The Building Color Quality Evaluation of Urban Commercial Street Based on Python Grabbing Street View Image: Taking Shenyang Xita Street as an Example

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Abstract—As an open space in the city, the commercial street can reflect the urban vitality and is the main place to increase the economic benefits of the urban area. At the same time, building color has a huge impact on the visual quality of the urban environment, it is an important part of the urban landscape. The study used Python in Baidu Street View (BSV) panorama to grab the images of the buildings on both sides of Shenyang Xita Street within a length of 1.2 kilometers, and used physical psychology method to evaluate and analyze the current situation of the building color quality (BCQ) on Xita Street. This study contributes to promote the color planning or management of urban, build a harmonious ecological urban area and provide suggestions for urban renewal.

Keywords-commercial street; building color quality; urban renewal; Python

1 INTRODUCTION

Color is the first perception of an unknown space, it is a visual characteristic that stands out from the complexity of the vision field [1]. To some extent, urban color is an outward expression of the inner culture of urban area, and is an important area that cannot be ignored in the overall urban planning. In urban design, color has become an important issue in urban beautification, urban image and building design [2]. The study of theories related to urban color began in the 1960s. French colorist Jean-Philippe Lenclos proposed the “Geograpy of color” theory. He believed that color had strong regional characteristics [3]. In the 1970s, Japan established the Color Planning Centre, which completed the collection of colors with precise electronic instruments, making the data results more accurate and more objective. In 1901, the German architect Fritz Schumacher pointed out that any aesthetic potential in building should be supported by color from the beginning. Smith believed that color can increase the recognition and cultural characteristics of the built environment [4]. However, in the process of rapid urbanization in China, as a famous commercial street with ethnic characteristics, Xita Street has gradually losing its regional cultural characteristics. The disorderly distribution and overuse of color in commercial streets make the building color in a chaotic state, which has

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caused a certain degree of damage to the overall color of the urban area. The disorderly distribution and overuse of color in commercial streets make the building color in a chaotic state, which has caused some damage to the overall color of the urban area. Color can play a symbolic role in the development of cities [5], and buildings form a large part of urban space. Therefore, building color is a very important influencing factor in urban renewal. With the development of digital technology, the scientificity and operability of building color quality (BCQ) evaluation have been enhanced [6].

This study selected the buildings on both sides of Xita Street, a representative commercial street in Shenyang. The Baidu Street View (BSV) panoramas were used to collect color information from public aesthetics. To quantify urban building color using physical psychology method, analyze the building color quality and problems, and explores the practicability of research methods to promote the future color planning of the urban commercial street to be more scientific and humanized.

2 METHOD

2.1 Study Area

This study area is established in Xita Street, Shenyang, China. Shenyang is a famous historical urban. Xita Street is a representative commercial street in Shenyang, which belongs to the characteristic cultural commercial street. It is located at the intersection of Heping District, Tiexi District and Huanggu District, and is connected to Taiyuan Street in the south. The study area is 1.2 kilometers long. Xita Street is the largest settlement of Chinese Korean in Shenyang. It is a characteristic street established for commercial activities and has been developed for more than 120 years, with deep cultural and economic value. Therefore, according to the current situation of this area, it can be divided into five blocks from north to south: Block A-E, containing 72 sample photos on both sides (Figure 1).

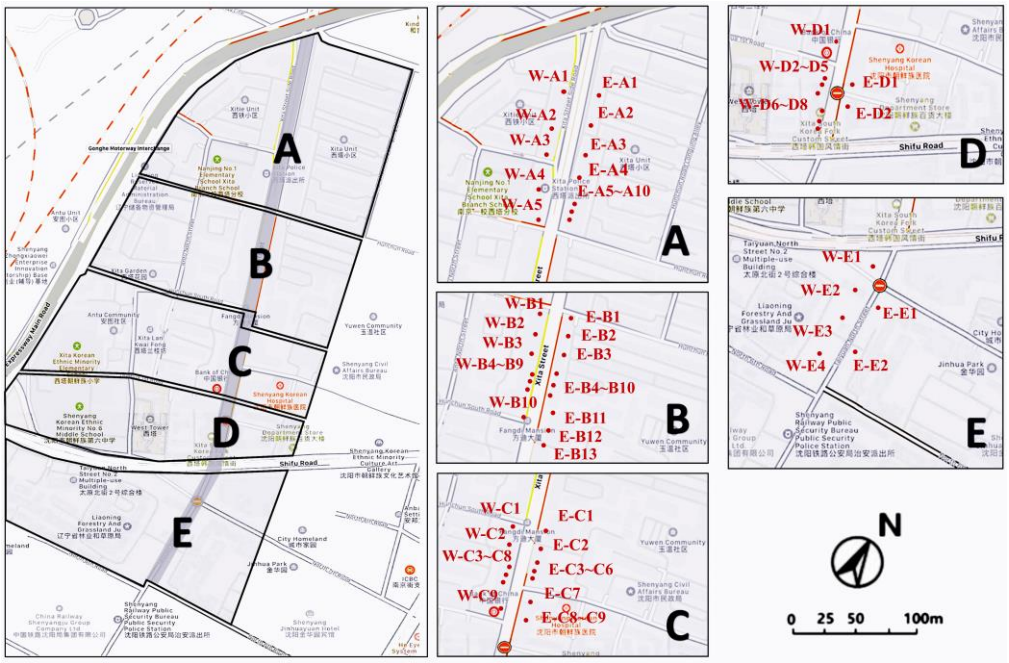

Figure 1 Study area map.

2.2 Data Acquisition and Data Pre-Processing

In this study, the photos of the building samples are mainly obtained by Python Grabbing of Baidu Street View (BSV) panoramas. In order to obtain the building images from the perspective of pedestrians, the horizontal angle is 0 when downloading the image, the facade of the building adjacent to the main commercial street is taken as the main measurement object. By capturing and collating images of the buildings on both sides of Xita Street, 72 street images of single building facades were obtained, including 36 images of the building facades on the east and west sides of the street. Compared to traditional photographic data collection methods, the advantages of this method are intelligent and fast, accurate control, and the ability to obtain building images with wide coverage. Its disadvantage is that it can only capture images with a resolution of 700*700. After the experimental comparison between high resolution and low resolution, the scores of RMSE for high resolution scoring and low resolution scoring is less than 0.5, so the influence of resolution on the evaluation results is small. In order to ensure the color accuracy of the acquired images, all samples need to be pre-processed for numerical correction of hue and saturation value (HSV). The automatic white balance (AWB) algorithm was used to process the images, restore all the images, weaken the influence of light conditions on the images, and make the images in different light conditions comparable (Figure 2).

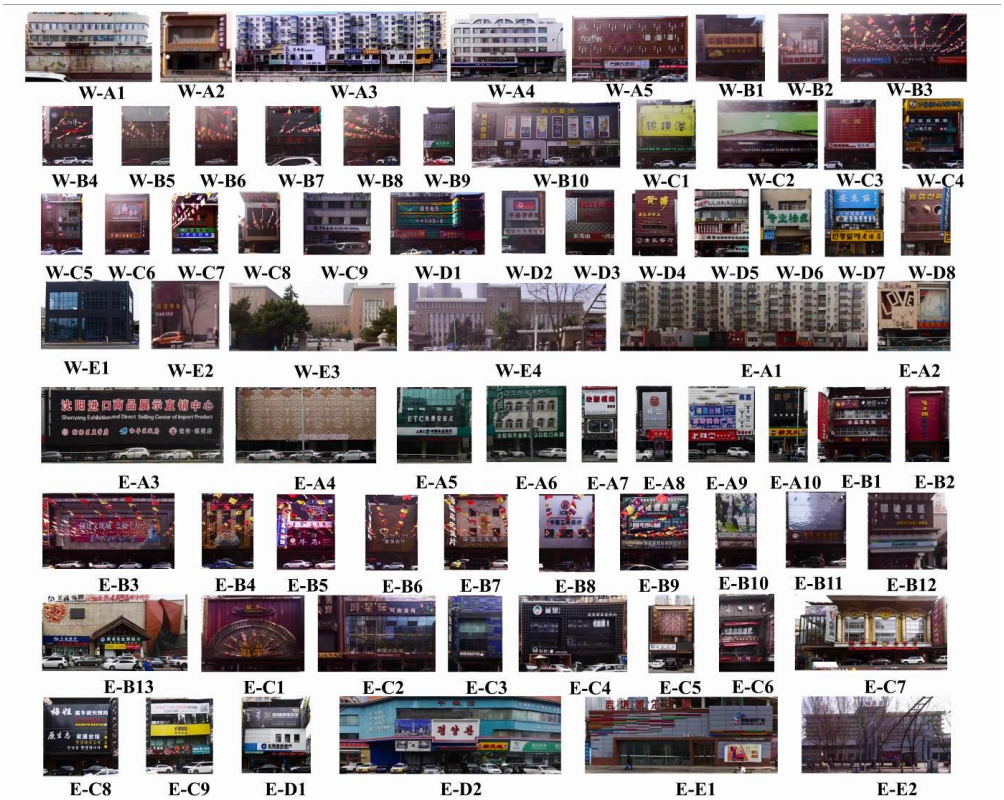

Figure 2 Photos of sample.

2.3 Date Processing

In this study, teachers and researchers in architecture, urban planning, landscape architecture and other related design majors, a total of 45 experts were invited to evaluate the BCQ of Xita Street by slide show. Before making an evaluation, all samples were roughly previewed, but the details of color evaluation are not involved, allowing the evaluator to establish evaluation criteria. Each slide was played for 20 seconds. The evaluator learned the color information of all samples and scored them independently on a Likert scale: 1 (low color quality) - 7 (high color quality). A total of 45 questionnaires were received, the return rate was 100%. After screening, 4 invalid questionnaires were excluded, and 42 valid questionnaires were finally obtained. Importing the evaluation results into SPSS for data standardization, which ran as follows:

$$Z_{ij} = \frac{\left(R_{ij} - \overline{R_j}\right)}{S_j} \tag{1}$$

$$SBE_i = \Sigma Z_{ij} / N_i \tag{2}$$

In Equation (1): Z_{ij} was the standardized value given by evaluator j for the observed sample photo i. R_{ij} was the rating value given by evaluator j for the observed sample photo i. $\overline{R_j}$was the average of the rating values of all building color sample photos by evaluator j. S_j was the standard deviation of the rating values of all building color sample photos by evaluator j. In Equation (2): SBE_i was the standardized score of BCQ for sample photo i. N_i was the total number of evaluators.

3 RESULT

3.1 Comparative Analysis of Building Color Quality in Xita Street

The 72 samples BCQ evaluation results in Xita Street were sorted in Table 1. The top 24 samples were selected as high quality samples and the latter 24 samples as low quality samples. By comparing high-quality samples with low-quality samples, analyzed the BCQ of Xita Street.

Table 1 Quality ranking order for samples Table Type Styles

Sample No.	Standardized value	Sample No.	Standardized value	Sample No.	Standardized value	Sample No.	Standardized value
W-E1	1.450	W-B3	0.394	E-C2	-0.129	W-B2	-0.399
W-C6	1.353	W-B1	0.387	E-C9	-0.138	W-B6	-0.485
W-E3	1.281	W-C5	0.370	E-B13	-0.143	W-C3	-0.497
E-B7	1.178	W-B4	0.361	E-E1	-0.175	E-C7	-0.526
W-E4	1.175	W-C4	0.299	W-A2	-0.227	W-C9	-0.533
W-D5	1.160	E-D2	0.282	E-A9	-0.230	E-A3	-0.544
E-C6	1.140	W-C7	0.182	E-B4	-0.234	W-A1	-0.575
E-C3	0.970	W-C8	0.152	W-C1	-0.259	E-A6	-0.637
E-A8	0.825	E-A5	0.146	E-A10	-0.277	E-B3	-0.686
E-C4	0.791	E-B6	0.114	W-D3	-0.278	W-B5	-0.721
W-A5	0.706	W-B7	0.073	E-B12	-0.282	E-D1	-0.761
W-C2	0.701	E-C1	0.052	W-D7	-0.305	E-A2	-0.914
E-B8	0.675	W-B10	-0.015	W-A4	-0.313	E-A1	-0.926
E-B5	0.654	E-C8	-0.040	W-D1	-0.324	E-B9	-1.015
E-C5	0.528	W-B8	-0.067	W-B9	-0.328	E-B10	-1.067
W-D4	0.491	E-E2	-0.106	E-B1	-0.329	W-A3	-1.126
E-A4	0.466	W-D8	-0.114	W-E2	-0.336	E-B11	-1.551
E-A7	0.413	W-D2	-0.114	E-B2	-0.389	W-D6	-1.775

In the high quality samples, the building colors of most samples were integrity. The main colors were red and yellow, the overall color was warm, the main color and auxiliary color of building were harmonious. In the top 24 high quality samples, the main color of some samples was outstanding, without other noise interference (such as W-E4, W-A5, E-A4). The color blocks of some samples were regularly distributed, showing obvious regionalism (such as E-C6, E-B5). The bright color matching of some samples can increase the visual appeal and attract customers (such as W-C6, W-C4). W-E1 had the highest BCQ (1.450). The whole building presented a large area of black wall, combined with glass curtain wall. It had no billboards on the building facade and had a good cleanliness.

In the low quality sample, the building facades of some samples were blocked by artificial temporary colors (such as billboards, plaques) so that it was difficult to see the whole picture. The colors were messy, which affected the visual comfort (such as E-B10, E-B9, E-B3). Some building samples were in a state of disrepair, resulting in poorly facade color updated and material deterioration (such as W-A3, E-A2, E-A6). Some samples had a confusing arrangement of color blocks and poor color harmony (such as E-A3, W-D1). W-D6 had the lowest BCQ (-1.775), its building facade was beige and very dilapidated. The artificial temporary color was abrupt, the combination with building color was low and had too much visual impact.

3.2 Comparative Analysis of BCQ in Different Blocks

Table 2 Statistical analysis of BCQ in different blocks

Block No.	Total mean value	Median value	Difference value
A	-0.214	-0.277	0.063
B	0.168	-0.234	0.402
C	0.245	0.167	0.078
D	-0.174	-0.196	0.022
E	0.548	0.535	0.013

In the process of aesthetic perception with building color as the object, individual building color had an impact on the overall street color environment. In order to obtain information on the overall BCQ of Xita Street, it was divided into 5 blocks and their BCQ averages were further compared. As can be seen from Table 2, the order of color quality of the 5 blocks was ranked as follows: BCQ E（0.548）＞BCQ C(0.245)＞BCQ B(0.168)＞BCQ D（-0.174)＞BCQ A(-0.214). In Block E with the highest BCQ, the hue and contrast between the main color and auxiliary color of its building facade were harmonious, and the overall color had a layered feeling. It has a regular color block distribution, good neatness and fewer billboards. In Block A with the lowest BCQ, the color of building facade fell off and the facade was dilapidated. Billboards were used in a wide range and had many kinds. The color composition was complicated and chaotic, the relationship between color blocks was fragmented.

By comparing the mean, median and standard deviation of BCQ in 5 blocks, it can be seen that the fluctuation and distribution balance of BCQ showed a positive skewed distribution. Statistically calculated the BCQ score for each block, if its mean was greater than the median, indicating the presence of an extreme value with statistically significant impact in the block. The highest point of the statistical value distribution curve of this block was affected by the highest value and shifted to the left along the X-axis. In Xita Street, the BCQ of five blocks was positive skewed distribution, which indicated that the high scoring building color samples in these five blocks positively influenced the overall color quality of the block. W-A5 was a high quality sample of Block A, the main color was orange, the auxiliary colors were red and white, the color matching was advanced, and the walls were neat. E-B7 was the highest score in Block

B. The main color was brown, white and yellow were embellished colors. The building colors were neat and comfortable. E-C6 was a high-scoring sample of Block C, the main color was reddish brown, combined with a large area of windows, without other noise interference, the color was soothing and elegant. W-D5 was the highest score in Block D. The wall adopted warm red, yellow and white as auxiliary colors, the colors were harmonious. W-E3 was a high-scoring sample of E block. Its main color was orange with low saturation, its visual stimulation was low (Figure 3).

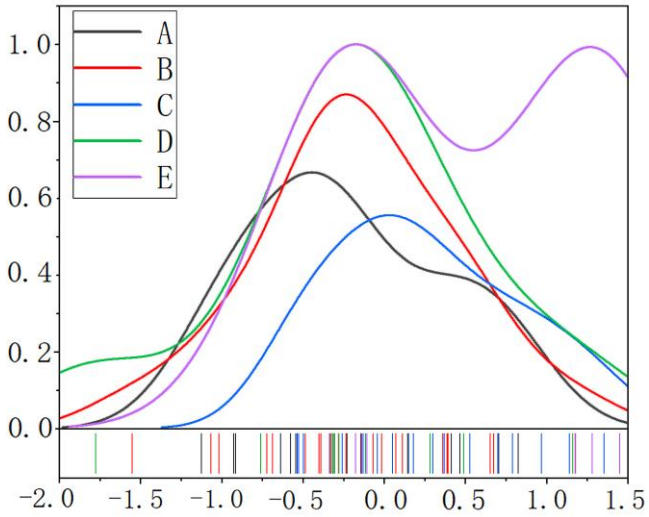

Figure 3 The block BCQ distribution map

4 DISCUSSIONS

4.1 Harmony of Billboard Color with Buiding Color

As an important element of the building appearance of commercial street, commercial billboards not only play an important role in displaying the internal functions of buildings, publicizing commercial products and attracting the people to enter the buildings for consumption, but also directly affects the visual effect of the urban public space. There are many kinds of colors in outdoor billboards. Parry et al. argued that the color harmony of billboards played an important role in effectively identifying information and beautifying the environment [7]. Color in Outdoor billboard is the first feature to be recognized by human vision, which has the most intuitive influence on the visual senses of commercial street buildings. Due to the commercial nature of Xita Street, the outdoor billboard hanging outside the buildings on both sides of street strive to achieve "maximum" and "most striking", thus neglecting the consideration of street culture and the overall color perception of the building. As a result, the "second profile" of the building formed by the advertising color obscures the color expression of the "first profile" of the building facade. Making the building becomes a backdrop and an accessory for the advertisement, affecting the sense of architectural hierarchy and the continuity of the characteristic commercial street, which affects the building layering

and the performance of the continuity of commercial street. Billboard that lack a design logic and visual connection to the building facade lead to a weakening of color harmony in the building, gradually losing its vitality. When setting up billboards on the building facade it is necessary to control the position, size, and color of the billboards. Pay attention to the use and matching of noise color to prevent the building facade from being confused with color and destroying the harmonious building color atmosphere.

4.2 The Number and Layout of Colors Are Related to the Integrity of Building Color

The number of building color has an impact on the aesthetic quality of urban building color, at the same time, unified and orderly color layout is more likely to attract attention. To a great extent, the choice of color directly affects people's subjective assumptions and emotions about the commercial street, and then affects the role that the whole building should play. By appropriately reducing the differences between the colors of building facade and controlling the number of colors, people can feel the integrity of building colors when walking in the streets. Excessive aggregation or fragmentation color layout has a negative impact on people's emotional state. The hue of the building color of Xita Street belongs to several color systems, resulting in the current color of Xita Street creating a lively atmosphere in the commercial street but tending to cause a feeling of color confusion. In order to create an integral and coherent atmosphere of commercial street, it should be paid more attention to the coordination and primary-secondary relationship of the colors of two adjacent elements to control and reduce the color difference, making the building colors in the direction of street travel change orderly and rhythmically.

4.3 The Humanistic Color in the Building of Commercial Street

Urban color is influenced by natural and humanistic environment. Humanistic color is determined by the regional environment, beliefs and living customs of people in the region, which is unique. The application of humanistic color in commercial street can increase people's sense of identity and impression. The weakening of traditional color features will destroy the continuation of color preferences such as region, culture and customs. Given the historical evolution and human characteristics of Xita Street, the humanistic color of the Xita Street can be studied mainly in terms of the Chinese Korean building style, traditional dress culture and folk cultural symbols. The main color scheme of traditional Korean architecture is white, with greenish-grey or light brown as the auxiliary color. The facade of most buildings in Xita Street use red and yellow colors with high brightness and purity, which have a strong visual impact and cannot clearly reflect the Chinese Korean characteristics of Xita Street. In the color design of buildings with national culture, the influence of regional culture on urban area development should be emphasized, and extract the corresponding regional cultural color for rational application in color design.

5 CONCLUSION

Through the investigation and analysis of the building color of Xita Street and the color quality evaluation, this study found that the overall color of the buildings on both sides of Xita Street is chaotic and lack of harmony. It is mainly caused by the conflict between building color and

billboard color. In addition, the number and layout of colors have not formed a unified standard, resulting in poor color quality of some buildings. Commercial street is the most frequent place for trade and cultural exchange in urban areas. The embodiment of national culture and the application of humanistic color are particularly important. Through systematic and distinctive commercial street building color planning, a beautiful and harmonious city will be created, combining regional and cultural characteristics, strengthening color protection and fully showing the unique charm of the commercial street.

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