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Review

Elderly Sustainable Mobility: Scientific Paper Review

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Abstract: The number of elderly people as a proportion of the world's population is growing significantly. Special attention to the accessibility and mobility requirements of this group is needed. The contribution of this paper is a review of travel patterns, mode preferences, infrastructure solutions, accessibility indices, mode choice models and datasets as they relate to elderly mobility. Key findings highlight the role of residential location characteristics in shaping elderly travel patterns, helping to explain why research on elderly travel has largely relied on case studies to date. The review also summarizes a range of indices that have been developed to measure public transport and walking accessibility among the elderly, including distance and time-based methods. Future research should consider the dominance of private transport in facilitating elderly mobility and its implications for cities experiencing an aging population.

Keywords: elderly; elderly transport accessibility; elderly accessibility index; elderly active transport; elderly sustainable transport; mobility; elderly travel pattern; elderly mode choice study

1. Introduction

Over the coming decades, with the aging of the baby boomer generation (those born between 1946 and 1964) and declining birth rates, the number of elderly people is expected to increase significantly worldwide [1]. It is estimated that, by the middle of the next decade, roughly one in three citizens of the world's industrialized nations will be over 65 years old [2]. Such rapid growth of the aging population will bring many challenges for governments and communities [3]. In the shorter term, around one in five people are expected to be 60 years or older by 2050, increasing from one in eight people today [4]. Figure 1 shows the past and forecast proportion of elderly people across the world, highlighting an expected increase in all regions.

Mobility and accessibility are two essential components of the transport system. A well-organized transport system should be easily accessible to all age groups of people. Public transport (PT) and walking should be encouraged as alternatives to avoid dependency on private transport [5]. Adequate accessibility for the elderly is not only crucial to older people themselves but also to those with whom seniors interact with daily, specifically where these others rely on a support such as childcare and voluntary work undertaken by senior citizens [6].

Several researchers have focused on elderly mobility, covering a wide range of topics. Some have focused on elderly living area preferences and travel patterns, while others have investigated structural and policy improvements to resolve elderly transport access issues. More recently, accessibility index and mode choice studies are receiving increased attention. However, a summary of elderly travel-related research (focusing on different classifications/aspects) is lacking. This paper therefore seeks to contribute to the literature through a review of travel patterns, mode preferences, infrastructure solutions, accessibility indices, mode choice models and datasets, as they relate to elderly mobility. Key objectives of this review are:

1. To understand key travel patterns among the elderly.
2. To understand travel mode preferences among the elderly.
3. To develop a classification of elderly transport access studies.
4. To synthesize previous infrastructure solutions related to elderly travel.
5. To synthesize previous accessibility index studies related to elderly travel.
6. To synthesize previous elderly mode choice model studies.
7. To summarize datasets used to analyze elderly travel.

Section 2 describes the methodology used to undertake this review. Sections 3–6 then summarize the literature into four different themes: social and transport, infrastructure improvement, accessibility index, and mode choice. This is followed by an overview of datasets used for elderly travel analyses in Section 7. Concluding remarks and future research directions are then presented in Section 8.

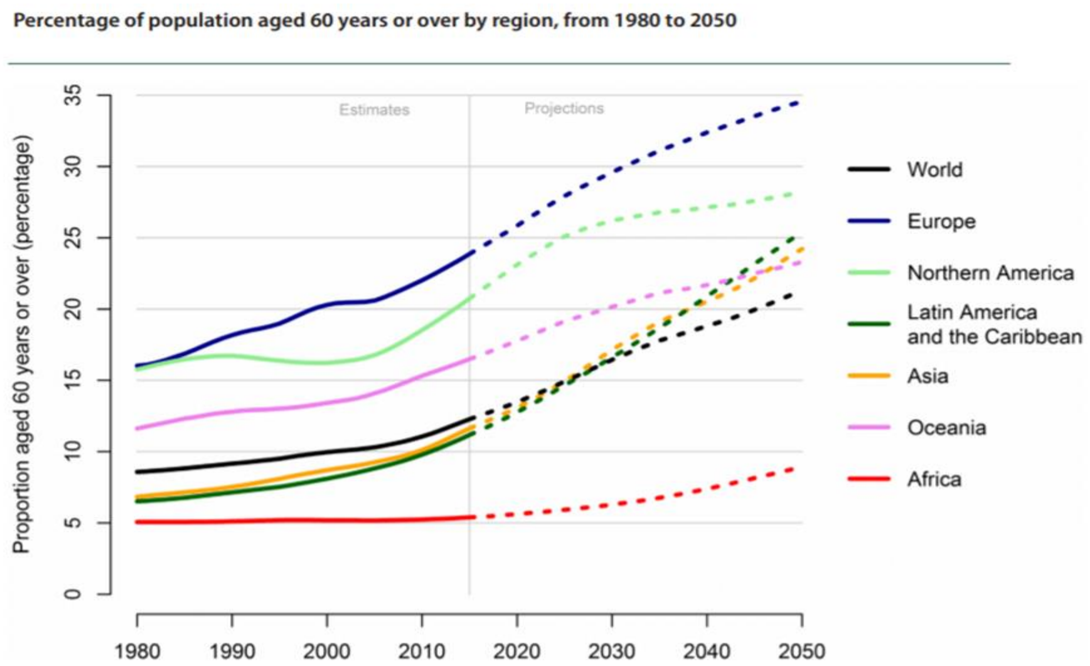

Figure 1. Global elderly population growth [4].

2. Research Method

This study involved a literature review of elderly travel-related studies to meet the research objectives. Various databases were used to source relevant literature including Google Scholar, MDPI, ScienceDirect, Scopus, Transportation Research Information Database, Taylor and Francis, Web of Science and Wiley Online Library. A range of different keywords was used in combination with one another, including: *elderly living*, *elderly travel pattern*, *elderly travel destinations*, *accessibility index*, *elderly accessibility index*, *distance-based access*, *time-based access*, *elderly travel plan*, *sustainable transport*, *active transport*, *public transport access*, *walking access*, *household data*, *public transport accessibility*, *walking accessibility for elderly*, *mode choice model*, *multinomial model*, *binary mode choice model*, *public transport mode choice model analysis*, *walking mode choice model analysis* and *elderly mode choice model*.

Following an initial review of key topics covered by the literature, elderly sustainable transport accessibility studies were classified into four key categories: social and transport, infrastructure improvement, accessibility index and mode choice (Figure 2). Previous literature and key words were used to inform this classification. The first category, social and transport, represents the social living style of the elderly, travel destination, travel pattern and mode preference related studies. The infrastructure improvement category includes previous studies investigating infrastructure solutions for elderly mobility. The accessibility index category includes previous public transport and walking accessibility index studies, further classified into distance-based and time-based methodologies. The last category, mode choice, includes previous studies related to mode choice modeling using various mathematical models.

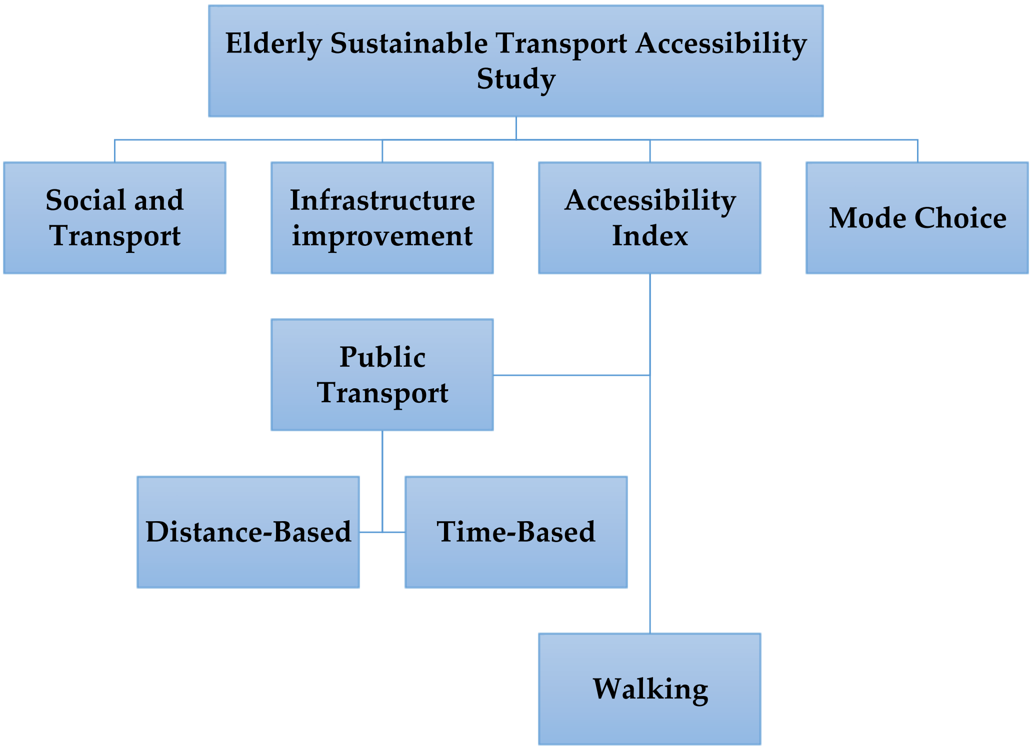

Figure 2. Elderly sustainable transport accessibility study classifications.

3. Social and Transport

3.1. Aging in Place

Studies indicate that the elderly desire to remain safely, independently and comfortably living in their home/community for an extended period following retirement; this is known as "aging in place" [7]. Most people tend to retire in the same neighborhood where they lived most of their adult working life, with the growth in older adults found to be particularly rapid in suburban areas [8]. For the past two decades, the broad definition of "aging in place" has been adopted by researchers and policymakers to describe many seniors' living preferences. Research studies consistently show that most seniors prefer to live in their homes as long as possible [9,10]. The option of moving into a retirement village is less attractive due to their high entry costs and regular charges. In some countries (e.g., Australia), government initiatives support aging in place. For instance, the nationwide home and community care program provides home-based care to seniors in the form of "meals on wheels" meal programs, domestic assistance, home and garden maintenance [11], nursing aid, personal care and community transport. However, this style of living can also be associated with feelings of loneliness and social isolation [12,13]. Many studies recommend that seniors undertake out-of-home travel regularly to engage with friends and the broader community in order to reduce social isolation. Travelling outside also provides health benefits by encouraging that the elderly remain active and physically mobile [7,14].

3.2. Elderly Trip Destinations

Elderly trip-making tends to mostly occur during a midday peak and daylight hours. Most elderly people make their trips between 9:30 a.m. and 3 p.m. [15]. Elderly people also tend to travel shorter distances and make fewer trips than other adults (25–59) [16]. They mostly travel for shopping, health care and recreation purposes [17]. Elderly travel may also include some trips to work-related and formal volunteering destinations [18]. A proportion of the older population group is also involved in the pick-up and drop-off of children at schools. Seniors also travel to visit retail services, banks, post offices and chemists.

Figure 3 shows the trip purposes among the elderly in Melbourne, Australia, according to the Victorian Integrated Survey of Travel and Activity (VISTA 2016) [19]. This shows that besides returning home (accommodation), most elderly travel is undertaken for the purpose of shopping.

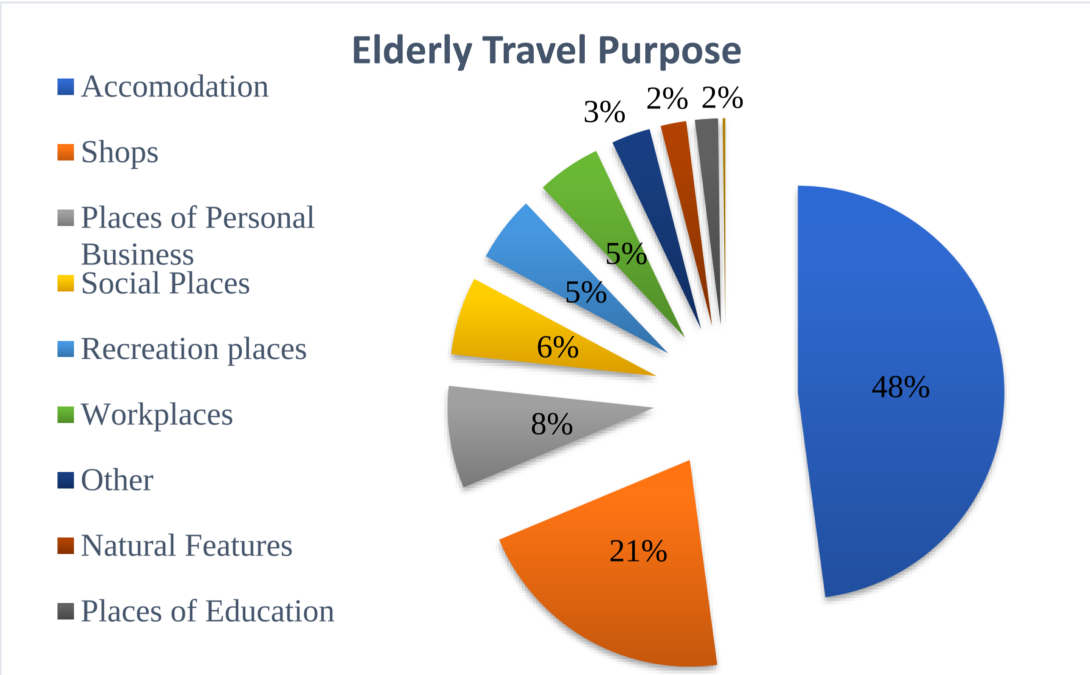

Figure 3. Elderly trip purposes based on Victorian Integrated Survey of Travel and Activity (VISTA) data (2016) for Melbourne, Australia.

3.3. Private Transport Preference

Improved mobility and quality of life are inextricably linked. The absence of adequate movement can be associated with poor health and wellbeing [14,20–22]. Various studies examined transport-related social exclusion [23–27]. One of the critical findings of these studies is that a lack of transport supply or access to transport provision can lead to social exclusion. [25].

Many elderly people prefer driving as a mode of transport, with today's seniors having a higher driving license rate than previous generations [28]. If an older person is unable to drive, it may also affect their immediate family through the need to provide transport support.

The trend towards car dependence is not a positive feature in an aging society [29]. Preference towards private transport has considerable impacts on congestion [30,31], road safety and the environment [2]. Many trips by seniors are short trips leading to an increasing number of cold starts. Catalytic converters require a certain period before activated, and short trips comprise a higher proportion of trip time under cold start conditions (typically the first 3 km of every journey from a cold start). The result is more atmospheric pollution (carbon dioxide emissions) and increased congestion on road networks [2,32]. Moreover, elderly drivers also face navigational problems (mainly those aged over 75 years), particularly when traveling through unfamiliar areas.

3.4. Attitudes towards Public Transport and Walking

A typical trip using public transport involves identifying the right service, walking to the public transport stop, boarding the vehicle, finding a seat, deciding where to alight, coping with interchanges as necessary and completing the journey to the destination [33]. For such a trip, travelers need to be confident that all trip links are manageable (accessible, coherent, compatible and continuous). For the elderly, this information can be complicated, leading to them not using public transport. Some case studies contribute to understanding attitudes towards public transport. For example, in Melbourne, Australia, until the early 1950s, most intra-urban travel was done by train, tram or bus [7]. However, following suburban development along outwardly radiating train and tram lines, the mode choice pattern changed. Outer suburban growth was associated with a rise in car ownership levels in the late 1950s [34,35]. As this continued through the 1960s and 1970s, residential development occurred further away from fixed tram and train routes [36]. Travel within and between the newly built housing areas required a private vehicle because tram/train services were beyond walking distance. Moreover, the low population densities made bus services uneconomical. Moreover, preferred destinations were too far for walking, and this tended to favor car use. Most case studies describe similar travel mode preferences.

Table 1 summarizes the use of different travel modes by the elderly in Melbourne using VISTA datasets (2016). This shows that the elderly use private vehicles as their dominant form of transport (81.0%), compared with public transport (12.5%).

Table 1. Elderly weekday travel mode based on VISTA data (2016) for Melbourne, Australia.

Types of Mobility	Mode of Transport	Elderly Users (%)
Public Transport	Bus	1.5
	Tram	2.5
	Train	8.5
Active Transport	Walking	2.7
Private Vehicle	Vehicle Driver	79.0
	Vehicle Passenger	4.0
Other	Other	1.8
Total	**Total**	**100.0**

4. Infrastructure Improvements

For the elderly, public transport or walking as the primary mode of transport is not always suitable. The elderly face several barriers to access including poor quality surfaces and the absence of railing at ramps [18]. Some jurisdictions have improved the design of steps, gaps, barriers and wheelchair slopes for the ambulant disabled and elderly. Furthermore, some strategic proposals have been implemented to facilitate public transport use among the elderly. Table 2 provides a synthesis of various infrastructure improvement studies for the elderly, grouping strategies into ticketing and fare concessions, special public transport services, public transport vehicle and stop improvements, elderly housing planning and alternative transport.

Table 2. Synthesis of infrastructure improvement studies for the elderly.

Strategies	Previous Studies
Ticketing and fare concessions	Discounts for off-peak rail travel can attract senior travelers and help the transport system's commercial revenue. A mixture of buses, community transport, taxis and lift-giving with good publicity and reliable services can also increase mobility among older people (mainly in rural areas). Moreover, providing more benches, more public toilets and better street lighting can make walking more comfortable and more attractive to the elderly [6].
	The London concessionary travel scheme, funded by London local authorities, allows free off-peak travel for elderly and disabled residents on buses, the Underground, Docklands Light Railway and London rail services [33]. This travel scheme represents the most advantageous scheme in terms of cost to users and the geographical extent of travel.
	Free bus passes for passengers aged over 60 have also been provided [37].
Special public transport services	Providing special transport services for people who are unable to use public transport or car, usually through public procurement of taxi services [38].
Public transport vehicle and stop improvements	For passengers with reduced vision, tactile markers can lead the way to buses and shelters; this modification also enhances safety for the elderly [39].
	Other improvements include space for a wheelchair with suitable safety provisions (including raised curbs), a boarding device to enable wheelchair users to get on and off vehicles, a minimum number of priority seats on buses for disabled passengers, specification of the size and height of steps, handrails to assist disabled people, color contrasting of features such as handrails and steps to help partially sighted people, easy to use bell pushes throughout a bus, audible and visual signals to stop a bus or to request a boarding device route information displays [40].
	Improvements need to also apply to new trains and trams. These are beneficial not only to the elderly but also for those with luggage or children [41].
Elderly housing planning	Housing planning should facilitate aging in place. The elderly need housing options that do not force them to depend on cars. Residential alternatives near secure shopping and medical choices to which they can walk or easily take public transit are some suggestions. This includes the elderly who choose to stay in their home to get home delivery services for everyday goods [2].
Alternative transport	School and post office vehicles can be used as support vehicles for the elderly. However, the unsuitability of insurance, administration, design, availability and routing arrangements can pose difficulties [42].

5. Accessibility Index Studies

Transport accessibility is a measure of reaching (and interacting with) destinations/activities from a specific origin space. A place with high accessibility is one from which many destinations can be reached quickly for a given amount of time/effort/cost. Accessibility indices are a popular method to measure transport quality. The public transport and walking accessibility indices presented in this review can also relate to elderly accessibility. Datasets, variables and methods are easily applicable to elderly accessibility studies.

5.1. Public Transport Accessibility Studies

Accessibility in transportation indicates the quality of travel for a group of people (or an individual) and the ability to reach the desired destination. The growth in complex and different routes is a characteristic of inflexible and poorly networked public transport services [21,43]. Calculations of accessibility are mostly based on distance from origin, area of destination, travel time and population. While different accessibility indices have been developed, there is no single best approach to measuring public transport accessibility [44]. Accessibility indices can be classified into two different themes: distance-based and time-based methods. Accessibility index studies focused on the elderly are particularly limited, due to insufficient data for this population group. Table 3 provides a synthesis of distance-based accessibility index studies, while Table 4 summarizes time-based accessibility index studies. Most accessibility indices for the elderly are distance-based.

Table 3. Synthesis of distance-based accessibility index studies.

Index	Definition	Highlights
Utility-based accessibility [44,45]	Assumes that individuals maximize their utility or destination.	Individuals' accessibility is calculated based on traveler's preferred activity opportunities/destination, rather than just the nearest opportunity/destination. A key disadvantage is that it requires extensive data collection of individuals' travel patterns and opinions.
Two-point distance accessibility [46–52]	Counts the distance from one location to a given destination.	Considers several components: network connectivity, the distance between origin and destination, service quality, elderly participation, mixed land use, service connection and number of trips and parking.
Cumulative-opportunity measure [53–56]	Assesses the number of opportunities/destinations commuters can reach within a given travel distance threshold. Basic index is: $A_i = \sum_{j=1}^{J} B_j a_j$ Where A_i is accessibility measured at a point i to potential activity in zone j and a_j is opportunities in zone j; B_j is a binary value equal to 1 if zone j is within the predetermined threshold and 0 otherwise.	Data requirement is simple and basic. Travel distances calculated as straight-line distances between zones, network distances along the shortest path between zones or a combination of these.
Land Use and Public Transport Accessibility (LUPTAI) [57–59]	Produced via destination-based accessibility analysis in GIS and applied to datasets obtained from many sources; using information relating to land use as well as road/pedestrian and public transport networks.	Considers many variables. Disadvantage is that datasets are sometimes not readily/accurately available.
Public Transport Accessibility Level (PTAL) [60,61]	Often used in United Kingdom to assess the accessibility of different geographical areas to public transport.	Simple, easily calculated approach that hinges on the distance from any point to the nearest public transport stop and service frequency at those stops.
Public Transport Accessibility Index (PTAI) [62]	Assesses the level of accessibility in the Melbourne metropolitan area. Index is: $PTAI_{SA1} = \sum_{j=1}^{3} \sum_{i=1}^{I} \left(1 + \frac{D_{Bij}}{D_{SA1i}}\right) * WEF_{SA1i}$ Where $PTAI_{SA1}$ denotes public transport accessibility index for a given SA1, D_{Bij} is the population density of buffer i for public transport mode j. D_{SA1} is the population density of the SA1, WEF_{SA1i} is the weighted equivalent public transport frequency calculated for the corresponding SA1.	Relevant to measuring public transport access but does not consider public transport route connections, which affects transport accessibility.
Service Accessibility Transport Disadvantage Index (SATDI) [63]	Considers two variables as utilization of accessibility by the elderly and quantifying the public transport availability. Provides a spatial index to quantify the degree of service accessibility transport disadvantage for the elderly population in two specific regions of South Australia.	Considers bus frequency and walking distances for the elderly. Provides a good measure of regional elderly public transport accessibility but would be more complex for metropolitan areas with a combination of different services.

Table 4. Synthesis of time-based accessibility index studies.

Index	Definition	Highlights
Time-Based Transit Service Area Tool (TTSAT) [64]	Considers transit service areas based on users' travel time.	All components of travel time from traveler's origin to destination (i.e., walk time, wait time, in-vehicle time, etc.), are included. Considers passengers' maximum acceptable walk time and total trip time.
Person-based measures [65]	Measures each person within a given time frame.	Calculation is mainly applicable to small sample sizes.
Gravity-based measures [44,66–69]	Follows Newton's theory of gravity. Considers that trips produced at an origin and attracted to a destination are directly proportional to the total trip productions and the total attractions. The basic gravity model used by Hanson is: $A_i = \frac{\Sigma_j a_j * f(d_{ij})}{A}$ Where a_j is the attraction in zone j, d_{ij} is the travel time, distance or cost from zone i to zone j, $f(d_{ij})$ is the impedance function and A is a standardizing factor.	Based on the spatial distribution of residence and travel time or cost.
Local Index of Transit Availability (LITA) [70]	A study of LITA used three primary time variables for calculation.	Considers the frequency of the service, capacity and coverage of service. Also considers the population.
The elderly population and time-based index [71–73]	A recent study introduced elderly time-based accessibility.	Considers elderly walk time, average waiting time, in-vehicle time and population. Index focused on key destinations relevant to the elderly.

5.2. Walking Accessibility Studies

A growing number of researchers and health practitioners encourage walking as a transport mode [74–81]. Measuring walkability generally involves analyzing individuals' willingness and ability to walk to various local destinations [82]. The proportion of elderly people is rapidly increasing, but when it comes to physical activity, they tend to be underrepresented [83]. The ability for elderly people to walk depends on a range of factors, such as physical strength and cognitive-motor skills, which generally result in elderly people walking slower than other adults [84]. Much research has involved studies of walkability [81,85–89], with most of the elderly walkability studies based on health-related aspects [80,90]. Some of the existing walkability indices include different variables, depending on the theoretical underpinning of the method used and the local availability of data. However, few indices have been validated against actual survey data [78]. Research on walking accessibility for Australian elderly people [88] highlighted that elderly adult walking travel patterns are different from other adult walking patterns. This study also found that walking habits for the elderly were positive for social purposes, such as travel to religious places, restaurants and hairdressers.

Table 5 provides a synthesis of previous walking accessibility studies. Walking accessibility indices are classified into distance-based, gravity-based, topological/infrastructure-based and walkability/walk score-type measures.

Table 5. Synthesis of walking accessibility studies.

Index	Definition & Highlights
Distance-based accessibility [46,81]	Considers distance between two specific points: (1) Distance to closest destination, (2) number of destinations within x meters or minutes, (3) mean distance to all lengths and (4) mean distance to the closest destination.
Gravity-based accessibility [81]	Follows Newton's theory of gravity. Trips produced at an origin and attracted to a destination are directly proportional to total trip productions at the origin and total attractions at the destination. Based on spatial distribution of residence and travel time/cost between zones. Basic model: $A_i = \frac{\Sigma_j a_j * f(d_{ij})}{A}$ Where a_j is the attraction in zone j, d_{ij} is the travel time, distance or cost from zone i to zone j, $f(d_{ij})$ is the impedance function and A is a standardizing factor.
Topological or infrastructure based [81]	Does not focus on origin and destination of neighborhood. Considers network connectivity and/or characteristics of walking infrastructure.
Walkability/walk score-type measures [81]	Considers built environment and accessibility from an origin to a destination
Walk Score [91]	One of the most common approaches for walkability. Considers distance to closest destination in each land use category. Based on gravity-based model.
Walkability Index (WI) [92–96]	Considers factors such as dwelling density, street connectivity, land use mix (LUMIX) and net retail areas. The WI calculates from the sum of z-scores of the four urban form measures. The typical form of the WI is: WI = (Z-scoreLUMIX) + (Z-ScoreResidential Density) + (Z-ScoreStreet Connectivity)
National transport-specific walkability index [95,97]	Analysis for Australian capital cities relevant to transport-related walking behaviors.

6. Mode Choice Studies

Previous research has used travelers' social and travel information to improve journey and network conditions. Commuters' social and travel patterns affect their travel mode choices [98]. Mode choice models analyze the probability of choices that individuals/groups of people make in selecting transport modes for different types of trip. These models used socio-economic and built environment variables to analyze mode choice. Moreover, these models are also applicable to elderly mode choice probability using similar variables. Several studies have analyzed mode choice using a range of different mathematic models as follows.

1. The Multinomial Logit (MNL) Model: one of the most used and flexible models [99], which analyzes a set of categorized dependent and independent variables to identify outcomes. It is used to predict a nominal dependent variable given one or more independent variables. Several researchers have used MNL models to establish mode choice preference [100–108], including the relationship between car ownership and elderly mode choice [109]. The MNL model is sometimes considered an extension of binomial logistic regression.
2. The Binary Logit Model: the basis of the binary logit model is the theory of utility maximization [110]. The binary logit model estimates a relationship between one (or more) explanatory variables and a single output binary variable. Most of the research studies focused on travel mode selection as an output binary variable [111]. Explanatory variables typically include age, sex, income, car ownership, household characteristics and trip details.
3. Mixed Multidimensional Choice Model: This mode choice model is a joint approach to the various modeling processes. In this approach, an MNL model of residential location ordered logit models of vehicle ownership/bicycle ownership, and an MNL model of commute tour mode choice/the models are econometrically joined to form a joint model system [98,112]. A working paper study of [113] represented a similar model called Integrated Choice and Latent Variable Models (ICLV). ICLV models considered an estimation of Structural equation models (SEMs) and a discrete choice model (DCMs) [114].
4. Hierarchical Mixed Logit: a multilevel travel mode choice model has been developed in previous research [110]. This mode choice model focused on individual and place heterogeneity. Individual heterogeneity is considered as a micro-level impedance while traveling is considered as a macro-level impedance [115–117].
5. Discrete Mode Choice Models: Discrete choice models can describe many forms, such as binary logit, binary probit, multinomial logit, conditional logit, multinomial probit, nested logit, generalized extreme value models, mixed logit and exploded logit. Discrete choice models explain and predict choices between two or more distinct alternatives [118–121].
6. Econometric Model: The econometric model [122] framework analyzes mode choice and travel distance as a combined form. For this model, mode choice is a discrete choice, and travel distance is a continuous variable.
7. Hybrid Choice Model (HCM): a new generation of discrete-choice models that integrate discrete-choice and latent-variables models [123]. This model describes the relationship between the indicators and the psychological factors for commuters [124,125].
8. Walking Mode choice: A study by [126] provided a detailed literature review regarding walking as a mode choice. The study follows the methodology as a hierarchical structure for mode choice. A research study of [127] indicates that route choice is one of the major influences for elderly walking mode choice.

7. Datasets

Most of the elderly transport-related studies are case study based and use geographical information systems [128,129]. These studies used datasets from variable sources such as household travel surveys, open government data and public transport timetable and route data [130]. Table 6 provides a summary of the most common datasets used for elderly travel analyses. These datasets are typically analyzed using statistical analysis software tools such as Statistical Package for the Social Sciences (SPSS), Statistical Analysis System (SAS), ArcMap and Australian Urban Research Infrastructure Network (AURIN).

Table 6. Datasets summary.

Dataset/Variable	Application	Highlights
Living area: elderly living in a specific geographical area	Public transport accessibility index, walking accessibility index, public transport mode choice model, walking mode choice model.	Most studies target a case study. Depending on the case study, geographical area calculation for indices and mode choice model analysis are conducted.
Travel pattern: places that the elderly visit most (e.g., medical centers, recreation centers, shopping centers).	Public transport accessibility index, walking accessibility index, public transport mode choice model, walking mode choice model.	Several studies are conducted based on the travel destination. As the destination is different for elderly travelers, it is one of the most used variables for elderly studies.
Travel distance: average distance from place of residence to destination.	Public transport accessibility index, walking accessibility index, public transport mode choice model, walking mode choice model.	For distance-based accessibility index, travel distance is a critical variable. Some studies used accessibility indices to analyze mode choice.
Walk time: elderly walk time is considered for PT and walking accessibility measures.	Public transport accessibility index, walking accessibility index, public transport mode choice model, walking mode choice model.	As elderly walking speed and time are different from other adults, it is a critical variable. Several studies developed a walking accessibility index and used those indices for mode choice analyses.
Travel time: specific time or part of the day mostly spent traveling.	Public transport accessibility index, walking accessibility index, public transport mode choice model, walking mode choice model.	For time-based accessibility index, travel distance a critical variable. Some studies used accessibility indices to analyze mode choice.
Travel mode: public transport and walking to reach the type of destination.	Public transport accessibility index, walking accessibility index, Public transport mode choice model, walking mode choice model.	For accessibility index, travel mode datasets are mostly used for validation purposes. For mode choice analysis, it is a key variable.
Travel period: estimated trip time (actual time according to km distance) and total trip time (actual time traveled).	Public transport accessibility index, walking accessibility index.	Mostly used for validating indices.
Public transport frequency: Availability of train, tram or bus for a specific time of elderly travel.	Public transport accessibility index, public transport mode choice model	One of the key variables to develop a public transport accessibility index. Some mode choice models use this accessibility index.
Household data: contain various information such as trip time, mode, start zone, destination zone, travel time, travelers' age, sex, car ownership, etc.	Public transport accessibility index, walking accessibility index, public transport mode choice model, walking mode choice model.	For accessibility index, it is mostly used for validation purposes. Household datasets contain socio-economic information about travelers—this information is included in mode choice modelling.
Population: population density according to different targeted study level.	Public transport accessibility index, walking accessibility index, public transport mode choice model, walking mode choice model.	Considered a critical factor for accessibility index. Also found for mode choice model analysis.
Land mix-use (LUMIX): used to develop elderly walking accessibility indices.	Public transport accessibility index, walking accessibility index, public transport mode choice model, walking mode choice model.	Mostly used for public transport and walking mode choice model analysis.Several walking accessibility indices also considered LUMIX datasets.
Road network: used to analyze and calculate indices.	Public transport accessibility index, public transport mode choice model.	One of the key factors for measuring the closest facility to a public transport stop/destination.
Street connectivity: number of intersections connected in a neighborhood for walking access.	Walking accessibility index, walking mode choice model.	For walking accessibility analysis and walking mode choice, street connectivity is an important measure.
Safety: accident rates are extracted and analyzed from various databases.	Walking accessibility index, walking mode choice model.	Safety datasets mostly used as a measure of pedestrian safety or pedestrian accident rates. To develop walking accessibility indices, safety is considered a key variable. Studies also used these waking indices in mode choice models.

8. Conclusions and Future Research Directions

This paper has provided a literature review of travel patterns, mode preferences, infrastructure solutions, accessibility indices, mode choice models and datasets as they relate to elderly mobility. From the review of previous studies, elderly travel behavior largely depends on the specific characteristics of where elderly people live, including but not limited to, the geography of their city/country, public transport availability, travel costs and key trip purposes. Hence, this might be why most elderly travel studies focus on case studies.

The review of accessibility index studies highlighted various indices used in previous studies, including both distance-based and time-based methods. Researchers have used both methods to measures public transport and walking access based on their specific research objectives. A range of mode choice model studies have analyzed elderly travel mode preferences. Mode choice is found to be directly associated with built environment and socio-economic variables. This review also provided a summary of relevant datasets used in different studies. For small area case studies, some researchers have used surveys, while others have collected information from available databases. While this review has synthesized various aspects relating to elderly mobility, the review did not consider elderly private transport accessibility and private transport mode choice model studies. Future review studies should include these classifications. Future research is also needed to further explore mobility impaired and disadvantaged groups among the elderly population.

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