

# Study of Aging-appropriate Design of Public Transportation Facilities in Berlin

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## Abstract

**The construction of an aging -appropriate environment for public transportation meets the needs of an aging society. This paper takes the aging-appropriate facilities of public transportation in Wannsee District of Berlin as an example, and analyze the behavior needs of the elderly in Germany to take public transportation from several aspects such as visual accessibility, auditory accessibility and behavioral accessibility to summarize the aging-appropriate design of public transportation carriages, waiting cars and transfer facilities, which can serve as a reference for the aging-appropriate design of public transportation facilities in other countries.**

## Keywords

**Germany; Public Transportation; Aging-appropriate Facilities.**

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## 1. Introduction

As the global trend of population aging intensifies, the elderly face serious challenges in their daily travel. Many countries lack targeted measures to address the possible difficulties and accessibility needs of the elderly in public transportation facilities. To some extent, this places the elderly in a disadvantaged position and affects social equity. Germany has been an aging society since the 1960s, and has developed a mature system of aging-appropriate public transportation facilities through exploration and research.

## 2. A Survey on the Aging-appropriate Facilities of Public Transportation Carriages in Wannsee District, Berlin, Germany

Under the community-based and home-based care model, the elderly in Germany are focusing on wellness and improving their quality of life, and the purpose of travel is shifting from survival to life. Walking is the main mode of travel, supplemented by public transportation. Aging-appropriate facilities on public transportation are accessible facilities provided by public transportation to enable the elderly to travel long distance. The types of public transportation includes the S-Bahn, U-Bahn, Stadtbahn, Tram, and bus.

### 2.1 The Design of Aging-appropriate Facilities for Bus Carriages

Buses are barrier-free. Taking the Nioplan N4516 as an example in Wannsee District, the driver can adjust the tilt of the vehicle through the control system after it stopped stably at the station according to the specific needs of the elderly, wheelchair users, and passengers with infants and toddlers. The body of the bus tilts 20 degrees to the door side, and the bottom of the front and rear door is only 100mm from the vertical height of the shoulder so that the elderly can get on and off the bus easily. (as shown in Figure 1).

There is an aided plate at the rear door of the bus, which should only be used when the bus is stationary. When the passenger door is closed, the aided plate is embedded in the body and cannot work. When the aided plate is not retracted, the passenger door or the wheelchair access door cannot be closed (as shown in Figure 2). The width of the aided plate is 800mm. When the body is tilted and the aided plate is placed on the shoulder at a height of 150mm, the slope between the body and the ground is about 12%. There are devices on both sides of the aided plate to prevent the wheelchair from rolling out of the edge, and the load capacity of the aided plate is 300kg. Besides, there are emergency handrails on both sides of the boarding area (as shown Figure 3).

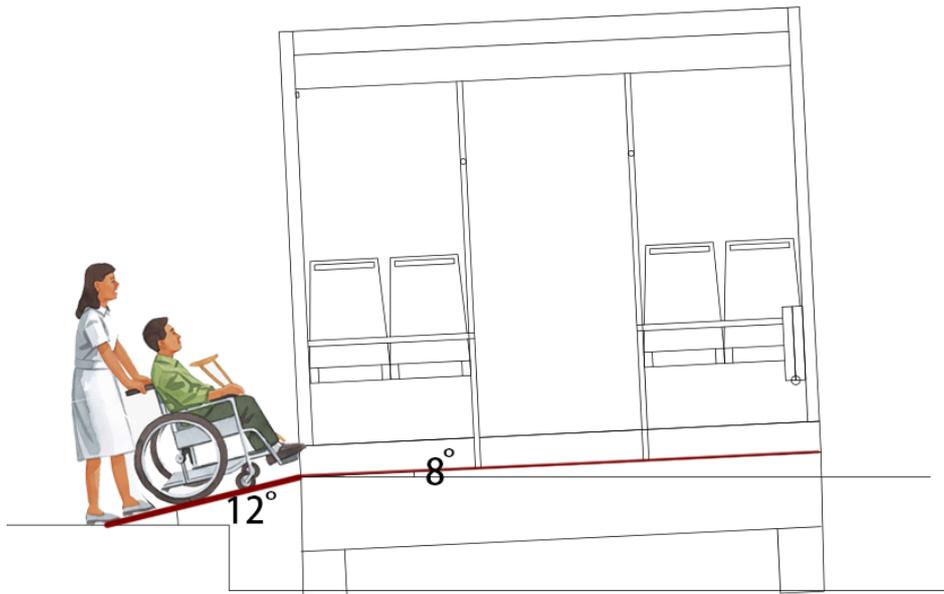


Figure 1 Tilt State of the Bus Entering the Station

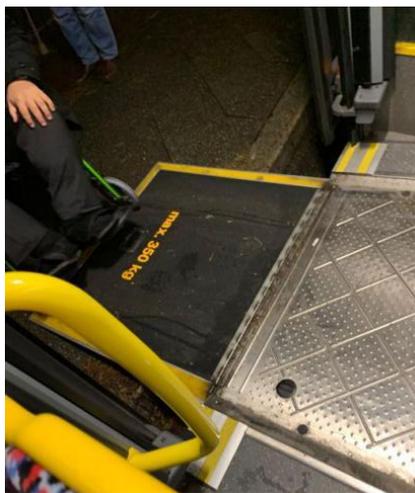


Figure 2 Wheelchair Boarding the Bus



Figure 3 State of Unfolding the Aided Plate

The rear door area is provided an accessible special-need area for disabled vehicles for the elderly or special vehicles for infants and toddlers. The area is 750mm wide and 1300mm long, with vertical anti-collision cushions and wheelchair fixed devices. The area is also equipped with temporary seats for standing or sitting when there is no need for use. Communication devices and emergency brakes devices are installed between 700mm-1200mm from the floor, (as shown in Figure 4). The floor of the wheelchair area is clearly marked, and the surface of the floor is made of anti-slip material.

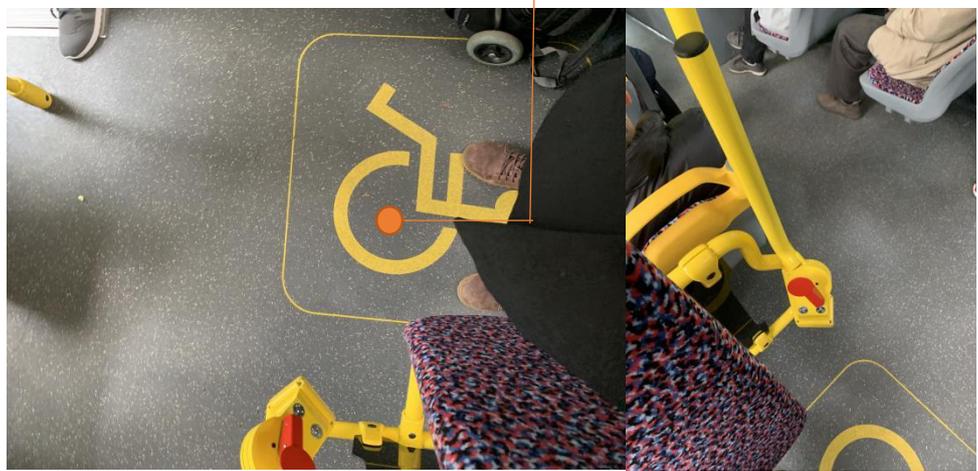
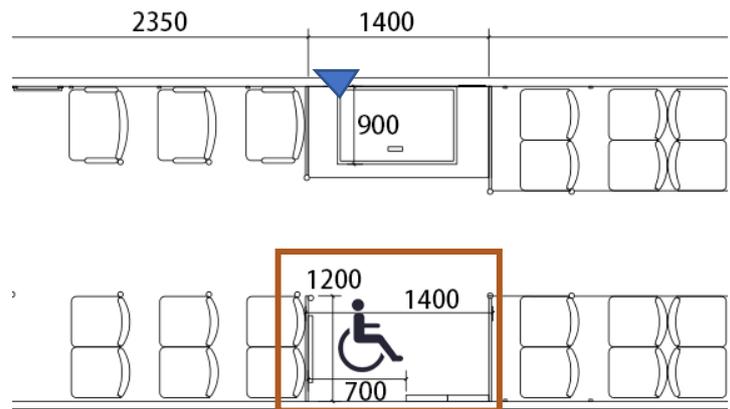


Figure 4 Bus Accessible Special Needs Area

There are communication devices in all parts of the bus and an emergency door opener button at the door. There are communication devices near each seat and the wheelchair area (as shown in Figure 5), which are between 700mm-1200mm high from the floor. For the non-seating area, the height of the communication devices is between 800mm-1500mm from the floor. All internal communication devices are controlled by hand, with Braille engraved on the buttons. The colors are warm yellow and green for easy identification (as shown in Figure 6).



Figure 5 Braille Signage on Bus Button



Figure 6 Bus Communication Devices Layout

Priority seats accounting for a third of the total number of seats with a standard width of 450mm are arranged in an arrangement opposite at the front of the bus. Handrails or handles are installed near priority seats, which are convenient for the elderly to grasp. The three priority seats on the door side are wide seats with a space for a guide dog to lie down. The height-adjustable seats near the accessible boarding doors with a 400mm up-and-down movable range and are equipped with USB charging ports and communication devices (as shown in Figure 7).

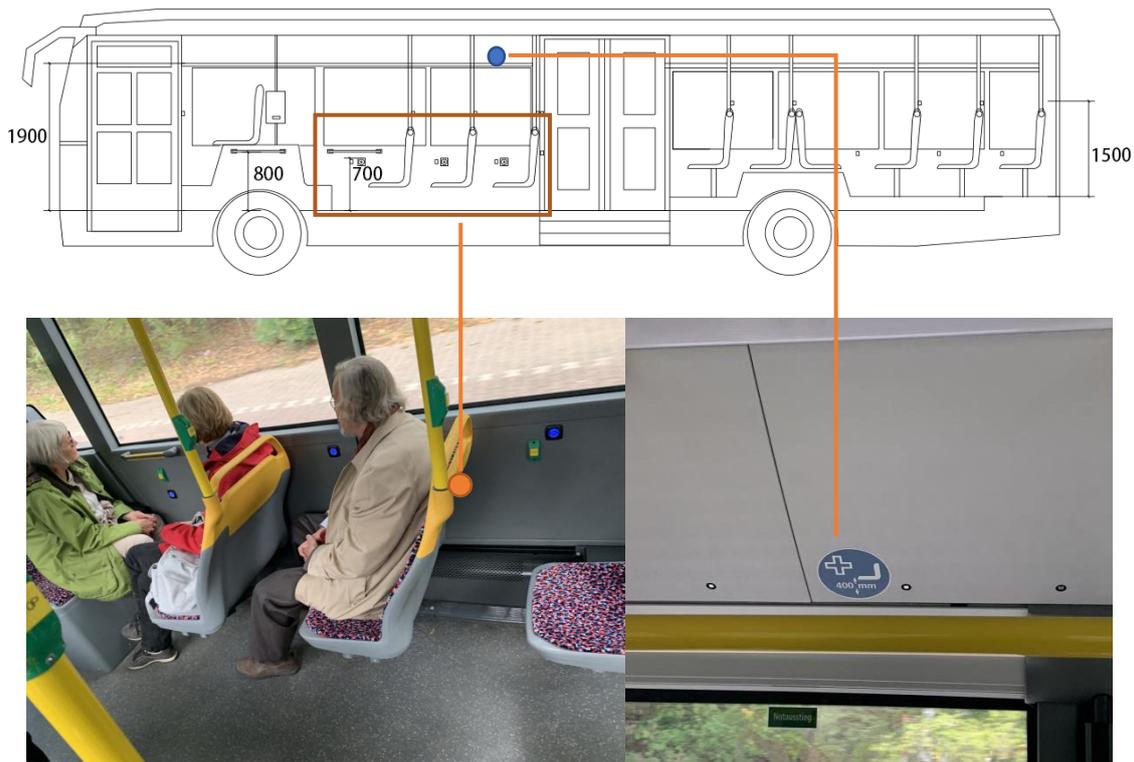


Figure 7 Priority Seating Diagram on a Bus

The space for moving on the bus is very wide, whose spatial layout is more friendly to the elderly who use mobility aids (as shown in Figure 8). Mobility aids commonly used by the elderly in buses include wheelchairs, crutches, and blind canes. The relationship between the conditions of use and the spatial scale of the human body and the mobility aids for a particular group of users is as follows: The minimum moving width for the elderly using crutches, wheelchairs and strollers is 950mm, 1100mm, and 800mm respectively.

Armrest height for wheelchair users is 650mm and accessible height for wheelchair users is 1200mm. The minimum size of the wheelchair is 1800mm at a 180 degree angle of rotation.

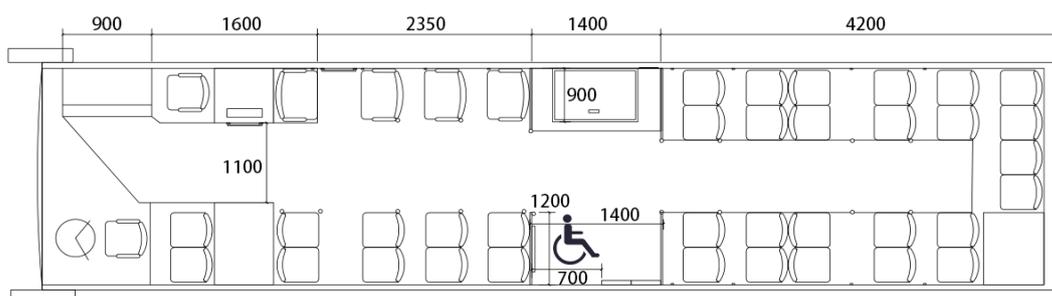


Figure 8 Bus Scale Plan

It is easy to conclude the aging-appropriate design features of bus carriages, including slight height difference in boarding, wide doors, upper and lower aided plates; sufficient video, audio, and visual sensing devices as well as simple structure, smooth styling, and vibrant colors. In addition, the features also include special emergency facilities, emergency call system settings, space for wheelchair or strollers and anti-slip treatment for grasping bars.

German buses have eliminated the need to check tickets for boarding, effectively reducing the waiting, walking and standing time for the elderly. Passengers can purchase season or annual tickets at the bus station or at the driver's office without checking their tickets. Passengers who have purchased a temporary ticket need checking their tickets at the ticket machine at the front of the bus, which is equipped with a safety handrail at a height of 1200 mm from the floor.

## 2.2 Aging-appropriate Design for Rail Transit Carriage Facilities

S-Bahn, U-Bahn, and Stadtbahn can realize accessible boarding. The floor of the vehicle is level with the height of platform, allowing the elderly in wheelchairs or pushing bicycles to board the carriage easily (as shown in Figure 9). A parking area for wheelchairs or strollers is provided in S-Bahn, which can also be used for bicycle parking. This area is equipped with temporary seats for standing or sitting when there is no need to park a wheelchair, etc., and the floor surface is made of anti-slip material (as shown in Figure 10).



Figure 9 Accessible Boarding on Rail Transit



Figure 10 Temporary Seat

There is a quiet zone in S-bahn, which is suitable for the physical and mental health of the elderly. Loud noise and telephone calls are not allowed in quiet areas. This zone is in contrast to the noisy environment outside. Meanwhile, the addition of the function similar to foyer makes the temperature in the area more constant, and the temperature difference caused by opening and closing the door changes little (as shown in Figure 11). The low-height luggage racks near the doors of S-bahn greatly facilitate the elderly who are carrying large luggage but have difficulty in lifting it (as shown in Figure 12).



Figure 11 Quiet Zone Divider



Figure 12 Low-height Luggage Rack

### 3. Summary of Public Transportation Problems and Aging-appropriate Carriage Facilities for the Elderly

Based on the above-mentioned survey on the aging-appropriateness of taking public transportation and waiting facilities, the possible problems of the elderly using public transportation and the corresponding measures for aging-appropriate facilities are summarized below.

Types of Dysfunction		Possible Problems During Travel	Corresponding Measures and Facilities
Vision Dysfunction	Poor eyesight, hyperopia, myopia, color, weakness etc.	Unable to recognize traffic conditions	Voice broadcast of vehicle entering station
		Unable to see the interior environment clearly	Warm color scheme of the signage to increase recognition
		Unable to realize self-service ticketing	Elimination of ticket check for boarding directly
		Unable to distinguish vehicle button functions	Braille signage added to buttons
Hearing Dysfunction and Lalopathy	Poor hearing and reduced expressive ability	Unable to tell where to stop	Stop reminder buttons in buses
		Unable to get voice information	Electronic screens in buses to synchronize text messages
Physical Impairment	Mobility aids for travel like wheelchairs	Necessary accessible boarding	A tilt of bus body to unfold the aided plate to create a slope
			Rail carriage flush with the height of platform
		No wheelchair parking area	Multifunctional area for wheelchairs, bicycles, and strollers, including temporary seating for temporary seating
		Greater demand for passing width of mobility aids	Increase the width of the passage in the bus.
		Unable to fix itself in an emergency	Anti-slip floor, emergency handrails and vertical anti-collision cushions and wheelchair fixing devices in wheelchair parking areas of buses
		Reduction of accessible height	Accessibility of handrails, buttons, etc. in the body of the vehicle
Physical Decline	Easily fatigued, decreased mobility, and decreased immunity	Unable to complete leg lifting and boarding	A tilt of the vehicle entering the station, reducing the height difference between the chassis and the road.
		Unable to stand or immobilize in an emergency	Emergency handrails in the vehicle and vertical anti-collision cushions in the wheelchair area.
		Unable to lift luggage	Low-height luggage racks in the vehicle
		Large temperature difference between carriage doors in winter	Quiet zone added to a divider with a function for keeping warm similar to a foyer
Don't like noise, or need a nap.		Quiet zone inside the vehicle with separate doors	

### 4. Aging-appropriate Design of Public Transportation Waiting and Transfer Facilities

#### 4.1 Aging-appropriate Design of Public Transportation Waiting Facilities

##### 4.1.1. Aging-appropriate Waiting Facilities of Bus Stop

Bus stops are easily recognizable, usually with large signage. There is a circular sign on the top two sides of the signage (as shown in Figure 13). The green letter "H" is the abbreviation for bus stop in

German. For the elderly with visual impairment, the green-on-yellow contrast of the warm color is easily recognizable.



Figure 13 Bus Stop Signage and Electronic Information Screen

The bus stop information can provide the elderly with information services such as travel guidance and arrival reminders (as shown in Figure 13). On the platform, there are bus schedules and route maps passing through the station, and the bus schedule is accurate to the minute. If there is a delay, it will be presented on the electronic screen, which can effectively reduce the elderly's energy consumption due to unknown waiting. At the same time, it solves the inconvenience caused by the elderly who do not know how to use cell phones to check the arrival time of the bus.



Figure 14 Bus Waiting Facilities

Bus stops are equipped with waiting facilities constructed of stainless steel and thickened glass (as shown in Figure 14). They are not only shaded from the sun and rain but also protected from the wind and cold along with wooden benches inside for passengers to rest. Most importantly, the elderly have

the priority to use them. There is automatic lighting at night, and the color of the long wave is yellow according to the visual condition of the elderly.

#### 4.1.2. Aging-appropriate Design of Rail Transit Waiting Facilities

S-Bahn, U-Bahn, and Stadtbahn stations are equipped with waiting facilities constructed of stainless steel and thickened glass (as shown in Figure 15). They are not only shaded from the sun and rain but also protected from the wind and cold along with wooden benches inside for passengers to rest. Most importantly, the elderly have the priority to use them. Smoking is forbidden in the waiting, but pets are allowed to enter.



Figure 15 Rail Transit Waiting Facilities

Figure 16 Electronic Information Screen at Platform

The platform information in the station of S-Bahn, U-Bahn, and Stadtbahn can provide the elderly with information services such as travel guidance and arrival reminders. On the platform, there are schedules and route maps passing through the station, and the schedule is accurate to the minute. If there is a delay, it will be presented on the electronic screen, which can effectively reduce the elderly's energy consumption due to unknown waiting. (as shown in Figure 16)

## 4.2 Aging-appropriate Design of Public Transportation Transfer Facilities

By transfer between different types of public transportation, the travel distance of the elderly can be effectively increased and their living circle can be expanded. The aging-appropriate facilities of public transportation in Berlin help the elderly to easily transfer between different modes of transportation so as to continuously improve the convenience, reliability and comfort of public transportation.

### 4.2.1. Transfer between Rail Transit and Bicycle

Bicycles are allowed on the S-Bahn (There are bicycle parking areas in some carriages.), and parking and bicycle storage areas are located outside the Wannsee Station, where bicycles can be pushed to the platform by straight, barrier-free lift or step aided devices (as shown in Figure 17).

### 4.2.2. Transfer between Rail Transit

Most stations adopt the same platform transfer design to facilitate transfers between different rail lines, saving transfer time and walking distance (as shown in Figure 18).

### 4.2.3. Transfer between Bus and Rail Transit

Bus stops are located outside the Wannsee Station of S-Bahn to shorten the walking distance for transfers. U-Bahn, and Stadtbahn, Tram and bus share a common electronic ticketing system, which allows passengers to take different public transportation modes within a city together with measures

such as no checking tickets for boarding, which greatly simplifies the boarding process for the elderly to reduce travel difficulties.

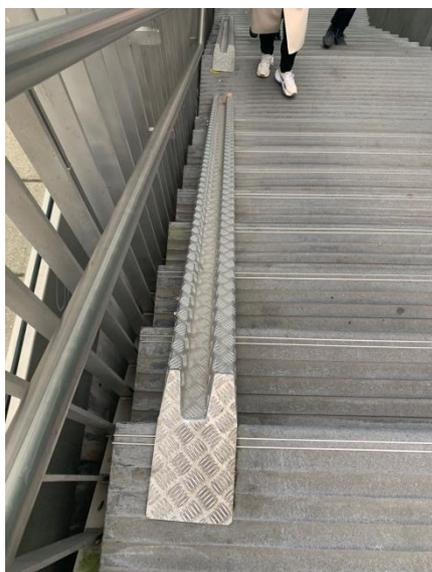


Figure 17 Bicycle Step Aided Device

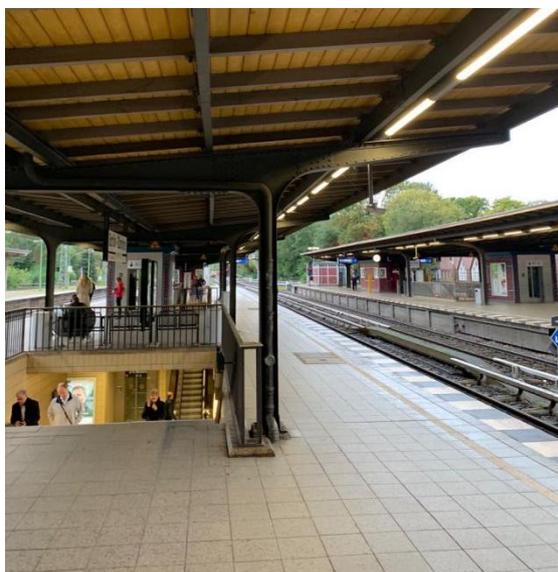


Figure 18 Transfer Platform in Station

The convenient transfer of public transportation in Berlin has improved the public transportation experience of the elderly and greatly extended their daily travel radius. The different types of public transportation and the ways in which they travel are summarized below.

Regional Travel Modes	Walking/ Wheelchair	Bus	Bicycle	S-Bahn
Travel Scope	Residential circles	Residential circles, Regional circles	Residential circles, Regional circles	Urban circles
Aging-appropriate Measures	Roads - accessible paving; crosswalks - crossing reminding devices; environmental signage, signage and street signs	Accessible boarding facilities; emergency communication devices; special seating for the elderly; Scale design with accessibility scale as the standard;	Dedicated bike lanes to upgrade bicycle riding grades; brightly colored pavement	Accessible boarding facilities; silent carriage; information services such as arrival reminders; intelligent bus system platform
Transportation Transfer Facilities	The rear door is equipped with an aided plate to adjust the tilt of the body to achieve accessible boarding; There is a wheelchair area in the vehicle, with safety fixings and anti-slip floor.		A bicycle parking area near the station; Stations with lifts, ramps, or push aided facilities; Multifunctional seats are installed that can be changed into bicycle areas.	
Transportation Transfer Basis	All stations are provided with route operating schedules with high punctuality, ensuring timely transfer connections for all schedules;			
	Public transportation tickets are common to all types of public transportation and are economically priced;			
	Accessible facilities are available.			

### 5. Summary

The following conclusions can be drawn from a survey of the aging-appropriate public transportation facilities in Berlin.

(1) Through the adoption of active aging-appropriate design of public transportation infrastructure for dysfunction such as visual impairment, hearing impairment, physical impairment, and physical decline, it fully reflects the important supporting role of public transportation infrastructure for the elderly travel to change the purpose of elderly travel: from survival to life.

(2) The priority level of public transportation is used to guide the elderly to choose different modes of transportation. The choice of transportation mode is the core of public transportation for the elderly. The development of public transportation should not only take into account the regular needs of young and middle-aged users, but also improve the accessibility of public transportation to create a fair, harmonious and efficient travelling environment. Therefore, it is necessary to clarify the priority level of aging-appropriate design for public transportation facilities and establish an aging-appropriate system for public transportation facilities that is closely related to the slow-moving transportation system. This is an effective way to solve the current difficulties of public transportation for the elderly and to improve their travel quality.

(3) Meet the travel needs of the elderly in different physical states through diversified and orderly public transportation organizations. Diversified public transportation system and good public transportation service level jointly support the healthy and safe travel of the elderly. Combination of comfortable and free walking and biking environment with the public transportation system is good for realizing the conversion of accessible transportation mode. Furthermore, it will help expand the independent travel distance of the elderly under the premise of their limited physical strength.

## 6. Enlightenment

The model of community-based and home-based care for the elderly and aging-appropriate public transport organizations are compatible and promote mutual development. The fact that the elderly with physical disabilities are less likely to use public transportation (especially rail transit) does not mean that they do not need to use it. First of all, it is necessary to meet the safety requirements of the elderly. Secondly, it is necessary to optimize the psychological experience of independence and equality in the travel process gradually so that the elderly can travel independently, freely, smoothly and happily, which can promote the wellness experience of the elderly in the integrated medical treatment and care model. Meanwhile, the increase in the number of trips by the elderly can effectively promote to construct an aging-appropriate public transportation facilities.

## Acknowledgements

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