

# Design and Research on Humanized Innovative Design of Pedestrian Space in Rail Transit

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**Abstract:** Walking is the main mode of transportation used by people to take rail transit, and it is also the link between rail transit and other kinds of transportation. Ensuring the convenience, comfort and safety of walking in the rail station area is not only an effective way to realize the functional integration of the station, but also the key to promoting green travel and ensuring the sustainable development of the city. This paper studied the walking environment by literature review. This paper summarizes the differences of various walking environments, and finally puts forward suggestions on the improvement of walking environment in urban rail stations.

**Keywords:** Rail Transit; Station; Walking Environment.

## 1. Introduction

In recent years, the rapid development of rail transit also brings some opportunities to the rail station construction and promotion, prompting rail transit experience from separate rail transit site development to rail transit site and commercial, residential, cultural, industry, urban and other multifunctional elements of composite development stage, gradually improve the rail station area function. Under the social background of urban renewal and sustainable development, the functional compound development of rail station area is to endow the rail station area with a certain community attribute, promote the deep integration of urban commuting and life circle with rail transit as the core, and meet the highest daily needs with the minimum amount of travel. Therefore, the previous research on the development of a single rail transit station area or the construction of life circle has gradually changed to the coupling research of rail transit station and life circle.

However, the reality of China's rail transit construction is mostly stuck in the concept design of TOD mode, but does not reflect the due "walking advantage" in the rail station area. According to the "2020 Annual Statistics and Analysis Report of Urban Rail Transit", the scale of China's urban rail transit lines in 2020 is 7969.7km, and the overall scale maintains a trend of increasing year by year. However, according to the statistical data from 2014-2023, with the growth of the total length of the urban rail transit operation lines, the intensity of passenger transport has declined instead (see the figure below). The proper and advanced construction of urban rail transit is helpful to promote the local development, but the construction process of the network also needs the cooperation of other spatial strategies, and the blind expansion will only lead to the emergence of the diminishing return of the scale effect. Therefore, in urban construction, in addition to strictly implementing the growth boundary and avoiding urban sprawl and inefficient stations in the process of rail transit construction, the more important thing is to pay attention to the stations in use, and carry out targeted environmental design optimization or urban renewal, so as to ensure the sustainable operation of each station itself.

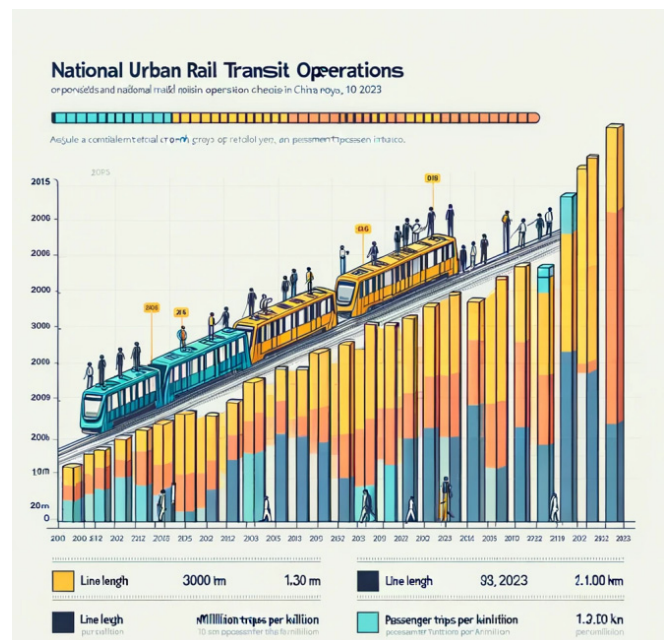


Figure 1. Statistics of National Urban Rail Transit Operation (2014-2023)

This paper mainly summarizes some of the domestic studies through the literature review, and puts forward some insights according to the corresponding deficiencies. Although the literature research method has certain limitations and is easily influenced by the established research direction, this process can expand the research horizon and further grasp the relevant theories of the object walking environment composition, spatial mode and walking behavior of orbital stations in TOD mode.

## 2. Literature Review

Research on comprehensive evaluation and optimization strategy of walking environment in urban communities -The main urban area of Nanjing. Paper using hierarchical analysis, to build the combination of subjective and objective of urban community walking environment evaluation index system to build the combination of subjective and objective of the urban

community walking environment evaluation index system, finally, the paper from the land use, service facilities, walking network and construction concept put forward the urban community walking environment quality improvement countermeasures and Suggestions of [1].

Research on walking organization optimization based on urban Rail Transit stations (Zhang Jiefei.2013), this article mainly starts with the characteristics and needs of pedestrian traffic around the station, combined with the advanced experience at home and abroad, discusses the optimization method based on the walking organization inside and outside the urban rail transit station, to provide support for the pedestrian traffic organization around the station [2].

Chongqing rail station domain walking environmental impact factor study - in five typical sites as an example (Li Gaoyuan) in this paper that compared with pedestrians subject after using environmental quality evaluation, grasp the object perspective under the domain space form characteristics, more helpful to planning practitioners from the space configuration walking environment optimization, make the walking behavior in the rail station domain travel advantage [3].

Feng Cen, in his paper puts forward the strategy of walkability and facility configuration optimization by analyzing the measurement of multiple railway stations and subway stations in the background. In order to promote the integration of more convenient pedestrian transportation network and more perfect daily service facilities, and promote the diversification of railway station functions, life convenience, regional vitality and the improvement of environmental livability. In addition, it also provides a reference for the coupling of business format and functional configuration of track station area and community life circle [4].

Rail station walking convenience improve - in Chongqing as an example(xiao-yong tang, gao zhigang, Liu Yanlin).In this paper introduces the Chongqing ongoing rail station walking convenience promotion work, build the rail station walking convenience evaluation method based on big data, analyzes the main reasons for the influence of walking convenience and gives the targeted planning strategy, summarizes the project implementation experience, the "small, quick work" effect of the people's livelihood, also can provide experience for other cities [5].

Research from the perspective of pedestrians (Wang Ningcheng 2021) this study is based on the perspective of pedestrians and three walking perception dimensions, draw on the technical framework of urban environment perception research, scene analysis, interpretable machine learning, questionnaire research, on the basis of the relatively comprehensive characterization of walking scene elements, establish a quantitative connection between pedestrian, environment perception and walking environment elements of; at the same time, this study also designed the perception experiment based on eye movement technology, try to explore the influence of environmental elements on pedestrian perception mechanism [6].

### **3. Research Methods**

This study chapter will present the research methodology used in this study. First, the purpose and significance of the study will be elaborated, research questions will be clarified, and appropriate research methods will be chosen to answer these questions. Secondly, the design and implementation

process of the study, including sample selection, data collection and analysis methods, will be introduced. Finally, the feasibility and limitations of the study will be discussed, and the improvement methods will be proposed [7].

#### **3.1. Study Purpose and Significance**

This study aims to explore the humanized innovative design of rail transit walking space, through the field investigation and case analysis of different urban rail transit walking space, analyze the problems existing in the existing rail transit walking space design, and propose improvement to improve the comfort, convenience and safety of rail transit walking space, and promote the sustainable development of the city.

#### **3.2. Study Design**

This study used a combination of field research and case analysis. First, several representative urban rail transit lines were selected for field research, including subway stations in Beijing and surrounding walking Spaces in Beijing, Shanghai, Guangzhou and other cities. Data on the design characteristics, usage and user needs of rail space were collected through on-site observation, questionnaire survey and interview. Secondly, some cases of rail transit walking space with innovative design were selected for in-depth analysis, including some well-known rail transit stations and transportation hubs at home and abroad[8]. Through the case analysis of these cases, we summarize the characteristics and effects of various innovative designs, and provide reference for the improvement suggestions.

#### **3.3. Data Acquisition and Analysis Methods**

For data acquisition, multiple methods were used in this study. First, a large number of qualitative data were collected through field research, including field observation records, questionnaire survey results and interview records. Then, the qualitative data were collated and analyzed to extract the main information and characteristics. Finally, the case analysis summarizes the common characteristics and successful experiences of various innovative designs. For data analysis, this study combined inductive and comparative analysis. First, the collected data were summarized and sorted out, and the main contents were extracted. Then, the data of different cities and different rail transit lines are compared and analyzed to find out their similarities and differences and regularity, so as to provide theoretical support for the improvement suggestions[9].

#### **3.4. Feasibility and Limitations of the Study**

The feasibility of this study is mainly reflected in the following aspects: firstly, field research and case analysis are effective research methods to fully understand the actual situation of rail transit walking space; secondly, representative cities and cases are selected for study, and finally, the research team has rich research experience and professional knowledge, which can ensure the quality and effectiveness of the study. However, this study also has some limitations. First, due to time and funding constraints, only some cities and cases were selected for this study, which may not fully represent the walking space of all urban rail transit; second, there may be subjective bias in the process of data collection and analysis, which affects the objectivity and credibility of the research results.

### 3.5. Improvement Method

In order to improve the objectivity and credibility of the study, the following improvement methods can be adopted: first, increase the diversity and quantity of samples, expand the scope of research, and improve the representativeness and universality of the study; second, strengthen the quality control during data collection and analysis to ensure the accuracy and reliability of data; finally, strengthen the communication and cooperation with experts in relevant fields, and make full use of professional knowledge and experience to improve the scientificity and practicability of the study.

In conclusion, this study adopts a combination of field research and case analysis, and analyzes the design characteristics and user needs of different urban rail transit walking space to propose some improvements, which provides theoretical support and practical guidance for the humanized innovative design of rail transit walking space.

## 4. Finding

### 4.1. Characteristics of the Walking Environment in the Urban Rail Station Area

The walking environment surrounding urban rail transit stations is a key component of urban planning and sustainable development. These areas often exhibit a high degree of accessibility and versatility, incorporating commercial, residential and recreational spaces to create a both convenient and vibrant walking experience. The path design focuses on intuition, safety and convenience, including smooth sidewalks, clear road signs and barrier-free facilities, while ensuring traffic and community safety.

In these areas, greening and good landscape design enhance the beauty and comfort of the environment, and trees and green space not only beautify the urban landscape, but also help to slow down the urban heat island effect and provide a pleasant walking experience. Community participation and the integration of cultural elements enhance the sense of identity and belonging of the region, making walking not only a way of transportation, but also a cultural experience[10].

The design and management of the walking environment follows sustainability principles, using environmentally friendly materials and technologies such as rainwater collection and solar lighting, while integrating modern technologies such as intelligent transportation systems and public Wi-Fi, enhancing the convenience and attractiveness of the walking environment[11].

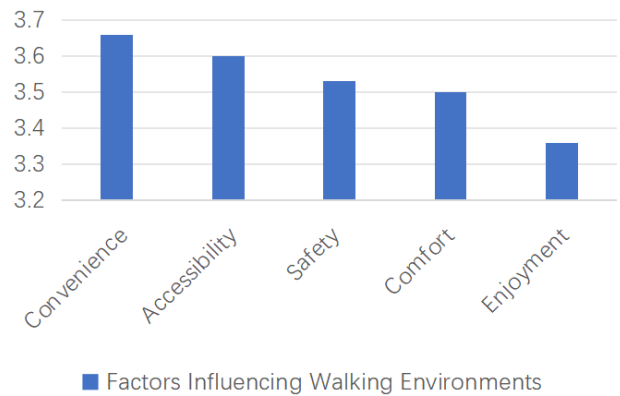
### 4.2. Walking Environment Elements in the Rail Station Area

Objectively speaking, the rational "traffic people" pursue the lowest traffic cost (time, distance). This shows that residents' cognition of spatial form characteristics has some commonness. Based on the rail transit travel mode based on walking transfer, the requirements of pedestrian for walking environment, such as accessibility, continuity, detour degree, safety, comfort, etc., are all developed around the physical structure and functional structure of space. Therefore, the decision of residents in the rail station can put aside the influence of the residents, and study and summarize the spatial common characteristics of the rail station from the

perspective of object environment [12].

In the urban rail transit system, the design of walking environment is crucial to improving user experience and promoting travel convenience. Through the review of the relevant papers, we can find that the cognition of the elements of the walking environment in the rail station area is consistent, mainly centering on the principles of convenience, safety, continuity and comfort (Figure 2) [13]. This paper aims to explore these principles in depth and expand on them to guide the design and improvement of the walking environment in the urban rail station area.

### Factors Influencing Walking Environments



**Figure 2.** The importance of factors influencing the walking environment around hybrid sites

#### (1) Principle principle:

Convenience is one of the primary considerations in the design of the walking environment in the urban rail station area. Studies have shown that a walking time within 5 minutes of 500 meters can meet the needs of most travelers, while 6 to 7 minutes is also in an acceptable range. However, a walking time over 15 minutes would be beyond the tolerance of average travelers, thus requiring special attention to the control of walking time. At the same time, the urban rail transit system should design pedestrian channels that facilitate transfer to ensure that passengers can reach their destination quickly and smoothly [14].

#### (2) Safety principles:

The safety of walking environment is the basic requirement to ensure the safety of passengers. Factors such as mixed traffic between people and cars, crossing between people and imperfect street crossing facilities may increase the insecurity of passengers' travel. Therefore, in the optimization design of walking environment, the safety principle must be fully considered, and measures should be taken to reduce the occurrence of traffic accidents, such as setting up traffic signs and dividing pedestrian areas.

#### (3) Continuity principle:

The principle of continuity emphasizes that the whole transfer process should be continuous, and passengers should have a clear walking passage and guide signs during the transfer process. At the same time, attention should be paid to the intermittent points existing in the transfer process, such as streets, intersections, buildings and other obstacles, and overpasses or underground passageways should be set up to ensure the continuity and convenience of the transfer process.

#### (4) Comfort principles:

Good walking organization design should provide a

comfortable walking environment for passengers, including road leveling, landscaping, seat setting, so that passengers can feel comfortable and pleasant while walking. In addition, barrier-free walking conditions should be provided to ensure that special groups such as the elderly and the disabled can transfer smoothly.

At the same time, the modern urban walking environment design should also consider the path quality and walking feasibility (see Table 1).

When designing the walking environment of urban rail stations, it is necessary to clarify the goal orientation, that is, around the optimization of the rail transit transfer conditions or improving the spatial efficiency of the core area of the rail stations. This is because the sustainable development of the urban rail transit network first needs the effective operation of each station itself. In this process, factors such as passenger

walking needs, path design, and site function should be considered comprehensively to improve the quality and feasibility of the walking environment. By reasonably planning walking paths, setting up appropriate transportation facilities and landscape decoration, passengers' walking experience can be improved and the development of urban walking culture can be promoted. Therefore, in the walking environment design of the urban rail station area, attention should be paid to the traffic organization and functional layout of the station, so that passengers can transfer and travel conveniently and quickly. At the same time, the surrounding environment and architectural characteristics of the site should also be taken into account, and the landscape elements in line with the city image and cultural characteristics should be designed, so as to improve the overall quality and image of the city.

**Table 1.** Summary of the design elements of the track walking environment

Design discipline	Research contents	Design elements	Index of correlation
connectedness	The walking distance between the starting and ending points is within the theoretical radius	Road network structure; land development form	Land use nature, road density, intersection, density, node connectivity, walking direct, coefficient, walking waiting coefficient, average plot size, average street length, etc.;
safety	In the process of walking people, car contradictions, protect the enthusiasm of walking	Traffic control; road properties; protective measures;	Traffic flow, road grade, motor vehicle, road width, sidewalk width, crossing time, signal light time, etc.;
amenity	Pedestrians in the walking process, landscape perception and physical comfort	Spatial scale; visual perception; wind-thermal environment;	Street D / H ratio, building line sticking rate, interface perspective rate, street green vision rate, sky visibility, wind speed, temperature, etc.;
Identifying	Space combination has the intention, sex, spatial information to guide pedestrians to the station	Leading function; space orientation; architectural form;	Land mixing, function mixing, plane view, identification setting, etc.;
Street vitality	Population and function to the walking road, on both sides of the path (buffer zone) gathered, to create a walking atmosphere	Population; accessible premises	Land scale, development intensity, commercial construction, construction area proportion, population size, post distribution, Poi density, etc.;

### 4.3. Design Method of Urban Rail Walking Environment

The design of medium-urban rail walking environment is an important part of the urban rail transit system, which is directly related to the travel experience of passengers and the display of the city image. This paper will discuss the methods of urban rail walking environment design from the aspects of humanized design, spatial layout, landscape design and functional design.

#### (1) Humanized design

The design of urban rail walking environment should be people-oriented and pay attention to the travel experience and security of passengers. First of all, entrances and exits should be set up to ensure that passengers can easily enter and leave the station. Secondly, the needs of different passengers, such as the elderly, children and people with disabilities, should be designed to provide convenience. At the same time, appropriate seats, waiting areas and signs should be set up to improve passenger comfort and convenience.

#### (2) Spatial layout

The spatial layout of urban rail walking environment design should take into account factors such as human flow, functional demand and space utilization (as shown in Figure 2). First of all, the layout of the station hall and platform should be reasonably planned to ensure that passengers can transfer and exit the station smoothly. Secondly, the change of passenger flow in different time periods should be taken into account, and the passage and traffic direction should be set reasonably to reduce congestion and congestion. At the same time, we should make full use of the space and design

reasonable multi-functional areas, such as business district, service area and cultural exhibition area, to improve the utilization rate and value of the space.



**Figure 3.** Layout diagram of urban rail walking space

#### (3) Landscape design

The landscape design of the urban rail walking environment should pay attention to the display of the city image and the comfort of the passengers. First of all, the surrounding environment and architectural style should be

taken into account, and the landscape elements in line with the urban style and cultural characteristics should be designed to improve the image of the city. Secondly, we should pay attention to the layout of greening and landscape plants, create a pleasant environment, purify the air, and improve the travel experience of passengers. At the same time, should consider the use of light and color, design appropriate lighting and decoration, improve the quality and aesthetic feeling of the space.



Figure 4. Landscape design diagram of urban rail walking space

#### (4) Work, performance design

The functionality of the urban rail walking environment design should take into account the actual needs and safety guarantee of the passengers. First, safety facilities and emergency rescue equipment should be set up to ensure the safety of passengers and the smooth escape passage. Secondly, environmental protection and resource conservation should be taken into account, and environmental protection materials and energy-saving equipment should be selected to reduce the operating costs and the impact on the environment. At the same time, attention should be paid to the maintenance and management of facilities to ensure the integrity of facilities and the safety of passengers.

To sum up, the design method of urban rail walking environment should be people-oriented and pay attention to the travel experience of passengers and the display of city image. Through the comprehensive consideration of humanized design, spatial layout, landscape design and functional design, the quality and comfort of urban rail walking environment can be effectively improved, and the development of urban rail transit system and the improvement of urban image can be promoted.

## 5. Conclusion

The reasonable link between various modes of transportation and urban rail transit is the key link of transportation integration. Only when they are closely connected, convenient to transfer, and achieve the integration of time and space, can the radiation attraction range of urban rail transit be improved with the help of other transportation functions, the advantages of urban rail transit be given full play, and finally realize a multi-level and multi-functional urban comprehensive transportation system. Walking is the

basis of transfer between various modes of transportation, reasonable walking traffic organization to consider the pedestrian path system, crossing facilities, car separation facilities, guide sign facilities and walking line organization design, be sure to make the transfer more efficient, convenient, safe, comfortable and humanized, so as to give full play to the advantages of urban rail transit, alleviate the increasingly serious traffic congestion.

Through a review of some domestic studies, the paper finds the advantages and disadvantages of the methods. Through integration, a set of comprehensive design methods are proposed. In the actual design process, the designer should put forward optimization strategies from four aspects: reinforcing the traffic texture, optimizing the facility configuration, strengthening the integration of elements, and implementing the system guarantee. In terms of reinforcing traffic texture, the road network density and road intersection density are encrypted to shorten the block length, and improve road connectivity and walking accessibility. In terms of optimizing the allocation of facilities, first of all, for the central urban area, the existing facilities on the basis of maintaining the existing functional facilities. Realize the balanced allocation of various functional facilities to meet the diversified needs; secondly, define the development scope around the site through the model, supply and optimize the area type of the model to realize the efficient configuration of the station facilities; moreover, the efficient use of facilities is also an important measure to promote the sustainable development of the station. Through the opening and sharing of facilities, not only the intensive utilization of urban land under the background of stock renewal, but also the maximum use of facilities through the use of various service facilities at different periods throughout the day to avoid the waste of space resources. At the same time, it pays attention to the integration of elements to improve the compactness of facilities. Through the high connectivity walking network, it connects with various service facilities and open space on the ground, underground and the second floor, so as to realize the connection between the rail transit station and the surrounding functional facilities and public space, and improve the walking accessibility of the rail station area. According to the current situation, the targeted improvement strategy is proposed, but it is still necessary to ensure the smooth implementation of the design strategy, truly solve the problems of road connectivity and facility configuration in the station area, and improve the walkability of the track station area. In this chapter, with rail transit stations as the core, optimize and improve road space and service facilities; understand the actual needs of the station users, accurately configure the service facilities and guide the road network planning and facility configuration for different urban areas, to avoid uneven facility allocation or waste of resources; in addition, the government needs the macro control, establish dynamic supervision and management platform and mechanism, and strengthen the dynamic monitoring of station update and promotion, so as to promote the sustainable development of the station.

## About the Author

Zhao Wenjin (1983-), female, studying for a doctor of Philosophy in design at The City University of Malaysia. Her main research direction is urban ecology and cultural landscape.

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