Comprehensive assessment to residents’ perceptions to historic urban center in megacity: a case study of Yuexiu District, Guangzhou, China

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ABSTRACT
Understanding residents’ perceptions of the urban form can guide efforts to improve the urban milieu. However, existing research on place perception of historic environment has overlooked the social dimension and focused on isolated historic quarters, resulting in “zones of gentrification.” Thus, a comprehensive analytical framework to the urban image inquiry of a megacity historic urban center is proposed to address this gap. An online questionnaire is distributed among the residents of the Yuexiu District in Guangzhou, China. The collected data are processed using ArcGIS to create a 3D cognitive map and a 2D affective map. The relationships between environmental features, subjective evaluated qualities, and residents’ perceptions are analyzed statistically where applicable. Results show that large natural features and public spaces are the most prominent for residents of a historic urban center, whereas designated historic districts are rarely noticed. In addition, districts are more imageable than landmarks, paths are frequently overlooked, and contextual sizable forms and functions are highly noticeable, different from conventional studies. Evaluations of walking environments, public spaces, and landscapes and green areas by residents are strongly correlated with their affective experiences. With the above findings, implications in improving socially-oriented urban design strategies in historic urban centers are discussed.

1. Introduction
Reimagining cities through careful preservation and regeneration strategies that target urban renaissances (Punter 2009) has long been the main approach in revitalizing decaying city centers, particularly in historic cores. In such locations, the sense of place is often emphasized through their unique and authentic imageability, usually using urban design (Heath, Oc, and Tiesdell 2013), to address the historical, cultural, economic, or environmental values (Bandarin and van Oers 2012). In addition to historic preservation measures, most of the conventional planning and design approaches applied to historic quarters focus on place-promotion (Cuthbert 2006) to improve their competitiveness in retail, culture, and tourism and compete with suburbanization. However, these practices are highly criticized for their gentrification consequences (Tallon 2013). Although the local communities’ crucial role in historic urban center development has been documented (Nasser 2003), the relationship between residents and the preservation and regeneration strategies remains underexplored. This case also applies to social sustainability in urban design strategies for historic urban centers, containing complex urban center functions and invaluable built heritage.

Most historic urban centers are also living communities. Thus, understanding how residents perceive their urban environment is necessary to formulate socially-oriented design strategies and policies (Mondschein and Moga 2018). Accordingly, person–environment congruity is arguably a suitable ideology, a renewed theme in urban image research, and generally linked to the discourse surrounding quality of life (Wicker 1972; Moser 2009; Kothencz et al. 2017; Douglas, Russell, and Scott 2019). High quality of life can lead to the achievement of considerable sustainable development goals on the basis of respect for the environment and social well-being (WCED 1987). This congruity could arguably be achieved from the positive relationships existing between objective environmental qualities and expressed subjective and personal satisfaction (Liu, Deng, and Peng 2020). However, it is seldom applied in the design aspect of historic urban centers.

Personal environmental perception is the key assessment of person–environment congruity as one of the primary endeavors in urban design. Since Lynch (1960) penned his “five-element” systematic approach to urban image, scholars maintained an interest in studies of environmental perception. They sought to identify the relationship between the physical urban environment and public perceptions and behaviors.
Early research on the urban image included structural analyses of cities, aiming to provide novel references for urban planning and design or tourist destination management (Mercer 1971). In a later study of urban form and its link with urban planning and design based on Canter’s (1977) theory of place psychology, Punter (1991) used the term “components of a sense of place” to describe a high level of affection in reaction to the urban form in an individual. Montgomery (1998) developed this construct further as one of the key principles in urban design quality that emerges as a conventional assessment approach of the relationship between urban form and social meaning (Campbell 2002; Swapan, Bay, and Marinova 2018). It involved the identification of environmental features (Green 1999; Tu and Lin 2008) or the use of maps (Müller-Eie and Llopis Alvarez 2020).

Preparing future visions for historic urban centers with insufficient focus on the quality of life does little in achieving sustainable revitalization. As cities transform from places of production to places of consumption (Wynne, O’Connor, and Phillips 1998), preservation and regeneration strategies for historic urban centers have long been influenced by economic, cultural, historical, and aesthetic values. Improvement policies for historic urban centers are normally profit-oriented (Tallon 2013), top-down, elite-led, and with little consultation of residents (Shin 2010; Cheng, Yu, and Li 2017). Therefore, social values are rarely addressed. This gap leads to a mismatch between the provided vision and local community needs and a waste of historical urban centers’ sustainability effects. This level of ignorance is apparent in the historic quarters in Western countries. It is also dominant in fast-developing countries where real estate incentives are normally utilized to finance preservation measures (Shin 2010). Consequently, an inconsistency of place quality is generated, leading to some isolated zones with significant historical and cultural values and a sharp downgrade of place quality outside the quarters.

For historic urban centers in modern megacities, understanding residents’ cognitive and affective perceptions of the urban form and the possible hidden factors that influence them is critical to identify potential improvement opportunities in the urban space. These efforts can lead to a better quality of life and sustainable urban development. Therefore, in the present study, a review of literature on urban design in historic urban centers is conducted. Prior studies related to environmental perception under a person–environment congruity ideology are analyzed. Subsequently, an analytical framework is proposed to examine a historic urban center’s cognitive–affective urban image comprehensively. The Yuexiu District in Guangzhou, China, is used as a case study. Following the explanation of the data collection and processing methods, two types of urban images are produced. The relationships existing between the perceived images and the relevant factors – forms and functions of perceived environmental features, personal environmental quality appraisals, and social backgrounds – are discussed. Finally, the results of the study are presented with their implications, and directions for future research are suggested.

2. Theoretical framework

2.1. Urban design in historic urban centers

Urban design is an effective tool in the preservation and regeneration of historic quarters. This tool has been acknowledged as a global practice in historic preservation, transforming from being building-based in the 1970s to area-based in the 1990s (Heath, Oc, and Tiesdell 2013). In the field of historic preservation, scholars and professionals work hard to preserve and enhance the historic fabric and values without compromising authenticity (Gratz 1989; Burtenshaw, Bateman, and Ashworth 1991). In the process, urban morphology and visual management have been added to the agenda (Pendlebury 1999). By carefully fixing or changing urban forms and functions in response to the constrained contexts, historic quarter revitalization efforts arguably have common concerns with urban design, permeable and legible urban forms, and high-quality public spaces (Couch and Dennemann 2000). Economic values are also hoped to be promoted, and residents, jobs, tourists, and investors are expected to be attracted through urban design (Cuthbert 2006; Punter 2009; Tallon 2013; García-Hernández, de la Calle-Vaquero, and Yubero 2017; Davoodi and Dağlı 2019), although social values are understated.

Urban design policies in historic urban centers normally overlook residents’ demands. This gap creates a mismatch between local needs and the vision of urban regeneration. The social dimension is subsequently missing from the three pillars of sustainable development, in which economic and environmental dimensions will likely succeed. Although scholars stressed the importance of quality of life, social welfare, and governance in urban regeneration (Hall and Barrett 2012), the emphasis is still on the economic sides of policies and practices, excluding community value and community voice (Couch and Dennemann 2000; Tallon 2013). As most of the historic revitalization plans include strong efforts to attract tourists, consumers, and investors, they are strongly criticized by the competition with the local community for resources (Law 1994; Mowforth and Munt 2009) and the resulting gentrified effects (Marks 1996; Smith 1998). Therefore, the need for more community-based policies is urged (Dhingra, Singh, and Chattopadhyay 2017) to provide an opportunity for long-term stewardship and create
an environment that supports a high quality of life for all.

Limited by administrative, resource, or investment boundaries, the conventional place-promotion approach to urban design in historic quarters is always concentrated in isolated areas. Thus, it generates space of a quality that is incompatible with residents’ daily urban lives (Tallon 2013). The UK Department of Environment (1987) clarified that historic quarters should retain a strong relationship with the city to ensure a complete living and working environment. However, evidence of how it could avoid the effects of “zones of gentrification” remains scarce (Sorkin 1992). As the places of historical, cultural, and tourist interest are not necessarily the places of interest to residents in their daily lives, the mismatch between these two circles creates a discontinuity of urban spatial quality, leading to the construction of an excluded landscape (Yeoh and Huang 1996). These phenomena are more extreme in fast-developing cities in which historic preservation zones counteract the tabula rasa tendency of real estate development (Broudehoux 2004). The function of the social construct for the urban public realm (Heath, Oc, and Tiesdell 2013) is consequently diminished by isolated zones. Accordingly, the entire historic urban center should be addressed with the input of residents, rather than focusing on individual historic quarters or improvement projects, to achieve social sustainability in historic urban centers through urban design.

2.2. Environmental perception under a person–environment congruity ideology

Understanding users’ environmental perception is a pre-condition for preparing an urban design strategy. When addressing social sustainability, residents are the major players to be concerned. With regard to locations and attributes, environmental perception offers considerable potential in revealing the psychological transformations of an individual in response to his or her daily spatial environment (Kitchin 1994; Downs and Stea 2011; Mondschein and Moga 2018). It may be visualized in two forms, of which cognitive map reflects the perceived physical features. When adapted to reveal meanings, cognitive maps can subsequently be referred to as an evaluative map, emotion map, or affective map (Nasar 1990; Williams 1992; Huang, Tang, and Wang 2015). They can also relate to the concept of sense of place as one of the three key components of place-making in urban design besides physical form and activities (Canter 1977; Punter 1991; Montgomery 1998). The sense of place refers to environmental satisfaction or place attachment depending on an individual’s expectations and focuses. It can compensate for the deficit of environmental conditions (Le Vy-Leboyer and Ratiu 1993), leading to a sustainable society. As cognition is not necessarily a positive response, an affective map offers great potential to steer efforts toward urban improvement, leading to the term “person–environment congruity.”

Person–environment congruity refers to a positive relationship established between objective environmental quality and individuals’ subjective satisfaction. After being proposed by earlier researchers (Barker 1968; Wicker 1972; Stokols 1982), the concept was later systematically developed by Moser (2009). It was considered a result of cognition, motivation, and behavior, demonstrating a certain level of satisfaction to a locality (Moser 2009; Liu, Deng, and Peng 2020). At the core of the concept is the belief that when an environment supports people’s activities, people respect the environment in their interactions, raising the considerations of individuals related to the quality of life and the social expression of well-being. The themes of correlation, antecedence, and consequence and the meaning of the psychological aspects of place are of particular concern (Gifford 2014).

However, the challenge lies in its application to broader urban scales and the subsequent increase in complexity.

Under the ideology of person–environment congruity, cognitive and affective meanings are the two key personal attributions to the environment (Russell and Pratt 1980). Cognition can be thought of as legibility perception from the physical environment, helping people orient themselves and understand the urban form (Nasar 1994; Del Aguila, Ghavampour, and Vale 2019). Affect is a measurement of the level of individual satisfaction with the environment (Yik, Russell, and Steiger 2011; Del Aguila, Ghavampour, and Vale 2019). Some studies argued that environmental cognition helps build meaning, and thus it contributes to the sense of place as one of the essential principles in the shaping of urban form (Montgomery 1998). In terms of methods, the sketch map method, which was once applied to understand people’s perceptions of urban physical structures, has now been adapted to map people’s emotions related to, and satisfaction with, the urban setting (Curtis et al. 2014). Lynch’s (1960) cognitive map approach focused on how people identify the physical structure of a city or orient themselves within the urban environment. Subsequently, Nasar (1990) extended this approach and further presented the satisfaction of individuals in the urban environment through affective maps, seeking to guide urban environmental aesthetics focusing on the human aspects of the urban form. In practice, identifying how the public perceives the built environment and understanding what factors lead to such a perception can help planners and designers achieve sustainability at an urban scale (Green 1999; Campbell 2002; Mondschein and Moga 2018; Aram et al. 2019; Del Aguila, Ghavampour, and Vale 2019).
Although urban design is based in part on person–environment congruity, it normally focuses on the values of history, culture, commerce, tourism, and the environment when applied to historic urban centers. How to achieve socially sustainable designs with the community in historic urban centers, rather than in individual historic quarters, has been less researched. In addition, the question of how physical environments can be improved to better support the life of residents has been the subject of fewer studies. Given the complex nature of historic urban centers and their regeneration, in terms of the approach to design strategies, a more bottom–up approach is needed to compensate for the elite-led design decision-making approach to bridge the gap between environmental improvement and quality of life. Measures need to be taken to explore the general urban image with an injection of emotional expression and clarify the typologies and users’ evaluations of the corresponding environmental features on the basis of local knowledge.

2.3. Theoretical framework for cognitive–affective urban image inquiry

Given the strengths and limitations of existing literature, a suitable approach is identified in the present research. The proposed method is used to understand residents’ urban perception prior to formulating design strategies and policies for historic urban centers concerning social sustainability. Residents gain long-term local knowledge of their urban environments, and their views can serve as valuable reference points in achieving high quality of life. The results of this study will provide evidence of the deep-rooted needs and expectations of residents in support of the preparation of urban designs for historic urban centers. By extending the ideas of person–environment congruity, a comprehensive analytical framework for the study of the cognitive–affective urban image, injected with spatial information, approaching the issue from two angles is proposed (Figure 1). The first angle is cognitive perception, referring to the perceived representative environmental features stored within residents’ minds. The second angle is the affective impression, rooted in their environmental appraisals/evaluations of the locations in question, leading to a level of emotional satisfaction with the environment. These two approaches to the urban image are associated with individuals’ social backgrounds and their daily local knowledge of the urban environment, leading to quality of life.

A case study is carried out to test the proposed theoretical framework. The Yuexiu District in Guangzhou, China, is selected as it shares some common characteristics with other historic urban centers in most of the megacities around the world. It also faces similar difficulties when looking for social sustainability in urban design. Having just been through rapid urban development, it has designated selective historic quarters in which its cultural authenticity would be preserved. Through environmental improvement programs, it has been transforming itself into a place for consumption, attracting investments to boost cultural tourism and modify or redevelop opportunistic spaces for office, retail, recreation, accommodation, and housing. The present case study was proposed to answer three questions:

Under the new analytical framework, what are residents’ perceptions to their daily urban environment in a historic urban center?

What are the environmental features and qualities that contribute to these perceptions?

How do social backgrounds influence these urban perceptions?

3. Method

In determining environmental perception in a historic urban center and the causal relations rooted in residents’ local knowledge, the conventional cognitive mapping approach has advantages and challenges, as discussed above. However, historic urban centers in modern megacities bring additional challenges to studies on the urban image. These challenges are related to the increased urban scale, diverse lifestyles, multiple transportation modes, and mixed land-use, which blur the boundaries between residential

Figure 1. A comprehensive analytical framework for cognitive–affective urban image inquiry to historic urban centers.
3.1. Image of Yuexiu: an old district in the megacity of Guangzhou

The case chosen for this study is Yuexiu – an administrative district in central Guangzhou, the capital of Guangdong Province in Southern China. The district covers an area of 33.80 km². It had a population density of 35,000/km² in 2016, which is higher than most historic centers in other megacities, including London, Paris, and Barcelona (Guangzhou Yuexiu District Government 2019). Yuexiu is flanked by the Baiyun Mountain to the north and the Pearl River along its southern edge, creating Guangzhou’s scenic and historic Yunshan–Zhushui (Baiyun Mountain–Pearl River in Chinese) panorama. Guangzhou has developed into a major international metropolis, and it is host to the largest trade fair in China (Hong and Bian 2017). As part of the city’s development strategy in the 1990s, key international and national firms started to move from the old city center to the new CBD and other newly developed locations, where new shopping facilities and new employment hotspots were established. Simultaneously, traditional wholesalers and commercialized streets continued to thrive as a result of affordable prices. Under China’s efforts to improve its infrastructures, Guangzhou, with its 2,000-year history and central districts, such as Yuexiu, has come to offer a diversity of transportation choices, including metro, bus, ferry, taxi, online car-hailing, cycling, and walking.

To preserve and enhance its history and culture, Guangzhou has designated around ten historic preservation districts in Yuexiu. The density of the district has increased continuously over the last century, although current development activities take place only in piecemeal infills or as part of public improvement projects. The district has constantly been searching for improvements in quality of life within the relatively stable built environments. Efforts are exerted to reverse the decay of public infrastructures and low-quality housing estates, finance the preservation of cultural relics, upgrade public spaces and streets, overhaul urban functions and services, and attract employees and businesses. These characteristics make Yuexiu a good case for examining how an urban image is formed from daily experiences in historic urban centers in megacities.

3.2. Data collection and analysis

Within the proposed analytical framework (Figure 1), strategies need to be carefully chosen for the reproduction of the perceived images. Different challenges should be considered in studying urban perception in megacities. They are locational accuracy, large sample size with diverse demographic groups, and ease of sampling. On-site or off-site sketch maps can guarantee the accuracy of feedback (Lynch 1960; Appleyard 1970; Nasar 1990). Interviews based on sketch maps offer the further advantage of allowing direct public appraisals of the urban form (Müller-Eije and Llopis Alvarez 2020). However, these conventional methods are time-consuming and could only afford limited samples. Studies show that applying a questionnaire on-site or via mail could net hundreds, and even thousands, of samples (Nasar 1990; Williams 1992; Green 1999; Stylidis, Sit, and Biran 2014; Gilboa et al. 2015). In such an approach, the respondents could be asked to highlight the representative features and make an appraisal with geo-references. The growing public access to the Internet makes large sample online questionnaires even more feasible for megacity research.

The adopted approaches to the analysis of environmental features also need to be carefully decided. They need to respect the nature of the urban environment if they are to ease planning decision-making. For urban cognition, form and function are the two key objective factors within the urban physical environment, as people’s understandings of the city are based on their perceptions of its form, visibility, function, and outstanding elements (Appleyard 1970). For the issue of form, Lynch (1960) raised five elements (landmark, node, path, edge, and district) for the structuring of the public’s mental image. Later research found sequential (roads) and spatial (buildings, landmarks, or districts) elements to be more easily retained in the public consciousness (Appleyard 1970). Landmarks, and sometimes nodes, are often highlighted as the anchor points in urban cognition (Erçevik Sönmez and Erinsel Önder 2019). By contrast, paths play a lesser role in people’s understanding of the urban structure (Evans, Marrero, and Butler 1981). Huang et al. (2021) further used big data in accordance with Lynch’s (1960) category. They found that “district,” “landmark,” and “path” were “in good agreements with benchmarks,” but “edge” and “node” were less so. A possible reason could be a path also has the characteristics of an edge in the real world, and a landmark covers node characteristics when the population is clustering. Accordingly, the “landmark–path–district” approach is proposed to classify the physical urban form’s typology. The most prominent land uses in cities are commercial, residential, transportation, and public space. However, for historic urban centers, cultural functions also have significant roles to play in the

neighborhoods, commercial zones, and shopping destinations. In a megacity, individuals perceive only some of the information, being bounded by their life circles. The general urban perception is also rooted in their daily experiences and activities, such as commuting. Accordingly, a new research approach grounded in daily urban experiences and location-based evaluation is needed to address these challenges.
formation of the urban image (Dai et al. 2018). For a healthy city, nature’s features, such as mountains, rivers, and green areas, are crucial for urban form sustainability (Jabareen 2016). They also have been proven to significantly contribute to personal perceptions of urban character (Green 1999). In terms of function, the typologies referred to in the present study are categorized under the headings of public space, transportation, culture, public service, residential, office, commercial, and natural areas.

Quality appraisals are made to identify the links between the perceived objective environment and the relevant subjective affective impression. Multi-attribute evaluations in the form of post-occupancy surveys are a common technique (Carp and Carp 1982; Zimring 2002; Johansson, Sternudd, and Kärholm 2016), with studies in this direction involving broad ranges of scales or factors, depending on the research objectives (Table 1). For questionnaires applied to non-professionals, factors such as architecture and town-planning space (Bonaiuto, Fornara, and Bonnes 2003), ground floor access and streetscape, and building appearance and landscape (Tu and Lin 2008) may be too vague for the respondents to comprehend. Additionally, indicators for the measurement of changes in urban forms, such as urban grain, city block, density, and compactness (Jabareen 2016), are not ideal in this case, as no radical change of urban form is foreseeable in the historic urban center. Scales strongly related to social aspects, such as pace of life, welfare provision, people and social relations (Bonaiuto, Fornara, and Bonnes 2003), public security, social interaction and mutual help, sense of insecurity, and sense of pressure (Tu and Lin 2008), fall outside the realm of planning interventions. Finally, those normally beyond the general public’s knowledge, such as adaptability and permeability (Montgomery 1998), are also ruled out.

On the basis of quality evaluations from previous studies, scales or factors needs to be appraised to come up with a response that suits the character of historic urban centers and can be managed using current planning tools. Thus, the six scales chosen for quality appraisal are public spaces, recreational facilities, shopping facilities, landscape and greenery, transportation services, and the walking environment. Together with the one scale designed to assess the overall affective impression of the locality among the residents, six instruments in the form of five-point Likert-type scales for the measurement of specific locational qualities are established, with responses ranging from “1 = not satisfied” to “5 = extremely satisfied.” Additional personal data are also needed, including gender, age, career level, duration of residency, mode of mobility, and home address.

In December 2018, the designed questionnaires were published online, and students in the Yuexiu District and their families were invited to participate. As students (including primary and middle schools) in Yuexiu normally live in the district, a large sample size of residents was guaranteed. By January 2019, a total of 2,170 completed questionnaires had been received, 1,573 of which were from respondents with a home address in Yuexiu who were validated and subsequently selected for further analysis. The respondents’ sociodemographic information was requested at the beginning, including home address, gender, family role, age, career, length of residency, and the most frequently used daily mobility mode. Their demographic profile included different social groups and individuals of varying ages, gender, and career status (Table 2). The female respondents (60.71%) far outnumbered the male respondents (39.29%). Although the majority were in the 31–40-year age range (38.78%), the most prominent career status was education, with students accounting for 35.47% of the total. Nearly 80% of the respondents had lived in the Yuexiu district for more than ten years (78.96%), and the majority used the metro (32.99%) for their daily commute, followed by buses (24.09%).

In the online questionnaire, the respondents were asked to write down the names of the most impressive environmental neighborhood features within a 15-minute walk out of their homes, such as buildings,

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**Table 1. Scale/factor comparisons in quality appraisals of urban environments from selected studies.**

| Sustainable Form (Jabareen 2016) | Urban Indicators | Perceived Residential Environment Quality (Bonaiuto, Fornara, and Bonnes 2003) | Perceived Residential Environment Quality (Tu and Lin 2008) | Residential Perception to Tourist City (Styliadis, Sit, and Biran 2014) |
|----------------------------------|------------------|--------------------------------------------------------------------------------|--------------------------------------------------------------------------------|--------------------------------------------------------------------------------|
| Density                          | Architectural and town-planning space, Organization of accessibility and roads, Green areas, People and social relations, Welfare services, Recreational services, Commercial services, Transport services, Pace of life, Environmental health, Upkeep and care | Urban Planning and Design (including ground floor access and streetscapes, open spaces and green areas), Security and Social Relationships, Transportation and Commercial Services, Residential Atmosphere, Environmental Health, Environmental pollution, Facility Management | Physical appearance, Community services (including the transportation system), Entertainment opportunities, Social environment |

Scales/factors in bold indicate similar scales to those selected for the present research.
Table 2. Demographic profile of the respondents.

| Factors                | Variables | Number | Percentage |
|------------------------|-----------|--------|------------|
| Gender                 | Male      | 618    | 39.29%     |
|                        | Female    | 955    | 60.71%     |
| Family role            | Children  | 565    | 35.92%     |
|                        | Parents   | 918    | 58.36%     |
|                        | Grandparents | 90 | 5.72%       |
| Age                    | 6–12      | 322    | 20.42%     |
|                        | 13–20     | 243    | 15.45%     |
|                        | 21–30     | 17     | 1.08%      |
|                        | 31–40     | 610    | 38.78%     |
|                        | 41–60     | 298    | 18.94%     |
|                        | Above 60  | 83     | 5.28%      |
| Length of Residency    | Under 3   | 46     | 2.93%      |
|                        | 3–5       | 65     | 4.13%      |
|                        | 5–10      | 220    | 13.99%     |
|                        | Above 10  | 1242   | 78.96%     |
| Mobility Mode          | On foot   | 330    | 20.08%     |
|                        | Cycle     | 71     | 4.51%      |
|                        | Bus       | 379    | 24.09%     |
|                        | Metro     | 519    | 32.99%     |
|                        | Car       | 256    | 16.27%     |
|                        | Others    | 18     | 1.14%      |
| Career                 | Public Servant | 52 | 3.31%      |
|                        | Privately Employed | 242 | 15.38%     |
|                        | Art, Education or Research | 68 | 4.32%      |
|                        | Health Care | 58     | 3.69%      |
|                        | Service Industry | 153 | 9.73%      |
|                        | Freelancer | 363    | 23.08%     |
|                        | Unemployed or Housewife | 79 | 5.02%      |
|                        | Student   | 558    | 35.47%     |
| Total                  |           | 1573   | 100%       |

The urban block approach was adopted in the affective map to reflect residents’ affective perception. Urban blocks could be created in GIS using the road network and boundary data of nature’s features downloaded from the Baidu Map. The overall affective impression values were transferred to the corresponding urban blocks containing respondents’ home addresses using address resolution methods. If an urban block gained more than one value, the average of the contributing values was used. However, if an urban block had missing values, no respondents were living in that block. Thus, the affective satisfaction values of these urban blocks were recorded as 0.

A multiple regression analysis was carried out to identify the association between the affective satisfaction scale and the six environmental quality appraisal scales. An F test was applied to identify any correlations between different sociodemographic characteristics (gender, family role, age, career, length of residency, and mobility mode) and personal affective satisfaction.

4. Results

4.1. Urban cognitive map

As for urban cognition, 249 environmental features were named by the respondents, with a total mentioned frequency of 2,209. These features were subsequently developed into a 3D cognitive map using the methods described above (Figure 2). The respondents were spread over the Yuexiu District, and some lived closer to the district boundary. Accordingly, some environmental features were located outside the district boundary (20.48% of the total). Most of the mentioned features were concentrated around the old city core, the Beijing Road District (with a mentioned frequency of 7.51%), and the Martyrs Park (6.43%; Table 3).

Natural landscapes, urban parks, and public spaces were prominent features. Ancient landscape characteristics were found to dominate the old city center in residents’ minds. The Baiyun Mountain (4.39%) stretching from the north and the Pearl River (2.17%) running along the southern edge received considerable mentions. In between, the Donghao Creek (2.13%) was an obvious inclusion, running from the mountain to the river, along with frequently mentioned large urban parks, such as the Martyrs Park (6.43%), Huanghuagang Park (4.71%), Luhu Park (3.76%), Donghu Park (3.35%), and Yuexiu Park (4.84%), scattered across the city. Commercial districts were prominent on the map, including the pedestrianized commercial Beijing Road District, a designated historic district with a 2,000-year history, followed by the modern China Plaza (3.94%) shopping complex. The historic quarters had only limited mentions. In the areas surrounding the district boundary, a host of strong modern structures had risen, including the Zhuijiang New CBD (0.50%) and Canton Tower (6.29%, as the most prominent landmark) to the east and the Shamian Historic District (0.45%) and Liwan Lake (0.09%) to the west. Although some transportation infrastructures were obvious on the map, such as the
Inner Ring Road and several arterial roads, they attracted extremely few mentions (0.05%). No artificial landmarks were prominent in the old city center. Most of the mentioned features were outside the designated historic districts.

Within the historic urban center, districts were more prominent than landmarks in residents’ perception, and paths were mentioned much less frequently, different from prior studies. The form typologies of the mentioned environmental features are broken down in Table 4. Although more than half were landmarks (55.42%), they had fewer than half of the total mentioned frequencies (41.42%) with 6.63 mentions per feature (compared with the average value of 8.87), showing a relatively dispersed characteristic. Although districts accounted for only 28.11% of the total environmental features mentioned, they garnered more than half of the mentions (50.79%), with 16.03 mentions per feature, showing a high degree of consensus for certain districts. Paths accounted for the fewest features (16.47%), mentions (7.79%), and the lowest average value of mentions per feature (4.20), with extremely limited imageability. Among the paths, the Pearl River and Donghao Creek, as large-scale natural landscapes, were mentioned most frequently and far more than road infrastructures.

In terms of the functions of the environmental features, nature was the most imageable. It recorded the

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**Table 3.** Selective environmental features named by residents.

| Environmental Features          | Frequency | Percentage | Form  | Function | Ranking |
|--------------------------------|-----------|------------|-------|----------|---------|
| Beijing Road District          | 166       | 7.51%      | District | Commercial | 1       |
| Martyrs Park                   | 142       | 6.43%      | District | Public Space | 2       |
| Canton Tower                   | 139       | 6.29%      | Landmark | Public Service | 3       |
| Yuexiu Park                    | 107       | 4.84%      | District | Nature | 4       |
| Huanghaiang Park              | 104       | 4.71%      | District | Public Space | 5       |
| Baiyun Mountain                | 97        | 4.39%      | District | Nature | 6       |
| China Plaza                    | 87        | 3.94%      | Landmark | Commercial | 7       |
| Luhu Park                      | 83        | 3.76%      | District | Nature | 8       |
| Zhongshan Library              | 64        | 2.90%      | Landmark | Public Service | 10       |
| Pearl River                    | 48        | 2.17%      | Path | Nature | 13       |
| Donghao Creek                  | 47        | 2.13%      | Path | Nature | 14       |
| Ersha Island                   | 12        | 0.54%      | District | Public Space | 31       |
| Zhuijiang New CBD              | 11        | 0.50%      | District | Commercial | 33       |
| Shamian Historic District      | 10        | 0.45%      | District | Culture | 38       |
| Liwan Lake                     | 2         | 0.09%      | District | Nature | 100      |
| Inner Ring Road                | 1         | 0.05%      | Path | Transportation | 133      |

**Table 4.** Form typologies of environmental features reported by residents.

| Form      | Mentions | Frequency | Percentage | Features | Mentions per Feature |
|-----------|----------|-----------|------------|----------|----------------------|
| District  | 1122     | 50.79%    | 70         | 28.11%   | 16.03                |
| Landmark  | 915      | 41.42%    | 138        | 55.42%   | 6.63                 |
| Path      | 172      | 7.79%     | 41         | 16.47%   | 4.20                 |
| Total     | 2209     | 100.00%   | 249        | 100.00%  | 8.87                 |
most mentions per feature (33.58; Table 5). Although this function had the least features (4.82%), it benefited from considerable mentions (18.24%). Public space ranked second with 20.88 mentions per feature, with a relatively large number of features (10.44%) and mentions (24.58%). Nature and public space had similar forms, being either large districts or paths, dominating the urban landscape with strong recreational functions and proximity to dense residential areas. Functions related to culture, commerce, and public service were all close to the overall average mentions per feature of 8.87 (10.77, 8.38, and 7.24, respectively). They showed strongly dispersed characteristics and were imageable only at a neighborhood scale. Much fewer imageable features were found in the residential, office, and transportation functions (3.29, 2.21, and 2.00, respectively). All of them had extremely few mentions and features and were mentioned occasionally only at a neighborhood level. Although transportation accounted for a large number of features (18.88%), it attracted only a few mentions (4.26%).

### 4.2. Urban affective map

For the affective map, the independent neighborhoods were based on two conditions: the form of the urban block and walking distance from the respondent’s home address coordinates. The walking distance, set originally as 1,000 m using a buffer geoprocessing tool in GIS, showed no significant spatial differences. Thus, 500 m was used to generate better results (Figure 3).

The affective satisfaction values of the urban blocks are as follows (N = 2942, M = 3.921, and SD = 0.328). The urban blocks in the west, including the ancient city core, recorded low satisfaction values. Those in the east with less than 100 years of history and adjacent to the new CBD further to the east had high satisfaction values. In the west, most of the urban blocks recorded low–medium satisfaction levels due to the lack of maintenance of infrastructure and the standard housing conditions. The only exceptions were observed in the southwest corner, which features a historic quarter that has undergone regeneration in recent years and the offices on the mixed-use Changdi Financial Street (predominantly small-scale private

![Figure 3. Affective map of the Yuexiu District based on online questionnaires conducted with residents for the classification of natural discontinuities.](image-url)
financial services). The historic quarters of the Oversea Chinese Village near the Huanghuagang Park and the Xinhepu District to the north of Donghu Park also recorded high degrees of satisfaction. This finding was probably due to the environmental improvement and historic preservation programs that were introduced. In addition, only the parcel of the renovated historic districts was reported with high satisfaction.

Urban blocks with high-quality urban services tended to enjoy high satisfaction. The lowest values were recorded in the northwest corner and the area to the south of the Yuexiu Park. The Railway Depot is located in the former, and the latter had a limited number of respondents. The highest values were recorded around Luhu Park, Ersha Island, Donghu Park, Guangzhou Zoo, and Huanghuagang Park, which might be due to the regular maintenance of the urban parks and their neighborhoods. Generally, urban blocks near big schools and hospitals recorded relatively high satisfaction levels. This finding was partly due to the high-quality basic urban services provided. For example, the urban blocks close to public facilities, such as Zhixin Middle School, the North Campus of Sun Yat-sen University, the First Affiliated Hospital of Sun Yat-sen University, or Guangzhou Tieyi Middle School, all recorded high satisfaction values. The urban blocks near the Pearl River also recorded high degrees of satisfaction, except for the part in the middle-south corner, which is dominated by old-lower dilapidated residential buildings.

A multiple hierarchical regression analysis was conducted to determine the relationship between environmental quality appraisal and affective satisfaction. This method predicted the affective environmental satisfaction from the environmental quality appraisal variables of public space, recreational facilities, shopping facilities, landscapes and green areas, transportation services, and walking environments using the demographic variables of family role, gender, age, career, length of residency, and mobility mode as the control variables. The final model (Model 2) included 12 variables, and the regression was significant: $F(6, 1572) = 461.547, p < 0.001$, and $R^2 = 0.779$ (Table 6). All predictors investigated were significant and weighted differently in the following order: walking environment ($B = 0.321, t(1572) = 16.034, p < 0.001 > public space ($B = 0.265, t(1572) = 12.446, p < 0.001 > landscape and green areas ($B = 0.203, t(1572) = 11.039, p < 0.001 > shopping facilities ($B = 0.078, t(1572) = 4.579, p < 0.001 > transportation services ($B = 0.065, t (1572) = 4.100, p < 0.001 > recreational facilities ($B = 0.047, t(1572) = 2.349, p < 0.05). These results indicated that the quality of the public realm, such as in walking environments, public spaces, and landscapes, contributed most to a high quality of urban life. Although shopping facilities, transportation services, and recreational facilities have significant effects on affective satisfaction, their levels of influences were slightly limited.

4.3. Social differentiation in urban perceptions

The relationship between sociodemographic characteristics and affective environmental satisfaction was explored using an $F$ test supported by backtesting, as shown in Table 7. Aside from the length of residency ($p > 0.05$), other sociodemographic factors were significantly related to personal affective satisfaction at the $p < 0.05$ level. The male residents ($M = 3.95$) scored higher than the female residents ($M = 3.86$), and children ($M = 4.06$) and grandparents ($M = 4.07$) scored higher than parents ($M = 3.78$). Satisfaction was higher among the young (ages 6–12, $M = 4.01$; ages 13–20, $M = 4.12$) and old residents (ages above 60, $M = 4.10$) than those of middle age (ages 21–30, $M = 3.59$; ages 31–40, $M = 3.80$; ages 40–60, $M = 3.74$). Students ($M = 4.06$) were more optimistic than those working in private sectors ($M = 3.71$), healthcare workers ($M = 3.78$), and freelancers ($M = 3.75$). Service industry workers ($M = 3.97$) and those

| Table 6. Multiple hierarchical regression analysis for the prediction of affective satisfaction based on quality appraisals. |
|---------------------------------------------------------------|
| Variables | Model 1 | Model 2 |
|-----------|---------|---------|
| Intercept | 3.711** | 1.789 |
| Family role | 0.101 | 0.016 |
| Gender | 0.009 | -0.09 |
| Age | -0.073 | -0.11 |
| Career | -0.008 | -0.001 |
| Length of residency | 0.058 | 0 |
| Mobility mode | 0.068** | -0.003 |
| Public space | 0.265** | 0.266 |
| Recreational facilities | 0.047* | 0.050 |
| Shopping facilities | 0.078** | 0.081 |
| Landscape and greening | 0.203** | 0.210 |
| Transportation services | 0.065** | 0.073 |
| Walking environment | 0.321** | 0.334 |
| $R^2$ | 0.024 | 0.779 |
| $F$ | 6.321** | 461.547** |
| $\Delta R^2$ | 0.024 | 0.757 |
| $\Delta F$ | 6.321** | 895.119** |

$N = 1572$, *$p < 0.05$, and **$p < 0.001$.}
Table 7. F test of affective satisfaction within sociodemographic characteristics.

| Factors | Variables | N  | M     | Std. Deviation | Variance | F-Ratio | Sig. |
|---------|-----------|----|-------|----------------|----------|---------|------|
| Gender  | Male      | 618| 3.95  | 0.88           | 0.78     | 4.27**  | 0.04|
|         | Female    | 955| 3.86  | 0.85           | 0.73     |         |      |
| Family role | Children | 565| 4.06  | 0.85           | 0.73     | 20.21** | 0.00|
|         | Parent    | 918| 3.78  | 0.87           | 0.75     |         |      |
|         | Grandparent | 90 | 4.07  | 0.76           | 0.58     |         |      |
| Age     | 6–12      | 322| 4.01  | 0.86           | 0.73     | 9.23**  | 0.00|
|         | 13–20     | 243| 4.12  | 0.85           | 0.72     |         |      |
|         | 21–30     | 17 | 3.59  | 0.87           | 0.76     |         |      |
|         | 31–40     | 610| 3.80  | 0.85           | 0.72     |         |      |
|         | 41–60     | 298| 3.74  | 0.90           | 0.81     |         |      |
| Career  | Above 60  | 83 | 4.10  | 0.76           | 0.58     |         |      |
|         | Student   | 558| 4.06  | 0.85           | 0.71     | 6.82**  | 0.00|
|         | Public Servant | 52 | 3.85  | 0.85           | 0.72     |         |      |
|         | Privately Employed | 242 | 3.71 | 0.90 | 0.81 | 3.75 | 0.05 |
|         | Art, Education or Research | 68 | 3.87 | 0.90 | 0.80 |         |      |
|         | Health Care | 58 | 3.78 | 0.96 | 0.91 |         |      |
|         | Service Industry | 153 | 3.97 | 0.89 | 0.79 |         |      |
|         | Unemployed or Housewife | 79 | 4.01 | 0.73 | 0.53 |         |      |
|         | Freelancer | 363 | 3.75 | 0.83 | 0.69 |         |      |
| Length of Residency | Under 3 | 46 | 3.80 | 0.83 | 0.69 | 0.74 | 0.53 |
|         | 3–5       | 65 | 3.97 | 0.97 | 0.94 |         |      |
|         | 5–10      | 220| 3.84 | 0.91 | 0.82 |         |      |
|         | Above 10  | 1242| 3.91 | 0.86 | 0.83 |         |      |
| Mobility Mode | Car     | 256| 3.78 | 0.90 | 0.82 | 8.05** | 0.00|
|         | Metro     | 519| 3.80 | 0.88 | 0.78 |         |      |
|         | Bus       | 379| 3.91 | 0.84 | 0.70 |         |      |
|         | On Foot   | 330| 4.12 | 0.80 | 0.63 |         |      |
|         | Cycle     | 71 | 3.99 | 0.84 | 0.70 |         |      |
|         | Other     | 18 | 3.44 | 1.04 | 1.09 |         |      |

The results of backtesting are as follows: Children > Parent*, Grandparent > Parent*, 6–12 years old > 21–30 years old*, 6–12 years old > 31–40 years old*, 6–12 years old > 41–60 years old*, 13–20 years old > 21–30 years old*, 13–20 years old > 31–40 years old*, 13–20 years old > 41–60 years old*, Above 60 years old > 21–30 years old*, Above 60 years old > 31–40 years old*, Above 60 years old > 41–60 years old*, Students > Privately Employed*, Students > Healthcare Workers*, Teachers > Freelancers*, Service Industry Workers > Privately Employed*, Service Industry Workers > Freelancers*, Unemployed or Housewives > Privately Employed*, Unemployed or Housewives > Freelancers*, On Foot > Car*, On Foot > Metro*, On Foot > Bus*, On Foot > Other*, and Cycle > Other*: N = 1572, *p < 0.05, and **p < 0.001.

unemployed or housewives (M = 4.01) were more optimistic than those working in private sectors (M = 3.71) and freelancers (M = 3.75). Residents mainly commuted by foot (M = 4.12) scored higher than those by bicycle (M = 3.99), metro (M = 3.8), bus (M = 3.91), and other mobility modes (M = 3.44). Residents mainly commuted by bicycle (M = 3.99) scored higher than those by other mobility modes (M = 3.44), and car users recorded the lowest satisfaction (M = 3.78). These results revealed a tendency for residents with few social pressures, such as children, the elderly, and housewives, to be more positive in their emotional responses. In terms of the daily mobility mode, the slower the transportation mode, the happier the resident, suggesting that sustainable transport modes provide a high level of satisfaction in the quality of life.

5. Discussion

Supporting the formulation of suitable urban design strategies and policies for a socially sustainable historic urban center, a cognitive–affective framework for the study of residents’ urban image is created and tested in this research. The proposed method is used to explore their possible causes and formulate urban planning suggestions for the creation of high quality of life.

With the proposed cognitive–affective framework, the cognitive map and the affective map demonstrate a new type of urban perception rooted in residents’ daily lives in a historic urban center, reflecting their quality of life. In addition, a 3D cognitive map provides direct visualization of the level of imageability of the environmental features with the forms and functions that are of most concern in planning terms. Affective perception, when supported by environmental evaluations, serves as a bridge between people and the environment. It also helps identify locations and environmental aspects with potential for future environmental improvement, resulting in a better quality of life. The imageability of urban form is linked closely to form and function, and the affective reflection is closely related to the quality and maintenance of the neighborhood environments. This framework leads to varying results to most conventional historic preservation, tourism-related, or business-incentive placemaking approaches, in which strong emphasis is on enhancing historical, cultural, and economic values through selective place-making processes (Tallon 2013).

The above results reveal that the officially designated historic districts judged purely for their historical and cultural values were not highly perceived by residents. In terms of urban form cognition, natural landscapes in districts or path forms were the most prominent features defining the permanent urban structure, followed by large public spaces. Public spaces and nature’s features provided crucial functions.
in terms of leisure and recreation, and their high imageability benefitted from their dominant forms and essential healing functions. For residents who are familiar with their city, the districts were the most prominent forms in their minds, especially in the historic city center, different from previous studies identifying landmarks as the most prominent environmental features in wayfinding and the creation of a mental image (Lynch 1960; Erçevik Sönmez and Erinsel Önder 2019). The landmarks in the old city center were mainly commercial or cultural and related to public service provision. However, they were less prominent in residents’ minds. The reason was the scale limitations under the constraints of site size and strict historical contexts. Large mountains, rivers, built landmarks, and concentrations of commercial functions attracted attention from the context and merited deliberation.

Residents’ affective experiences were positively and significantly correlated with their evaluations of walking environments, public spaces, and landscapes and green areas. This finding represented the basic quality of the daily life environment in the public realm and indicated steps that could be taken to improve the quality of life. Although recreation, shopping, and transportation services were also significant, they were found to contribute less to environmental satisfaction.

Individuals’ social backgrounds also influenced their perceptions of urban images to a significant degree. The affective evaluations gave indications of ways of improving quality of life. The lower the social pressure of residents, the more satisfied they tended to be with their daily urban environment. Sustainable daily mobility modes, such as walking, cycling, and riding buses, also tended to be associated with high levels of environmental satisfaction.

Sustainable urban centers are good places to work, enjoy, and live. Places with obvious historical, cultural, or economic values are rapidly improved through place-promotion design strategies and following a careful financial cost-effective analysis. However, social sustainability is less researched and addressed in practice. Yuexiu is a good example in this regard, being fully developed and highly mixed, with designated historic quarters and imbalanced spatial investment. A few lessons could be learned from the case study that could steer future policy decisions.

First, in terms of the physical environment, basic environmental qualities of urban blocks, rather than eye-catching features, contribute most to residents’ affective experience of their urban environment in historic urban centers. Landmarks may not be a wise choice for redevelopment in old city centers. By contrast, mixed-use is a crucial condition for success. Urban form cognition can steer urban renovation, clarifying that block-level measures are most needed, and designing places should be done for everyday life rather than attracting curious tourists. Second, the significant role of quality open space containing artificial or natural landscaping in the spatial definition of the imagined urban structure is further strengthened. It enhances the urban identity in residents’ minds and affectively increases personal satisfaction in the daily urban environment. Accordingly, the design, improvement, and maintenance of open space need to go beyond itself and address the surrounding neighborhoods that provide crucial context and access routes. Third, commercialization and tourism need to be carefully managed, as both could contradict residential satisfaction. As the budgets are always not enough for revitalizations, balanced investments by the public sector are needed to improve the quality of life outside place-promotion districts. The direct off-site contributions enhancing the quality of targeted space could also be used for commercial infill developments. It could also be part of the planning conditions or planning contributions.

In this study, only the perceptual aspect of the historic urban center of a megacity was covered, with families of students as the main respondents. Thus, further research could directly explore the relevant design strategy. The finding that districts were more prominent than landmarks might only be applicable in historic urban centers without prominent historic landmarks like Yuexiu. In terms of the conception of place, only two dimensions of Canter’s (1977) theory, physical

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**Figure 1.**

A comprehensive analytical framework for cognitive-affective urban image inquiry to historic urban centers
form and conception, were considered in this study, leaving the issue of behaviors for further investigation.

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