Visual preference evaluation on urban landmarks in the process of urbanization: a case study of Shanghai Oriental Pearl Radio & TV Tower

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1. Introduction

1.1. Research background

Urban landmarks are not merely a regional visual focus which helps people recognize and judge the surroundings, but also an important carrier of urban space history, culture, aesthetics and emotional attachment. Meanwhile, they are also a key component of urban spatial form. The urban landmarks of a city are to a large degree the embodiment of public impression on the city.

The Oriental Pearl Radio & TV Tower (OPT, hereinafter referred to as “the Tower”) is one of the important urban landmarks of Shanghai. As one of the most representative buildings of Shanghai urban modernization, it is indeed the symbol of modern Shanghai to many Chinese people since its completion (1995).

Urban landmarks are remarkably influential to urban spatial form. Karimimoshaver and Winkemann (2018) claimed that the influence of high-rise buildings on urban skyline can be assessed from the following three dimensions: aesthetic dimension, visibility dimension, and meaning dimension. Yusoff, Noor, and Ghazali (2014) maintained that skyscrapers, as important components of the skyline of Kuala Lumpur, capital of Malaysia, mainly influenced people’s first impression on the city.

Visual preference evaluation of urban landmarks is another important aspect of urban building evaluation. Samavatekbatan, Gholami, and Karimimoshaver (2016) studied the aesthetic issues of urban high-rise buildings with computer software. Their study revealed that height was the most influential factor for the visual aesthetic evaluation of high-rise buildings. Browne (2006) observed that aesthetic value was one of the key functions of landmark buildings.

The change of the surroundings around a particular building influences visual preference evaluation as well. Zarghамia et al. (2019) studied the tension created by the height, width, and height–width ratio of high-rise buildings and exerted upon the observers at different distances. Yabuki, Miyashita, and Fukushima (2011) studied the integration of buildings of different heights and surrounding landscapes by using the AR method. Collins, Sitte, and Collins (2006) maintained that the height of surrounding buildings around the square would influence viewers’ feeling. Lin, Homma, and Iki (2018) discovered that building height and vegetation types around the lake exerted some impact on people’s visual preference evaluation upon the lake.

The main standard to evaluate the characteristics of visual environment is visual aesthetics which refers to the degree people’s aesthetic experiences of visual landscapes can reach. To be specific, visual aesthetics is closely related not only with some objective factors...
such as landscapes and buildings but also with the demographic characteristics of the evaluators (Wang and Zhao 2017). According to the previous researches, cultural background (Yu 1995), education background (Molnarova et al. 2012), gender (Lindemann-Matthies et al. 2010; Strumse 1996), age (Van den Berg and Koole 2006), professional knowledge (Strumse 1996; Vouligny, Domon, and Ruiz 2009), familiarity with the environment (Howley, Donoghue, and Hynes 2012), and living environment (Yu 1995; Zube, Pitt, and Evans 1983) are all influential to people’s visual preference evaluation.

In terms of research methods, most studies on visual preference evaluation in the field of architecture and related fields were based on subject feeling (Arrazia et al. 2004; Kaltenborn and Bjerke 2002; Kaplan and Kaplan 1989; Uuemaa et al. 2009). By contrast, only quite few studies adopted objective research method (Tveit 2009).

Some evaluation methods which combine subjective feelings and objective data have already been used to evaluate visual preference on buildings as well as in other relevant fields. Stamps lii (1990) observed that there existed a highly positive correlation between the information people obtain from static colored photos and that from actual views. Iverson (1985) put forward the concept “visual quality” and described visual effect from a quantitative viewpoint. Magill (1992) and Geneletti (2008) attempted to define visual preference with a series of indexes and landscapes. Other researchers explored how the change of landscapes’ physical characteristics influenced landscape aesthetics and tried to establish a correlation between physical characteristics and landscape aesthetics (Buhyoff et al. 1994; Real, Arce, and Sabucedo 2000).

1.2. Research questions

In the context of China’s urban fast development for nearly 30 years, the surroundings of many urban landmarks have been changing constantly (Z. Wang 2018). This research tried to explore people’s visual preference on urban landmarks as well as their surroundings during different periods through photo incentive method. The Tower and its surroundings in different periods were shown through a series of pictures to the participants. Through photo incentive, aesthetic evaluation, picture analysis, and statistical analysis, the visual preference laws of urban landmarks and the corresponding surroundings were thence obtained.

This research collected participants’ visual preference data of these pictures (of different periods) and demographic characteristics through questionnaire survey. By analyzing the data collected the following two questions were to be investigated: Is there any difference between different groups in their visual preference for urban landmarks in the context of fast-changing surroundings around urban landmarks? Is there any difference between people of different demographic characteristics in their preference on the physical characteristics of urban landmarks as well as the surrounding buildings?

2. Research methods

2.1. Research materials

The research materials of this research are mainly a series of pictures of the Tower and its surrounding building groups. The original photo was taken in Chen Yi Square, where a full view of Lujiatui financial district complex centered around the Tower across Huangpu River can be clearly obtained. Meanwhile, Chen Yi Square is also one of the most important scenic spots for all the tourists to Shanghai. Therefore, the location of photo shooting for this research is highly representative.

The photo was shot at the chosen location as introduced above. According to “Report on nutrition and chronic diseases of Chinese residents” released by the State Council in 2015, the average height of Shanghai residents (both male and female) is 168 cm. Accordingly, on November 22th, 2018, the photo was taken with iPhone 7 Plus at the height of 165 cm above the ground (as shown in Figure 1).

The above-mentioned photo was put into computer for processing. To be specific, the surrounding buildings around the Tower were removed one by one according to their respective completion time with Photoshop CS5. Similar methods are also widely used in studies of visual preference evaluation (Larsen and Harlan 2006; Tsoutsos et al. 2009; White and Gatersleben 2011; Samavatekbatan, Gholami, and Karimimoshafer 2016; Lin, Homma, and Iki 2018). In total, 23 pictures were produced. These pictures reconstructed the state of the Tower and its surrounding buildings from its completion in 1995 to November 2018 year by year. Four pictures (the pictures of 2001, 2005, 2014 and 2018) were deleted later in that no change occurred compared with the previous year. Therefore, with one of the first photos taken, there are 20 pictures shown in Figure 2.

2.2. Physical characteristics of the pictures

In this research, the physical characteristics of the pictures of the Tower and its surrounding building group were divided into four types: height ratio (a), building density (d), distance between the Tower and its surrounding high-rise buildings (l), and volume of the surrounding buildings (v).

2.3. Calculation of the physical characteristics

The 20 pictures were put in AutoCAD2014 for grid analysis. Firstly, the height of the Tower was set as H. Then, the top three tall buildings around the
Tower were marked out and the height ratio of the three buildings and the Tower could be calculated by the following formula: \( a = \frac{h}{H} \). Secondly, the number of cells between the top three tallest buildings and the Tower was counted, so that the distance between and the mean value (l) could be calculated. Thirdly, the number of cells that the buildings occupy (c1) and that of the sky (c2) was counted, respectively. So the building density could be calculated by the following formula: \( d = \frac{c1}{c2} \). Finally, the number of cells that every building takes up was counted, so the volume of the top three largest buildings in the pictures and the
mean value (v) were calculated. In the case that a cell is not fully stuffed, it should be counted as 0.5 cell. The grid analysis and physical characteristics’ extraction are shown in Figure 3. The calculation results of the 20 pictures are shown in Table 1.

2.4. Survey of participants’ preference

After being processed with computer software, the 20 pictures were shown to the participants of this research. For the convenience of the participants to score the pictures, the pictures were printed on five pieces of full-color photo paper (A4 size, four pictures on each piece) and then bound in a volume in random order so that the participants would not know the year that each picture represented. Then, these pictures were shown to random Chinese participants in Chen Yi Square of Shanghai (the location of photo shooting).

To begin with, participants need to complete their demographic characteristics according to the questions on the questionnaire. The demographic characteristics involved in this research included gender, age, educational background, and rural growth experience. Then, participants were asked to score each of the 20 pictures of the Tower (ranging from 0 to 5; 0 denoting the least preference and 5 denoting the most preference). They could revise their scores at their own will before the questionnaire was finished. The first survey was conducted on 29 November 2018 which included 160 participants altogether. To ensure the reliability of survey data, a second survey was conducted on 20 December 2018, with 170 participants in total. All the scores given by the participants were recorded and compared. The result indicated that the average preference scores of the two surveys were close to each other (single-factor analysis of variance F = 0.458, p = 0.230). Accordingly, the two rounds of questionnaire survey could be further analyzed as a whole. The scores corresponding to the variables of each demographic characteristic are shown in Table 5. Of the 330 questionnaires, 278 were valid and the rate of validity was 84.2%. The demographic characteristics of the participants, which were in line with the statistical results of Shanghai Statistical Yearbook (2018), are shown in Table 2.

Then, the data collected were analyzed with SPSS 22.0. Through correlation analysis, the influence of different demographic characteristics on people’s visual preference evaluation was studied. On this basis, the data were further analyzed with multiple linear regression models. These analytical methods are also widely used in similar studies (Wang and Zhao 2017; Zhao, Zhang, and Cai 2020).

3. Results

3.1. Overall evaluation of the pictures

At first, the intergroup reliability of preference scores obtained was examined. The SPSS calculation results showed that the reliability was 0.782, indicating a high internal reliability. It also demonstrated that the questionnaire survey was highly reliable and the data obtained could be analyzed.

The average score of each picture (s) was calculated, with the maximum score being 4.23 and the minimum being 2.22. The average preference score of all the pictures was 3.41. The highest average score was given to the picture of 2007 while the lowest went to the picture of 1998.

3.2. Demographic characteristics and visual preference evaluation

Single-factor analysis of variance was conducted to study the relationship between demographic characteristics and visual preference evaluation. The results indicate that gender difference (F = 11.204, p = 0.02), age difference (F = 2.692, p = 0.01), experience in rural areas (F = 6.230, p = 0.03) all contribute to participants’ scoring process, which finally leads to the difference in the average scores of each picture. However, participants with education difference (F = 2.021, p = 0.64) does not show any difference in their average scores of each picture.

In addition, whether demographic characteristics interact with each other (collinearity) was also studied. Based on the results of multiple linear regression analysis, collinear analysis was conducted to independent variables. As is shown in Figure 4, the standardized

Figure 3. The diagram of the grid analysis and physical characteristics’ extraction.
Table 1. The physical characteristics of the surrounding buildings around the Tower.

| Year | Height ratio (a) | Distance (l) | Building density (d) | Volume (v) |
|------|-----------------|--------------|----------------------|-----------|
|      | Mean value of the height ratio of the three tallest buildings and the Tower | Mean value of the distance of the three tallest buildings and the Tower | Ratio of cells of the buildings and the sky | Mean value of the top three largest buildings |
| 1995 | 0.24 | 11.7 | 0.06 | 14.33 |
| 1996 | 0.27 | 7.2 | 0.06 | 14.33 |
| 1997 | 0.31 | 8.2 | 0.08 | 18.67 |
| 1998 | 0.40 | 11.5 | 0.18 | 18.67 |
| 1999 | 0.41 | 8.8 | 0.19 | 18.67 |
| 2000 | 0.41 | 8.5 | 0.21 | 22.00 |
| 2001 | 0.41 | 8.5 | 0.23 | 22.00 |
| 2002 | 0.41 | 8.5 | 0.23 | 22.00 |
| 2003 | 0.42 | 22.2 | 0.27 | 28.67 |
| 2004 | 0.42 | 22.2 | 0.28 | 30.67 |
| 2005 | 0.42 | 22.2 | 0.30 | 30.67 |
| 2006 | 0.42 | 7.8 | 0.30 | 30.67 |
| 2007 | 0.48 | 13.2 | 0.36 | 32.00 |
| 2008 | 0.52 | 16.0 | 0.44 | 32.67 |
| 2009 | 0.52 | 16.0 | 0.46 | 32.67 |
| 2010 | 0.52 | 16.0 | 0.46 | 36.00 |
| 2011 | 0.52 | 16.0 | 0.46 | 36.00 |
| 2012 | 0.52 | 16.0 | 0.48 | 36.67 |
| 2013 | 0.52 | 16.0 | 0.48 | 36.67 |
| 2014 | 0.61 | 18.3 | 0.52 | 36.67 |
| 2015 | 0.61 | 18.3 | 0.52 | 36.67 |

residual of the models follows a normal distribution pattern. Meanwhile, for meaningful independent variables (age, gender, and experience), their tolerance and VIF value are as follows: age tolerance 0.97, VIF = 1.031; gender tolerance 0.453, VIF = 2.206; experience tolerance 0.451, VIF = 2.218. Arriaza et al. (2004), John (2008), Menard (2002) claimed that when VIF was over 10 or tolerance smaller than 0.2, collinearity existed in the model. In this research, all the VIF of independent variables are smaller than 10 and all tolerances are over 0.2; the residual is distributed in a normal pattern. Therefore, it can be concluded that there is no collinearity in the model (as shown in Figure 4).

3.3. Participants’ gender and pictures’ physical characteristics

Participants of different genders were asked to score each picture, respectively. The average score of each picture is set as a dependent variable and the physical characteristics of the 20 pictures as independent variables. The stepwise multiple linear regression models indicate that significant predictors for males and females are different. For male participants, height ratio (a) is the reliable predictor of visual preference evaluation; for female participants, height ratio (a) and building density (d) are reliable predictors of visual preference evaluation (as shown in Table 3).

3.4. Participants’ age and pictures’ physical characteristics

Participants of different age groups were asked to score each picture, respectively. The average score of each picture is set as a dependent variable and the physical characteristics of the 20 pictures as independent variables. The stepwise multiple linear regression models indicate that significant predictors for different age groups are different. For participants under 17 and between 18 and 35 years old, distance (l) is the reliable predictor of visual preference evaluation; for participants between 36 and 59 years old, height ratio (a) and building density (d) are reliable predictors of visual preference evaluation; for those over 60 years old, height ratio (a) and building density (d) are reliable predictors of visual preference evaluation (as shown in Table 4).

3.5. Participants’ growth experience and pictures’ physical characteristics

Participants with and without any experiences in rural areas were asked to score each picture, respectively. The average score of each picture is set as a dependent variable and the physical characteristics of the 20 pictures as independent variables. The stepwise multiple linear regression models indicate that significant predictors for participants with different growth experiences are different. For participants with rural growth experiences, height ratio (a) and building density (d) are reliable predictors of visual preference evaluation; for those without rural growth experiences, distance (l) is the sole reliable predictor (as shown in Table 5).

4. Discussions

Howley, Donoghue, and Hynes (2012) maintained that people of different ages had different visual preference evaluations. A similar conclusion can be drawn from this research. There exists a positive correlation between age and visual preference scores. To be specific, the older the participants are, the higher scores they would give to the Tower and its surrounding buildings (as shown in Table 4). This may be justified
by the fact that the older groups witnessed the standstill and backwardness of China's cityscape before the reform and opening-up, and they also experienced the fast development of urbanization in China. Their life experience let them more accustomed to the fast change of China's cityscape and more readily contented with China's urbanization process. Noticeably, the average score of visual preference given by the younger group is significantly lower than those given by the middle-aged and old groups. However, Zube, Pitt, and Evans (1983) argued that age was negatively correlated with visual preference evaluation of waterbody. Riechers, Barkmann, and Tscharntke (2018) claimed that age was negatively correlated with the attitude to urbanization. They observed that the older groups preferred living in rural areas. These researches drew contrary conclusions from this research.

Yu (1995) put forward that people with different educational backgrounds showed different visual preferences for landscapes. R. Wang and Zhao (2017) claimed that people with higher education preferred well-vegetated landscapes. However, this research discovered that educational background did not influence people's visual preference evaluation. One reasonable explanation for this is that Chinese participants have already been accustomed to the fast

### Table 2. Demographic characteristics of participants.

| Demographic characteristics | Variables            | Number of participants | Proportion of participants (%) | Proportion of Shanghai native participants (%) |
|-----------------------------|----------------------|------------------------|--------------------------------|-----------------------------------------------|
| Gender                      | Female               | 134                    | 48.20                          | 49.60                                         |
|                             | Male                 | 144                    | 51.80                          | 50.40                                         |
| Age                         | Below 17             | 26                     | 9.35                           | 11.20                                         |
|                             | Between 18 and 34    | 72                     | 25.90                          | 20.20                                         |
|                             | Between 35 and 59    | 125                    | 44.96                          | 38.40                                         |
|                             | Over 60              | 55                     | 19.78                          | 30.20                                         |
| Educational background      | High school and below| 111                    | 39.93                          | 36.50                                         |
|                             | Junior college       | 105                    | 37.77                          | 41.50                                         |
|                             | Undergraduate program| 50                     | 17.99                          | 15.60                                         |
|                             | Postgraduate program | 12                     | 4.31                           | 6.40                                          |
| Rural growth experiences    | No                   | 125                    | 44.96                          | 46.20                                         |
|                             | Yes                  | 153                    | 55.04                          | 53.80                                         |

### Figure 4. Collinearity judgment.

![Collinearity judgment](image)

### Table 3. Analysis of participants’ gender and pictures’ physical characteristics.

| Dependent | Unstandardized coefficients | Standardized coefficients | Collinearity statistics |
|-----------|-----------------------------|---------------------------|-------------------------|
|           | B               | Std. Error | Beta   | t       | Sig.  | Tolerance | VIF   |
| Scores for male $(R^2 = 0.58, N = 144)$ | Constant          | 1.598      | 0.349  | 3.697   | 0      | 0.394     | 5.243 |
|           | a                | 0.632      | 1.287  | 0.502   | 2.944  | 0.025     | 0.394  |
| Scores for female $(R^2 = 0.43, N = 134)$ | Constant          | 2.724      | 0.689  | 4.023   | 0      | 0.512     | 3.369 |
|           | a                | 0.782      | 0.697  | 0.428   | 3.698  | 0.001     | 0.485  |
|           | d                | 0.482      | 0.859  | 0.721   | 6.369  | 0.004     | 0.485  |
urbanization of China. Therefore, educational background fails to function when the participants evaluate the urban landmarks and the surrounding building groups.

Abello and Bernáldez (1986) observed that gender difference would lead to the variation of visual preference evaluation. As is discovered in this research, females’ score averagely higher than males do (as shown in Table 3). This may be justified by the fact that the subjects of these pictures are urban landmarks and surrounding building groups. Generally speaking, females may prefer bustling cities. As China’s urbanization advances, it is natural that females should render a higher evaluation on urban landmarks and surrounding building groups than males do. However, this conclusion is opposite to that of Yao et al. (2012).

Keane (1990) held that life experience did not influence people’s visual aesthetic evaluation of landscape. However, as is revealed in this research, people with life experience in rural areas are generally more appreciative of the Tower and its surrounding building groups. This is mainly because of the relatively large urban-rural gap in China. In most rural areas in China, high-rise buildings are quite rare. In this case, people living there or who once lived there would find dense high-rise buildings a more enjoyable sight. In contrast, participants who grow up in cities and have no growth experience in rural areas display a much weaker preference to dense high-rise buildings.

Groups of different gender usually render different visual preference to urban landmarks and surrounding buildings. It can be seen in this research that male groups would primarily give their priority to the building height in the pictures when they evaluate the Tower and its surrounding building groups; as the height increases, the score they give rises accordingly. The reason for this may lie in that the male groups may be more interested in scientific and technological capabilities in terms of building height. On the other hand, female groups are more concerned about height and density when they evaluate the Tower and its surrounding buildings. Besides, height and density are basically positively correlated with the average score of pictures. This can be justified by the fact that the height and density of high-rise buildings in some sense mirror the prosperity of a city, and for Chinese female groups, the prosperity in the city also indicates the safety and prosperity of life.

Groups of different ages also display different visual preference to urban landmarks and surrounding buildings. For the two groups of 0–17 and 18–35 years old, when they evaluate the Tower and its surrounding building groups, their main concern is the distance between the two. For the group of 36–59 years old, their main concern goes to height when evaluating the Tower and surrounding buildings. People of over 60 years old are more concerned about height and density. Similar to the group of 36–59 years old, they are generally contented with the current situation of Chinese cities. From the above analysis, it can be seen that the young generation is more rational than the middle-aged and old groups. They are more integrated into information era and more open-minded to other big cities in the world in that they are comparatively better educated; meanwhile, they have no direct personal experience of the standstill and backward cityscape in the past, thus failing to develop a full view of China’s fast urbanization. Consequently, they do not show strong preference to the current cityscape, the fruit of China’s fast urbanization. Contrarily, the middle-aged and old groups attach more importance to urban development and prosperity.

Table 4. Analysis of participants’ age and pictures’ physical characteristics.

| Model | Unstandardized coefficients | Standardized coefficients | Collinearity statistics |
|-------|-----------------------------|---------------------------|------------------------|
|       | B     | Std. Error | Beta | t   | Sig. | Tolerance | VIF   |
| 0–17 years old (Constant) | 2.482 | 0.257 | 0.852 | 6.258 | 0 | 0.521 | 3.258 |
| R² = 0.521, n = 26 | d | 0.521 | 1.471 | 3.158 | 0.001 | 0.521 | 3.258 |
| 18–35 years old (Constant) | 4.528 | 0.387 | 0.632 | 4.325 | 0.002 | 0.369 | 5.685 |
| R² = 0.632, n = 72 | d | 0.365 | 0.912 | 2.257 | 0 | 0.369 | 5.685 |
| 36–59 years old (Constant) | 8.368 | 0.251 | 0.261 | 4.517 | 0 | 0.961 | 7.324 |
| R² = 0.584, n = 125 | a | 0.369 | 1.363 | 5.381 | 0 | 0.421 | 3.313 |
| 60 years old or older (Constant) | 7.856 | 0.473 | 0.783 | 3.125 | 0.002 | 0.695 | 4.202 |
| R² = 0.642, n = 55 | a | 0.982 | 2.323 | 3.652 | 0.03 | 0.479 | 6.363 |
| d | 1.251 | 0.952 | 0.821 | 3.125 | 0.002 | 0.695 | 4.202 |

Table 5. Analysis of participants’ growth experience and pictures’ physical characteristics.

| Model | Unstandardized coefficients | Standardized coefficients | Collinearity statistics |
|-------|-----------------------------|---------------------------|------------------------|
|       | B | Std. Error | Beta | t | Sig. | Tolerance | VIF   |
| Experiences in rural areas (Constant) | 3.618 | 0.385 | 0.714 | 2.278 | 0 | 0.541 | 7.321 |
| R² = 0.652, n = 125 | a | 0.471 | 2.221 | 2.278 | 0 | 0.541 | 7.321 |
| No experience in rural areas (Constant) | 4.528 | 0.582 | 0.247 | 3.652 | 0.03 | 0.479 | 6.363 |
| R² = 0.617, n = 153 | l | 0.471 | 1.052 | 0.397 | 4.747 | 0.01 | 0.636 | 1.258 |
Groups with or without growth experience in rural areas display different visual preference evaluations of urban landmarks and surrounding building groups. For people with growth experience in rural areas, their concern is mainly directed to building height and density when they evaluate the Tower and its surrounding buildings. To be specific, the denser and the higher the buildings are, the higher the average scores of pictures would be. Compared with those who grow up in cities, especially big cities, they have relatively scarce opportunity to see high-rise buildings before. When they are exposed to these high-rise buildings around the Tower, it is natural that they display more surprise and enjoyment. However, people without any living experience in rural areas are more concerned about the distance between the surrounding high-rise buildings and the Tower because they are already quite familiar with the high-rise buildings. In this case, they can analyze the coordination between the Tower and its surrounding buildings in the pictures more rationally. This coordination is highly relevant to the distance, which justifies their main concern clearly.

In addition, as has been found in this research, groups of different demographic characteristics show no concern about the volume of the Tower and surrounding buildings (v).

5. Conclusion
A building or an overall planning cannot win the public support unless it meets the needs of most groups (Gobster et al. 2007). For urban architects, one of their fundamental tasks is to acquaint the needs of urban residents and then design accordingly. To meet the need of the urban population is crucial for the success of a project. This research is of help for architects to understand how different groups of urban residents evaluate China’s fast urbanization and know the main concern of different groups of people when they conduct visual preference evaluation over urban landmarks and surrounding buildings. To be specific, from this research, the architects can know which physical characteristics (or features) attract the main concern of certain groups. The experiment conducted and analytical results obtained can provide valuable reference and instructions to architects and planners and indicate the changing trend of visual preference evaluation over urban landmarks and surrounding building groups in the future.

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