Article

Social Sustainability Issues and Older Adults' Dependence on Automobiles in Low-Density Environments

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Abstract: An implicit assumption underlying government strategies to achieve a more sustainable urban transportation system is that all automobile users will be encouraged or persuaded to use more "green" transportation: public transportation, walking and cycling. Little consideration has been given as to how sustainable transportation policies and programmes might impact on different age groups in society, including those retired or semi-retired, despite the fact that an unprecedented number of older drivers will be on the highways in the next few decades. There is limited literature on the contextual factors behind their continued reliance on automobiles, their actual driving behavior (e.g., route choice and time of day to drive) framed within the context of social sustainability. This paper introduces the elements of transportation and social sustainability then conducts a comprehensive international literature review focusing on older drivers, their travel choices and associated social sustainability issues. It describes a case study, low-density city and presents empirical evidence, from two surveys conducted in Canberra, Australia. The paper concludes with future research directions that address these issues associated with sustainable transportation.

1. Introduction

The scope of this paper on transportation sustainability could be classified as "social" in that it includes the principle of achieving intra- and inter-generational equity focusing on social inclusion for older people and their travel patterns, especially preferences in mode choice from driving an automobile to either taking public transit, walking or cycling [1]. The significance of this paper is the identification of the issues of social sustainability structured around personal mobility of older adults who are retired or semi-retired and the social inclusion/exclusion component of transportation policies. The number of older adults is projected to grow significantly in Australia during the next 40 years, as it is in many countries [2].

The research problem that is addressed is the ever-increasing older drivers and this is especially serious in low-density urban environments where users cannot expect governments to provide frequent and efficient public transportation services as may be the case in higher-density environments. To satisfy the daily mobility needs, a significant number of people in the retirement age cohort, especially those living in low-density area, keep driving for as long as possible [3] and this raises serious concerns about highway accidents. The significance of concentrating on this age group is a discourse about social sustainability. Research in [4] explored the travel behavior of older people in Australia, Germany, New Zealand, Norway, United Kingdom and the USA and concluded: "*older people around the world are more likely to have a license, to take more trips, and to do so more often as the driver of a car than older people just a decade ago; they are also less likely to use public transit*" [4] (p. 375).

People without access to automobiles are likely to face increased social exclusion unless current land-use and transportation policies are adjusted for this growing segment of society. This has led us to hypothesize that, unless trends are dramatically reversed, population aging and trends towards greater longevity will result in more older people driving on the highways with the associated increased societal problems in the form of highway accidents with its greater cost burden on the health system. Furthermore, the use of private transportation at the expense of both public transit and "green" modes of transportation runs counter to achieving a more sustainable transportation system where the reduction of greenhouse gases from the transportation sector is one of the key objectives.

This paper is primarily a review of the literature on social impacts of transportation and on automobile drivers in the retirement age group, and their travel behavior. It is complemented by a summary of our analyses into the age cohort 60 years and above, based on primary and secondary data collection in Canberra, Australia. The situational context for Canberra as a low-density "automobile-dependent" city is described based on secondary data sources, such as government reports or studies undertaken by consultants for government agencies. The summary analyzes of two surveys conducted in Canberra in 2012 are presented. Two data sources are used: "The quality of life in your city and living environment questionnaire survey" [5]; and the smart card data of public transit in Canberra.

From these primary and secondary data analyses, we tease out some policy implications and research directions to address an aging society, transportation and social sustainability issues.

The structure of the paper is as follows. Section 2 contains the literature review on transportation and social sustainability with particular reference to the Australian context, together with the literature review of the mobility of older adults and travel behavior, and their reliance on automobiles. Section 3 describes the situational context of Canberra. It focuses on the retired and semi-retired people above 60 years old and the types of transportation policies that may affect them as a case study. Personal travel preferences in this low-density environment are analyzed from survey data. This section covers travel mode choice for daily shopping, public transit usage and whether or not drivers in this age group are willing to make one less journey by automobile per week to achieve sustainability outcomes for the wider community in Canberra. Section 4 is a discussion on the policy implications of the findings and research directions, followed by Section 5 that concludes the paper.

2. Literature Review

Without entering into an unnecessary long definition of "sustainability" (see, for example, [1]) we interpret sustainable transportation primarily from an Australian perspective [6]. From our general understanding of the sustainable transportation literature, we start from first principles by noting some broad research themes that include: identifying and quantifying the characteristics of unsustainable transportation systems (for example, [7]); applying measures that track progress, or otherwise, to more sustainable urban transportation systems (ecological footprints in [8], environmental sustainability and performance indicators in [9]); identifying demand- and supply-side land-use and transportation policies that lead to more sustainable outcomes [10] and evidence-based case studies that demonstrate the impact of integrated policy packages on the triple bottom line of economic, social and environmental performance indicators (for example, [11,12]).

The Australian Federal Government was one of the countries that recognized early the global significance of the Brundlandt Report [13]. In its response, the Government established a series of industry working groups—ecologically sustainable development (ESD)—including one on transportation to which the second author was a member representing the Australian Council of Social Service (ACOSS). The principles of ecologically sustainable development were adopted at the Council of Australian Governments (COAG) in 1993, which meant, in practice, that all three tiers of government in Australia (federal, state and local) had to assess developmental projects, programmes and policies in terms of their economic, social and environmental implications. In the transportation sector, whilst the impacts must be identified and assessed on a project-by-project basis, there is a fairly consistent international understanding of the operational definition of social sustainability. These include: inter- and intra-generational equity (the distributional implications of investment in transportation); accessibility to land-use activities; transportation safety and accidents; and social inclusion (exclusion). Their measurement is included in various state government guidelines but further details on measurement for practitioners can be found in such documents as the UK Government's "Transport Analysis Guidance—WebTAG: Social and Distributional Impacts Worksheets" [14].

Whilst equity can be interpreted as the distributional aspects of a policy or programme on different sections of the community as defined by age, rarely does urban transportation appraisal distinguish

outcomes in this way. Nevertheless, both an increasing number of retired and semi-retired older adults and transportation mobility has long been identified as an emerging issue for policy makers [4,15–17]. From the beginning of the 21st Century onwards, the young who grew up in the advanced industrial nations of the world in a period of post-war unprecedented affluence and material consumption, are now entering into the retired and semi-retired cohorts. In general, these people are now highly mobile with more leisure time at their disposal, and they desperately want to maintain the independence and mobility that the automobile offers them—and for as long as possible [3]. This raises vexing issues for governments in achieving more sustainable transportation in cities on how to persuade this cohort to embrace more sustainable modes of transportation and in encouraging the next cohorts not to follow the same unsustainable pathways as do the current cohort.

From the literature, the link between low-density living, automobile dependency and obesity is well documented. There is clear evidence about the health benefits of exercise and using sustainable modes of transportation (see for example, [18–20]). Throughout developed economies, there are a noteworthy number of people who are overweight or obese in the older cohorts of the population. For example, in Australia, 79.9% of males in the 65–74 year age group were overweight or obese compared to 41.7% in the 18–24 year age group (in 2011–2012) and the highest overweight/obesity rate for females in 2011–2012 was in the 65–74 year age group (69.5%) [21]. For policy makers, the promotion of sustainable transportation is associated with the living environment (situation context of land-use density) that encourages or discourages automobile dependency and physical activity [22].

The above literature review used keywords of "Transportation and Social Sustainability" and now, we narrow the scope by adding "mobility" and "older drivers" to keywords. The literature was selected, first, by the relevance of the topic, next, the year of publication. The majority of the selected literature was published after 2001, after Rosenbloom gave a wake-up call for transportation researchers in [4]. Therefore, our literature review contains the more recent research in the last decade on the increasing reliance on automobiles by the older adults, highway safety issues, and their driving behaviors.

The literature can inform us a lot about the mobility patterns of older adults and their use of private transportation. Mobility is essential to them for social and physical activities and they can participate in these activities and remain as part of the community [23], in addition to meeting their daily needs such as shopping for essential needs and medical appointments. Therefore, to older people, mobility is a fundamental underpinning of quality of life and psychological well-being [24–28]. Difficulties associated with traveling to fulfill social needs causes "social exclusion" [29]: the "independence" and "autonomy" that the automobile offers significantly increases their freedom [30].

Other modes, such as public transit, taxis, cycling and walking, are of lesser convenience. According to [31], taxi use increases significantly with age. However, this depends on the specific subsidy scheme operating for taxi services for older people, the individuals' affordability of taxi fares and any volunteer drivers' qualifications to assist older passengers with disabilities. Walking also allows independence and accessibility to a wide range of relatively short-distance destinations and so is a realistic mobility option available for all people. In this context, [32] reports that health, higher physical functioning, confidence of walking abilities and lower household income are all associated with the likelihood of walking within three to four blocks by older people over driving for short trips. There are particular environmental conditions that are associated with the motivation of older people to

walk. According to a study in [33], walking environments with higher levels of comfort (such as benches), safety from crime (through surveillance), and pleasantness (through landscaping and vegetation) are perceived by older adults as more inviting. People who are not confident with walking may also not choose the option to cycle, or to take public transit, even if a service is readily available near to where they live. In addition, older travelers have a variety of concerns about public transit, such as safety, personal security, flexibility, reliability and comfort [34]. These factors reinforce the fact that the ability to drive is invaluable to achieve sufficient levels of mobility [35].

Because the automobile predominantly resolves the concerns associated with mobility, losing access to an automobile is a constant threat for older adults [36]. A recent study by [37] revealed the "unmet mobility needs" of unlicensed people who were over 70 years old in North Europe, especially for leisure-related and social travel needs. Although older people are increasingly using delivery services [24], travel remains imperative to participate in social activities. Therefore, both men and women maintain their automobile-use habits into old age as leisure and other social activities remain a relatively stable component of their lifestyle [38].

The convenience of the automobile has implications for highway safety outcomes and public policy. An increase in older drivers on the highways means greater safety risks to themselves and/or others [39–43]. Furthermore, this highway safety problem will intensify as the population continues to age in absolute, as well as in relative terms [44]. The main factor of risk is described in this way: "*older drivers as a group are more likely to have some level of functional impairment and, at least intuitively, a reduction in some driving skills.*" [44] (p. 644). Moreover, older drivers' heightened casualty crash involvement per distance traveled is associated with physical frailty in almost all cases [44]. Many crashes involving older drivers are more likely to occur at intersections [44]. Excessive speed is usually not a factor, only poor judgment and slower reaction times.

The statistics on mortality amongst older people involved in highway accidents is of concern to policy makers. A study in [39] conducted a comprehensive literature review on cognitive and physical factors affecting older drivers. They concluded that while cognitive, sensory (for example, attention, vision, reaction and hearing) and physical variables (for example, neck rotation and potential factors associated with falls risk, arthritis and heart disease) determine an individual's driving capacity, self-monitoring beliefs (such as insight into individual's driving capacity) determines the choices of individuals about driving behavior and hence driving safety. A study in [45] reported that death rates per vehicle-miles of travel start to rise in the 65–69 age group. Death rates then rise again after the age of 74, based on the analysis of 1993–1997 US Federal Government data. The authors also reported that the driver deaths per crash involvement started to increase at age 60 with a steep increase at age 80 and over. It is concluded in [44] that fragility, which may increase at ages of 60–64 and above, appears to be the most significant factor in explaining the increased fatality risk per unit of travel amongst older drivers. As well as the obvious health, injury and potential disability consequences for the older driver involved in an automobile accident, there is a significant financial burden placed on the community in providing medical treatment and health care [46], as cited in [39].

There is a large literature on the travel patterns of older adults. It is found in [47] that the 65+ cohort tends to engage in increased trip making, in particular when they have access to automobiles. There is also research reporting that the number of peak-hour senior travelers has increased from 1995 to 2005 [48]. Despite Baltes and Baltes theory [49] that older adults used selection, optimization, and compensation

adaptations across a range of mobility behaviors, the empirical study by [50] reported that adaptive driving strategies (driving less or avoiding night-time driving) are predominantly found in the 80-plus age group, not in the earlier age cohorts, despite the fact that fragility in some people may increase at the age of 60 and above as mentioned earlier. The findings by [51] revealed that the 65 to 74 age-group have the highest rates of using the automobile as the driver when they are compared amongst the four age groups 60–64, 65–74, 75–84, and 85+, with constant trip activity throughout the day.

Some research has reported that older drivers are as safe, or safer, than other age groups because they drive less distance and try to avoid particular situations such as peak-hour journeys [52]. A study in [51] reported that the trips by the 75 to 84 age-group are concentrated around noon, as most are errands or social activities, and the 85 and older age group have the fewest and shortest trips. Focusing on Australian older drivers, [53] researched the self-regulatory driving behavior of these people. Avoidance of specific driving situations (at night, on a rainy night and in busy traffic) was found to be limited: the majority of older drivers remained very confident of their ability up to the age of 74. They also found that older females are more likely to be self-regulators than males.

Although many older drivers have considered stopping driving altogether, the majority of them have not actually planned for this [53]. The living environment, such as in a transit-oriented and high-density neighborhood, has a significant influence on travel-mode decisions of older people [51,54]. In general, older adults in urban core areas of cities rely less on the automobile than those who live in lower-density environments [27,36]. In Australian cities, which have low-density residential developments by international comparisons, the daily lives of older suburban residents are highly reliant on the automobile as the main transportation option and trip chaining is common [3]. In the USA, it is reported that residents in transit-oriented development environments still use the automobile as their main transportation mode [51].

Low-density living and an auto-oriented lifestyle are also associated with social capital that is a substantial component of social sustainability. Social capital refers to the informal institutions and relationships, plus the values, attitudes and norms that shape the quality and quantity of social interactions [55,56]. Social networks [57,58] of older people need careful empirical study to tease out relationships between where they live, urban density and their accessibility to activities, the frequency and spatial dimensions of their social networks, and their travel patterns.

From the review of the literature we can identify some of the research gaps that are related to an aging population and social sustainability as follows:

- An aging society will have a substantial impact on future transportation systems, but the understanding people's travel during their aging process and any associated co-morbidity they might have remains imperfectly understood from a mobility research perspective.
- In Australia, there has been little study that has examined the social networks of older people and their activities, their travel behavior, issues of accessibility to land uses, mobility difficulties and social isolation.
- For the purposes of understanding more fully the link between spatial interaction and social networks, social networks are based (1) in the home; (2) outside of the home, of which physical travel is necessary. For the purpose of data collection in a research design, social networks in the home might exclude all interactions with more immediate family members (note that in

many cultures it is family life that contributes the greatest to quality of life) but include visits to friends and relatives, and communication by Internet, mobile phone and land line and postal services.

- To establish the social networks outside of the house, standard household travel questionnaires or travel activity diaries used by transportation planners need to be augmented to include the number of people met at each destination (if any), and the relationship of that exchange.

- There is still insufficient research on the factors/motives that might encourage older people to shift towards a less automobile-oriented lifestyle.

- Detailed micro-level investigations should be undertaken into the design criteria of successful neighborhoods where older people feel comfortable with walking and using public transportation.

- Although there is evidence that some older people self-limit their own driving, others remain confident drivers and the impossibility of classifying driving ability by age alone raises questions on how licensing regulations work to identify any driver who is actually unfit to be on the highway.

3. Canberra

This section draws on a case study and describes the necessary background of the low-density environment where the majority of people interviewed in our study are dependent on the automobile for daily activities. First, we describe the situational context—the urban form that creates the low-density environment. Second, the transportation system in Canberra, and perceptions by those interviewed aged 60 or more on Canberra's transportation are described, followed by a discussion on their reported travel characteristics as revealed by using empirical data from Canberra that we have either collected from our interviews or analyzed from Government sources.

3.1. Situational Context

Canberra is a typical "low-density" city where the automobile is the main transportation mode by most residents including older people. Canberra is one of a few cities in the world that was completely developed as a "new town" from a deliberate planned design. Canberra, which is part of the Australian Capital Territory, was planned in 1911, strongly influenced by the Garden City and City Beautiful movements at the time, which shaped the low-density land use of Canberra. The original design of Canberra stressed highways organized along radial arterials (similar in concept to the Washington, DC plan), and an artificial lake separating the north and south sides of the city [59] (Chapter 5) with ample open green spaces within and between the suburbs. The urban form that appears in Canberra today reflects this design principle. A core set of shops and amenities and their surrounding residential areas are called a "suburb" in Canberra. The suburbs were designed to be self-contained communities of 7000 people initially [60] but now they have from 80,000 to 175,000 people. Open green spaces, corridors and peripheral freeways connect the suburbs. With its strict planning control, Canberra has mostly avoided the suburban sprawl that other communities of its size and density have exhibited [61].

Canberra currently consists of the seven districts as defined for statistical purposes. Figure 1 shows the location of each district. Today Canberra has a population of 365,621 (as of the 2011 Australian Bureau of Statistics Census), which is spread across an area of 807.6 km^2. This area supports an urban population density of 452.2 persons/km^2 with an average household size of 2.6 persons

and 1.7 automobiles per household (as of 2011, Australian Bureau of Statistics Census). The number of people over 60 years old is 56,341 (15.8% of the total population, as of 2011, Australian Bureau of Statistics, 2012). People aged 65 years and over made up 10.7% of the population in 2011 (Australian Bureau of Statistics Census 2011) and this cohort is expected to keep increasing.
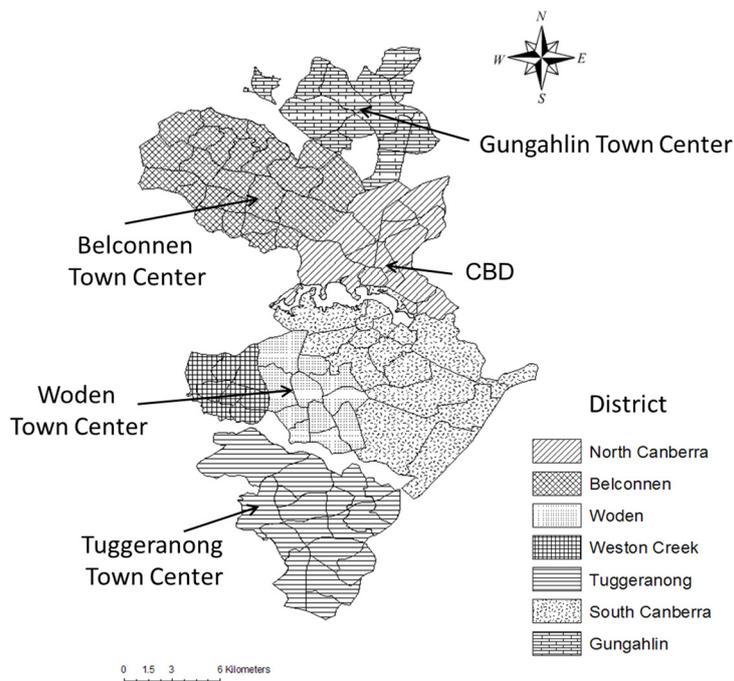

Figure 1. Districts in Canberra (map created by the first author) Source: Australian Bureau of Statistics Census Statistical Division 2011.

The inner districts such as North Canberra and South Canberra are strongly influenced by the development principles of the original plan (Garden City). Belconnen, Woden, Weston Creek and Tuggeranong are the "new towns" developed from the 1960s to the 1980s, based on a land-use and transportation study undertaken in the late 1960s [62]. Gungahlin is the newest district developed during the past two decades and is based on the Australian New Urbanism concept that aims at a high-density urban form. However, Canberra still has a low overall density: even in higher-density areas detached houses are predominantly found. The percentage of separate houses in Canberra overall is 72.8%, that of semi-detached, row or terrace houses, townhouses is 14.6%, and flats, units or apartments is 12.4% [21].

The main public transportation in Canberra is the Australian Capital Territory (ACT) Internal Omnibus Network (ACTION). It provides bus transit services to Canberra suburbs including a regional community minibus service. ACTION offers two rapid routes, 86 routes on weekdays and 46 routes during the weekend. One rapid transit service runs from Gungahlin Town Center to the Central Business District (CBD). The other rapid transit service runs from Belconnen Town Center to Tuggeranong Town Center, via the CBD and Woden Town Center. There is also a regional railroad service to and from Canberra but this is only for interstate travel with limited frequency and the railroad is not used for daily intra-city transportation. A light rail system linking the CBD and Gungahlin is currently in the first stage of its planning (as of May 2015).

At the suburb level, fifty eight suburbs out of one hundred and ten in Canberra have population densities greater than 1000 per square kilometer. This number is equivalent to some US cities that have light rail systems [61]. A few suburbs in North Canberra and Belconnen have densities greater than 2000. However, these suburbs with relatively high population densities are dispersed in Canberra due to its "new town" design, which makes the delivery of public transit services inefficient and costly.

3.2. Transport Policy—Past and Future

In an automobile-dominated society such as Australia, encouraging people to shift away from the automobile to non-automobile transportation is one of the critical challenges in aiming for sustainability [63]. People in the retirement age cohort are an obvious target group for behavioral change because they are arguably less constrained in terms of time to allocate for their travel and therefore might be encouraged to take public transit instead. However, in automobile-dependent cities, the shift to non-automobile travel is not easy as our case study will demonstrate.

Canberra represents an important case study of international relevance in developed cities of the world with high automobile ownership and high-income levels where current government strategies are being targeted towards travel behavioral change. Developed primarily as a national government town, the workforce is highly educated, enjoying relatively high incomes. As Canberra grew rapidly in the post-Second World War era, the planning authority (National Capital Development Commission, NCDC) deliberately implemented a highway network designed to eliminate the problems of traffic congestion being faced by motorists in other Australian cities [62]. Therefore, with a generous provision of highway space and a high household automobile ownership the highway-based public transit services (line-haul buses linking the town centers with feeder bus services to and from the residential suburbs) were poorly patronized in off-peak periods and this continues to be an issue hindering progress towards a more sustainable city.

The results of a sample survey (60 percent response rate of residents aged 15 and above) in Canberra on attitudes to prepared statements about public transit in 1966 [64] confirm the poor performance of buses, not enough services throughout the day, and the perceived stigma of using public transportation. In 1974, the NCDC published its transportation policy against the backdrop of concerns with oil security following the Arab embargo on oil exports. It devised policies to persuade commuters to use public transit to the CBD and other town centers whilst leaving freedom of mode choice for other than work-trip purposes. The implementation of measures to control parking in the CBD and to improve public transit was not without difficulty. From 1973, parking meters, with a 30-min time limit and five-cent charge (21 cents in 2012 prices based on the Reserve Bank of Australia long-term inflation rates) for 15 min, and then voucher parking (20 cents—or 84 cents in current prices—for thirty minutes up to a two-hour limit) in car parks were introduced but these restrictions proved little deterrent to the use of automobiles, primarily because of the lack of policing of any illegal parking and the affordable tariff.

Today, in addition to the high highway standards already referred to above, there is a generous supply of on-street and off-street parking throughout Canberra. The current parking charge in the CBD for a short-stay visit is $4.50 for two hours and from $9.50 to $14 all day—depending on the parking lot (charges as of February 2015). The City Plan [65] states that parking will be increasingly costly and

based around "park and ride" options as public transportation improves over the long term. The number of long-stay parking spaces will be reduced.

The ACT Government released a new Transport Strategy "Transport for Canberra" in March 2012. This aims to support a shift to more sustainable transportation in conjunction with the ACT Planning Strategy. It targets, by 2016, an increase in journey-to-work trips by walking to 6.5% (from 4.9% in 2011), cycling to 6% (from 2.8% in 2011) and public transit to 10.5% (from 7.8% in 2011). In September 2014, the "Transport for Canberra Report Card" was published to report on the progress in delivering "Transport for Canberra". The key achievements that related to sustainable transportation include: light rail planning; bus stations; bus stops; park and ride; real-time passenger information; and a city cycle loop [66]. In addition, the document reported that 23.7% of the ACT population now resides within 750 meters (10-min walk) of a rapid public transportation corridor (up from 14.5% in 2012). However, the review on the use of the public transit notes that services "need improvement". There is a plethora of research reports on the ACT Government Website: it is evident that Canberra's population is aging, and that older people, who will no longer able to drive, need alternative modes of transportation. The core aim of the new frequent public transit network, which will help guide government's decisions about the location of social and affordable housing, is to ensure people with the highest need for public transportation have access to the best services. The future coverage and service levels together with community transportation services are expected to enable people to "*age in their community*" [67] (p. 10).

3.3. Older People's Travel Preferences in Low-Density Environments

From the perspective of an auto-owning older traveler—when accessing day-to-day activities—all of these issues discussed in the previous section of the paper, in essence, relate to mode-choice decisions in Canberra. This section provides an idea of typical travel mode choice and the preference of people 60 and above who are living in low-density environments.

3.3.1. Travel-Mode Choice for Daily Shopping

Travel-mode choice for daily shopping were teased out from the primary data collected as part of broader questionnaire survey conducted in 2012 in Canberra. The survey, "the quality of life in your city and living environment questionnaire survey" was conducted by the first author during the period of May–August 2012. The total number of responses was 648 (Male 230: 37.4%; Female 385: 62.6%). The data of who were wholly retired, and over 60 years of age, were used for this paper (84 samples in total). Among these respondents, 15% lived in North Canberra, 26% lived in Belconnen, 23% lived in Woden, 6% lived in Weston Creek, 16% lived in Tuggernong, 9% lived in South Canberra and 5% lived in Gungahlin. Compared with the Population Census 2011 data locations of residents by district, our sample is only slightly biased: we have a slightly higher representation from Woden, and a slightly lower sample from Gungahlin; other districts have very similar proportions of people residing in each district when compared with the census.

Almost 90% of these respondents aged 60 and above stated that they use the automobile for daily shopping, followed by bus (7%) and walk (6%). The districts that have access to rapid bus services, have more older bus users, as will be presented in Section 3.3.3. Fourteen people among nineteen

respondents who were 80+ years old stated that their daily travel mode was the automobile (70%). The time intervals for travel were: 0–10 min (31%); 11–30 min (53%); 31–60 min (8%); and over 60 min (8%). These results indicate that the majority of people aged 60 and above shop within a driving distance of 30 min, which is a relatively short trip.

3.3.2. Willingness to Make One Less Journey by Automobile per Week for Sustainability Reasons

The percentage of respondents who answered the question: "how willing or unwilling would you be to make one less journey by car per week to improve air quality and traffic congestion?" was analyzed using the same data in Section 3.3.1.

The results show that about 40% of wholly retired people aged 60 and above are unwilling to reduce one automobile journey for environmental sustainability purposes, whilst 37% are either "very willing" or "fairly willing" to do so. However, despite of this stated willingness, the reality is that the majority of this cohort still prefers to use the automobile for daily shopping because of the stated inconvenience of public transit services. Some comments from the survey respondents below indicate their attitudes to public transit in Canberra, regardless of their willingness to reduce one automobile journey per week. For example, a female (70–79 years old) who is "fairly unwilling" to reduce one car journey per week commented:

"The bus services are slow and infrequent and just too inconvenient compared with the car." A female (60–69 years old), who is "fairly willing" to reduce one automobile journey per week (but uses the automobile for daily travel) commented:

"There used to be 2 bus routes through the suburb. One was abolished. I can no longer go by bus direct to the places where I go to University of the Third Age courses."

There was another female who commented:

"Canberra lacks of adequate public transport" (over 80 years old and "very willing" to reduce automobile travel but uses the automobile as a main transportation mode).

Furthermore, a male (60–69 years old) who is "fairly willing" to reduce one automobile journey per week (but uses the automobile for daily travel) commented "Inadequate bus service—too many slow meandering bus routes compounded by woeful connections".

On the other hand, the comments below represent the reliance on automobiles and self- regulatory driving behavior, which is consistent with what we have reported from the literature. "As my level of physical and mental health deteriorates, my dependence on my car for independence increases." (Female, over 80 years old, living alone).

"I wish social activities, preferably daytime as I cannot and don't want to drive at night." (Male, over 80 years old, living alone).

"There is no night bus services to meet bus and train to civic." (Male, over 80 years old, living with partner).

3.3.3. Older People's Public Transit Use in Canberra

Based on an analysis of smart card data, this sub-section overviews the public transit usage of residents over 60 years old in Canberra. Canberra's only public transportation system (ACTION bus) instaled a smart card called "The MyWay card". The ACT Government collected "The MyWay" card

data on weekdays in June 2012. The data contains information on origin stop, destination stop, smart card type (adult, student, concession, senior, *etc.*), origin time (when the smart card was tagged to get on the public transit service); and destination time (when the smart card was tagged off to exit the service). Among the recorded 1,048,575 trip data, data for "senior" card-holders (75,545 person trips) were extracted for the analysis in this paper. To be eligible for a Seniors Card, a person must be over 60 years of age, a permanent resident of the ACT, and not being in paid employment for more than 20 h a week. ACT residents aged 70, or over, are entitled to free travel on a "MyWay Card". The percentage of users—residents aged 70, or over—was around 9% amongst all age groups using public transit.

Table 1 shows the spatial distribution of users 60 years and over who use public transit in Canberra. North Canberra had the highest percentage of these public transit users amongst seven other districts. In contrast, Weston Creek has the lowest percentage. This distribution matches the service levels of public transportation routes in each district: North Canberra has a public transit corridor along the main highway that provides high accessibility to public transportation. In Weston Creek, however, the service is relatively poor. Belconnen, which has the second highest percentage of trip origins, has a rapid public transit service to the CBD with frequent services every five minutes throughout the day. Considering some of the comments made during our quality of life survey made above, people aged 60 and above are highly likely to choose the automobile if their travel requires connecting public transit services (no direct bus to the destination) and their trip origins and destinations are not located along the express public transit routes. This is consistent with the literature that discusses such travelers' motivations to walk or to use public transit, and concerns about the flexibility, reliability and comfort of public transit.

Table 1. Bus trip origin and destination (60+ years old, June 2012).

Districts	Bus Trip Origin		Bus Trip Destination	
	60+ Bus Users	%	60+ Bus Users	%
North Canberra	25,447	33.7%	25,988	34.4%
Belconnen	17,488	23.1%	18,337	24.3%
Woden Valley	14,321	19.0%	13,768	18.2%
Weston Creek	1732	2.3%	1740	2.3%
Tuggeranong	7851	10.4%	7223	9.6%
South Canberra	4387	5.8%	4221	5.6%
Gungahlin	4319	5.7%	4268	5.6%
Total Canberra	75,545	100%	75,545	100%

4. Discussion-Policy Implications and Research Directions

We recognize that in contemporary Western societies people 60+ might no longer consider themselves to be "old": many are still healthy; a significant proportion remain fully or partially in the workforce; and some are committed to extended family duties. The problem that we have addressed in this paper is about aging populations with an increase in older drivers with potential physical difficulties on the highways, especially in low-density cities of the industrialized world where automobile ownership amongst those old enough to drive is near universal. From the literature review in Section 2 and from the travel preferences in Canberra noted in Section 3, the policy implications and research directions are now teased out.

4.1. Older Drivers' Safety and Licensing

The data from Canberra reinforces what is widely known about older people's reliance on private transportation. Our survey sample confirms that the majority of people over 80 years old in Canberra still use the automobile for their daily activities. This raises concerns about social sustainability and the highway safety and licensing issues of older people. A study in [68] identified policy spheres that are relevant to the transportation needs of older adults: the general transportation policy framework; travel-mode preference; alternative transportation infrastructure stock and investments; housing-land-use-transportation linkages; research and technology applications that improve travel mode choice on public transportation and the environment; and institutional and legal reforms.

We touch on a couple of these themes of which legal issues are paramount and the outcomes may partially determine social exclusion of older adults. For example, the legal onus of older license holders in the Australian Capital Territory is to report any permanent or long-term illness, injury or incapacity that may impair their ability to drive safely to the Road Transport Authority. Once reported, a medical assessment may be required, usually undertaken by the person's General Practitioner, who may recommend a driving assessment. This assessment by the Road Transport Authority will determine whether that person is fit to continue to hold a driver's license.

With respect to legal reforms, a major issue that relates to older people's mobility is driver licensing laws. Driver licensing is an important policy concern as the automobile continues to be a primary mode of transportation for older people in most cities of the developed world. Older people are seen as a highway safety risk in the light of the illness-related functional impairment affecting their driving ability. Thus, the implementation of a reliable and functional screening test has been an important policy issue throughout the developed world but this is not without controversy. There has been a trial of a shorter renewal cycle and stringent testing amongst older adults has shown some promising safety results [68–70]. In Ontario, Canada, the province now requires license renewal every two years for seniors 80 years and over as they are considered to be high risk, as well as the fastest growing segment of the driver population. They are required to take a mandatory vision test, knowledge test, driving record review and driver education programme. A highway test may be required upon recommendation by the examiner.

In Canberra, courses are also available to assist older drivers recognize and develop strategies to address age-related driving problems. Just recently a team of researchers at the University of Sydney, Faculty of Health Sciences, have developed a test, "DriveSafe-DriveAware" (released by Apple on 17 April 2015), that identifies older drivers likely to be unsafe—without taking them on the highway. The test, commercialized by a multinational testing company, is designed for use by general practitioners or geriatricians who must certify that older adults are fit to drive. It is largely self-administered and takes about 15 min. The number of service providers of such a test is likely to increase in the future.

4.2. Evidence-Based Policy Research on Older People's Safety Issues

Related to the point above, evidence-based policy research can assist in fine-tuning license renewal regulations. There are a number of issues that evaluative studies in Canberra should consider and that will benefit driver-licensing policy. There is a need to address the perennial and conflicting question of

whether age should be the marker for highway safety among drivers where the highway geometric standards in the Australian Capital Territory are of superior engineering quality. Alternatively, should efforts be targeted towards the search for more effective tools to eliminate all bad drivers from the public highways and thereby not discriminate by age? Data on automobile and pedestrian accidents and deaths involving older drivers should be collected on a more detailed basis (e.g., possibly recording who is judged at fault and context variables of accidents) in order to make an empirical assessment of driving risks among older adults. The Road Transport Authority could partner with medical and insurance providers to extend database collection and encourage academic researchers to shed light on differing policy claims and support to improve licensing practice in Canberra. Time-series analysis can also be undertaken in the future as more collision data are gathered to establish more conclusive evidence of current programme effectiveness.

Information about legal responsibilities and alternatives to driving are key resources that must be disseminated widely, and this is facilitated today by the near universal computer literacy of the current age cohort 60–70. There are also some actions that can be taken to reduce risk on the highways including consulting information provided by the Australian Council on the Ageing [71].

4.3. Understanding the Aspirations of Older People in Organizing a Lifestyle

Little research has been done into how older people plan their life in retirement, and how much this differs from earlier generations who will enter this age cohort, and what this will mean for transportation infrastructure and service provision [54,72]. The comments from our survey respondents (Section 3.3.1.) provide some information on the participation in activities such as study and social activities in addition to daily errands. More investigations are required into understanding how life planning and aspirations will affect choices of residential location and travel. Moreover, research on the "triggers" of a change from the current "driving habits" of older people into more sustainable and active transportation would provide valuable information on implications for urban policy and infrastructure planning in Canberra. The stated willingness to reduce automobile travel is not especially low in Canberra (6 out of 10 of those aged 60 and above say they would like to give up one automobile trip per week). However, the reality is that older people choose the automobile because of the perceived inadequacy of public transit services. If they were to use public transit more frequently, and physical exercise (walking) could be incorporated into travel, then there are additional health benefits over driving an automobile from door-to-door.

In this context, a life-course approach is a useful method for understanding the life planning of people after retirement because travel choices are intimately connected to life stages and the location of home and other land-use activities. This research approach enables the exploration of the changes in human lives over a stretch of a lifetime [73]. Although there may not be any new life stages after retirement, at least two significant stages should be considered before stopping driving. Stage 1—Stay in the same place and continue to drive after retirement for household chores and social activities, but self-limit the driving distances and avoid peak-hour driving. Stage 2—Still physically able to drive but starting to consider either moving to locations where daily needs are satisfied by public transportation or walking, or increasing the use of alternative modes of transportation, such as community transportation services, taxis, or asking family or friends to be the chauffeur.

Narrative inquiry has been used as a way of characterizing the phenomena of human experience and it is appropriate to many social science fields of enquiry. It is grounded in the principle that "*humans are story telling organisms who, individually and socially, lead storied lives*" [74] (p. 2). This method has not been much applied in the transportation research field but we suggest that it is a useful approach along with the qualitative interview technique to explore life-courses. An example from the transportation research field using qualitative interview is [75].

5. Conclusions

There is a vast literature on factors influencing transportation mode choice in general, but there has been little exploration of the reasons behind the dependence of older people on the automobile, given the overwhelming evidence about the highway safety risks of these age cohorts, the health benefits of exercise and the environmental benefits of using sustainable modes of transportation. We have drawn together the relevant literature on older drivers. A low-density, automobile-dependent city (Canberra) was selected as a case study and the paper has described the main features of its urban form, its transportation arrangements, travel preferences of those aged 60 and above, health-related issues and current government policy on sustainable transportation. Comments about the dependence on the automobile which were provided by survey participants has reinforced what other studies in the international literature have found: older people prefer to drive everywhere for independence, and want to continue to do so as long as they are capable of driving. Clearly, they wish to avoid social exclusion and are less prepared to change long-standing habits of driving an automobile for environmental reasons despite the accident risk implications of their behavior. The latter issue is tempered somewhat by the findings from the survey results in Canberra that most people aged 60 and above make short-distance journeys (less than 30 min) by automobile, and avoid particular situations on the highways for safety reasons, which is also consistent with international literature.

From public transit usage data of Canberra specifically about those aged 60 and above, it is apparent that they use public transportation only if the origins and the destination of the journeys are made along the inter-town express public transit network—but the usage is very low. The stated willingness to reduce one automobile trip per week is a positive sign that if the level of public transportation is improved, nearly 40% of older people might consider reducing their amount of driving. The current public transportation system in Canberra has long been perceived to be inconvenient with services adequate to their needs. Therefore, they rely on the automobile to satisfy their mobility needs to avoid social exclusion.

The literature review has pointed to highway safety involving older drivers as a key challenge in an aging society. It is evident from the Canberra sample that a significant proportion (70%) of people who are over 80 years old use the automobile as their main transportation mode. Even if they are willing to reduce automobile journeys to reduce the safety risk of driving, they choose to drive because of the perceived inconvenience of the current public transit system. The discussion in this paper has identified policy spheres that are relevant to the transportation needs of older adults: travel mode preference; alternative transportation infrastructure stock and investments; housing-land-use-transport linkages; research and technology applications that improve the travel experience; and institutional and legal reforms. Legal reforms around the driver licensing of older people in Canberra is one priority for

researchers. It is recommended that driver education courses and driver tests are made as conditions in the process of renewing older people's driving license in Canberra, information about new highways are provided, trends in recent traffic accidents that change over time are provided along with information on new urban development. This could also help assist older people to reconsider their travel choices on a regular basis.

It is expected that the life expectancy of Australian people at birth is projected to be 95.1 years for men and 96.6 years for women in 2054–2055 [2]. Other developed countries have similar trends. In a society where the population has an unprecedented long life, there is a need to understand older people's aspirational life-course planning and associated transportation needs, especially in light of the issue of social inclusion as indicated by our survey results. A shift to sustainable transportation will only be achievable when it brings a better quality of life to the older people and this requires careful consideration when formulating policy that has inter-generational equity implications. It is suggested as a research theme that an understanding of the aspirational goals of life after retirement and associated lifestyles is needed. This will help update the urban design policy that meets the needs of all generations with more empirical data. For example, the ongoing plan of light-rail transit development in Canberra, and its wide dissemination would give information that would be useful to maximize both the benefit of transit and identifying the neighborhoods where older people could achieve a preferred lifestyle without driving.

There are research areas that are necessary to provide a sound basis for policy formulation. Understanding about older people and their mobility and travel from a social sustainability perspective during their aging process from retirement and onwards remains imperfectly understood. There has been little study that has examined older people's social networks and activities, their travel behavior, issues of accessibility to land uses, mobility difficulties and social isolation. There is still insufficient research on the factors/motives that might encourage older people to shift towards non-automobile oriented lifestyles, complemented by the design criteria of successful urban neighborhoods where people feel comfortable with walking and using public transportation.

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Author Contributions

Hitomi Nakanishi: The main author for this publication initiated the research design, conducted the analysis and wrote part of the literature review in Section 2, and wrote the discussion and conclusions.

John Black: John Black wrote the introduction, part of the literature review in Section 2, and Canberra's urban environment. He reviewed the final manuscript and contributed to the discussion and conclusions together with Hitomi Nakanishi. Both authors have read and approved the final manuscript.

Conflicts of Interest

The authors declare no conflict of interest.

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