vancouver, 2012b; J. Kerr et al., 2012). The development of aesthetically pleasing bicycle and walking routes, as well as zoning for mixed land-use is also included in Vancouver's plans to implement measures that facilitate active lifestyles and active aging, aligning with recommendations from the growing field of age-friendly and active aging research (Carlson et al., 2012; City of Vancouver, 2012b; J. Kerr et al., 2012; MetLife Mature Market Institute, 2013).

3.2.2. Greenest City initiative

In 2012 Vancouver's city council passed the Greenest City 2020 Action plan, a platform initiative of the city council led by Vision Vancouver and the city's mayor Gregor

Robertson (City of Vancouver, 2012a; Scerri & Holden, 2013). The plan builds upon work from 2009 by the Greenest City Action Team and sets visions, goals and targets to transform the City of Vancouver into the "Greenest City" worldwide by 2020. The ambitious vision puts Vancouver on the "leading edge" of sustainable city planning and sets goals that shall lead Vancouver to a "healthy, prosperous and resilient city" (City of Vancouver, 2012a, p. 4). In the Greenest City Action Plan, ten key goals are mentioned: 1) Green Economy, 2) Climate Leadership, 3) Green Buildings, 4) Green Transportation, 5) Zero Waste, 6) Access to Nature, 7) Lighter Footprint, 8) Clean Water, 9) Clean Air, and 10) Local Food (City of Vancouver, 2012a; Scerri & Holden, 2013). The most influential goals of the Greenest City Action Plan, in relation to how they affect the ability of older adults to age in place, are "Green Transportation" and "Access to Nature".

The "Green Transportation" goal expresses two major plan targets, highlighting the city's efforts to reduce car travel in the city and expand active transportation:

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

The city recognizes the role of the built environment, stating that "to achieve the Green Transportation goal, we need to make Vancouver a city where moving on foot or by bike is safe, convenient, and enjoyable" (City of Vancouver, 2012a, p. 29).

The plan formulates priority actions, as well as key strategies to achieve the targets mentioned above. Priority actions include the completion of a new Active Transportation Master Plan, implementing a pedestrian safety study, support transportation and active transportation planning through efficient land use policies and pursue the development of a bike-share program. Further, some of the plan's key strategies are to make active transportation choices feel safe, convenient, comfortable and fun for all ages, plan for complete communities and support transit improvements, as well as advancing policies to encourage reduced car ownership. (City of Vancouver, 2012a)

"Access to Nature" is also very relevant to older adults' well-being (see 2.2.2). The Greenest City 2020 Action Plan mentions that streets, public spaces, and neighbourhoods should be vibrant places that are alive with people, plants, and activities. It formulates the target of giving every resident of Vancouver easily accessible greenspace - a 5-min walk to a park, greenway, or other green space - and plant 150,000 new trees by 2020. One of the key strategies mentioned, include the building and upgrading of parks, greenspaces and greenways and focus on a local neighbourhood level to achieve these targets. (City of Vancouver, 2012a)

3.2.3. The Comox-Helmcken Greenway

In the early 2000's the City of Vancouver outlined its goals to manage traffic flow and transportation in the city and improving the city transportation networks with an increasing traffic volume and higher density population in mind. The Downtown Transportation Plan was passed by city council in 2002 and outlined the city's goals to develop infrastructure and manage traffic in a way that accommodates sustainable transportation and an increasing population, while maintaining or improving the city's livability (City of Vancouver, 2002). The focus of city transportation planning was to increase walk, bike and transit trips by recommending major improvements for these modes.

As part of the transportation plan the city proposed the development of the Comox-Helmcken Greenway at a cost of $5.4 Million, a shared user, multi-modal, vehicle-traffic calmed route connecting Stanley Park in the west with False Creek in the east of the downtown peninsula (City of Vancouver, 2002, 2015). The greenway is proposed along a multi-family residential street with some commercial uses, such as hotels at Denman and Burrard Streets, a school at Bidwell Street and St. Pauls Hospital at Burrard Street.. In the fall of 2011, City staff consulted with businesses, seniors, children, youth and others and took into consideration their feedback in the proposed greenway through open houses, walking tours (guided and self-guided), workshops with youth and seniors, a survey, and community and stakeholder meetings (Scott, 2012). Subsequently, the greenway has been developed in two sections (see Figure **1**) with Section 1 of the greenway complete as of June 2013. Section 1 describes road improvements and changes for Comox and Helmcken streets in the West End (between Stanley Park and Hornby Street); Section 2 connects the Downtown Core with the False Creek Seawall via Helmcken and Drake Street (City of Vancouver, 2015).

Figure 1**: The proposed Comox-Helmcken Greenway (City of Vancouver, 2015)**

The intended benefits of the Comox-Helmcken Greenway was to create safe and accessible connections to parks, schools, community centres, neighbourhoods (West End and Yaletown, respectively) and retail areas in the downtown core. The main focus is to encourage people of all ages and abilities to explore their city by foot, bicycle, wheelchair and stroller in a comfortable, convenient and interesting way, improving pedestrian and cyclist safety. (City of Vancouver, 2012b, 2015; Scott, 2012)

Additionally, by implementing the Comox-Helmcken Greenway, the city intended to improve the attractiveness and livability of adjacent neighbourhoods by providing places to sit, rest and socialize for nearby residents as well as through investments in landscaping and street/neighbourhood beautification (City of Vancouver, 2012b, 2015)

Through various consultation mechanisms (survey, workshops and senior walking tours), the city collected concerns and recommendations from the public. The five most important topics, associated with the Comox-Helmcken Greenway, were a) on-street parking, b) residential and commercial access, c) traffic calming measures, d) changes to neighbourhood streets, and e) bike lane design (City of Vancouver, 2015; Scott, 2012). Residents raised concerns regarding the potential of reduced vehicle access to their homes, increased traffic on adjacent neighbourhood roads, increased pedestrian and cycling traffic, the reduced number of vehicle lanes, project costs and landscape maintenance. Based on input through the public transportation, residents thought the improvements on the Comox St corridor would promote an active lifestyle by featuring trees and gardens, less vehicle traffic, even sidewalks, separated bike lanes and seeing more people walking and cycling. (City of Vancouver, 2015; Scott, 2012)

The greenway design was influenced by the city's attempt to balance the needs of citizens and businesses, as obtained through public input and urban planning research. The main objective was to provide a safe, convenient and comfortable walking and cycling experience for people of all ages and abilities through improved street lighting and smoother sidewalks, reducing the number of cars on Comox Street to enhance pedestrian and cycling safety, improving intersection safety and accessibility, separating cyclists from vehicle traffic on high traffic volume segments and improving safety and accessibility to Stanley Park. Also, the greenway was designed to maintain on-street parking wherever possible, and create places to sit and relax at intersections and mini-gardens, enhance mini parks along the route and recognize potential safety concerns and arising conflicts between pedestrians and cyclists (Scott, 2012).

In summary, the changes on Comox and Helmcken Streets through implementation of the first section of the greenway are:

Comox Street: Stanley Park Drive to Burrard Street

- Improved intersections with corner bulges and curb ramps to provide a shorter and safer crossing as well as places for neighbours to garden, sit and socialize
- Improved sidewalks and lighting
- Traffic restrictions for traffic calming
- Bicycles share the street with cars except for two blocks where there are higher vehicle volumes and specific requirements for the hotels and hospital

Burrard Street: Comox Street to Helmcken Street

- The sidewalk has been widened on the east side of Burrard. Cyclists can use the sidewalk and are separated from pedestrians.
- A new traffic signal and bike signals for the Burrard Street and Comox Street intersection to improve circulation for pedestrians, cyclists, and vehicles

Helmcken Street: Burrard Street to Hornby Street

- A two-way separated bike lane on the south side of the street to separate cyclists from vehicle traffic

(City of VancouverCity of Vancouver, 2015)

In the context of this research paper, I will refer to Phase 1 of the Comox-Helmcken Greenway (see Figure **1**).

3.2.4. The West End neighbourhood

The Comox-Helmcken Greenway traverses Vancouver's West End neighbourhood, a vibrant, diverse, walkable, and densely populated community surrounded parks and beaches, and bordering Vancouver's downtown and Central Business District. The West End includes the Davie Village—traditionally a hub for the city's LGBTQ community—and Denman Street, which together provide local shopping, services and restaurants in walking distance to many residents. This area also has high-end retail on Robson and Alberni Streets. (City of Vancouver, 2012c)

The West End is defined as the area between West Georgia Street, Burrard Street, Stanley Park and English Bay on Vancouver's downtown peninsula. It comprises 204 hectares, making up 35% of the downtown peninsula (excluding Stanley Park). There are 112 blocks in the West End, making the area a very walkable neighbourhood with an average WalkScore® of 92. The West End has the highest walk to work mode share of any neighbourhood in the City of Vancouver at 40%. (City of Vancouver, 2012c)

The neighbourhood can be characterized as primarily residential, with commercial shopping streets serving the community and some higher density mixed use development in the northern and eastern parts of the neighbourhood. Most of the neighbourhood, with exception of the commercial areas, is zoned as multiple and high density housing areas. Market rental and non-market units comprise 69% of the total housing units in the West End. This makes the West End neighbourhood the main provider of market rental units in the City of Vancouver. The West End's population sits at about 44,500 (2011 Census), and population density is approximately 217 persons per hectare, making it one of Vancouver's most dense neighbourhoods. The majority of the West End's population is aged 20-64 (82 %), with about 13 % of population aged 65+, and roughly 6% aged below 20 years of age. (City of Vancouver, 2012c)

The neighbourhood boasts nine mini-parks, a few medium sized neighbourhood parks, as well as close proximity to Vancouver's Stanley Park, English Bay Beach and Sunset Beach Parks. Along Comox Street, a East-West corridor through the West End neighbourhood, Nelson Park (including a community garden) and mini-parks at Cardero Street and Comox Street, as well as Chilco Street and Comox Street provide recreational opportunities to residents and visitors alike. The total area of park space in the West End neighbourhood is 15.93 hectares. (City of Vancouver, 2012c)

Tree-lined residential streets are a key aspect of the West End's unique character. Various elements contribute to the streetscapes and walking experience in the community's residential areas, such as mature trees, building setbacks, display gardens and landscaped traffic circles.

The West End neighbourhood provides a variety of community services, such as access to recreation centres, a public library, several community centres and neighbourhood houses, religions institutions and the St. Paul's Hospital. The variety of community amenities, services and retail opportunities makes the neighbourhood a great place for older adults seeking independency in their lives. (City of Vancouver, 2012c)

3.3. Active Streets, Active People Research Study

3.3.1. Overview

The ‘Active Streets, Active People’ (ASAP) study was a three-year longitudinal study (2012-2014), evaluating the impacts of a natural experiment by assessing a real-world change in the built environment of downtown Vancouver along the Comox-Helmcken Greenway. The overall study design includes a mixed-methods approach, including self-reported measures of physical activity, mobility, daily travel, health, perception of the built and social environments, as well as objective measures of mobility and physical activity of participants. Additionally, observational measures of changes in street-level micro features (i.e. changes in smoothness of pavement, number of places to sit, lighting) have been taken. As well, the ASAP team collected qualitative data from semi-structured exploratory interviews from a subset of the participant group.

3.3.2. Research purpose

The broad aim of the ASAP study is to better understand how changes to the built environment impact the mobility and health of older adults. The ASAP study’s core motivation is to understand how cities can respond to the needs of older adults who wish to live longer in their communities, despite inevitable age-related declines in mobility and health. The research study aims to “discern what built environment features best support older adults to ‘age in place’ – in their homes, neighbourhoods and communities” (Centre for Hip Health and Mobility, 2015). Specifically, the ASAP study is designed to investigate whether travel patterns, street usage, and social opportunities are enhanced after the development of the greenway. Ultimately, the ASAP team aims to promote solutions toward creating neighbourhoods that are healthy places for people to grow old in. (Centre for Hip Health and Mobility, 2015)

The primary outcomes for the ASAP study align with my own research interests to explore the interface between older adults’ mobility and the built environment. In the ASAP study, older adults mobility is captured through several methods: objective

GPS/Accelerometry measurements, self-report travel diaries, questionnaires, and qualitative interviews.

3.3.3. Methodology of data collection

Inclusion criteria

Eligible participants included English-speaking, community-dwelling older adults aged ≥60 years living near or along the Comox-Helmcken Greenway, who report leaving their home most days (at least 3-4 days per week). Individuals not eligible to participate included those who did not fit the inclusion criteria, who planned to move out of their residence in the next two years, who were unable to leave their residence and/or would not consent to participate in the research project. The study participants reported having lived in the West End neighbourhood for a substantial amount of time, on average our study participants have been residing in the West End for 15 years.

Recruitment

Study Participants in the ASAP study were recruited through mail-in introductory letters and follow-up calls to 3,402 eligible households within a 2 block (400m) buffer of the proposed greenway route. Eligible households (residents ≥60 years) were determined through obtaining consumer records from a Canadian marketing firm (infoCANADA). As well, supplementary recruitment methods – newspaper advertisement and snowball sampling, social media advertising (Twitter) – generated three additional participants willing to take part in the study. A total of 1102 older adults contacted were eligible, of which 20.1% agreed to participate, and 193 completed the measurement sessions in 2012. In 2014, the 193 study participants were contacted for a follow-up and asked to complete measurements for T2. 38 participants withdrew their participation at this point due to various reasons, such as declining health, busy lives etc. 155 Participants were retained for the data collection in T2 (Retention rate of 80.3%).

Research methods

Detailed information about the methodology of the ASAP study, as well as findings by researchers from the ASAP team are highlighted in Winters et al (2014) paper about older adults' travel behavior in highly walkable environments. The quantitative component of the ASAP study design included the completion of a questionnaire booklet, 7-day trip diary and the wearing of two activity monitors (accelerometer and GPS) for a study period in the fall of 2012 (T1) prior to the construction of the Comox-Helmcken Greenway, and again in fall 2014 (T2) after the greenway has been constructed. We asked participants to wear an accelerometer (to measure duration and intensity of daily physical activity) and a global positioning system (GPS) unit (to capture where they went), and in addition we asked our study participants to record daily travel in a travel diary for the seven days following the in-person assessment. We used tri-axial ActiGraph accelerometers (ActiGraph GT3X+, ActiGraph LLC, Pensacola, FL, USA) to objectively quantify physical activity over a 7 day period. To measure mobility, participants wore a GPS device (QSTARZ BT_Q1000XT) for up to 7 days. We time aligned all data from the accelerometers with the GPS data to provide a dataset that included time, location, and physical activity intensity. The ASAP team performed analyses for questionnaires and monitor measurement data using Stata Version 10 (StataCorp LP., College Station, TX, USA). The time-aligned GPS/Accelerometry data was then processed following protocols developed by the ASAP team at the Centre for Hip Health and Mobility (Voss, Winters, Frazer, & Mckay, 2014, 2015; Winters et al., 2014).. Using available accelerometry, location and speed information from the two devices, we manually identified trip start, end, duration, and travel mode by using the Esri Tracking Analyst extension in ArcGIS 10.1 (Esri, Redlands, CA, USA). In short, for individual trips (one-way trip between two destinations) we assigned a travel mode according to speed thresholds and patterns characteristic for each travel mode (car max speed $\geq$ 35 km/h, pedestrian average speed $\geq$ 1 km/h, bicycle average speed $\geq$ 10 km/h). We defined individual trips as periods of movement separated by a pause (speed = 0, or location fixed) of 5 min or more. The thresholds used for travel and trip identification are similar to methods used in comparable research studies in the literature (Huss, Beekhuizen, Kromhout, & Vermeulen, 2014; Jankowska, Schipperijn, & Kerr, 2015).

SWEAT-R methods (street/neighbourhood audit)

To characterize the built environment along the Comox-Helmcken Greenway and comparison streets in the neighbourhood, the ASAP team used a validated older adult-specific audit tool called the *Seniors Walkability Environment Audit Tool-Revised* (SWEAT-R) (Chaudhury et al., 2011; Michael et al., 2009) to document features of the microscale environment. The tool has 152 items, across domains of 1) functionality (e.g. structural aspects such as building usage), 2) safety (e.g. personal and traffic conditions such as presence of street lights), 3) aestethics (visual appeal and quality of surroundings and public spaces), and 4) destinations (e.g. availability of services such as transit stops). The baseline street audit occurred over 15 days in June and July 2012. Two trained observers audited n=112 street segments in the West End and Downtown Vancouver neighbourhoods within 200 meters of the Comox-Helmcken Greenway at two time points: 1) a baseline audit in June-July 2012 before construction had occurred and 2) a follow-up audit in June-July 2014 after construction had taken place. On average, residential segments took 16 minutes to audit and commercial segments took 25 minutes.

3.4. My own research

3.4.1. Purpose and hypotheses

The purpose of this research project is to investigate how the implementation of the first phase of the Comox-Helmcken Greenway contributes to the West End being a sustainable, livable and 'healthy community' that fosters 'Aging in Place'. Being embedded in the broader ASAP research study, this specific research is an opportunity to highlight the contribution of cross-disciplinary research studies for the successful implementation of age-friendly communities, and age-friendly community planning in British Columbia and beyond.

Based on the extensive literature review presented above, I will evaluate how the greenway design considered factors of age-friendly community planning and implemented measures of age-friendliness. My research aims to evaluate whether the improvements to the corridor enabled and/or motivated older adults in the neighbourhood to use sustainable modes of transportation, such as walking, cycling, wheelchair or walker, to run daily errands or connect socially. More specifically, the study will evaluate potential changes in the transportation behaviours and route choices of older adults living near the greenway route by performing a street-segment analysis for the greenway corridor (Comox Street) and comparing the results to a same level neighbourhood street (Barclay Street) running parallel to Comox Street (refer to Figure 2).

Figure 2: Overview of the study area

As age-related decline in physical activity among the study participants can be assumed due to the time passed in between measurements, I hypothesize that the construction of the Comox-Helmcken Greenway resulted in at least a sustained number of older adults walking or cycling along the corridor during the study period in 2014 (September 4th, 2014 - November 4, 2014) in comparison to 2012 (November 5th, 2012 - October 21, 2012). Further, I anticipate a greater number of cycling and walking trips taken among all study participants in total, and specifically along the 900-1200 blocks of Comox

St for the study period in 2014. Also, I expect that the construction of the Comox-Helmcken Greenway did indeed change the microscale features of the built environment in ways that address the needs of older adults, making the greenway route a significant contribution to age-friendliness in the West End neighbourhood. This hypothesis will be tested using SWEAT-R audit data, taking into consideration the changes made on Comox Street due to the construction of the greenway in 2013.

3.4.2. Methodology

Creation of subset of data

For this particular research project, I compiled a subset of the processed trip data by extracting trip data based on inclusion criteria developed for the purpose of this study. In this context, processed data is defined as all GPS data for which trip start, end, duration, and travel mode were identified.

Eligible data for the subset was compiled by identifying all participants with three or more days of valid data (based on the inclusion criteria and data processing protocols from the ASAP study) for both timeframes, T1 and T2, that were residing in the West End neighbourhood (for a description of the West End neighbourhood, refer to 3.2.4). Assigning these criteria resulted in a subset of data of 111 participants. For participants for which more than 3 days of valid data was available, only the first three days of valid data were selected for analysis. All data was extracted and the subset of data compiled through ArcGIS10.1 (Esri, Redlands, CA, USA) and Microsoft Excel 2010 (Microsoft, Redmond, WA, USA).

Identification of trips and travel modes

In a next step, I separated all trips made by four modes – car, bike, walk, and transit. The separation by travel mode would provide me with total trip counts for the 111 study participants for each of the four travel modes for both study periods (Fall 2012, Fall

2014). This data was then used to report on basic statistics for each travel mode, such as total trip counts, trip duration and percentage of mode share. The findings are compiled in Table 1 in section 4.2.

For the purpose of a spatially more detailed analysis of the subset of data, I secluded trips per travel mode for Comox Street – the greenway corridor – as well as Barclay Street - another neighbourhood street located parallel to the greenway corridor. There is no public transit servicing these streets. To perform a spatial selection of these trips, I used a Python2.7 script (modified, original script developed by Jana Hirsch, Centre for Hip Health and Mobility) in ArcMap10.1 to convert the geometry of all trip data from points to polylines. Then I identified trips that used the greenway (and Barclay Street), and those that did not. To do this, I applied a 50 m rounded buffer to the Comox-Helmcken Greenway and segments of Barclay Street, and overlaid this with the trip routes. I looked specifically for all car, walking, and cycling trips that included travel on the current extent of the Comox-Helmcken Greenway, as well as segments of Barclay Street (900-2100 block) for the purpose of reporting on geospatial statistics and percentage of mode share. The spatial seclusion will also aid in identifying potential changes in the route choice among our study participants living close to the greenway corridor (see Figure 2).

Specifically, Identification of the location of trips (on or off Comox Street/Barclay Street) was done through visual inspection, as well as with the help of the 'Select by Location' tool in ArcMap10.1. I assigned individual trips that would stretch over more than one street block (~ 150m) as a valid trip.

To get an even more detailed look at potential microlevel changes in transportation behaviour among the study participants, I completed a street-segment based analysis for street blocks on Comox Street and Barclay Street. In order to map traffic volumes among our study participants on Comox Street and Barclay Street, I used the 'Intersect' tool, part of the analysis toolbox in ArcGIS10.1, to map the trip frequency for each of the three modes – car, bike, walk – by block for the area along 900-2100 block of Comox Street and Barclay Street. This street-segment based analysis was visualized in ArcMap 10.1., and statistical information derived by performing analysis in Microsoft Excel 2010.

Obtaining weather data

We obtained daily weather data for both timeframes, T1 and T2 from Environment Canada (Environment Canada, 2015) to control for/provide context on weather related factors. We plotted daily precipitation (mm), as well as daily mean temperatures (° Celsius) by day using Microsoft Excel (Microsoft, Redmond, WA, USA).

3.5. Limitations

Being embedded in the overall ASAP research project, I acknowledge that my study design and overall data collection methods have been constrained by the fact that I made use of available data, research design and research context from the 'Active Streets, Active People' study. The opportunity to use data that was fairly readily available from an existing research project, may have likely lead to overlooking potential alternative methods of data collection to support my research. There are several limitations associated with data from the ASAP study, as well as my own research design.

The use of accelerometers and GPS tracking units as the main source of data collection makes the data quality and accuracy dependent on the wearer, their environment and the functionality of the devices. High rise buildings in downtown areas, such as Vancouver, can result in signal loss of the GPS devices, cold starts lead to potential data gaps and the devices stop functioning when not charged (Jones & Evans, 2012; Jacqueline Kerr, Duncan, & Schipperjin, 2011; Mccrorie, Fenton, & Ellaway, 2014). Our study participants may have unconsciously or deliberately left their GPS devices or accelerometer at home, resulting in missed data. In addition, manual trip coding of the data and the sheer amount of GPS records may have affected the objectivity and inter-rater reliability researchers in our research team.

Varying data availability (see Table 2, Table 3) made daily comparisons for individual study participants, and a more detailed per-person analysis of how the weather may have affected our study participants' choice to use active transportation challenging.

The availability of data also resulted in differing amounts of available GPS data between T1 and T2, affecting implications and assumptions about the differences in our study participants' transportation behaviour prior and post construction of the greenway. Similar research studies should evaluate the potential changes in transportation behaviour and effects of bad weather on an individual level to draw more meaningful conclusions about the effects of street-level changes to the built environment.

As the data collection has been performed in the West End neighbourhood, a very walkable and age-friendly neighbourhood, our findings and implications are specific to the area and the Comox-Helmcken Greenway, respectively. A similar study of a newly constructed greenway in a different area will likely result in different findings. Many older adults living in the West End neighbourhood may have moved to the neighbourhood because of its age-friendly environment. As participation in the ASAP study was voluntarily, our study participants may be "keen" older adults, already physically active and perhaps more inclined to take on more active transportation as they feel motivated through participation in the research study as well as the changes on Comox Street.

Additionally, external factors likely highly influenced variability in the data and subsequently our findings. The weather during the study period in 2014 differed greatly from the weather in the fall of 2012, likely affecting potential uptake of active transportation modes along Comox Street. Also, as the intervention for T2 occurred just one year after completion of the project, it is likely that the full effects of the construction of the Comox-Helmcken Greenway are yet to be felt.

Chapter 4.

Findings

4.1. SWEAT-R results

Below, I present summarized results from the street audits done in 2012 and 2014 by the ASAP team. In this particular research project, I will use the results of these street audits for the purpose of data analysis and to characterize the changes along Comox Street due to the construction of the greenway.

Safety features

The construction of the first phase of the Comox-Helmcken Greenway resulted in sidewalk extensions being installed in about 15 places along Comox Street, as well as installment of street medians for traffic flow separation along long stretches of the greenway. In 2012, medians existed only along Nelson Park for the 1100 block of Comox Street. After the construction of the Comox-Helmcken Greenway, in 2014, medians were in place between the Bidwell and Gilford Street intersections, Cardero and Broughton street intersections and all the way from Nelson Park to Helmcken Street covering most blocks of Comox Street.

During the construction of the greenway, pedestrian street lights got added along Comox Street to improve conditions after dark. Prior to the greenway construction, pedestrian street lights were almost absent from the streetscape along the corridor.

To provide neighbours and travelers of the neighbourhood with places to sit and relax, the city installed benches along the whole stretch of the greenway. In 2012 benches existed only along Nelson Park and by St. Paul's Hospital, 1000 and 1100 blocks respectively, as well as between Denman and Gilford Streets. Refer to Figure below for the location of these safety features.

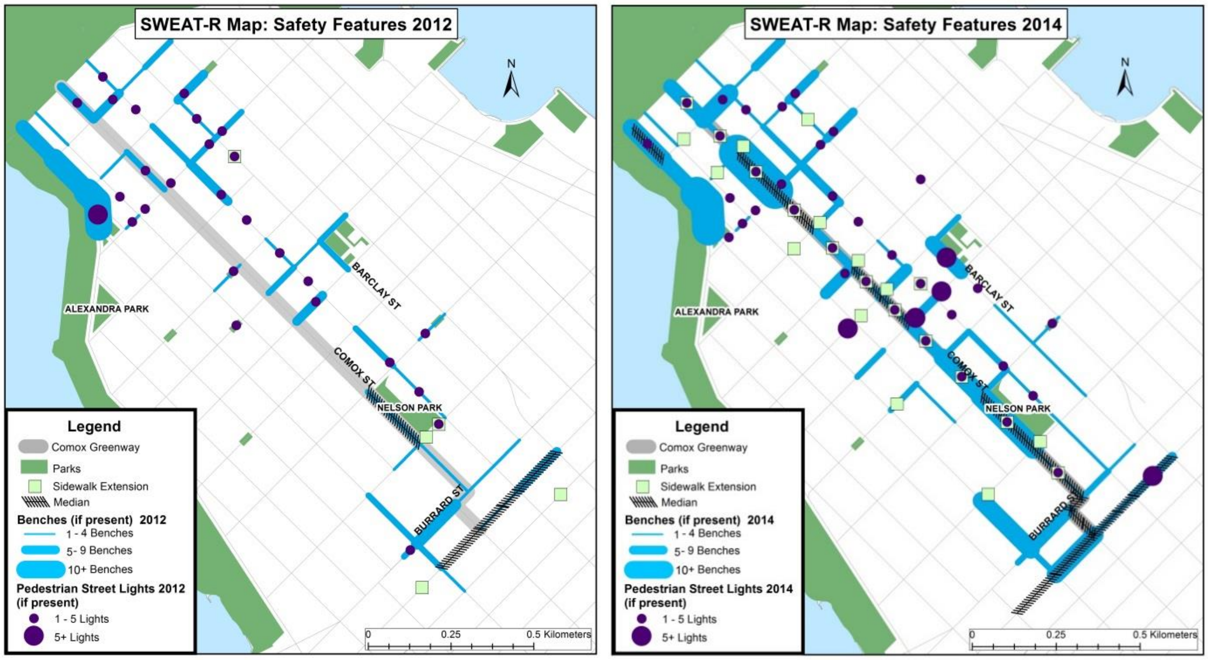

Figure 3: Safety Features along Comox Street in 2012 and 2014 (© Caitlin Pugh, CHHM)

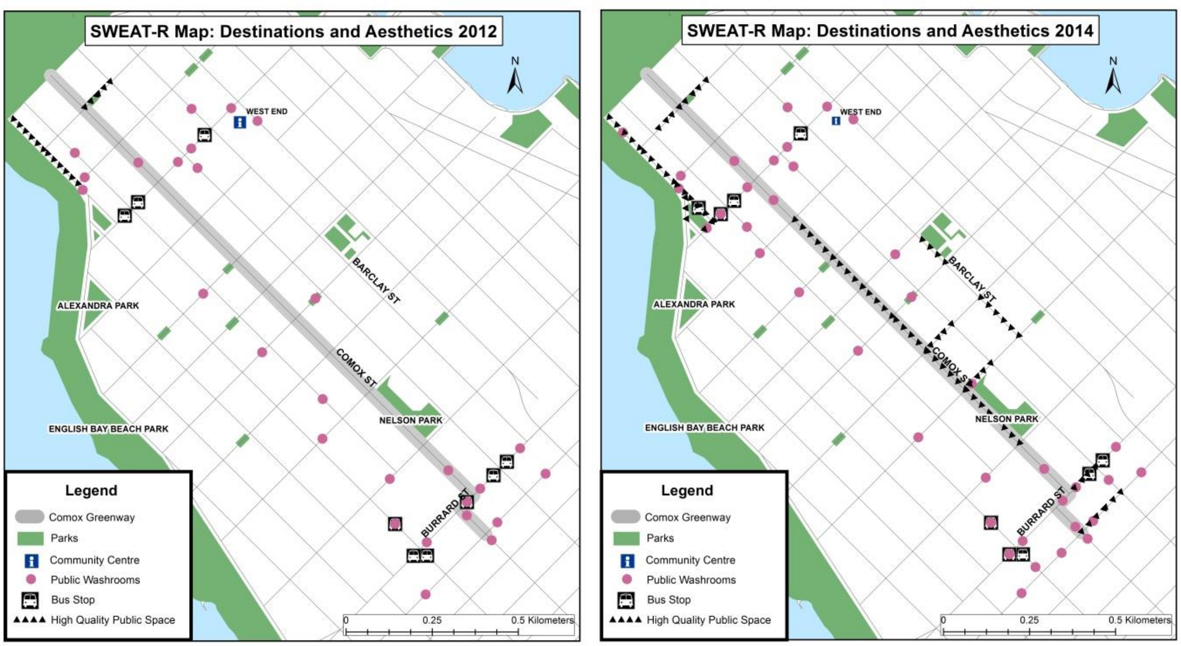

Figure 4: Street Aesthetics and Community amenities along Comox St in 2012 and 2014 (© Caitlin Pugh, CHHM)

Landscaping and Community Amenities

Construction of the Comox-Helmcken Greenway also included improved landscaping and gardening along Comox Street, creating small mini-gardens and planting trees along the corridor. Most mini-garden construction and tree planting was performed between the Denman and Burrard Street intersections for the 1000 – 1700 blocks of Comox Street. Prior to construction of the greenway, high quality public space such as mini gardens and seating areas did not exist along the Comox corridor. For the location of these features, please refer to Figure 4.

4.2. Overview of trips per travel mode

Table 1 below gives an overview of the results from the extracted subset of 111 participants for both timeframes, T1 and T2. In the following sections, I will be describing key points of the results relevant to my research. In the ASAP study, study participants had different start and end dates for their 7-day wear period of GPS and accelerometer. Available data for the study periods in 2012, and 2014 is thus highly variable. For the study period in 2012, available participant data ranges from 1-20 participants per day (Appendix, Table 2), whereas for the studied timeframe in 2014, the available data ranges from 1-21 participants per day (Appendix, Table 3).

Table 1: Trip counts and Participant counts per travel mode for T1 and T2

	T1	*T2*
Walking		
# of trips	1314	1140
# of participants	110	110
Time spent (hours)	227.1	221.5
Comox St		
# of trips	66	60
# of participants	37	37
Barclay St		
# of trips	39	31
# of participants	28	18
Cycling		
# of trips	79	59
# of participants	16	14

Time spent (hours)	25.1	22
Comox St		
# of trips	4	4
# of participants	3	3
Barclay St		
# of trips	4	4
# of participants	3	1
Car		
# of trips	324	366
# of participants	61	72
Time spent (hours)	89.7	107.2
Comox St		
# of trips	15	1
# of participants	11	1
Barclay St		
# of trips	14	17
# of participants	11	16
Transit		
# of trips	133	143
# of participants	45	43

4.2.1. Trips taken in T1

For the subset of data analysed, GPS recorded trips occurred on 43 days between November 5th, 2012 and October 21, 2012. During this time frame there were 4 days without any recorded trips taken, November 24th and October 1st, 8th and 20th respectively.

Walking

All participants walked a total of 1314 trips during the time frame mentioned above for a total of 227 hours during 3 observation days each.

Cycling

16 of the 111 participants participated in cycling activities during the above mentioned time frame for a total of 79 trips with cycling activity spiking in mid-September 2012. The 16 participants rode a total of 25.1 hours.

Car

61 of the 111 participants drove a car for a total of 324 trips during the above mentioned time frame. The 61 participants drove their cars for a total of about 90 hours, with car activity occurring at a fairly constant rate over the time period with about 9 trips taken per day on average.

Transit

45 of the 111 participants rode transit for a total of 133 trips during the above mentioned time frame with most trips taken on September 21st and October 13th, with 15 and 14 transit trips per day.

4.2.2. Mode share in T1

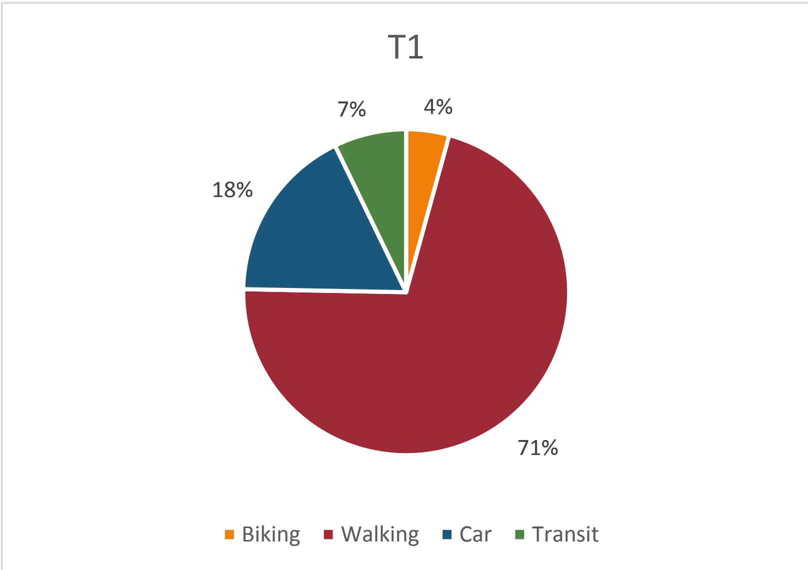

Figure 5: Overall mode share in T1

Mode share

When looking at overall mode share for the time period, walking is the most common mode, accounting for 71% of trips. 18% of trips were by car, whereas 7% of trips were taken by transit and 4% of trips were taken by bike (see Figure 5)

4.2.3. Trips taken in T2

For the subset of data analysed, GPS recorded trips occurred on 49 days between September 4th, 2014 and November 4, 2014. During this time frame there were 12 days without any recorded trips taken, September 15th,22nd and 29th, October 13th,14th, 18th – 23rd and 28th , and November 3rd respectively.

Walking

All participants walked a total of 1140 trips.for a total of 221 hours during 3 observation days each.

Cycling

14 of the 111 participants participated in cycling activities during the above mentioned time frame for a total of 59 trips with cycling activity spiking in mid-September and early October 2014. The 14 participants rode a total of 22 hours.

Car

72 of the 111 participants drove a car for a total of 324 trips during the above mentioned time frame. The 72 participants drove their cars for a total of about 107 hours, with car trips occurring at a fairly constant rate between September 15th and Oct 15th - about 10 trips taken per day on average – and then declining to only up to 5 trips per day.

Transit

43 of the 111 participants rode transit for a total of 143 trips during the above mentioned time frame.

4.2.4. Mode share in T2

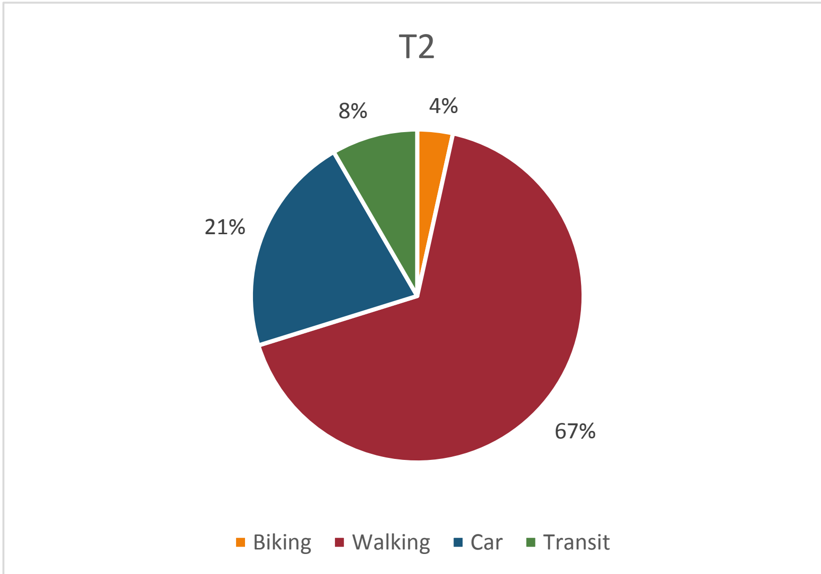

Figure 6: Overall mode share in T2

Mode share

When looking at overall mode share (see Figure 6) for the time period, walking activity contributes to the highest mode used, with 67% of mode share between the three transportation modes – cycling, walking, transit and car. 21% of trips taken in the time period were by car, 8% by transit and 3% of trips were taken by bike.

In the following sections I will highlight the results for traffic counts and mode share for Comox Street and Barclay Street, a calm West End neighbourhood street running parallel – two blocks north - to Comox Street.

4.2.5. Comox Street

Overall very few trips were made directly on Comox Street. Of the total of 1314 trips made by our study participants in 85 were made on Comox Street. In 2014 of a total of 1140 trips, 64 trips were made on Comox Street.

Walking

In 2012, 37 study participants took 66 trips along Comox Street, whereas in 2014 there were 37 who walked along the route 60 times.

Cycling

There were 3 study participants who made 4 cycling trips along Comox Street accounting in 2012, and the same in 2014.

Car

In 2012, 11 study participants took 15 trips by car along Comox Street, whereas in 2014 only 1 trip has been taken by one participant of the study group.

4.2.6. Barclay Street

Overall even fewer trips were made directly on Barclay Street. Of the total of 1314 trips made by our study participants in 57 were made on Barclay Street. In 2014 of a total of 1140 trips, 52 trips were made on Comox Street (see Table 1).

Cycling

3 study participants rode a bike on Barclay Street accounting for 4 cycling trips taken on Comox Street during the study period in 2012.

In 2014 1 study participant also rode a bike on Barclay Street accounting for 2 cycling trips taken on Comox Street during the study period in 2012.

Walking

In 2012, during the given study period, 28 study participants took 39 walking trips in total on the selected sections of Barclay Street, whereas in 2014 18 participants walked along the route 31 times.

Car

During the study period in 2012, 11 study participants took 14 trips in their vehicles along the specified sections of Barclay Street, whereas for the given time period in 2014 16 study participants drove a car along the route on 17 trips in total.

4.2.7. Street-segment based analysis - T1 and T2

Comox Street

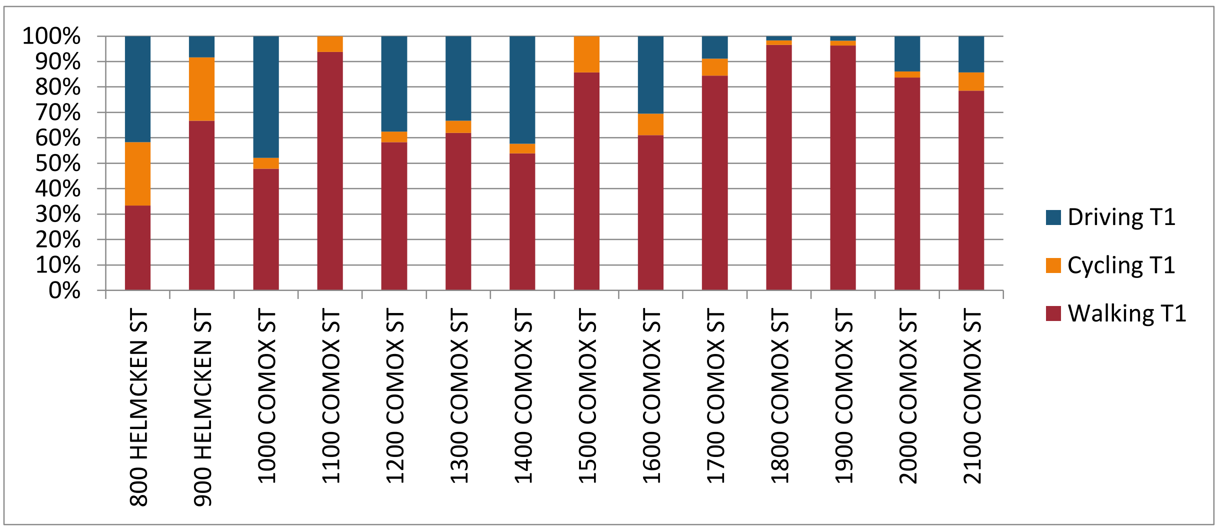

Figure 7: Traffic volume per block for Comox Street in T1

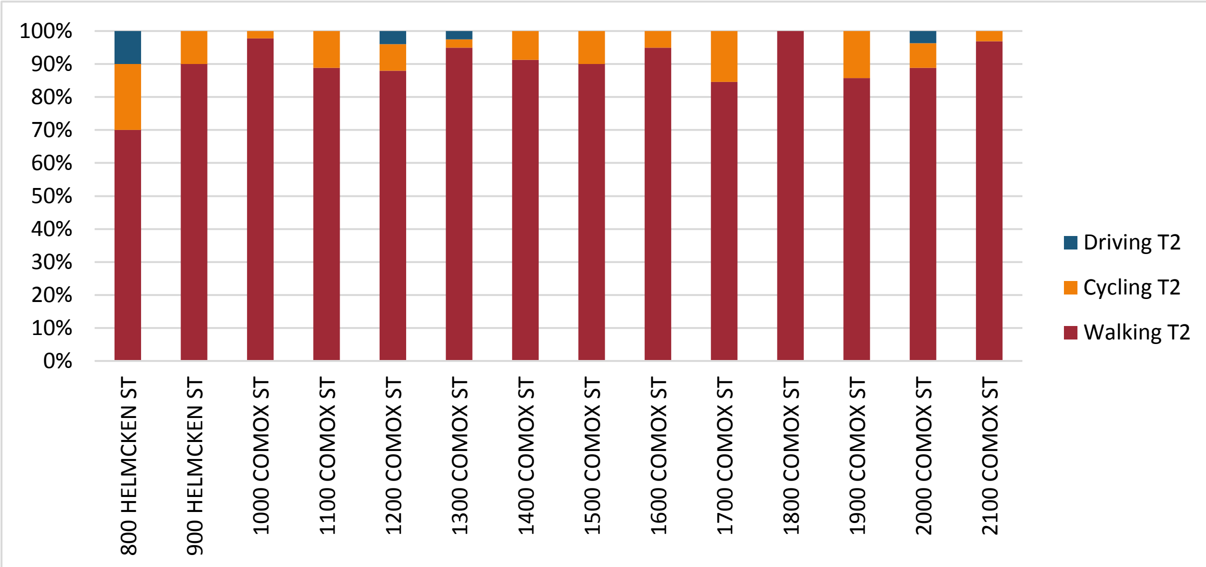

Figure 8: Traffic volume per block for Comox Street in T2

Mapping the traffic volume on the proposed Comox-Helmcken Greenway route by block (displayed as percentage of mode share in Figure 7 and 8 above) revealed the following results:

Walking

The 1800 and 1900 Block of Comox Street had the highest traffic volume counts by walking with 55 and 52 counts in the given time period of 2012. There were 38 and 36 counts for the 1700 and 2000 Block of Comox St, with the remaining sections of the proposed greenway route averaging about 15 trips per block.

During the given time period in 2014, the 1000 and 1300 Block of Comox Street had the highest traffic volume counts by walking with 44 and 38 counts respectively. There were 31 trips recorded for the 2100 Block of Comox St, with the 1800 and 1900 Block of Comox St counting 3 and 6 walking trips each. The remaining sections of the greenway route were travelled on by foot by an average of 18 trips per block.

Cycling

In the given time period for 2012, two sections of the proposed greenway, between the 1500 and 1700 blocks of Comox St, and 800-900 Block of Helmcken St had a traffic volume by cycling study participants of 3 trips per block. All remaining sections of the proposed greenway route counted only 1 trip per block in the study period of 2012.

During the given time period in 2014, the 1000 Block of Comox Street had the highest traffic volume counts by cyclists - 3 counts. The 1800 Block of Comox Street has not been travelled on by bike by any of the participants whereas the remaining sections of the greenway counted mostly 2 cycling trips per block.

Car

For the given study period in 2012, the 1000, 1400 and 1600 Block of Comox Street was travelled on by car 11 times each. The fewest traffic counts by car – 0 to 2 trips per block – occurred on the 1100, 2500, 1800-1900 and 2100 Block of Comox St, as well as on the 900 Block of Helmcken St. All remaining sections of the greenway were used by study participants driving their car resulting in 6 counts per block on average.

In 2014, only 4 blocks of the greenway - each once - have been travelled on by car by one person of the study group. The travelled sections were the 1200-1300 and 2000 Block of Comox St, as well as the 800 Block of Helmcken St.

Mode Share

Figure 7 and 8, introduced above, illustrate the results of the street-segment based analysis on Comox Street that was performed using the available data from the 111 participants for the study period in the fall of 2012, and 2014 respectively. For the study period in 2012, the traffic volume mapping by block resulted in 98% of traffic volume on the 1800 and 1900 Block of Comox St caused by pedestrian traffic, with the remaining 2% of traffic occurring through cyclists and drivers. On the other end of the spectrum, the 1000 Block of Comox St counted 48% of traffic occurring through study participants travelling on foot, and 48% of traffic caused by study participant's driving. The remaining 4% of traffic occurred by study participants cycling on the block. The 800 Block of Helmcken St was characterized by 25 % cycling traffic, 42 % car traffic and 33% of traffic caused by study participants travelling the area by foot.

During the given time period in 2014, the traffic volume mapping by block shows that most of the occurring traffic on the greenway resulted from study participants walking the route. The 1000 Block of Comox St counted 98% of traffic volume caused by walking traffic and the remaining 2% of traffic caused by cyclists. The 800 Block of Helmcken St was characterized by a traffic volume broken down to 70% pedestrian traffic, 20% cycling traffic and 10% car traffic.

Barclay Street

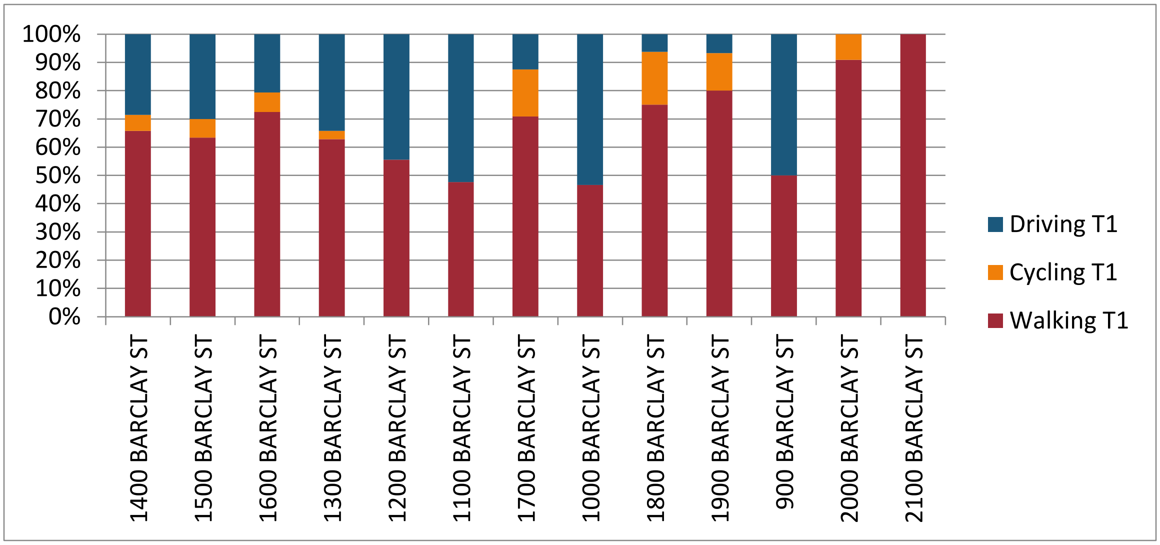

Figure 9: Traffic volume per block for Barclay Street in T1

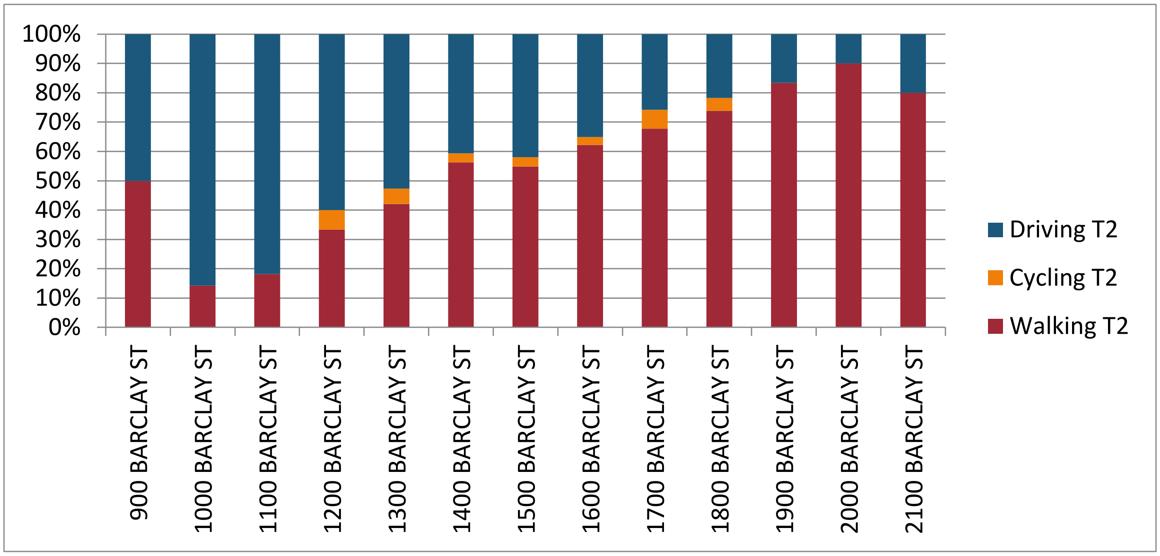

Figure 10: Traffic volume per block for Barclay Street in T2

Walking

The 1300 -1600 blocks of Barclay Street registered the highest walking counts during the study period in 2012, with 19-23 pedestrian traffic counts per block whereas the 900-1000 and 2100 block of Barclay Street counted only between 3-7 pedestrian trips among the study participants in the given time period for T1.

In 2014, for the given time period of this study, participants caused high pedestrian traffic counts for the 1400 to 1900 blocks of Barclay Street, counting 15-23 trips by foot per block. The 900-1100 block was subject to the fewest pedestrian trips, counting only up to two trips per block during the study period in 2014.

Cycling

In the given time period for 2012, the 1700 – 1800 block of Barclay Street counted 3-4 cycling trips by the study participants, whereas the 900-1200 block, as well as the 2100 block of Barclay Street did not register any cycling traffic. All remaining sections of Barclay Streets counted 2 cycling trips.

During the given time period in 2014, only the 1700 Block of Barclay counted more than 1 cycling trip – 2 counts. All other sections of Barclay Street have been travelled on by bike by participants of the study only once, or not at all.

Car

For the given study period in 2012, the 1100 – 1400 blocks of Barclay Street were the most heavily used sections of Barclay Street by participants driving along the route, accounting for 10-12 car traffic counts per block. The western sections of Barclay Street, 1700 – 2100 block, have only been subject to a maximum of 3 trips by car by the study participants.

During the given time period in 2014, the traffic volume mapping showed that the 1100-1600 blocks of Barclay Street counted the most car trips, between 9-13 trips per block. The 900 block of Barclay Street, as well as the 1900 to 2100 blocks were the least travelled sections of the street, counting up to three car trips per block (1900 block of Barclay Street).

Mode Share

For the study period in 2012, the traffic volume mapping by block resulted in 90 or 100 % of traffic volume on the 2000 and 2100 Block of Barclay Street caused by pedestrian traffic, with the remaining traffic occurring through cyclists. On the other end of the spectrum, the 900 - 1300 Block of Barclay Street counted 44-52% of traffic occurring through study participants travelling by car on Barclay Street, with the remaining traffic caused by study participants walking. No cyclist traffic occurred on these blocks in the study period of 2012.

For the study period in 2014, the traffic volume mapping by block shows that all blocks of Barclay Street have been subject to car traffic, and car traffic overall increased among most sections of Barclay Street. Notably, the 1000 and 1100 Block of Barclay Street counted 82 – 85% of traffic caused by study participants driving along this section of Barclay Street, whereas the remaining traffic occurred as walking traffic. Cycling traffic along Barclay Street is low on all studied sections of Barclay Street, with cycling causing a maximum of 6% of the traffic volume (1700 Block of Barclay Street) (see Figures 9 and 10 above).

4.3. Weather data

Figure 11 below gives an overview of the mean temperature and total precipitation amounts for the given study period in 2012 (Sept. 5th – Oct 21st). Data shows that the mean average temperatures for the selected study period ranged from 18.7° C in early September to a low mean temperature of 6.2° C at the end of the study period. Temperatures for the given study period have been fairly constant with a slow drop in mean temperature in the beginning of October. The average mean temperature for the study period was at 13.7°C. The study period in 2012 can be characterized as fairly dry with most precipitation falling in mid to late October. With the exception of 6.8 mm of precipitation on September 9th, 2012, most days of the study period until October 12th have been days without nearly any precipitation. Between October 12th and October 15th, a cumulated precipitation total of 111.2 mm has been measured at the weather station in Vancouver's coal Harbour, in close proximity to the West End neighbourhood.

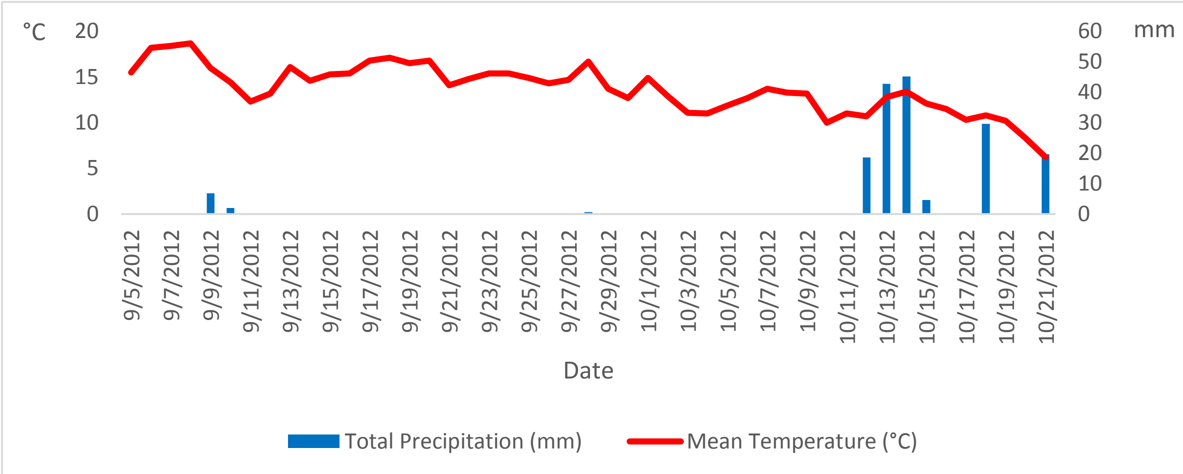

Figure 11: Historical weather data - Fall 2012 (Vancouver Harbour CS, Coal Harbour

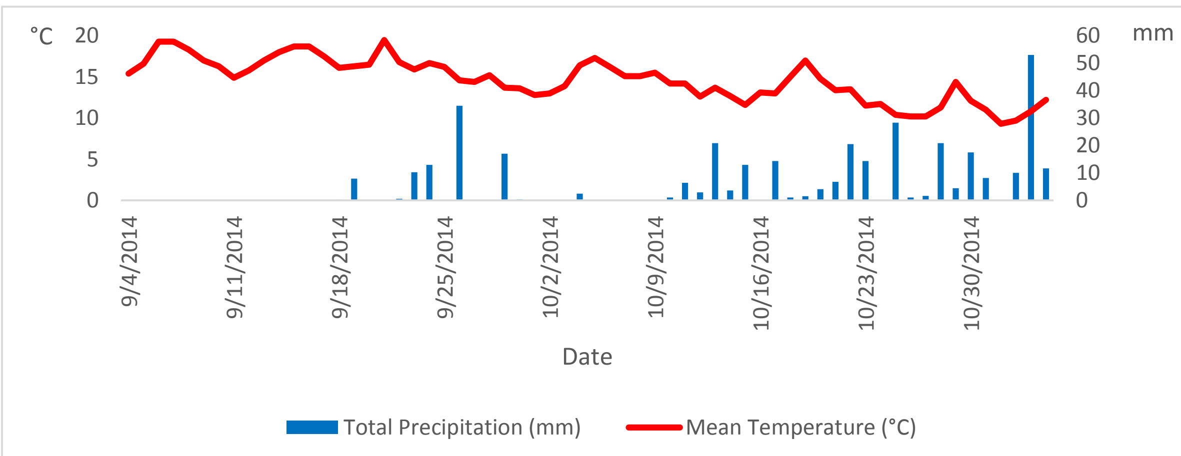

Figure 12: Historical weather data - Fall 2014 (Vancouver Harbour CS, Coal Harbour)

Figure 12 shows an overview of the weather for the study period in 2014 (Sept. 4th – Nov. 4th). Mean average temperatures for the study period in 2014 were higher than 2012, ranging from 19.5° C in early September to a low mean temperature of 9.3° C at the end of the study period. The overall study period in 2014 can be characterized as warmer, with an average mean temperature at 14.6° C. The study period in 2014 was wetter than the study period in 2012, with high precipitation amounts in late September, and precipitation falling for most of October 2014.

Chapter 5.

Discussion

The following chapter will discuss the findings from my research work under the aspect of age-friendly community planning and the implementation of age-friendly features in the built environment along the newly constructed greenway. I will evaluate the Comox-Helmcken Greenway in respect to the hypotheses outlined in my methodology section (3.4.2) by drawing on findings from my research work, as well as the literature. First, I will discuss the changes that were made to the built environment along Comox Street by reviewing the results from the street audits in 2012, and 2014. Then I will respond to each of my hypotheses and highlight the key findings of this research by discussing the findings relevant to the concept of age-friendly community planning.

The construction of the greenway improved the built environment on Comox Street, enhancing walkability and contributing to the age-friendliness of the West End neighbourhood

Improved traffic safety

The construction of the first phase of the Comox-Helmcken Greenway enhanced traffic safety and walkability along the corridor. Sidewalk extensions, addition of street medians and traffic-calming measures have been installed that make long stretches of Comox Street a safer and more walkable environment than before construction of the greenway. In addition, the city installed many pedestrian lights all along Comox Street lighting up dark areas of the street. As mentioned above, prior to the greenway construction, pedestrian street lights were almost absent from the streetscape. With installing additional safety features, evening out sidewalks and preventing traffic through flow for motorized traffic the City of Vancouver incorporated many requests from the greenway's public hearing events (Scott, 2012) (see The Comox-Helmcken Greenway). Based on findings in the literature, these added safety features should positively influence the perceptions of safety of older adults (Franke et al., 2013; MetLife Mature Market

Institute, 2013; Strach et al., 2007) living in the area, and may subsequently lead to higher levels of walking and cycling along Comox Street.

Street beautification and landscaping

Furthermore, the walkability of the area has been enhanced by landscaping and beautification (J. Kerr et al., 2012; Michael et al., 2006; Strach et al., 2007) along the street, as the city added small gardens, seating areas and more trees to the corridor. These additional landscape features were also part of the public input to the planning process of the Comox-Helmcken Greenway. As mentioned in the literature section above, researchers suggest that enhanced street aesthetics and mini gardens provide older adults with “interesting things to see along the way” (Franke et al., 2013), positively influencing the age-friendliness of an area by motivating older adults to walk.

More places to sit and rest

Additional places to sit and relax were installed along the whole stretch of the greenway. These seating areas do not only provide crucial resting opportunities for older adults (J. Kerr et al., 2012), whose mobility may be compromised due to age-related decline or injuries, but also offer opportunities of social interaction while enhancing neighbourhood cohesion. Such seating areas may act as connection point in a natural neighbourhood network ,or even play the role of a third place itself (Gardner, 2011). These places are significant for the social well-being of older adults and play an important role in providing an age-friendly environment (see Social activity and the built environment).

The Comox-Helmcken Greenway connects valuable greenspace

One contribution of the greenway that should not be overlooked is its significance in providing a multi-modal connection between greenspaces, reflecting a major element of sustainable community planning in urban settings (Horton et al., 2007). One of the key motivations cited by the City of Vancouver when planning the Comox-Helmcken Greenway, was to provide an active transportation corridor functioning as a connection between Stanley Park and the greenspaces along the False Creek waterfront. Despite the fact that this has not been accomplished to date (Phase 2 of the greenway needs to be constructed in order to provide this connection), the greenway nevertheless connects greenspaces. By completing the first phase of the Comox-Helcmken Greenway, the city created a traffic-calmed active transportation corridor that provides cyclists and pedestrians coming from the downtown core (Burrard Street) or West End neighbourhood with the opportunity to access Stanley Park and Nelson Park, as well as several mini-parks along Comox Street. Greenspaces and parks are highly significant public space in our cities and especially for older adults provide safe and pleasurable opportunities for physical and social activity and recreation (Gardner, 2011; Kaczynski et al., 2009; Thompson & Kent, 2014).

The construction of the Comox-Helmcken Greenway did not lead to increased levels of active transportation among our study participants

The findings of this study did not reveal significant changes in the uptake of active transportation among our study participants. Based on the findings above, my evaluation of the effects of the greenway on motivating older adults in the area to walk and cycle more to destinations results in a rejection of my hypothesis that study participants sustained or increased their levels of active transportation. Despite a longer study period in 2014 – 6 days more data in comparison to 2012 - the GPS receivers recorded 174 walking trips and 20 cycling trips less than in 2012 (Table 1). The study results indicate that the participants in the ASAP study chose to drive their car and take transit more often in 2014 than during the study period in 2012. For the study period in 2014, the mode share results show a slight 3% increase in car use and a slight increase of 1% in transit use over 2012, while the share for walking decreased slightly by 4%. However it has to be noted that the participants in this study are a highly active group among their age cohort. For both time periods studied, more than three quarters of all trips were taken by active transportation modes such as walking and cycling.

There are a variety of possible reasons of why the study participants chose to drive their cars or take transit instead of walking or cycling to destinations. An age-related decline in the physical ability of the study participants may be one of a few possible explanations as to why there were so many fewer walking and cycling trips in 2014 than during the study period in 2012. Some of the study participants may have encountered mobility issues hindering them from participating in active transportation on a regular basis. Also, as the weather data for the study periods show, the fall of 2014 can be characterized as a wetter fall with overall more precipitation than during the study period in 2012. The bad weather very likely influenced the transportation behaviour of our study participants, to choose car travel and transit over walking and cycling. Days with high amounts of precipitation, as typical for the fall of 2014, may have consciously and subconsciously triggered a mode switch in our study participants. In the literature, findings of comparable studies affirm these assumptions, where rainy weather has been found to correlate with a decrease in active transportation activity (Dill, McNeil, Broach, & Ma, 2014). Rain does not only make walking or cycling unpleasant, but also affects the safety and perceptions of safety among older adults (Carlson et al., 2012; Franke et al., 2013; Hanson et al., 2012; Harrell et al., 2014; MetLife Mature Market Institute, 2013). Wet sidewalks can be slippery and may lead to an increased risk of falls (Franke et al., 2013). Low visibility affecting drivers and other cyclists may create unsafe environments for older adults and other traffic participants (Hanson et al., 2012). As mentioned in the literature section above, weather and safety are key issues affecting the ability of older adults to be physically active.

The results of this study are comparable to findings from similar studies that looked at the effect of bicycle boulevards and traffic calming measures on the physical activity of nearby residents. In a comparable study on adults in Portland, Oregon, Dill et al. (2014) found that newly constructed bicycle boulevards - traffic calmed neighbhourhood streets similar to the Comox-Helmcken Greenway - did not have any effect on the cycling and walking activities of study participants. In the UK, residential street improvements were also found to not have any effect on the physical activity levels of nearby residents. The study found that perceptions of nearby residents changed, however their physical activity levels and behaviours in terms of using active transportation or spending time outside remained the same (Ward Thompson et al., 2012). As mentioned above, it is likely that the full effects of the newly constructed greenway cannot be identified yet, as we observed travel behaviours and choices of our study participants just one year after the construction was completed. More time may have to elapse for neighbouring residents, old or young, to change their transportation routines and route choices. Dill et al. (2014) observed similar findings in a study in Portland, Oregon, recommending follow-ups at longer time intervals.

Traffic-calming measures were successful in diverting car traffic away from Comox Street

For trips made by our study participants, when we take a look at the trips counts for Comox Street in particular, active travel trips along the corridor were fewer for the study period in 2014 compared to the study period in 2012. Walking trips along Comox Street as total count decreased by 6 trips, and the cycling trip count decreased by 20 trips over 2012. However, car traffic has basically been eliminated from Comox Street, where for the study period in 2012 our participants drove along Comox Street for 15 trips and in 2014 only one car trip could be counted. These results show the success of the traffic calming measures preventing car traffic throughflow on Comox Street that have been installed as part of the greenway construction.

Before the construction of the greenway, 11 study participants drove a car along Comox Street during the study period. In contrast, during the study period in 2014, post construction of the greenway, only one participant drove a car along Comox Street. It seems that our study participants may have chosen to use Barclay Street, a neighbourhood street running a few blocks parallel to Comox Street, as an alternative route choice when driving their cars from/to the West End neighbourhood. For the study period in 2014, 6 more participants chose to use Barclay Street as a route to drive their car than compared to the study period in the fall 2012.

Walking and cycling traffic is more dispersed along Comox Street after construction of the greenway

In order to analyse more closely how the changes on Comox Street may have affected the behaviours of our study participants to use Comox Street as a transportation behaviour, I mapped the traffic volume of three different modes (walking, cycling and car) per street block (see Street-segment based analysis - T1 and T2). The results of the traffic volume mapping exercise paint a more detailed picture on how and if the construction of the greenway may have affected our study participants. Despite the fact that walking and cycling counts have decreased for the study period in 2014 compared to 2012, our study participants seem to use more blocks of Comox Street in its whole length and more often (see Figure 13 below).

In 2012, more than half (69%) of walking trips on the proposed greenway route occurred close to the Denman Street/Comox Street intersection (~ 1700-1900 Comox), close to the main retail strip in the neighbourhood. However, during the study period in 2014, walking traffic is more dispersed, with most walking trips occurring on the 1000 and 1300 Block of Comox Street, close to Nelson Park (note higher trip volume and walking volume along Nelson Park in 2014 (Figures 7 and 8 above).

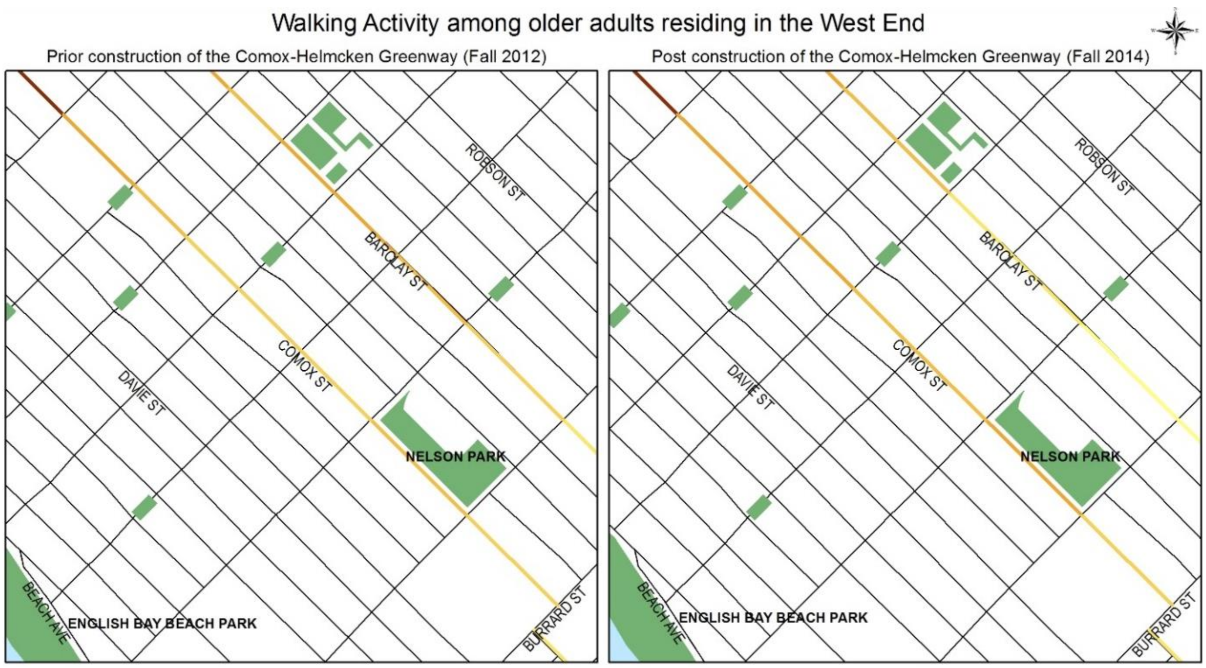

Figure 13: Detailed overview of traffic volume mapping results for the 1000-1800 block of Comox Street

The fact that our study participants seem to use Comox Street at nearly its whole length, may be an effect of the successful traffic-calming measures installed in 2013, that enhance the safety and walkability of the area (Strach et al., 2007). Additionally, the landscaping and street beautification projects along Comox Street may have motivated our study participants to walk further and longer stretches along the greenway corridor. It is also worthy to note, that based on the findings of the traffic volume mapping exercise, walking traffic increased particularly in those areas (e.g. along Nelson Park), where benches were added to the street scape, now providing places to sit and rest (see Figure 14 below).

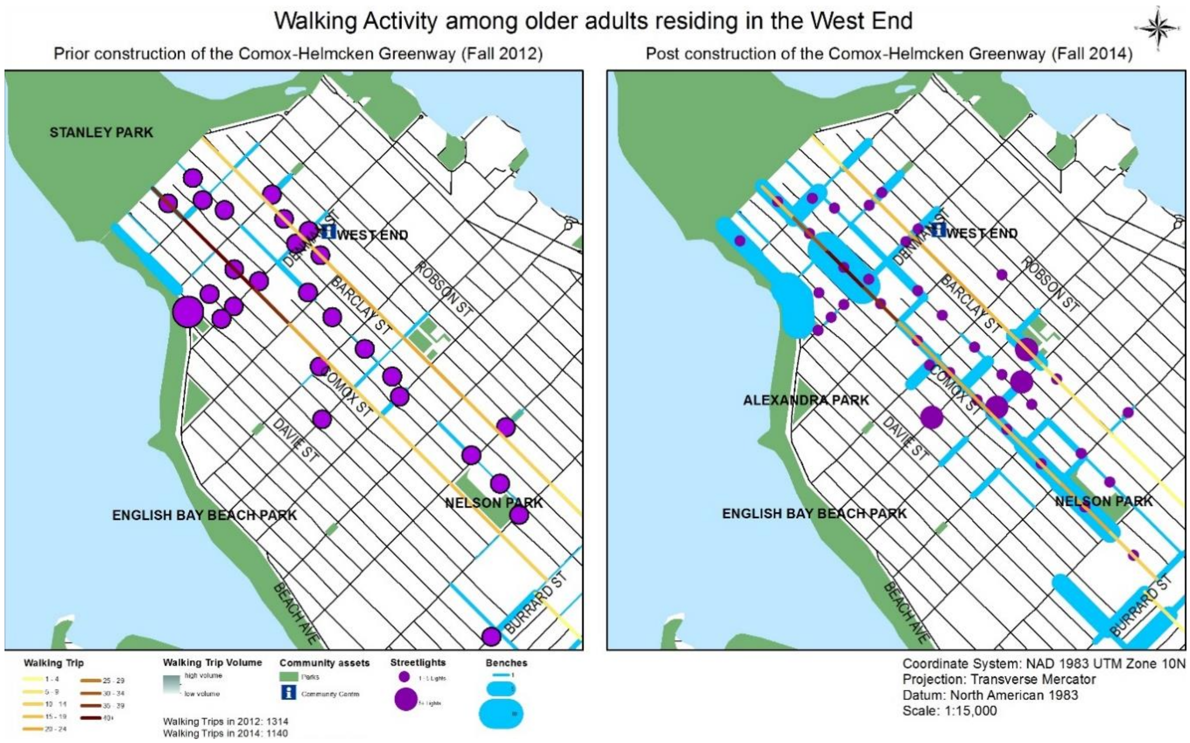

Figure 14: Overview of the walking activity of our participants for T1 and T2 in relation to the street level changes on Comox St

Further, the addition of seating areas may have lead to an increase of walking traffic along Nelson Park. The findings of this study indicate that the changes on Comox Street contributed to an increased use of Nelson Park and the surrounding street scape among our study participants. It seems as if the changes on Comox Street now provide older adults with a more feasible option to access and recreate in and around the neighbourhood park, which may have not been used as much by our study participants prior to the construction of the greenway. The improved walkability of Comox Street, in combination with added amenities and street beautification, may have motivated the older adults in our study to walk to Nelson Park and the surrounding area to recreate. The findings reflect the significance of greenspace and accessibility of such for older adults (Kaczynski et al., 2009), as highlighted by researchers of both the planning and public health community.

Similar to the findings in relation to walking traffic, a comparable pattern can be obtained for the cycling trips of our study participants. Whereas in 2012 most cycling trips occurred on the 1500 to 1700 block of Comox Street (39% of cycling trips) and the 1800 to 1900 block of Helmcken Street (25% of cycling trips), in 2014 cycling traffic is much more dispersed along the greenway route, with the highest traffic volume (14% of cycling trips) occurring near Nelson Park (1100 Block of Comox St). However, due to the low number of cycling trips on Comox Street for the study period in 2012 and 2014, these results have to be treated with caution and should not be used to support the findings of this study.

The street audits (SWEAT-R) performed by the ASAP research team before and after construction document on the ground changes along the Comox-Helmcken Greenway. The fact that after the construction of the greenway our study participants seem to use Comox Street at nearly its whole length and solely for modes of active transportation points to a successful implementation of the Comox-Helmcken Greenway project. The construction of the greenway enhanced the walkability and age-friendliness of the corridor, and contributes to a livable neighbourhood.

Chapter 6.

Conclusion

The findings of this research support the significance of the urban built environment to the uptake of active transportation and trip-based physical activity of its residents, and stress the importance of carefully designed public spaces that are inclusive and inviting to people of all ages and abilities.

Per se, the findings of this research study do not indicate increased levels of active transportation use among our study participants – a highly active group of older adults - after construction of the Comox-Helmcken Greenway. However, the findings show how older residents of the neighbourhood near the greenway – our study participants - altered their route choices in favour of the newly constructed greenway, and used Comox Street primarily as a an active transportation corridor. Based on the findings from this study, the implementation of the Comox-Helmcken Greenway was successful in diverting vehicle traffic from study participants off Comox Street, enhancing the safety of pedestrians and cyclists using the route. The study participants responded to the changes on Comox Street by using the greenway corridor at its whole length and especially near parks and greenspaces, indicating the transformation of Comox Street from a regular neighbourhood street to a meaningful public space. The findings from this research study indicate that the addition of age-friendly features to the built environment of Comox Street may have triggered a change of perception among our study participants. The addition of landscaping features, mini-gardens with seating, pedestrian street lights and washrooms, as well as the diversion of vehicle traffic can very likely be seen as an explanation for this change. During personal visits of the newly constructed greenway corridor I have witnessed people sitting on benches and in the new seating areas chatting with a neighbour or friend, kids playing soccer on the street, teenagers skating and seniors walking the sidewalks.

As mentioned earlier, increased levels of active transportation use on Comox Street could not be detected as the data collection period was likely too close to the implementation of the greenway in order to significantly alter the behavior of our study participants. It is feasible that the bad weather in the fall of 2014 (T2), in comparison to 2012 (T1) weakened the real influence of the greenway construction on the study participants. The findings affirm the great influence of bad weather (e.g. rain or snow) on physical activity levels among older adults (Franke et al., 2013), a factor that is hard to control through city planning. An opportunity to lessen the impact of rain on the physical activity levels of older adults and encourage transportation walking in Vancouver, even in the rainy fall and winter months, are covered sidewalks. It would be unrealistic and impracticable to install sidewalk coverings on neighbourhood streets, however continuous storefront awnings on retail streets in the neighbourhood, such as Denman Street and Robson Street, might present a practicable solution in providing route choices for older adults that would be protected from the elements. In its Transportation 2040 plan, the City of Vancouver states the intention of creating storefront covered sidewalks in major commercial areas of the city (City of Vancouver, 2012b), and a pedestrian design study of Robson Street from 2010 also highlights similar solutions (Thomson, 2010).

In conclusion, based on the findings from this study the construction of the greenway improved the age-friendliness of the West End by adding an active transportation corridor to the neighbourhood that may also act as a meaningful public space. At a cost of $5.4 Million it can be debated if the money could have been invested more effectively to further improve the age-friendliness of the West End, however the development of a network of active transportation corridors is without doubt an important investment for a city eager to pursue leadership in sustainable city planning. The study proves that the City of Vancouver is on the right path towards creating livable communities and a built environment that encourages sustainable transportation use.

Implementing strategies to plan for age-friendly communities will cost our municipalities a lot of money, and it may be difficult for smaller communities to implement any age-friendly community measures. In times of economic downturn and recession, when cutting costs and resources are the norm amongst all levels of government, it is hard to imagine how municipalities may be able to retrofit their communities by eliminating mobility barriers and creating age-friendly built environments. However, federal, provincial, and local governments may be saving significant costs in the long run, when being proactive and promoting and facilitating age-friendly strategies now. Aging in Place is believed to be more cost-effective than institutional care (Wiles et al., 2009), and the costs associated with improving the built environment and planning for healthy communities may be lower than health care costs associated with inactive, sick older adults (Franke et al., 2013). Implementing measures to create age-friendly communities will improve communities and neighbourhoods as a whole, and aligns with the key pillars of sustainable community planning.

This research project presented the opportunities and challenges of studying behavioural changes through real-life experiments and the use of coupled GPS/Accelerometry data. While the limitations of this research project may have greatly influenced the chance of further and more detailed analysis in relation to how the changes of the built environment altered the transportation behaviour of our study participants on an individual basis, it highlights the strengths of interdisciplinary research work and its contribution to age-friendly community planning.

In a time of changing demographics, age-friendly community planning will become a focus of future planning theory and practice in Canada. More studies are needed that explore the effects of changes of the built environment on older adults, and how we can design inclusive communities that facilitate sustainable transportation for people of all ages and abilities. As the findings of this study indicate, the use of GPS and accelerometers can provide planners and policy researchers with the needed objective measures to affirm the need for implementing age-friendly features in our built environment. Alternative methods of collecting such data is through manual and automated traffic counts as it is currently done in the City of Vancouver at numerous places. However, available data from these traffic counts cannot effectively measure walking travel and such data does generally not differentiate by age or ability. The City of Vancouver currently provides only very sporadic measurements at a few intersections. A road segment analysis, as done in this study would not be possible by simply using traffic count data. Going forward, rapidly changing technology presents new and cost-effective opportunities to collect such data, through the use of smartphone GPS (Herrera et al., 2010), and physical activity tracking devices (e.g. Fitbit, Mio) that become more common, more accurate, and cheaper. Complementing objectively derived GPS data with qualitative data from questionnaires or in person interviews may provide a rich background of data to study the impact of age-friendly community planning in more detail.

The aging of our population is a reality that planners have to respond to by planning age-friendly communities and retrofitting neighbourhoods to accommodate aging in place (Hodge, 2008). Older adults are an increasing proportion of the population, and the demand for walkable places is likely to grow significantly among this age cohort (J. Kerr et al., 2012). Among public health researchers, there is presently a strong focus on studying the links between the built environment, transportation walking and health, and researchers in the planning field need to recognize the importance of age-friendly community planning by seeking opportunities of inter- and transdisciplinary research.

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Appendix .

Overview of availability of data per study period and per day

Table 2: Participant Count per day - T1

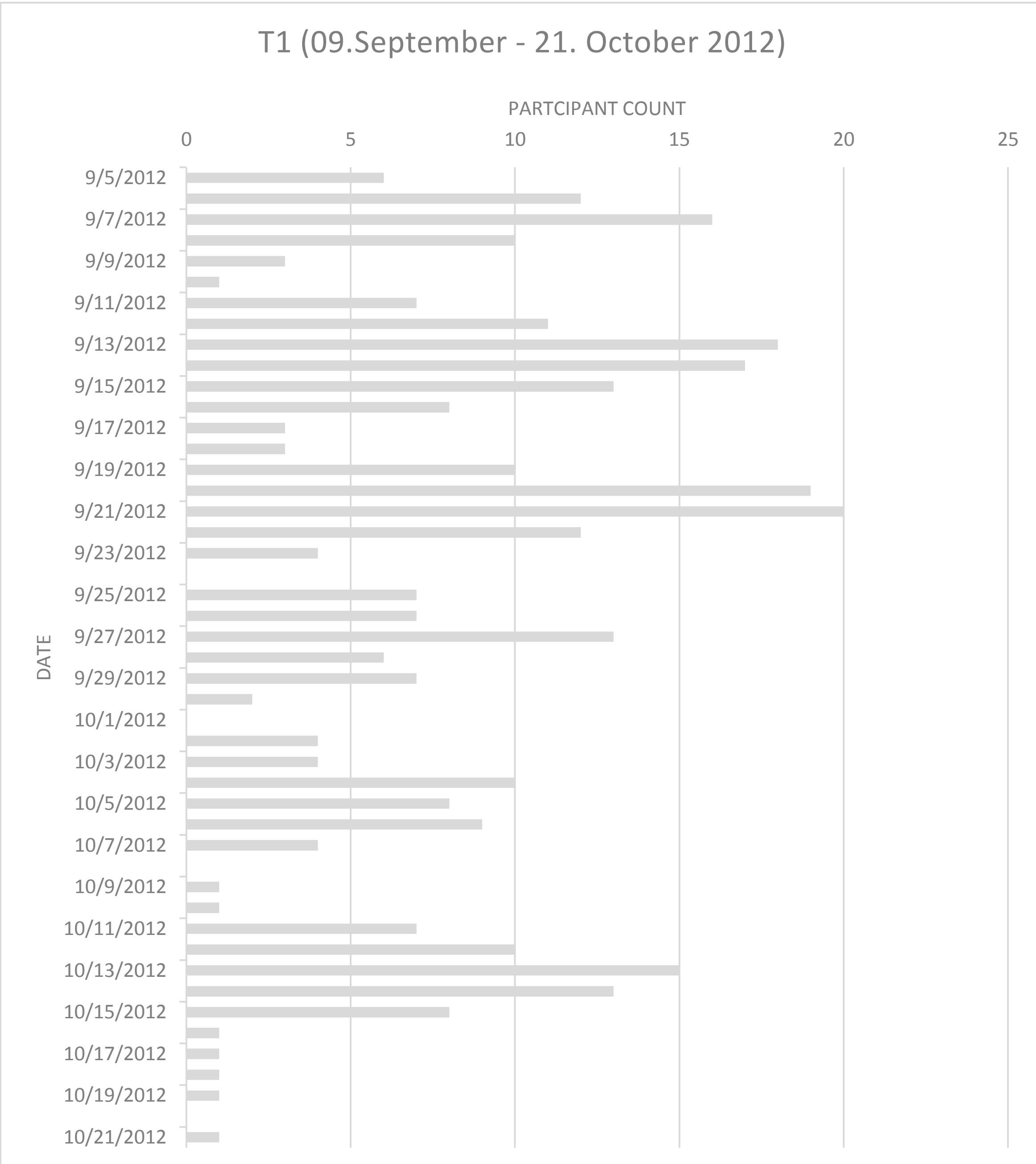

Table 3: Participant Count per Day - T2