XXVIII International Seminar on Urban Form
ISUF2021: URBAN FORM AND THE SUSTAINABLE AND PROSPEROUS CITIES
29th June – 3rd July 2021, Glasgow

A study on the urban form of landmark buildings in Shanghai based on visual preference evaluation

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Abstract

The urban form dominated by landmark is of great significance to the cityscape, and also affects people's environmental psychology. With the rapid development of urban construction in China, the large number of high-rise buildings makes the urban form dominated by landmark change greatly in a short time. In order to research the people's visual preference evaluation for this rapidly changing in terms of urban morphology, this study conducted two experiments on the Lujiazui Financial District of Shanghai, China, which is dominated by the two landmarks, the Oriental Pearl TV Tower and the Shanghai Tower. One of the experiments was to study people's evaluation of the changes in the spatial form of the new and old landmarks by using pictures from multiple viewpoints at the similar time as experimental materials; another experiment was to study people's evaluation of the change of urban form dominated by landmark by taking the pictures of 23 years from the same viewpoint as the experimental materials. In this study, the height ratio, volume ratio, density and relative distance ratio of the buildings were taken as physical properties, and photo stimulation experiments were conducted with participants of different demographic characteristics. The analysis of the experimental results indicate that some physical properties are the main factors that affect people's visual preference evaluation of the landmark spatial form, when the physical properties are in certain numerical ranges, higher visual preference evaluation results can be obtained; people with different demographic characteristics have different evaluation on the rapid changes of landmarks and their environment. The results would provide a reference value range for the physical properties of urban form from some specific perspectives, help planners and architects to understand people's varied views on the rapid development of urban construction in terms of urban morphology.

Keyword: *urban form, landmark, visual preference evaluation, demographic characteristics*

Introduction

In Lujiazui Financial District of Shanghai, the most representative CBD of China, there are two super high-rise buildings: The Oriental Pearl Radio & TV Tower (468 meters tall and built in 1995, hereinafter referred to as "the Tower") and Shanghai Tower (632 meters tall and built in 2016). To many Chinese people, these two buildings are the highly representative landmarks of the urban modernization of Shanghai and even China (Zhao et al., 2020).

With the outer spatial form of the two landmark buildings as research object, this paper aims to explore the following issues: (1) people's visual preference evaluation on the change of urban form in different times; (2) the influence of physical properties such as height, distance, density, viewpoint upon visual preference evaluation; (3) the difference in visual preference evaluations rendered by people of different demographic characteristics.

Urban landmarks

Urban landmark buildings play a crucial role in urban form. Lynch (Lynch, 1960) proposed that urban landmark buildings, usually the highly recognizable physical objects in the urban form, were the external orientation points. Browne (Browne, 2006) claimed that the newly-built super high-rise buildings would change the original urban form and the public's satisfaction degree with this change was controversial. Tavernor (2007) observed that high buildings were very important to the spatial sustainability of urban areas. High-rise buildings possess certain potentials to create urban image (Veschambre, 2018) and this image is highly recognizable (Czyńska et al., 2019).

The height, volume, mutual distance and surrounding environment are the key physical properties of urban landmark buildings. For example, Samavatekbatan (Samavatekbatan et al., 2016) discovered that the building height was the greatest influence factor for visual preference evaluation of high-rise buildings. Stamps et al. (2005) revealed that the urban skyline could be adjusted via the control over the height, volume, roof style, and color. Short (Short, 2007) put forward that new buildings would influence the existing urban landscapes. Ashihara (Ashihara et al.,2004) demonstrated the correlation between outer space distance and building texture with a series of pictures.

Visual Preference Evaluation

The visual preference evaluation of urban landmark buildings is an important method for the study of urban form. As the most common and effective research tool to aesthetic evaluation study (Barrosoaabaa, 2012), visual preference evaluation is widely accepted and used (Hernández et al., 2004). In practice, photo stimulation is one of the methods to study the visual preference evaluation. Stamps (Stamps, 1990) held that the information people obtained from static colored photos was positively correlated with the information they obtained from the real scenery. In addition, the main criteria for evaluating visual environment are not only related with the objective factors of urban form, but also relevant to the demographic characteristics of the reviewers, such as education level (Molnarova et al., 2012), gender (Lindemann-Matthies et al., 2010), age (Van den Berg, 2006).

Methodology

Research Materials

The research materials are a series of photos of the Tower and Shanghai Tower. The photos were shot with an iphone at eight representative viewpoints (as shown in Figure 1) on July 28, 2018 and April 15, 2019. Then these photos were processed with Photoshop CS5. Eight photos in total, one basic photo for each viewpoint, were obtained.

Figure 1. *The distribution of the Tower, Shanghai tower and the eight viewpoints*

To study the time sequence of the urban form change, 20 photos were shot from the viewpoint of Chen Yi Square according to the completion time of the surrounding buildings adjacent to the Tower. These photos, some of which are shown in Figure 2, display the changes of buildings chronologically from the completion of the Tower in 1995 to the year of 2018. In order to study the influence of urban landmark buildings, especially Shanghai Tower, upon the urban form in this area, the eight photos shot at the eight viewpoints were processed to remove Shanghai Tower. Consequently, 16 photos were obtained to show the different states of the Tower and its surrounding architectural groups before and after the construction of Shanghai Tower. Figure 3 shows some of these photos.

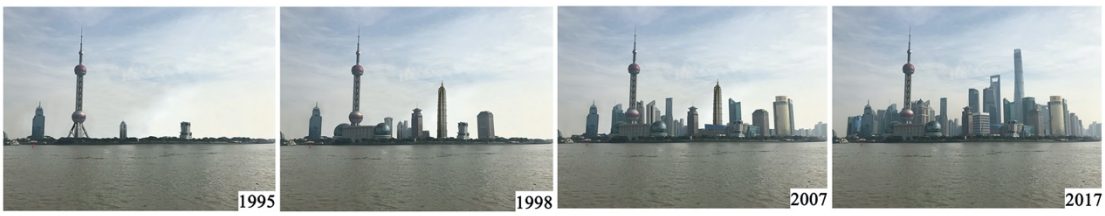


Figure 2. *The distribution of the Tower, Shanghai tower and the eight viewpoints*

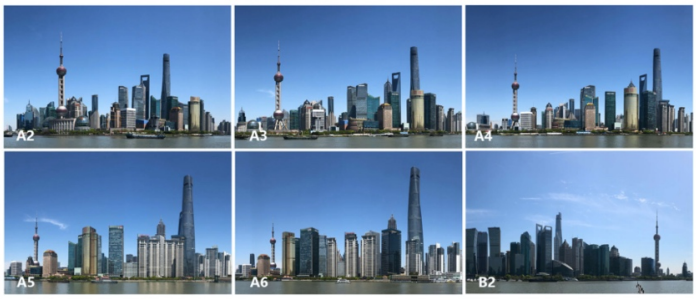


Figure 3. *The architectural state before and after the construction of Shanghai Tower*

The calculation of physical properties

The physical properties of the Tower and its surrounding architecture complex are classified into eight types: the average height ratio of the Tower to its surrounding high-rise buildings (a), the average distance (l), building density (c), average volume (w), the relative height of the Tower to Shanghai Tower (a'), relative volume (w'), the ratio of the distance from the Tower to Shanghai Tower and the photo width (l'), and the ratio of the distance of the vertical center line of the Tower and Shanghai Tower to the center line of the photo (d').

AutoCAD 2014 was used to conduct image and grid analysis of the twenty photos taken in Chen Yi Square. To be specific, the height ratios of the Tower to the top three high-rise buildings around the Tower were calculated respectively and the average value of the ratios (a) were calculated, too. Meanwhile, the distance of the three buildings to the Tower was calculated respectively and the average value (l) was obtained consequently. The building density (c) was calculated by the following equation: c=c1/c2, where c1 denoted the grid number of the buildings, and c2 represented the grid number of the sky. The building volume of the top three buildings could also be obtained by counting the grid number and the average volume (w) was thus obtained (the grid not fully filled was counted as 0.5 grid). Similarly, the photos taken at the eight viewpoints were calculated in the same way.

The experiment of visual preference evaluation

All the photos were printed on A4 paper in full color and then bound randomly in book form, four photos per page. Then these photos were shown to the participants.

The first round

The twenty photos taken at Chen Yi Square were shown to Chinese participants who happened to be in the shooting area. The participants were firstly asked to provide their demographic characteristics such as gender, age, education background, with or without living experience in the countryside. Then they scored the twenty photos according to their preference. The score range was from 0 to 5, to be specific, 0 denoting strongly dislike, 1 denoting dislike, 2 denoting mildly dislike, 3 denoting like, 4 denoting mildly like, and 5 denoting strongly like. In total, two experiments were conducted in the first round. The first experiment was conducted on November 29th, 2018, with a total of 160 participants. The second experiment was conducted on December 12th, 2018, with a total of 170 new participants. Among the 330 questionnaires in the two experiments, 278 were valid, the validity rate reaching up to 84.2%.

The second round

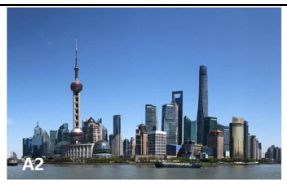
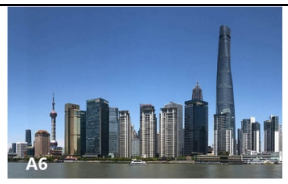
The sixteen photos taken at the eight viewpoints were shown to Chinese participants who happened to be at the viewpoints. Two experiments were conducted in the same way on April 18th and 27th, 2019, respectively. The first experiment had a total of 120 participants while the second experiment had a total of

110 participants. Among the 230 questionnaires in the two experiments, 206 were valid, the validity rate reaching up to 89.6%.

Results and Discussions

The data collected were analyzed with SPSS 22.0. At first, the intergroup reliability of two groups of photos were tested and the reliability value was 0.782 and 0.778, respectively, displaying a relative high internal reliability. The actual scores were shown in Table 1.

Table 1. The scores obtained from the experiments.

The average score of the first round：3.41		The average score of the second round：3.27	
The highest score：4.32	The lowest score：2.22	The highest score：4.73	The lowest score：2.01
			

The demographic characteristics and visual preference evaluation

One-Way ANOVA was conducted to explore the relationship between demographic characteristics and visual preference evaluation. As the results show, gender (F=11.204, p=0.02), age (F=2.692, p=0.01), and life experience in the countryside (F=6.230, p=0.03) do exert certain impact on the average score rendered by the participants; the influence of education level (F=2.021, p=0.64) is not significant, thus being excluded from the following analysis.

The score of each photo rendered by the participants of different demographic characteristics was taken as the dependent variable; the physical properties of buildings (namely, height, distance, density, volume) were taken as independent variables. Then the significant predictors for visual preference evaluation could be revealed through stepwise multiple linear regression model, as is shown in Table 2. K-S was used to test whether there exists any collinearity between the models. As the calculation results show, the residual errors are normally distributed, which indicates that there is no collinearity.

Table 2. The predictors for visual preference evaluation rendered by participants with different demographic characteristics

demographic characteristics	a	l	c	w
male	●	\	\	\
female	●	\	●	\
0-17 years old	\	●	\	\
18-35 years old	\	●	\	\
35-59 years old	●	\	\	\
60+ years old	●	\	●	\

having life experience	●	\	●	\
Having no life experience in countryside	\	●	\	\

"●" denoting "yes", "\" denoting "null"

From Table 2 and the calculation results, it can be seen that as the age increases, the scores rendered by the participants displays a rising trend. The average score given by the young participants are noticeably lower than that given by the middle-aged or senior participants. This is opposite to the conclusion drawn by Riechers (Riechers et al., 2018); the average score given by females is higher than that given by males, which is opposite to the conclusion obtained by Yao (Yao et al., 2012); the scores rendered by male participants are positively related with the building height while the scores rendered by female participants are positively related with building density. For the age groups of 0-17 and 18-35, their focus is mainly placed upon the distance between the surrounding high-rise buildings and the Tower; the age group of 36-59 mainly focus on building height; for the participants over 60 years old, they pay more attention to building height and density. It seems that the young participants are more rational while the middle-aged and senior participants attach greater importance to the urban development and prosperity. The participants who have life experience in the countryside usually prefer high-rise buildings, which is opposite to the conclusion of Keane (Keane, 1990). The score given by those with life experience in the countryside is positively related with building height and density; for those participants who have no life experience in the countryside, their score is positively related with the distance between Shanghai Tower and the Tower.

The influence of landmark buildings on visual preference evaluation

As is revealed by the score calculation, the new Shanghai Tower does exert certain influence upon the visual preference evaluation of the urban form in Lujiazui District. There is a significant difference between the average score of visual preference evaluation before and after the removal of Shanghai Tower from the photos ($t=2.331$, $P=0.048<0.05$). In the multiple linear regression model, a', b, c, and d were set as independent variables and the average score of the photos was taken as the dependent variable. The results indicate that a' ($p=0.015$), w' ($p=0.033$), and l' ($p=0.047$) exert significant influence on the score of the photos and they are positively related with the scores rendered; d' ($p=0.602$) has no significant influence on the scores. In the case of stepwise multiple linear regression model, a', w', and l' all exert certain influence on the average score of the photos.

Table 3. The photo evaluation and physical properties

Evaluation	a'	w'	l'
high	(1.50, 1.71)	(0.75, 1.10)	\
medium	(0.75, 1.00)	(1.80, +∞)	(0.6,0.78)
low	(0.64, 0.75) & (1.00, 1.50)	(0.23, 0.75) & (1.10, 1.80)	(0.2,0.6)
The optimal	1.71	0.9	0.5

As is shown in Table 3, when the ratios of relative height, relative volume, and relative distance of the Tower to Shanghai Tower are within a certain range, the scores of visual preference evaluation are relatively higher. Meanwhile, the optimal values of physical properties are obtained.

The photos which are scored relatively higher are taken at A2, A3, and A4 viewpoints (as shown in Figure 3). In these photos, the Tower, even though it has been under the influence of Shanghai Tower, still maintains its landmark status in the urban form. This conforms to the participants' visual inertia formed in the past decade.

The photos which are scored relatively lower are taken at B2, A5, and A6 viewpoints. In the photos taken at A5 and A6 viewpoints, the relative volume of Shanghai Tower is disproportionally too large. In the photo taken at B2 viewpoint, the composition is unbalanced because the volume of the building complex on the left and right sides is too large. These photos undermine the participants' deep-rooted impression that the Tower should be dominating in the spatial form (as shown in Figure 3).

Conclusions

This paper draws some conclusions on the urban form of Lujiazui Financial District: (1) People of different demographic characteristics have different feelings about the rapid change of the surrounding environment of the urban landmark buildings. (2) Most people take a welcoming attitude to the increase of building height and density, but some people have already become concerned about the distance between landmark buildings and their surrounding buildings. (3) Although most people are tolerant of Shanghai Tower which has become the new urban landmark building, the Tower will remain its prominent status in the spatial form of Lujiazui Financial District for some time in the future. (4) The physical properties like building height, volume, and distance do exert certain influence on people's evaluation of urban form. (5) The construction of Shanghai Tower has changed the original urban form. Accordingly, the degree of attraction to people and the number of people in different viewing areas may change, and countermeasures need to be studied in urban design in the future.

Acknowledgements

We want to express our heartfelt thanks to the hundreds of anonymous participants.

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