

Research on the improvement of conventional public transportation in the context of population aging

Wumeng Yang, Haolong Li, Qiyan Yao, Bin Hong*

School of Engineering, Tibet University, Lhasa, China, 850000

* Corresponding Author Email: 17773327131@163.com

Abstract. With the aggravation of the trend of population aging, the conventional bus planning and service in Lhasa city need to be adjusted continuously to meet the needs of the elderly, so that they can enjoy convenient transportation services to better integrate into the city life, so the conventional bus improvement in the context of aging is a relevant study. According to the research characteristics of this paper, Lhasa Chengguan District is selected as the research area, and the current situation of regular bus development in the region is briefly analyzed, and based on the Gaode Map API to obtain the station and road network data, the spatial barrier model is used to assess the accessibility of regular buses, and then ArcGIS is used to visualize the data. Finally, the conventional bus improvement strategy adapted to the aging society is proposed from the three aspects of bus stops and road network, bus facilities for aging, and bus service quality, so as to provide the elderly with more convenient, comfortable, and barrier-free bus services, thus realizing the sustainable development of Lhasa City.

Keywords: Population Aging, Conventional Public Transit, Spatial Barrier Modeling, Accessibility, Aging-friendly.

1. Introduction

As the capital of Tibet Autonomous Region, Lhasa is the most populous city in the region. In recent years, with the rapid development of social and economic development, the living conditions of the people have been significantly improved, and the medical and health service system has been continuously improved, and the life expectancy of the population has continued to increase, coupled with the declining fertility rate, which has led to the problem of population aging becoming more and more prominent, therefore, to meet the basic needs of elderly people's travel has become a top priority for the development of Lhasa at present. As an important mode of transportation for the elderly, it is important to study its improvement strategy to promote the convenience of elderly travel.

Scholars propose a variety of options for regular transit accessibility and age-appropriate transit research for older adults. Wei Wei[1] An improved potential model to explore the effects of bus detours and road gradient on public transit accessibility for the elderly. ghosh Tanmay et al.[2] Assessing demand and access to public transportation for equitable allocation of public transportation resources. Duan Meihua et al.[3] Improving a model for evaluating the distributional equity of public transportation system services among the elderly population using a method to measure the actual service coverage of bus stops. Li Junda[4] Studying the well-being of elderly people's regular bus travel and its related factors based on the level of bus service. Liu Meng et al.[5] Based on the experiences of Taiwan, Singapore, and Japan, we propose three measures to optimize the relevant policies and regulations, improve the urban public transportation network, and enhance the atmosphere of slow-moving travel for age-appropriate transportation in China's aging society. V. Dimitra Pyrialakou et al.[6] provides an assessment of transportation demand and demand gaps to explain the three essential elements of disadvantage for a particular population or region due to difficulties in accessing transportation or opportunities: accessibility, mobility, and realized travel behavior. He Changliang[7] A study on the characteristics of public transit travel of the elderly population in a plateau city with Lhasa as the research object. Zhang Yu et al.[8] An in-depth study and case analysis of the German experience in designing age-adapted public transportation services

and facilities to ensure independent travel of the elderly in the city of Berlin as an example. Yu Yifan[9] it is proposed that the exploration of aging transportation requires systematic reflection and innovation at the levels of public policy, planning and design, and social practice in order to cope with the challenges of population aging. Zongni Gu et al.[10] Summarize the experience of planning transportation services for disadvantaged groups in Florida, and based on this experience, propose the construction of an age-friendly public transportation environment for China's aging population.

Scholars have conducted a lot of research on regular bus accessibility and ageing transportation, and applied the research results to specific practices, which is of some significance for promoting the construction of ageing buses in cities. At present, scholars have done less research on the combination of population aging background analysis and regular bus accessibility assessment results, based on which this paper researches the improvement of regular buses in the context of population aging and proposes improvement measures in three aspects to make the bus system meet the needs of the elderly to the maximum extent possible, thus improving the quality of travel of the whole group of elderly people in the context of aging, and guaranteeing that the elderly can realize social participation and enjoy the convenient services of the city. The study also proposes improvement measures in three aspects to maximize the bus system to meet the needs of the elderly, thereby improving the quality of travel of the elderly group in the context of aging, and ensuring that the elderly can realize social participation and enjoy convenient urban services.

2. Analysis of the Current Situation of Conventional Public Transportation in the Context of Population Aging

2.1. Analysis of population ageing

Lhasa is located in the southwest of China, in the middle of the Tibetan Plateau and on the north side of the Himalayas, and is the political, economic, cultural, scientific and educational center of Tibet. The total area of the city is 29,640,000 square kilometers, with 3 districts and 5 counties under its jurisdiction. According to the Seventh National Population Census in 2020, the resident population of Lhasa is 867,891, of which 73,681 are aged 60 and above, accounting for 8.49%, and compared with the Sixth National Population Census in 2010, the proportion of the population aged 60 and above has increased by 1.29%, with an obvious tendency of population aging. The trend of population aging is obvious.

Organize Lhasa City districts (counties, functional parks) the seventh national census of the main data bulletin to get Table 1, Figure 1, the analysis can be seen that Chengguan District compared with other areas of Lhasa, the number of resident population accounted for more than half of the city, the number of people over the age of 60 is in the first place, and the level of economic development is higher, the conventional public transport supporting infrastructure construction is better, the line and the station coverage is wider, the selection of Chengguan District as the study area will make the research of this study has a strong significance of reality.

Table 1. Breakdown of the resident population and the number of elderly people in each district (county and functional park) of Lhasa City

District (county, functional park)	Number of resident population (persons)	Number of elderly people (persons)	Proportion of elderly population (%)
Chengguan District	473586	40374	54.8
Duilong Deqing District	91065	6518	4.39
Dazi District	32318	3237	5.23
Linzhou County	50596	5908	8.85
Dangxiong County	47900	3857	0.53
Nimu County	29989	3185	8.02
Qushui County	41851	4091	6.25
Mozhu Gongka County	49511	4602	4.32
Lhasa National Economic and Technological Development Zone	11804	389	5.55
Other	39271	1520	2.06

Note: 1. Due to incomplete data, others refer to the Tibet Cultural Tourism Creative Park and Lhasa Liuwu High-tech Zone

2. Article 2 of China's Law on the Protection of the Rights and Interests of the Elderly stipulates that: "The elderly referred to in this Law are citizens over 60 years of age."

3. The proportion of elderly population = number of elderly population in each district (county, functional park) / total number of elderly population in Lhasa City

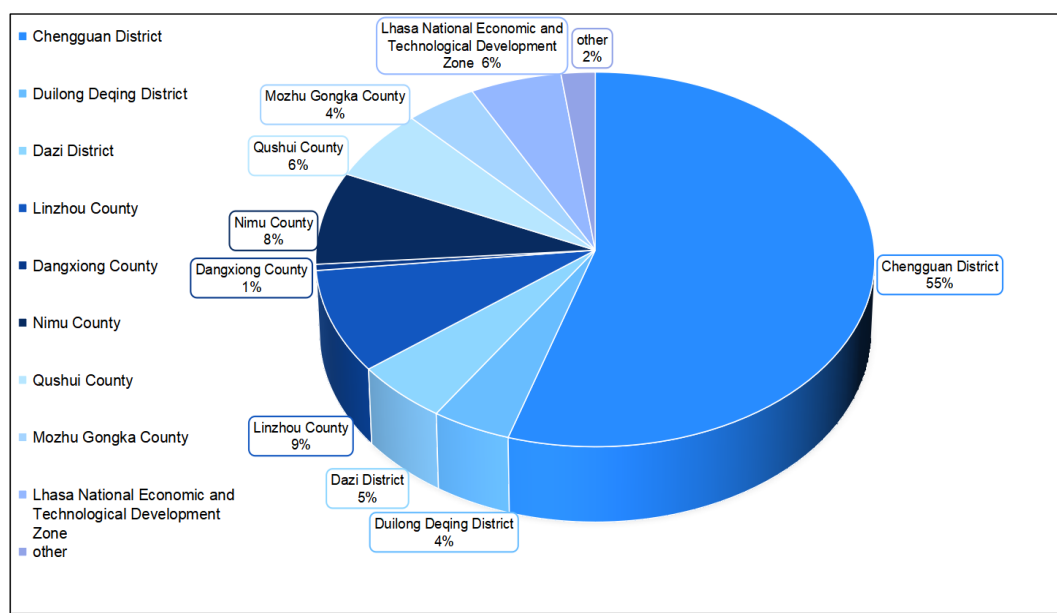


Figure 1. In the seventh national census in 2020, the proportion of the elderly population in Lhasa counties and districts in the total number of elderly people in Lhasa City

2.2. Status of Conventional Public Transportation Development

The Lhasa Transportation Department has always been adhering to the strategy of giving priority to public transportation, and by the end of 2022, the city will have 562 buses and 38 routes, with a total route length of 1,057 kilometers. Since April 2009, Lhasa has introduced the Senior Citizen Bus Card, which provides free rides on all city buses to senior citizens aged 60 and above. According to relevant data, as of 2021, this policy has benefited more than 70,000 elderly people, and the cumulative number of card swipes has reached 95,411,300, with an average of 36,000 elderly people taking the bus every day, making regular public transportation an important mode of transportation for the elderly in their daily trips.

With the acceleration of the aging process, how to meet the needs of the growing elderly population for regular public transportation has become the top priority in the development of urban public transportation. With reference to domestic and international strategies to cope with population aging conventional public transport improvement, most of them focus on bus travel for the elderly and improve the quality of transportation services for the elderly as the core, combined with the characteristics of the urban development of Lhasa and the current situation of public transport operations, we can see that focusing on improving the accessibility of conventional public transport, promoting the transformation of the bus for the elderly and the improvement of the quality of public transport services will make conventional public transport to better meet the needs of the elderly and thus improve the quality of travel of the whole group of elderly people effectively. The quality of traveling of the whole elderly group.

3. Conventional Public Transportation Accessibility Assessment

3.1. Analysis of bus stops and road network data

In this paper, in order to ensure the comprehensiveness of the basic data of regular public transportation, through the access to information and field investigation finally combined with the conventional bus stops and road network data obtained from the Gaode map API in Chengguan District of Lhasa City, due to space reasons, only two lines are selected to show part of the data, as shown in Table 2. Using ArcGIS to visualize the data to get the distribution map of regular bus stops and road network in Chengguan District, as shown in Figure 2.

Table 2. Data table of regular bus stops and road network in Chengguan District

Name of Public Transportation	Public Transportation Routes	Bus Stops along The Route
13 Road Trip	[[91.14655594142165, 29.675020480703044]	Luangsai Ninth District Station - Zhaqi Temple Station - - Longxi District Station - Tianzhi Garden Station
15 road trip	Fig. 1. [[91.08486074300885, 29.60871210112818]	Military and People's Road Station - South Bank Tendu Station -- Raidi Township Kimei Village Station - Raidi Township Police Station

Note: Data from the Goldmap API (<https://lbs.amap.com/>)

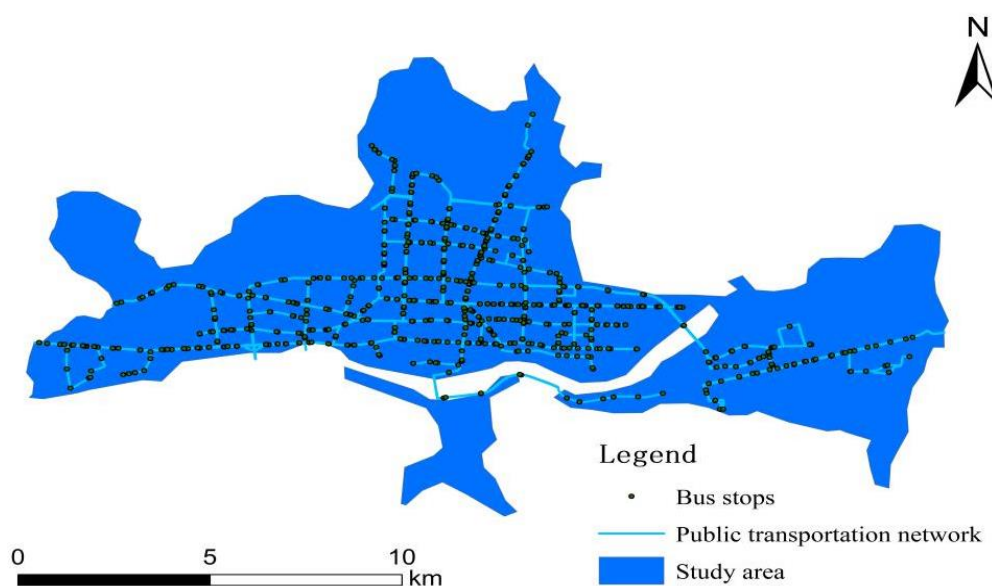


Figure 2. Map of regular bus stops and road network in Chengguan District

3.2. Conventional Transit Accessibility Assessment and Analysis

Selection of a spatial barrier model[11] Accessibility assessment of conventional bus system. By studying the bus network of Lhasa Chengguan District, the shortest travel time between different stations is analyzed and its average value is calculated to assess the accessibility of the conventional bus system. The calculation formula of the spatial barrier model is shown in (1):

$$A_i = \frac{1}{n-1} \sum_{\substack{i=1 \\ i \neq j}}^i t_{ij} \quad (1)$$

Where: A_i is the time accessibility of the transit stops i in the study area, the higher the accessibility the higher the value of A_i ; t_{ij} indicates the minimum travel time between the stop i and the stop j ; n is the total number of stops in the study area.

Using formula (1) to calculate the shortest travel time between different bus stops, the solved bus stop accessibility results are visualized in ArcGIS software to get the conventional bus accessibility assessment results map, as shown in Figure 3.

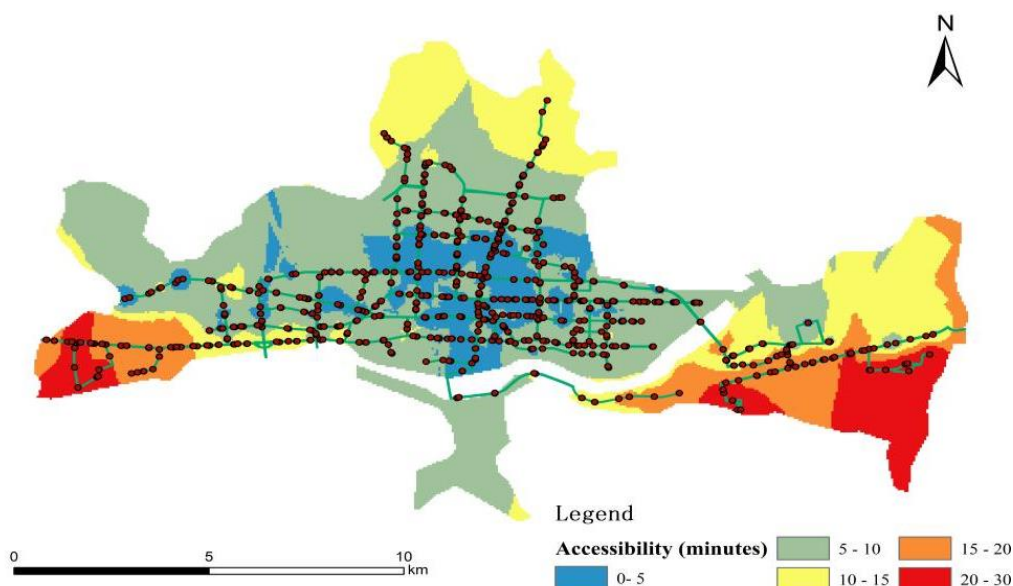


Figure 3. Map of the results of the regular transit accessibility assessment in Chengguan District

The color gradient in Figure 2 reflects the degree of convenience of regular public transportation in Chengguan District, in which the color gradually transitions from blue to red, with the blue area indicating that the region has a better degree of convenience in reaching other regions, i.e., a higher degree of accessibility; and the red area indicating that the region has a worse degree of convenience in reaching other regions, i.e., a lower degree of accessibility. On the whole, there is obvious spatial variability in the accessibility of public transportation, showing a gradual decrease in the distribution from the core area to the outside.

4. Improvement measures

4.1. Bus stops and road network

In order to meet the travel needs of the elderly at different times and in different regions, based on the results of the regular bus accessibility assessment in Chengguan District, we expand the coverage of the bus network in areas with poor accessibility and set up more bus stops and increase the service frequency of buses; optimize the bus network in areas with good accessibility and reduce cross-coverage and duplicated routes in order to ensure the optimal layout of the routes. At the same time, analyze senior card data to understand the characteristics of senior citizens' public transportation so

as to continuously optimize and improve the service, and make important stops into transfer hubs, so as to facilitate senior citizens to quickly transfer between different routes to reduce waiting time and walking time; at the same time, establish more short-distance routes, and connect bus stops with important places (such as hospitals, drugstores, temples) in the communities in order to reduce the walking distance and time of senior citizens, and improve the travelling distance and time. walking distance and time, and improve the convenience of traveling.

4.2. Aging facilities for public transportation

Actively promoting the ageing-adapted transformation of bus stops and vehicles, in order to create a more comfortable waiting environment can be added to the stops specially designed for the elderly seating, shading facilities and clear signage information, and within 100 meters of the stops set up eye-catching guide signs to help the elderly more easily identify the bus vehicles and stops; in addition, in addition to the core stops and all the buses set up audio information systems and accessible touch-screen equipment to provide real-time bus information and route planning and travel advice for the elderly with visual or hearing impairments. In addition, audio information systems and accessible touch-screen devices are installed at core stops and in all buses to provide real-time bus information, route planning, and ride suggestions for older adults with visual or hearing impairments. At the same time, in order to ensure the safety, convenience and comfort of older persons when they travel on public transportation, a certain number of low-floor public transportation vehicles equipped with exclusive seats for older persons and wheelchair anchors have been introduced on main routes.

4.3. Quality of public transportation services

Establishing exclusive feedback channels for older persons in the community and organizing regular tripartite forums involving the transport sector, the bus company and older persons to customize age-friendly bus services according to the actual situation. In order to meet the special needs of an aging society, training for bus drivers and related staff is organized to include interaction and communication skills with the elderly and measures to deal with emergencies, so as to improve understanding of the needs of the elderly and service levels to provide friendly and professional services. In order to better serve the elderly, we have created model lines on the main routes to honor the elderly and love them, set up stickers on the outside of the buses to honor the elderly and love them, and posted posters inside the buses, so as to create a strong atmosphere of honoring, loving and helping the elderly, and to build a more inclusive and caring public transport service.

5. Conclusions

Conventional buses have developed into an indispensable part of Lhasa's public transportation, and are an important mode of transportation for the elderly during their daily trips. In the study of regular bus improvement in Lhasa under the background of population aging, this paper selects the representative Chengguan District as the study area, and uses the spatial barrier model to evaluate the accessibility of buses, and analyzes the evaluation results to show that the stations with better accessibility are mainly concentrated in the Zaxi Street, Jirigai Street, and Jibangang Street of Chengguan District, while those with poor accessibility are distributed in the core area of Chengguan District in the east, west, and north of the three directions of the edge area. The poor accessibility stations are distributed in the east, west and north of the core area of Chengguan District, and there are still many areas in Chengguan District in which the distribution of regular bus stops and routes is not reasonable. Based on the analysis of the background of population aging and the results of the accessibility assessment, we propose improvement strategies for regular buses in the context of the aging society in terms of bus stops and road networks, aging facilities, and the quality of bus services, with a view to promoting the quality of travel for the elderly and maximizing the contribution to the construction of Lhasa as a modern plateau city for the elderly.

Acknowledgements

The authors would like to express their sincere gratitude for the financial support from the 2023 Central Support for the Reform and Development Funds of Local Universities Project: Innovation and Entrepreneurship Training Program for College Students (Project No.2023XCX015; Project Category: School Level; Project Leader: Wumeng Yang) Fund.

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