

# **An Empirical Study on Travel Difficulties of People with Disabilities and the Construction of Barrier-Free Environments in the Guangdong-Hong Kong-Macao Greater Bay Area**

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## **Abstract**

**This study takes Shenzhen, a core city in the Guangdong-Hong Kong-Macao Greater Bay Area, as the research focus. Ten typical urban rail transit stations, including Shenzhen North Station and Buji Station, are selected. Using a combination of field surveys, questionnaire surveys, and in-depth interviews, the study systematically analyses the actual difficulties faced by people with disabilities and the elderly when using rail transit, and evaluates the effectiveness and shortcomings of barrier-free environment construction. The findings indicate that while some stations have made notable progress in hardware configuration and detailed design, several issues remain prominent during peak hours, including resource competition, blind path occupation, route discontinuities, insufficient wayfinding information, and psychological pressure. The paper proposes comprehensive recommendations covering the improvement of barrier-free facilities, optimisation of information guidance, strengthening of emergency support, and enhancement of social acceptance, providing empirical references for building an age-friendly and inclusive rail transit environment in the Greater Bay Area.**

## **Keywords**

**Guangdong-Hong Kong-Macao Greater Bay Area; rail transit; travel difficulties; barrier-free environment.**

## **1. Introduction**

The rail transit network in the Guangdong-Hong Kong-Macao Greater Bay Area is becoming increasingly developed. Due to differences in physiological functions, age, and types of impairments, special passenger groups face different constraints and safety risks during travel. Combining the layout of Shenzhen's metro network, passenger flow characteristics, and station functions, this study selected ten typical and representative key stations for comprehensive field research. These stations cover large transport hubs, major interchange stations, line terminals, stations attached to commercial complexes, stations in older residential areas, and newly built stations in developing urban districts. They span the core administrative areas of Shenzhen, including Futian, Nanshan, Luohu, Longhua, Bao'an, and Longgang, thus providing a broad picture of the overall level and prominent issues in Shenzhen's barrier-free metro environment. Within the urban rail network, Shenzhen North Station and Buji Station represent, respectively, a recently built large comprehensive hub and a medium-sized transfer node. The design and user experience of barrier-free facilities at these two stations reflect a thoughtful, detailed, and more human-centred approach. Nevertheless, people with disabilities still encounter some subtle difficulties in their daily travel.

## 2. Current Status of Barrier-Free Environment Construction

### 2.1. Current configuration of passage facilities

All main entrances and exits of the ten surveyed stations are equipped with barrier-free ramps according to regulations. The ramps strictly follow a 1:12 slope ratio, with a width of no less than 1.2 metres. Handrails are installed on both sides at a suitable height (0.8-0.9 metres), and the surfaces are covered with anti-slip materials. At hub stations such as Shenzhen North Station, Futian Station, and Airport East Station, the ramps cover all passageways and are seamlessly connected to the ground-level tactile paving and bus stops. At older stations like Luohu Station, some secondary entrances and exits have ramps with slightly steeper slopes or loosely installed handrails.

Regarding accessible elevators, all stations have installed them between concourses and platforms and at key points along interchange passages. The elevators are equipped with braille buttons and stainless steel handrails. At large hubs such as Shenzhen North Station, Futian Station, and Hongshuwan South Station, the number of elevators is sufficient and their distribution is reasonable. However, at some stations with heavy passenger flows, queues form at accessible elevators, and ordinary passengers also use them for convenience, leading to congestion at the elevator entrances.

For tactile paving systems, all ten stations have installed tactile paving on main pedestrian routes, with clear tactile sensation and standard width. At hubs like Shenzhen North Station and Futian Station, the tactile paving is continuous. At older stations such as Luohu Station and Buji Station, there are breaks in the tactile paving, and some sections are occupied by rubbish bins, railings, or construction barriers. According to the questionnaire survey, 10.29% of passengers reported multiple breaks in the tactile paving, and 34.08% reported that the tactile paving is frequently obstructed.

With respect to wide-channel ticket gates, all stations have installed accessible wide gates near accessible elevators and at main entrances/exits, with a channel width of no less than 1.2 metres and sensitive sensors. At stations such as Shenzhen North Station and Airport East Station, the number of wide gates is sufficient and they display priority-access notices.



(a) Accessible ramp

(b) Congestion at accessible elevator



(c) Break in tactile paving

(d) Wide-channel ticket gate

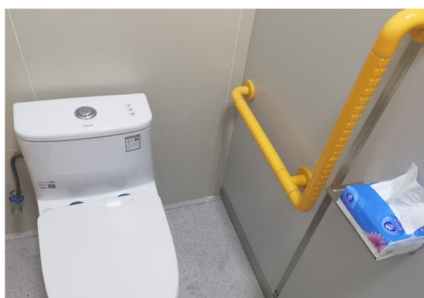
**Figure 1.** Shows photographs of the surveyed accessible passage facilities

## 2.2. Current configuration of service facilities

All ten stations have independent accessible toilets. Six stations, including Shenzhen North Station, Futian Station, and Civic Centre Station, are additionally equipped with family/assisted toilets, featuring standard handrails, emergency call buttons, washbasins, and anti-slip flooring. At older stations such as Luohu Station and Buji Station, problems such as loose handrails and unsuitable washbasin heights were observed. The questionnaire survey indicated that 36.01% of passengers had experienced facility malfunctions that made them unusable.

Priority seats are provided on all station platforms and train carriages according to standards, and dedicated wheelchair waiting areas are located near accessible elevators on platforms. However, at some stations the signage is not sufficiently clear, and during peak hours the priority seats are often occupied. The survey showed that 29.58% of passengers reported that priority seats and waiting areas are frequently taken by non-target users.

Regarding low-level service facilities, all stations have low-level service windows next to customer service centres. Some stations (Shenzhen North Station, Futian Station, Huanggang Port Station) provide assistive devices such as wheelchairs and crutches free of charge. However, most stations lack auxiliary equipment such as braille instructions or headphone jacks, making it difficult for passengers with hearing or visual impairments to obtain effective services.



(a) Mismatched handrail height in accessible toilet



(b) Occupied priority seat



(c) Low-level service counter

**Figure 2.** Shows photographs of surveyed accessible service facilities

### 2.3. Current status of wayfinding and information facilities

All ten stations have a unified system of accessible wayfinding signs, with blue as the main colour and clear fonts. However, some signs are blurred. 28.94% of passengers considered the signage unclear or discontinuous.

Regarding braille signage, all stations have braille signs on elevator buttons, at customer service centres, and at accessible toilet entrances, with clear tactile sensation. However, at some stations braille signs are only provided at core locations, and are missing at key points such as interchange passages and platform edges. Shenzhen North Station and Buji Station have braille signs at the start and end points of stair handrails, with correct braille characters and clear relief - a rare and commendable feature among many stations in China.



(a) Accessible wayfinding sign

(b) Braille map

(c) Braille sign

**Figure 3.** Shows photographs of accessible wayfinding and information facilities

### 2.4. Current status of emergency facilities

All ten stations are equipped with emergency call buttons, emergency lighting, and emergency passageways according to regulations. At hubs such as Shenzhen North Station and Futian Station, additional emergency shelter signs have been installed and staff are designated for emergency response. However, at some stations emergency call buttons are damaged and not repaired, and emergency evacuation signs lack braille and voice prompts, making it difficult for special groups to evacuate independently during emergencies.

## 3. Analysis of Travel Difficulties for People with Disabilities

### 3.1. Facility use pressure during peak hours

Shenzhen North Station, as a comprehensive hub with extremely high daily passenger volume, has dedicated accessible passages and elevators. Nevertheless, during peak hours these dedicated facilities are often inevitably occupied or queued for by ordinary passengers. One wheelchair user described: "There is a long queue at the elevator, and many people do not really need the lift - they just do not want to take the stairs. I feel embarrassed to push in, and sometimes I have to wait for two or three trips to get on." This "invisible competition" means that although accessible facilities exist, they cannot provide immediate service to those who truly need them at critical moments.

### 3.2. High spatial cognitive load

Visually impaired passengers rely on tactile paving, voice prompts, and braille on handrails for navigation. The survey observed that Shenzhen North Station and Buji Station have braille signs at the start and end points of stair handrails, with correct braille and clear relief. However, tactile paving systems are still temporarily blocked by stalls, cleaning carts, or passengers' luggage. One visually impaired passenger stated: "Once the tactile paving is interrupted, I do not know where to go. Even though someone may help, I feel uncomfortable having to ask for

directions every time." This reliance on others' help essentially undermines the right to independent travel.

### **3.3. Broken transfer routes**

Although accessible elevators and ramps are provided in the transfer area between high-speed rail and metro at Shenzhen North Station, the connection between different transport modes is not always seamless. Wheelchair users often have to queue repeatedly, show documents, and adjust directions at ticket gates and security checkpoints, consuming far more energy than ordinary passengers. Visually impaired people have difficulty identifying which gate is the accessible channel when faced with multiple side-by-side gates, and often have to feel around or ask for help. These seemingly minor inconveniences accumulate and erode the dignity of travel.

### **3.4. Psychological insecurity**

Buji Station is relatively small, with compact space and narrow passages, so wheelchairs pass extremely close to ordinary passengers. Some wheelchair users reported that during crowded periods they always feel they are "blocking others' way", and even encounter impatient urging or sidelong glances. This social psychological pressure is sometimes more difficult to overcome than physical obstacles, leading some people with disabilities to choose to travel during off-peak hours, or even to reduce unnecessary travel.

## **4. Comprehensive Optimisation Recommendations**

### **4.1. Improve barrier-free facilities and enhance continuity and exclusivity**

It is recommended to add accessible elevators and ramps at older stations, repair breaks in tactile paving, and introduce physical barriers to prevent obstruction. "Accessible priority passages" and dedicated staff during peak hours should be promoted to ensure priority use by those who truly need them. Accessible toilets should undergo regular inspection of handrails and call buttons, and door widths and turning spaces should be appropriately enlarged.

### **4.2. Build a multimodal information guidance system**

Additional braille signs, illuminated indicators, and voice announcements should be installed at key locations such as interchange passages and platform edges. For hearing-impaired passengers, flashing warning lights should be provided in concourses, and staff should be equipped with text display boards or sign language interpretation devices. Mobile apps should provide real-time updates on facility status, as well as large-font and voice-based travel information.

### **4.3. Implement age-friendly design principles**

Safety principle: complete accessible elevators on transfer routes; use continuous double handrails (upper 0.9 m, lower 0.6 m) on entire stair sections; apply high anti-slip treatment to floors; plan accessible evacuation routes with luminous emergency signs and voice guidance.

Comfort principle: ensure good ventilation and appropriate temperature and humidity; install rest seats every 50 metres along passages, with backrests and armrests; use soft and uniform lighting to avoid glare.

Convenience principle: optimise station entrances/exits and transfer paths, prioritising accessible elevators and ramps; self-service ticket machines should have large buttons and low operating panels (height  $\leq 1.2$  m), with cash payment and manual assistance options retained.

Intelligent principle: install smart service posts at entrances/exits and concourses, supporting braille buttons, voice navigation, and sign language translation; use intelligent monitoring to

detect abnormal behaviours such as falls or prolonged stays, automatically triggering alerts and rescue responses.

#### 4.4. Strengthen emergency support and human-centred care

For emergency support, AEDs, first-aid kits, wheelchairs, and stretchers should be placed at designated points in concourses and on platforms. Accessible evacuation routes should be planned, and staff assigned to assist special groups in evacuation, ensuring that these groups receive priority during emergencies. Differentiated emergency assistance measures should be provided according to the specific needs of different special passenger groups: prioritise the evacuation of wheelchair users using accessible elevators; provide voice announcements and professional guidance for visually impaired passengers; provide flashing warning lights and text prompts for hearing-impaired passengers; offer arm support, priority passages, and medical coordination for elderly and pregnant passengers; and set up assembly points for children to prevent them from getting lost. Through multimodal warning methods and staff coordination, all special passenger groups can receive timely and effective help during emergencies.

For human-centred care, a feedback channel for special passengers should be established, caring service posts should be set up, and staff should be trained in communication skills with special passengers, actively providing assistance with ticket purchase, transfers, and other needs. At the same time, public awareness campaigns should reduce the occupation of accessible facilities by ordinary passengers and reduce unconscious discrimination against people with disabilities, thereby creating an inclusive and friendly travel environment.

### 5. Conclusion

Significant progress has been made in the construction of barrier-free environments for urban rail transit in the Guangdong-Hong Kong-Macao Greater Bay Area. Typical stations such as Shenzhen North Station and Buji Station demonstrate a shift from merely "meeting standards" towards "perceptibly friendly" design in terms of hardware configuration, detailed design, and manual services. Nevertheless, problems such as resource competition during peak hours, obstruction of tactile paving, route discontinuities, inadequate wayfinding information, and psychological pressure remain prominent. Future optimisation should go beyond simply increasing the number of facilities and instead focus on stability and usability under real, dynamic, and high-load operating conditions. Only when hardware, management, and social attitudes improve together can the goal of "independent, equal, and dignified" travel for people with disabilities and the elderly be truly achieved.

### References

- [1] SUN C, WANG B, ZHANG Y L, et al. Research on the planning of barrier-free transportation system in Shenzhen[J]. *Planners*, 2012, 28(12): 37-41.
- [2] GB 50763-2012, Code for barrier-free design[S]. 2012.
- [3] XIA J, CHEN H S, WANG X P. Low utilization rate of barrier-free facilities from the perspective of disabled people: a case study of Nanjing[J]. *City Planning Review*, 2020, 44(12): 47-56.
- [4] WANG Y. Research on barrier-free design of railway passenger stations based on travel needs of people with travel difficulties[J]. *Comprehensive Transportation*, 2018, 40(3): 57-60+105. DOI: 10.20164/j.cnki.cn11-1197/u.2018.03.012.
- [5] GB/T 44718-2024, Specification for accessible operation service of urban rail transit[S]. China Standard Press, 2024.
- [6] JING Y X. Research on age-friendly renovation design of rail transit station space[Master's thesis]. University of Jinan, 2022. DOI: 10.27166/d.cnki.gsdcc.2022.000931.

- [7] ZHANG J X, QIN K, LIU X F, et al. Research on path planning and path selection for barrier-free subway travel[J]. Computer Knowledge and Technology, 2020, 16(7): 218-221. DOI: 10.14004/j.cnki.ckt.2020.0831.
- [8] WANG J G. Post-occupancy evaluation of barrier-free rail transit environment[J]. China Safety Science Journal, 2022, 32(6): 151-156. DOI: 10.16265/j.cnki.issn1003-3033.2022.06.2787.