Environmental Evaluation of Small Coastal Cities Based on Street View Images

Jing Chen, Xiaoxuan Wang, Yujing Wu, Bing Shi, Jifu Lu*
Huali College, Gangdong University of Technology, Zengcheng, China

*Corresponding author: jifu@163.com

Abstract. Whether out of the need of theoretical exploration or practical application, carrying out urban environmental assessment research can attract the attention of the public and managers, and it is conducive to improving the existing environmental impact assessment system. With the continuous breakthrough of artificial intelligence technology and its application in various fields, it is possible to carry out urban environmental assessment research based on street view images on a large spatial scale. Based on the analysis of the theories and methods of urban environmental assessment, combined with the landscape vision application in the planning of small coastal cities (littoral), this paper constructs an overall understanding of urban environment, specifically the assessment of environmental quality.

Keywords: The street view images, Urban environmental assessment, Small coastal cities

1. Introduction

The narrow sense of urban environment is the physical environment composed of natural environment and artificial environment, while the broad sense of urban environment also includes social environment, economic environment and aesthetic environment. Beautiful and comfortable urban environment can not only improve the social lifestyle of citizens, enhance the vitality and image of the city, delight urban residents, enhance the sense of belonging and affection of local residents to the city, but also increase the comprehensive attraction and influence of the city on the outside world. Therefore, the study of urban environmental assessment can provide scientific and effective methods and basis for the construction of good urban landscape in China, and also provide some decision-making suggestions for urban planning and construction. Compared to the traditional field survey data, the street view images not only wide coverage, large amount of data, which provide the API interface development, and the map can be downloaded for free street view images, more important is the image contains rich urban infrastructure information, can provide the street level of artificial landscape and the natural landscape, intuitive response city elevation information accurately. These advantages make street view image become an important new data source in the study of urban environmental assessment and bring new methodological opportunities for the study of urban environmental assessment[1,2].
2. The Theoretical Framework Construction of Urban Environmental Assessment [3,4]

2.1 City Image
The city image is composed of five elements, namely, road, node, edge, area and symbol. People can use the combination of these five symbols to clearly draw their own image of the city on the paper. "Readability" means that a city can be cognitive, this is because the city is like a book, which is composed of we can cognitive symbols. Urbanite is like reading a book in virtually every day in perception of a city, which can form on the image of the city, and again before it can be through abstract symbols express the kind of image.

2.2 Theory of Element Organization
These organizational principles fall into three categories: (i) Spatial organization: proximity, enclosure, interlock, continuity, similarity, etc. (ii) Structure: balance, tension, rhythm, proportion, scale. (iii) Organizational order: axes, symmetries, grades, benchmarks, transitions, etc.

2.3 View Control Theory
The view control method is to ensure the visibility of the city's commanding height. The control area is classified into landscape viewing gallery, wide-angle view surrounding landscape consultation area and background consultation area. Different height control and management are implemented in each division to ensure the right of citizens to enjoy the beautiful scenery from a distance in the city. On this basis, some scholars further put forward the "Spindle-shaped view control theory", which aims to protect the overall urban landscape structure such as "scenic spots, viewpoints and corridors", and its object is the general urban fabric. Specifically, the volume of the building should be placed in the plane formed by the two straight lines at both ends of the roof ridge and the viewer, and the cube formed by the projection on the ground -- namely, the "spindle" -- through the body.

2.4 Types of Visual Evaluation
Urban environmental assessment is a systematic method, which can be divided into different levels and types to adapt to different research objects, objectives, evaluation scale and depth. The significance of distinguishing different evaluation levels and types lies in: 1) According to different research requirements and evaluation levels, different evaluation schemes and methods are adopted to effectively solve problems; 2) For different types and levels of evaluation, the time, manpower and financial resources are also different due to the different research depth.

According to the timing sequence of evaluation, the purport of evaluation, and the nature of evaluation, environmental evaluation can be divided into the following categories, as shown in TABLE 1:

| Classification          | Type             | Define                                                                 | Purpose                                                                 |
|-------------------------|------------------|------------------------------------------------------------------------|------------------------------------------------------------------------|
| Evaluation of temporal  | Review the evaluation | A retrospective evaluation of the regional environmental characteristics of a region in a certain historical period based on historical data | It reveals the development and change process of regional environment and predicts the development trend in the future |
|                         | Status evaluation | Based on the recent survey data, the characteristics and changes of an area's environmental status were evaluated | To reflect the environmental quality status, explore the causes of environmental quality status, and provide scientific basis for regional resource management, protection, planning and |
| Section | Description |
|---------|-------------|
| The future forecast | On the basis of retrospect evaluation and current situation evaluation, the author identified, predicted and evaluated the environmental changes caused by natural changes and human actions, and put forward some countermeasures to avoid and reduce the negative environmental impact reasonably on the basis of evaluation. The conclusion of future prediction is an important basis for the decision of visual environmental protection. |
| Environmental quality assessment | According to certain evaluation criteria and use of certain indicators and evaluation methods, to a certain region within the scope of the environmental quality is quantitatively described, in order to find out the research on the history and status quo of the regional environmental quality, determine the main factors influencing the environmental quality, master the regular pattern of the regional environmental changes, to predict the future development trend, which will provide a scientific basis for study of regional environmental planning. Determine the basis of planning and management objectives and construction measures. |
| Environmental suitability assessment | It is a comprehensive measure of environmental sensitivity to human interference, shielding or assimilating external influences, and the ability to recover from damage. Comprehensively measure the visual carrying capacity of regions with different sensitivity levels, and judge the extent of regions suitable for human action. |
| Landscape integrity evaluation | Used to measure environmental characteristics that come from nature or that occur naturally. |
| Preference evaluation | Focus on the reactions and processes generated after human contact with the environment, including exploring a series of reactions generated by human contact, cognition and action in the environment, such as feelings of likes and dislikes. |

3. Urban Environment Evaluation Based On Street Landscape

3.1 Selection of Evaluation Method and Construction of Evaluation System

1) Evaluation Method: environmental quality evaluation index method

\[ B = \sum X_i F_i \]

Where, B represents the comprehensive evaluation index of a street landscape; \( X_i \) represents the weight of a street landscape evaluation factor; \( F_i \) represents the score value of some street landscape elements under corresponding evaluation factors; \( X_i F_i \) represents the sub-index of a street landscape visual evaluation. The comprehensive evaluation index of street landscape is obtained by the superposition of sub-indexes, which is suitable to study the multi-attribute and multi-factor evaluation system structure.
2) Evaluation Index Selection

According to the spatial characteristics of urban main roads, the visual evaluation of street landscape can be divided into three categories: horizontal interface factor, vertical interface factor and street facility factor.

Horizontal interface factor: refers to the ground of the street, which is the most direct contact surface between the vehicle and the street, and the interface on which the vehicle and the person can stay. Horizontal interface is the main element of street space, which has the highest frequency of contact with people psychologically, physiologically, visually and tactile. It also determines the spatial distribution of various activities in the street, such as the division of walking path and lane, the spatial limit of rest and activity space, and so on. The quality of horizontal interface is related to the layout, scale, pavement material and texture of street interface. A good street floor can not only provide a convenient and safe traffic environment, improve the use efficiency, but also enrich the street public life and beautify the environment.

Vertical interface factor: refers to the interface that restricts the vertical space of the street on both sides, mainly the enclosed buildings, and may also include the trees and mountains that can form the vertical interface. The enclosed characteristics of street space are mainly determined by the vertical interface, such as closed, open, narrow and so on. The quality of the vertical interface depends mainly on the form and layout of the buildings along the street. Vertical interface, which has strong visual and psychological effects on people, is the most difficult to control street landscape elements.

Street facilities factor: refers to the facilities used to meet the needs of people in all aspects, including practical facilities, aesthetic facilities and other aspects. According to its functional classification, it can be roughly divided into the following three categories: 1. Traffic service street facilities, mainly used to organize the operation of traffic signs and facilities, such as bus stops, road boundaries, traffic signs, street lights, guardrail, etc.; 2. Pedestrian service street facilities mainly meet the daily public life needs of people on the street, such as telephone booths, rest facilities, garbage cans, public toilets, signs and so on; 3. Cultural and artistic street facilities are mainly used to create a cultural and artistic atmosphere of the street and create a civilized environment, which includes street sketches, sculpture, advertising, street lighting, greening, art paving and other facilities. Street facilities serve people directly, which is closely related to the quality of street use and the organization of street visual landscape environment. Street facilities are the most frequently contacted street factors in daily life.

Figure 1 Planning scope of Ying Bin Avenue
3.2 The Object and Scope of Evaluation

The evaluation object is the status quo and historical photos of the Ying Bin Avenue landscape. Evaluation scope of Ying Bin avenue planning scope, mainly for the north south avenue, south to development road, the road on the west side to branch network, and with evaluation, Ying Bin avenue, the main road outside the red line control width is about 350 meters to 650 meters, the east combined with landform consider reasonable distance between roads, control within 500 meters of the red line of road concrete as shown in figure 1.

The selected evaluation subjects were the main residents along Ying Bin Avenue. A total of 60 questionnaires were issued, including 15 village settlements. Three to five questionnaires were issued in each settlement, and a total of 50 valid questionnaires were collected.

Table 2. Composition Characteristics of the Evaluation Subject

| The structure | Record of formal schooling characteristics | Gender | Age structure |
|---------------|--------------------------------------------|--------|---------------|
|               | Bachelor and above | High school | Junior High school and below | male | female | 12~18 | 19~49 | 50 and above |
| number        | 2 | 15 | 33 | 28 | 22 | 6 | 29 | 15 |
| The proportion (%) | 4 | 30 | 66 | 56 | 44 | 12 | 58 | 30 |

3.3 Analysis of Evaluation Results

In this paper, the weights of 16 evaluation factors are divided and calculated by using the calculation method of landscape composite index. The index weights and results are shown in Table 3. below:

Table 3. Weight and Comprehensive Value of Street Landscape Visual Quality Evaluation Index

| Street landscape elements | The evaluation index $X_i$ | The weight | Current landscape quality | Historical landscape quality |
|---------------------------|-----------------------------|------------|---------------------------|-----------------------------|
| Road body factor A        | The road A1                 | 0.097981   | 4.71                      | 2.56                        |
|                           | Road line A2               | 0.063827   | 4.13                      | 3.48                        |
|                           | Traffic smoothness A3      | 0.054479   | 4.83                      | 4.21                        |
|                           | Intersection experience A4 | 0.065822   | 3.38                      | 2.16                        |
| Road facility factor B    | Traffic facilities B1      | 0.064379   | 3.04                      | 2.46                        |
|                           | Living facilities B2       | 0.082927   | 3.38                      | 1.78                        |
|                           | Sanitation B3              | 0.070798   | 3.46                      | 1.69                        |
|                           | Service facilities B4      | 0.063896   | 3.79                      | 1.45                        |
| Road landscape factor C   | Greening configuration C1  | 0.102022   | 3.96                      | 1.55                        |
|                           | The facade perception of residents along the street C2 | 0.0766 | 2.96 | 2.42 |
|                           | Squares, parks C3          | 0.083406   | 2.88                      | 1.63                        |
|                           | Street sketches, sculptures and other cultural landscape C4 | 0.076106 | 2.79 | 1.58 |
|                           | Night view lighting C5     | 0.055207   | 3.38                      | 1.36                        |
|                           | Perspective visibility C6  | 0.042659   | 3.75                      | 3.48                        |
|                           | Comprehensive value of street landscape quality | 5 | 3.6 | 2.19 |

According to the division results in Table 3, the comprehensive index M value of the humanitarian status of welcoming guests after planning and construction is 72%, and the landscape visual quality
belongs to grade II, which is good. The original comprehensive index M value of street landscape visual quality is 43.8%, and the landscape visual quality belongs to grade III, which is general. In general, the planning and implementation of Ying Bin Avenue has greatly improved the visual quality of street landscape, but there is still room for further improvement. There is a certain deviation between the road construction status quo and the original planned scene (Figure 2). With the deepening of the project construction, the planned street landscape will be better displayed.

Figure 2 Panoramic view of Ying Bin Avenue planning

Acknowledgements
The Special Talent Innovation Project of General Colleges and Universities in Guangdong Province in 2020, "Quantification and measurement of street space quality in rapid urbanization areas in the post-epidemic era--taking Zengcheng District as an example ", (2020KTSCX194). The Young Innovative Talents Project of General Colleges and Universities in Guangdong Province” The Cooperative Application Model of BIM and GIS in Urban Construction” (2016KQNCX211). The Young Innovative Talents Project of General Colleges and Universities in Guangdong Province” The adaptability evaluation of residential climate districts within a hot-humid city” (2020KQNCX122).

References
[1] Kelly C M, Wilson J S, Baker E A, et al. “Using Google Street View to Audit the Built Environment: Inter-rater Reliability Results”. Annals of Behavioral Medicine, vol.45, no.1, pp.108-112, 2013.
[2] Wang S, Paul M J, Dredze M. “Social Media as a Sensor of Air Quality and Public Response in China”. Journal of medical Internet research, vol.17, no. 3, pp. 19-22, 2015.
[3] Meitner M J, "Scenic Beauty of River Views in the Grand Canyon: Relating Perceptual Judgment to Locations", Landscape and Urban Planning, vol.68, no. 1, pp. 3-13, 2004.
[4] Cengiz Acar, Cigdem Sakici, "Assessing Landscape Perception of Urban Rocky Habitats", Building and Environment, vol.43, no. 2, pp. 115-117, 2008.