

Community-Based Transportation and Outdoor Mobility for Older Adults: A Literature Synthesis and Case Study

**by
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Ethics Statement



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Abstract

This capstone project is a synthesis of literature on transportation alternatives for older adults. Database searches resulted in 112 relevant articles grouped across three categories: older adult driving and supports for transitioning to non-driver status; community-based transportation options for older adults with mobility impairments; transportation planning and advocacy for older adults. The findings demonstrate that citizen-led neighbourhood-based options such as community-based micro transit and volunteer driver programs facilitate access of older adults. Function, comfort, and safety of older adults are important aspects in neighbourhood design. Regulatory and financial incentives, street infrastructure upgrades and older adult empowerment and advocacy programs facilitate the transition of older adults to an active transportation lifestyle from a car-focused one. Projects that take an integrated, multi-sectoral approach are more successful in diffusion of transportation alternatives at the community level than single sector approaches. A focused case study on neighbourhood barriers and facilitators complements the literature synthesis findings.

Key words: older adults; accessible transportation; active transportation; outdoor mobility; driving cessation; walkable/wheelable neighbourhood

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Glossary

Activities of Daily Living (ADL)	Activities of daily living refers to a person's ability with self-care activities such as feeding oneself, bathing, grooming, getting dressed, making meals, etc.
Active transportation	Active transportation commonly refers to modes of transportation that uses one's own power such as walking, cycling and riding transit.
Community Based Participant Research (CBPR)	Community Based Participant Research refers to a type of research project that involves stakeholders as equal partners in the research process, with all partners sharing expertise and contributing to the decision-making process.
Geriatric Depression Scale (GDS)	Geriatric Depression Scale refers to a clinical test that is administered to measure levels of depression in older adults.
Instrumental Activities of Daily Living (IADL)	Instrumental activities of daily living refers to a person's ability with activities such as driving/transporting oneself, shopping, managing one's medications, banking, medical appointments, etc.
Micro transit	Micro transit commonly refers to modes of transit transportation that are primarily community-based, such as accessible community mini-bus service or volunteer driver service.
Mini Mental State Examination (MMSE)	Mini Mental State Examination refers to a clinical test that is administered to measure level of cognitive impairment.
Mixed Method Research (MMR)	Mixed Method Research refers to research studies that use multiple data collection methods, i.e. both quantitative and qualitative data in one study.
Mobility Assistive Technology (MAT)	Mobility Assistive Technology refers to equipment that are used to increase, maintain or improve the functional capabilities of people with disabilities. Examples of mobility assistive technology devices include: canes, walking poles, walkers and wheelchairs.
Outdoor mobility	Outdoor mobility refers to one's ability to move themselves out of their home (place of residence) and into the neighbourhood setting, whether unaided or with the aid of a mobility assistive technology.
Self agency	Self agency is the personal belief in control over one's life, to believe in one's capacity to influence one's own thoughts, desires and behaviours.
Self efficacy	Self efficacy is the personal belief in one's ability to succeed in accomplishing a task.

Short Physical
Performance Battery
(SPPB)

Short Physical Performance Battery refers to a clinical test that measures level of physical function and strength in older adults.

Supplemental
Transportation Program
for Seniors (STPS)

Supplemental Transportation Program for Seniors refers to forms of transportation that offer “door-to-door” service and sometimes extra supports such as “door-through-door” service, for older adults who have mobility impairments.

Chapter 1. Introduction and Purpose

1.1. Literature Background: Health, Aging and the Built Environment

The literature available on health and aging contains ample evidence suggesting that moderate levels of physical exercise can delay or reduce the incidence of chronic conditions across one's life course (particularly heart disease and diabetes), and that it can also positively affect one's psychological well-being and emotional, cognitive, and social functioning (Blumenthal & Guillette, 2002; Colman & Walker, 2004; Li, Fisher, Bauman, Ory, Chodzko-Zajko, & Harmer 2005; Lindwall, Ljung, Hadzibarjramovic, & Jonsdottir, 2012). In addition, researchers in this area have also shown a positive correlation between older adults' levels of social connectedness—particularly their relationships with family, friends, and neighbours—and their well-being and quality of life (Seeman, Lusifnolo, Albert, & Berkman, 2001; Chaudhury, Campo, Michael, & Mahmood, 2016). Walking on a regular basis, whether as instrumental transportation or recreation, is one prominent example of a sociable, moderately physical activity that the literature recommends as being suitable for older adults.

A number of studies have shown that maintaining out-of-home activities can have a protective effect on one's health by increasing functionality and lowering their risk of mortality (Maratolli, Mendes de Leon, Glass, Williams, Cooney, & Berkman, 2000; Glass, Mendes de Leon, Seeman, & Berkman, 1997; Glass & Balfour, 2003; Bygren, Konlaan, & Johansson, 1996). Furthermore, maintaining an active lifestyle has also been shown to improve illness recovery times and lower the risk of stroke, heart disease, arthritis, and bone fractures (Ragland, Satariano, & MacLeod, 2005).

Despite the well-documented health benefits of active living, older adults remain one of the most sedentary population groups in North America, with overweight and obesity rates climbing at historically high incidence levels (Carlson, Sallis, Wagner, Calfas, Patrick, Groesz, & Norman 2012; Kaplan, Huguet, Newsom, McFarland, & Lindsay, 2003; de Groot, Verheijden, de Henauw, Schroll, & van Staveren, 2004). The concurrence of aging and inactivity can result in a host of physical ailments that may

lead to declines in day-to-day functioning, outdoor mobility, independence, and quality of life (Alley & Chang, 2006; Lockett, Willis, & Edwards, 2005).

Increased old-age co-morbidity due to sedentary lifestyles and physical impairment is further exacerbated by North America's car-centric approach to out-of-home mobility. Whether as a driver or a passenger, 89% of older adult Americans use a personal automobile as their primary mode of transportation (Rosenbloom, 2003). It is expected that, by age 70, older adult men will have out-lived their driver's license by approximately six years, while women will have outlived theirs by approximately ten years (Silverstein, 2008). North American neighbourhood environments are also primarily car oriented due to an over-reliance on suburban, single-family land-use design.

Globally, people are living longer than ever before, with the "oldest-old" cohort being the fastest growing demographic segment. By the year 2020, it is estimated that adults over the age of 65 will outnumber children for the first time in world history (U.S. Census Bureau, 2017). This forecast has already been realized in Canada, as the 2016 census recorded 5.9 million Canadians aged 65 years and older compared to 5.8 million children under the age of 14 (Statistics Canada, 2017).

In Canada and the United States, many older adults will live out their later life with physical limitations and disabilities. This is supported by Statistics Canada data, which indicates that the incidence of physical disability among Canadians generally increases with age (Statistics Canada, 2012). In 2012, 10.1% of Canada's working population (age 15 to 64) reported having a disability; in comparison, 26.3% of Canadians aged 65 to 74 reported living with a disability, with this number rising to 42.5% for those over age 75. Disability levels are even higher in the United States: nearly 40% of Americans aged 45 and up report having difficulty with physical movements, with this figure rising to 51.8% among those aged 65 and older (Altman & Bernstein, 2008). This rise in disability rates has been accompanied by an increase in sedentary behaviour. Indeed, one recent U.S. study of older adults with mobility disabilities found that nearly 30% of older adult respondents took part in *no* physical activity at all (Rosenberg, Huang, Simonovich, & Belza, 2012).

1.2. Project Rationale

Along with their consequences for health and well-being, aging-related physical deteriorations are also linked to driving cessation. Researchers have found that adults who retire from driving tend to be from older age groups and exhibit declining health characteristics, such as poor vision, diminished executive functioning, poor grip strength, more medical conditions (co-morbidity), and subjective feelings of poor health and well-being (Ackerman, Edwards, Ross, Ball, & Lunsman, 2008; Anstey, Eramudugolla, Ross, Lautenschlager, & Wood, 2006). Given that most North Americans depend on cars for their out-of-home mobility, driving cessation can lead to negative physical health outcomes, as well as social isolation, especially among older adults who live alone. Social isolation has been linked to an increased risk of depression, which can further erode health and increase the likelihood of relocation to long-term care facilities, thereby inflating healthcare costs (Mezuk & Rebok, 2008; Ragland et al., 2005; Freeman, Gange, Munoz, & West, 2006).

There are three main transportation options that mobility-impaired older adults with co-morbidity can choose from to maintain their outdoor mobility independence once they have reduced their driving or retired from driving altogether:

- 1) Walking with or without a mobility assistive device (i.e. cane, walker, walking poles),
- 2) Using a motorized wheeled device (i.e. electric wheelchair, electric mobility scooter, electric bicycle-tricycle);
- 3) Being transported by someone else via public transit, para-transit shuttle bus, accessible taxi, or family, friends, or community members (i.e. shared services).

Over the years, there have been numerous calls from academics and practitioners to support older adults who are transitioning to their non-driving years by providing proactive health-promotion measures and developing appropriate, accessible, alternative transportation options that will allow these individuals to maintain their safe mobility and independence (Maratolli et al., 2000; Ragland et al., 2005; Anstey, 2006; Donorfio, Mohyde, Coughlin, & D'Ambrosio, 2009; Dahan-Oliel, Mazer, Gelinias, Dobbs, & Lefebvre, 2010).

At the same time, city planners and officials around the world are trying to address population aging through the development of guidelines and programs that take into account a wide range of mobility requirements. The World Health Organization's "Age-friendly Cities" report (2007) and the United Nations Environment Programme's "Livable Communities" (2007) report exemplify the global community's focus on designing walkable, transit-oriented neighbourhoods that will allow older individuals to "age in place," thus allowing them to remain close to their family, friends, and neighbourhood amenities (Ball, Ross, Eby, Molnar, & Meuser, 2013). Neighbourhood-level built-environment features, such as wide (level) sidewalks, defined crosswalks, and well-placed benches, have been shown to play a role in encouraging and enabling older adults to continue to lead active, socially engaged lives (Chaudhury, Campo, Michael, & Mahmood, 2016; Mahmood, Chaudhury, Michael, Campo, Hay, & Sarte, 2011; Rosso, Auchincloss, & Michael, 2012). The World Health Organization's Age-Friendly Community framework (2007) provides broad guidelines for assessing, designing, and monitoring features of the built and social environments that are globally recognized as important for enabling older adults to continue to fully participate in community life.

Cities around the world are also beginning to recognize the need to build "active transportation" infrastructure, particularly cycling and transit infrastructure, in order to reduce car dependency and to improve air quality and physical activity rates (United Nations, 2016). However, no in-depth reviews have been conducted on the literature related to the presence and quality of community-based transportation options and the attendant gaps for older adults, particularly for those with mobility impairments.

1.3. Research Project Objectives

This capstone project addresses the above-mentioned gap by critically reviewing and synthesizing the literature related to supportive community-based transportation options and active transportation infrastructure for older adults, particularly those with mobility impairments. In addition, the findings of a case study, wherein a section of an urban neighbourhood is audited using a user-led built-environment audit tool and photo elicitation, are presented in order to supplement the literature review.

While there has been growing global interest in advancing active transportation and liveable, age-friendly communities, it is unknown whether specific focus has been

placed on the needs of older adults with disabilities. This is an important research area that demands further study, as 80% of people with disabilities reported using mobility aids and/or assistive devices to carry out their day-to-day activities (Statistics Canada, 2012). Furthermore, the entire Baby Boomer cohort is now over the age of 50, with the oldest strata of this cohort having begun to turn 70 years old. This means that a growing portion of the North American population is now considered aging and at a greater risk of mobility impairment. In North America, the total Baby Boomer population totals approximately 86 million people (9.6 million in Canada and 76.4 million in the United States), and the number of people aged 65 years and older is expected to comprise approximately 25% of the North American population by 2031 (Statistics Canada, 2012).

This literature review and synthesis summarizes current research on services and options for older adults who are transitioning to non-driver status and adopting an active transportation lifestyle. This review also includes research on the barriers to and facilitators of out-of-home mobility, as well as the presence and efficacy of transportation infrastructure for older adults with disabilities. The literature review is complemented by a case study wherein a neighbourhood in Vancouver, BC, Canada, where an older-adult motorized-wheelchair user lives, is assessed by the researcher for barriers to and facilitators of out-of-home mobility for this person. Significantly, the street infrastructure of the participant's neighbourhood had recently been upgraded in order to better facilitate active transportation. The case study evaluated whether these infrastructure upgrades met the wheelability requirements of an older adult using a wheeled mobility assistive device. The built-environment assessment was completed using a street audit tool specifically designed for use by older adults and those with mobility disability: the Stakeholders Walkability/Wheelability Audit in Neighbourhoods (SWAN) Tool. This was supplemented by photographic documentation of the mobility path of the older adult. The last section of this capstone provides a summary of policy trends in the area of active transportation and community-based transportation specific for older adults and highlights gaps in the research and policy agenda.

The overarching objective of this capstone project is:

To synthesize three key areas of research: active transportation for older adults with mobility disability; community-based transportation systems; and barriers and facilitators related to transit, walkability, and wheelability in urban streetscapes.

Furthermore, this project focused on the following sub-objectives:

- To understand the status of older adult drivers and programs related to driving cessation and transitioning to other modes of transportation;
- To identify objective and perceived aspects of the neighbourhood built environment that are salient to older adults with mobility limitations;
- To understand the strategies these older adults use to adapt to the urban infrastructure in order to satisfy their outdoor mobility needs;
- To identify progress and gaps in policies that facilitate the advancement of active transportation and community-based transportation options for older adults with mobility limitations.

1.4. Key Concepts and Theoretical Frameworks

1.4.1. Contextualizing the review within a social-ecological system framework for older adults

First introduced by Urie Bronfenbrenner in 1979, the social-ecological system framework is a useful theoretical framework to guide planning processes for community dwelling older adults. Social-ecological models propose that human behaviour and development are influenced by the different physical and social environments that individuals interact with on a day-to-day basis (Bronfenbrenner, 1979). For example, an older adult's physiological state would be very different while sitting at the beach on a sunny day than it would be while walking through a dark alleyway at midnight. The model uses a series of concentric circles (Figure 1.1) to identify the spheres of (built) environmental and inter-personal interactions and influences. The circles begin with the individual at the center, which is followed by the "micro" system of their immediate relationships with family/friends and their instrumental relationships with school/work/faith-based and health professionals. Next come the "meso" and "exo" systems, which include the individual's interactions with the various entities at the community level, such as relationships with neighbours, community services, businesses, government services, and the built infrastructure. Lastly, the "macro" system identifies cultural, generational (time-bound), socio-economic, and public-policy issues.

When the social-ecological model is applied from an outdoor-mobility viewpoint, the design of the immediate neighbourhood environment becomes increasingly important for older adults with physical mobility challenges. The presence of environmental supports or barriers can affect an older adult's ability to walk to the grocery store or visit a neighbour down the street (Clarke & George, 2005). The inability to walk 400 meters (approximately three standard city blocks) has been commonly used as an indicator of mobility disability risk (Pahor et al., 2006). Therefore, the lack of access to important shops, services, and relationships that fall outside this range can further compound an older mobility-disabled adults' ability to perform the instrumental activities of their daily life. For older adults, the salience of their immediate neighbourhood is attributed to features of the built environment—for example, the presence of wider, smoother sidewalks, the presence of green space, and adequate street and sidewalk lighting—which can influence their level of outdoor physical activity and comfort (Frank, Devlin, Johnstone, & van Loon, 2010).

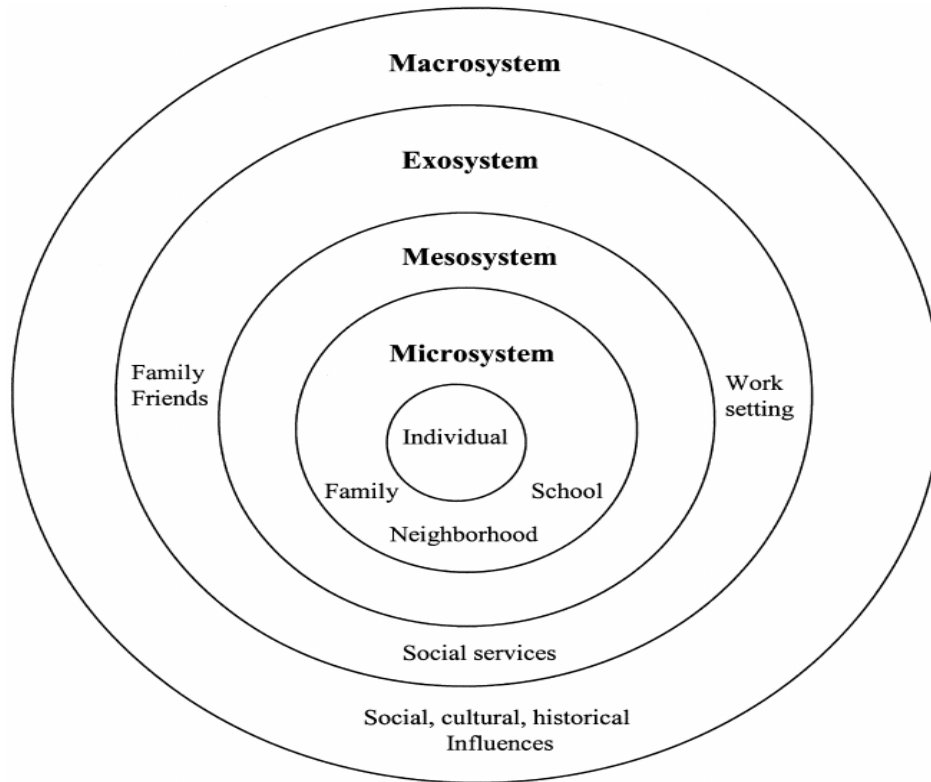


Figure 1.1. Social Ecological System Model, Urie Bronfenbrenner, 1979

1.4.2. Ecological model of aging: the person-environment fit model

The Person-Environment Fit model is a particularly useful theoretical framework for this review (Lawton & Nahemow, 1973). This model posits that an older adult’s physical environment and its features will become too taxing (too much press) as their physical functioning (competence) declines over time with age. Thus, environmental changes are required in order to restore equilibrium. It is also noteworthy that this model discourages removing too much press (lack of stimulation), as this can lead to passivity, boredom, and dis-engagement, which may in turn result in further physical and cognitive decline. The Person-Environment Fit model is about finding the right “fit”, or balance, between a person’s current competence level and the demands of their physical and social environments (Figure 1.2).

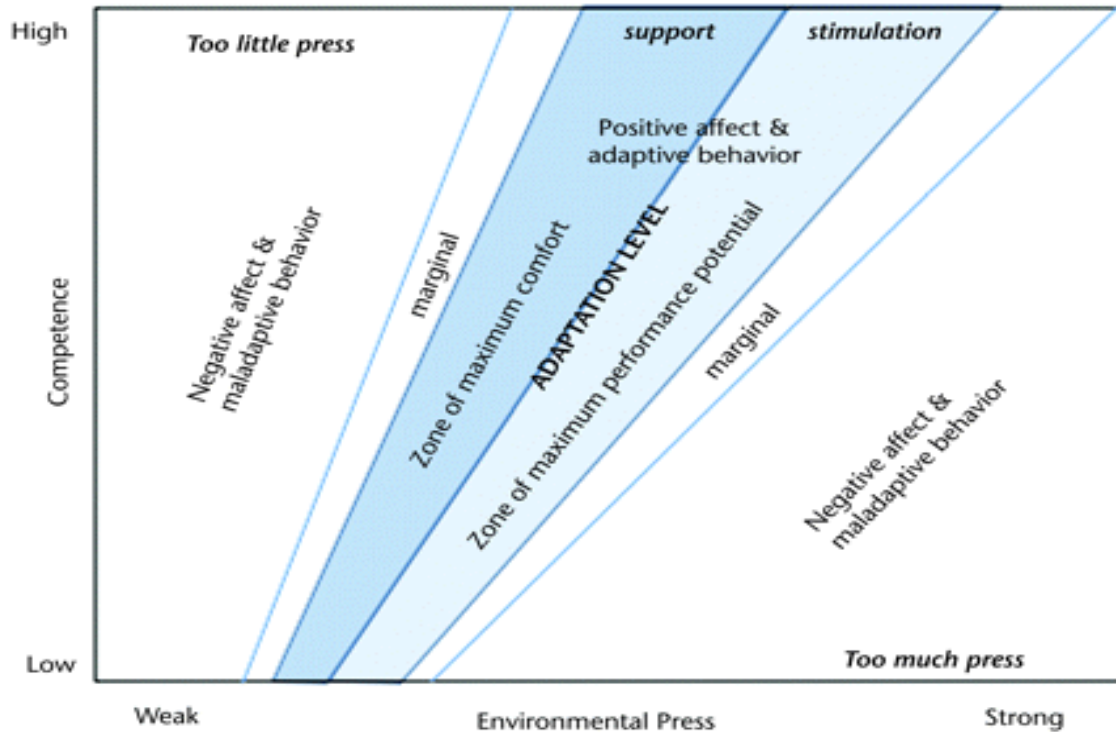


Figure 1.2. Ecological Model of Aging: Person-Environment Fit, Lawton & Nahemow, 1973

Since the vast majority of older adults in North America remain active drivers, the Person-Environment Fit model provides a useful lens for examining outdoor mobility and community-based transportation issues. Though this model has been seldom used in research on outdoor mobility environments, it can be valuable for evaluating disabled older adults' mobility behaviours and its related "fit", or congruence, with outdoor neighbourhood environments. When older adults experience functional, cognitive, or sensory (vision and hearing) challenges, the fit between their capabilities and the traditional North American outdoor built environment, which emphasizes automobiles and related street infrastructure, become sub-optimal. As such, this sub-optimal person-environment equilibrium gives rise to a number of unsafe conditions related to driving, walking / wheeling, and public transit, which can result in negative health and social behaviours, such as decreased out-of-home activities and increased social isolation.

Glass and Balfour (2003) extended the Person-Environment Fit model (Figure 1.3) to include neighbourhood characteristics that either support (buoy) or create barriers (press) to an older adult's health and functioning vis-a-vis their level of competence. In this model, neighbourhood features such as accessible destinations, services, and

resources are all considered positive environmental buoys, as is the availability of social supports and opportunities for enrichment. In contrast, factors of environmental press include physical barriers and inaccessibility, as well as resource inadequacy and social stress. The model indicates that personal physical-health conditions, such as chronic illness, depression and cognitive decline, can also exacerbate personal competency and coping response.

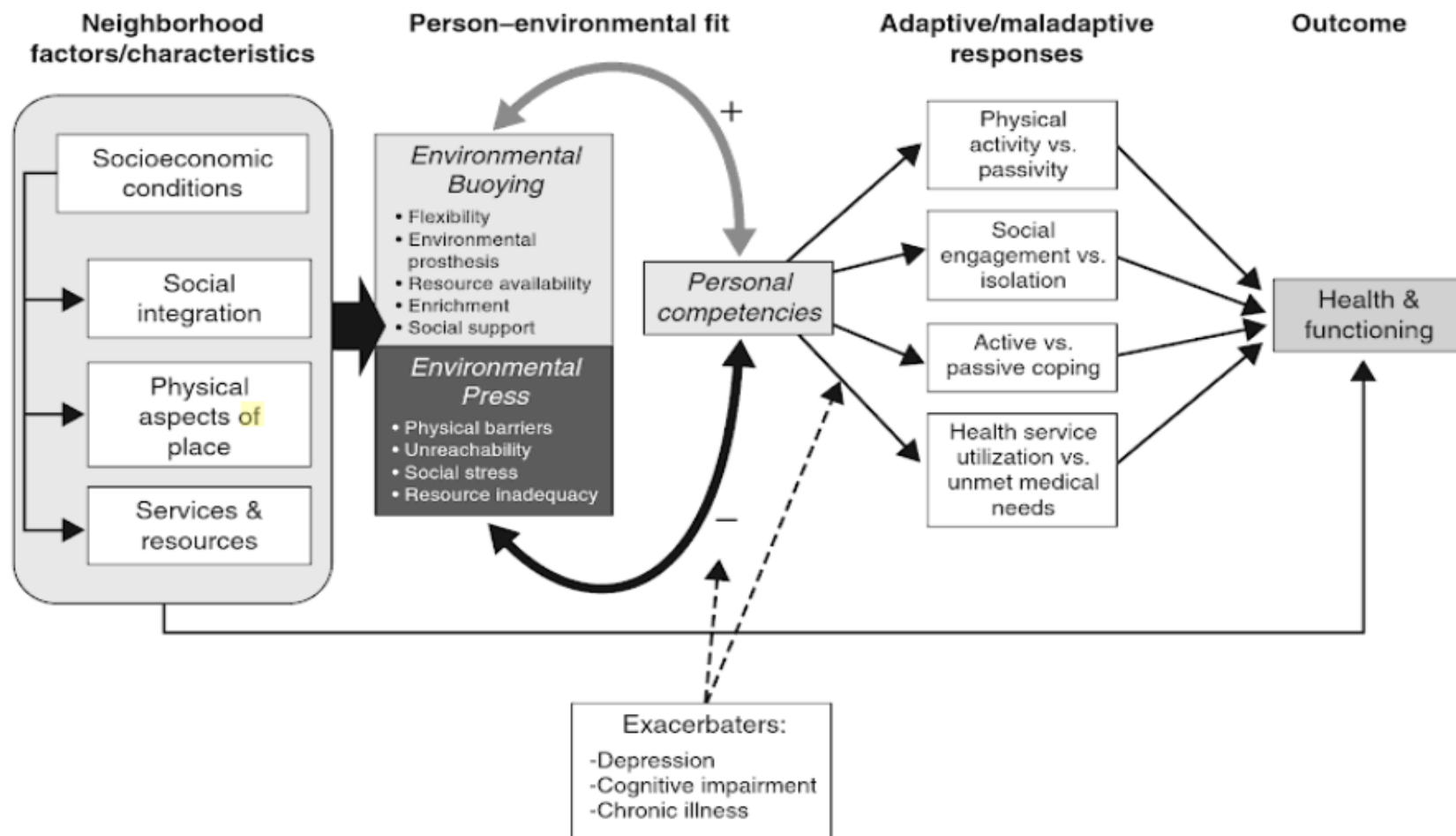


Figure 1.3. Causal model of neighbourhood effects on aging (Glass and Balfour, 2003)

1.4.3. Disablement and adaptability model

Related to the Glass and Balfour (2003) model is the Disablement and Adaptability model. This model was designed in the 1970s by Saad Nagi as a social-medical model that follows a linear pathway from disease (or injury), to impairment, and, eventually, to disability. Verbrugge and Jette (1994) extended Nagi's model to include relationships between the physical-social environments and the individual's personal lifestyle, attitudes, and behaviours, particularly the various roles that an individual inhabits during their day-to-day life. Verbrugge and Jette emphasized that disability is not a personal characteristic, *per se*; rather, it is a *gap* between an older adult's personal capabilities and the demands of the environment. Conceived in this manner, Verbrugge and Jette's model can be seen as being linked to Lawton and Nahemow's Person-Environment Fit model. Later, Rosso, Auchincloss, and Michael (2011) would further extend this model by identifying three aspects of the built environment (Figure 1.4) that may be linked to mobility impairments: transportation systems, land-use patterns, and urban design features (i.e safety, attractiveness and site design). This capstone project summarizes the facilitators (buoys) and barriers in the built environment that have been empirically shown to affect the outdoor mobility of older adults with mobility limitations.

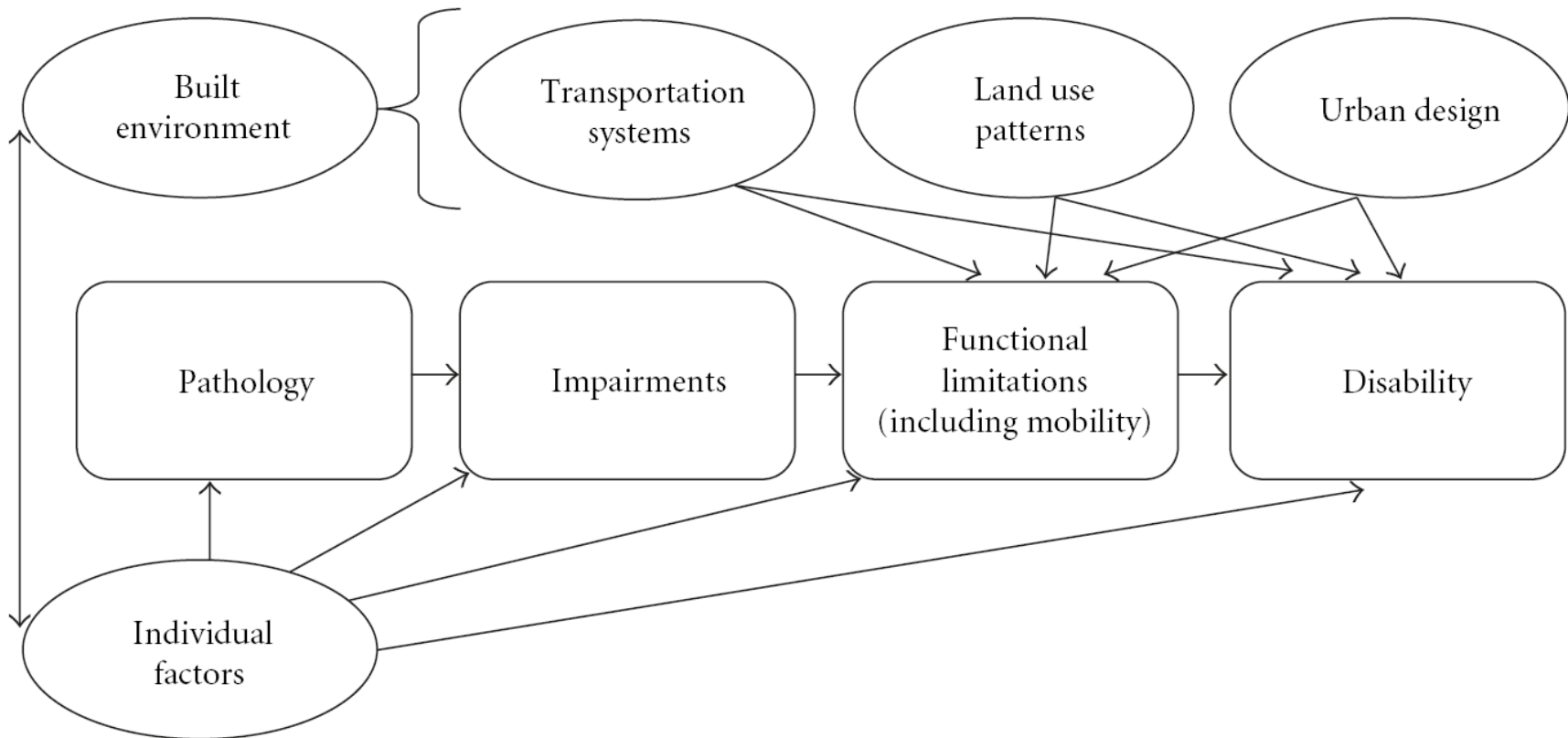


Figure 1.4. The Disablement Process, Verbrugge and Jette, 1994. Adapted by Rosso et al., 2011.

The social ecological systems model has likewise been linked to the Age-Friendly Community framework (Figure 1.5), which organizes the key social-, economic-, and built-environment elements into eight categories of assessment. Housing, transportation, outdoor buildings and spaces, community support, and health services are linked to the built-environment domain, while the social-environment domain is linked to social and civic participation, employment, respect, and social inclusion. Communication and information are considered part of both domains (World Health Organization, 2007). The second phase of this capstone project, the case study, summarizes the evidence related to the transportation and outdoor spaces categories of the Age Friendly Communities framework through the street audit assessment tool, SWAN.

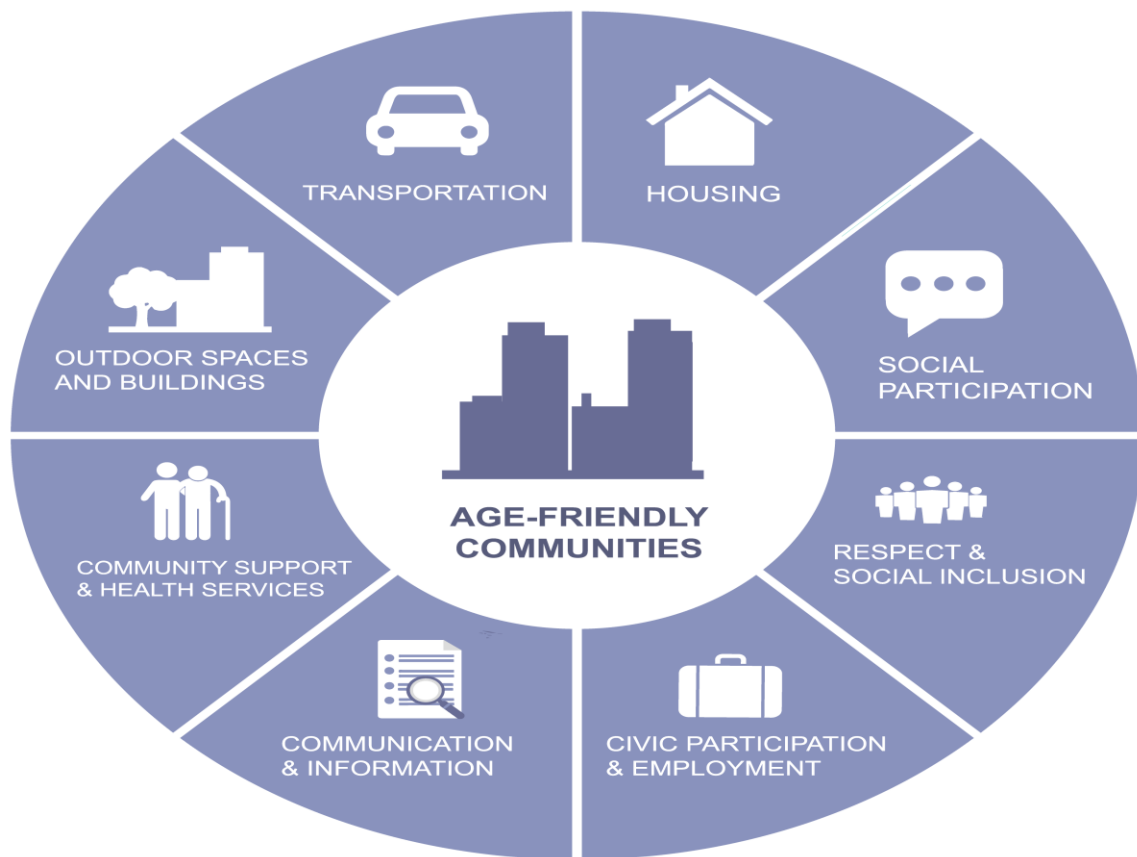


Figure 1.5. Age Friendly Community Framework, World Health Organization, 2007

1.5. Outline of this paper

This paper consists of five chapters. Chapter One has provided a background discussion of the research topic and outlined the conceptual frameworks that guided this research. Chapter Two describes the research methods that were used for the review and the case study, while Chapter Three synthesizes all of the literature that was found relating to this study's research objectives. Chapter Four supplements these results by summarizing the findings of a case study. Finally, Chapter Five details recommendations for further research and policy development, in addition to outlining this study's limitations and providing concluding remarks about the review.

Chapter 2. Methods

This capstone project involves two components: 1) a main section that reviews and synthesizes the literature related to the outdoor mobility of older adults; and 2) a case study of a neighbourhood that is audited for out-of-home mobility facilitators and barriers for older adults with mobility disabilities. This case study involved the use of a user-led audit tool and was accompanied by photo elicitation of the travel route.

2.1. Systematic Review Methodology

The literature review process used in this capstone project consisted of the following steps: defining eligibility criteria for inclusion based on the objectives of the present study; identifying potential research publications based on the selected eligibility criterion; assembling a dataset of research publications by extracting data according to quality appraisal of studies; and analyzing the dataset through synthesis and preparing a structured report of the research in this area (Pope et al., 2007). Between June and August of 2016, the author searched a variety of electronic databases to identify gerontological and health literature related to the outdoor mobility of older adults with mobility disabilities. The databases selected for this search process were Ageline, Psychinfo, CINAHL and PubMed (Medline), and Google Scholar, and the key search words included: *seniors, older adults, accessible transportation, aging population, active transportation, adapted, outdoor mobility, driving cessation, driving retirement, dial a ride, community mobility, walkable neighbourhood, wheelchair, cycling, outdoor design, urban environment, and roads*. To be included in this review, articles were required to be peer reviewed and written in English. To supplement the academic literature search, a Google search using the above search terms was performed to identify any relevant government and public policy documents.

The initial database search returned over 6,000 articles. The second step of the search process involved narrowing this sample to articles published between January 2000 and August 2016 and removing all duplicates and irrelevant topics. This process narrowed the sample to 498 articles. In the third step, the article titles and abstracts were scanned for study samples that included older adults, defined here as 50 years old and above, and excluded studies that focused on institutional living environments. This step

further narrowed the sample to 226 journal articles. The final step involved reading each abstract to identify articles that were relevant to the research objectives and the project focus area of older adults with mobility disabilities. This step further eliminated 118 articles, resulting in a preliminary final review list of 108 articles. Periodic searches for new articles related to this topic area continued to be performed throughout 2017 and 2018. These searches yielded four additional studies, bringing the final total to 112 articles. A flow chart of the search process is presented in Figure 2.1

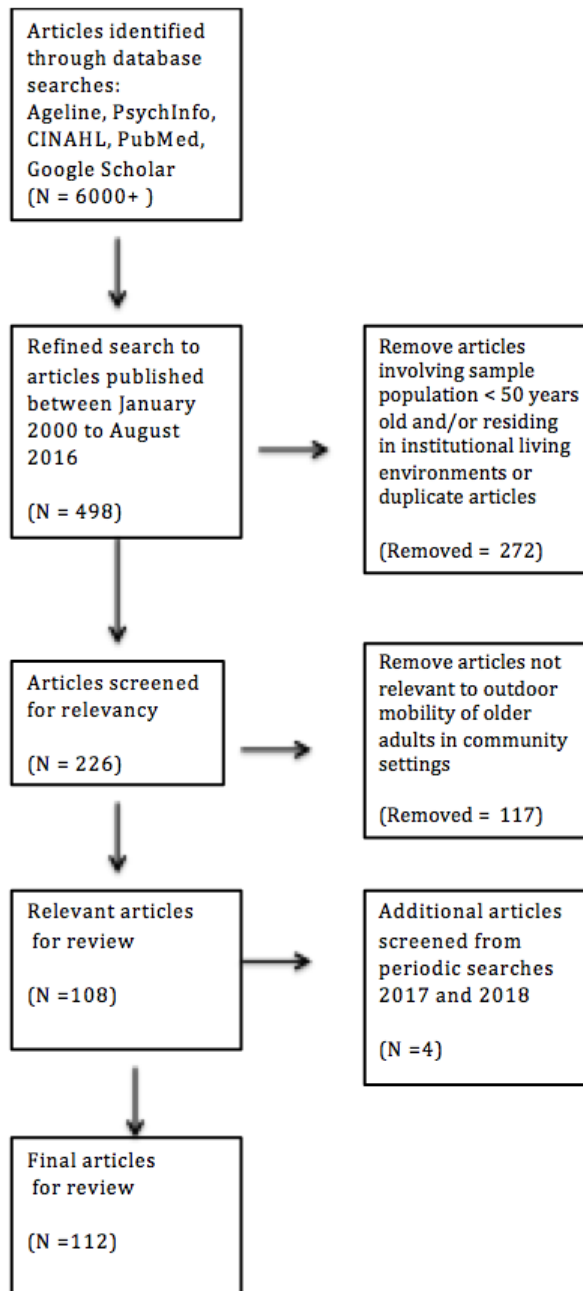


Figure 2.1. Flow Chart of the Literature Search Process and Search Results

2.2. Case study methodology

The systematic review was supplemented by a case study in order to obtain an older adult's perspective on the walkability/wheelability of the infrastructure in their out-of-home mobility area. Case studies are a useful approach because they provide a way of translating the literature review findings to a more practical context. The case study consisted of two parts: a) a pilot test of a built-environment audit tool by the researcher (the author) and; b) a field test with an older adult in a motorized wheelchair. Both audits were performed within the same general time frame. The case study employed an audit of the built environment by the researcher as well as photographic documentation (by the researcher) of the neighbourhood environment's salient features to complement the audited data. This photo elicitation provided the opportunity to document the older adult's social interaction with the built environment. The researcher took photographs of the mobility facilitators and barriers in the audited built environment (the West End neighbourhood of Vancouver, BC, Canada), as well as photographs of the social environment along the travel routes and at the community destinations frequented by the older adult. Additionally, the researcher photographed interactions between the older adult and the social and built environments of the neighbourhood under study. These photographs were taken as the older adult traveled along some typical daily travel routes with her grandchildren. The researcher then summarized all observed environmental facilitators and barriers into graphs and tables, highlighting concentrations of walkability/wheelability, supportive land use, and built-environment features. Informed consent was obtained from the older adult before photographing her and documenting her routes. Care was taken to ensure photographs of faces were obscured.

Description of the Built environment audit tool used for the case study: Stakeholders' Walkability/Wheelability Audit in Neighbourhoods (SWAN)

Environmental-audit tools are used to evaluate the micro-level built environment (streets and sidewalks) in order to identify street-level features and resources that may facilitate or create barriers to outdoor mobility, particularly walking. There are several validated and reliable researcher-led auditing tools designed to gauge walkability for older adults (e.g., Cunningham, Michael, Farquhar, & Lapidus, 2005; Chaudhury, Sarte, Michael, Mahmood, Keast, Dogar, & Wister, 2011; Michael, Keast, Chaduhury, Day, Mahmood, & Sarte, 2009; Kerr, Carlson, Rosenberg, & Withers, 2012). However, none of these tools have been specifically designed to be used by older adults or persons with

disabilities who use wheeled mobility-assistive devices. In this case study, the environmental audit was performed using a newly developed user-led tool designed for older adults and persons with disabilities, the Stakeholders' Walkability/Wheelability Audit in Neighbourhoods (SWAN). The SWAN tool was adapted from another audit tool, the Senior's Walkability Environmental Audit Tool-Revised (SWEAT-R), which is an environmental tool primarily designed for use by professional researchers, and not by older adults (Mahmood et al., 2012). In contrast, the SWAN tool specifically includes wheelability and is intended to be used by older adults and others with mobility disability.

The SWAN audit tool was designed to be a neighbourhood-level environmental-audit tool that older adults and people with mobility disability can use to evaluate the features and resources in their own neighbourhoods that affect their walkability/wheelability, either positively or negatively. Using an audit tool that was purposefully created to be used by people with mobility challenges allows researchers to collect objective data as well as subjective perceptions, so that the voices of older adults and those with mobility challenges can be documented and shared with decision-makers. Furthermore, user-led input can also be useful for Community Based Participatory Research (CBPR) planning and advocacy training.

The SWAN audit tool consists of 110 quantitative items that require the user to respond either "Yes," "No," or "Not Applicable (N/A)." The 110 items are categorized across five domains:

- 1) Street Functionality Domain: is sub-divided into two sub-domains; Function of Street Crossings and Function of Sidewalks. The 'Function of Street Crossing' sub-domain consists of checklist items related to way finding, curb cuts/ramps, crosswalk markings and crosswalk signals. The 'Function of Sidewalk' sub-domain consists of items corresponding to the physical condition of sidewalks as well as the presence/absence of sidewalk obstacles.
- 2) Street Safety Domain: is also sub-divided: Safety of Street Features and Personal Safety of the Pedestrian. The 'Safety of Street Features and Traffic' sub-domain consists of checklist items related to traffic conditions, street conditions, vehicular speed and cyclists. The 'Personal Safety' sub-domain consists of items related to the

presence/absence of lighting fixtures, as well as subjective items related to perception of personal safety, such as the presence/absence of negative social elements i.e. suspicious people.

- 3) Appearance and Maintenance Domain (Aesthetics): This domain consists of checklist items related to the street segment's overall level of maintenance, such as the condition of houses and commercial establishments, as well as the overall aesthetics of the environment.
- 4) Land use and Supportive Features Domain (Destinations): This domain consists of checklist items related to the presence/absence of businesses relevant to older adults, in addition to the presence/absence of transit stops and other supportive street amenities such as benches, rain covers, water fountains, accessible bathrooms.
- 5) Social Aspects Domain: This domain includes checklist items related to the overall friendliness of people on the street segment and the availability of suitable places for older adults to socialize.

For the purpose of this case study, the researcher tried to document aspects of all five SWAN domains while photographing the identified facilitators and barriers to outdoor mobility within the case study site. The next section presents the results of the literature review and synthesizes the main findings in relation to three aspects of this project's theme: a) older adult drivers and driving cessation; b) features of the social and built environments that either facilitate or hinder the outdoor mobility of older adults with mobility disability; and c) multiple modes of innovative community-based transportation.

Chapter 3. Results of the Literature Review

The body of research on outdoor mobility and community-based transportation for older adults is growing in size and sophistication. Indeed, the literature search yielded a total of 112 articles related to these topics. In the five-year period between 2000 and 2004, there were only four articles related to transportation/outdoor mobility for older adults. This number grew substantially to 40 studies in the subsequent five-year period from 2005 to 2009. Moreover, an additional 66 studies were published between 2010 and 2018, which represents an increase of 65% since 2009. Two additional studies from 1997 were added to the review; even though these studies were outside of the search parameters, their focus on disability was deemed relevant to the research objectives. The majority of the research in this field originates in the United States of America, with Canada producing the second largest share of articles and Australia, Northern Europe (United Kingdom, Ireland, Sweden, Finland, Austria, Netherlands, Germany), and Asia (Japan and Hong Kong) contributing a smaller share of articles.

The earlier research results, published between 2000 and 2004, were predominantly from health-related disciplines such as epidemiology, public health, ophthalmology, nursing, biostatistics, and geriatrics. In more years, however, the body of research on this topic has evolved to include studies conducted in the social sciences and applied-design disciplines, such as gerontology and aging studies, psychology, social work, mental health, transportation, urban studies, geography, gender, and family development. Furthermore, technology-related firms and health-promotion agencies have emerged as research partners, showcasing innovations in transportation services and health-promotion programs for older adults. There has also been substantial interdisciplinary collaboration among various universities across North America.

The research methodologies used in this research topic area are also becoming more sophisticated. While earlier research focused on how the physiological aspects of aging impacted older adults' outdoor mobility, research has since evolved from these initial cross-sectional methodologies to more recently, the majority of the studies have large sample sizes following a cohort over longer periods of time. The current literature also includes in-depth qualitative studies aimed at understanding older adults' decision-making processes, as well as their perceptions of their own mobility and the surrounding

outdoor mobility infrastructure. This type of qualitative research helps to highlight older adults' wants, needs, and concerns in relation to continued outdoor mobility. Another growing trend is the use of mixed method research methodologies. Mixed method studies in this area tend to be highly robust, as they often combine observational audits of built environment features with GIS data, which is in turn layered with other available data from large sets. Examples of such datasets may include census geo-coded data, regional travel diary data on current driving status, data on the use of public transit, and the use of mobility assistive technology (MAT). These multi-faceted studies provide a well-rounded picture of how the social-spatial context of neighbourhood environments influences older adults' outdoor mobility and the life-space distance of their societal participation.

This literature review and synthesis is organized according to three categories that are based on overarching factors in the transportation/outdoor-mobility domain:

- 1) Driving, driving cessation, and transitioning to other forms of transportation. This category includes studies that focus on older-adult driving, driving cessation, and the process of transitioning into a non-driver.
- 2) Alternative forms of transportation. This category focuses on products and features in outdoor mobility environments that provide support to older adults with mobility disabilities. The studies in this category examine pedestrian infrastructure for older adults with mobility impairments, as well as available transportation options that can help support their continued independent outdoor mobility and societal participation.
- 3) Public policy. This category includes global frameworks and local policy related to inclusive transportation for aging individuals. The literature in this section also focuses on community engagement and advocacy building among older adults in relation to transportation issues.

A flow chart illustrating the number of studies identified for each major category, as well as the number of studies within each sub-category, is presented below (Figure 3.1).

Each section of the literature review results is followed by a summary table. The summary table organizes the results by sub-categories, which are loosely guided by a social-ecological lens:

- Personal health-functioning issues;
- Psychosocial issues;
- Interpersonal issues;
- Socio-economic and demographic issues;
- Built-environment issues;
- Regulatory and policy issues.

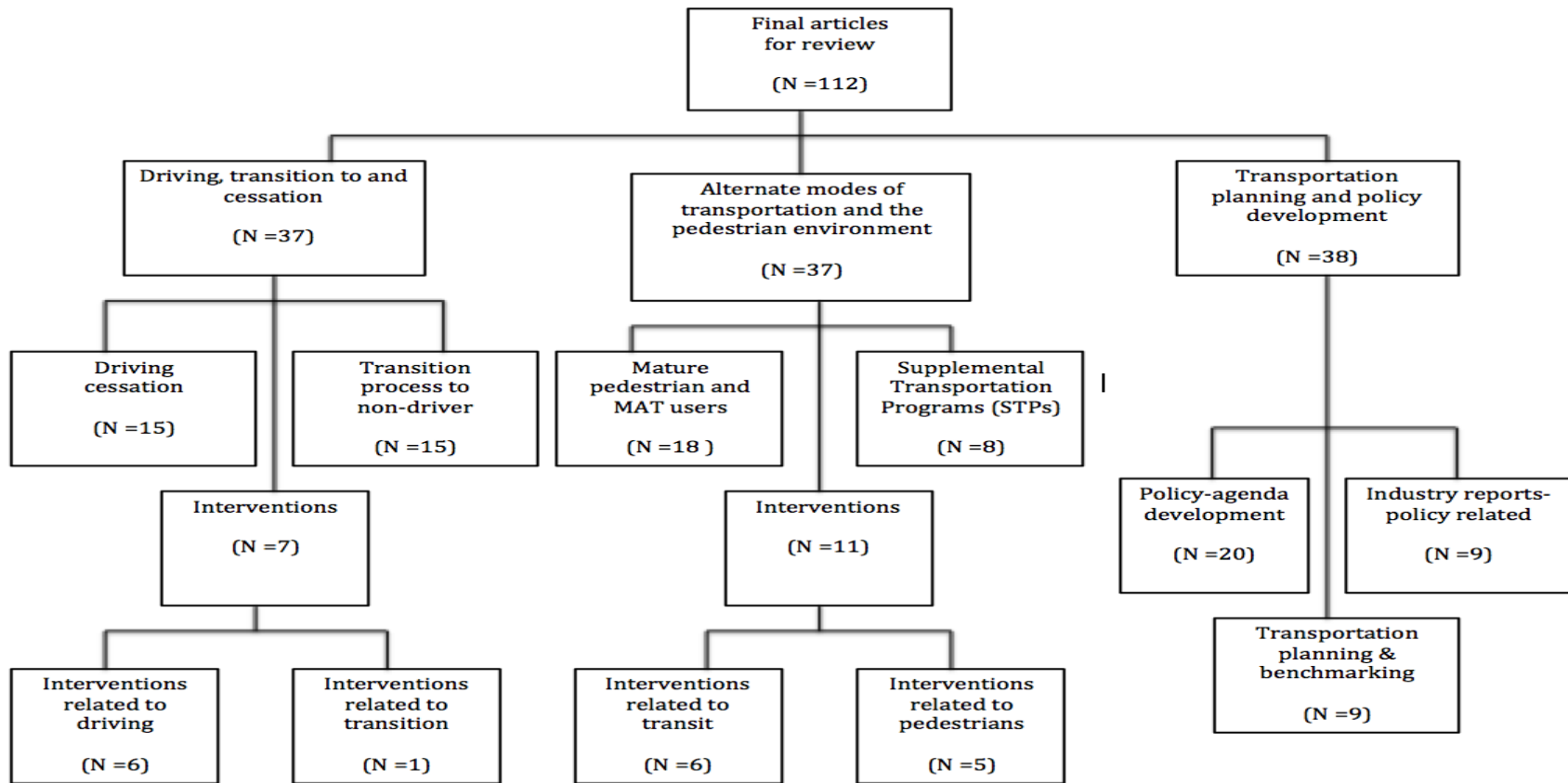


Figure 3.1. Flow chart of the literature review results: number of studies identified per sub-category

3.1. Older Adult Driving, Driving Cessation and Transitioning to Alternative Forms of Transportation

In total, 37 studies relating to older-adult driving, retirement from driving, and transitioning to alternative modes of transportation were reviewed. Of these studies, 15 focused on older-adult driving/driving cessation, while another 15 examined supports for the transition to driving cessation. The final seven studies in this category discussed educational and regulatory interventions designed to support the transition to driving cessation. The majority of the studies focusing on older-adult driving/driving cessation used quantitative methods, while the majority of studies relating to the transition process used qualitative methods. Furthermore, the majority of the studies examining educational or regulatory interventions either used quantitative methods or were in the form of program evaluations. A summary of the research methodologies used in these studies is detailed in Table 3.1 below.

Table 3.1. Literature Review Results for Driving, Transition, Cessation by Research Methodology

# of Articles by Research Methodology	Quantitative	Qualitative	Mixed Method Research	Program Evaluation	Literature Review	Non-Empirical	Total
Driving Cessation	15	0	0	0	0	0	15
Transition Process	4	6	2	0	0	3	15
Interventions-driving & transition related	4	0	0	2	1	0	7
Sub-total	23	6	2	2	1	3	37

3.1.1. Older adult driving and driving cessation

The literature on older-adult driving thoroughly explores how personal health and psychosocial factors associated with aging contribute to driving cessation. The 15 studies reviewed in this category were all quantitative longitudinal cohort studies with large sample sizes and three, five, and ten-year follow-up time frames. In a study of 1,316 older adults in New England, Maratolli et al. (2000) found that older adults who had retired from driving also reported decreased levels of out-of-home activity, which

was viewed as an indicator of social isolation. Similarly, Ragland et al.'s (2005) study of 1,953 older adults in California revealed a link between driving cessation and symptoms of depression. In both studies, the authors concluded that supports are needed to help older adults transition to a non-driving lifestyle and that other practical transportation options should be developed to help with this transition. In addition, it has also been recognized that driving cessation can be an emotional life transition for many older adults. As a result, research on older-adult driving has since focused on gaining a more thorough understanding of the specific health conditions that necessitate driving cessation, as this will allow older adults, their families, clinicians, and road-safety regulators to better prepare the aging population for this significant life transition.

The longitudinal studies used objective-assessment measures to identify specific personal health, functional, and cognitive factors that can be used to predict which older adults are at risk for driving cessation. Of these longitudinal studies, 60% focused on aging-related personal health characteristics that affect driving. For example, Anstey et al.'s (2006) five year study revealed that poor results on objective measures of cognitive visual processing speed, in addition to poor results on subjective self-rated health measures, were predictors of driving cessation. These results were supported by Sims et al.'s (2007) two-year study of 649 older adults, which found a correlation between subjective self-reported health and driving cessation. Similarly, Ackerman et al.'s (2008) four-year study of 1,838 older adults determined that, aside from poor cognitive information processing speed, poor balance on the 360-degree turn test, poorer instrumental function performance, and advanced age also predicted driving cessation. In terms of long-term health impacts, Freeman et al.'s (2006) eight-year study of 1,593 older adults found a positive correlation between driving cessation and entry into long-term residential care. Furthermore, of the 660 older adults in Edwards et al.'s (2009) three-year study, those who had retired from driving exhibited poorer health and a higher three-year mortality rate compared to those who continued to drive. The respondents reported that, when deteriorations in their health began to affect their confidence and enjoyment in driving, they started to restrict how often and when they drove. In particular, they reported avoiding situations that caused increased anxiety, such as driving at night or in bad weather, driving during rush hour, or driving at high speeds.

Six studies examined the social effects of driving cessation. Maratolli et al. (2000) identified an association between driving cessation and a reduction in out-of-home

activities. Additionally, Mezuk and Rebok (2008) studied 583 older adults over an 11-year period and found that former drivers had a smaller network of friends than those who continued to drive. In their two-year study of 1,170 adults, Bookwala and Lawson (2011) found that poor vision in later life contributed to symptoms of depression and subjective feelings of social isolation due to the restrictions in everyday life routines, including driving. Likewise, Curl et al.'s (2013) 14-year study of 4,788 older adults revealed that driving cessation negatively impacted older adults "productive engagement" activities, such as paid employment or formal volunteering roles.

In their two-year study of 700 older Australians, Windsor et al. (2007) found that personal agency mediated the relationship between driving cessation and depressive symptoms. That is, depression is not a direct product of driving cessation; rather, it stems from losing personal autonomy over one's outdoor mobility. Additionally, Choi, Adams, and Kahana's (2012) three-year study of 636 older adults in Florida revealed that participants who had readily available, non-family transportation support options (whether from peer providers or paid agencies/organizations) were more likely to stop driving than those who had little or no transportation support. Significantly, the authors also found that the older adults in their study were not using public transportation, even if a bus stop was within three blocks of their home. These two studies were the first to focus on identifying the root causes of poor health outcomes among older adults who had ceased driving, and they were instrumental in drawing attention to the need to provide adults in this cohort with other appropriate forms of transportation.

The findings presented in this section consistently indicate that declining health and functionality are strongly associated with eventual driving cessation. The findings also indicate that older adults with declining health can have a difficult time contending with a number of driving conditions, especially those that are more complex or that require more skill; for example, driving in heavy traffic, at high speeds, or in poor weather conditions. Furthermore, the findings also show that feelings of social isolation and depressive symptoms can occur when older, non-driving adults do not have access to viable forms of transportation, thus leading to further health decline and increased use of health care resources.

The next section examines the research findings related to the decision-making process involved in driving cessation, and how older adults can be supported in their transition to alternative forms of transportation and pedestrian mobility.

3.1.2. Providing support for the transition to driving cessation: strategies that effect change

Fifteen studies focusing on the process of transitioning to non-driver status were identified. The studies in this sub-category primarily focused on understanding the underlying psychological-cognitive factors that influence older adults' decision to retire from driving and how they can adapt and plan for the transition to other forms of transportation. The majority of the studies in this sub-category were qualitative. Most of the studies focused on older adults who had retired from driving or who were in the process of reducing their amount of driving. A few of the identified studies included insights from other stakeholders in the decision-making process, such as family members, physicians, clinicians, occupational therapists, and government regulators, which enabled a rich discussion of the ways in which driving cessation and its related issues are often handled collaboratively. All qualitative studies focused on voluntary vs. involuntary driving reduction and driving cessation. For these studies, the qualitative insights provided inputs that could be used to develop appropriate tools and training sessions to aid the transition process to driving cessation. Furthermore, several studies used theory as the foundation for the creation of new measures and tools for benchmarking the transition process. A conceptual model by Choi, Adams & Mezuk (2012) has also been created to summarize the qualitative themes and to bring coherence to the research theme of driving self-regulation and eventual driving cessation.

The main finding indicates that older adults voluntarily self-monitor and self-regulate their driving as their age increases, particularly when they surpass 70 years of age. This was confirmed in focus groups by Donorfio, Mohyde, Coughlin, and D'Ambrosio (2008), who used the model of adaptation created by Baltes and Baltes (1990), called the Select Optimize Compensate (SOC) model, within the study. In these sessions, Donorfio et al. (2008) discovered that the older adult participants were very aware of their age-related functional declines, and that they adjusted their driving behaviour accordingly when driving situations became too challenging. The decision to

fully retire from driving occurred when it became “too much work,” even in restricted driving situations (e.g., driving only during the day, or driving during non-peak hours). Donorfio et al. (2009) further confirmed this finding in a follow-up cross-sectional study with 3,824 older adults, observing that self-regulation increased sharply after the age of 70 and was associated with increased health and functioning issues. Pickard, Tan, Morrow-Howell, and Jung (2009) also used the SOC framework to classify 281 respondents on a continuum of driving status, ranging from 1) active driver, to 2) transitional driver who restricts/reduces driving, and, finally to 3) a fully retired driver. Their results showed that the majority of respondents were in the transition phase and were self-regulating their driving as they became increasingly aware that their driving skill and comfort level were not adequate for various challenging driving environments. Self-regulation status, therefore, can be viewed as an outcome measure that indicates that the transition toward driving cessation has begun.

Interestingly, self-regulation driving was found to be more stressful than driving cessation. In-depth interviews conducted by Pickard et al. (2009) revealed that symptoms of stress and depression were higher in respondents who self-regulated their driving, compared to those who had retired from driving. This was likely due to the fact that self-regulating drivers also reported having less access to social resources and transportation support. Conversely, those who had stopped driving reported having comparatively greater access to such resources. Pickard et al. (2009) also noted that it is not a sustainable option to remain in the transition phase indefinitely, as advancing age and its attendant health declines will inevitably necessitate retirement from driving. Thus, driving self-regulation must be accompanied by cessation preparedness and planning for alternative means of independent mobility.

Several studies have documented innovations in cessation preparedness and planning for individuals' non-driving years. New measures have been created in an attempt to quantify the number of older adults who are ready to transition to driving cessation. Significantly, these new measures have revealed that personality issues can be an indicator of transition readiness. In a small qualitative study of 12 participants, Adler and Rottunda (2006) found that older adults fell into one of three personality categories when it came to making the decision to reduce their driving: 1) being “proactive” and openly acknowledging when the appropriate time to reduce/stop driving arrives; 2) being a “reluctant acceptor” who knows that they will need to stop driving

soon and gradually reduces how much they drive until they stop completely; or 3) being a “resister” who is in denial of their deteriorating driving skills and who likely will only stop driving involuntarily. These personality categories were confirmed by Meuser, Berg-Weger, Chibnall, Harmon, and Stowe (2011), who used the results of focus groups with older adults to formulate the Assessment of Readiness for Mobility Transition (ARMT) tool, which was the first tool developed for measuring older adults’ emotional and attitudinal readiness for the transition to non-driver status. In a follow-up survey, the validity and reliability of the ARMT tool was tested with 295 respondents, with the findings revealing a correlation between transition readiness, positive mental health status and openness to new experiences.

Not all older adults are open to change. Older adults who scored high on measures related to self-reliance and unwillingness to burden others were deemed to be at risk of not transitioning well. King, Meuser, Berg-Weger, Chibnall, Harmon, and Yakimo (2011) confirmed these findings with focus groups participants. In these sessions, the respondents indicated that they had not done much planning for driving retirement or the effects of eventual mobility challenges. They also said that their greatest fear was that they would become dependent on others if they stopped driving, which would begin a negative lifestyle change due to reduced social contact.

In order for the transition to driving cessation to occur, Meuser et al. (2011) argued that older adults need to possess a “threat appraisal aptitude.” They noted that older adults need to be aware not only of the threat of their normative mode of independent mobility coming to an end, but also of the threat that they pose to public safety when they continue to drive in a state of declining health and functioning. Rudman, Friedland, Chipman, and Sciortino (2006) found similar results in focus groups with 79 participants, noting that older adults tended to resist planning for their driving retirement years and only began to do so after a negative interaction—or a series of negative interactions—in the driving environment (i.e. a crash or near miss).

Inter-personal relationships were also identified as playing a role in the smooth transition to driving cessation. The primary theme of these results was the need for continued dignity, respect, and involved decision making with older adults. Jett, Tappen, and Rosselli (2005) explored driving cessation among cognitively impaired older adults by conducting guided interviews with 216 stakeholders, including clinicians, mobility

counsellors, other professionals in the aging industry, safety officers, older adults with mild cognitive impairment, and family members. Stakeholders spoke of involved decision-making vs. imposed decision-making and the need to continue to respect and include cognitively impaired older adults in the discussion of driving and eventual cessation. It was suggested that the best way to preserve their dignity was to provide them with the facts regarding unsafe driving conditions and guide them through the process towards driving cessation. While imposed decision-making was generally not supported, it was recognized that it is sometimes the only option when the level of impairment increases. Relatedly, Connell, Harmon, Janevic, and Kostyniuk (2012) held focus groups with 37 family members of older drivers, particularly with adult children, with the themes in these discussions also centering on involved decision-making. Historical family relationships and patterns of communication played a role in whether involved strategies proved effective, or whether imposed outside mobility counselling was necessary to bring about change when safety was a concern.

Two studies were identified that related to mobility counselling. The first study, published by Nasvadi (2008), was an editorial directed to the medical community in British Columbia, Canada. In this editorial, Nasvadi (2008) noted that, due to time restrictions, primary care physicians were only able to recognize 11% of drivers with poor cognitive assessment scores during appointments. As such, the editorial recommended that clinicians perform visual-spatial and attention-concentration tests as a way to assess and discuss cessation risk factors *before* frailty develops so that older adults and physicians can prepare together for cessation and adapt to other travel modes. In the second of these articles, O'Neill (2010) notes that clinicians tend not to have difficulty discussing driving cessation with cognitively impaired patients; rather, he points out that it is family members who have the most difficulty with the discussion. O'Neil (2010) suggests the importance of collaborative, involved decision-making between doctor, patient, family member, and, if necessary, to involve road safety enforcement officers in difficult cases. O'Neill (2010) also stressed the need for older adults to appropriately prepare for cessation, but that quality alternatives also need to be available for older adults in cognitive decline.

The availability of transportation options was also identified as a transition support. King et al., (2011) used the Trans-Theoretical Model (TTM) of behaviour change to classify older adult respondents on a scale of transition readiness and found

that it wasn't necessarily an older adult's driving status that determined their level of adaptability. Rather, they found that 1) an older adult's attitude towards change and 2) their ability to access alternative means of maintaining their independent mobility were the best indicators of adaptability. Furthermore, King et al. (2011) also found that a respondent's level of disability and history of personal experiences affected their attitudes toward transition preparedness. Respondents with mobility challenges who were in the "contemplation/preparation" stage were more open to adapting; conversely, respondents in the "action/maintenance" stage who experienced the highest constrictions in life space and higher levels of functional disability tended to express feelings of anger, frustration, grief, and resentment at being subjected to a diminished quality of life due to living within "undesired" boundaries and dependence on others.

Socio-demographic indicators have also been identified as factors in the transition process, particularly gender, living arrangements, and financial capacity. Donorfio et al. (2008) and Choi et al. (2013) found that older women tended to regulate their driving behaviour more than men. Older women were more likely than older men to be cautious and often avoided driving at night, during rush-hour traffic, or on fast-moving highways. It was also found that receiving transportation support from peers increased the likelihood that women would self-regulate their own driving. In terms of living arrangements, driving cessation was delayed among older adults who were married or had another driver in the household (Donorfio et al., 2008). Choi, Mezuk, and Rebok (2012) explored the theme of voluntary self-regulation more thoroughly in a longitudinal study with 83 participants, finding that financial considerations were also an issue in the decision to continue driving or to stop. The respondents said that the decision to retire from driving also occurred when the financial burden of repairs, maintenance, or the cost of purchasing a new vehicle became oppressive.

Finally, Choi, Adams, and Mezuk (2012) proposed the first conceptual model capable of incorporating the many disparate findings on driving cessation into a single theoretical framework. This conceptual framework aims to guide synthesis and to encourage further depth in this research area from a gerontological perspective. The model places emphasis on the stress-coping theory, which focuses on the development of coping supports and empowering interventions that abate the sense of loss that emanates from health decline and driving cessation.

The findings for this sub-category indicate that older adults tend to self-regulate their driving behaviour as they age and their health and function decreases, particularly after the age of 70. Older adults who find it challenging to navigate the driving environment—even after restricting driving to daylight hours and reduced speeds—tend to exhibit greater readiness to begin the transition process to driving cessation. Assessing personality traits has also been shown to be an effective way of classifying older adults' degree of openness to planning for the transition to driving cessation and learning about other transportation options. The findings indicate that older adults with greater transportation support, either from peers or formal organizations, are more likely to self-regulate or cease driving. Furthermore, the findings also highlighted that it is essential for clinicians to preserve a sense of dignity and respect when counselling older adults about driving cessation. In addition, involved decision-making was recommended whenever possible vs. forced cessation. Moreover, older adults who lived with a spouse or other family members were shown to be less likely to cease driving than those who lived alone. This sub-category also demonstrated some of the innovations related to the driving-cessation process, with several authors using theory to create new measures, as well as a conceptual model capable of visualizing the factors involved in the transition process to driving cessation. The following section will discuss the findings from the studies that focus on interventions that support the transition process to driving cessation.

3.1.3. Interventions to support the transition to driving cessation

The literature search process identified seven studies focusing on interventions that support older adults' transition to driving cessation and encourage alternative transportation options. Since the majority of studies in this sub-category are descriptive in nature, it can be classified as an emerging field of study. Four of the identified studies used quantitative cross-sectional methods, while two were program evaluations and one was a literature review that focused on regulatory interventions.

Bryantan and Weeks (2014) conducted a cross-sectional study with 210 older adults in Canada to gain a better understanding of their educational needs concerning transition preparedness. The respondents confirmed that their voluntary decision to reduce/stop driving came when they no longer felt comfortable or confident on the road and when their health difficulties increased. While the majority of respondents indicated

that they had not considered retiring from driving, they also indicated that they would be open to attending an education session on the topic, particularly if the in-classroom content was combined with video content. The respondents also requested workshops where they could generate lists of alternative transportation resources and have peer presenters who had already retired from driving speak to them about it. They also expressed a desire that time be allocated for group interaction and peer-support networking.

A second finding concerned regulatory policies that place restrictions on older adults driver's licenses. Two studies were found that related to this theme. In the first study, Nasvadi and Wister (2009) conducted a secondary data analysis of over 7,000 older adults' driving records in British Columbia, Canada. In particular, their analysis focused on a six-year period and exclusively examined the records of older drivers who held a restricted license, which restricted their driving to daytime driving and no highway driving. Their results showed that the risk of a crash was 87% lower for older drivers with a restricted license and that restricted older drivers were able to keep their license and stay crash-free for longer than their unrestricted counterparts. These findings suggest that driving restrictions on maximum speed, area of travel, and time of day may be effective measures for prolonging crash-free mature driving, thus enabling continued driving. Furthermore, Nasvadi and Wister (2009) also note that it is highly prudent to screen older adults for vision in low-light conditions. Conversely, Dugan, Barton, Coil, and Lee (2013) conducted a literature review of existing American regulatory policies intended to enhance older-driver road safety. State-level regulatory policies were reviewed across the United States to evaluate which ones were most effective at reducing vehicle crashes among older adults. Their results revealed that the following policies had the greatest effect on reducing collisions and fatalities: in-person renewals of drivers licenses; restricting driving times; and more intensive licensing renewal procedures, for example, requiring medical testing.

A third finding related to educational interventions for improving transition preparedness. In total, four studies were found that examined driver education workshops and remedial cognition and on-road driving skills training. In the first study, Maratolli et al. (2007) conducted a mixed method study that consisted of in-classroom education sessions and on-road testing with 126 drivers aged 70 years and over in Connecticut. Whereas the experimental group received eight hours of classroom

instruction and two hours of in-car practice, the control group did not. For the in-car practice portion of the study, the experimental group was given a chance to work on their skills related to road sign identification and road signal observance, parking manoeuvres, lane changes, merging, maintaining a safe distance, traffic-density skills (low, medium, high traffic density), and highway skills. When both groups were re-tested eight weeks later, relative to baseline scores, the experimental group's follow-up road test scores were 2.87 points higher vs. the control group scores and their knowledge test scores were 3.45 points higher vs. control group scores. In Canada, Nasvadi (2007) conducted a quantitative self-report survey that tested 367 participants' ability to recall a mature driver workshop they had attended up to four years prior. The workshop content included topics related to mature driving and aging effects, road rules and road signs, and strategies to reduce risk. The survey results indicated that 75% of participants had changed their driving behaviour post-workshop, particularly visual skills/road hazard awareness, speed/space margins, and vehicle manoeuvres. Older men respondents had indicated that they improved their driving skills and had higher confidence/comfort level on the road. Respondents spoke of the importance of having opportunities to interact with other older drivers and the value of practicing road skills. It was also noted that respondents appreciated having a safe place to talk and express their views about mature driving.

Two of the identified studies involved computerized cognition tests. In the first of these studies, Edwards, Delahunt, and Mahncke (2009) partnered with a technological firm to test field of view in 568 participants. To do so, they used the Useful Field of View (UFOV) test, which was developed as a computerized training module to help older adults improve their cognitive speed of (visual) processing. In this study, the performance of older adults who had completed eight UFOV training sessions was compared to that of a control group who had not received training sessions. The results showed that UFOV participants were 40% less likely to have retired from driving within the three-year follow-up period vs. 14% who did not receive UFOV training. In the second study, Horswill et al. (2010) studied 271 older adult drivers in Australia who had participated in the video-based Hazard Perception Test. In this test, the participant views video footage from real traffic situations as though they were sitting in the driver's seat, and, as quickly as possible, they must identify any road user that could potentially be at risk of a traffic collision. Road users in the video included stationary and moving

vehicles, cyclists and/or pedestrians. The results showed that respondents whose mean response time to traffic hazards was slower than 6.68 seconds were 2.32 times more likely to be involved in a crash than those with faster response times. Although follow-up testing was not provided, computerized multi-media skills training programs appear to hold potential to prolong safe driving years for mature drivers.

The findings from this category further confirm that older adults reduce their driving as their age and health conditions advance and that, when given the opportunity, they appreciate participating in remedial knowledge and on-road skills sessions, particularly when conducted in a collaborative, respectful manner, with their peers. Results from regulatory interventions (restricted driver's licensing) as well as computer-based remedial training interventions indicate that safe driving can be extended in the short-term (i.e. three years), allowing sufficient time to transition to transportation alternatives before fully retiring from driving.

Table 3.2 presents a summary of findings by social-ecological domain. As Table 3.2 shows, the studies on driving cessation focused on personal health functioning and psychosocial issues. In the transition-process studies, the major focus was on psychosocial issues associated with health functioning decline, with a few studies looking at interpersonal factors and when to involve other stakeholders in the decision-making process. The focus of the intervention studies included health functioning issues and policy interventions to regulate safe driving conditions. Significantly, Table 3.2 reveals an evidence gap in the areas of inter-personal and built environment influences as well as policy related to driving cessation and transitioning away from driving.

Table 3.2. Literature Review Results for Driving, Transition and Interventions Related to Driving Cessation - by Social-Ecological Domains

	Personal health-functioning issues	Psychosocial issues	Inter-personal issues	Built Environment Issues	Policy-regulatory issues
Driving Cessation	<i>Ackerman et al., 2008; Anstey et al., 2005; Bookwala and Lawson, 2011; Choi et al., 2012; Curl et al., 2013; Edwards et al., 2008a; Edwards et al., 2009; Edwards et al., 2009b; Edwards et al., 2009c; Freeman et al., 2006; Maratolli et al., 2000; Mezuk and Rebok, 2008; Ragland et al., 2005; Sims et al., 2007; Windsor et al., 2007.</i>	<i>Ackerman et al., 2008; Anstey et al., 2005; Bookwala and Lawson, 2011; Choi et al., 2012; Curl et al., 2013; Edwards et al., 2008a; Edwards et al., 2009; Edwards et al., 2009b; Edwards et al., 2009c; Freeman et al., 2006; Maratolli et al., 2000; Mezuk and Rebok, 2008; Ragland et al., 2005; Sims et al., 2007; Windsor et al., 2007.</i>			
Transition Process	<i>Adler et al., 2006; Choi et al., 2012a; Choi et al., 2012b; Choi et al., 2013; Donorfio et al., 2008a; Donorfio et al., 2008b; Donorfio et al., 2009; King et al., 2011; Meuser et al., 2011; Nasvadi, 2008; Pickard et al., 2009; Rudman et al., 2006.</i>	<i>Adler et al., 2006; Choi et al., 2012a; Choi et al., 2012b; Choi et al., 2013; Donorfio et al., 2008a; Donorfio et al., 2008b; Donorfio et al., 2009; King et al., 2011; Meuser et al., 2011; Pickard et al., 2009; Rudman et al., 2006.</i>	<i>Conell et al., 2012; Jett et al., 2005; Nasvadi, 2008; O'Neill et al., 2010; Rudman et al., 2006.</i>	<i>Choi et al., 2012a; Choi et al., 2012b; Choi et al., 2013; Conell et al., 2012; Jett et al., 2005; King et al., 2011; Nasvadi, 2008; Rudman et al., 2006.</i>	<i>Donorfio et al., 2008a; Donorfio et al., 2008b; Jett et al., 2005; Nasvadi, 2008; Rudman et al., 2006.</i>
Interventions-driving & transition related	<i>Bryantan et al., 2014; Dugan et al., 2013; Edwards et al., 2009; Horswill, 2010; Maratolli et al., 2007; Nasvadi, 2007.</i>	<i>Bryantan et al., 2014; Edwards et al., 2009; Nasvadi, 2007; Nasvadi & Wister, 2009.</i>	<i>Nasvadi, 2007</i>	<i>Bryantan et al., 2014; Nasvadi & Wister, 2009.</i>	<i>Dugan et al., 2013; Nasvadi & Wister, 2009.</i>

The following section will discuss the findings from the next category, which details the search results relating to various forms of alternative modes of transportation and outdoor mobility products for older adults with mobility impairments.

3.2. Alternative Transportation Options for Older Adults with Mobility Impairments

Thirty-seven studies were identified relating to the use of alternative modes of transportation, including walking, public transit, and the use of micro-transit (community shuttle bus) and volunteer driver programs. Specific to older adults with mobility limitations, 18 studies were found that focused on walking/wheeling outdoors with mobility assistive technology (MAT), such as canes, walkers, power wheelchairs/scooters, and a new product, the hybrid (electric) tandem bicycle. An additional eight studies evaluated new supplemental transportation programs for seniors (STPS), while six studies examined interventions designed to increase public transit use among older adults. Finally, the search results yielded five studies that explored ways of increasing neighbourhood-based walking among older adults.

Although the literature on outdoor mobility, MAT, and public transit use among older adults is growing, it is still considered an emerging field of study. In one of the earliest reports on this subject, Satariano (1997) highlighted the need for more research addressing the outdoor mobility issues of the aging population. However it would be eight years later before there was an increase in published research examining outdoor mobility among older adults with mobility limitations. Since then, this number grew to 15 relevant studies published between 2000 and 2009, with an additional 20 studies being published between 2010 and 2018. The majority of the studies in this category originated in the United States, while the remaining were international studies conducted by researchers in Canada, Australia, Europe (United Kingdom, Finland and Germany) and Asia (Japan and Hong Kong).

The majority of the studies identified in this category are cross-sectional, but a new trend towards mixed method research (MMR) methodologies has recently emerged. The MMR studies focusing on MAT-use research employed a mix of quantitative surveys, physical performance tests, secondary data from census tract and GIS databases, outdoor ethnography via built-environment observation audits, and the use of

participant GPS trackers. Two MMR studies also used qualitative methods to further understand how subjective perceptions affect the interactions between “people and place” as it relates to outdoor mobility and the maneuverability of MATs. Several program evaluation studies are found in this sub-category related to increasing the use of alternative transportation, particularly public transit and powered MATs. Regulatory interventions as well as policy-level studies and editorials are also contained within this sub-category, particularly those that describe and assess the implementation of pilot projects related to micro transit services (community shuttle bus services), volunteer driver ride-share programs, and pedestrian mobility interventions. These reports have been published for the purpose of descriptively explaining the success of these pilot projects so that they might be replicated and formally evaluated. Taken together, these disparate topics demonstrate an ongoing effort to understand the travel patterns of older adults with mobility disabilities and which suitable, available transportation alternatives require more extensive research and policy support.

The findings in this section will be summarized based on mode of transportation, namely:

- Walking outdoors and MAT use (manual and power MATs);
- Use of transit and micro-transit (Community shuttle bus) and;
- Use of Supplemental Transportation Programs for Seniors (STPS) or volunteer driver programs.

The results of each sub-category are presented by research methodology in Table 3.3.

Table 3.3. Literature Review Results for Alternative Transportation Modes by Research Methodology

# of Articles by Research Methodology	Quantitative	Qualitative	MMR	Program Evaluation	Literature Review	Non-Empirical	Total
Pedestrian Environment and MAT use*	8	0	6	2	1	1	18
Community-based Supplemental Transport Programs for Seniors (STPS)	2	0	0	2	0	4	8
Interventions related to transit	4	0	1	1	0	0	6
Interventions related to pedestrians*	0	0	0	0	0	5	5
Sub-total	14	0	7	5	1	10	37

* Note: pedestrian-related studies that contained results related to built environment issues will be discussed in detail in Section 3.3: Transportation Planning and Advocacy for an Aging Population.

3.2.1. Out-of-home walking with a mobility limitation: outdoor MAT use and the pedestrian environment

Aside from a few studies from Canada, Asia (Japan, Australia), and Europe (Germany, Finland, Sweden), the majority of the studies on outdoor mobility and MAT-use were cross-sectional studies conducted in the United States. The samples for these studies predominantly consisted of older adults (>65 years), but a few identified the participants as being “retirees” or “middle age” and included individuals aged 50 years and older. Two secondary data analysis studies have been published using data from large national health and aging panel studies from the USA. These large quantitative analyses sought to identify relationships between physical-health-functioning and socio-demographic characteristics and whether they correlate to disablement and outdoor mobility changes. Additionally, one German longitudinal study followed more than 800 respondents over 10 years in order to document changes in physical functionality, outdoor mobility, transport use and motivation over time.

Much of the current research dealing with the outdoor mobility of older adults with mobility disabilities focuses on the functional decline issues associated with diminished walking capacity and how to measure it. There is a growing consensus that it is possible to use certain objective-assessment measures of personal health-functioning to identify older adults who are at risk of mobility disability. However, a unified agreement on the definition of specific measures has yet to be achieved. Overall, the findings point to four common outcome measures related to mobility disability: lower-body functional decline and reduced walking speed; sensory impairments; co-morbidity; and poor self-rated health. (Langlois et al., 1997; Clarke & George, 2005; Mitchell, 2006; Freedman, Grafova, Schoeni, & Rogowski, 2008; Spivock, Gauvin, & Brodeur, 2008; Mollenkopf, Hieber, & Wahl, 2011; Rosenberg, Huang, Simonovich, & Belza, 2012; Clarke, 2014; Satariano, et al., 2016, Viljanen, Mikkola, Rantakokko, Portegijs, & Rantanen, 2016). In addition, new self-report measures of outdoor mobility incapacity have also been identified such as:

- Self-reported walking difficulty, which is measured by the inability to walk outdoors ¼ mile, or 400 meters;
- Self-reported use of MATs (cane, walker, wheelchair, power wheelchair/scooter); and;
- Self-reported sedentary lifestyle (indicated by low amounts of physical activity and low active transportation levels).

In terms of results related to reduced walking speed, Langlois et al. (1997) found that poor results on the eight feet walking speed test correlated to an inability to cross street intersections at the standard pace of four feet per second. Regression analysis found that respondents with the slowest mean walking speeds concurrently had functional limitations, poorer vision, lower cognition scores, one or more ADL supports, and were 10 times as likely to report difficulty crossing the street, thus putting them at risk of injury as a pedestrian. The majority of the study's respondents did not meet the standard walking speed: fewer than 1% of respondents were able to cross the street at 4 feet per second, with 81% of respondents walking at a pace of 1 to 3 feet per second. A subsequent cross-national study of 884 older adults by Satariano et al. (2016) found similar results, although it used a different unit of measurement. In this study, the respondents' average walking speed on a 60 second walking performance test was 2.3 feet per second.

Self-rated measures of outdoor mobility difficulty have been used in several studies (Mitchell, 2006; Freedman, et al., 2008; Mollenkopf, et al., 2011; Clarke, 2014; Satariano, et al., 2014; Viljanen, et al., 2016). These measures ask respondents to indicate whether they have difficulty walking outdoors or down the street, with or without requiring help from an MAT or a caregiver. While the results are consistent, the units of measure are not. In Mollenkopf's 10-year longitudinal study (2011) of 804 older adults in Germany, approximately 25% of all respondents (compared to 50% of respondents with mobility limitations) indicated that they had difficulty going outside on their own. In his review of UK literature on pedestrian safety best practices, Mitchell (2006) notes that the UK General Household Study (1998) found that approximately 10% of adults reported being unable to walk 400 yards (365 meters) without taking a rest, while 5% could not walk 200 yards (183 meters), and 3% could not walk 50 yards (46 meters) without resting. Similarly, Satariano et al. (2014) found that 26.4% of older adult respondents in the US study reported difficulty walking two to three blocks. In contrast, Viljanen et al.'s (2016) study of 848 older adults in Finland found that respondents 75 years of age and older self-reported "some" difficulty walking 2km, which is approximately 10 times greater than the distance used in the above-noted studies from North America and the United Kingdom. In a National Health and Aging Trends study of 7,609 older adults in the USA, Clarke (2014) found that respondents were descriptively classified based on their level of difficulty walking outdoors, and regression analysis showed a positive relationship between increased co-morbidity and level of difficulty walking outdoors. Clarke (2014) found that for every increase in the number of chronic conditions, there was a corresponding increase in the odds of reporting "a little" difficulty walking outdoors.

A third assessment measure was found in several studies, namely, the Short Physical Performance Battery (SPPB) test (Guralnik et al., 1995). The SPPB has been shown to be effective in assessing lower body functional limitations related to outdoor mobility difficulties (Clarke et al., 2005; Satariano et al., 2014) as it measures attributes such as gait speed over a three or four foot course, standing balance from one leg to tandem, and the amount of time required to stand up from a sitting position. Other lower body strength measures include: difficulties with stooping/kneeling/crouching (Freedman, et al., 2008) and difficulty walking up/down one or several flights of stairs (Freedman, et al., 2008, Satariano, et al., 2014). Furthermore, the SPPB test has been

shown to be predictive of disability, institutionalization, and mortality. In a longitudinal study comparing urban and suburban older adults in North Carolina, Clarke et al. (2005) found that lower body functional limitations were positively associated with both IADL and ADL disability. In addition, they also found that the expected number of ADL disabilities increased by 166% for every functional limitation an individual possesses. In a later study, Clarke et al. (2014) noted an inverse relationship between lower body functionality and outdoor mobility difficulty, finding that odds of reporting “some/a lot” of difficulty going outdoors independently decreased by a ratio of 0.53 for every one unit of increase in lower body capacity on the SPPB index.

Findings specific to MAT users also confirm that lower body functional decline, co-morbidity, and poor self-rated health/physical activity are associated with mobility disability. (Spivock, et al., 2008; Mollenkopf, et al., 2011; Rosenberg, et al., 2012; Clarke 2014). Once again, the units of measure are not uniform across studies: some studies focus on wheelchair users (Spivock, et al., 2008), others look at cane/walker usage (Mollenkopf, et al., 2011; Clarke, 2014), and one examines the use of multiple MATs (Rosenberg, et al., 2012). Spivock et al.’s (2008) cross-sectional study of 205 Canadian adults with mobility disabilities found that 30% of the MAT users who were middle-aged or older used a wheelchair, with 70% reporting a lower body disability, 23% reporting a neuromuscular disability, and 14% reporting balance-agility limitations. Rosenberg et al. (2012) found that 54% of the older adult respondents in their study used multiple MATs, with 57% using canes/walkers, 26% using a power chair/scooter, and 20% using a manual wheelchair. Over 50% of respondents also indicated that they had three or more chronic conditions in addition to vision impairments, and 74% reported that they had ceased driving. On a national scale, Clarke’s (2014) secondary data analysis of the National Health and Aging Trends dataset found that 15% of older adult respondents used a cane/walker, and the majority of respondents had two or more chronic conditions and an “average” SPPB score. In Germany, similar results were found, with 15% of respondents indicating that they generally used a cane or walker when going outdoors (Mollenkopf, et al., 2011). In terms of self-reported physical activity, the results to date consistently indicate that MAT users have very poor physical activity levels. Forty percent of respondents in the Spivock et al. (2008) study indicated engaging in no physical activity at all, with 75% saying they did not engage in active transportation at all. The results from the study by Rosenberg et al. (2012) were very similar, with 30% of

respondents stating that they did not engage in any physical activity at all. While none of these studies use the same units of measure, the results show that reduced walking speed or self-reported difficulty walking outdoors is associated with personal health and functional decline.

The results in this category also identified psychosocial and socio-demographic issues associated with outdoor walking with a mobility limitation. The study by Mollenkopf et al. (2011) asked subjective questions about the psychological meanings attached to outdoor mobility and transportation. The findings indicated that, in spite of longitudinal increases in co-morbidity and mobility limitations, respondents reported a strong desire to maintain their independence throughout the 10-year study. Qualitative responses were categorized into themes that expressed personal movement /outdoor mobility as: *“a basic human right...a basic emotional experience... a social need...an expression of personal autonomy and freedom...a source of stimulation and diversion...as movement and participation in the natural environment...as a reflective expression of the person’s remaining life force.”*

Advanced age and gender have been found to be related to mobility limitations and difficulty walking outdoors. However, there are no universal standards in terms of age categories among the reviewed studies. Langlois, et al. (1997) found that both older age and gender were associated with difficulty crossing the street. Of the respondents aged 80 and over who reported difficulty crossing the street, there was only a 1.6% increase in walking difficulty among men compared to those in the 72-79 year old age group. In contrast, the incidence of difficulty walking outdoors increased by 8.7% for women in the older age group compared to their counterparts in the 72-79 year old age group. Mitchell (2006) found a similar gender gap among older adults in Britain: in the 80 to 84 year old category, 8% of men indicated difficulty walking along the street compared to 11% of women. Furthermore 4% of men (compared to 12% of women) said they were able to walk along the street, but that they required “help” to do so. In their secondary data analysis of the 2002 National Health and Retirement dataset of 15,480 older adult Americans, Freedman et al. (2008) found that nearly 70% of women aged 55 and older reported one or more lower body limitations compared to 54% of men. Similarly, Rosenberg et al. (2012) found that 74% of respondents who reported a mobility limitation were female. In a regression analysis of the National Health and Aging Trends dataset,

Clarke (2014) confirmed that older age was associated with “some/a lot” of difficulty going outside, particularly among female respondents.

Not all gender-related findings identify difficulties specific to females, however. Some findings point to male-specific gender differences. Mollenkopf et al.’s (2011) German study found that a downward trend of satisfaction with outdoor mobility opportunities applied particularly to men aged 75 and older, but not women. Specific to advanced age, Mollenkopf et al. (2011) found that nearly 30% of respondents aged 75 and older reported a decline in outdoor mobility at the five-year follow-up wave compared to 24% of respondents in the 65 to 74 year old age group. At the ten-year follow-up, the gap had increased to nearly 50% among the older age group (75 years and older) compared to 20% of respondents in the 65 to 74 year old age group. The respondents in Viljanen et al.’s (2016) Finnish study also cited advanced age (75 years and older) and gender differences as sources of outdoor mobility difficulties: 48% of female vs. 33% of male respondents indicated at least “some” difficulty walking 2km. Furthermore, these respondents also reported more chronic conditions, more depressive symptoms, and poorer cognition.

A few studies focused on socio-economic factors in relation to mobility limitations. Freedman et al. (2008) conducted a regression analysis on the National US Health and Retirement dataset and found an inverse relationship between economic advantage and stage of disability. Their findings indicated that economic advantage was associated with a reduced risk of lower body limitations and IADL disability, while economic disadvantage was associated with an increased risk of ADL disability. In light of these findings, Freedman et al. (2008) created a geography-based index of economic advantage using variables obtained from census tract information, such as percentage of owner-owned housing units, percentage of families with annual income greater than >\$75,000, and percentage of adults with a college degree or higher. Similarly, Viljanen et al.’s (2016) Finnish study also revealed that respondents who reported having difficulty walking 2km tended to have poorer financial situations and were more likely to live alone than were respondents who did not have difficulty walking. With regards to ethnicity, Clarke’s (2014) regression analysis of the US National Health and Aging Trends dataset found that being Hispanic and having less than a high school education was associated with “some/a lot” of difficulty going outside, especially among females.

The two European studies highlight the social effects of a restricted life space on older adults with mobility limitations (Mollenkopf et al., 2011; Viljanen et al., 2016). Both studies used self-report measures of decreased out-of-home mobility. Viljanen et al. (2016) created the Life Space Mobility Index by augmenting the Life Space Assessment measure (Baker, Bodner, & Allman, 2003) with questions related to the use of an aid (either a MAT or a caregiver), transport modes, and distance/frequency of travel. Their findings showed that life space restrictions increased with advanced age, co-morbidity, and corresponding mobility limitations. Furthermore, their results also showed that respondents 75 years and older reported that their life space had become restricted to their home and their neighbourhood. Gender effects were also present, as 18% of male respondents reported having a neighbourhood-level restricted life space compared to 35% of female respondents. On the Life Space Mobility Index, male respondents scored 71.1 (out of a max. of 120) vs. female respondents, who scored 59.5. Similar results were found in Mollenkopf et al.'s (2011) longitudinal study although the unit of measure was different. The results in the Mollenkopf et al. (2011) study showed that 27% of respondents had experienced a decline in out-of-home mobility at the first five-year follow-up. At the 10-year follow-up, nearly 50% of respondents with mobility limitations reported going on journeys to less distant locations that were shorter in duration compared to respondents in the younger age groups.

The main findings in this sub-category reveal that, as their health and ability to function physically declines, older adults experience greater difficulty walking outdoors. As a result, the distance and duration that they travel outdoors becomes restricted to the neighbourhood-level as they age. These findings follow a similar pathway of functional, sensory, and cognitive declines; advanced age; co-morbidity; poor self-rated health; sedentary behaviour; and the use of formal supports for IADL and ADL. Although qualitative data are limited within the studies of this category, the data that do exist show that, despite their physical limitations, older adults consistently express a desire to maintain their outdoor mobility so as to remain socially connected and independent. Moreover, substantial innovation is present in this sub-category. Several of the reviewed authors have developed new ways of measuring outdoor walking capacity and have created robust indices to measure interactions with the socio-economic and built environments, while also attempting to link these measures to MAT use and transport modes. However, because this sub-category is in its infancy, it is difficult to compare

results or replicate these studies until standard measures are created and agreed upon. The next section will discuss the findings from studies related to the use of motorized MATs.

3.2.2. Motorized MATs for independent outdoor mobility

The two studies in this sub-category focus on the use of electric (battery) powered MAT products, specifically for trips that would be too long to complete using a manual MAT, i.e. a cane or a walker. Both studies were program evaluations that measured pre/post changes in out-of-home mobility and psychosocial quality of life indicators following the provision of an electric powered MAT. In the first study, May and Rugg (2010) used a mixed method design to assess a convenience sample of British adults with mobility disabilities who had received an electrically powered wheelchair. In the second study, Fitzsimmons and Schoenfelder (2011) evaluated an outdoor mobility program in the United States that used electric wheelchair-tandem bicycles to enable wheelchair-bound older adults to enjoy community outings with a caregiver/companion. Both studies used small, purposive samples.

May and Rugg (2010) assessed the experiences of 20 electric power wheelchair users nine months after receiving their chair, with follow-up testing being conducted at 4 and 12 weeks afterwards. Conversely, Fitzsimmons and Schoenfelder (2011) studied 40 older adults in a random control trial study. Of these 40 participants, 20 were prescribed outdoor wheelchair mood therapy with a companion every day for 2 weeks, while the other 20 (control group) were not prescribed anything. The therapy device in this study was a tandem wheelchair bicycle, which is configured with a wheelchair-like attachment to the front of a bicycle. During therapy sessions, the older adult sat in the wheelchair at the front, while the companion pedaled the bicycle from behind. This study measured pre-/post-depression levels in order to determine whether sessions on the bicycle improved mood/depressive symptoms. Results are described below, with the results related to personal health functioning and psychosocial issues described first. This is followed by a discussion of the results as they relate to facilitators and barriers to motorized MAT usage.

Personal health-functioning and psychosocial characteristics of motorized MAT users

In May and Rugg's study, the participants were predominantly male (67%), living alone (50%), and ranging in age from 55 to 92 years old, with a mean age of 57. In contrast, Fitzsimmons and Schoenfelder's sample had a very different participant profile, with average age 80.5 years old, a variety of co-morbidities, and a 50% dementia diagnosis rate. Prior to the intervention, May and Rugg's participants' described their feelings about their mobility loss in qualitative interviews. The majority of responses were negative, with participants expressing feelings of sadness and depression due to their loss of mobility, feeling like "a prisoner" in a restricted life space due to reduced participation in everyday activities, and a loss of control due to the inability to make their own choices and control their own actions and activities. Additional responses described feeling dependent on others for out-of-home mobility and feeling like a burden. As one respondent noted, "*I'd rather go without than ask (to be taken out).*" However, despite their state of impairment, all of May and Rugg's participants indicated a desire to reclaim their independent mobility. Conversely, Fitzsimmons and Schoenfelder's study used the General Depression Score (GDS) measurement tool to obtain an objective assessment of the level of depressive symptoms in their participants. Both the control and treatment groups had similar GDS scores prior to the wheelchair-bike therapy, with the control group scoring an average of 7.95 and the treatment group scoring an average of 7.68.

The post-intervention results in May and Rugg's study indicated improvements in mobility, mood, outdoor trips, independence, fear of falling, confidence, and engagement in activities such as cooking, shopping, gardening, child care/play, and sports. Respondents felt "free" rather than "pushed," and they expressed positive feelings of "spontaneity" in their lives. In Fitzsimmons and Schoenfelder's study, post-intervention results showed that the experimental group's average GDS score decreased to 4.21 compared to 7.68 pre-treatment. On the other hand, the control group's average GDS measure actually increased to 8.65 post-intervention compared to 7.95 pre-intervention. These outcome scores were replicated in a follow-up study with a larger sample of 70 older adults one year later. In this study, the experimental group's GDS scores dropped to 4.48 following the intervention vs. 8.0 pre-intervention, while the control group's GDS score increased to 8.9 post-testing vs. 8.4 pre-intervention. Ten weeks later, Fitzsimmons and Schoenfelder tested both groups again, finding that the experimental

group's scores had decreased even further to an average GDS of 3.14, while the control group's score remained high at 8.37.

In terms of social factors, May and Rugg's respondents indicated that, prior to receiving their wheel chair, there was often interpersonal tension that arose due to the conflict between their desire for outdoor independence and their caregiver's concerns for their safety. The respondents also expressed concerns about their caregiver's ability to cope with over-dependence, which arose due to their mobility loss. However, 85% of respondents indicated that receiving their wheelchair had eased caregiver burden. May and Rugg's respondents also indicated that their wheelchair allowed them to visit family and friends on their own; the increased locus of control augmented the participants' sense of self-worth, confidence, and general happiness, and, as one noted "*the chair gives you safety.*" In Fitzsimmons and Schoenfelder's study, caregivers said that they had enjoyed riding the bike and that the therapy had observably decreased the level of depression in the older adults. They also noted that they had personally benefited from the intervention, describing it as an "enjoyable," "meaningful," and "fun" activity to do rather than just focusing on ADL tasks.

Facilitators and barriers to motorized MAT usage

In terms of factors enabling MAT usage, May and Rugg noted that the United Kingdom's National Health Service funded the provision of electric wheelchairs at a total sum of £ 6.4 million from 1996 to 2000. As a result, the program grew from 2,545 users in 1996 to over 11,000 users in 1999/2000, with a substantial wait list at the end of the four-year program period, thus indicating unmet demand. The cost of electric wheelchairs is otherwise cost prohibitive, ranging from a basic model at £2,000 up to £20,000, which is approximately US\$ 2,720 to \$27,200.

In terms of barriers to motorized MAT usage, May and Rugg's respondents indicated that, despite their renewed independence, they still lacked access to many public facilities, in addition to expressing persisting feelings of being "invisible" in public settings. For these respondents, separation from society due to disability was still very real. The respondents lamented that there was no one really challenging public inaccessibility, and that they felt as though they were still living a disabled role in a world "*run mainly by, and for, able-bodied people*", which is known as *able-ism*. On this point, the respondents indicated that they had accepted a level of disability-identity, which is a

social model that accepts the normative view of disability as separate from full society participation.

The main findings from these interventions show that having access to a motorized MAT can positively affect a mobility disabled person's mood, as the enhanced level of personal agency enables an increase in outdoor mobility and societal participation. The tandem wheelchair-bicycle MAT allowed for companion travel, thereby facilitating a social experience, both for the older adult and the caregiver. The findings also highlighted that government subsidies on the purchase of motorized MATs enabled a larger number of people to access these otherwise cost-prohibitive products. However, it was also highlighted that the relative inaccessibility of public spaces and amenities remains an issue that requires more attention.

The following section will discuss the findings of the studies that describe program evaluations of transit-related interventions.

3.2.3. Community-based transportation options: public transit and supplemental transportation programs for seniors (STPS)

The studies in this category focus on older adults' use of community-based transportation options, which can be divided into two sub-categories: public (para) transit bus services, and a new category of service known as supplementation transportation programs for seniors (STPS). STPS offers a more supportive transportation service for older, mobility-limited adults who are experiencing health decline and require one-on-one attention and care when travelling to neighbourhood-based destinations. The public transit literature will be reviewed in the first sub-section, with the STPS program literature being reviewed in the second sub-section.

A) Use of public transit and para-transit bus services

Six studies were found relating to public transit use by older adults. Five of these studies were quantitative and one was mixed method. All six studies focused on the use of interventions and incentives to encourage transit use. The studies also elicited responses related to the social-built environment facilitators and barriers to transit use, according to older adults.

Babka, Cooper, and Ragland (2009) conducted an evaluation of a transit travel education and skills training workshop for 53 older adults who were transitioning to non-driver status. Over half of the participants (56%) reported that they had enrolled in the training program to prepare for their future non-driving years. The education program consisted of three in-classroom knowledge workshops and one in-field ridership skills training session on a regular transit bus and another on a rapid-travel bus in Southern California. Broome, Worrall, McKenna, and Boldy (2010) conducted a mixed method study of 227 older adult Australians with the aim of identifying factors that contribute to age-friendly bus services. The study was combined with ethnographical observations of environmental factors across the “transport chain” that most impact bus usage in order to make the transition easier for those who no longer drive. Nasvadi and Wister (2006) attempted to gain a better understanding of the predictors of para-transit usage by conducting a quantitative cross-sectional study wherein they analyzed secondary data responses from a sample of 869 older adults with co-morbidities in British Columbia, Canada. Para-transit is a specialized door-to-door transit service for people with mobility and cognitive impairments. Similarly, Coronini-Cronberg et al. (2012) conducted a secondary data analysis of the national free bus-pass program in the United Kingdom in an attempt to identify associations between 16,911 older adults free bus pass holders and increased amounts of active transportation. In Japan, Mizuno et al. (2011) conducted two studies that examined incentives and other support measures offered across 1,067 municipalities that are aimed at encouraging driving cessation and enhancing older adults’ outdoor mobility.

The results of these studies are described below, beginning with the results related to personal health-functioning and psychosocial issues. This is followed by a discussion of the results related to the facilitators and barriers to transit/para-transit usage.

Personal health-functioning and socio-demographic characteristics of transit users

The results of Babka et al.’s (2009) study indicated that program participants were majority women (74%) who lived alone (68%), had low incomes (86% <\$30,000 annually), and were aged 65 years and over (78%). It was interesting to note that, while 58% of participants still drove, only 37% used their automobile as their primary mode of transportation. This suggests that many participants are in the transitional stage into

driving cessation. 76% of respondents self-rated their health as good or very good. Broome's study of older Australians showed similar results; participants had a median age of 71.9 years old, 74.9% were female, and 57.7% still drove even though over 30% used transit occasionally or frequently. Those who had retired from driving (23.8%) used transit more frequently. The sample in Nasvadi and Wister's (2006) study of para-transit users had a median age of 69 years, but this sample was more gender equal, with women comprising 58.4% and 55.5% reporting being married or common-law. Over 90% of these para-transit users reported having three or more chronic conditions.

Facilitators and barriers to transit, para-transit usage

The findings show that several factors played a role in enabling transit and para-transit use, including: transit knowledge; IADL and ADL support; peer support; and government incentives. The results of Babka et al.'s (2009) post-program knowledge tests showed an average increase of 35% in transit knowledge compared to the baseline scores. In addition to increasing transit knowledge, the post-program tests also revealed that the participants had increased their ability to independently access and use transit information sources to plan their travels by 30% (i.e. using call centre, internet, or paper-based schedules).

The results of Nasvadi and Wister's (2006) regression analysis showed that contributing factors for para-transit use included: being retired, having a positive attitude towards para-transit's usefulness, having poor/fair self-rated health, and a chronic condition. These results also showed that, while having knowledge of para-transit was high—82.8% of respondents reported that they had heard about the service—it was not a statistically significant enabling factor. Instead, the regression analysis showed that level of support was a key enabling factor; a participant's odds of using para-transit were 2.5 times greater (compared to those receiving no help) if they received help monthly, and these odds increased to 3.04 times greater for those receiving help on a weekly or daily basis for personal activities, such as housework, shopping, driving, money management, or personal care. Babka et al. (2009) recruited participants through senior activity centers, and, during the workshops, they observed that a sense of camaraderie developed among the participants as a result of the group learning process. In both of the above studies, the presence of social support networks acted as a channel for

receiving information and encouragement about alternative transportation options and interventions.

Three studies were identified that examined regulatory incentives to promote transit usage. Mizuno et al. (2011) conducted a nationwide study of municipalities in Japan in 2008, which was supplemented with a follow-up study in 2012. The purpose of this study was to analyze the types of support measures that municipalities had implemented to encourage older adults to voluntarily retire from driving, specifically the offer of discounts on public transportation. Similarly, Coronini-Cronberg et al. (2008) analyzed longitudinal data from a four-year National Travel Survey of older adults who had participated in a national free bus pass program in the United Kingdom. Of the 1,027 baseline municipalities in Mizuno et al.'s survey, only 21 (2%) had implemented public transportation discounts. In the follow-up survey, the percentage of participating municipalities had substantially increased to 56.2%, indicating that programs with mobility and transportation support to older adults, including those with dementia, were becoming more common. In the United Kingdom, England introduced a National Bus Pass program for older adults in 2006, which offered free local bus travel for adults 60 years and over. The free bus pass program was restricted to off-peak hours, which included any time after 9:30am on weekdays and all day on weekends and holidays. Coronini-Cronberg et al. (2008) conducted a secondary data analysis of National UK Travel Survey data over the four year period of 2005 to 2008, comprising a sample of 16,911 older adults 60 years and older. The results of their analysis showed that 66% of respondents were using the free bus pass program. Moreover, the results also revealed that the number of free bus pass holders increased from 56.8% in 2005 to 74.7% in 2008, with a higher number of bus passes being held by women over the age of 70 who were renters in denser areas.

Aside from the financial benefits of being in the bus pass program, the results showed that bus pass holders indicated a higher level of active travel compared to those without a bus pass. Results showed an increase in instrumental walking, 3 or more times per week. Regression analysis showed that these results held, even when excluding London residents from the analysis.

In terms of barriers to transit usage, the findings indicated that inaccessibility was a main concern, with three main areas being highlighted: lack of access to transit

service; lack of access to timely transit information (such as lack of information on transit routes and schedules); and lack of access to a seat on the bus. Fear for personal safety was another noted barrier, specifically the fear of falling (injury) and the fear of crime on the bus or at the bus stop. Lastly, the social environment on the bus was also cited as a barrier, particularly concerns about rude or unhelpful bus drivers and inconsiderate bus passengers (Babka et al., 2008).

The findings from the above studies show that older adults will use transit and para-transit if training is provided, especially in a peer-supportive setting. In addition, the presence of formal supports for IADL and ADL also played a role in enabling para-transit usage. Furthermore, the results demonstrated that financial incentives (i.e. free bus pass programs) are effective at encouraging transit use. One residual benefit of transit use is an increase in active transportation, particularly walking. Identified barriers to transit use included: lack of access to service provision and timely transit information about routes and schedules; fear of falling and fear of crime on the bus; and an unfriendly social environment on the bus.

The following section will discuss the findings from the next sub-category, which describes program evaluations of community-based supplemental transportation programs, known as STPS.

B) STPS shared services: the use of micro transit (community-based shuttle bus programs) and volunteer driver programs

Eight studies were found relating to older adults' use of STPS community shuttle bus and volunteer driver programs. Seven of these studies were conducted in the United States, while one was conducted in Canada. Three publications were editorials intended to inform social workers and gerontologists about emerging "shared service" supplemental transportation programs and how they are evolving in different parts of North America (Zinn, 2001; Freund, 2003; Freund & Vine, 2010). Two studies were quantitative, cross-sectional surveys: one was a needs assessment / concept test for the start-up of a community shuttle bus service in New England (Marx, Davis, Miftari, Salamone, & Weise, 2010), while the other was a national satisfaction survey on volunteer driver programs (Kerschner & Rousseau, 2008). The final three identified studies were program evaluations (Kerschner, 2003; Fitzgerald, 2009; Navarro, Siciliano, & Saucer, 2013). Collectively, these eight studies provide an overview of the

features and benefits of these new, community-based transportation options, as well as the challenges and barriers to scaling them up in order to achieve economic sustainability. Sample sizes ranged from small qualitative samples (N=3) for in-depth interviews to large quantitative samples (N= 714) for the satisfaction survey.

There are two types of community-based transportation programs evolving for older adults in North America:

1) Volunteer driver programs: these are programs where volunteers use their own vehicles to provide rides to older adults, who in turn, reimburse the volunteer for the mileage consumed during their outing.

2) Micro-transit (Community shuttle bus programs): in these programs, a fleet of accessible vehicles, such as vans and para-transit shuttle busses, owned by community non-profit organizations are used to provide older adults with rides to neighbourhood-based destinations, such as shops, medical appointments, and to visit nearby family and friends.

Five studies were found focusing on volunteer driver programs (Freund 2003; Freund & Vine, 2010; Kerschner, 2003; Kerschner & Rousseau, 2008; Navarro et al., 2013) These studies describe the evolution of two volunteer driver programs: one on the east coast of the United States, led by the Independent Transportation Network (ITN), and one on the west coast of the United States, led by the Beverly Foundation.

In 2003, Freund published an editorial describing a novel volunteer driver program that had been created by ITN in Maine. In this editorial, Freund detailed how ITN was trying to serve older adults who had ceased driving by creating a “*seniors-friendly*” supportive ride-share service. This service, she noted, functioned by using volunteer drivers who would assist the older adult “*door-through-door and arm-through-arm*” from their home and to their desired destination. The driver would also provide additional support, such as folding up mobility walkers and loading/removing them from the vehicle and carrying shopping packages. In 1997, ITN was chosen by the Federal Transit Administration as *the* model for community-based transportation for older adults. In large part, ITN was able to secure this contract due to its volunteer-based model, which was conducive to the economically sustainable use of its \$225,000 annual operations budget. By 2001, ITN had grown to provide approximately 16,000 rides per

year to older adults in New England; more significantly, however, the network had also achieved economic sustainability and no longer relied on Federal grants. In 2010, Freund and Vine wrote a follow-up editorial, making the case that ITN and other volunteer driver and ride-share programs are viable alternatives for older adults who no longer drive and who also cannot use taxis or public transit. In this editorial, Freund and Vine highlighted the fact that livery laws need to be modernized so they do not act as a barrier to volunteer driver programs.

Concurrently, Kerschner (2003) published an evaluation of an equivalent volunteer driver program in Pasadena, California, led by the Beverly Foundation. The Beverly Foundation is a non-profit organization that provides organizational support to the start-up of volunteer driver programs for older adults. Kerschner noted that volunteer driver programs are classified as supplemental transportation programs for seniors (STPS) because they provide flexible, customized transportation options that traditional public transit cannot. The Beverly Foundation provides a national database of volunteer driver programs, as well as a toolkit of published materials and resources to assist local communities in launching their own volunteer driver program. Kerschner defined older adults' "five degrees of mobility", beginning with full mobility, which declines progressively through stages of reduced mobility until outdoor mobility is no longer possible; hence, the purpose of STPS programs is to fill those gaps of reduced mobility. Subsequently, Kerschner and Rousseau (2008) published the results of a national quantitative survey of 714 volunteer drivers representing volunteer driver programs across 40 states. The survey results provided a profile of volunteer drivers, the reasons why they volunteer and the issues and challenges that they face serving older adults' transportation needs. Kerschner and Rousseau (2008) echoed Freund's position, arguing that volunteer driver programs may be a viable option for meeting the growing future demands of older adults' outdoor mobility needs. Lastly, Navarro et al.'s (2013) evaluation of a volunteer driver program in Pasadena, California, led by a Christian church ministry, highlighted how religious organizations could play an effective role in serving the transportation needs of older adults. The church-led volunteer driver program came into existence when the church noticed the growing transportation needs of its aging members, particularly those who had ceased driving and had mobility challenges, yet still wanted to remain actively engaged with church-life. The church additionally noticed that its members who had experienced health issues were also in

need of transportation to and from medical services. The mixed method program evaluation used a logic model framework to describe the program's structure, process, best practices and barriers to date. The volunteer driver program provides curbside service, driving the church member as close to the entrance as possible and also assistance with navigating wheelchairs or offering "stand-by" help. After 12 months in operation, the program had secured a program co-ordinator, a pool of regular drivers, and had 20 members using the service.

Three studies were identified in relation to micro-transit (Zinn, 2001; Fitzgerald, 2009; Marx et al., 2010), with each one focusing on how community shuttle bus programs are evolving. In a program evaluation editorial, Zinn (2001) described how separate, smaller transportation programs for older adults in Ohio had amalgamated into one larger, shared program in order to increase operational efficiency and extend the service's reach. Specifically, the program amalgamated vehicles (one car, one wheelchair-accessible Dodge caravan, one 15 passenger para-transit shuttle bus, and one 30 passenger tour bus), staff (2 full-time coordinators and 3 drivers), and scheduling systems. As a result, the program is now able to serve the 370 older adults residing in the immediate community, as well as additionally serving the residents of the nearby independent living, assisted living, and skilled nursing-complex care buildings. The program is also able to serve home-care clients living within community in addition to providing back-up transportation services for the local senior's community centre.

Marx et al.'s (2010) quantitative transportation needs assessment study and shuttle bus concept test was comparatively larger than the above studies, using a sample of 641 New England residents (older adults and people with disabilities). In conducting their study, Marx et al. (2010) aimed to assess current transportation use by mode of travel and willingness to use a shuttle bus service if offered. This study was initiated by a coalition of local health and human-service agencies, as well as the local municipality, transit provider, and interested consumers whose mission was to increase access to transportation, particularly through improving the coordination of existing transportation resources geared towards adults 60 years and older. Close to 80% of respondents reported that they would use the shuttle bus service if it were available, and 30% estimated that they would use it two or three days per week. The majority (78%) indicated they would use the service for medical appointments, while 64% said they would use it for grocery shopping, and 52% said they would use it to do errands.

Respondents noted that unreliable transportation has prevented them from participating in important activities in the past, particularly running errands (going to the bank, the grocery store, the pharmacy) or attending recreational/social events. As such, the respondents indicated that they were likely to use the new shuttle service if it was flexible and reliable, offered expanded routes and hours, and was reasonably priced (up to \$3 per trip).

Fitzgerald (2009) conducted a program evaluation of a pilot shuttle bus service that had been operating for three years in Vancouver, Canada. Focus groups were held with current shuttle users, for a total of 26 participants. The shuttle service is a multi-stakeholder partnership that provides supplemental transportation to older adults via a “demand-response” service model. This means that, rather than following a set route, the shuttle bus travels to a set number of community-based destinations, such as local shops (grocery store, pharmacy), the seniors centre, community centre, seniors housing sites, and key medical offices. The service is flexible because the driver can deviate from their route to pick up older adults at their homes, and it is supportive because the driver can provide personal assistance getting to and from the vehicle, carrying parcels, and assisting with mobility devices. The shuttle service was deemed a success due to its stable ridership statistics, positive performance measures and survey results, and the fact that it is still operational three years after start-up. In fact, ridership grew to 6,388 trips by the third year of operation and the daily number of riders ranged from 6 to 88 depending on the season and the weather conditions.

Personal health-functioning and psycho-social-demographic characteristics of users of community shuttle bus and volunteer driver programs

The findings showed consensus that supplemental transportation programs were effective at serving “hidden populations” of older adults who have special mobility needs. This group of older adults is considered “hidden” because they have higher rates of social isolation due to the following characteristics:

- They no longer drive (Freund, 2008; Kerschner & Rousseau 2008; Fitzgerald, 2009; Marx et al, 2010; Navarro et al., 2013)
- They are in the “oldest-old” age cohort of 85 years and older, with physical and cognitive limitations that lead to frailty and greater mobility challenges than the younger cohort of older adults. Thus, they require much higher levels of

transportation assistance and support than traditional transit can provide.

(Kerschner & Rousseau, 2008; Marx et al., 2010)

- They are transportation disadvantaged because they live in areas (either suburban or rural) where transportation options are either unavailable, not wheelchair accessible, run infrequently, or are too far away to reach since bus stops are more than three blocks away (Fitzgerald, 2009; Marx et al., 2010; Navarro et al., 2013)
- They are living alone. As Marx et al. (2010) found, respondents who were living alone were twice as likely to be unable to get to appointments or activities compared to those who were living with a spouse or family member.

Several quotes and comments from study participants highlight the need for reliable and appropriate transportation services for this “oldest-old” cohort of older adults.

“ The thing is we’re getting older. Right now, I’m 95 and in a few years, I’m not going to be able to get on and off a bus. If there’s something like the <shuttle bus> for us, I’d still be able to get places.” – - Shuttle bus rider, Vancouver, Canada

“If you live within this core area... then transport and the bus stops are very good. If you’re beyond that area it’s another story. If you live in the Properties, which I did for years, there’s one bus per hour and it was about four blocks from where I lived.” – Shuttle bus rider, Vancouver, Canada

“ If I could get dependable transportation, it would make some very difficult circumstances much, much easier” – respondent, New England concept test study for new shuttle bus service

Findings have also identified signs of reduced stress-coping capacity during outdoor travel. Qualitative interviews and focus groups indicated that respondents with chronic conditions and declining health experienced increased levels of stress and fatigue, thus making outdoor mobility challenging (Navarro et al., 2013). However post-intervention, respondents indicated that the volunteer driver program had relieved the stressful aspects of outdoor travel:

“My knees hurt a lot, getting in and out of the car is hard for me...I would get pretty stressed out, I would get bumped around a bit, and many times I’d end up in tears...<the service>... relieved my stress, makes me happy, I am so thankful...the service is great...the people are very nice, they help me with the long walk to the church” – older adult with rheumatoid arthritis, Navarro et al., (2013).

In terms of social connectedness, the findings showed that users of STPS programs were able to re-engage in societal participation and meaningful activities due to increased outdoor mobility. The findings also indicated that the STPS experience itself was socially enriching for both the older adult passenger and the driver. The respondents in Kerschner and Rousseau’s (2008) volunteer driver program satisfaction survey indicated that the program allowed older adults to travel to a variety of “life-sustaining and life-enriching” destinations. Although 80% of trips were medical related, other frequent destinations included local shops and services (pharmacy, groceries, bank, barber/hairdresser, library, church, volunteer activities) as well as visits to friends and family. In Navarro et al.’s (2013) study, respondents from the church community voiced that, in spite of experiencing health issues and mobility challenges, they still wanted to remain active and involved in the church and the volunteer driver program allowed them to do so. Participants commented on the genuine sense of caring they experienced from the volunteer drivers: *“They check in on me, which I think is very sweet”*.

Socialization was stated as the main benefit of these community-based programs. *“Getting to know the passenger,”* was a source of satisfaction for both the driver and the passenger. Focus-group respondents from the shuttle bus program in Vancouver, Canada also noted similar socialization benefits, which are transcribed below.

“It’s a little family. We all talk together, and you don’t get that on the public bus...what we’ve got is so great. John (the driver) is so good with us all. He knows us all by first name...and it’s door-to-door service, which we need more of.” – Shuttle bus rider, Vancouver, Canada.

“Meeting new and different people, interesting people, conversations, friendship... the journey is often more important than the destination.” - Participant, Volunteer Driver Program, California.

Generativity was another cited benefit of STPS programs. The majority of the drivers in the study of volunteer drivers were older adults themselves (Kerschner & Rousseau, 2008), with 86% being 56 years and older. Respondents stated that they realized that all the “extra” activities required to support the older adult’s outdoor mobility were meaningful activities that were *“making the difference between isolation and independence”* for the older adult passenger. The majority of respondents found being a volunteer driver *“exceptionally enjoyable and gratifying,”* and this was the main reason that they continued to do so (i.e. helping passengers bring groceries into their house; accompanying them at the medical office and waiting until they are done; helping with their walker; or helping them up the stairs of the van). Other stated reasons for volunteering included: to help others (89%); to give back to the community (52%); to contribute time rather than money (39%); and to get to know the riders (60%). *“The relationship and sense of connection takes on primary significance, making the act of providing transportation secondary in comparison.” – Volunteer driver, California.* The volunteer drivers in the study by Navarro et al. (2013) expressed similar sentiments; the drivers stated that they experienced an increased connection and sense of community. They also expressed that they felt a sense of service to the program participants.

Barriers to STPS program start-up and diffusion:

Three studies identified barriers to the start-up and expansion of STPS programs. Freund and Vine (2010) highlighted the fact that livery laws are restricted to taxis and public transit, and that this makes them a barrier to volunteer driver programs. As such, they argue that livery laws must be modernized if they are to meet the supportive needs of older adults. Additionally, car insurance issues were also mentioned as a barrier that hinders volunteer drivers. To overcome this barrier, organizations that operate volunteer driver programs generally provide an umbrella insurance policy to provide additional coverage to their volunteer drivers to supplement their own private insurance. Non-profit organizations provide additional coverage to the driver in the event of property damage or bodily injury occurring during the ride. Additionally, in focus groups conducted by Navarro et al. (2013), non-profit staff stated that operational efficiency was highly valued and that the availability of in-house information technology systems could help increase the efficiency of the passenger matching process and the transportation logistical process. Lastly, although not a barrier, the studies by Zinn (2001) and Marx et al. (2010) show that working collaboratively and forming alliances

with other seniors-serving organizations is an effective way to scale up organizational capacity in order to serve a wider region of older adults who require supportive transportation services.

The main finding in this category is that supplemental forms of community-based transportation are highly valuable for mobility limited older adults who are considered transportation disadvantaged due to living in lower-density areas that lack adequate public-transit access. STPS programs fill a gap by providing an extra supportive service for older adults who require more one-on-one assistance; the programs are able to relieve the stress and fatigue associated with outdoor travel. The findings also show that STPS programs offer a meaningful social experience for both the passenger and the driver. In order to help the expansion of STPS programs, livery laws and insurance policies must be modernized in some geographical jurisdictions. Finally, the results discussed in this section show that collaborating and forming alliances with other seniors-serving organizations is an effective strategy for scaling up organizational capacity and market reach.

Table 3.4 provides a collated list of research characteristics for all four sub-categories, namely: outdoor walking with MATs, Supplemental Transportation Programs for Seniors (STPS), and interventions to encourage transit usage and walking in neighbourhoods. It should be noted that interventions related to encouraging neighbourhood walking will be discussed in the following section, which focuses on macro-level neighbourhood planning issues. This organizational step was taken because these interventions involved a process designed to evaluate barriers in the neighbourhood's built environment.

As the distribution of studies in Table 3.4 shows, most studies on outdoor walking and MAT-use focused on health functioning and psychosocial issues, with an equal number focusing on built-environment issues affecting pedestrians. In the STPS studies, the primary focus was on psychosocial issues, specifically how the availability of appropriate transportation services, or lack thereof, affects social participation issues for older adults with health functioning issues. The intervention studies related to transit use primarily focused on psychosocial (participation) issues as well as policy issues to encourage usage. The intervention studies related to improving walking conditions in neighbourhoods addressed all levels of social ecological domains. There is an evidence

gap in the area of policy and inter-personal issues related to pedestrians. STPS programs have an evidence gap related to built-environment issues; and transit-related interventions have an evidence gap related to health functioning, inter-personal and built environment issues.

Table 3.4. Literature Review Results for Driving, Transition and Interventions Related to Driving Cessation by Social-Ecological Domains

	Personal health-functioning issues	Psychosocial issues	Inter-personal issues	Built Environment Issues	Policy-regulatory issues
Pedestrian issues - Walking with MATs	Clarke and George, 2005; Clarke et al., 2008; Clarke, 2014; Clarke et al, 2017; Fitzsimmons and Schoenfelder, 2011; Freedman et al., 2008; Hallgrimsdottir and Stahl, 2016; Langlois et al., 1997; May and Rugg, 2010; Mitchell, 2006; Mollenkopf et al., 2011; Rantakokko et al., 2014; Rosenberg et al., 2008; Spivock et al., 2008; Satariano et al., 1997; Satariano et al., 2016; Viljanen et al., 2016; Yan-Yan et al., 2014.	Clarke and George, 2005; Clarke et al., 2008; Clarke, 2014; Clarke et al, 2017; Fitzsimmons and Schoenfelder, 2011; Freedman et al., 2008; Hallgrimsdottir and Stahl, 2016; Langlois et al., 1997; May and Rugg, 2010; Mitchell, 2006; Mollenkopf et al., 2011; Rantakokko et al., 2014; Rosenberg et al., 2008; Spivock et al., 2008; Satariano et al., 2016; Viljanen et al., 2016; Yan-Yan et al., 2014.	Fitzsimmons and Schoenfelder, 2011; May and Rugg, 2010.	Clarke and George, 2005; Clarke et al., 2008; Clarke, 2014; Clarke et al, 2017; Freedman et al., 2008; Hallgrimsdottir and Stahl, 2016; Langlois et al., 1997; May and Rugg, 2010; Mitchell, 2006; Mollenkopf et al., 2011; Rantakokko et al., 2014; Rosenberg et al., 2008; Spivock et al., 2008; Satariano et al., 2016; Viljanen et al., 2016; Yan-Yan et al., 2014.	Fitzsimmons and Schoenfelder, 2011; May and Rugg, 2010; Satariano et al., 1997
Supplemental Transportation Programs for Seniors (STPS)	Fitzgerald, 2009; Freund and Vine, 2010; Kerschner and Rousseau, 2008; Marx et al., 2010; Navarro et al., 2013; Nasvadi and Wister, 2006; Zinn, 2001.	Fitzgerald, 2009; Freund, 2003; Freund and Vine, 2010; Kerschner, 2003; Kerschner and Rousseau, 2008; Marx et al., 2010; Navarro et al., 2013; Nasvadi and Wister, 2006; Zinn, 2001.	Kerschner and Rousseau, 2008; Navarro et al., 2013; Nasvadi and Wister, 2006.	Fitzgerald, 2009; Marx et al., 2010.	Fitzgerald, 2009; Freund, 2003; Freund and Vine, 2010.
Interventions-transit related	Babka et al., 2009; Mizuno et al., 2011.	Babka et al., 2009; Broome et al., 2010; Coronini-Cronberg, 2012; Mizuno et al., 2011; Mizuno et al., 2012.	Babka et al., 2009	Broome et al., 2010.	Coronini-Cronberg, 2012; Mizuno et al., 2011; Mizuno et al., 2012.
Interventions-pedestrian-related	Hooker et al., 2007; Hooker et al., 2009; Perez et al., 2015; Shendell et al., 2011; Transportation Alternatives, 2009.	Hooker et al., 2007; Hooker et al., 2009; Perez et al., 2015; Shendell et al., 2011; Transportation Alternatives, 2009.	Hooker et al., 2007; Hooker et al., 2009; Perez et al., 2015; Shendell et al., 2011; Transportation Alternatives, 2009	Hooker et al., 2007; Hooker et al., 2009; Perez et al., 2015; Shendell et al., 2011; Transportation Alternatives, 2009	Hooker et al., 2007; Hooker et al., 2009; Perez et al., 2015; Shendell et al., 2011; Transportation Alternatives, 2009.

* Note: pedestrian-related studies that contained results related to built environment issues will be discussed in detail in Section 3.3: Transportation Planning and Advocacy for an Aging Population.

The next section examines studies that focus on macro-level planning and preparation related to the transport needs of North America's aging population. These studies classify older adults' travel patterns by mode-share, as well as their travel needs in terms the age-friendliness of the surrounding built and social environments. Section 3.3 discusses community-based-participation research tools that are being developed to assist older adults in advocating for age-friendly transportation options. The built-environment issues related to pedestrians are also discussed in this section.

3.3. Transportation Planning and Advocacy for an Aging Population: Engaging Older Adults in the Collaborative Design of Age-Friendly Neighbourhoods to Enable Active Living

This section surveys studies that focus on macro-level planning and preparation in relation to the transport needs of North America's aging population. The literature on transportation planning, advocacy and policy development related to older adults is relatively new, with only 6 (15%) of the 38 identified studies being published prior to 2010. The studies in this category come from a variety of sources, such as benchmarking studies, editorials and position papers related to advancing the aging-mobility agenda. This section also highlights community-based participation research (CBPR) tools that are being developed to assist older adults in neighbourhood-based planning and building advocacy skills for their age-friendly transportation needs, particularly walking.

The findings will be summarized in three sub-categories:

- Transportation planning and benchmarking;
- Policy development;
- Industry-level reports.

Furthermore, findings related to social- and built-environment facilitators and barriers to age-friendly neighbourhoods, particularly walking, are also discussed in this section. The results of each sub-category are listed by research methodology in Table 3.5.

Table 3.5. Literature Review Results for Transportation Planning and Policy Development by Research Methodology

# of Articles by Research Methodology	Quantitative	Qualitative	MMR	Program Evaluation	Literature Review	Non-Empirical	Total
Transportation Planning & Benchmarking	7	0	2	0	0	0	9
Policy Development	1	1	0	0	6	12	20
Industry Reports**	0	0	0	0	0	9	9
Sub-total	8	1	2	0	6	21	38

** Note: Pedestrian-related interventions are also discussed in this section

3.3.1. Macro-level Transportation Planning and Preparedness for Age-Friendly Community Design: Transportation Mode-Share Analysis and Future Preferences

This sub-category provides an overview of industry benchmarking and planning studies for active transportation modes appropriate for older adults. Six studies benchmarked the changes in modes of transportation of older adults, while two studies were cross-sectional studies that examined future transportation preferences. One stakeholder study was identified that probed municipalities for facilitators and barriers to developing age-friendly communities. Five studies originated in Canada, one was from Australia, and three were from the USA.

The findings indicate that older adults do increase their active travel modes over time, with the upcoming cohort of older adults, the Baby Boomers, showing significant increases in walking and biking mode-share. In addition, the Baby Boomers have also expressed a desire for more walkable neighbourhoods in which to live. Three travel studies showed that walking is becoming a popular mode of active transportation for older adults. Dahan-Oliel, Gelinas, Dobbs, and Lefebvre (2010) analyzed urban travel data in a sample of 90 older adults from Montreal, Canada, and found that, by the average age of 76.3 years old, active transportation mode-share was sizeable: 18% were actively walking, 12% used public transit, and 5.5% used para-transit/taxis. It was also noted that, while 57% still travelled by personal automobile, only 30% of those respondents were still active drivers and 27% had moved over to the passenger seat. Similarly, Spinney (2013) analyzed four cycles of national time-use data in Canada between 1992 and 2010, finding that walking mode-share had nearly doubled among

older adults, from 13% in 1992 to 24% in 2010, with an average recreational walking time of 60 minutes per day. O'Hern and Oxley (2015) found similar trends in Australian regional travel data: while 70% of older adult respondents continued to drive, 20% walked, and an average of 7% used public transit, which increased to 11% among the 85+ years old cohort. Australian travel data also showed that older adults' outdoor life space was shrinking, with respondents reporting walking trips of 520 meters on average, and car trips of less than 5 km on average.

One identified study measured mode-share of older adults in a specific neighbourhood after it had significantly upgraded its active transportation infrastructure. In this mixed method quantitative-qualitative study, Winters, Sims-Gould, Franke, and McKay (2015) assessed the transportation mode-share of older adults who lived within two blocks of a recently upgraded active transportation corridor in downtown Vancouver, Canada. Their results indicated that active transportation mode-share was significant: 63% of trips were via walking, 10.5% by public transit, and 3.2% by bicycle. Only 22% of trips were via driving, even though nearly 70% of respondents had access to a vehicle. It is notable that the cycling mode-share was over 3% for study respondents, which is two times higher than the cycling mode-share of the region's general population.

Personal health-functioning and socio-demographic factors by mode-share

Dahan-Oliel et al.'s (2010) study included measures of societal participation and leisure activities, specifically the CHART (Craig Handicap Assessment and Reporting Technique) measure and the NLQ (Nottingham Leisure Questionnaire) measure. Their results revealed that independent forms of outdoor mobility produced protective health benefits; older drivers, older adults who walked, and older adults who used public transit had higher cognitive independence scores than older adults who travelled as a passenger in a private vehicle. These findings indicate that more "spontaneous" active modes of transportation require higher levels of cognitive ability than being a passive passenger in a vehicle. Relatedly, Choi and DiNitto (2016) analyzed two waves of data from a US National Health and Aging Trends dataset (6,680 participants in 2011 and 5,413 in 2012). Their analysis showed that newly retired drivers had higher rates of being diagnosed for depressive symptoms than current drivers; however, those who walked or used a mobility wheelchair (or scooter) tended to exhibit lower levels of depressive symptoms.

Gender effects were prevalent in this category, with older women having higher active transportation participation rates than older men. When Dahan-Oliel et al. (2010) analyzed their data by gender, they discovered some stark differences: 61.8% of older men were still active drivers, whereas 91.7% of older women had stopped driving and moved to the passenger seat. It was also found that, aside from being a passenger, 90.1% of female respondents rode public transit, 80% used adapted transit/taxi, and 56.2% regularly walked.

The above authors all highlight the need to alter the urban design environment to reflect the mode-share changes of older adults. This is particularly critical for those over the age of 75, as, over time, their life space shrinks to destinations closer to home and walking becomes a more popular travel mode. This view is substantiated by industry reports. Three industry studies supported the latent demand for walkable neighbourhood designs. In a poll of 1,223 adults living in Vancouver, Canada, Frank, Kershaw, Chapman, and Perrotta (2014) found that nearly 67% of urban respondents indicated a strong desire to live in neighbourhoods that encourage foot traffic. Similar sentiments were recorded in a benchmarking report by the Alliance for Walking and Biking (2016), which found that 40% of American respondents aged 50 years and older felt that their neighbourhood was not pedestrian-friendly enough. Comparatively, a Canadian urban benchmarking study of walking and biking (Behan & Lea, 2010) conducted between 2001 and 2006 found that the Baby Boomers (those aged 55-64) showed the greatest increase in active transportation usage (both walking and biking). Lastly, Lehning's (2011) survey of 62 city planners in California demonstrated that people with disabilities had been successful in advocating for housing and transportation changes, whereas residents 65 years and older had not been successful in securing such changes. The author suggested that older adults must become more involved in advocacy efforts if built-environment changes that benefit them are to take place.

The next section details specific features of the built environment that either facilitate or hinder the outdoor mobility of mobility limited older adults. This discussion will be based on the identified studies that focus on outdoor walking and MAT use.

3.3.2. Social-Built Environment Issues: Facilitators and Barriers to Active Living and Age-Friendly Neighbourhood Design

Several studies have identified multiple features of the built environment that act as either facilitators or barriers to outdoor mobility. Many responses from study participants, particularly those from the previous studies involving MAT users, discussed the ways in which the outdoor built environment either supported their walking experience, or acted as a barrier or risk to their personal safety (Clarke, 2017; Clarke & George, 2005; Clarke, 2014; Hallgrimsdottir & Stahl, 2016; Langlois et al., 1997; Mitchell, 2006; Mollenkopf et al., 2011; Spivock et al., 2008; Rantakokko et al, 2014; Rosenberg, 2012; Satariano et al., 2014; Yan Yan et al., 2016). Two additional studies described how various features of the built environment affect older adults' outdoor mobility behaviour, specifically, transit use and cycling. Broome et al. (2010) studied the age-friendliness of bus services in Australia by drawing upon ethnographic observations about which outdoor features of the "transport chain" had the greatest impact on older adults' bus use. Similarly, Winters et al.'s (2015) study of older adults' active transportation mode-share identified built-environment factors that affected bicycle use among older adult urban cyclists. Combined, these studies highlight common features of the built environment that impact ease of outdoor mobility and societal participation for older adults.

In the majority of the analyzed studies, the most commonly mentioned facilitator of outdoor mobility was good urban design, particularly the presence of well-built sidewalks and safe, accessible street crossings. Specifically, study participants expressed a need for sidewalks that are wide, smooth, free of obstructions, well lit, and featuring a grass boulevard that separates pedestrians from vehicles. In terms of street intersections and crosswalk features, speed and volume of oncoming vehicles was the next most common concern. Other important pedestrian safety features identified by respondents included walk lights that give extra time to cross and extended curb corners that are free from parked cars and/or shrubbery that can block views of oncoming vehicles. The presence of curb cuts was an important feature, particularly for older adult MAT users. Furthermore, respondents with mobility or sensory impairments also mentioned adapted signage and traffic signals, color-contrasted street markings, and center medians as desirable supports to safely crossing the street. Other cited supportive pedestrian amenities included sheltered benches and bus stops, accessible

bathrooms, water fountains, and wheelchair-accessible parking close to community destinations. Having access to nature, parks, animals (birds, dogs), community gardens, and children playing were other supportive elements that were viewed as making the pedestrian environment more enjoyable and socially stimulating.

The next most mentioned facilitator involved mixed land-use practices. Mixed land-use describes neighbourhoods that have a variety of housing forms and commercial and community establishments within close proximity. In contrast, single land-use neighbourhoods are strictly comprised of single-family houses, and are most commonly observed in suburban settings. Five studies identified mixed land-use features as being critical to walkable neighbourhoods, particularly having a density of community destinations within a short walking distance of one another (Mitchell, 2006; Satariano et al., 2014; Spivock et al., 2008; Rantakokko et al., 2014; Yan Yan et al., 2016). The authors of these five studies found that older adults with walking difficulties were more sensitive to the effects of the built environment. In contrast, results in Satariano et al.'s (2014) study showed that older adult respondents who had the lowest level of lower-body functioning, yet perceived their neighbourhoods as having positive walkable features (i.e. the presence of a number of walkable destinations, a low number of barriers to outdoor walking, and a short walking time to destinations), were *less* likely to report difficulty walking two to three blocks vs. respondents who perceived their neighbourhood as lacking walkable features.

In terms of barriers, the most frequently mentioned barrier to outdoor mobility across studies was perceived fears about personal safety related to broken sidewalks, vehicular speed /traffic congestion, and injury/harm from people or dogs (Mitchell, 2006; Spivok et al., 2008; Broome et al., 2010; Mollenkopf et al., 2011; Rosenberg, 2012, Hallsgrimdottir, 2016). Fear of falling was the most commonly cited concern, not only as a result of poor sidewalks and street environments, but also due to features of the social environment. Broome et al.'s (2010) study of public transit age-friendliness contained concerns regarding fears of barking dogs and crowds, both at the bus station and on the bus itself. In contrast, Mollenkopf et al.'s (2011) study documented comments related to fear of isolation. In particular, the respondents in this study expressed a fear of travelling in less dense areas, as they were concerned about no one being around to help if a medical situation arose.

Steep terrain and adverse/extreme weather conditions was the second most frequently stated barrier to outdoor mobility. Extreme rain, snow, wind, or sun, in addition to neighbourhoods with hills, posed significant challenges for older adults with mobility difficulties and hastened fatigue and discomfort. Having well-placed benches, bus stops with shelters, or trees that provide shade were some of the features that were seen as being potentially useful for mitigating these outdoor barriers. In terms of barriers to MAT users, the presence of stairs, as opposed to a ramp, was mentioned as a barrier to outdoor mobility. Clarke (2014) studied how the presence of stairs at residential building entrances affected older adults who used wheeled MATs. Regression analysis showed that wheeled MAT users' outdoor mobility difficulty dropped when a ramp was present. Interestingly, Clarke's (2014) results also revealed that the presence of an entry ramp made it 50% more likely that non-wheeled MAT users would report some/a lot of difficulty going outdoors. Thus, while certain elements of the built environment may act as facilitators for one type of MAT user, they can act as barriers to other MAT users.

The findings in this section indicate that older adults actually increase their level of active transportation as they age. Independent forms of outdoor mobility, such as driving, walking and riding transit, have all been shown to be associated with higher levels of cognition. The upcoming cohort of older adults, the Baby Boomers, has likewise shown increasing amounts of active transportation, particularly walking and biking. Survey results have also indicated that they would like their neighbourhoods to be more walkable. In terms of age-friendly neighbourhood features, the findings indicate that older adults are predominately concerned with safety issues related to the street and sidewalk environment. Other prominent themes include the need for street-level supportive amenities; the desire for traffic-calmed, mixed land-use neighbourhoods; a density of community destinations within walking distance (two to three blocks); and a friendly and stimulating social environment. The findings also show that facilitators and barriers to outdoor mobility are not universal, particularly in relation to older adult wheeled MAT users and non-wheeled MAT users. As such, further study is required in this area. Table 3.6 summarizes the main facilitators and barriers that were found in the results, by author. The next section describes how the policy environment is evolving to address the mobility needs of North America's aging population.

Table 3.6. Summary of Findings: Facilitators and Barriers of the Neighbourhood Social and Built Environment

Domains of the Social and Built Environment of Neighbourhoods						
Sidewalk factors	Street environment and street crossings	Street environment and street crossings (cont'd)	Supportive amenities	Natural amenities	Other factors	Land-use factors
<u>Wide and smooth</u> Langlois et al., 1997 Mitchell, 2006 Rosenberg, 2012 Spivock, et al., 2008.	<u>Extended walk light (count-down timer)</u> Langlois et al., 1997; Mitchell, 2006; Rosenberg, 2012; Spivock, 2008.	<u>Speed and volume of vehicles</u> Broome et al., 2010; Hallgrimsdottir et al., 2016; Langlois et al., 1997; Mitchell, 2006; Rosenberg, 2012; Winters et al., 2015.	<u>Sheltered benches, bus stops</u> Rosenberg, 2012	<u>Access to nature, water</u> Rosenberg, 2012	<u>Stairs</u> Broome et al., 2010; Langlois et al., 1997; Mitchell, 2006; Rosenberg, 2012; Spivock, et al., 2008.	<u>Mixed land-use, density of destinations</u> Mitchell, 2006; Rantakokko et al., 2014; Spivock et al., 2008; Satariano et al., 2014; Yan -Yan et al., 2016.
<u>Obstruction-free</u> Broome, 2010; Rosenberg, 2012.	<u>Curb cuts and ramps</u> Langlois et al., 1997; Rosenberg, 2012.	<u>Adapted signage and signals</u> Spivock, 2008	<u>Accessible toilets</u> Rosenberg, 2012	<u>Access to parks, greenways</u> Rosenberg, 2012	<u>Hills</u> Broome et al., 2010; Langlois et al., 1997; Rantakokko et al., 2014; Rosenberg, 2012.	
<u>Good lighting</u> Rosenberg, 2012	<u>Centre median</u> Langlois, 1997; Mitchell, 2006.	<u>Colour contrasted street markings and signage</u> Langlois, 1997	<u>Water fountains</u> Rosenberg, 2012	<u>Access to community gardens</u> Rosenberg, 2012	<u>Extreme /Inclement Weather</u> Broome et al., 2010; Clarke et al., 2017; Hallgrimsdottir et al., 2016; Rantakokko et al., 2014.	
<u>Grass buffer / median</u> Rosenberg, 2012	<u>Extended curb corners /bulges obstruction-free</u> Mitchell, 2006		<u>Nearby accessible parking</u> Rosenberg, 2012	<u>Access to playgrounds, children playing</u> Rosenberg, 2012	<u>Crowds</u> Broome et al., 2010; Langlois et al., 1997.	
	<u>Right turning vehicles restrictions</u> Langlois et al., 1997				<u>Dogs</u> Broome et al., 2010	

3.3.3. Public Policy: Making the Case for Integrated Mobility Policy Development

Twenty editorials were identified that relate to setting a research agenda and developing public policy for sustaining the mobility of older adults. Fifteen of these editorials originate from the USA, while an additional four are from Australia, and one from Canada. All articles were published in peer-reviewed academic journals. The literature in this area has grown over the past 10 years; while no articles were published prior to 2005, six were published between 2005 and 2009, and 14 more were published between 2010 and early 2016. Furthermore, the authors of these editorials are respected academics with backgrounds in gerontology, geriatrics, occupational therapy, and health promotion/injury prevention (Andersen et al., 2013; Anstey, 2016; Ball, Ross, Eby, Molnar, & Meuser, 2013; Classen, 2010; Classen, Eby, Molnar, Dobbs, & Winter, 2011; Dickerson et al, 2007; DiStefano, Stuckey, & Lovell, 2012; Eberhard et al., 2006; Freund & Vine, 2010; Oxley & Whelan, 2008; Ross, Schmidt, & Ball, 2013; Rosso et al., 2011; Satariano, 2007; Silverstein, 2008; Silverstein, 2012; Songer, et al., 2009; Staplin & Freund, 2013; Unsworth, 2012; Webber, Porter, & Menec, 2010; Wieland, 2013.)

The majority of the editorials are position papers that advocate for more focused attention on research and policy issues specific to advancing the continued mobility of older adults. Two articles are literature reviews of health-promotion interventions intended to prolong older adult mobility, while three other authors contribute conceptual frameworks for organizing the research agenda into an integrated, multi-disciplinary approach to older adult mobility.

The findings show that the majority of authors emphasize the need to stimulate more aging-mobility research and the corresponding research development needs to be undertaken with an interdisciplinary and multi-modal lens. The second theme focuses on the need for capacity development, particularly by increasing professional competency in aging-mobility expertise, as this would allow practitioners to transfer this knowledge to older adults through aging-mobility education and advocacy training programs. The third theme highlights the need for equitable road safety strategies, with an emphasis on safe system design and infrastructure upgrades that encourage active transportation. The findings from these three themes are detailed below.

The need for inter-disciplinary aging-mobility research

Twelve authors argue that the gerontology community—in addition to health practitioners in occupational therapy and health promotion—need to take a greater leadership role in advocating for a priority focus on mobility and aging research in policy development (Anstey, 2016; Ball et al., 2013; Classen et al., 2011; DiStefano et al., 2012; Eberhard et al., 2006; Lehning, 2011; Oxley & Whelan, 2008; Satariano, 2007; Silverstein, 2012; Staplin & Freund, 2013; Webber et al., 2010; Wieland, 2013). Several authors also draw attention to the fact that there is a growing need to “accelerate” the pace of research-to-practice due to multiple forces:

- The growing number of Baby Boomers over 70 years old signals that the aging population is increasing;
- Globalization effects on an aging population are also evident with increasing numbers of older adults in the developing world. When coupled with increased wealth, particularly in China and India, this has led to an increase in car purchases;
- Increased calls for upgrades to safe street infrastructure in response to a growing number of older adult injuries/fatalities vs. all other age categories of road users;
- The proliferation of technology has helped produce innovative “app-driven” transportation services.

These authors note that, while interventions focusing on extending the safe driving years of older adults have yielded promising results, it is now time to grow a concurrent evidence base of initiatives and programs that have proven to be effective in prolonging older adults’ independent, active outdoor mobility. In order to accomplish this as expediently as possible, researchers have focused on forming inter-disciplinary stakeholder groups to develop solutions that consider multiple modes of mobility simultaneously, rather than taking a linear, single-mode approach. There is now a call to focus on interventions and policies that are effective in the promotion of healthy, independent, outdoor mobility behaviours, particularly those involving walking, physical strength and cognitive training, transit and MAT use, and the delivery of alternative transportation options that serve the community setting. In addition, there has also been a call for the establishment of standard measures in the collection of evidence, as this will facilitate the rapid deployment of these initiatives across all regions and states.

Furthermore, researchers have called for the establishment of minimum standards of operation for road design and licensing across all age groups to ensure that policy standards are uniformly applied.

Webber et al. (2010) proposed a new conceptual framework for bridging the various disciplines involved in mobility, transportation and community design. Webber et al. (2010) recommend forming “comprehensive mobility teams” as a way of stimulating new, more complex research questions, and arriving at collaborative, integrated multi-modal solutions. In doing so, they posit that their multi-disciplinary model will more effectively inform policy development and improve the dissemination of appropriate programs and services.

The need for capacity development

The second theme in the findings relates to the need to focus on professional capacity development. Thirteen authors pointed out the substantial capacity gap in the aging-mobility profession (Andersen et al., 2014; Anstey, 2016; Ball et al. 2013; Classen, 2010; Dickerson et al., 2007; DiStefano, 2012; Lehning , 2011; Silverstein et al., 2007; Silverstein, 2012; Songer, et al., 2009; Unsworth, 2012; Webber et al., 2010; Wieland, 2013). Professionals in gerontology, occupational therapy, and health promotion/injury prevention identified a need for more trained practitioners in the following areas:

- Older-adult mobility counseling: assessment/remediation, planning and preparedness for alternatives to driving;
- Health-promotion program management: the management and evaluation of effective health-promoting interventions for active mobility, particularly focusing on interventions that effectively stimulate more walking and transit use;
- Leadership-skills training: how to lead and facilitate inter-disciplinary teams, implement a systems approach, and train older adults in community engagement and advocacy skills.

Five authors detailed the work that has been done to build the capacity base of industry professionals. For instance, Dickerson et al. (2007) wrote an editorial detailing the Gerontological Society of America’s (GSA) efforts to start a special working group on aging and mobility and to formulate a research agenda. Similarly, Silverstein et al.

(2012) published an article that provided an update on the GSA's efforts. Aside from publishing their research agenda in 2007, the GSA held a stakeholder symposium in 2008 to translate the research findings and focus on remaining gaps. By 2012, the GSA interest group had increased to over 150 members.

Relatedly, Ball et al. (2013) documented how the Transportation Research Board had formed a Committee on Safe Mobility and convened a stakeholder conference with the aim of bringing academic scientists and policy makers together to identify new issues related to older adults' mobility needs. The conference proceedings determined that, aside from the expanding numbers of aging Baby Boomers, the emergence of the new community-based healthcare delivery environment, and its reliance on informal caregivers for frail elders, were seen as key growing issues. Although the attendees concluded that the new research and policy agenda needs to involve "mobilizing" solutions for community mobility, a gap remains in relation to a coordinated effort to evaluate the most effective solutions and bring these solutions to the marketplace.

Andersen et al. (2014) wrote an editorial detailing a multi-disciplinary stakeholder initiative. The objective of this initiative was the development a mobility policy framework for prioritizing the most impactful initiatives for the promotion of mobility among older adults. Using the Health Impact Model as the guiding framework, the stakeholders selected the Complete Streets program as the most effective means of ensuring the built environment was suitable for the safe mobility of older adults. The second priority area was the need for Coordinated Action ensuring the integration of safe, supportive mobility considerations into other health promotion programs for older adults and into macro-level liveable-community plans.

In terms of building citizen advocacy skills specifically for older adults, as discussed in the previous section, Lehning (2011) surveyed city planners in California to identify macro-level barriers to the adoption of age-friendly initiatives within urban municipalities. The study's main finding was that strong citizen advocacy for changes to the built environment produced positive results for both the citizens and the surveyed municipalities. Therefore, it was recommended that older adults be provided with advocacy training in order to more effectively facilitate age-friendly initiatives.

The need for equitable road safety strategies

Many authors spoke of the need to increase funding and resources for safety improvements in road/highway design and related infrastructure upgrades, as well as the need to promote reduced vehicle speed limits and increased walking and transit use (Andersen et al., 2013; Anstey, 2016; Classen, 2010; Classen et al., 2011; DiStefano et al., 2012; Oxley & Whelan, 2008; Satariano, 2007; Staplin & Freund, 2013; Wieland, 2013). An integrated mobility approach can be used to develop and implement built-environment solutions. For example, instead of following the bare minimum safety standard of a striped road marking at crosswalks, ensure that the “best practice” also includes the addition of a stoplight, adequate signage and lighting, and curb cuts on all corners or, install a raised crosswalk.

Several of these authors also argued that a culture change is needed in North America, as the present culture is overly dependent on automobiles and too readily acceptant of driving-related injury-fatality statistics (Anstey, 2016; Classen et al., 2011; Oxley & Whelan, 2008; Wieland, 2013). Authors note that forward-thinking countries have adopted a Safe System approach or Vision Zero strategies, moving away from car dependency and implementing heightened safety measures to promote the safe mobility of the most vulnerable road users: older adults (and children) as pedestrians. Oxley and Whelan (2008) specifically highlight the transportation inequity of older women, the financially disadvantaged, and those living in less-dense areas.

The main findings in this section indicate a growing desire for the gerontology community and other allied health sectors to provide more leadership and to advocate for priority attention for aging-mobility research in policy development. The authors call for the formation of collaborative, inter-disciplinary teams in order to stimulate more complex research and inclusive policy that incorporates an integrated mobility approach to community-based implementation. In order for rapid implementation to take place, there is a need to build the body of evidence showing the effectiveness of interventions and programs that prolong the outdoor mobility of older adults. To do so, it is suggested that standard research measures be developed. The authors also call for professional development in the aging-mobility sector, particularly in older-adult-mobility counselling, health-promotion program management, and leadership-skills training. This professional capacity development also needs to translate into supporting the advocacy skills for

older adults. Lastly, the authors identify the need to advocate for more funding and resources for infrastructure upgrades that achieve the following ends: prioritize active transportation and transit use; remove barriers and create incentives to advance walkable neighbourhood design and the Complete Streets concept; and move towards a Safe System approach and Vision Zero strategy in order to counteract the overriding car culture in North America. Table 3.7 summarizes the main recommendation areas that were found in the results, by author. The next section details an environmental scan of government documents related to strategies.

Table 3.7. Summary of Findings: Recommendation Areas From the Policy-Research Agenda Development Reports

Recommendation Areas From the Policy-Research Agenda Development Reports						
Need for inter-disciplinary aging-mobility research, and a larger evidence base of interventions	Need for professional development and leadership/advocacy development	Need for equitable road safety strategies	Need for urban design improvements	Need for more transportation alternatives that integrate walking, cycling and MAT-use	Create incentives (remove barriers) for access to “shared” transportation services	Need for effective promotion of health behaviours and alternative transportation options
<i>Anstey, 2016; Ball et al., 2013; Classen et al., 2011; DiStefano et al., 2012; Eberhard et al., 2006; Lehning, 2011; Oxley & Whelan, 2008; Satariano, 2007; Silverstein, 2012; Staplin & Freund, 2013; Webber et al., 2010; Wieland, 2013.</i>	<i>Andersen et al., 2014; Anstey, 2016; Ball et al. 2013; Classen, 2010; Dickerson et al., 2007; DiStefano, 2012; Lehning, 2011; Silverstein et al., 2007; Silverstein, 2012; Songer, et al., 2009; Unsworth, 2012; Webber et al., 2010; Wieland, 2013</i>	<i>Andersen et al., 2013; Anstey, 2016; Classen, 2010; Classen et al., 2011; DiStefano et al., 2012; Oxley & Whelan, 2008; Satariano, 2007; Staplin & Freund, 2013; Wieland, 2013</i>	<i>Classen, 2010; Classen et al., 2011; Freund and Vine, 2010; Lehning, 2011; Oxley & Whelan, 2008; Staplin and Freund, 2013</i>	<i>Andersen et al., 2014; Classen et al., 2011; Freund and Vine, 2010; Satariano, 2007; Staplin and Freund, 2013; Oxley, and Whelan, 2008.</i>	<i>Freund and Vine, 2010; Wieland, 2013</i>	<i>Anstey, 2016; DiStefano et al., 2012; Oxley, and Whelan, 2008.</i>

3.3.4. Industry Reports of Age Friendly Communities and Active Transportation Implementation

This section details an environmental scan of government documents related to strategies for implementing age-friendly communities and active-transportation strategies for older adults. This section will also describe how age-friendly neighbourhood-advocacy programs are being developed through the use of community-based participatory research (CBPR) projects. In these CBPR projects, the use of tools for auditing the social and built environment is combined with health-promotion programs in order to encourage more neighbourhood-based active-transportation among older adults, particularly walking.

Industry reports of Age Friendly Communities, active transportation strategies for older adults

Nine industry reports were found that relate to setting implementation strategies for age-friendly communities and active-transportation for older adults. Google was used to perform an environmental scan for municipal, provincial, federal, and global documents related to age-friendly communities and active-transportation strategies focused on older adults. The results showed that, at the global level, world-governing bodies are beginning to publish guidebooks related to age-friendly cities (World Health Organization, 2007) and that, within a Canadian context, the federal government has published a companion guideline document (Public Health Agency of Canada, 2015). The government of British Columbia has also published a guidebook, (Ministry of Health, 2011), as has the City of Vancouver (City of Vancouver, 2013). While all of these publications set forth useful guidelines, none document an actual implementation strategy at the neighbourhood level. In contrast, the environmental scan for active-transportation strategies returned no published documents detailing the implementation of an active-transportation strategy for older adults. The United Nations Environment Programme has published a document entitled, “Global Outlook on Walking and Cycling” (UN-EP, 2016), but it does not specifically focus on older adults. Several complementary documents were found, such as, “Global Network for Safer Cities” (UN-Habitat, 2012), “Safer Cities and Safe Public Places for Women” (UN-Women, 2017), and the “Global Street Design Guide” (NACTO, 2017). At the federal level, a resource guide entitled, “Active Transportation in Canada” (Transport Canada, 2011), has been published, but it is also not specific to older adults.

Several intervention studies were found at the grassroots level that relate to older-adult-specific programs for encouraging neighbourhood-based walking. These studies will be discussed in the next section.

3.3.5. Enabling active living behavioural change via health promotion and advocacy programs

There is an emerging area of literature that combines quantitative built-environment audit tools and qualitative research techniques with advocacy capacity building by engaging older adults in community-based participatory research (CBPR) projects. This research format allows older adults to work both collaboratively as a group and directly with stakeholders to advocate for changes to the built environment that would ease their outdoor mobility. Five mixed method CBPR studies were identified in this literature review. The five identified studies are all program evaluations from the United States that review “Safe Routes for Seniors” programs that have been piloted in several regions, including New York, Florida, Georgia, and California. (Hooker, Ciril, & Wicks, 2007; Hooker, Ciril, & Geraghty, 2009; Transportation Alternatives, 2009; Shendell, Johnson, Sanders, et al., 2011; Perez, Garces, Hunter, & Marquez, 2015).

Safe Routes for Seniors is a health-promotion program for older adults that focuses on increasing active transportation, particularly instrumental and recreational walking. The program is a community-based participatory research (CBPR) project wherein older adults collaborate with community and municipal stakeholders to audit their neighbourhoods and advocate for the re-design of street-level features in order to gain confidence in their outdoor mobility abilities. As the findings of several studies note, older adults initiated the Safe Routes for Seniors program in response to the noticeably higher levels of pedestrian injury and casualty rates among their demographic. The programs tended to be patterned after the nationally funded Safe Routes to Schools program, which is operational in numerous schools across North America, including Canada. The Safe Routes for Seniors programs follow a multi-step process consisting of:

- 1) Inviting and training older adults to audit their neighbourhood walking routes using street-audit tools, GIS maps, Photo Voice, and other techniques (measuring wheels, stop watches, and speed tracking radar guns);
- 2) Hosting a stakeholder workshop to present audit findings, display photos / discuss built-environment facilitators and barriers, and collaborate with community and municipal stakeholders to form an action plan for prioritizing street-level engineering upgrades (i.e.

sidewalks and amenities, traffic calming measures, safe crossing measures) that will help older adults feel more confidence while walking in their neighbourhoods;

3) Creating walking maps that identify the Safe Routes connecting older adults to their desired community destinations (i.e. local shops, churches/places of worship, recreation centers);

4) Creating walking groups specifically for older adults.

All of the program evaluation literature provides excellent descriptions of the processes that were used and the outcomes that were achieved. As such, they provide a good blueprint for guiding community public-health professionals in setting their own Safe Routes program and selecting community stakeholders to partner with. For example, potentially good partners may include the Department of Transportation and Engineering, community-based organizations that serve seniors, the Department of Parks and Recreation, community law enforcement officials, local shop owners, elected officials, and other health-promotion non-profit organizations. The outcomes of these programs have been well documented, and they invariably show that significant outcomes can be achieved by engaging older adults throughout the project and training them how to work collaboratively with funding and policy stakeholders. Examples from the New York program include:

- 2,000 older adults engaged in street audits / neighbourhood design workshops;
- Pedestrian-safety improvements at 65 locations;
- The creation of three Safe Route maps;
- 13 walking groups formed.

The New York program ultimately became institutionalized through the adoption of the state-funded Safe Streets for Seniors program. The Safe Routes programs in Florida and California had similar outcomes, with the California program achieving self-sustainability by hosting annual health-promotion fairs. The New York program was replicated across nine neighbourhoods over a six-year timeframe.

The Safe Routes for Seniors program is a promising grassroots-level CBPR. It is a novel approach that encourages stakeholders to work collaboratively on pedestrian-friendly street-infrastructure upgrades in order to encourage older adults to engage in active lifestyles. The findings from the program evaluations indicate that these programs have been successful in the following ways: they are seniors-led initiatives; they have resulted in the implementation of pedestrian-safety infrastructure upgrades; Safe Route walking maps have been created;

walking groups have been formed and sustained; and some programs have become self-sustaining. Table 3.8 summarizes the common CBPR program components, while Table 3.9 provides a summary of the social-ecological domains for all three sub-categories of results presented in this section.

Table 3.8. Summary of Findings: Collaborative “Safe Route” Intervention Studies

CBPR “Safe Routes for Seniors” Program Components								
Author	Location	Older adult-led initiative?	Use of Safe Route to School Toolkit?	Neighbourhood built env’t audit tool?	Photovoice of perceived built env’t barriers and facilitators?	Other data collection methods used?	Creation of maps of safest walking routes?	Creation of walking groups?
Hooker, et al., 2007a, 2009b	California, USA	Yes	No	Yes	N/A	N/A	Yes	Yes
Transportation Alternatives, 2009	New York, USA	Yes	Yes	Yes	Yes	Measuring wheel, stop watch	Yes	Yes
Shendell et al., 2011	Georgia, USA	No	No	Yes	Yes	Measuring wheel, radar gun, traffic counter	No	No
Perez et al., 2015	Florida, USA	Yes	Yes	Yes	Yes	Google maps	Partial	No

Table 3.9. Literature Review Results for Transportation Planning and Policy Development by Social Ecological Domains

	Personal Health-Functioning Issues	Psychosocial Issues	Inter-personal Issues	Built Environment Issues	Policy-Regulatory issues
Transportation Planning & Benchmarking	<i>Choi & Dinitto, 2016; Dahan-Oliel et al., 2010; Frank et al., 2014; Lehning et al., 2011; O'Hern and Oxley, 2015; Winters et al., 2015.</i>	<i>Alliance for Walking and Biking, 2016; Behan & Lea, 2010; Choi & Dinitto, 2016; Dahan-Oliel et al., 2010; Frank et al., 2014; Lehning et al., 2011; Spinney, 2013; O'Hern and Oxley, 2015; Winters et al., 2015.</i>	<i>Choi & Dinitto, 2016; Winters et al., 2015.</i>	<i>Alliance for Walking and Biking, 2016; Behan & Lea, 2010; Dahan-Oliel et al., 2010; Frank et al., 2014; Lehning et al., 2011; Winters et al., 2015.</i>	<i>Alliance for Walking and Biking, 2016; Behan & Lea, 2010; Lehning et al., 2011.</i>
Policy Development	<i>Anstey et al, 2016; Ball et al, 2013; Classen et al., 2010; Dickerson et al., 2007; Distefano et al, 2012; ; Eberhard et al., 2006; Meyer and Janke, 2013; Oxley & Whelan, 2008; Ross et al., 2013; Rosso et al., 2011; Satariano et al., 2007; Silverstein, 2008; Silverstein, 2012; Staplin and Freund, 2013; Unsworth et al., 2012; Webber, 2011; Wieland, 2013.</i>	<i>Ball et al, 2013; Classen et al., 2010; Eberhard et al., 2006; Meyer and Janke, 2013; Oxley & Whelan, 2008; Webber, 2011.</i>	<i>Anderson et al, 2014; Ball et al, 2013; Classen et al., 2011; Silverstein, 2008; Silverstein, 2012; Songer, 2009; Unsworth et al., 2012; Webber, 2011.</i>	<i>Anderson et al, 2014; Anstey et al, 2016; Ball et al, 2013; Classen et al., 2011; Dickerson et al., 2007; Distefano et al, 2012; Meyer and Janke, 2013; Oxley & Whelan, 2008; Rosso et al., 2011; Satariano et al., 2007; Silverstein, 2012; Staplin and Freund, 2013; Webber, 2011; Wieland, 2013.</i>	<i>Anderson et al, 2014; Anstey et al, 2016; Ball et al, 2013; Classen, 2010; Classen et al., 2011; Eberhard et al., 2006; Dickerson et al., 2007; Distefano et al, 2012; Meyer and Janke, 2013; Oxley & Whelan, 2008; Ross et al., 2013; Rosso et al., 2011; Satariano et al., 2007; Silverstein, 2008; Silverstein, 2012; Songer, 2009; Staplin and Freund, 2013; Unsworth et al., 2012, Webber, 2011; Wieland, 2013.</i>

Literature Review Results for Transportation Planning and Policy Development by Social Ecological Domains (cont'd)

	Personal Health-Functioning Issues	Psychosocial Issues	Inter-personal Issues	Built Environment Issues	Policy-Regulatory issues
Industry Reports	<i>BC Ministry of Health, 2011; City of Vancouver, 2013; Public Health Agency of Canada, 2015; World Health Organization 2007.</i>	<i>Transport Canada, 2011; UN-Environment Programme, 2016; UN-Habitat 2012; UN-Women, 2016.</i>	<i>UN-Habitat 2012</i>	<i>BC Ministry of Health, 2011; City of Vancouver, 2013; National Association of City Transportation Officials, 2017; Public Health Agency of Canada, 2015; Transport Canada, 2011; UN-Environment Programme, 2016; UN-Habitat 2012; UN-Women, 2016; World Health Organization 2007.</i>	<i>BC Ministry of Health, 2011; City of Vancouver, 2013; National Association of City Transportation Officials, 2017; Public Health Agency of Canada, 2015; Transport Canada, 2011; UN-Environment Programme, 2016; UN-Habitat 2012; UN-Women, 2016; World Health Organization 2007.</i>

The distribution of studies in Table 3.9 shows that all of the studies on transportation planning/benchmarking focus on psychosocial issues, specifically on social-participation issues, as it relates to health-functioning and aging and effects of the built environment on active transportation. There is an evidence gap related to policy and inter-personal/stakeholder issues. The reports on policy –research agenda development are all focused on policy-regulatory issues as it relates to health-functioning decline and aging issues and how to address appropriate built-environment upgrades for older adults. There is less of a focus on psychosocial and inter-personal issues within these reports. Lastly, all of the industry reports focus on policy development as it relates to built-environment upgrades. Some of these reports address personal health functioning and psychosocial issues however very few have addressed inter-personal/stakeholder issues. The findings from this section also show that there are no studies that specifically relate to strategy development at the neighbourhood level for age-friendly communities or the promotion of active transportation for older adults.

The next section builds on this literature review by detailing a case study of an older adult in Vancouver, BC, using a newly developed social-built environment audit tool as she navigates a walkable neighbourhood in her motorized wheelchair.

Chapter 4. Case Study

4.1. Evaluation of a Walkable Neighbourhood for an Aging Population in Vancouver

This case study builds on the findings from the literature review by showcasing how well age-friendly features are currently being implemented “on the ground” in a designated walkable neighbourhood in the West End neighbourhood in Vancouver, Canada. The West End neighbourhood is known to have a high concentration of older adult residents, particularly living in residential apartment buildings; therefore it is a useful neighbourhood for observing how older adults interact with the social and built environments. Additionally, the City of Vancouver has recently retrofitted a corridor within the West End neighbourhood to be an active-transportation corridor. The active-transportation corridor, known as the Comox-Helmcken Greenway, was recently upgraded to include a dedicated cycling corridor on a traffic-calmed street. Additional pedestrian amenities, such as benches, street and sidewalk lighting and water fountains, were also included along the route (City of Vancouver, 2015). This neighbourhood also has a large section that is free from hills - a 6 block by 10 block radius - which provides a generous walkable area surrounded by mixed land use comprised of a density of community destinations, many apartment buildings and ample natural amenities such as parks, beaches and lush gardens.

The West End neighbourhood has been touted as an example of an ideal walkable neighbourhood with high levels of active-transportation infrastructure (Winters, Sims-Gould, Franke, and McKay, 2015) but it is unknown whether the destinations of choice for older adults, or the travel routes themselves, are able to accommodate the additional supports and accessibility requirements for older adults with mobility limitations, particularly for walker / wheelchair users. For instance, is there a dedicated para-transit parking spot in front of the bank or seniors centre? Is there a curb cut at the parking spot so older adults can comfortably navigate the walker or wheelchair onto the sidewalk? Can older adults with mobility difficulties safely cross the street to reach a store entrance? Is there a curb cut at the intersection or a ramp at the store entrance? These are a few of the built-environment facilitators and/or barriers that were mentioned by older adult respondents in the studies discussed in the literature review.

This case study looks for evidence that these built-environment upgrades have been planned with an aging population in mind. Specifically, this case study seeks to determine whether these upgrades will effectively encourage older adults to walk or wheel within their neighbourhood setting. To this end, the built-environment upgrades in the West End neighbourhood were evaluated for age-friendliness with regards to accessibility, safety and comfort of neighbourhood destinations, as well as the corresponding travel routes. A mixed method research methodology was used to 1) quantitatively capture the facilitators and barriers to outdoor mobility, and 2) qualitatively observe the social environment. The Stakeholders Walkability/Wheelability Audit in Neighbourhoods (SWAN) tool was used for the quantitative portion of this case study because it is designed to specifically be used by older adults, and it also allows the concerns and needs of older-adult-wheeled-MAT-users to be recorded. For the qualitative observation, the author visually observed an older adult in a motorized wheelchair manoeuvring throughout the West End neighbourhood with her grandchildren. The author followed behind the family, taking photos of the observed facilitators and barriers to their outdoor travel. The faces of all subjects were obscured in the photographs to protect their privacy. The older adult who was selected for the audit had recently moved to the West End and was living in an apartment building near Denman Street at the time of the study. The older adult was an ideal participant since she uses a wheelchair for her out-of-home mobility. Lastly, the case study concludes with a discussion of what is going well and areas in need of improvement in regards age-friendly strategy implementation within the neighbourhood. The next section will review the City of Vancouver's policies relating to its Age Friendly City strategy and active transportation.

Public Policy review

As was noted in the literature review, no actual strategy documents relating to active transportation or age-friendly strategy implementation at the neighbourhood were found. However, there are a few macro-level documents from the City of Vancouver that are relevant to this case study. One such document, the City of Vancouver's Transportation 2040 plan, presents a vision of a City that has "*healthy citizens who are mobile in a safe, accessible and vibrant city*" (City of Vancouver, 2012). The Transportation 2040 vision is a sub-set of the City's larger Healthy City Strategy: *A Healthy City is an Active City* (City of Vancouver, 2015). Over the past several years,

the City has invested heavily in transit and dedicated cycling lanes as a means to achieve its vision. Furthermore, traffic-calming measures have also been introduced in select neighbourhoods to enhance walkability. The City has concurrently drafted an Age-Friendly City plan (City of Vancouver, 2013) based on the World Health Organization's global Age-Friendly City guidebook (World Health Organization, 2007), which similarly aims to keep older adults active and engaged in their communities. To that end, the Vancouver Transportation 2040 plan has set a goal of "enabl(ing) people of all ages and abilities (AAA) to get to where they need to go, comfortably and safely" which is an important goal knowing that, demographically, the City's population is already aging (City of Vancouver, 2013).

The City of Vancouver's Healthy City Strategy and the Transportation 2040 strategies list numerous ways that active transportation can be promoted in the design of safer streets and street crossings. The Transportation 2040 action plan places heavy emphasis on improvements to the city's streets and sidewalks, with walking being positioned as the highest priority mode of transportation. The plan emphasizes safety, particularly as it relates to the most vulnerable, at-risk groups, such as children, seniors and people with mobility disabilities. In doing so, it advocates for engineering changes that support a vibrant public life and encourages walking and social connectedness via a built design that puts "eyes on the street," fosters feelings of safety and interest, and locates density and destinations close to public transit.

The City of Vancouver's Transportation 2040 plan and the Age Friendly City plan both place emphasis on improving the safety, accessibility and comfort of streets and street crossings, in addition to supporting a healthy, vibrant, socially connected city lifestyle. The SWAN audit tool is an appropriate instrument as it measures many of the above listed attributes by focusing on five aspects of the social-built environments:

- Street Functionality Domain:
- Street Safety Domain:
- Appearance and Maintenance Domain (Aesthetics):
- Land use and Supportive Features Domain (Destinations):
- Social Aspects Domain:

The next section details the streets that were audited using the SWAN tool. This is followed by the results of the SWAN audit.

Street Audit Sample: Selected Travel Routes and Destinations

A) Travel Routes

Eight streets within the West End were selected for the survey travel routes. In total, 78 street segments (city blocks) were included in the survey. The selected streets within the sample fall into three categories:

1) Commercial / Tourism Corridor: These corridors contain high foot traffic streets where the majority of the neighbourhood's local business establishments are located (i.e. banks, grocery stores, medical clinics, etc.) as well as social destinations of high interest to residents and visiting tourists, such as English Bay, Sunset Beach, Stanley Park.

Three streets were surveyed within the Commercial-Tourism Corridor:

- Davie Street: 9 segments (blocks) were selected for environmental audit
- Denman Street: 8 segments were selected for environmental audit
- Beach Avenue: 14 segments were selected for environmental audit

2) Active Transportation Corridors: These corridors contain traffic-calmed streets that prioritize cycling and walking. Traffic calming measures included: one-way streets, traffic diverters, raised crosswalks and speed reduction to 30 km/hr.

Three (3) streets were surveyed within the Active Transportation Corridor:

- Bute Street: 11 segments were selected for environmental audit
- Broughton Street: 10 segments were selected for environmental audit
- Comox Street: 8 segments were selected for environmental audit

3) Residential Corridors: These corridors contain primarily residential dwellings, particularly apartment buildings.

Two (2) streets were surveyed within the Residential Corridor:

- Haro Street: 9 segments were selected for environmental audit
- Barclay Street: 9 segments were selected for environmental audit

B) Community Destinations

Several community destinations of interest to older adults were also identified. Many of these destinations are located along the selected travel routes, falling within the following categories:

- Seniors housing buildings: (3) Haro Park Centre, which includes independent living, assisted living and residential care.
- Seniors recreation centre: (5) Barclay Manor, Gordon Neighbourhood House, West End Community Centre, West End Aquatic Centre (swimming pool), Joe Fortes Library
- Community services: (5) Qmunity Community Services, West End Seniors Network, West End Community Policing Centre, West End Fire Hall, Mole Hill Community Housing
- Places of Worship: (3) Guardian Angels Catholic Parish, St. Paul's Anglican Church, St. Andrew's Wesley United Church
- Community gardens, playgrounds, parks: (6) Nelson Park, Lord Roberts Elementary School, Bute Street Mini-Park / Plaza, Roedde House Museum, Broughton Street Mini-Park, Morton Park
- Beach amenities: (3) Sunset Beach, English Bay restaurant, Beach Cafe
- Shopping Mall: (1) Denman Place Shopping Mall
- Grocery stores: (3) Safeway, No Frills, independent fruit/vegetable stands
- Medical services, pharmacy: (4) St. Paul's Hospital, Shoppers Drug Mart, London Drugs, Medical Clinics
- Financial services: (4) Bank of Montreal, Royal Bank, Vancity, HSBC

The two maps below identify the West End neighbourhood under study, as well as the selected travel routes and community destinations.

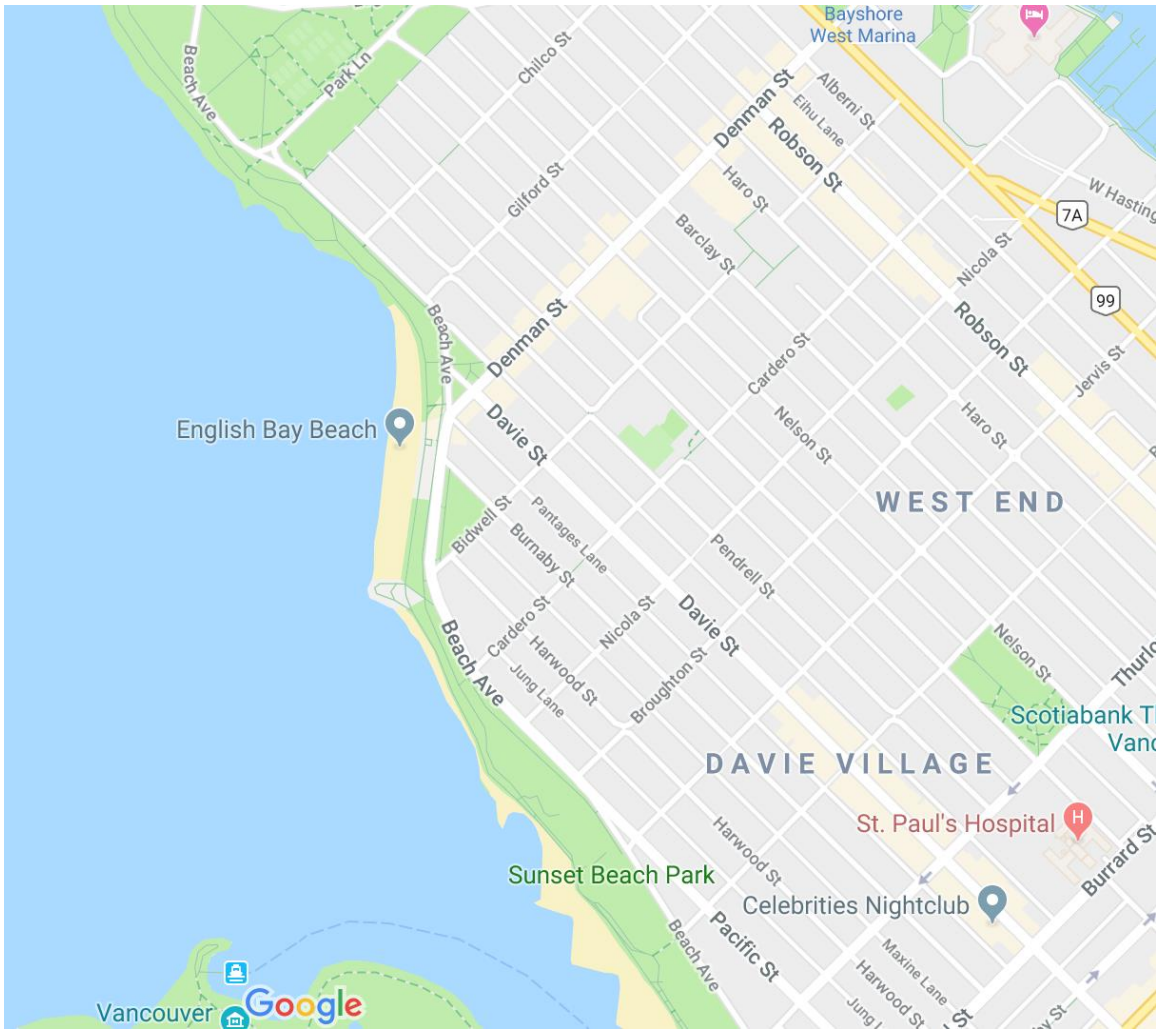


Figure 4.1. Map of the West End neighbourhood, Vancouver, BC.

Sample Selection: 8 West End Streets

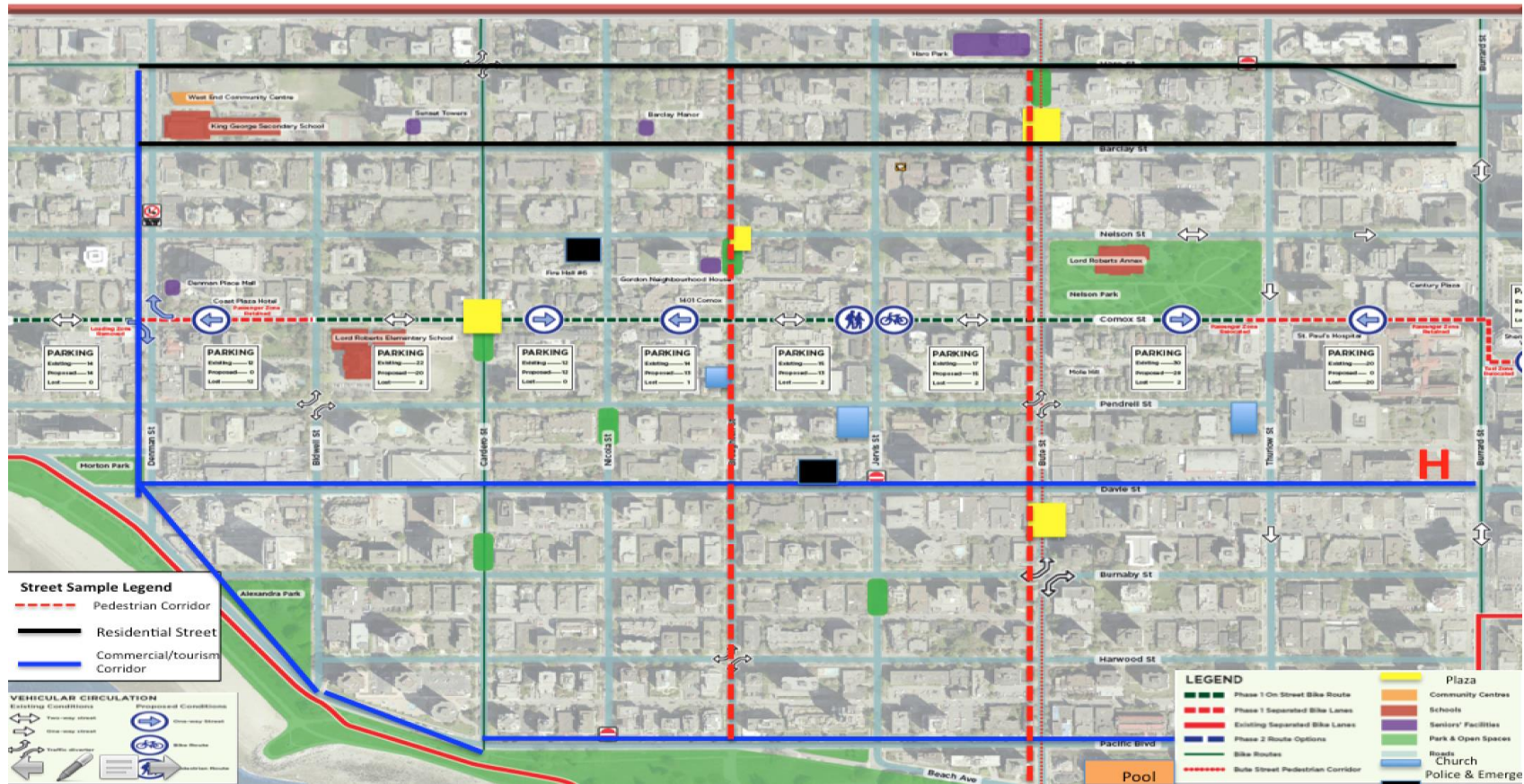


Figure 4.2. Map of street segments to be surveyed

Results of the Audit:

Part 1) Results of the qualitative observation: Martha and her grandchildren go shopping on Denman Street

The first part of this case study was the researcher's observation of the participant - a grandmother - who takes her grandchildren shopping on Denman Street on a Saturday afternoon. "Martha" (not her real name) was observed qualitatively through the use of photographs. The researcher walked behind Martha and her grandchildren and observed their travel patterns and how the social-built environment facilitated or created a barrier to their walkability and wheelability. The family walked seven blocks of Denman Street, from Pacific Boulevard at English Bay, then walked north to Robson Street, a major shopping corridor.

a) Walkability/wheelability facilitators: beautiful surroundings, variety of destinations to visit, shop & eat

It was a sunny spring day. Martha and her grandchildren appeared to be having fun within the bustle of Denman Street, window-shopping, people watching, and enjoying the sights. These vibrant aspects of the neighbourhood are what draw people to the West End, particularly the popular commercial and tourist corridors. The children had fun stopping for a treat at the coffee shop and playing at the Laughing Guys sculpture.



View of Denman Street Commercial Corridor



Playing at the Laughing Guys



A nice coffee shop to have a snack



Green space at English Bay

b) Walkability/wheelability barriers: incomplete safe crossings; broken sidewalks

A few common barriers to walkability/wheelability were observed with Martha and her grandchildren.

i) Broken, narrow sidewalks; no safe buffers in laneways

Broken and narrow sidewalks proved to be a challenge for the family; it was difficult for Martha to have a conversation with her grandchildren while walking on Denman Street, since the sidewalks were narrow and filled with sandwich boards. This forced one grandchild to walk behind and the other grandchild had to walk among the broken sidewalk and tree roots. It was not possible for other pedestrians to pass at the same time. At one point, the group crossed a laneway with a large delivery truck protruding into the sidewalk area. The younger

granddaughter was left behind and Martha appeared concerned when she noticed her granddaughter was far behind her, with the truck posing a risk to her safety.



Exposed tree roots



Sidewalk clutter, exposed tree roots



Unsafe crossing at lane



Inaccessible shop, Denman and Robson

ii) Incomplete curb cuts; unmarked crossings lead to confusion; bus stops hard to find; lack of supportive amenities

Another barrier for Martha was the incomplete curb cuts. The safety risk became apparent to Martha when she had to negotiate a curb cut that lead her into the centre of the intersection, rather than straight across the street. In such situations, it was also uncomfortable for her; the wheelchair would make a 'crunching' sound when the curb cut was old and less smooth compared to the new curb cuts that were more level and eased the wheelchair down into the street.

Additionally, the new active transportation intersection crossing at Comox St. and Denman St. proved very confusing for Martha and her grandchildren. It was not clearly understood where pedestrians are to cross, or if they are to cross at all on the east side of the intersection. It appears to be a cyclist priority intersection as the primary paint on the asphalt is bright green to signify that cyclists are using the intersection. Pedestrian markings are minimal. No zebra stripes for the pedestrian crossing were visible. The same observation was made when Martha attempted to cross the pedestrian plaza at Pendrell and Bidwell; it was not clear where pedestrians are to cross and where cyclists have priority. There were no pedestrian crossing markings at all. Lastly, Beach Avenue and Denman Street intersections were very confusing and frustrating for Martha. She wanted to take her grandchildren to lunch at the Cactus Club restaurant on the beach-side of the intersection, but there was no safe crossing to get there. The actual safe crossing intersection is further away from the destination and after trying twice to find a crossing, Martha became frustrated and abandoned the idea altogether. The children wanted to go down to the beach but it was not clear to Martha if she would be able to join them down in the sand area so they did not go. There were no other play areas to take the children to, so they went back to Denman Street. Back on Denman Street, bus stops were observed to be lacking amenities and many bus stops were difficult to locate because there was no bus shelter to identify the bus stop.



Uneven curb cut, Denman St



Dangerous sidewalk edging, Denman St



Incomplete curb cut



Confusing intersection markings



Confusing street crossing



Bus stop with incomplete amenities



Beach Avenue - Burnaby St. - Inaccessible Cactus Club Restaurant



Beach Ave.-English Bay: no wheelchair access to sand and water, no play area for kids



Pendrell and Bidwell traffic diversion intersection: Lack of marked pedestrian crossing

Overall, the shopping excursion for Martha and her grandchildren was an enjoyable afternoon among a vibrant commercial corridor as well as surrounded by beautiful green spaces and natural landscapes. However, from an age-friendly viewpoint, more dedicated resources needs to go into this area to increase an older adult's sense of safety and security from vehicular and cyclist traffic. From a comfort viewpoint, the narrow sidewalks are in need of upgrading so that older adults with companions can walk side-by-side, rather than single-file as is currently the pedestrian experience on Denman Street. Way-finding also needs to be improved with clearly marked zebra-striped painted street crossings, pedestrian signage and walk lights. At intersections that are also cyclist crossings, it would also be helpful to add a zebra-striped painted crossing next to the bright green cyclist crossing so that the pedestrian and cyclist crossing areas are clearly delineated. The same way-finding is needed at street crossing intersections on traffic diversion streets: clearly delineated pedestrian and cycling crossing areas are needed. From an accessibility viewpoint, there are a few areas within the commercial corridor that still have stairs at entryways, or lack of curb cuts, making it impossible for wheelchair users to access those establishments. Inter-generational spaces are also needed in this area.

The next phase of the case study involved a full social-built environment street audit of 78 city blocks (segments) within the West End neighbourhood using the SWAN audit tool.

Part 2) Results of the SWAN environmental audit of the West End neighbourhood social-built environment infrastructure

In this second phase of the case study, the researcher audited the street segments from a wheelability point of view, based on the experiences of following Martha along Denman Street. In the interest of time, the researcher conducted this phase of the case study without Martha. To review, the SWAN tool contains five domains of the social-built environment to audit for age-friendliness:

1. Street Functionality Domain;
2. Street Safety Domain;
3. Appearance and Maintenance Domain (Aesthetics);
4. Land use and Supportive Features Domain (Destinations);
5. Social Aspects Domain.

A summary of the results of the 78 audited street segments is below. Summarized graphs for each domain are found in Appendix B.

Domain 1: Street Functionality

Domain 1a): Functionality of the Street Crossings -Intersection Markings

The first domain, Street Functionality, contains four sub-categories: intersection markings; curb cuts; sidewalks (smooth, unobstructed); and signage & way finding. The results of the functionality domain for intersection markings show that only 4% of street crossings within the West End neighbourhood contain well-marked zebra-painted crosswalks, while 42% of intersections contain a pedestrian walk light. Twenty percent of the intersections contained a crosswalk marked on one-side, while fully 77% of the intersections contained minimal markings or none at all. Of the 42% of intersections that contained a pedestrian walk light, only 9% had been converted to a walk countdown timer of 10 seconds. These countdown timers were found on the high-traffic corridors, along Burrard Street, Davie Street and Thurlow Street. No intersections had yet to be converted to a 25 second countdown timer to accommodate slower walking speeds.

In the high foot-traffic corridors, only one intersection was found to have full crosswalk markings on all four sides: the popular intersection at Bute and Davie. The Bute-Davie

intersection crosswalk has been painted in the well-known LGBT rainbow colours, to visually signify that this intersection is a Place of significance and Pride for the West End community. It is also a very active pedestrian corridor, adjacent to a pedestrian plaza and close to Qmunity Community Services and the Nelson Park-Community Garden. The only other intersection to have full crosswalk markings on all four sides was found at a traffic circle intersection at Nelson-Jervis Street.

Domain 1b): Functionality of the Street Crossings - Intersection Curb Cuts

Twenty-four percent of intersections contained age-friendly curb cuts on all four sides of the intersection. Twenty eight percent of intersections also contained warning markings for the visually impaired, on all four sides. All other intersections had at least one side with a curb cut. Conversely, 50% of intersections had warning markings that were incomplete and 22% had no warning markings at all.

Domain 1c) Functionality of the Sidewalks: smooth, free of obstacles

The majority of sidewalks were reported as smooth and level (78%), with no obstacles present. This was particularly true for the active transportation corridors and the residential streets. However for the high traffic areas, specifically Davie Street and Denman Street, the majority of sidewalk segments are in need of repair. Nearly all sidewalk segments within both of the Business Improvement Areas (BIA) on Davie St. and Denman St. were broken, posing tripping hazards to older adult pedestrians and difficult to manoeuvre for those using a walker or wheelchair. Comparatively, the sidewalks on the tourism corridor at Beach Avenue did not have broken sidewalks; they were smooth and level and easy for pedestrians to use.

These BIA streets were also observed to host a lot of sidewalk clutter, specifically involving “sandwich board” advertising signs. In some segments the bus stop shelters were awkwardly placed within the sidewalk. On Denman Street, when bike racks were in full use, the bikes would extend onto the sidewalk, further making it difficult to manoeuvre through the corridor. These obstruction issues were primarily due to the fact that these BIA sidewalks are quite narrow, not at the same commercial width that could be found on Burrard Street and Robson Street. The width of sidewalks in the West End BIA area was observed to be nearly the same width as the sidewalks on the adjacent residential streets.

Domain 1d): Signage and Way-finding

Way-finding signs related to City and tourist information were mostly found within the commercial and tourism corridors, at 30% of those street segments. It was rare to find a way-finding sign within the active transportation and residential street corridors. Conversely, road signs related to posted speed, school zones, cycling routes, pedestrian crosswalk signs, etc. were plentiful within both the commercial-tourism corridors and the active transportation corridors, at 70% of street segments. At community destinations, very few locations had accessibility parking signs or taxi-passenger drop off parking signs. No HandyDart parking signs could be found at any destinations or along commercial-tourism corridors. Signage indicating Safe Places was only found at two locations – the Community Policing Centre on Davie Street and one residential apartment building on Bute Street. Community event signs were found at the two mini-park locations at Bute-Haro and at Broughton-Barclay.

Domain 2: Street Safety

Domain 2a): Traffic Safety

The second SWAN domain, Street Safety, has two sub-categories: safety from traffic and personal safety. For the first sub-category, traffic safety, the audit identifies speed and access control measures implemented within the active transportation and residential street corridors. The results show that several segments within the West End are effective in terms of slowing down the speed of cars within these areas. Speed control measures (speed reduced to 30 km/hr., speed humps, traffic circles, raised crosswalks) were observed in 31% of the active transportation street segments and 16% of residential street segments. Access control measures (one way streets, traffic diverters) were similarly in place in 32% of active transportation segments and 16% of residential street segments. No speeding cars were observed within those corridors, nor were speeding cars observed on the commercial corridors.

However, in the tourism corridor, even though speed is reduced to park zone speeds of 30 km/hr. along the entire corridor, and posted speed limit signs were observed on 20% of the street segments, many of the observed vehicles appeared to be travelling well over the posted park zone speed limit. At the Beach Avenue – Cardero intersection, where the intersection is minimally marked and no walk light is present, several vehicles were observed to be speeding and subsequently not stopping for a waiting pedestrian.

In terms of cyclists, there were not many incidents observed of speeding cyclists or cyclists on sidewalks, with these behaviours observed on only 4% of the overall street segments. Cyclists on sidewalks were observed on two occasions near the Denman and Davie Street intersection. Speeding cyclists were observed heading west on Comox Street, close to the school zone at Bidwell and Cardero intersections. It is noted that the road slopes downward, heading west from Broughton onwards, therefore cyclists can easily pick up speed when cycling westbound.

Domain 2b): Personal Safety

In terms of personal safety measures, the majority of all street segments contained a “safe buffer” between sidewalks and vehicles, through the use of a grass divider. A few unsafe areas were identified, however. On the north side of Beach Avenue segments, particularly where Beach Avenue intersects with Denman Street and Bidwell Street, the sidewalk is very narrow. There is no safe crossing to English Bay in this area and no safe buffer between the sidewalk and oncoming vehicles.

Other aspects of the personal safety domain include street lighting, sidewalk lighting and street cleanliness. Ample street lighting was found at all street segments. Sidewalk lighting, unfortunately, was harder to find. Denman Street has sidewalk lighting incorporated onto their street lampposts. Otherwise, sidewalk lighting was sporadic. Broken glass was observed at two locations in the Commercial Corridor, both on Denman Street and on Davie Street. In both incidences, the broken glass was found close to a liquor store. There were no observations of suspicious people, however a few homeless people were observed. This is a common part of urban life in Vancouver and is not deemed dangerous or suspicious in the majority of cases, but sometimes their presence can make some people feel uneasy.

Domain 3: Appearance and Maintenance

The third domain measures the social perception of the overall appearance and maintenance of the area. The West End was found to be a very clean and beautifully maintained neighbourhood. It was rare to find trash lying around. Buildings and houses were very well maintained. Plants, flowers, shrubbery and trees are plentiful, both in commercial areas and on individual streets, including laneways and corner bulges. The mixture of heritage houses scattered among apartment towers oozes charm and makes for a very pleasant walking experience. Public art is emerging in certain pockets of the neighbourhood. Street art was

found on the road intersection at Davie and Bute St, together with wall murals on commercial establishments and murals on the BC Hydro boxes, which all help to create a fun atmosphere. Sculptures were also found at a few locations on Bute Street, Comox Street and Denman Street. While the West End beautification efforts create an overall positive effect, one street in particular, Denman Street, is starting to feel tired and worn down, and seems to be in need of refurbishment. An empty lot was observed, however a new building had just completed next door to it. A few commercial establishments on Denman Street, close to the Robson intersection, were very old buildings that did not have an accessible entry to their shop. Alexandra Park at the Beach Ave. and Bidwell intersection was also looking in need of some extra attention and beautification.

Domain 4: Land use and Supportive Features

Domain 4a): Destinations and Land Use

The fourth SWAN domain, land use and supportive features, has two sub-categories: diversity of destinations and land use; and supportive street amenities. For the first sub-category, destinations and land use, the majority of shops and services are found along the Commercial Corridors. Many apartment buildings are also present in this neighbourhood. In terms of diversity and density of destinations, both the Denman and Davie commercial corridors have a diverse mixture of shops that meet the daily needs of older adults, particularly drug stores, medical clinics, postal offices, grocery stores and lots of cafes and restaurants. Outdoor seating areas are also present on both Denman Street and Davie Street. Community destinations such as a community garden, Community community services, and West End Community Policing Centre can all be found on Davie Street, in the east geographical zone of the West End neighbourhood. To the west, Denman Street is home to the West End Community Centre and ice rink, and the Joe Fortes Library. Denman Street also has the West End Seniors Network located within the Denman Place shopping centre, although there is no sign outside to advertise this to seniors. A few community amenities can be found within the traffic calmed active transportation corridors, such as the Nelson Park community garden and farmer's market on Bute Street, which is co-located together with the Lord Roberts Elementary Annex School. Broughton Street has Barclay Manor and the Roedde Museum, which also has an office of the West End Seniors Network. Gordon Neighbourhood House is located a few blocks away on Broughton Street. Along the Comox greenway, St. Paul's Hospital can be found near Thurlow Street at the east end of the neighbourhood while Lord Roberts main elementary

school building is located at the western end of Comox, close to Denman Street, which is co-located with a pedestrian plaza and a small convenience store. There are also two Fire Halls within the active transportation corridor, one on Haro Street and the other on Nicola Street.

Unfortunately there are no bus stops located within the traffic-calmed corridors, even though accessible shuttle buses and mini-vans were observed driving within the area. No community shuttle buses could be seen within the traffic-calmed area. However a HandyDart bus was observed near St. Paul's Anglican Church, as well as a wheelchair taxi. Additionally, Haro Park Centre, a campus of care community, has their own accessible shuttle bus for their residents to use, with its own dedicated parking signage and corresponding curb cut at the roadside at the front entrance to the Centre. Public green spaces were primarily found along Beach Avenue, although at least one public green space was found at each end of the commercial corridor – the community garden at the corner of Davie and Burrard intersection which is at the east end of the neighbourhood, and the “Laughing Guys” sculptures are located at the Denman and Davie intersection at the west end of the neighbourhood. The West End neighbourhood is unique in the fact that several “mini parks” have been carved out in the traffic-calmed areas where street segments are permanently closed to vehicle traffic. Only two playgrounds were observed –at the two elementary school locations. While English Bay has a huge expanse of green space at road level, it is unfortunate that no playgrounds are present in the area. There are also no play areas in the Denman Street area or the surrounding parks, such as Alexandra Park.

Domain 4b) Supportive Street Amenities

For this second sub-category of domain 4, the audit identifies street amenities that offer extra support for older adults as they walk to destinations. Bus stop amenities were the most plentiful with 30% of bus stops along the commercial-tourism corridor having supportive amenities such as an accessible bench, rain cover and trashcan. Davie Street had the highest concentration of these amenities, followed by Beach Avenue, however only on one side of the street on Beach Avenue. Denman Street had significantly less bus stops with supports present. Very few water fountains were found; one was present at the Davie-Burrard intersection and one on Denman Street at the Community Centre-Library location. One public bathroom was present at the Davie-Bute intersection, however it was not accessible. An accessible public bathroom was present a few blocks away on Bute St. at Nelson Park, however there was no sign to notify pedestrians of its location. Along the active transportation corridor, one water

fountain was found along Comox at Cardero intersection. While there were no bus stops present within the active transportation corridor, benches have been placed at a few locations along the route, specifically at Nelson Park and at Cardero Street.

Domain 5: Social Aspects of the Neighbourhood

Domain 5: Social Aspects

The fifth domain measures subjective aspects of the social environment. The West End appears to be a friendly place. Many people were observed to be friendly among one another, whether on the commercial corridors or on the active transportation routes, especially the pedestrian-only corridors and the mini-parks. The residential streets also appeared to be friendly, although less people were present walking on these long, residential streets compared to the pedestrian corridor streets. In terms of social gathering spots, the commercial corridors had the most number of cafes, coffee shops and restaurants, and many of these establishments had outdoor seating areas. The mini-parks and larger community parks were observed to have ample benches to encourage people to socialize outdoors. Beach Avenue did not have as many friendly people present but this is mostly due to the fact that the actual beach area is not visible from the roadside. As mentioned previously, the green space along Beach Avenue is lacking in terms of social gathering amenities that would attract those looking for a break from the sand and the sun.

In terms of inter-generational spaces such as playgrounds, they could only be found at the school grounds. The community centre and library are also known to offer additional indoor play spaces. For larger social events, English Bay is a well-known area for large outdoor entertainment events. The Bute-Davie intersection is also known to hold smaller scale community events and is in the process of becoming of a permanent pedestrian plaza. Nelson Park is home to a dog park, community garden and farmers market.

In terms of ways to advertise upcoming community events, two bulletin boards were identified in the mini-parks. The bulletin boards held many posters advertising community events and services appropriate for local neighbours. Otherwise, the City's way finding boards are located at key intersections along the commercial corridors but none could be found within the active transportation corridors.

Detailed graphs of the results of each domain can be found in Appendix B.

4.2. Discussion of the Case Study Results

a) Observed strengths of the West End neighbourhood's age-friendliness:

The results of the SWAN environmental audit, together with the social observations of Martha and her grandchildren, and the overall observation of pedestrian flow, revealed many areas where the West End neighbourhood is already well positioned for age-friendliness. The domains related to density of destinations/ mixed land use, social environment, and appearance-maintenance all had very high diversity and accessibility scores. Taken together, these domains show that the West End's built, social, and natural environments are working well for encouraging older adults to maintain independent outdoor mobility. Interesting and vibrant attractions and diversity of destinations provide older adults with good reasons to go outside. Indeed, an outdoor environment that is lush with greenery, beautiful flowers, seasonal colours, and singing birds, combined with the sounds of playing children and the presence of outdoor entertainment, interesting shops and places to visit with family and friends, all proved to be effective at enticing older adults to get outside and walk around the West End neighbourhood. This was evidenced by high number of older adults who were observed walking along commercial, tourist, and residential pedestrian corridors in the traffic-calmed areas. The West End is also home to several pocket parks that have been created using traffic diverters and one-way streets, as well as mini-parks next to elementary schools and ground-level shops in walk-up apartment buildings. It was observed that these traffic-calmed mini parks were popular walking corridors for older adults.

However, fewer older adults were observed walking along the residential side of the street along the Beach Avenue beach corridor. One possible reason for this discrepancy may be that these streets and corridors are very long east-west corridors that do not feature many destinations or amenities. Rather, the destinations are only located at either end of the route, at Denman Street and Thurlow-Burrard Streets. Similarly, very few people were observed walking along the new Comox active-transportation corridor. Like the Beach Avenue corridor, the Comox active-transportation corridor is a very long east-west corridor without many interesting destinations or amenities. Conversely, the Davie Street corridor, which also runs the same east-west distance, was full of people of all ages due to its variety of destinations and shops and its vibrant atmosphere.

A second possible reason why so few older adults were observed walking along these long east-west routes may be the lack of transit stops. Although accessible para-transit (HandyDart), taxis, and health-sector-owned shuttle buses were all observed travelling within the traffic-calmed area, there were no designated bus stops or passenger drop off parking spots at any of the observed community destinations. The one exception to this trend was at Haro Park Centre, which is a long-term care building on Haro Street. Furthermore, no Translink community shuttle buses were observed in the traffic-calmed areas. For older adults who cannot walk far outside due to mobility difficulties, it is important to ensure that smaller accessible shuttle buses are able to easily stop and park at community destinations of interest, as this will help these destinations remain inclusive of this cohort of individuals.

b) Areas in need of improvement within the West End

i) Safety: Built Environment -- sidewalks and safe crossings

The safety domain requires improvement in the West End. With the exception of well-maintained buildings, the overall safety domain scored very low. The busiest areas for pedestrian flow, the commercial corridors, had the highest score for broken sidewalks. Sidewalk lighting was also very difficult to find, with none being observed in high-traffic areas outside of Denman Street. Most surprisingly, there were no sidewalk lights along the Beach Avenue tourism corridor. A similar trend was observed along the traffic-calmed streets, with sidewalk lights rarely being observed along these routes as well. This is concerning because dark areas are a safety risk for falls, and it has been well documented that falls among older adults can be devastating to their health and costly for the healthcare system (Public Health Agency of Canada, 2010). The majority of the SWAN audit fieldwork took place during the months of January and February, which are winter months in Vancouver that are known for dark, rainy days. The presence of slippery sidewalks and the absence of adequate sidewalk lighting can be perceived as a barrier for older adults with mobility limitations.

In terms of safe street crossings, only two intersections were observed to have fully marked crosswalks on all four sides, with the majority featuring minimal markings or none at all. Only one-third of intersections had pedestrian walk lights, and none had yet to be equipped with a 25 second countdown timer, which is the suitable allotment for pedestrians who need more time to complete their crossing. Additionally, the majority of intersections had incomplete curb cuts, and a similar number had incomplete intersection markings for the visually impaired. It was

evident that Martha was frustrated by the lack of curb cuts, as they forced her to find an alternate route to her destination or to abandon the destination altogether. Likewise, curb cuts that had only been made into the centre of the intersection appeared to pose a safety risk because the curb let down placed Martha directly into the path of turning vehicles.

ii) **Safety – Speed of oncoming traffic**

The second area of the West End's safety domain requiring improvement relates to the speed of oncoming vehicles. More pedestrians of all ages were observed along traffic-calmed streets that were also speed controlled. Pedestrian observations were completed at three different times: a weekday morning in February; a Saturday afternoon in March; and a Sunday evening in March. At all three observations a high number of pedestrians of all ages and abilities were observed walking along the traffic-calmed streets, particularly along the Bute Street pedestrian corridor. It was rare to see a speeding car in the West End's traffic-calmed area; even taxi drivers were observed to be obeying the 30 km/hr. speed limit and regularly yielding the right of way to pedestrians at crosswalks.

Unfortunately, the same traffic behaviour was not observed on Beach Avenue, despite the entire corridor being designated a park zone with a speed limit of 30 km/hr. Speeding cars were the norm on this stretch, and pedestrians were frequently observed waiting to cross the street with vehicles failing to yield to their presence. Very few marked crosswalks and pedestrian walk lights were observed along the Beach Avenue corridor, even at the pedestrian corridor intersections of Bute Street and Broughton Street. In addition, there are no traffic lights east of Cardero Street, even though Beach Avenue is lined with residential apartment towers and the popular Aquatic Centre is located near the corner of Beach Avenue and Bute Street. Given the lack of adequate speed control and safe crossings, it is not surprising that vehicles do not adhere to the speed limit and that pedestrian foot traffic in this area is much lower than in the area west of Cardero Street.

iii) **Supportive amenities: Built Environment supports for older adults with disabilities**

The third area in need of improvement is the West End's supportive amenities. Transit amenities were generally well observed within the commercial and tourist corridors. Most bus stops along both sides of Davie Street featured accessible benches and rain covers, and they were colourfully painted to make them more visible from afar. Unfortunately, these supportive

amenities were not complete along the other commercial and tourist corridors of Denman Street and Beach Avenue. Martha had difficulty locating the bus stops on Denman Street because they did not have the large rain shelters over them, as was the case on all of Davie Street.

Furthermore, it was difficult to find an accessible bathroom or a water fountain. While many businesses and public establishments may allow the general public to use their facilities, a growing number of establishments keep their washroom doors locked or restrict their use to paying customers. This is problematic, as incontinence can be a very real barrier for older adults who wish to leave their home for any length of time. More prominent signage would be helpful in alleviating anxieties about whether an accessible public washroom is nearby.

iv) Activating the outdoor recreational spaces: the need for age-friendly and inter-generational recreational spaces

The last area in need of improvement within the West End is the relative lack of age-friendly and inter-generational spaces. Nelson Park is popular among a variety demographics due to its diverse offering of activities. Although the park is quite compact, spanning only one city block, it is home to an elementary school, two playgrounds, a community garden, a dog park, a pergola, and a grassy knoll for picnics and general lounging. Even at dusk, it was still possible to observe families with young children and several older adults enjoying the park. Two visually impaired men were observed crossing Bute; they appeared very relaxed and were engaged in a pleasant conversation as they crossed the intersection.

No other comparable inter-generational spaces were observed throughout the West End, despite the presence of a number of ample green spaces, such as at Alexandra Park and English Bay. Given the West End's dense population and high number of residential towers, more inter-generational spaces would help to encourage parents—and grandparents—to go outside and enjoy outdoor parks. The absence of interesting nearby amenities that can appeal to a range of age groups, such as playgrounds or parks, may lead families to stay inside or drive to destinations that are further away. At the same time, playgrounds can be upgraded to include age-friendly play equipment that is suitable for older adults, as this would allow them to get some exercise and have fun playing *with* their grandchildren instead of just being passive observers. The addition of community gardens in neighbourhood parks is another inter-generational activity that can create a social community of neighbourhood gardeners.

4.3. Recommendations to further advance the Age-Friendly Neighbourhood policy agenda (Vancouver)

This case study demonstrated that SWAN is an effective tool for tracking progress on Vancouver's Transportation 2040 and Age-Friendly action plans. The five audit domains of street/sidewalk functionality, safety, land use/destinations, appearance/maintenance, and social aspects paint a complete picture of what is going well and what needs more attention for age-friendly neighbourhoods to be achieved. Coupled with the qualitative story that emerged from the photographs of Martha and her grandchildren's interactions with the built and social environments, this case study research was able to produce rich data about facilitators and barriers to outdoor wheelability that can be used to make the "voices" of mobility-limited older adults more audible to decision makers. The case study findings also proved to be aligned with the literature review findings. The MAT-user studies that had findings related to the built environment facilitators and barriers to outdoor mobility found that defects in the safe, accessible street and sidewalk environments were the number one concern voiced by MAT-user respondents. This finding also matched the SWAN audit results and Martha's experience 'on the ground' around the West End neighbourhood.

The SWAN tool is not intended to be used by researchers; rather, it is intended as a tool that older adults and persons with mobility disability can use to audit their own neighbourhoods and subjectively rate their neighbourhood's age-friendliness. The case study methodology used in this project has the potential to be scaled up. The SWAN results from the West End, together with Martha's personal experience interacting with the social-built environment of the area, are useful inputs for future decision-making on accessibility priorities for older adults who live in that neighbourhood. For example, Martha could be trained to use the SWAN tool and she could participate in future research projects - together with other older-adult West End residents with and without mobility disability - using the SWAN tool to collect observational data, while also photographically documenting the routes and destinations that they frequent. This type of collaborative data gathering can provide opportunities for older adults to work with municipal stakeholders to advocate for changes in the built and social environments in their local areas. It also has the potential to foster the development of an age-friendly, active-transportation infrastructure network throughout different parts of a city. A community-based participant-research program, such as the Safe Routes for Seniors program, could also be an effective complement to the SWAN tool, and could be used as inputs to crafting an age-friendly, active-transportation implementation strategy for neighbourhoods.

Overall, the SWAN tool was effective in quantifying what the West End does well in terms of age-friendliness and highlighting areas that require improvement. The case study revealed that the West End already contains many age-friendly features and amenities that would motivate older adults to leave their homes and explore the neighbourhood. Heavy foot traffic was observed along the flat, pedestrian corridors that contained traffic-calmed streets (speed control and access control), pocket parks, quaint shops, and inter-generational destinations - proving that the West End is, indeed, a walkable neighbourhood. However, the SWAN audit and Martha's experience shows that the West End is not an ideal 'wheelable' neighbourhood at this time. The lack of standard implementation of curb cuts on all sides of the various intersections, in addition to the lack of standard implementation of zebra-striped marked crosswalks and no implementation of 25-second walk-light timers, all point to a lack of accessible, active transportation infrastructure that prioritizes the most vulnerable type of pedestrians – older adult MAT-users.

A second area in need of improvement is the implementation of wider sidewalks. The photo elicitation findings show that it is challenging for an older adult in a motorized wheelchair to travel with a companion (or, in this case, two companions). The West End's sidewalks are primarily built for "single-file" walking, which makes it difficult for a family to carry on a conversation while travelling to their destination. It was particularly surprising to see narrow sidewalks within the commercial and tourism areas, which have the highest volumes of foot traffic. Another significant observation related to the lack of pedestrian priority at the intersections of the active-transportation corridor. The cycling lanes were painted bright green on all sides of the intersection, but no striped pedestrian markings were present on any sides of the intersection. This caused confusion, as Martha wasn't sure whether she was allowed to cross at that intersection or if she needed to go to another location to do so. To truly be a pedestrian-priority route, zebra-striped crosswalks and clear signage is needed along active transportation corridors.

Lastly, the SWAN audit also identified facilitators and barriers to transit amenities within the West End neighbourhood. The findings showed that when transit amenities are clearly marked with identifying features (i.e. brightly coloured benches and rain covers) older adults are able to quickly and easily find the bus stops. This was distinctly observed when Martha travelled along Davie Street, which had these transit amenities vs. Denman Street, which hardly had any. Another finding was that community-based micro-transit options were only observed along the main commuter-transit corridor. No micro transit options were found within the

residential or active-transportation corridors. Linking this observation back to the literature review, the findings from the literature review indicated that many older adults of advanced age have difficulty walking beyond three to four city blocks. Therefore, to make transit more age-friendly within the West End neighbourhood, micro-transit shuttle buses are needed within the residential and active transportation corridors, with bus stops located at the many seniors-serving organizations and apartment buildings that are located in the area, as shown in the map in Figure 4.2. The literature review findings also revealed that hills are also a barrier to older adults' outdoor walkability and wheelability. The area between Beach Avenue and Davie Street is known to have steep hills. This is another area that is in need of a micro-transit shuttle bus, so that older adults can easily frequent the Aquatic Centre and the beach area, which are located at the bottom of the steep hill.

From a reflexive viewpoint, it should be noted that Martha is the author's mother. As such, the intimate nature of the author's relationship with the audit participant created a heightened sense of interest for the author. In regular everyday situations, the author would be traveling alongside Martha as a fellow family member, engaged in conversation while shopping. In this case study, travelling behind Martha was a new experience for the author. It was the first time where the author's singular objective was to observe the situations and street infrastructure that either made travel easy or challenging for Martha. Observing and sensing Martha's frustrations and fears due to inaccessibility and lack of safe pedestrian infrastructure elicited deep feelings of concern within the author, more so than she normally feels while being a shopping companion. Additionally, the author felt Martha's frustration that she could not find a suitable, or accessible, inter-generational space for the children to enjoy. For a city to be truly AAA (All Ages and Abilities) a diversity of destinations and activities are needed for all age groups, at all major destination areas. This SWAN audit and the case study's observation method are good teaching tools that can be used to increase stakeholders' and the general public's understanding of the barriers and sense of exclusion that people with disabilities – and children - contend with on a daily basis in our urban environments.

The next section will highlight areas for future research and policy development, and it will also offer some concluding thoughts based on the results of the literature review and the case study.

Chapter 5. Conclusion, Future Recommendations

5.1. Key findings and the strengths of this capstone

This capstone project provides a comprehensive synthesis of research on: a) older adult drivers and driving cessation; b) barriers and facilitators in the built and social environments that affect the outdoor mobility of mobility-limited older adults; and c) multiple modes of innovative community-based transportation.

The systematic literature review was conducted in order to 1) survey relevant literature from a broad range of disciplines, such as gerontology, occupational therapy, social work, health sciences, urban design, transportation planning, geography, as well as reputable industry and government sources; and 2) identify the critical issues raised in the literature regarding the outdoor mobility of older adults. The examination of how variables in the social and built environments affect the outdoor mobility of mobility-limited older adults provided a more robust understanding of how effective walkability/wheelability infrastructure and transportation options can be developed. As such, this study's findings have practical implications, as they can help inform and guide discussion among community stakeholders and city officials at planning sessions, forums and workshops aimed at creating more age-friendly, inclusive communities.

The literature synthesis revealed the existence of a sizeable number of publications on the topics of aging, outdoor mobility, and community-based transportation options. However, the research documented in these articles vary in their degrees of thoroughness and rigour. For instance, substantive literature was found in relation to the theme of driving. One reason for this may be because of North America's driving-centric culture. Furthermore, the majority of the current studies on older adult drivers and driving cessation were mostly longitudinal, with large sample sizes and multi-year follow-ups.

In terms of rigour, the research on older drivers and driving cessation produced several well-designed standard assessment measures that have been replicated in other studies. These include several measures that connect a person's health-functioning factors and social determinants of health to driving cessation. These measures, which were developed in the USA, have also been replicated in Canada and Australia. Measures of assessment are being developed that can quantify the number of older adults who are reducing how much they drive

and who may be trying out outdoor mobility alternatives, if available in their communities. Additionally, the literature relating to older adult drivers and driving cessation includes a sizeable body of qualitative studies that elucidate the processes involved in their decision to drive less and seek out other mobility options. The body of research in this area is further enhanced by the development of conceptual models and theory-based measures. In addition, these articles often include quotes from the participants of focus groups and interviews, which serves to share the “voices” of older adults. This type of rich data can be used to develop future communication materials and workshops related to driving transition and alternative-transportation preparedness.

The same cannot be said about the research available on alternative modes of transportation. Research related to the outdoor mobility of older adults and alternate transportation options is still in its early stages. Most of the available literature on this topic consists of cross-sectional studies that use small, purposive samples and descriptive results. The majority of these studies evaluate small, pilot implementations of interventions to establish a baseline regarding currently available options in North America for older adults who no longer drive or want to use active transportation. There is good news, however: the current research contributions relating to older adults and innovative modes of alternative transportation have shown promising results and can serve as a blueprint for setting a future research agenda involving larger sample sizes, longitudinal time frames, and multiple regions. One strength of this capstone project is that the literature search focused on the understudied cohort of older adults with disabilities and the various mobility supports they use to maintain their outdoor mobility. This review uses an integrative lens to link the literatures on aging, outdoor mobility, and disability, and it highlights the importance of community-based innovative transportation options that can promote access, independence, and well-being for mobility-limited older adults.

The literature review also revealed that some “younger” older adults are more open to transitioning to active means of outdoor mobility and seeking out supportive community-based transportation options. Research on driving cessation has found that this younger group of older adults, who are moving into the age cohort of 70 years and above, have begun to self-regulate their driving behaviour as their health and functioning issues become more salient. Linking the findings back to the theoretical frameworks guiding this project, when considered through the Person-Environment Fit model, it seems plausible that the shift to self-regulating driving behaviour may be due to the growth of the gulf between driving-environment-related challenges and the older adult’s ability to deal with them, both in terms of personal health and coping

capacity. The findings also indicate that the concurrence of advancing age and declining health and functionality increases the environmental press related to walkability/wheelability infrastructure in the pedestrian environment. That is, as individuals' age and their health and mobility decline, the traditionally designed streets and sidewalks in their local areas begin to become too challenging to navigate independently. Findings show that it is at this point that older adults either seek out public or alternative modes of transportation, or they curtail their outdoor mobility and risk becoming socially isolated, especially if they are living on their own. However, the findings also demonstrate that, if there are enough new and innovative community-based transportation options within their local areas, older adults will be open to learning more about them, learning how to use them, and giving them a try. Additionally, evaluations of innovative transportation interventions have shown that older adults who use these transportation modes also enjoy the social aspects of proactive transitioning. Older adults interviewed in these studies said that they had enjoyed the social benefits from attending driving-transition workshops with fellow peers, as well as from using community micro-transit and other community-based options, such as volunteer driver programs. These findings indicate that the Causal Model of Neighborhood Effects on Aging (Glass and Balfour, 2003) is an appropriate social-ecological framework when studying how the social- and built-environments affect the outdoor mobility of older adults who are experiencing a decline in health and functionality. However, the model does not identify disability as one of the "Exacerbators", thus, it is recommended that disability be added as an Exacerbator factor. Adding to this is the adapted version of Rosso et al.'s Disability Process Model (2011), which specifically refers to the built environment as a contributing factor to the ability gap experienced by people with mobility impairments in relation to challenges in the outdoor environment. Within their model, transportation systems are identified as features of the built environment. Based on this capstone's findings, it is recommended that various types of MATs be added to the model as components in the transportation system, as this would ensure that independent, accessible forms of transportation are also included in future studies that use this framework. Lastly, the literature review findings identified that, even with the provision of motorized MAT products, such as the motorized wheelchair intervention (May and Rugg, 2010), respondents still reported inaccessibility issues and feelings of exclusion from society. Therefore, it is recommended that the Causal Model of Neighborhood Effects on Aging (Glass and Balfour, 2003) also include macro-level factors such as what Bronfenbrenner (1979) refers to as the "attitudes and ideologies of the culture." Indeed, the findings of the literature review and the case study identified ableism and ageism as the primary cultural attitudes and ideologies that form societal

barriers to the systematic implementation of age-friendly, accessible upgrades to neighbourhood built environment infrastructure.

Regarding walkability, the literature on older, mobility-limited adults' walking behaviour is not as comprehensive as the corresponding driving-cessation research. More work is needed in this area in order to establish standard measures of assessment, as this will allow measures of walking capacity, sedentary behaviour, life space, and MAT-use to be used in conjunction with social- and built-environment audit tools. This would enable scaling-up to larger-size studies, as well as studies across geographic areas, which would enable the gathering of population-level data. Many of the existing studies were difficult to compare because they often used different measures for walking capacity, size of life space travelled, and type(s) of MATs used. For example, some studies measured the mobility of wheelchair users, but not that of other mobility device users, such as those using canes, walkers, or walking poles. Another example of this disparity related to measures for walking distance. Whereas some studies measured participants' ability to walk 300-400 meters, others measured their ability to walk a given number of city blocks. Moreover, depending on the study's country of origin, distances were variously measured in miles or kilometers. Furthermore, some studies measured sedentary behaviour in conjunction with MAT use, while others did not. However, many of the intervention studies show promising results and are therefore worthy of replication across regions, with standard measures, larger sample sizes, formal evaluation using a pre-post design, and the use of control groups.

Multi-method investigations into mobility and social- and built-environment accessibility for MAT users is a growing area of research that has spurred the creation of a number of multi-disciplinary conceptual frameworks and environmental-assessment tools. The results of these studies have the potential to generate a sufficient evidence base to help city planners and engineers prioritize upgrades to pedestrian infrastructure. To date, no research has linked the development of pedestrian infrastructure to transportation nodes and locations with a high density of destinations that are relevant to older adults.

There is also some progress in the area of policy development in relation to active transportation. Stakeholders are lobbying for active-living interventions that promote greater active-transportation alternatives in their communities. A scan of the grey literature also showed that global governing bodies and country-specific federal bodies have begun to craft policy guidelines for implementing age-friendly and active-transportation policies in a coordinated

manner. However, no policy documents could be found that relate to delivering age-friendly active-transportation strategies at the neighbourhood level. At the grass-roots level, community-based participatory research (CBPR) programs focusing on Safe Routes for Seniors have proven effective in terms of building mobility literacy, community capacity-building, and advocacy skills among older adults. Given the success that some of these programs have had in securing neighbourhood-based built-environment upgrades from their municipalities, these types of CBPR programs may be a potentially effective avenue for creating neighbourhood-based, age-friendly active-transportation implementation policies.

5.2. Recommendations for further research and policy

In order to move away from North American dependency on cars, population-health practitioners have focused on promoting healthy behaviours, particularly active living. The World Health Organization has defined health promotion as, “a process of enabling people to increase control over, and therefore, improve their health, with a focus on changing behaviour through interventions at the social and environmental (population) level, rather than at the individual level” (World Health Organization, 2008).

Likewise, Everett Rogers (1962) developed the Diffusion of Innovation framework to be a behavioural change model that focuses on supporting the spread (diffusion) of a new, desired behaviour, rather than giving attention to the “old” behaviour. Rogers’ model includes the early adopters of this innovative product or service as co-collaborators and co-developers by working with them to understand their needs, their way of life, and how they will use this new service or product. The Diffusion of Innovation framework emphasizes trial and error, piloting the innovation, and allowing for continuous improvement until the innovation is ready to be introduced to the mainstream public. Going forward, this framework should be used to promote and develop a variety of active-transportation options for the growing older adult population, especially those with mobility disabilities.

Findings from this review and case study can provide some preliminary guidance for future research and policy-development, including:

- The development of standard measures for evaluating mobility-limited older adults’ built and social environments will enable studies to be scaled up and replicated. Studies on these topics need to begin adopting longitudinal designs that use larger

sample sizes and multiple sites. In addition, program evaluations must become more robust. This will involve including a pre-post component and linking findings to long-term health and well-being impacts, as well as savings within the health care system.

- The development of standard design guidelines for safe, inclusive, and accessible outdoor environments for older adults.
- The tandem bike-wheelchair discussed in this review has shown some positive results. This points to the need for an innovation fund dedicated to bringing innovative products and solutions into the field of aging and community mobility, as this will facilitate effective pre-post trial research.
- There is a paucity of research on the group travel patterns of older adults with companions, families, and pets. The results from the small case study presented in Chapter 4 highlights the need for such research.
- Professional training needs assessment research and related training programs on the topic of aging-mobility competency, in addition to multi-modal competency including MATs, should be further developed.
- The development of an active transportation strategy for older adults and related national funding for a Safe Routes for Seniors program is needed. There needs to be a concurrent understanding that sustained funding for active-transportation infrastructure and related health-promotion programming must be a part of a multi-year program. The implementation strategy for this type of program must be planned all the way down to the neighbourhood-level
- Instilling cultural change via the development of a multi-media public awareness campaign related to aging and road safety is needed. Placing the “voices” of older adults front and centre in these campaigns are needed in order to shift attitudinal change within North American society towards pedestrians as the top priority road users.

From a Canadian perspective, the implementation of these community-mobility innovations will require the gerontology and allied health sectors to take a leadership role in setting a research, policy, and practice agenda for creating an active transportation strategy for

older adults, including the diffusion of community-based transportation programs to the neighbourhood level. Collective leadership is needed to encourage innovation funding, research and evaluation, and multi-sectoral collaboration and advocacy building among stakeholders and older adult communities.

5.3. Limitations of the study

While this systematic review is comprehensive, it is not exhaustive. The literature search was performed using search engines commonly used for gerontology and health-related publications. Therefore, this literature review may not contain articles that are exclusive to databases not included in this search. Future reviews on this topic could include searches of databases not used here or searches in other languages, such as French, Swedish, or Japanese.

Another limitation of this capstone is the very small sample size for the case study and the use of only one type of assistive device. In future studies, the case study could be scaled up to include multiple older adults with and without mobility disabilities. These types of user-led audits could be performed by multiple older adults using different models of assistive devices, such as walkers, scooters, or white canes, to gather data on a diversity of experiences, and to record their perceptions about mobility barriers and facilitators in the outdoor-mobility landscape. This type of collaborative research can provide sufficient data to create opportunities for older adults to work with other municipal stakeholders to advocate for changes in their built and social environments. As a result, this could potentially foster the development of age-friendly and active-transportation infrastructure throughout different parts of their cities.

5.4. Concluding Remarks

In total, the literature review identified 112 studies relating to the status of transportation and outdoor mobility for aging populations. The majority of the research focused on mature driving and older adults' transition to becoming non-drivers. While the body of research relating to the development, trial, and diffusion of alternative transportation methods is growing, less is known about best practices for active modes of transportation from a multi-modal perspective. Furthermore, more research into the impact of active transportation on the prolonged health and well-being of older adults, particularly from the perspective of those with mobility disabilities, would also be highly beneficial. As the Baby Boomers approach the age of 70, there has been a

renewed sense of urgency to mobilize resources and to invest in the collaborative diffusion of an active transportation strategy for older adults. This urgency is coupled by the fact that driving is now becoming a globalized instrumental activity around the world, as aging populations surge in some countries in conjunction with growing economic development, particularly in Asia.

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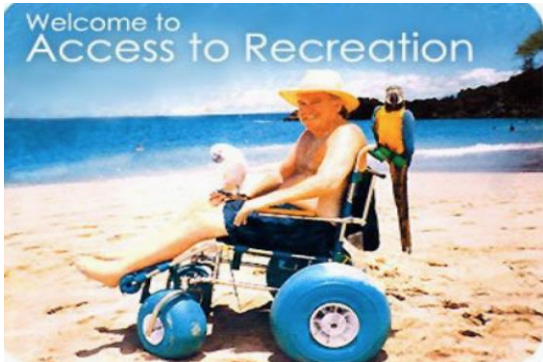
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Appendix A.

Examples of Accessible Micro Transit and Adapted Outdoor Mobility Devices for Older Adults







Appendix B.

Graphs From the Case Study

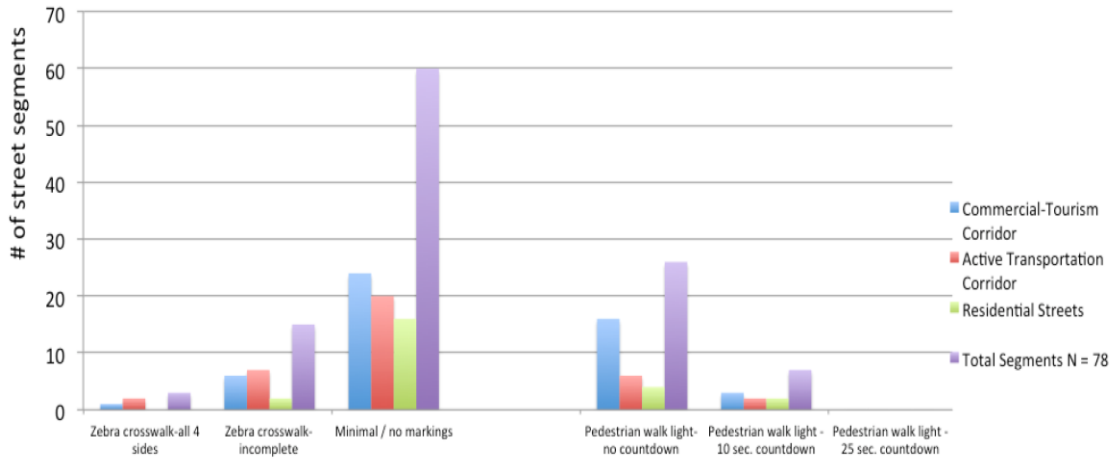


Figure B.1 Summary of Results: Functionality of Street Crossings-Intersection Markings & Walk Lights

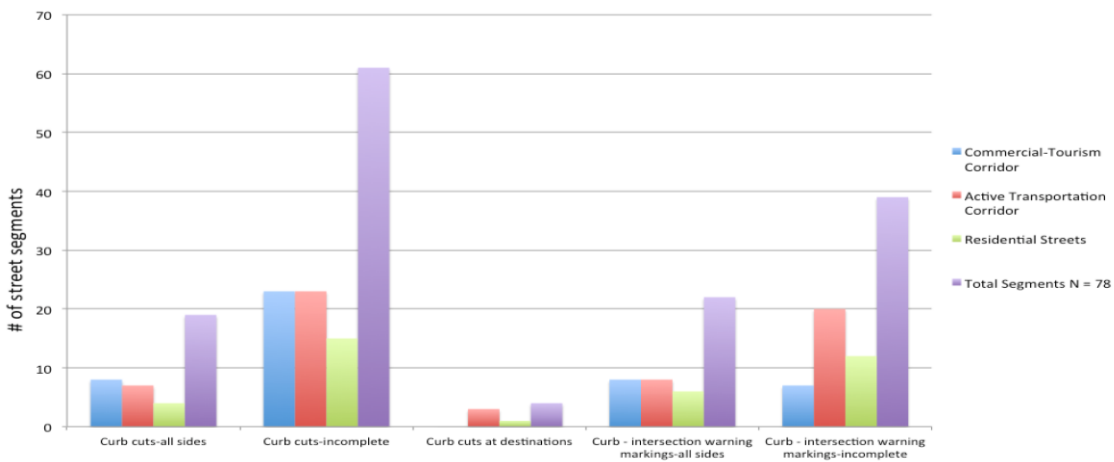


Figure B.2 Summary of Results: Functionality of Street Crossings-Intersection Curb Cuts

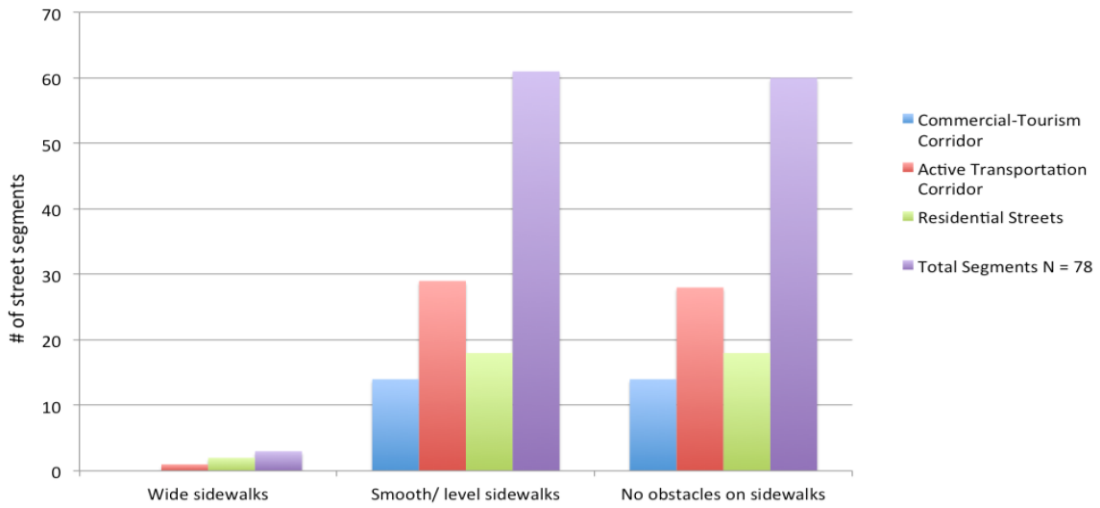


Figure B.3 Summary of Results: Functionality of Sidewalks

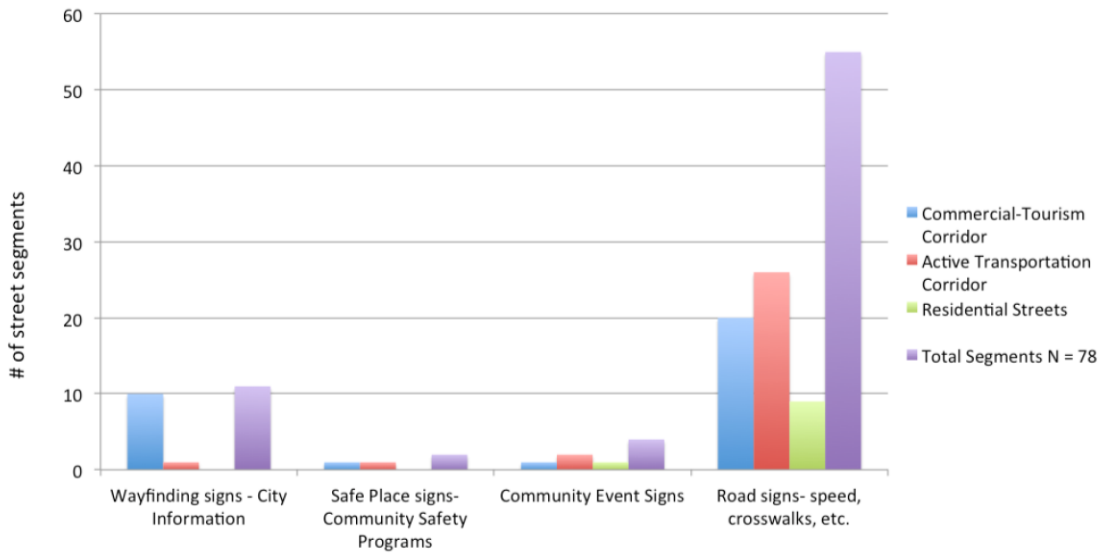


Figure B.4 Summary of Results: Signage and Wayfinding

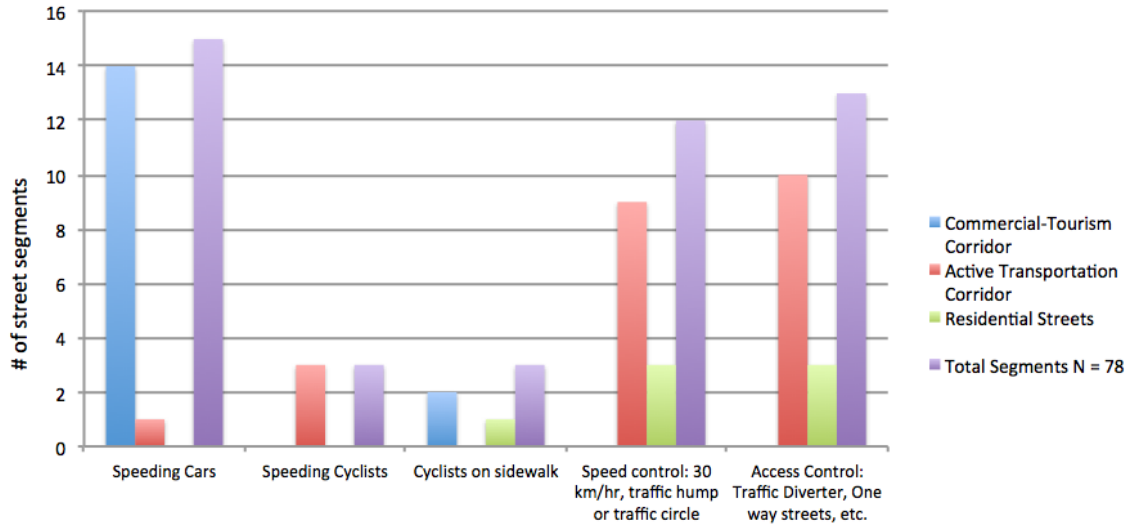


Figure B.5 Summary of Results: Traffic Safety

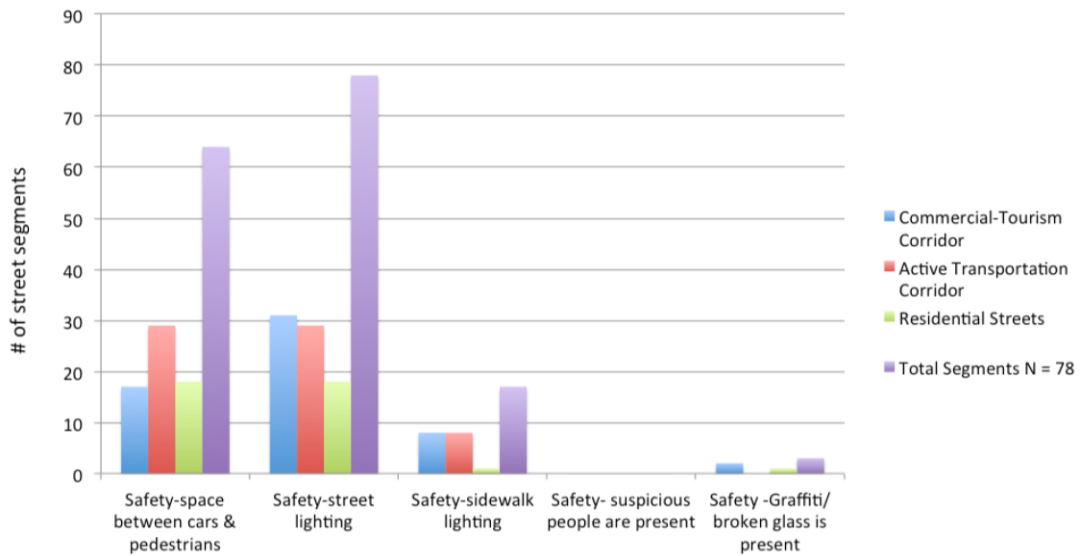


Figure B.6 Summary of Results: Personal Safety

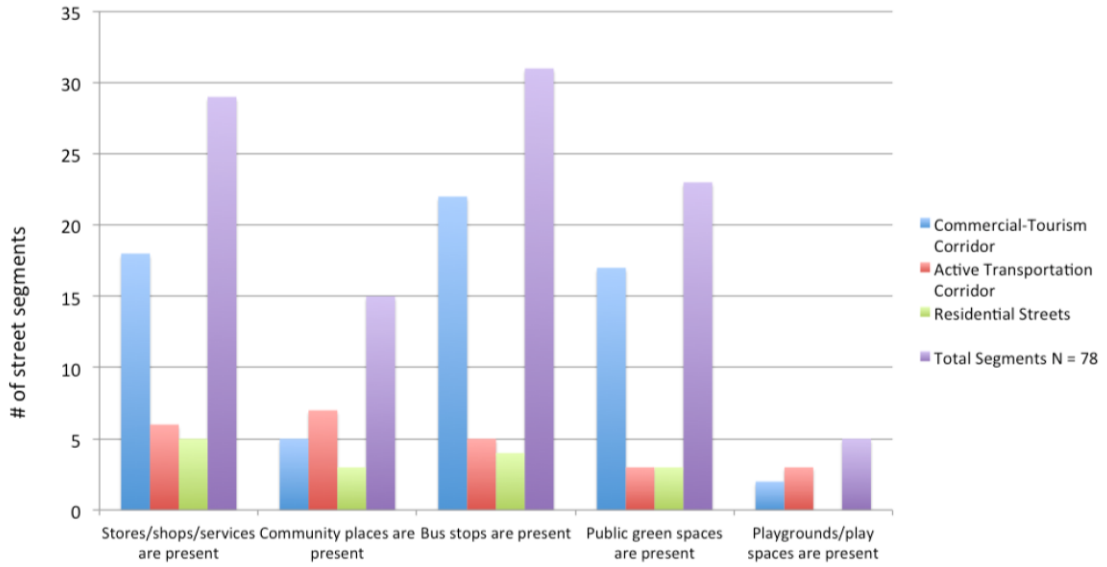


Figure B.7 Summary of Results: Destinations and Land Use

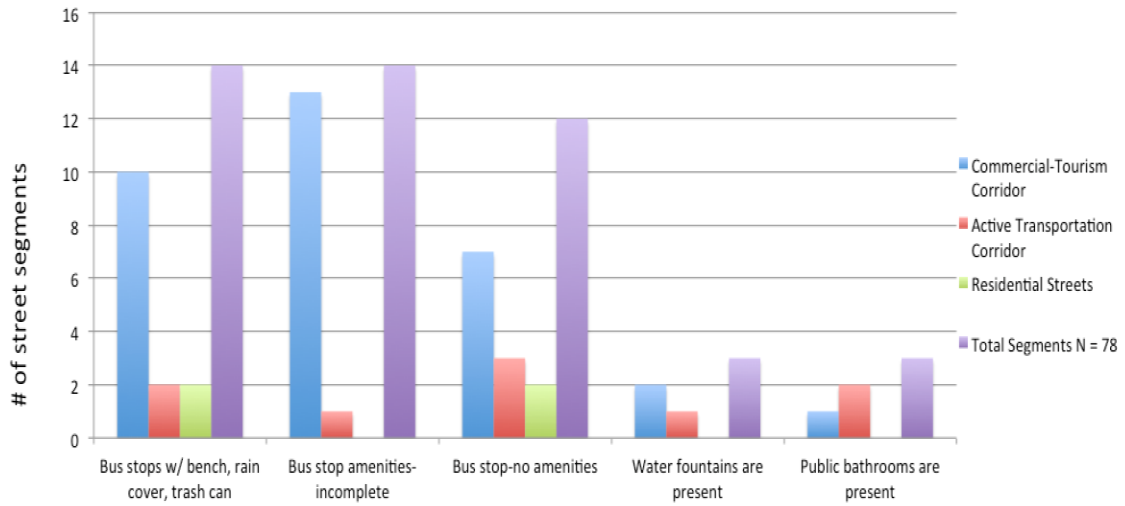


Figure B.8 Summary of Results: Supportive Street Amenities

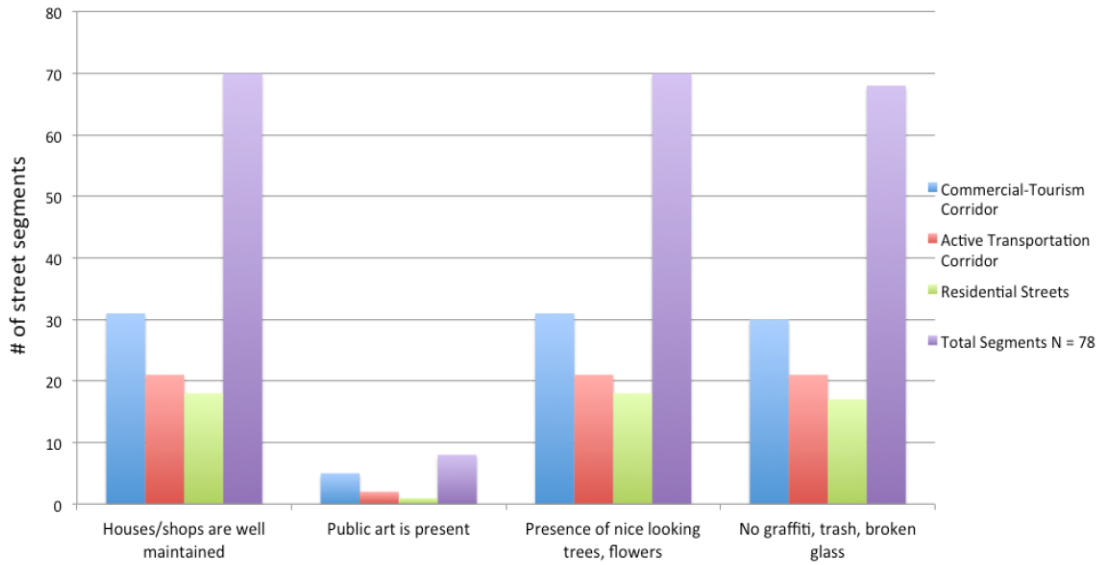


Figure B.9 Summary of Results: Appearance and Maintenance

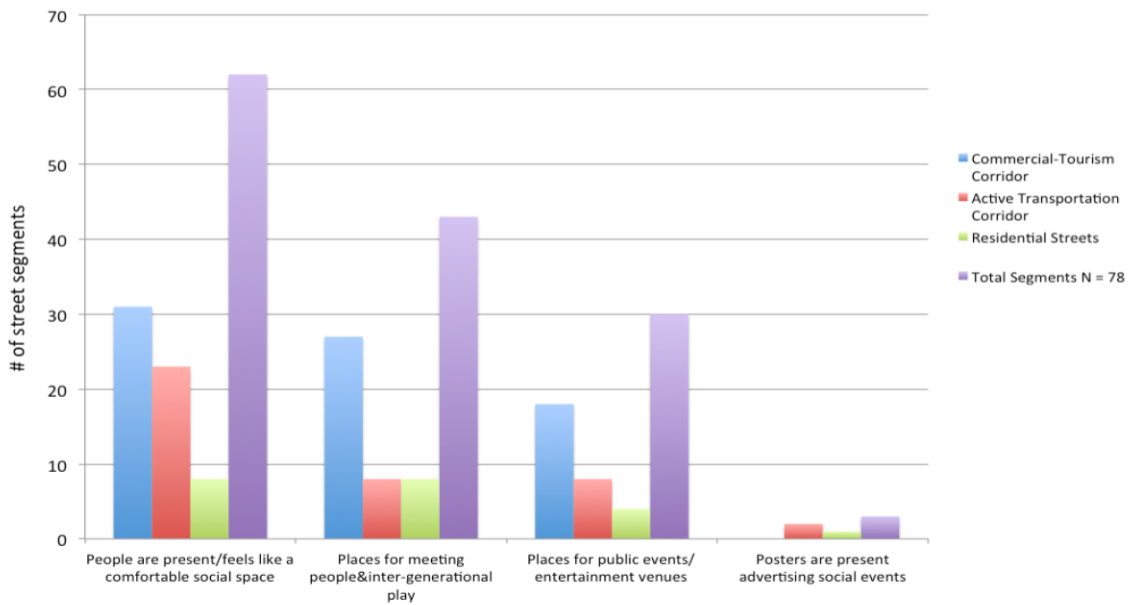


Figure B.10 Summary of Results: Social Aspects