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Study on the Olfactory Landscape of the Shichahai Area in Beijing

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Abstract: Odor, as a type of non-visual perception, has received relatively little attention. However, with the exacerbation of urbanization and environmental pollution, people have become more concerned about the odors in urban air. This study aims to explore the relationship between odors and cities, and to demonstrate how odors and locations are linked through design. We hope to contribute positively to urban development by visualizing odors in a form of olfactory landscape, focusing on the Shichahai area in Beijing. Odor-related data were collected through olfactory walks, and then visualized through odor maps, to gain insights into the distribution and characteristics of odors in urban landscapes. This approach can provide comprehensive information for urban planning, ensuring the livability of urban spaces and the quality of life of residents.

Keywords: Olfactory landscape, Olfactory informationization, Beijing, Shichahai, Olfactory design

1. Introduction

In today's world, our perception of information in daily life primarily relies on vision. The sense of smell, as a sensation, is largely taken for granted, leading to a significant lack of attention towards olfaction [1]. Smell is, in fact, a more sensitive and nuanced mode of perception; the perception of odors often strongly evokes memories and emotions associated with events and scenes. Therefore, the role of smell should not be underestimated. For instance, olfactometers can be used to measure environmental odors and conduct pollution monitoring [1].

Through this study, we aim to better understand the olfactory characteristics of the area and, consequently, take targeted measures to improve the environmental quality and enhance the quality of life for residents. Olfactory landscape is an indispensable part of urban planning, and this study can further advance urban planning, improving the overall image and attractiveness of cities. Moreover, the Shichahai area in Beijing is a famous tourist attraction with a large number of visitors. By studying the olfactory landscape of this area, we can better meet the needs of tourists, improve the quality and standards of tourism services, and promote the development of the tourism industry. The Shichahai area in Beijing boasts rich historical and cultural heritage, with olfactory landscape being one of them. Research on the olfactory landscape of this area can better preserve and inherit these cultural heritages, leaving behind valuable treasures for future generations. Olfactory landscape research involves multiple disciplinary fields, including environmental science, urban planning,

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tourism studies, and cultural heritage conservation. Through the study of the olfactory landscape of the Shichahai area in Beijing, the development of these disciplines can be promoted, fostering academic exchanges and cooperation.

In urban planning and design, besides focusing on creating visual landscapes, attention should also be given to creating olfactory landscapes. Through the rational arrangement of vegetation and the management of environmental odors, more pleasant and personalized urban spaces can be created. Furthermore, outdoor odor research should also become an important part of urban environmental monitoring to safeguard residents' health and quality of life. Beijing, as the capital city of China, has always been a focus of attention. Therefore, we conducted research using the Shichahai area in Beijing as an example. Data collection on olfaction was carried out in the surrounding areas, and then the data were integrated for visualization and analysis. Odor itself has various research values, and the study of olfactory landscape in the Shichahai area of Beijing holds significant practical and theoretical significance, providing valuable references and insights for urban planning, environmental protection, tourism development, and cultural heritage conservation, among other fields.

2. Literature Review

In the 1990s, Norwegian odor expert Cecilie Thoresen collected various forms of odors, totaling more than 7,000 types, including body odors and urban smells, thereby establishing a vast "odor museum." Thoresen gathered odors from cities such as Stockholm, London, and Berlin, and materialized "smell," creating odor maps and producing "urban scentscapes". [2] British "sensory artist" Kate McLean created an odor system classification wheel and defined colors for different odors, subdividing urban land and defining the colors of odors in city centers and main areas. She led volunteers in odor detection in the streets of New York and subsequently drew "sensory maps" in multiple cities and regions including New York, Paris, and Singapore. [3] Currently, they have conducted research and drawn odor maps for cities such as London, Barcelona, Madrid, New York, and Boston. In comparison, research on urban odors in China has made little progress. Studies related to odors in China mainly focus on air quality and odor from water bodies, with little attention given to odor as an aspect of human spatial perception.

3. Methodology

Research on urban olfactory landscapes is a progressive process. For this study, we chose the Shichahai area, which comprises both commercial and residential areas. To gain a comprehensive, objective, and effective understanding of the olfactory situation in the Shichahai area, our approach followed a progressive method.

We employed a three-step research method, including olfactory walks [3], on-site interviews, and visualization methods such as odor heat maps.

The first step involved planning routes and conducting olfactory walks, collecting data along the way. The second step involved randomly selecting nearby individuals during the olfactory walks for interviews to gather firsthand information on public perceptions of odors. The third step involved analyzing the collected data and interview responses. This analysis primarily utilized odor heat maps supplemented by odor direction wheels and other visualization techniques to intuitively study odors.

3.1. Olfactory Walks

We recruited 30 volunteers to conduct olfactory walks in the Shichahai area. Following pre-planned routes, volunteers experienced various odors and captured details of difficult-to-perceive smells. They filled out forms detailing their perceptions of each odor, rating them on a five-point scale. It rained

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lightly on the day of the olfactory walks, which made predicting the odors more challenging but also ensured a more comprehensive study.

3.2. Interview Method

During the olfactory walks, we prepared several questions for the recruited volunteers to interview nearby residents and tourists. We were concerned about the volunteers' motivation and the cooperation of the interviewees. However, our concerns were unnecessary, as everyone involved took the task seriously. Interviews were recorded, and volunteers provided their insights and opinions during the process.

3.3. Charting Method

With the completion of the aforementioned tasks, the responsibility of our research team is to organize the data painstakingly collected by the 30 volunteers and present it in the form of charts. First, all collected odors are listed and categorized into the predetermined five categories. The concentration, frequency, location, etc., of the odors encountered along the route are then categorized and summarized. Finally, odor heat maps are created based on the compiled data. Due to the necessity of the experiment, odor-related heat maps and odor direction wheels were also drawn, allowing us not only to accurately determine the distribution of odors in Shichahai but also to observe macroscopic odor distribution phenomena, which are crucial for our study.

3.4. Site Selection

The Shichahai neighborhood is located in the Xicheng District of Beijing and is the largest and most well-preserved historical neighborhood in Beijing. The historical Shichahai area has taken shape since the Yuan Dynasty and became one of the scenic spots in Yanjing during the Qing Dynasty. Among them, Huguo Temple Street, Yandaixie Street, Ya'er Hutong, and the Three Seas (Historical and Cultural Street Space Urban Design Perception Quality Evaluation—Taking the Shichahai Historical and Cultural Street Area as an Example) are important pedestrian commercial districts in Beijing and even across the country. The Shichahai historical neighborhood consists of 5 administrative districts covering West Lake, Front Lake, Back Lake, North Lake, and surrounding areas [4]. The information used includes the names, coordinates, etc., of commercial service shops and tourist attractions. The research scope encompassed a total of 463 commercial service points (including dining and shopping services). These were further categorized based on the business characteristics within the Shichahai area, with dining services divided into restaurants, bars, and cafes, and shopping services divided into lifestyle services and specialty goods. Additionally, there were 129 tourist attractions, including 36 key cultural heritage sites at or above the district level and 93 other general scenic spots. Moreover, there are tens of thousands of residents living in this area. Given its diverse array of odors, it holds significant research value.

As one of the most well-preserved historical districts within Beijing, the Shichahai Historical District boasts rich historical and cultural heritage along with a distinctive urban landscape. Originating from the Yuan Dynasty, this area has undergone various dynastic evolutions, eventually becoming one of the scenic spots of Yanjing during the Qing Dynasty. Below is an expansion on the research scope of the Shichahai Historical District:

Historical and Cultural Background: The history of the Shichahai Historical District can be traced back to the Yuan Dynasty, making it one of the oldest areas within Beijing. It holds a wealth of cultural history, encompassing ancient hutong culture, religious culture, commercial culture, and more. During the Qing Dynasty, this area flourished as a bustling hub of Yanjing, hosting numerous imperial temples, noble residences, and other historical sites that remain rich and unique to this day.

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Commerce and Tourism: As a significant pedestrian commercial district within Beijing, the Shichahai Historical District not only houses a variety of commercial service shops but also features numerous distinctive dining and shopping venues. The distribution and types of these commercial establishments reflect the unique commercial atmosphere and consumer characteristics of the area. Additionally, among the 129 tourist attractions, there are 36 district-level and above key cultural relics protection units, along with other general scenic spots and historical sites, making this area a unique destination for cultural history and tourism experiences.

Residential Life: Beyond being a center for commerce and tourism, the Shichahai Historical District is also home to thousands of residents. These residents live within the historically significant hutongs, carrying on generations of living habits and cultural traditions. The blending of residents with commerce and culture has created a unique community atmosphere.

Diversity of Odors: Due to the convergence of various commercial and dining establishments, the Shichahai Historical District exhibits a rich diversity of odors. From traditional old Beijing snacks to modern cafes and bars, each aroma carries unique cultural and historical connotations, providing an excellent study subject for olfactory landscape research.

Urban Planning and Development: As part of the core area of Beijing, the planning and development of the Shichahai Historical District are crucial for the overall image of the city. In-depth research of this area can provide valuable references for future urban planning and historical-cultural preservation, facilitating the organic integration of historical context with modern development.

In conclusion, the Shichahai Historical District is an area with profound historical heritage, unique cultural characteristics, and diverse olfactory landscapes. Research on this area contributes to a better understanding of the balance between urban development and cultural inheritance, offering valuable insights for future urban planning, cultural preservation, and tourism development.

3.5. Experimental Preparation

We selected the area near Shichahai for the olfactory walk experiment. Prior to the experiment, team members conducted route selection and odor theme classification. These themes included odors of varying degrees emitted from sewers, garbage bins, and toilets; food sales points such as restaurants and snack shops emitting food and cooking odors; calls from vendors; odors emitted by residents and roadside vegetation; the smell of the lake water in Houhai; and odors of automobile exhaust and mildew. The mixed characteristics of commercial and residential areas in the Shichahai area, along with the layout of the Houhai bar street and its nature as a tourist destination, make the study of olfactory landscapes and the exploration of odor distribution in this area significant. Considering the walking time and types of odors, we chose a route starting from the intersection of Longtoujing Street and Sanzuoqiao Hutong, passing through Liuyin Street, the southern bank of Houhai, Yinding Bridge Hutong, Nanguanfang Hutong, Qianjing Hutong, Beiguanfang Hutong, Houxiaojing Hutong, Daxiao Jinsi Hutong, and finally ending at Yinding Bridge (Figure 1), and pre-classified the types of odors.

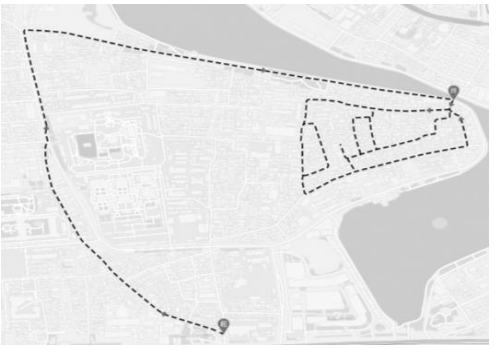

Figure 1: Walking Route

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The olfactory walk in Shichahai serves three purposes: ① To record and explore various odors in the area and the associations or memories they evoke. ② To collect data and create an olfactory landscape map of the area, visualizing the olfactory experience. ③ To summarize and analyze the experimental results and anticipate future applications. Due to the limited number of team members and the inherent differences in perception among different participants, the survey needs to be reasonably comprehensive and must have sufficient sample support. Therefore, we recruited 30 students to participate in the olfactory walk experiment.

Detailed Description of Walking Route and Pre-classification:

Starting Point Selection: We chose the intersection of Longtoujing Street and Sanzuoqiao Hutong as the starting point. This location is at the core of the Shichahai area, adjacent to both commercial and residential areas, making it an ideal starting point for the olfactory walk.

Route Selection: The route passes through Liuyin Street, the southern bank of Houhai, Yinding Bridge Hutong, Nanguanfang Hutong, Qianjing Hutong, Beiguanfang Hutong, Houxiaojing Hutong, Daxiao Jinsi Hutong, and finally ends at Yinding Bridge. This route covers the main attractions and hutong of the Shichahai area, ensuring comprehensive and representative exploration during the walk.

Olfactory Theme Classification: Urban olfactory landscape classification is a discipline that studies the different odors in the city. It attempts to classify and analyze the odors in the city and explore their impact on the urban environment and people's lives.

In urban olfactory landscape classification, odors can be classified based on their sources, nature, and impact. According to their sources, odors can be categorized into natural odors and artificial odors. Natural odors include those emitted by plants, soil, and water bodies, while artificial odors include those generated by human activities such as traffic, industry, and commerce. Based on their nature, odors can be classified into different types such as aromatic odors, irritating odors, and strange odors. According to urban olfactory landscape classification, we divided the odors detected into five categories: natural odors, traffic-related odors, commercial odors, industrial odors, and household odors.

This experiment aims to record and explore various odors in the Shichahai area. Through systematic classification of odors, a more comprehensive understanding of odor distribution in urban spaces, including odors from different activities and places, can be achieved. With the participation of 30 students, the experimental team collected rich subjective perception data. These data will be integrated to create an olfactory landscape map of the Shichahai area, visually presenting the odors and providing innovative data support for urban planning. Additionally, the experimental team will conduct comprehensive analysis of the collected data to summarize the distribution patterns of different odors in the Shichahai area. This will help to deepen the understanding of the olfactory landscape in this area, providing substantial insights for future urban management and planning. It is hoped that the experimental results will provide innovative ideas for urban management. Possible applications include improving urban environment, optimizing tourism experiences, and considering olfactory factors more comprehensively in urban planning.

The experiment was meticulously designed in terms of route selection, olfactory theme classification, and experimental objectives, providing robust methods and data support for in-depth research on the olfactory landscape of the Shichahai area.

After conducting the olfactory landscape reconnaissance, we prepared an olfactory information collection form (Table 1) and recruited 30 volunteers. Considering that olfactory walking is a new experimental method for freshmen and that some odors in the target area, such as sewage odor, detergent odor, and food aroma, are common in households or daily life and may be overlooked by volunteers participating in odor detection for the first time. Therefore, we filled in several obvious odors in the information collection form in advance as examples. These include sewage, which is a

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relatively obvious odor, and stones, which require closer inspection to detect subtle odors, to demonstrate the range of intensity of odor exploration.

Olfactory Information Collection Form Explanation (Example, to be filled in according to this type):

Table 1: Olfactory Information Collection Form

No.	Odor Type	Specific Description	Detection Difficulty & Intensity (1-5)	Sensation (1-5)
1	Sewage Odor	Near the road, possibly odor emitted from sewers.	4	3
2	Stone Odor	Walking along the roadside stone wall, a faint stone odor can be detected.	2	4
3	Floral Scent	Passing by the park, a fresh floral scent is perceived.	3	2
4	Garbage Odor	Near the garbage bin, there is a noticeable garbage odor.	5	3
5	Coffee Shop Scent	Passing by the coffee shop, one can smell the rich aroma of coffee.	4	2
6	……	……	……	……

Collection Table Instructions:

• Odor Type: Describes the type of odor detected, such as sewage odor, stone odor, floral scent, etc.

• Specific Description: Provides detailed descriptions for each odor, including possible sources and distribution in the environment, to help participants better understand.

• Intensity (1-5): Participants rate the perceived intensity of the odor, with 1 being very weak and 5 being very strong.

• Perception (1-5): Indicates the degree of liking for the odor, with 1 indicating dislike and 5 indicating liking.

Recruitment of Volunteers Instructions:

• Novel Experimental Method: Emphasizes that olfactory walking is a new experimental method, which may be a completely new experience for first-year students, encouraging them to participate actively and try it out.

• Example Fill-in: Pre-fill several obvious odors in the information collection table as examples to help volunteers better understand how to fill out the form, paying special attention to some odors that are easily overlooked.

• Odor Intensity and Detection Difficulty: Reminds volunteers to consider the intensity and detection difficulty of odors when filling out the form, which helps to obtain more comprehensive and accurate data.

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Through the design of this information collection table, volunteers can be better guided to conduct olfactory walking experiments, ensuring that they can perceive and record different odors meticulously, and providing rich material for subsequent data analysis.

3.6. Experimental Process

On November 5th, the team members brought 30 volunteers to the designated area to conduct the "olfactory walk" experiment. Throughout the entire process, we conducted olfactory walks on an individual basis rather than as a group to complete this project. Volunteers went in groups of two or three to explore the designated area, taking photos and recording their findings. They filled out information collection forms during the walk and marked them on the map on the back of the form. It took us two and a half hours to complete the odor collection work in the target area. After the odor collection was completed, volunteers interviewed different groups of people in the experimental area, including residents, shop owners, and tourists. To prevent missing important information and to avoid situations where some interviewees were unwilling to be filmed, we recorded the interviews. Volunteers introduced the interviews, and the recordings were saved. Finally, the team members collected the recordings and conducted a written analysis of the interview content.

Execution of Olfactory Walk Experiment and Interview Process:

Field Olfactory Walk:

Date: On November 5th, the team organized 30 volunteers to conduct olfactory walk experiments in the designated area.

Individual Olfactory Walk: To ensure data diversity, individual olfactory walks were conducted rather than as a group. Volunteers explored the designated area in groups of two or three and recorded perceived odors by taking photos.

Information Collection Forms: During the olfactory walk, volunteers filled out information collection forms, detailing the specific descriptions, intensity, and difficulty of detecting each odor, ensuring the comprehensiveness and accuracy of the data (Figure 2).

(a) (b) (c) (d)

Figure 2: Olfactory Walk Experimental Process

(a) At the beginning of the experiment, (b) Floral scent, (c) Garbage odor, (d) Recording

Map Markings: Volunteers marked the walking route and discovered odors on the map on the back of the information collection form, providing geographic references for subsequent data analysis.

Odor Collection Time Schedule:

The entire olfactory walk experiment lasted for two and a half hours, covering the target area thoroughly. Volunteers deeply perceived the distribution of odors in the area through odor collection work, providing a detailed data foundation for subsequent analysis. After collecting odor data, volunteers conducted interviews with different groups of people in the experimental area, including residents, shop owners, and tourists (Figure 3). To ensure the complete recording of interview content, the interviews were recorded, and to respect the interviewees and avoid interference, cameras were

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not used for filming. Volunteers saved the recordings after the interviews, and while introducing the interviews, they also protected the privacy of the interviewees. After the field interviews concluded, team members collected the recording devices and organized the recording content. The interview content was recorded in written form, extracting key information and representative viewpoints. The user interview record table is shown in Table 2.



(a) (b) (c)

(a) Interviews with local residents, (b) Interviews with shop owners, (c) Interviews with tourists

Figure 3: Interview Records

Table 2: User Interview Record Table

Name	Mrs. Wang	Interview Type	Resident ☑ Shop Owner □ Tourist □
Residence/Work/Visit Duration		30 years	
Q: Do you smell any particular odors living here? For example, pleasant or unpleasant smells? A: There aren't any other smells, we're quite comfortable living here. Q: Do you think there is a strong smell of cooking fumes nearby? A: There's no particularly strong cooking fumes. There aren't any cooking units here, it's just us residents cooking regularly. Nowadays, we use natural gas, unlike in the past when we used wood-fired stoves. Q: How do you feel about the smell around Shichahai? A: It's fine here, there have been fewer tourists these past couple of years. The area in front is Qianhai, and behind is Houhai, the air is very good.			
Name	Mr. Yang	Interview Type	Resident □ Shop Owner ☑ Tourist □
Residence/Work/Visit Duration		5 years	
Q: Do you notice any particular smells while working here? A: There aren't any particular smells. Q: What do you think is the strongest smell around here? A: Mainly the smell of cooking fumes and food. Q: How is the air around Shichahai in your opinion? A: The air here is quite good.			
Name	Mrs. Li	Interview Type	Resident □ Shop Owner □ Tourist ☑

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Table 2: (continued)

Residence/Work/Visit Duration	40 minutes
Q: Have you smelled any particular odors since you arrived here? A: No, the air is quite fresh. Q: How do you feel after smelling this fresh air? A: I feel very relaxed. Q: Would you like these smells to be present in your living area? A: Of course, I would.	

Through this systematic field olfactory walk and interview process, we have obtained rich olfactory data and subjective perceptions of people regarding the experimental area, providing ample material and basis for the subsequent production and in-depth analysis of olfactory landscape maps. This comprehensive experimental method not only intuitively presents the distribution of odors in the target area but also captures the perceptions and attitudes of different people towards these odors.

We divided the interviewees into permanent residents and tourists. Permanent residents, due to their long-term residence in the Shichahai area, have become fully accustomed to the surrounding odors, considering certain common odors such as moldy smells as normal. They have habitually accepted this as part of Shichahai and do not have strong reactions to it. However, tourists mainly regard Shichahai as a travel destination, with activities mainly concentrated on both sides of the lake. The fresh air by the lake may positively affect tourists' travel experiences. Tourists are more concerned about environmental relaxation and enjoyment, thus showing a higher acceptance of odors.

The interview results show that residents, shop owners, and tourists give positive evaluations of the odors in the Shichahai area, believing that the air here is fresh and livable, without any unpleasant odors. Although subjective perceptions in the evaluations may be influenced by individual differences and the duration of time spent in the area, everyone's evaluation of this place is positive.

4. Results

Through the olfactory data collected by volunteers during olfactory walks and interviews with local residents, shop owners, and tourists, we can now proceed with the plotting of odor heat maps and analyze the distribution of different odor types.

4.1. Olfactory Visualization

After completing the olfactory walks, we retrieved the information collection forms. The odors perceived by volunteers were organized and used to create an odor heat map (Figure 4).

Figure 4: Odor Heat Map

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From the heat map, we can see that odors such as sewage smell, household garbage odor, and moldy smell are mainly distributed in the residential areas. Additionally, the aroma of food and the smell of cooking oil permeate throughout the residential area. We found that in the Houhai Bar Street, there is a white trash can approximately every hundred meters, and the smell of vomit can be detected nearby. The exhaust fumes from cars, due to their specific source, are distributed in different sections.

In total, we collected data on 37 different odors. According to urban olfactory landscape classification, odors were categorized into five groups: natural odors, traffic-related odors, commercial odors, industrial odors, and household odors. We then created an urban odor aromatic wheel and a matrix heat map showing the correlation between different odors, as shown in Figures 5 and 6.

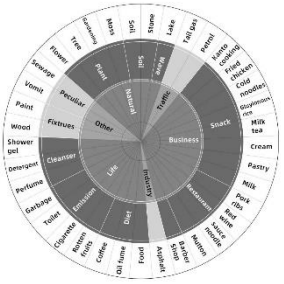

Figure 5: Odor Direction Wheel

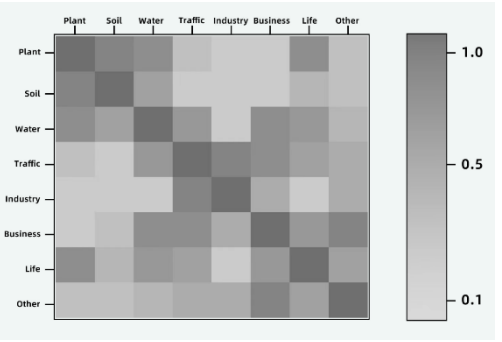

Figure 6: Odor Correlation Heat Map

Through the odor correlation heat map, we found that the smell of soil is often accompanied by odors from plants and bodies of water. Additionally, we discovered that residential areas have many green plants and flowers planted by citizens, leading to a strong correlation between plant odors and household odors. Due to the concentration of bars, snack shops, and restaurants in the Houhai area, commercial activities are often associated with odors such as sewage and vomit, indicating a correlation between commercial odors and unpleasant odors.

4.2. Analysis of Odor Distribution

We categorized the collected odors into four major classes: natural odors, household odors, commercial odors, and other odors, based on urban olfactory landscape classification, as detailed in Table 3.

Table 3: Heat Classification Table

Odor Type	Odor Name
Natural	Leaves, Trees, Moss, Stones, Lake Water, Floral Fragrance
Commercial	Guandongzhu, Coffee, Barbershop, Cream, Fried Dough Twists, Sewage, Cooking Oil, Food Aroma
Household	Cooking Oil, Food Aroma, Toilet, Musty Smell, Garbage, Detergent
Other	Car Exhaust, Asphalt, Vomit, Wood, Paint Odor

In the classification-based map, we further plotted the heat maps of different types of odors based on their sources (see Figure 7). Through these heat maps, we observe that natural odors primarily

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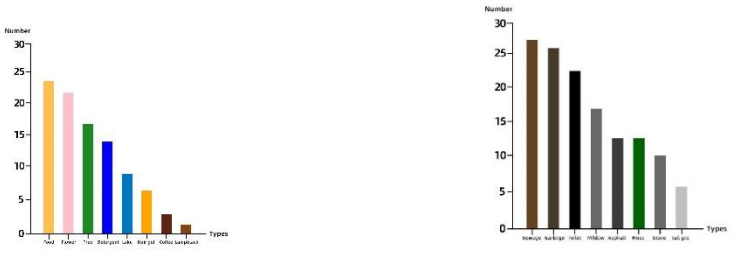
originate from the lake water and the flowers and plants grown by residents in the living areas, concentrated mainly along the lakeside and in the hutong of the residential areas. Commercial area odors are mainly concentrated around subway stations and intersections with high pedestrian traffic, particularly noticeable near Yin Ding Bridge, where numerous shops emit various commercial odors. The residential area odors are concentrated in the hutong around Yinding Bridge Hutong, Nanguanfang Hutong, Qianjing Hutong, Beiguanfang Hutong, Houxiaojing Hutong, Daxiao Jinsi Hutong, and so on, where the predominant odors are cooking oil fumes and food aroma. Other odors, including car exhaust and asphalt, are more scattered throughout the area. Additionally, there are odors from wood and paint emitted from house renovations.

(a) (b) (c) (d)

(a) Natural Odor Heat Map, (b) Commercial Odor Heat Map,(c) Household Odor Heat Map, (d) Other Odor Heat Map

Figure 7: Odor Heat Maps

We visualize the collected odors using heat maps, combining maps with actual geographic locations, enabling observers to better understand the spatial distribution of odors. Using graphical charts, we analyze participants' preferences for different odors (see Figure 8), revealing that the least welcomed odors are vomit, sewage, and cooking fumes. The most favored odors are those of food, flowers, and trees, respectively.



(a)Ranking of Most Welcomed Odors (b)Ranking of Least Welcomed Odors

Figure 8: Odor Preference Statistics

5. Discussion

Through volunteer odor detection and interviews, we found that odors of sewage and household garbage are concentrated in residential areas, indicating a need for further environmental sanitation management. The strong presence of food odors requires proper planning of commercial areas to minimize their impact on surrounding residents. The presence of vomit odors near the White Trash Cans on the Houhai Bar Street suggests a need for increased sanitation management efforts. The widespread distribution of car exhaust suggests the need for traffic management and environmental

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protection measures. Through the analysis of odor maps and odor preference statistics, we can not only comprehensively understand the distribution of odors in the target area but also gain deeper insights into residents' perceptions and attitudes toward these odors. This provides valuable reference for subsequent environmental improvements and urban planning. Furthermore, the positive feedback from residents, businesses, and tourists suggests that city managers should consider maintaining the current environment to ensure its freshness and pleasantness. Regarding the issue near the White Trash Cans, particular attention may be needed to the sanitation conditions in these areas to enhance cleanliness management. Through the comprehensive analysis of odor detection walks and interviews, we can gain a more comprehensive understanding of the odor situation in the Shichahai area. The perceptual differences among different groups provide additional perspectives for urban planning and management, contributing to the creation of a more livable and enjoyable urban environment.

5.1. Limitations

This study explores how to present, record, and visualize urban odor landscapes, aiming to attract scholars enthusiastic about urban multi-sensory experiences. At any given time, it is not possible to detect the entire range of odors in a region as a whole. Odor detection walks can only partially address this issue because they suffer from sample bias and response bias, with people's task execution during walks differing from their behavior "in the field."

Compared to visual and auditory landscapes, the study and design of olfactory landscapes pose greater challenges: firstly, there is a lack of tools for on-site odor detection and concentration measurement; secondly, there is a lack of ways to quantify and replicate odors; thirdly, there is the subjectivity and variability of olfactory perception. Additionally, the way people perceive odors and the results are influenced by various factors such as personal factors, environmental factors, and contextual factors.

Personal Factors: The age, gender, and sensitivity to odors of the subjects in the experiment will affect the results. Studies have shown that under the same conditions, women have a higher olfactory ability than men; age has a certain limit on olfactory influence, with 50% of people experiencing a loss of olfactory function after the age of 65. Additionally, smoking habits can also impair olfactory performance.

Environmental Factors: Factors such as weather, season, and climate at the experimental site will affect the results. In some extreme urban areas, such as those with high humidity or subzero temperatures, there may be odors that are not commonly noticed in daily life. In densely populated areas, there will always be food, garbage, and materials.

Contextual Factors: Urban planning and layout have a significant impact on urban odor detection. Remote odor detection is highly time-sensitive, depending on weather conditions, wind patterns, and seasonal activities. Temperature directly affects the intensity and volatility of odors. Additionally, the same street may host different activities at different times: for example, daytime activities are related to cafes and retail culture, while nighttime activities are related to drinking culture. This results in different odors.

5.2. Future Applications

Every olfactory landscape has its own characteristics. Its perception is discontinuous, fragmented in space, and sporadic in time. Olfactory landscapes use smell as a medium to create dynamic and reproducible landscape images through olfactory perception. With the application of modern technology, olfactory landscapes may soon be created in the metaverse film world. Additionally, by integrating olfactory technology with cutting-edge concepts such as artificial intelligence and remote education, and collaborating with industries such as gaming, healthcare, education, film and

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television, e-commerce, and virtual reality, the olfactory market can be developed. The research on smells can also be applied to odor solutions or standardized electronic olfaction products in traditional industries such as advertising, food, media, publishing, home appliances, and architecture, promoting the popularization and dissemination of olfactory technology and knowledge, bringing richer, better, and healthier experiences to people.

In fields such as environmental protection, medicine, and economics, greater functionality can be achieved through online monitoring and reproduction technologies for odor identification. For example, adding olfactory experiences to e-commerce product advertisements, allowing consumers to smell perfumes online when choosing a fragrance. In medical diagnosis, the improvement of human olfactory function is related to certain diseases, and the diagnosis of the body's health status can be made by monitoring the different odors released by patients. Olfactory monitoring technology plays an important role in the development of smart cities. In the field of environmental protection, it can be part of the development of smart cities, used to monitor air quality in real-time. This helps to discover and solve odor problems in cities more quickly, improving the environmental quality of cities. In the entertainment industry, olfactory technology can be applied to film and gaming experiences, allowing viewers or players to be more deeply immersed in the plot. It goes beyond just auditory and visual immersion, adding olfactory participation. Olfactory technology can also be used to create new consumer experiences, such as adding specific smells in restaurants to enhance appetite or presenting the unique cultural atmosphere of a locality in the tourism industry.

The application areas of future olfactory technology will continue to expand, providing more detailed and comprehensive sensory experiences in various fields. This will also encourage scientists, engineers, and designers to continue exploring the potential applications of olfactory landscapes in different fields.

6. Conclusion

In recent years, there has been significant development in the research on the relationship between human senses and social spaces. Traditionally, smell has been considered one of the weaker human senses and often overlooked. Victoria Henshaw pointed out in her book *Urban Smellscapes* that the relationship between smell and society has changed. In the past, cities and landscapes were largely shaped by modern visual perception. The dominance of vision determined the practices of architects in urban design and planning. However, in the postmodern era, smell has become increasingly important.

The beauty of a city can be perceived not only through the eyes but also through the nose. Olfaction, as something beyond cognition, is a sense directly linked to more concrete worldly experiences. Therefore, olfactory mapping can tell different stories from those told by methods that rely more on sound and vision. Thus, by using olfactory mapping as a method, a more representative appreciation of places and material experiences can be effectively conveyed. Additionally, smell has the ability to guide people through instant spatial-temporal journeys in memory, transforming anonymous spaces into personalized locations.

We have contributed to an increasing body of literature on how people experience cities sensorially, including studies on how we see and hear cities, but there is limited research on how we smell cities. This work examines, in a less conspicuous way, the role of social media in mapping urban smellscapes. In the future, we hope to conduct more comprehensive multisensory evaluations by comparing the aesthetics of sound, vision, and smell in the same city. We aim to empower designers, researchers, and urban managers by providing methodological tools and practical insights to reconsider the role of smell in their work.

Through volunteers' olfactory exploration of commercial streets and residential areas near Shichahai, we can draw the following conclusions:

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The residential areas in the experimental area are primarily characterized by the smells of cooking oil, food, and household garbage. We found that floral scents are concentrated in residential areas, originating from flowers and plants planted by local residents at their doorsteps. In the depths of the hutong, we found that certain areas have a strong mildew smell, possibly due to the high humidity near the lake.

Along the southern edge of Houhai's bar street, there are occasional white trash bins emitting strong odors, accompanied by the pungent smell of vomit that hasn't been promptly cleaned up along the roadside. The area near Yinding Bridge boasts a rich variety of dining establishments, resulting in a plethora of food smells permeating the air during meal times. Additionally, barber shops along the street emit odors of hair gel and hair tonic.

Through interviews with local residents, merchants, and tourists, we found that local businesses mainly operate in the southern edge of Houhai's bar street and near Yinding Bridge. Their perception of the experimental area's smells is mainly related to the smells of the food or goods they sell, and most merchants, having operated here for a long time, have become accustomed to some of the smells detected by our volunteers, such as cooking fumes. Interviews with local residents revealed similar findings to those of merchants. Since tourists are more likely to stroll along the lakeside streets, which are more spacious and open compared to the inner hutong, various smells dissipate more quickly, and the air is fresher. All the tourists we interviewed unanimously agreed that the air in Shichahai is fresh and refreshing. In summary, the odor characteristics of the residential areas in the experimental area are obvious, primarily consisting of floral scents, cooking fumes, and food odors. The commercial streets are filled with a richer variety of smells. Local residents, merchants, and tourists positively evaluate the air quality in this area, considering it fresh and livable.

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