

Reviewing the applications and prospects of the concept 'Image of the City' in urban planning research

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Abstract:

In the 60 years since *Image of the City* was proposed by Lynch, it has been widely applied while also receiving various critiques and queries. However, recent developments of internet have led to new theoretical frameworks and research paradigms based on the classical *Image of the City*. To explore application transformation of *Image of the City* in urban planning over the past 20 years, this paper conducts qualitative and quantitative analyses based on 126 articles selected from the China National Knowledge Infrastructure (CNKI) and 244 articles selected from the Web of Science (WOS). It outlines an overview of research hotspots, trends, and significant changes in the study of *Image of the City* within the field of urban planning. The study reveals that Kevin Lynch's foundational work has been expanded to incorporate digital and cultural dimensions into *Image of the City* researches. Furthermore, it highlights the adoption of "big data," "images," and other relevant data, alongside advanced technologies such as "deep learning" and "convolutional neural networks." These technologies have progressively replaced traditional cognitive mapping and questionnaire methods in the study of *Image of the City*. This shift not only marks a significant methodological evolution but also broadens the scope of research in capturing and analyzing the complexities of urban environments.

Keywords: Lynch, Image of the City, CiteSpace, Applications and prospects

1 Introduce

The theoretical approach to urban imagery originates from the perceptual research methods proposed by Lowenthal (1961), yet it is widely acknowledged that Lynch's seminal *Image of the City* has become emblematic of the concept itself (Gu and Song, 2001). In the six decades following Lynch's publication, while his theory has been extensively utilized, it has also encountered numerous critiques and challenges. These criticisms have catalyzed the ongoing expansion and evolution of the *Image of the City* concept. In the digital age, the cognitive patterns, subjects, and theoretical underpinnings of the *Image of the City* are progressively transforming, prompting the development of new theoretical frameworks and research paradigms based on the original theory. Consequently, there is a pressing need to summarize and review the recent shifts in the theoretical content and research paradigms related to the *Image of the City* within urban planning.

To address this, the present paper utilizes CiteSpace as a bibliometric analysis tool, drawing on core journals from the China National Knowledge Infrastructure (CNKI) and the Web of Science Core Collection databases (WOS) to pinpoint research hotspots and trends in *Image of the City* studies over the past two decades. From this analysis, the paper delineates the shift in

Image of the City research paradigms within urban planning.

2 General Progress In Image Of The City Research

2.1 Data Resources

To gain a deeper understanding of the research progress on *Image of the City* in urban planning within both Chinese and international contexts, we conducted searches and downloads of basic data from CNKI and WOS, restricting the publication period to between 2000 and 2022. Utilizing the CNKI journal database, the search parameter SU='城市意象' (Image of the City) yielded 273 papers from SCI or EI indexed journals, Chinese core journals, CSSCI journals, and CSCD journals. To specifically focus on urban spaces, studies concerning urban imagery in literature and film were manually excluded, ultimately resulting in 126 relevant documents. In the WOS Core Collection, the search was conducted using TS="urban image", focusing on journal articles and conference papers, which initially provided 245 core journal papers. After an examination to remove irrelevant publications, 244 papers remained. This paper employs CiteSpace 6.1.R6 software to perform foundational bibliometric analysis.

2.2 Volume Of Publications

From the perspective of publication volume, Chinese scholars' engagement with *Image of the City* studies in the field of urban planning appears limited, exhibiting a fluctuating trend with a slow rise and decline in recent years. Conversely, international scholars have demonstrated a steady increase in their research on *Image of the City*, particularly after 2016. This indicates a period of heightened activity and growing interest in the subject (Figure 1).

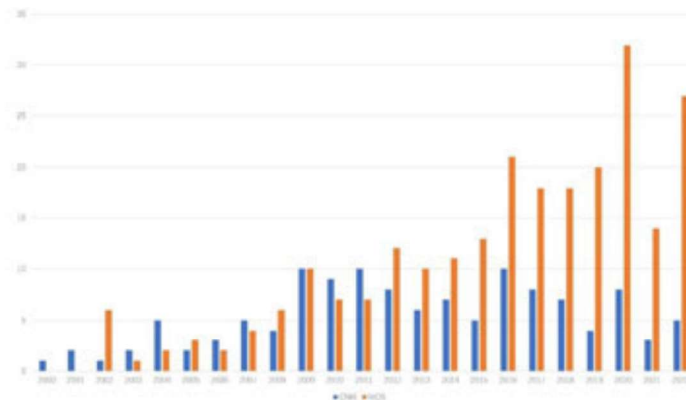


Figure 1. Comparison of year-to-year changes in the number of publications in CNKI and WOS papers

2.3 Research Hotspots

A co-occurrence keyword graph is instrumental in analyzing research hotspots and their evolution. In such graphs, each node represents a keyword, with larger nodes indicating higher frequencies of occurrence, thus highlighting the current hot topics in *Image of the City* within the field of urban planning. In Chinese research, besides fundamental topics like "spatial imagery" "cognitive maps" and "imagery maps" the main research topics include "urban

design" "urban tourism" "urban characteristics" and "big data" (Figure 2), focusing on the application of *Image of the City* theory in urban planning and design, such as identifying urban characteristics. Similarly, international studies on *Image of the City* also focus on "urban design" "urban planning" and "urban development," and like Chinese studies, show a notable interest in new big data-related technologies such as "deep learning" and "convolutional neural networks." However, international research differs by also emphasizing exploration of specific historical urban districts, with a focus on "urban historical district renewal" and "urban historical heritage preservation" (Figure 3).

Centrality in the keyword graph indicates the degree of connection between keywords, with higher centrality suggesting stronger links with other keywords. As shown in Table 1, besides primary nodes with high centrality such as "urban image " "Image of the City", keywords like "space syntax" "big data" and "deep learning" are emerging as secondary important nodes in both Chinese and international research spectra, indicating significant future research trends. Since 2016, related data such as "big data" and "images," along with new technological methods like "deep learning" and "convolutional neural networks," have been increasingly applied in *Image of the City* research, replacing traditional cognitive mapping and survey questionnaires, showcasing high centrality and becoming significant nodes within the research field. Thus, the paradigm of *Image of the City* research is shifting from traditional surveys and cognitive sketches involving small samples to utilizing computer algorithms to mine information from big datasets.



Figure 2. Co-occurrence keyword mapping in Chinese *Image of the City* researches

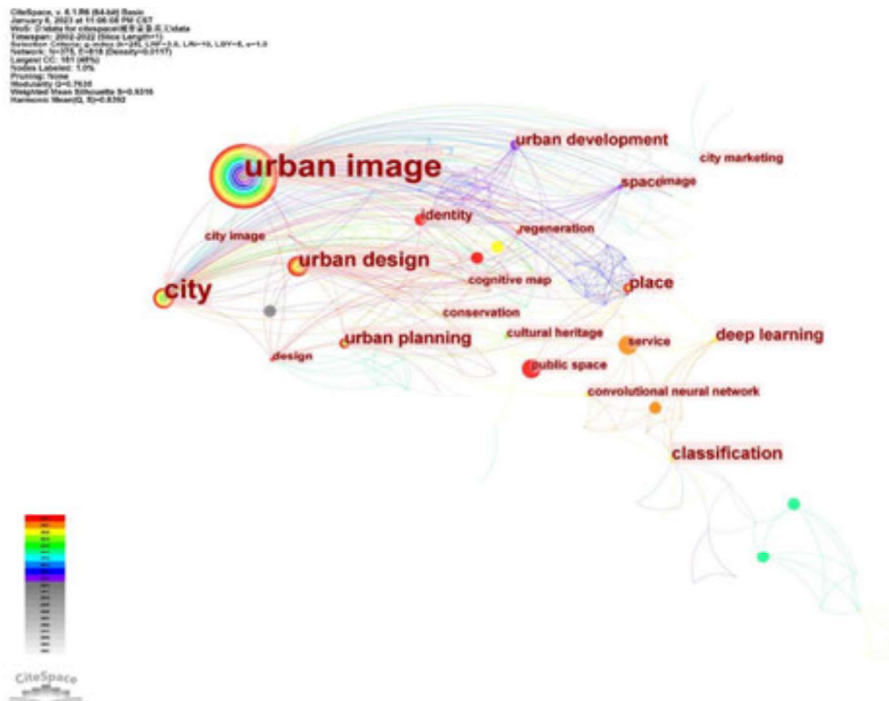


Figure 3. Co-occurrence keyword mapping in international *Image of the City* researches

Table 1. Keyword centrality of *Image of the City* researches

Keyword centrality of Chinese <i>Image of the City</i> research				Keyword centrality of international <i>Image of the City</i> research			
Order	Centrality	Year	Keywords	Order	Centrality	Years	Keywords
1	1.47	2000	image of the city	1	0.29	2002	urban image
2	0.13	2007	cognitive maps	2	0.13	2002	city
3	0.10	2006	spatial imagery	3	0.08	2009	classification
4	0.09	2014	space syntax	4	0.08	2018	deep learning
5	0.07	2018	public space	5	0.06	2012	urban design
6	0.05	2007	environmental imagery	6	0.04	2009	image fusion
7	0.04	2016	big data	7	0.03	2017	design
8	0.04	2014	urban space	8	0.02	2005	place
9	0.04	2004	space	9	0.02	2007	urban planning
10	0.04	2019	deep learning	10	0.02	2014	city image
11	0.03	2004	imagery	11	0.02	2020	convolutional neural network

12	0.03	2005	urban image	12	0.02	2017	algorithm
13	0.03	2003	map	13	0.01	2002	urban development

2.4 Research Trends

Chinese scholars' research on *Image of the City* can broadly be divided into three stages (Figure 4). The first stage (2000-2010) focused on applying and empirically testing classical methodologies of *Image of the City*. The second stage (2010-2015) centered on enhancing these classic methods through the integration of theories from environmental psychology and semiotics. The third stage (2015-present) has seen the adoption of multidimensional data such as online text, internet images, street view images, and big data. This data is analyzed using deep learning techniques to categorize and deconstruct in order to explore subjective perceptions alongside objective environmental analyses.

Internationally, research on *Image of the City* can be divided into two stages (Figure 5). The first stage (2000-2010) was characterized by keywords such as social capital, cultural capital, regional renewal, and negative imagery, applying classic *Image of the City* methodologies to the fields of regional renewal, city branding, and urban transformation. This phase emphasized enhancing distinctive urban features and employing city branding as a robust image-building strategy, which subsequently led to the exploration of creative cities and urban personality planning. The second stage (2010-present), similar to developments in China but starting earlier, utilizes images, remote sensing imagery, and other data sources, analyzed using deep learning, convolutional neural networks (CNN), and convolutional autoencoders (CA). This phase places a greater emphasis on culture, focusing on the cognition of urban culture, the protection of urban cultural heritage, and the preservation of historical urban environments.

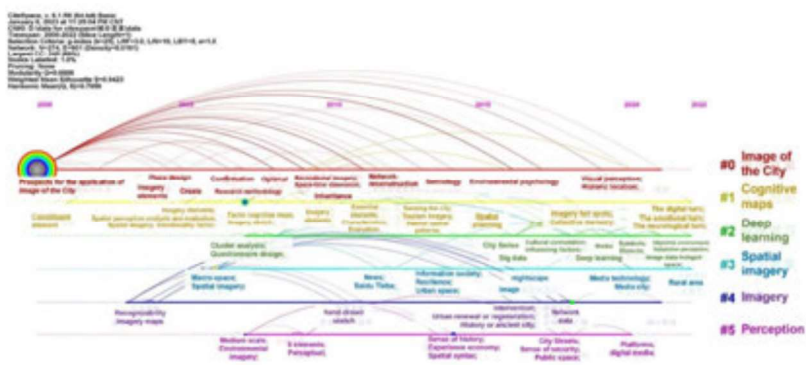


Figure 4. Time series map of keyword changes in Chinese *Image of the City* researches

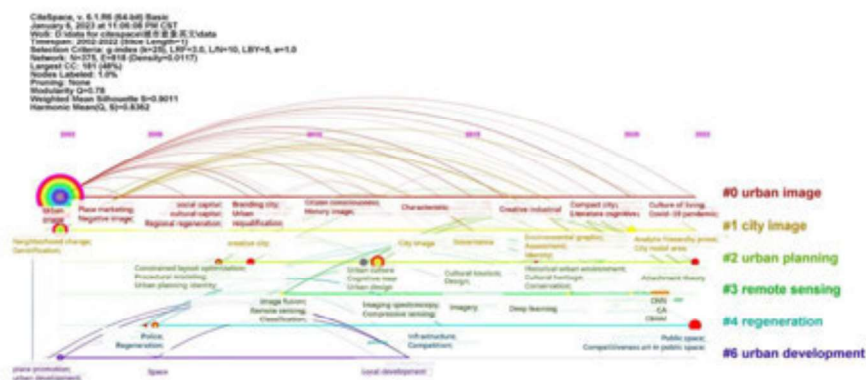


Figure 5. Time series map of keyword changes in international *Image of the City* researches

3 Paradigms Shifts In Image Of The City Research Within Urban Planning Studies

3.1 Evolution Of Theoretical Content Of Image Of The City

(1) Limitations of *Image of the City* theory

Kevin Lynch, in his seminal work "Image of the City", provided a comprehensive set of theories and methodologies related to urban imagery. Lynch posited that urban imagery results from the interaction between the environment and individuals, where perceptions are influenced by urban environments to create spaces of experience, either directly or indirectly. These perceived images, which residents can recall, constitute the "subjective environmental" spaces in their minds. Thus, individuals can organize and attribute meaning to everything they perceive. Lynch's research across cities like Boston, Jersey City, and Los Angeles distilled urban imagery into five structural elements: paths, edges, districts, nodes, and landmarks. And he proposed that residents construct mental maps of the city through path-dominated or space-dominated approaches (Lynch, 1960). Cognitive mapping and social survey techniques have been commonly used to obtain these mental maps of urban imagery, with studies varying in scale from city-wide (Xiong et al.,2011) to region (Miao,Li and Xu,2010) ,and campus levels (Topcu and Topcu,2012).

However, as a product of the 1960s, the suitability of Lynch's *Image of the City* theory for exploring subjective spatial perception in contemporary urban environments has been widely debated. First, Lynch's structural elements of urban imagery are focused on tangible aspects of urban design, leading to highly similar findings about urban characteristics that often appear repetitive and generic (Xu, 2012). Second, cognitive maps, as abstract schematic structures, detach from the cultural essence of the city itself, serving primarily for directional purposes and overlooking the motivations behind behaviors, thus failing to genuinely represent the holistic urban structure and to uncover the city's true character (Shen, 2004). Third, the sample bias in surveys does not reflect the perceptions of millions of urban dwellers but only those of a few

individuals (Wang, 2003).

(2) Expansion of *Image of the City* Connotations

With the transformation in information technology and transportation, *Image of the City* perception now integrates more culturally and emotionally valuable media. The cognitive models of *Image of the City* have evolved to combine visual and virtual cognition, with the objects of *Image of the City* cognition shifting towards urban spaces popularized by online platforms like TikTok and social media (Zheng et al.,2020). People's perceptions of the real world are influenced not only by physical experiences but also by interactive recommendations on social media, and by the rapid dissemination of literature, cinema, and short videos, gradually forming more fixed urban imagery within the digital realm. Gradually, the study of *Image of the City* has moved beyond just the interaction between observer and environment, focusing increasingly on the role of media imagery. In the digital domain, the transfer of digitized images eliminates physical distances between subjects and objects, making geographical traversal unnecessary for path-finding cognition, thus giving *Image of the City* perception an instantaneous and geographically unbounded sharing quality (Zhao and Chen, 2023).

3.2 Perception And Recognition Of Urban Image Based On Multivariate Data

Since the internet has become a common medium for large groups to share photos, information, and feelings, the images and text found online can reflect people's subjective perceptions of the physical environment to some extent. The advancement of digital technologies, artificial intelligence, and network information technology has significantly transcended the traditional "cognitive map" route for identifying *Image of the City*, shifting towards research that leverages "network media" to perceive *Image of the City*. Consequently, images and text are increasingly replacing small-sample data obtained through cognitive maps and survey methods as the primary data sources for urban imagery research (Table 2).

(1) Identifying Urban Imagery Based on Image Data

Long and Zhou (2025) introduced "Pictorial Urbanism," advocating that image data not only embodies the objective world and subjective perceptions but also can be applied on a large scale quantitatively in urban studies. Images, reflecting static visuals inherent in human vision, are extensively used to identify *Image of the City* elements and assess their features. Depending on their origin, images are categorized as online images (from the internet), street view images (from services like Baidu Maps, Google maps), and attributes of images (from photographic metadata).

Online images are widely utilized to explore the composition of *Image of the City* and identify its characteristics (Zhao, Xu and Li, 2015; Cao, Long and Yang, 2017; Li et al., 2017), street view images are employed for perceiving street spaces (Xu, Jiang and Chen, 2018). These image datasets are often analyzed using deep learning and machine learning technologies to recognize content, categorize features, and conduct quantitative analyses.

Attribute information such as shooting location, uploading practices, description tags, exposure parameters, and geographic information in the image can also be utilized to mine *Image of the City*. For example, Bahrehdar, Adams and Purves (2020) used a combination of user-generated

content from Flickr and street network data from OpenStreetMap to investigate urban perception and city elements such as paths, landmarks, districts, edges, and nodes.

(2) Identifying Urban Imagery Based on Text Data

Online texts, as mediums conveying daily thoughts and emotions, effectively express individuals' emotional and preferential responses to entities. Researchers have used online texts as raw data to analyze *Image of the City*. In China, sources of online textual data include Weibo, Baidu Tieba, and Dianping.

Research in this area often focuses on the imagery preferences of various demographic groups (Feng et al., 2011; Zhao and Liu, 2012) and the urban imagery of specific regions (Xie et al., 2017). Text data carries limited information, confined to content and coarse geographic details, making it less capable of extracting detailed information and suitable only for broad, qualitative spatial perception descriptions. Thus, research solely based on text data for identifying urban spatial imagery is uncommon. Text data primarily aids in enhancing urban imagery perception studies, for instance, Fan and Zhang (2022) used POI density to gauge functional perception, street view images for visual perception, and textual notes to extract emotional perceptions.

Table 2. Data basis of *Image of the City* perception and recognition in Chinese

Data categories	Sub-categories	Combined with other data	Research content	Source
Image	Online images	None	Identifying the composition, dominant direction, characteristic degree and similarity of <i>Image of the City</i> elements in 21 Chinese cities	Cao, Long and Yang, 2017
	Online images	Combining questionnaires and cognitive maps	The basic elements of the <i>Image of the City</i> Composition of Dingxing Ancient City	Fu et al., 2017
	Night Scene Web Image	Nighttime remotely sensed light intensity data	The main spatial characteristics of Zhuhai's urban nightscape Imagery and the tendency of popular Choice	Li et al., 2017
	Online images	None	Evaluation of feature recognition of 21 Cities in Guangdong province	Zhao, Xu and Li, 2015
Street view images	Baidu Street View map	None	Perceived safety of public space in Shanghai streets	Xu, Jiang and Chen, 2018
Online texts	word frequency of Weibo hot area	None	Image of the Beijing City	Xie et al., 2017

	microblogging text	None	Similarities and differences in chinese and western tourists' perceptions of Beijing's urban Imagery	Feng, 2011
	Economic news text, Baidu posting geographical term frequency	None	Differences and similarities between the media and the public on urban imagery of Shanghai's downtown area	Zhao and Liu, 2012

3.3 Reanalysis Of Urban Imagery Structures Based On New Computational Methods

The development in big data and computing has continually fostered new models for understanding Image of the City. Deep learning and machine learning, key branches of artificial intelligence, provide tools for extracting objective environmental imagery and the subjective perceptions of the public. These technologies are extensively applied in urban planning and related research. The primary significance of deep learning and machine learning in urban imagery lies in their ability to "mimic human learning" processes, autonomously learning from large datasets to derive patterns, particularly in analyzing image, text, and spatiotemporal data. Consequently, numerous scholars have attempted to employ these methods to develop new models for exploring *Image of the City*.

For example, Cao, Yang and Long (2019) used Weibo data comprising photos, texts, and location tags, combined with big data and deep learning techniques, to construct a model that deeply characterizes urban imagery across three dimensions: structure, types, and evaluation. Zheng (2021) utilized street view big data, machine learning, and both subjective and objective quantitative evaluations to quantify the objective environmental components and primary perceptual outcomes in Nanjing's central urban area, proposing a new set of five urban imagery elements different from Kevin Lynch's model: core, node, corridor, layer, and blind spot.

Internationally, Doersch et al (2012) based their study on large-scale street view data, using unsupervised computer recognition algorithms to identify elements representing Paris's urban environment. Their findings indicate that Paris's urban imagery elements are embedded in everyday culture rather than unique urban landmarks or structures. Liu et al (2016) applied deep learning techniques to categorize and classify photo content from Panoramio and Flickr by elements (e.g., green visual imagery, water visual imagery), exploring the *Image of the City* element types and spatial distribution characteristics in seven cities. Zhou et al (2016) used deep learning to identify and classify geographical photo data from 21 cities, investigating each city's urban imagery features and spatial characteristics, and further exploring the differences among these cities.

4 Summary

Image of the City is summarized in two adjustments in urban planning research:

(1) Theoretical Contributions and Expansions

Kevin Lynch's foundational work has been expanded to integrate digital and cultural dimensions into the study of *Image of the City*. The original elements of paths, edges, districts, nodes, and landmarks have been adapted to include digital interactions and cultural perceptions. This expansion is crucial as it acknowledges the changing urban experiences in the digital age,

where physical and virtual spaces converge. The incorporation of more culturally and emotionally charged elements into the study of *Image of the City* is a significant theoretical advancement. By acknowledging the influence of media and digital platforms, current research captures a more holistic view of how urban residents perceive their environments. This approach reflects a shift from a purely functional view of urban spaces to one that includes emotional and experiential dimensions.

(2) Methodological Innovations

The use of big data analytics, deep learning, and convolutional neural networks marks a substantial methodological shift. These technologies have enabled researchers to analyze large datasets of images and texts, providing a broader and more nuanced understanding of *Image of the City*. This approach contrasts sharply with the traditional methods of surveys and cognitive mapping, which often relied on smaller, less diverse samples. The transition to multivariate data analysis allows for a more comprehensive examination of *Image of the City*. By utilizing both image and text data sourced from the internet, researchers can capture a wide array of perceptions and interactions that were previously inaccessible. This methodological shift enhances the ability to analyze complex urban dynamics and understand the multifaceted nature of urban imagery.

5 Conclusions

This paper outlines the overall research progress on *Image of the City* within the field of urban planning and summarizes the research hotspots and trends. It further categorizes changes in research content, dividing it into the expansion of the connotation of *Image of the City*, perceptual identification of *Image of the City* based on multivariate data, and the re-discrimination of *Image of the City* structures using new computational methods. The study reveals that Kevin Lynch's seminal work has been expanded to incorporate digital and cultural dimensions into *Image of the City* research. Moreover, in terms of methodology, data related to "big data" and "images," along with new technological approaches like "deep learning" and "convolutional neural networks," have progressively replaced traditional cognitive mapping and survey questionnaires. Looking ahead, using deep learning, convolutional neural networks, and other computer algorithms in conjunction with large datasets such as text and images to further analyze *Image of the City* remains a key research direction. Applying these methods to historical heritage preservation, urban design, cultural tourism, and city branding holds significant potential. However, the complexity of online information and whether it can truly replace the perceptions of the majority of urban populations remains a topic for further debate and investigation. Therefore, future research should focus on enhancing the explanatory power of digital information for *Image of the City* theory.

References

- Bahrehdar, A.R., Adams, B. and Purves, R.S., 2020. Streets of London: Using Flickr and OpenStreetMap to build an interactive image of the city. *Computers, Environment and Urban Systems*, 84, p.101524.
- Cao Y., Yang P., and Long Y. (2019) The Innovation of City Image Cognitive Method Based on Deep Learning: A Case Study of Chongqing Main District. *Chinese Landscape Architecture*,35(12):90-95.

- Cao Y., Long Y., and Yang P. (2017) City Image Study Based on Online Pictures: 24 Cities Case. *Planners*,33(02):61-67.
- Doersch, C., Singh, S., Gupta, A., Sivic, J. and Efros, A.A. (2015) What makes paris look like paris? *Communications of the ACM*, 58(12), pp.103-110.
- Fan L. and Zhang D. (2022) Research on Spatial Perception of Urban Image Hotspots under New Social Media: Take the Note Data of Beijing Xiaohongshu as an Example. *Urban Development Studies*,29(10):1-8.
- Feng J. (2011) Perceptions of the Image of Beijing's Tourist Destinations-An Analysis of the Multi-dimensional Discourses on the Blogs from Chinese and Western Tourists. *Tourism Tribune*, 26(09):19-28.
- Fu W., Liu Y., Xue B., Wu Y., and Wang S. (2017) Web-Data Based Historic City Image Study: Taking the Old Town of Dingxing as an Example. *Urban Development Studies*, (08):31-38.
- Gu C. and Song G. (2001) The study on the urban image and its application in the urban planning. *City Planning Review*, 25(3), pp.70-73.
- Liu, L., Zhou, B., Zhao, J. and Ryan, B.D. (2016) C-IMAGE: city cognitive mapping through geo-tagged photos. *GeoJournal*, 81, pp.817-861.
- Li Y., Zhao M., Xu Y., and Chen Y. (2017) Space Image of Multi-Scalar Urban Nightscape Represented by Photo Landscape on The Internet. *Planners*, 33(09):105-112.
- Lowenthal L. (1961) *Literature, Popular Culture, and Society*. Englewood Cliffs, NJ: Prentice-Hall, 109-140.
- Long Y., and Zhou Y. (2017) Pictorial Urbanism: A New Approach for Human Scale Urban Morphology Study. *Planners*, 33(02):54-60.
- Lynch, K.(1964) *The image of the city*. MIT press.
- Miao T., Li D., and Xu X. (2010) Analysis and Evaluation of Urban Image Space and Image Elements in the Main Districts of Lanzhou. *Modern Urban Research*, 25(11):75-79.
- Shen Y. (2004) Necessity of city image research from the aspect of city characteristic. *Urban Problems*, (03):8-11.
- Topcu, K.D. and Topcu, M., 2012. Visual presentation of mental images in urban design education: cognitive maps. *Procedia-Social and Behavioral Sciences*, 51, pp.573-582.
- Wang Y. (2003) Critical Reading on Kevin Lynch's *The image of the City*. *New Architecture*, (03):70-73.
- Xiong P., Xu J., Yu X., and Zhang Y. (2011) Xi' an Urban Image Research Base on Cognitive Map. *Planners*, 27(S1):33-37.
- Xie Y., Peng X., Huang Z., and Liu Y. (2017) Image perception of Beijing's regional hotspots based on microblog data. *Progress in Geography*, 36(09):1099-1110.
- Xu L. (2012) *The Rethinking of Themes and Paradigms: A Review of Urban Image Studies in China*. *New Architecture*, (01):114-117.
- Xu L., Jiang W., and Chen Z. (2018) Study on Perceived Safety in Public Spaces: Take Perception of Street View in Shanghai as an Example. *Landscape Architecture*, 25(07):23-29.
- Zhao M. and Liu H. (2012) The Media Representation of Spatial Image of Downtown Shanghai. *Human Geography*, 27(05):36-41+82.
- Zhao M., Xu G., and Li R. (2015) The Pictorial Expression of City Image on Internet: A Case Study of Twenty-One Cities in Guangdong. *Architectural Journal*, (02):44-49.
- Zhao M., and Chen R. (2023) Theoretical Progress and Planning Prospect of City Image in The

Network Society. *Human Geography*, 38 (01): 71-78.

Zhao Y. (2021) Research on Formation Pattern of Urban Image Based on Street View Data: From the Perspective of Subjective Perception and Objective Environment Deviation. Doctoral dissertation, Southeast University.

Zheng Y., Yang J., Dai X., Wang Q., and Xie R. (2020) Research and Reflection on the Cognitive Model of City Image Under Digital Background. *Urbanism and Architecture*, 17(13):54-58+62.

Zhou, B., Liu, L., Oliva, A. and Torralba, A. (2014) Recognizing city identity via attribute analysis of geo-tagged images. In *Computer Vision–ECCV 2014: 13th European Conference, Zurich, Switzerland, September 6-12, 2014, Proceedings, Part III 13* (pp. 519-534). Springer International Publishing.