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Research on Urban Community Street Environment Evaluation and Optimization Strategy under the Concept of a Healthy City: A Case Study of the Dingwangtai Area of Changsha City

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Abstract: The World Health Organization (WHO) articulated a vision in 1986, hoping that countries around the world would actively promote the construction and development of healthy cities. In the context of China, a paradigm shift in urban development has been triggered by the deep implementation of the Healthy China Strategy and the gradual completion of the comprehensive national spatial planning. This shift emphasizes a micro-level focus, advocating a human-centered approach to urban space exploration. In this paper, the Dingwangtai Area of Changsha City is selected as a case study. A street space health evaluation index system called "5D+" is constructed from six dimensions, namely, human perception, degree of mixing, density, distance to transit, destination accessibility, and devise. This research adopts the community as the fundamental unit of analysis, employing the Entropy-weighting TOPSIS method for the computation of indicators. The results of this study show that the Dingwangtai Area exhibits relative deficiencies in the dimensions of density, devise, and destination accessibility. Specifically, at the community level, the Ma Wang Street Community and the Fanhou Street Community have scored particularly low. In response, this paper proposes targeted measures and detailed recommendations aimed at optimizing the design of the street, enhancing the human experience, enriching functional attributes, and refining the street network. The ultimate goal is to propose a Healthy Streets Evaluation Index System based on the concept of a healthy city and to explore its relationship with healthy streets so as to provide valuable insights for the development of healthy city streets.

Keywords: healthy city; street space; entropy-weighting TOPSIS method

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1. Introduction

Health stands as a universal aspiration for humanity in the 21st century, and the healthy city is an important carrier for realizing the physical and mental health of human beings. In 1986, the first global conference on health promotion provided a definition of a healthy city, which aims to continuously create and improve the environment and enrich the resources of a community so that the city can support people's lives in a way that further satisfies their need for self-fulfillment. However, with the globalization wave progressing gradually and urbanization developing rapidly, the urban space is expanding rapidly and disorderedly [1], neglecting the design of the inner-space environment of the city. The living environment of the residents has not been significantly improved [2], and the cities of each country are gradually paying attention to the conversion to a healthy city.

Globally, the World Health Organization (WHO) integrates quantifiable indicators, such as air quality, water quality, waste, etc., to construct a healthy city indicator system, which is continuously improved and periodically revised [3]. However, there is no unified standard for the construction of healthy cities, and China put forward an outline for the "Healthy China 2030" initiative in 2016, aligning with the nation's unique conditions and formally integrating the concept of healthy cities into the national strategic framework. In 2018, the National Healthy City Evaluation Indicator System (2018 Edition) was formulated, proposing a new index system containing five major categories, twenty medium categories and forty-two subcategories. These include healthy environment, healthy society, healthy service, healthy culture, and healthy people. The spatial scale of a healthy city consists of five levels: general urban space, public space, street space, living space, and architectural space. These spatial scales are gradually subdivided, and the human-centered concept is increasingly important as the Healthy China Strategy has been deepened and the preparation of the overall national spatial plan has been gradually completed. The construction of healthy cities has shifted from the macro to the micro level, requiring the planning and construction of urban space to be deeply explored using the human-centered concept. As an important part of the microspace of a healthy city, street space plays an important role in the healthy lives of residents [4,5] and the sustainable development of the city [6]. As a result, it has received extensive attention from scholars in various countries [7–9].

In international research, there is a lack of research literature on street space from the perspective of healthy cities. However, there is a rich scientific literature on designing street space directly or evaluating street environments by categorizing them as built environments. The London Street Design Guidelines, published in the United Kingdom in 2004, set out the classic structure of "policy vision + design guidance + management implementation" for subsequent street guidelines [10,11]. Subsequently, America, Canada, the Netherlands, and other western countries have introduced street design guidelines at the city or neighborhood level one after another. The idea has gradually evolved from "health and livability" to "humanity, vitality, and interaction", emphasizing the importance of human-centered street design [12–15]. Matthew Carmona et al. [16] point out that street space planning and design is undergoing a gradual evolution, from transportation to its place in the world. Evgeniya Prelovskaya [17] studied street design from a sustainability perspective, transforming existing urban streets in Russia and suggesting that it should increase green, shared, and convenient urban streets. Peter Jones [18] combined the functions of streets with the needs of users to categorize streets in the built environment, and he provided a human-centered concept of thought for subsequent street design. Chester Harvey et al. [19] used multi-source data to quantify street space and found that livability indicators of street space can play a decision-making role in the built environment of a city. As the depth of quantitative research advances, some scholars have begun to focus on the influence of urban street attributes on specific populations. Kaczynski, A. T. and Angela Curl [20,21] concluded that street space attributes have health-promoting effects on adolescents and the elderly.

In Chinese literature, studies relevant to street space focused on development following the introduction of the new urban construction concept in the early 21st century, and most scholars mainly focused on some of the street elements in the city and their own research methods. Firstly, in terms of street elements, Hao Xinhua [22] conducted a large number of measurements for Beijing's streets using street functional density, functional mixing, and transportation accessibility as indicators, and he explored some of the street- influencing factors. Ye Yu [23] carried out a refined multidimensional study of street elements, suggesting that the interaction between residents and urban spaces should be strengthened. Wang Lan [24] was the first to propose that urban planning's creation of street environments affects residents' health from the perspective of healthy cities. Secondly, in terms of research methodology, Long Ying and Shen Yao [25] took the lead in proposing Street Urbanism, and they carried out a quantitative comparison study of street quality in many cities in China based on streetscape images on a large scale and refined scale [26,27]. In the subsequent research on quantitative measurement of spatial quality in urban streets, it has been found that the streetscape images of high obtainability are the main data source in current research for street spatial measurement [28]. Some scholars [29–31] have explored the existing evaluation indexes of healthy city planning and proposed constructing a "multi-factor, multi-dimension and multi-scale" evaluation index system of healthy city planning. However, existing research objects are mostly Beijing, Shanghai, Nanjing, Shenzhen, and other relatively coastal cities, especially developed-area cities [32–36], and fewer studies are on cities in less developed areas.

In conclusion, although there is a large amount of existing literature on street space, research on street space from a healthy city perspective is still inadequate. Firstly, the current healthy city evaluation index system has a macro-spatial scale and lacks evaluation indexes for middle and micro scales such as street area space, especially the human-centered scale space. Secondly, previous explorations of the indexing system for healthy street space have included more quantitative research on objective attributes but have included fewer quantitative studies on subjective attributes.

The existing problems of the street, such as poor human perception, poor street traffic organization, lack of design, and low density of facilities, directly affect the healthy development of the street. In this study, we examined two research questions: (1) Characterize the spatial distribution of healthy streets under multidimensional evaluation. (2) Evaluate the relationship between evaluation indicators and street health development in different spaces. Therefore, in order to promote the construction of healthy streets, taking Dingwangtai as an example, this study constructed a street space Healthy Streets Evaluation Index System by screening the indicators using the human-centered concept. The Entropy-weighting TOPSIS method was used for comprehensive evaluation and ranking, and corresponding improvement strategies were provided to the community. This study aims to (1) explore the characteristics of the multidimensional distribution of healthy streets at the microspatial scale and (2) reveal the mechanisms by which each of the studied indicators affects healthy streets. The purpose of this study is to provide better guidance on planning practices for healthy streets and to promote healthy and sustainable people-centered urban development. The innovations and contributions of this paper are as follows:

(1) This paper takes Changsha's Dingwangtai Area as an example, combines domestic and international research progress, and constructs a street space health evaluation index system to make up for the vacancy in evaluation indexes for medium, micro, and human scale spaces, such as street area spaces.
(2) This paper tries to add quantitative indicators of human perception to the evaluation indexes of healthy street space for the purpose of quantitative assessment of the Dingwangtai Area from the perspective of a healthy city. It also conducts a comprehensive evaluation of the Dingwangtai Area's internal community environment from a comprehensive and refined perspective in order to propose corresponding quality enhancement countermeasures for the construction of healthy streets.

2. Materials and Methods

This paper selects Dingwangtai Street, a typical area in Changsha City, as the research object and obtains the research data through field research and network crawling, then processes and analyzes them. It synthesizes the contents of international references, constructs a Healthy Streets Evaluation Index System, and utilizes the Entropy-weighting TOPSIS method for comprehensive evaluation.

2.1. Study Area

The Dingwangtai Area is located in Changsha's commercial center zone (Figure 1). Within it, there are Changsha IFS, Huangxing Road Pedestrian Street and other commercial service points, Wuyi Square, Furong Square, and other square service points. The total area of this area is 1.48 square kilometers with a resident population of about 40,000 people. The street environment was complex, and crowd activities were frequent, which is a strong typicality. Therefore, this paper selects the Dingwangtai Area as the research object and uses the community as the evaluation unit to evaluate its street space health.

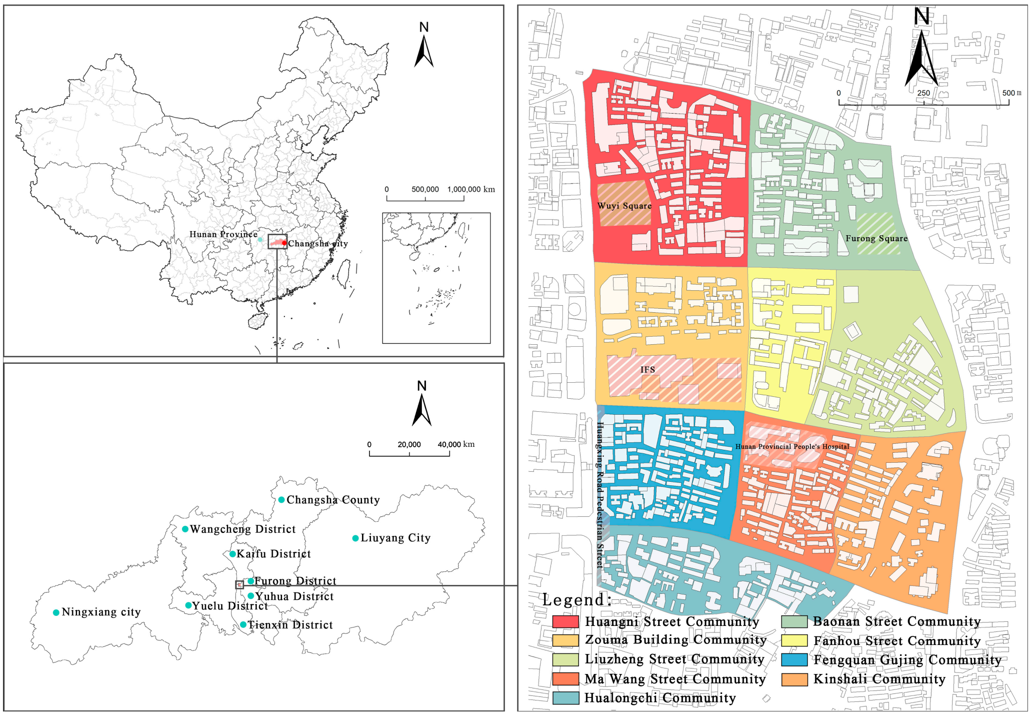


Figure 1. Study area.

2.2. Data Source and Processing

2.2.1. Data Source

Data acquisition methods included mainly Network Acquisition and field surveys. (1) The Network Acquisition data mainly included basic geographic data and web open-source data, which were obtained through official website downloads and web crawlers. (2) The field survey data were primarily objective scoring data. During the fieldwork, the site road network was measured by dividing sampling points at 50 m intervals, and the data obtained from the network were modified as appropriate. Details are shown in Table 1.

Table 1. Study data.

Data Type	Data Name	Data Source
Basic geographic data	China map vector data	National basic geographic information center
Web open-source data	Road network data Building data POI data Street view image data Heat data	Open Street Map official website Web crawler Gaode map crawler Baidu map crawler Baidu map crawler
Objective scoring data	Nighttime street brightness Noise level Street furniture (seating, trash cans, signs) Landscape level Road speed limit Sidewalk width Presence of barrier-free passage Presence of non-motorized lane	Lumeno meter measurement Decibel noise tester measurement Objective marking on the map Objective scoring of landscape vertical design Objective marking on the map Field measurements Objective marking on the map Objective marking on the map

2.2.2. Data Processing

The raw data were normalized and then systematically analyzed using a GIS (10.6) platform and semantic segmentation. Finally, the comprehensive evaluation and ranking were carried out by the Entropy-weighting TOPSIS method. In this paper, the following representative thermal and image data are selected for analysis:

(1) The heat data were selected to be divided into four time segments for congestion studies in segment a (1:00–6:00), segment b (7:00–12:00), segment c (13:00–18:00), and segment d (19:00–24:00). We processed data on a GIS platform and classified the population congestion into 7 grades: very low, lower, low, average, high, higher, and very high, which are 7 levels (Figure 2).

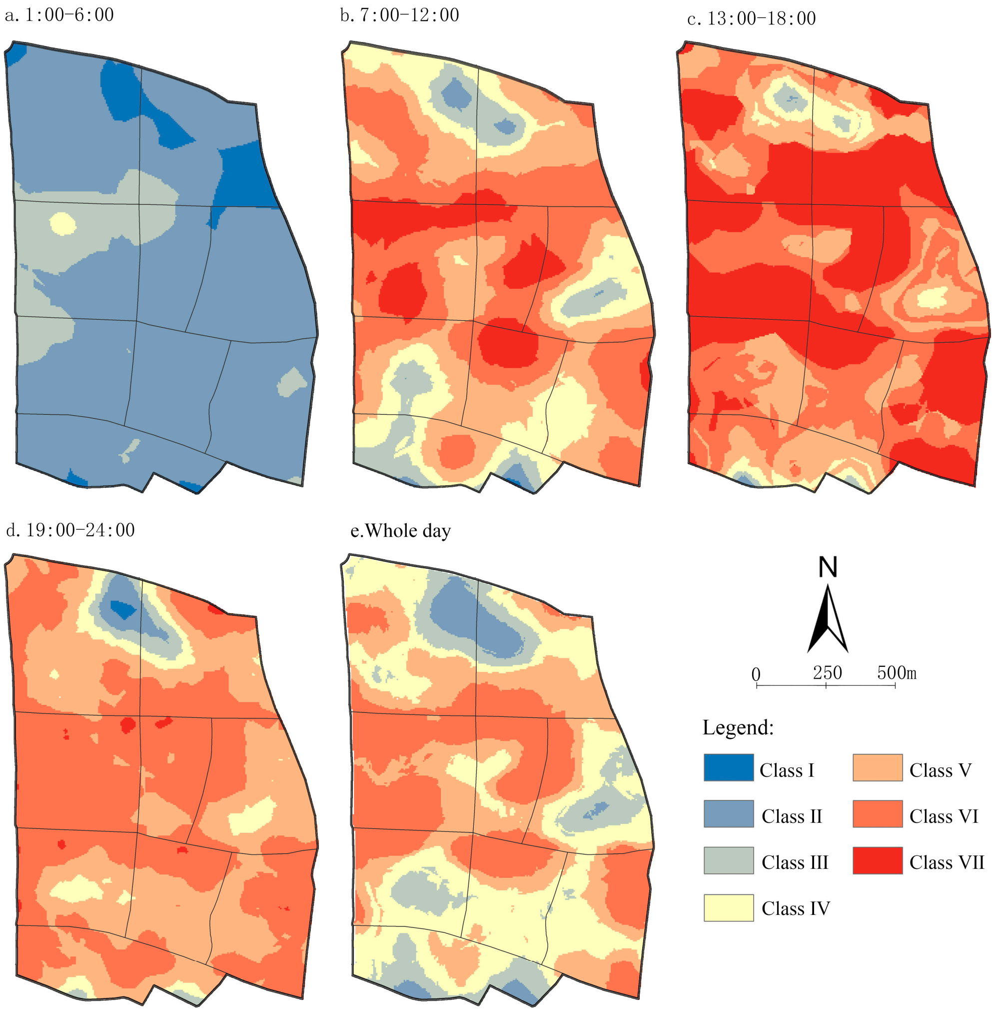


Figure 2. Time interval heat map.

(2) In this paper, the streetscape images were derived from web-scraped September 2022 data, which were sampled at 50 m intervals in four directions, 0°, 90°, 180°, and 270°, for a total of 1896 images. The image was converted from RGB to HSV, and the color pixels in the HSV channel from 60–180° were extracted and counted, and then systematically analyzed by formulae and MATLAB (2021a) software to calculate the percentage of green (Figure 3).

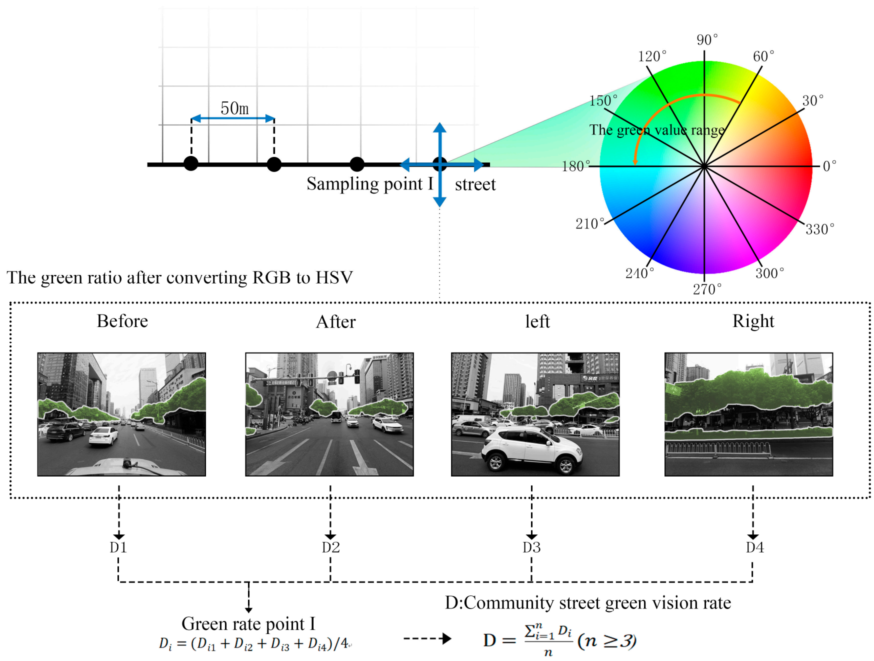


Figure 3. Green vision rate acquisition and analysis method.

2.3. Research Methods

2.3.1. Selection of Indicators

Domestic and foreign research on the street space environment evaluation index has gradually improved, and many scholars have put forward their own understanding of street space under the index system. The focus of the index system is more dispersed, and its content is more focused on a direction based on the research. Ewing et al. [37] provided another way of thinking for this paper's indicator system dimension construction, which consists of a "5D" index system for the urban built-space environment. The dimensions of the index system are more comprehensive, including degree of mixing, density, devise, destination accessibility, and distance to transit. However, modern health includes not only the traditional view of the absence of disease and infirmity but also an intact state of physical, mental, and social adaptation [38]. Increasing the ways in which the street environment interacts with urban residents and utilizes street components to support health is particularly important. Therefore, this paper adds the dimension of human perception to the "5D" evaluation dimensions to form a six-dimensional system according to the acquired data and based on the principles of availability, comparability, measurability and legality of indicators. The indicator layers under the dimensions of degree of mixing, destination accessibility, and distance to transit were appropriately deleted, and the indicator layers under the dimensions of human perception, density, and devise were organized and sorted.

In the human perception dimension, Dong Yu and other scholars [39] studied urban stressors and found that factors such as noise, crowding, and light affect residents' psychological emotions, while comparatively positive street spaces help alleviate residents' stress and loneliness [40]. Some scholars [41–44] believe that the Green View Ratio is more representative of residents' actual feelings in the street space than the green ratio and the green landscape ratio. The scale of the street and the building affects the residents' overall perception of the space. For the scale of its livability, Gao Kao and others [45] conducted in-depth research on the street width ratio and proposed a corresponding calculation method.

In the density dimension, Yang Junyan [46] believes that the street furniture is arranged so that the concept of sharing is implemented while improving the comfort of residents traveling. Therefore, this paper quantifies the density of the distribution of street furniture (seats, trash cans, signs). Some scholars [47,48] proposed a compact road network layout, which is similar to the idea of Shen Jie [49]. The high-density road network and high-density intersections will allow road accessibility to be improved, increase the probability of residents traveling, and enhance their physical function. Based on the qualitative research method, Tang Xiaoting [50] analyzed the relationship between space and physical activity through model construction. It was learned that reasonable building density can enhance the attractiveness of the area, and healthy and reasonable density of service facilities is the key to residents' activities [51,52].

In the devise dimension, Xie Yuwei [53] conducted an evaluation study on community jogging environments and found that within the same region, residents tended to exercise on paths with good shading conditions and rich surrounding landscapes. Li Hengxin [54] proposed the concept of a road connectivity index for urban road problems and provided a way of evaluating road patterns for sustainable livability. Chen Yu [55] believes that the speed limit design of the car line is related to the safety of the residents; the lower speed of the car caused less impact on the residents, thus improving the safety of the residents. The installation of dead-end roads in the city seriously affects traffic coherence and reduces the interest in travel. For streets and their surrounding buildings, some scholars have suggested that their design requires a coherent and unified street interface [56,57] and appropriate walking widths [58,59], and other scholars [60,61] have argued the need for increased consideration of user safety in design elements. The safety needs of bicyclists and special populations are fully considered in the design of its non-motorized path and accessible passageways.

By summarizing the research progress at home and abroad and combining the contemporary humanistic planning concept and the actual problems of this research object, this paper attempts to construct the "5D+" street space health evaluation index system (Table 2) by selecting thirty-one secondary indicators and six dimensions. The weighting data are calculated by objective evaluation with the Entropy-weighting method.

Table 2. "5D+" street space health evaluation index system.

Dimension Layer	Indicator Layer	Nature of Indicator	Weights (%)
Human perception	Green View Ratio	Positive indicators	1.979
	Crowding degree	Negative indicators	1.901
	Nighttime street brightness	Positive indicators	8.286
	Noise level	Negative indicators	2.431
	Street width ratio	Interval indicators	1.803
Degree of mixing	Functional mixing degree	Positive indicators	2.078
Density	Street furniture (seating, trash cans, signs)	Positive indicators	1.984
	Road network density	Positive indicators	2.200
	Building density	Negative indicators	2.565
	Scenic spots and historical sites density	Positive indicators	4.627
	Density of healthcare facilities	Positive indicators	5.283
	Density of sports and recreational facilities	Positive indicators	3.694
	Density of science, education, and cultural facilities	Positive indicators	4.895
	Density of transportation service facilities	Positive indicators	3.581
	Density of commercial service facilities	Positive indicators	2.438
	Density of intersections	Positive indicators	2.865
Distance to transit	Accessibility of commercial service facilities	Positive indicators	3.098
	Accessibility of healthcare facilities	Positive indicators	3.072
	Accessibility of scientific, educational, and cultural facilities	Positive indicators	3.446
	Accessibility of scenic and historical sites	Positive indicators	3.248
	Accessibility of transportation service facilities	Positive indicators	3.643
	Accessibility of sports and recreational facilities	Positive indicators	2.654
Destination accessibility	Transportation accessibility	Positive indicators	4.526

Table 2. *Cont.*

Dimension Layer	Indicator Layer	Nature of Indicator	Weights (%)
Devise	Landscape level	Positive indicators	2.454
	Road connectivity index	Positive indicators	3.424
	Road speed limit	Negative indicators	2.938
	Dead-end road	Negative indicators	3.091
	Line rate	Positive indicators	2.838
	Sidewalk width	Positive indicators	2.378
	Presence of barrier-free passage	Positive indicators	2.469
	Presence of non-motorized lane	Positive indicators	4.111

2.3.2. Entropy-Weighting TOPSIS Method

This paper uses the interquartile range normalization of polar deviation to pre-process the data and transform the data into dimensionless indexes. In order to make the data processing meaningful, the dimensionless indexes can be increased by 0.01 all the time in order to meet the requirements of the TOPSIS method of arithmetic.

(1) The entropy value (e) of the ith index is calculated as follows:

$$e_j = -\frac{1}{ln^n}\sum_{i=1}^{n} p_{ij} ln^{(p_{ij})},\ 0 \le e_j \le 1 \quad (1)$$

(2) The difference coefficient (g) is calculated as follows:

$$g_j = 1 - e_j \quad (2)$$

(3) The weight (W) is calculated as follows:

$$W_j = \frac{g_j}{\sum_{i=1}^{m} g_j}, j = 1, 2, 3 \ldots\ldots m \quad (3)$$

(4) The weighting of the indicators in the normalized matrix to form a weighting matrix is calculated as follows:

$$c_{ij} = b_{ij} * w_j \quad (4)$$

(5) To determine the positive ideal solution c^+ and the negative ideal solution c^-, we use the following:

$$c^+ = \left[c_1^+,\ c_2^+,\ \ldots,\ c_n^+\right]; c^- = \left[c_1^-,\ c_2^-,\ \ldots,\ c_n^-\right] \quad (5)$$

The positive ideal solution is as follows:

$$c_j^+ = \begin{cases} max\ c_{ij}, & j \text{ is a very large property} \\ minc_{ij}, & j \text{ is a very small property} \end{cases},\ \text{j} = 1, 2,\ \ldots,\ \text{n} \quad (6)$$

The negative ideal solution is as follows:

$$c_j^- = \begin{cases} min\ c_{ij}, & j \text{ is a very large property} \\ maxc_{ij}, & j \text{ is a very small property} \end{cases},\ \text{j} = 1, 2,\ \ldots,\ \text{n} \quad (7)$$

(6) To calculate the distance from each object to be evaluated to the positive and negative ideal solutions, we use the following:

To evaluate the distance from object a_i to the positive ideal solution, the equation is as follows:

$$d_i^* = \sqrt{\sum_{j=1}^{n} (c_{ij} - c_j^+)^2},\ \ i = 1, 2, \ldots, m \quad (8)$$

To evaluate the distance from object a_i to the negative ideal solution, the equation is as follows:

$$d_i^0 = \sqrt{\sum_{j=1}^{n} (c_{ij} - c_j^-)^2}, \ \ i = 1, 2, \ldots, m \tag{9}$$

(7) To calculate the relative closeness of each object to be evaluated, the equation is as follows:

$$f_i = \frac{d_i^0}{d_i^0 + d_i^+}, \ \ i = 1, 2, \ldots, m \tag{10}$$

Then, f_i is arranged from large to small to discern the priority of each evaluation object.

3. Results

3.1. TOPSIS Method Results

The processed data were put through the TOPSIS algorithm to derive the health ranking of each community (Table 3). The Huangni Street Community and Baonan Street Community, which have square facilities, did not achieve the expected health rankings, but instead ranked fifth and seventh, respectively. The Zouma Building Community with the IFS commercial facility achieved the desired health rankings. But the Hualapai community ranked first in health, far exceeding the expected ranking. It can be seen that community health is a result of a combination of dimensions.

Table 3. TOPSIS method results.

Community Name	Positive Ideal Solution Distance (D+)	Negative Ideal Solution Distance (D−)	Composite Score Index	Arrange in Order
Hualongchi Community	3.131833	3.669372	0.539518	1
Kinshali Community	3.315379	3.030137	0.477524	2
Zouma Building Community	3.629652	3.307988	0.476818	3
Fengquan Gujing Community	3.639317	3.02641	0.454026	4
Huangni Street Community	3.535476	2.845015	0.445893	5
Liuzheng Street Community	3.660868	2.854895	0.438152	6
Baonan Street Community	3.678601	2.839215	0.435608	7
Fanhou Street Community	3.846028	2.810013	0.422175	8
Ma Wang Street Community	4.08249	2.94093	0.418732	9

3.2. The Dingwangtai Area Spatial Health Evaluation Results

The spatial health evaluation of the Dingwangtai Area is divided into two aspects: sub-dimensional evaluation and overall evaluation. The sub-dimensional evaluation includes six dimensions of evaluation: human perception, degree of mixing, density, distance to transit, devise, and destination accessibility. The results of each dimension are divided into five levels according to the natural breaks (Figure 4).

Considering the richness of indicators under these dimensions, the three dimensions of human perception, density, and devise were selected for specific analysis, and the results are as follows:

The general interval under the human perception dimension is (0.047–0.065], and scores higher than the general interval are good intervals, which can be categorized into two specific cases. One category is the high-value range, such as the Ma Wang Street Community. It has a high internal Green View Ratio, low noise levels, and well-designed street scales, which have a greater enhancement effect on residents' feelings. However, the installation of light facilities is missing, and residents lack a sense of security at night, which has a negative effect on residents traveling at night. The other category is the very high-value range of the Fengquan Gujing Community. The community is located in the vibrant location of the Wuyi business district, with pleasant street scale design and adequate safety for residents traveling at night, making it highly attractive to residents. Scores below the general interval are low intervals, categorized as lower- and very low-value ranges. Among them, the Fanhou Street Community is in the very low-value range. Although the internal noise level is well-controlled, the crowding degree of the interior and the dimness at night makes the residents feel unsafe to travel, which has a negative effect on their psychological situation. Overall, the dimension of human perception within the study area showed a distribution phenomenon of high scores in the southwest direction and low scores in the northeast direction.

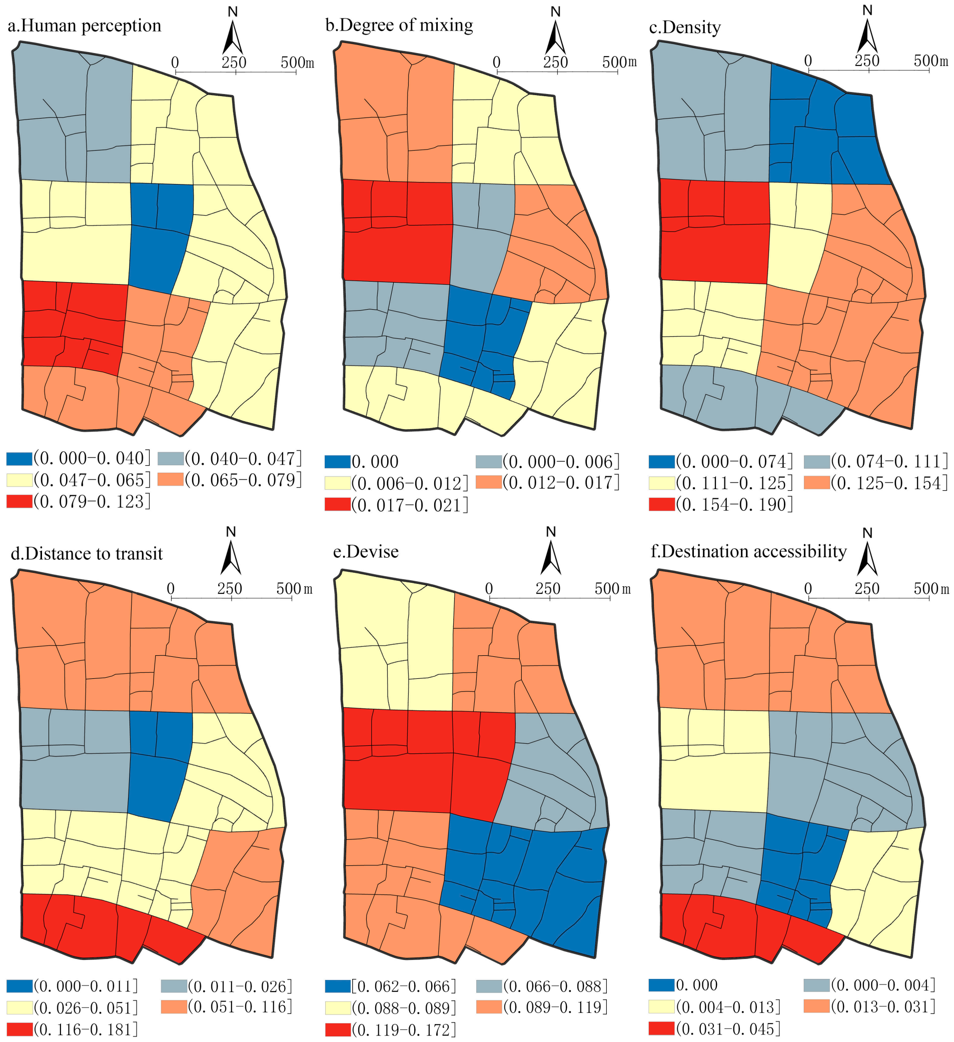
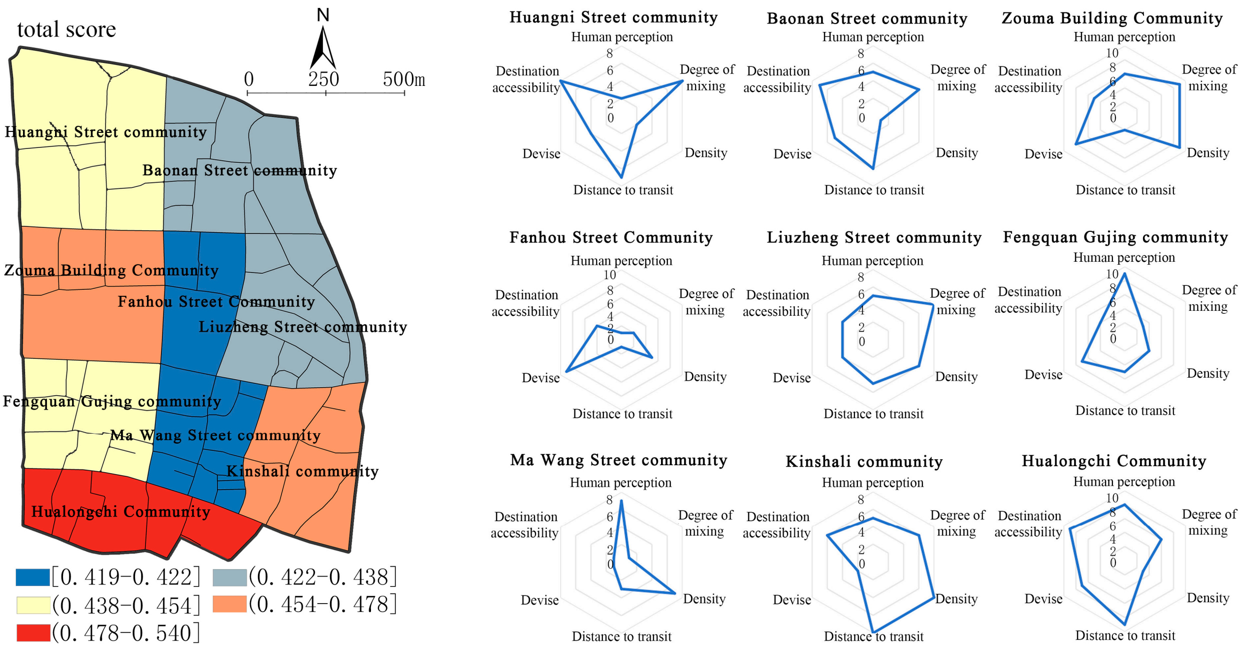


Figure 4. Results of evaluation through six dimensions.

The general interval under the density dimension is (0.111–0.125], and ratings above the general interval are good intervals, categorized into two categories. One category is the high-value range, such as the Kinshali Community, where road intersections are densely distributed. Residents have more options for traveling, and travel is more convenient. There is a reasonable building density, but the community lacks corresponding infrastructure on the street, reducing the quality of the travel experience for residents. The other category, the very high-value range, is the Zouma Building Community, which has a high density of internal street furniture amenities in terms of amenity density, which is a good guide for residents to travel. Among the amenities, the density of sports and leisure facilities, science facilities, education and cultural facilities, transportation facilities, and commercial facilities is high, providing residents with a richer and more convenient life and enhancing the attractiveness of the community. Ratings below the general interval are in the lower intervals, with the Baonan Street Community in the very low-value range, where the lack of street furniture as well as healthcare facilities reduces the quality of life for residents and affects their travel. Overall, within the study area, the density dimension showed an overall distribution of high scores in the central direction and low scores in the north and south directions.

The general interval under the devise dimension is (0.088–0.089], and scores above the general interval are good intervals, which are divided into two categories. One category is high-value ranges, such as the Hualongchi Community, whose higher internal road connectivity index and reasonable slow-moving system and street network design ensures that residents have more choices for traveling, enhancing residents' willingness to travel and promoting the healthy development of their physical functions. However, the interior of the community has a single landscape level and lacks vertical design. The other category is the very high-value range, such as the Zouma Building Community, which occupies a good spatial location with the internal establishment of the IFC Business Center. This community has a well-designed road network and wide pedestrian streets to significantly enhance the image of the community as well as its attractiveness. Scores below the general interval are lower intervals, with the Ma Wang Street Community in the very low-value interval. Although the continuity of the street interface within the community is good, the low landscape richness and the low provision of non-motorized lanes and narrow sidewalk widths have a negative effect on residents' travel. Overall, within the scope of this study, the devise dimension as a whole showed a distribution phenomenon of high scores in the south direction, low scores in the north direction, high scores in the west direction, and low scores in the east direction.

In order to visualize the evaluation results, the community scores for each dimension were ranked separately; communities with a difference of less than 0.002 in single-dimension scores were classified as a rank. Rankings 1–9 were given a new 9-1 score, which was visualized by radar charts (Figure 5).



(**a**) (**b**)

Figure 5. (**a**) Comprehensive results of street space health evaluation; (**b**) Radar chart of the scores of each community by dimension.

For the overall evaluation, the results of the above sub-dimensional evaluations were summarized and counted to produce the results of the street space health evaluation for each community; the very low-value range is (0.419–0.422], including the Fanhou Street Community and the Ma Wang Street Community. Its common problems are manifested in the two dimensions of destination accessibility and degree of mixing. While the Fanhou

Street Community places more emphasis on the devise dimension, it neglects the construction of the human perception dimension, whereas the Ma Wang Street Community is the opposite of the Fanhou Street Community. The low-value range is (0.422–0.438], including the Baonan Street Community and Liuzheng Street Community. Of these, the Liuzheng Street Community has issues with destination accessibility and the devise dimensions, while the Baonan Street Community is primarily characterized by the density dimension. The general-value range is (0.438–0.454], including the Huangni Street Community and the Fengquan Gujing Community. One of the main problems in the Huangni Street Community is reflected in the human perception and the density dimensions. The Fengquan Gujing Community places relative emphasis on the human perception dimension, but it lacks the construction of a degree of mixing dimension and is relatively deficient in the density and destination accessibility dimensions. The high-value range is (0.454–0.478], which includes the Zouma Building Community and the Kinshali Community. They have outstanding issues with distance to transit and the devise dimensions, respectively. The very high-value range is (0.478–0.540] for the Hualongchi Community, which is relatively lacking in the density dimension but scores relatively high on the remaining five dimensions. A spatial visualization of the results of this study results in a distribution of higher spatial health indexes for peripheral communities, lower spatial health indexes for internal communities, high scores in the western direction, and low scores in the eastern direction in the study area.

4. Strategy and Suggestion

4.1. Healthy Streets Space Design Strategy

According to the research results and the practical problems of the research scope, the ideal model of a healthy street is proposed, which includes the goals of good human feelings, complex functional types, a bright street environment, and a better walking and cycling experience (Figure 6). Three design optimization strategies are proposed for the healthy street space design of the Dingwangtai Area Community.

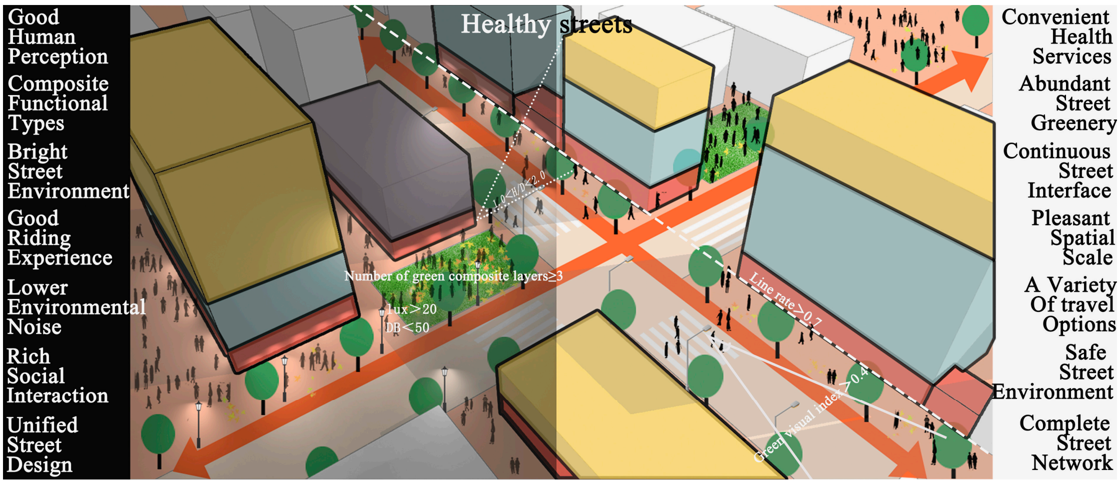


Figure 6. Ideal model for healthy streets.

4.1.1. Optimize the Design of Streets to Improve Human Perception

By planning the street layout properly, the human comfort of the neighborhood can be improved and the quality of the built environment of the city can be enhanced at the same time. First, increasing the density of vegetation and landscape levels around streets and alleys, as well as using crowd behavior analysis to reduce the degree of street crowding, can effectively improve the residents' sense of travel safety and experience using the street, and these changes can improve the overall impression of the street. As an example, the Zouma Building Community has significant deficiencies in these three areas. Pocket parks can be created by relying on wide street space, which not only enhances the richness of street greenery, but also effectively reduces the discomfort caused by overcrowding and the problem of emptiness due to overly open squares. The continuity of the street interface and its width are directly linked to the street image. Secondly, rational streets should ensure that the scale is rationalized in order to satisfy aesthetics and ensure the neatness and continuity of the street interface. Wide sidewalks directly affect the ability of a street to accommodate pedestrian traffic and the residents' sense of space. There are obvious problems in these two areas in the Kinshali Community: The first is the discontinuity of the street facade, which leads to visual confusion. The second is that the the sidewalks are not wide enough, which creates a depressing feeling for the residents. Due to structural limitations of the building, it is not possible to adjust the location of the existing building to widen the pedestrian walkway. Therefore, it is recommended to introduce architectural features on the building or adjust the appearance of the building. This can enhance the attractiveness of neighborhoods as a way to create distinctive living spaces, alleviating the current feelings of fragmentation and congestion in the street space and improving the overall functionality and aesthetics of the community.

4.1.2. Adjusting the Functional Structure to Enhance the Vitality of the Population

Optimizing the functional structure within the community can ensure that residents have greater convenience while achieving their daily travel purposes. Thus, residents are encouraged to increase the frequency of their trips, and the vitality of the community space is enhanced. In view of the low degree of mixing of functions in the Mawang Street Community, there may be practical challenges in changing the functional layout on a large scale. By creating podiums or replacing functions on the ground floor, the community's functional diversity can be enriched and its comprehensive service capacity can be enhanced. Reasonable functional organization can better meet the needs of residents and enhance the quality of life of community residents. In the Fan Hou Street Community, the scenic viewing value of the area can be enhanced through such measures as the construction of a high-rise podium for viewing. In response to the lack of healthcare facilities in the Baonan Street Community, underutilized space in the community can be used to build new healthcare facilities, or existing building functions can be remodeled, enhancing the residential environment and the health of the residents. In the Ma Wang Street Community, there is a relative lack of sports and recreational, scientific, educational, and cultural facilities. By providing residents with suitable recreational and leisure venues and emphasizing the provision of educational resources, we are able to meet the community's internal educational and cultural needs and promote the all-around development of the community's residents. The Liuzheng Street Community has serious problems with transportation services facilities, which could be improved by adding more parking lots and improving the parking system. The establishment of cab harbor parking stations could improve the travel experience of residents. The Hualongchi Community has a low density of commercial facilities and a high level of vitality within the parcel, which allows for the creation of a distinctive commercial-themed street to increase the density of commercial facilities and revitalize the community's economy.

4.1.3. Optimize Traffic Organization and Improve Travel Experience

Adjusting the road traffic within the community and constructing a suitable road system network could increase the opportunities for residents to make travel choices and enhance the attractiveness of travel. Enriching the street type increases the probability that residents will travel by bike or on foot. Roads within the Ma Wang Street Community are generally narrow, and traffic congestion is relatively high. It is difficult to set up non-motorized lanes to alleviate the opposite traffic flow congestion phenomenon, depending on the actual situation to increase the time-limited one-way roads. There are significant deficiencies in the design of the barrier-free passage to the pedestrian walkway in the Fengquan Gujing Community, and the barrier-free passage is frequently occupied. In order to optimize the situation, the degree of attention to barrier-free passages can be raised, and the walking experience of residents can be improved by increasing the design of barrier-free passages and strengthening the management strategy to ensure the safety and convenience of the use of the trail. The Huangni Street Community has a high number of dead-end roads within the community that limit the continuity of traffic flow and the efficiency of its use; by extending existing roadways and connecting them to neighboring roadways, residents are provided with more options for convenient travel. A high road connectivity index means that residents have more travel options. While the road network in the Baonan Street Community is dense, there is a lack of road connectivity, indicating that there are fewer road intersections within the community, which limits travel for residents. New connecting roads can be constructed to open up parallel road traffic, improve traffic flow and accessibility within the community, and improve the travel experience of residents.

5. Discussion

5.1. In Terms of Research Evaluation

This study proposes a "5D+" Healthy Streets Evaluation Index System, which is more comprehensive and refined than the traditional Healthy Streets Evaluation Index System. It aims to provide a quantitative tool that can be applied to the evaluation and updating of streets and help the designer understand the object of this study accurately and improve the quality of the streets. However, the evaluation of healthy streets is a multidimensional and complex subject, so this study refers to Ewing's "5D" evaluation index system and adds the human perception dimension to evaluate the healthy streets. From the results of this study, the problems found in the study area are similar to those found by the research team of Zhao Mengni [44] in the main urban area of Nanjing. If we can obtain the research data of the main urban area of Nanjing, we can use the "5D+" Healthy Streets Evaluation Index System proposed in this paper to conduct a study on it, so as to verify the generalizability of the indexing system in this paper. From the perspective of geographic location, the Healthy Streets Evaluation Index System should not be a fixed indicator; if data from other areas can be obtained, horizontal comparisons can be made for the Dingwangtai Area. Depending on the unique focus and needs of its different regions [62], the weights of the indicators are not the same. In this way, it is possible to know which indicators are geographical and changeable, thus obtaining a more detailed system of healthy city evaluation indicators at the medium scales and micro scales, such as the space of street wards.

5.2. In Terms of Optimization Strategies

Many authors have proposed improvement strategies for healthy streets from the traditional perspectives of functional structure [34], traffic organization [37], and design elements [59]. Their problem-solving strategies are mostly macroscopic coordination of the study area and its surroundings and sorting out the urban pulse, while the consideration of the human perception on the micro scale is comparatively weak. Therefore, this paper proposes three major corresponding improvement strategies for the problems of community health construction in the Dingwangtai Area, combined with the concept of a human-centered city, in order to achieve the ideal goal proposed in this paper for healthy streets. Since the study area is located in the center of Changsha City, with high pedestrian flow, high building density, and complex land ownership, large-scale demolition and renovation is not applicable. The strategy of this paper mostly focuses on the renovation of the existing environment and the functional supplementation of small spaces.

5.3. Insufficiency of Research

The basis for realizing the healthy street is based on the theoretical study of the street's microspace. This paper evaluates the health of the Dingwangtai Area, which still has relative deficiencies. Firstly, the evaluation of streets in this paper relies only on objective data and is missing a secondary subjective evaluation in the weighting of indicators. Secondly, there are problems in the indicator evaluation system, such as uneven division of indicator layers and the difficulty of obtaining or slow updating of some indicator data in small and medium-sized cities. Examples include questionnaire surveys as well as community population heat data and streetscape image data. Finally, there is a link between the community and its surroundings, and there are dynamic changes that make it difficult to evaluate them using fixed indicators.

5.4. Future Prospects

The city is a complex entity composed of multiple elements, and the interactions between its internal elements cannot be fully revealed by simple academic discussions. Healthy streets, as one of the bases for building a healthy city, are also intricately related to other elements in the city. It is hoped that the relevant teams will utilize new technologies and perspectives, combine multidisciplinary dimensions, fully integrate objective indicators with subjective evaluation, and promote the improvement and development of the Healthy Streets Evaluation Index System in their subsequent studies. This system is a way to guide the construction of healthy streets and promote the construction of healthy cities, carry out deeper research and exploration of healthy cities, and put forward more scientific and practical strategic recommendations for the construction of healthy cities.

6. Conclusions

In this study, we constructed a "5D+" street space health evaluation index system to evaluate the health of the Dingwangtai Area in Changsha City, with the community as the evaluation unit. The Entropy-weighting TOPSIS method was used to compute the indicator data to obtain the health ranking of the corresponding community. The conclusions of this study are as follows:

(1) At the area level, the Dingwangtai Area is comparatively weak under the three dimensions of density, devise, and destination accessibility. Four communities scored poorly in the corresponding dimensions, respectively.
(2) At the community level, the Ma Wang Street Community and the Fanhou Street Community scored lower. The Ma Wang Street Community is at a poor level in four dimensions: degree of mixing, distance to transit, devise, and destination accessibility. The Fanhou Street Community is at a poor level in four dimensions: human perception, degree of mixing, distance to transit, and destination accessibility.
(3) At the indicator level, comparing the weights of the indicator layers of each dimension, it was concluded that the indicators of nighttime street brightness, functional mixing degree, density of healthcare facilities, accessibility of transportation service facilities, presence of a non-motorized lane, and transportation accessibility have a significant impact on the development of healthy streets in the Dingwangtai Area.
(4) At the strategy level, this paper proposes three major transformation strategies for community problems based on the concept of humanism: optimize street design to improve human perception, adjust the functional structure to enhance the vitality of the population, and optimize traffic organization and improve travel experience.

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