

Research on the Cognition Degree and Satisfaction Degree of Sponge City Construction based on Subjective Perception

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Abstract: *The concept of sponge city has more and more influence in the land and space planning. However, in the current study, there are few researches on the cognition and satisfaction of the construction of sponge City, and there is a lack of public feedback on the landing facilities of sponge city. Therefore, based on the current domestic research on sponge City, this paper selects Beijing citizens as the research sample, summarizes the subjective perception of the masses of sponge city construction from the perspective of basic information, cognition and satisfaction of the interviewees, and puts forward reasonable opinions on the future development of sponge city.*

Keywords: Sponge City, The Research of Cognitive Level, Satisfaction Research.

1. Introduction

Because the construction of sponge city has a good performance in adapting to environmental changes and responding to natural disasters brought about by rain, the concept has an increasing influence in land space planning [1], people's attention to "ensuring water safety, preventing water pollution, protecting water ecology, and building sponge city" has been increasing, and urban development has achieved remarkable results in strengthening rainwater and flood management. In recent years, Beijing has performed well in dealing with extreme meteorological disasters, not only comprehensively taking measures such as infiltration, detention, storage, purification, utilization and drainage, increasing the proportion of local rainfall consumption and utilization, reducing the risk of urban waterlogging, but also improving the urban comprehensive ecological environment by supporting the development and implementation of sponge city related projects, micro space transformation and other ways [2]. Beijing has a good momentum of "sponge". According to the authoritative news media, Beijing plans to reach the standard rate of sponge cities in the city's built-up areas of 36% by the end of 2024.

The achievements of sponge city construction provide a large number of cases and research experience for the analysis of its development prospects. At present, the research on sponge City focuses on theoretical research [3], urban water environment governance [4-6], the relationship between urban planning and construction of sponge city [7-8], and low impact development. Wei Yunshuang mentioned in a study in 2022 that the public acceptance willingness is particularly

important in all aspects of the sponge city construction project, which is directly related to the implementation and use of the project [9]. The general office of the Ministry of housing and urban rural development also said that scientific evaluation should be carried out to highlight the satisfaction of the people as the performance evaluation index of sponge city construction, so as to avoid taking the number of projects and the investment scale as the work effect [10].

However, in the current research, there are few researches on the cognition and satisfaction of sponge city construction, and there is a lack of public feedback on the landing facilities of sponge city. Therefore, based on the current domestic research on sponge City, this paper selects Beijing citizens as the research sample, summarizes the subjective perception of the masses of sponge city construction from the perspective of basic information, cognition and satisfaction of the interviewees, and puts forward reasonable opinions on the future development of sponge city.

2. Construction of Satisfaction Analysis Model of Sponge City Construction

2.1 Select Index Variables

In order to make the cognition degree and satisfaction degree of sponge city construction studied in this paper more universal and accurate, the survey indicators are formulated according to the relevant documents such as the technical guide for sponge city construction. The indicators and attributes are shown in Table 1.

Table 1: cognition degree and satisfaction index of sponge city construction

Attribute classification	Attribute	Attribute description
	Gender	1 = Male; 2 = Female
	Age	1=Under 15 years old; 2=15 to 20 years old; 3=21 to 25 years old; 4=26 to 30 years old; 5=31 to 40 years old; 6=41 to 50 years old; 7=51 to 60 years old; 8=Over 60 years old
Basic information	Residential area	1 = Urban area of Beijing; 2 = Suburb of Beijing; 3 = Outer suburb of Beijing
	Occupation	1 = Employees of state organs, Party organizations, enterprises and institutions; 2 = Professional and technical employees; 3 = Social production service and life service personnel; 4 = Employees in the first, second industry (including farmers and workers); 5 = Military personnel; 6 = Retirees; 7 = Student; 8 = Other

	Education experience	1=Primary school and below; 2=Junior high school education; 3=High school, specialized secondary school or technical school education; 4=College degree (including adult higher education); 5=Bachelor degree (including adult higher education); 6= Postgraduate or above
	Understanding of the concept of sponge City	1 = Never heard of; 2 = not familiar with; 3 = general understanding; 4 = better understanding; 5= very understanding
	The construction of sponge city in China	1 = Never heard of; 2 = Not familiar with; 3 = General understanding; 4 =Better understanding; 5= Very understanding
Cognitive level	Understanding of the following sponge facilities: ① Wetland;② Permeable pavement;③ Green roof facilities;④ Infiltration facilities such as sunken green space and rainwater garden;⑤ Landscape water body;⑥ Transmission facilities such as grass planting ditch; ⑦ Storage facilities such as water reservoir and rainwater tank; ⑧ Vegetation buffer zone and other sewage interception and purification facilities; ⑨ Biological detention facilities	1 = Completely unknown; 2 = Know the facility; 3 = It is very clear that the facility is a sponge facility
	Satisfaction with the following sponge facilities: ① Wetland;② Permeable pavement;③ Green roof facilities;④ Infiltration facilities such as sunken green space and rainwater garden;⑤ Landscape water body;⑥ Transmission facilities such as grass planting ditch; ⑦ Storage facilities such as water reservoir and rainwater tank; ⑧ Vegetation buffer zone and other sewage interception and purification facilities; ⑨ Biological detention facilities	1 = Unsatisfied; 2 = Not satisfied; 3 = General; 4 = Satisfied; 5 = Very satisfied
Public attitude	The overall attitude to the construction of sponge City	1 = Against; 2 = Relatively opposed; 3 = General; 4= Relatively supportive; 5= Very supportive
	If your community plans to implement sponge city transformation, will you support it?	1 = Not supported; 2 = Not supported; 3 = General; 4= Relatively supportive; 5= Very supportive
	The necessity of building sponge City	1 = Not necessary at all; 2 = Not necessary; 3 = Uncertain; 4 = Necessary; 5 = Very necessary

2.2 Build an Analysis Model

From the perspective of subjective perception of sponge city construction, according to the current situation of sponge city research and the basic methods of citizens’ satisfaction survey, this paper constructs a sponge city construction awareness and satisfaction evaluation index system, and designs a questionnaire based on the system. Through the way of questionnaire collection to obtain the required data, and statistical analysis of data sample characteristics. In the process of data analysis, SPSS 27 statistical analysis software was used to analyze and judge the reliability of the collected data.

3. Data Collection and Analysis

3.1 Sample Characteristics

From August 2024 to February 2025, more than 300 questionnaires were distributed to residents living in three types of districts in Beijing, namely, urban area, suburban area and exurban area, with a total of 295 recovered, of which 8 were invalid and 287 were valid. This paper conducts 4 statistical analysis on the sample characteristics of the questionnaire according to gender, age, residential area and other personal basic information. The sample characteristics of basic information are shown in Figure 1.

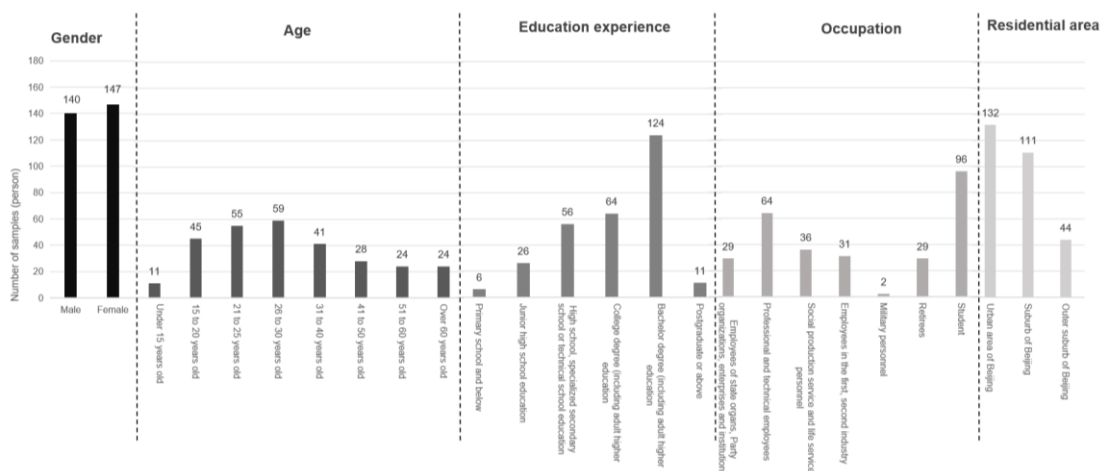


Figure 1: Characteristics of basic information samples

3.2 Sample Data Analysis

Among the 287 valid questionnaires, there were 140 males,

accounting for 48.78% of the total number of samples, and 147 females, accounting for 51.22% of the total. The proportion of men and women is relatively close, and the

gender distribution is relatively balanced. From the perspective of age, the proportion of under 15 years old is 3.83% of the total, the proportion of 15 to 20 years old is 15.68%, the proportion of 21 to 25 years old is 19.16%, the proportion of 26 to 30 years old is 20.56%, the proportion of 31 to 40 years old is 14.29%, the proportion of 41 to 50 years old is 9.76%, and there are 24 people from 51 to 60 years old and over 60 years old respectively, accounting for 8.36%, which indicates that the age of the interviewee group is mainly young adults from 15 to 40 years old. From the perspective of education distribution, the proportion of people with higher education is about 47.04%. From the perspective of occupational distribution, students are the main group to be interviewed. The residential areas of the interviewees are mainly located in urban and suburban areas.

In general, the interviewees are representative, and the samples collected can provide data basis for the study of “sponge city construction awareness and satisfaction”.

3.3 Sample Quality Inspection

In this paper, the software SPSS 27 uses clone Bach coefficient to test the reliability of the questionnaire. The coefficient measures the internal consistency of the test according to a certain formula, which is the most commonly used reliability index in social research. The formula of clonal Bach coefficient is as follows:

$$\alpha = \frac{K}{K-1} \left(1 - \frac{\sum S_i^2}{S_x^2} \right)$$

In the formula, α is the reliability coefficient, and K is the number of test items, which represents the score variation of all subjects in question I, and is the variance of the total score of all subjects.

Table 2: sponge City Cognition and satisfaction questionnaire reliability test

Cronbach's alpha	Reliability of the questionnaire	Excellent	Good	Acceptance	To be revised
0.945	0.945	≥ 0.90	$0.90 < \alpha \leq 0.80$	$0.80 < \alpha \leq 0.70$	$0.70 < \alpha$

4. Analysis of People's Cognition of Sponge City

In order to more accurately understand the public's cognition of sponge City, in the survey process, first of all, statistics were carried out on the public's understanding of the concept of sponge city. Among the 287 interviewees, 45 said that they had never heard of the concept of “sponge city” before filling in the questionnaire and the interview, accounting for 15.68% of the total number of interviewees. The number of people who heard of the term sponge city but did not know its meaning (not very well) accounted for 17.07% of the total number. The number of people who know its meaning but did not further understand it (general understanding) accounted for 21.25%. The number of people who roughly understand the sponge city theory and have a certain understanding (relatively understanding) of sponge city accounted for 32.40% of the total number. 13.59% have systematically understood the contents of sponge city or engaged in related industries (very understanding). The specific results are shown in Table 3.

Table 3: survey results of basic cognition of sponge city (number of people)

Cognitive level	Never heard of it	I don't know much about it	General understanding	Better understanding	I know it very well
The theory of sponge City	45	49	61	93	39
The construction of sponge city in China	49	49	78	75	36

It can be seen from the table that most of the citizens understand the concept of sponge city and have a certain degree of understanding of the domestic construction situation, but there are still quite a few groups lack of awareness of this concept.

In the process of the study, the basic information of the interviewees and the cognitive level of sponge city were cross analyzed, and the factors affecting the cognitive level were extracted. The interviewees' occupation is that the practitioners of the institutions have the highest understanding of the concept of sponge city and the construction of domestic sponge City, followed by the student group, and the retired group has a polarized understanding of sponge city. From the perspective of education level, the group with junior college education and above has a higher cognition of sponge City, and the junior high school education and below has a lower cognition of sponge city. From the perspective of gender, the cognitive level of men and women is close. In summary, the degree of recognition of sponge city is highly related to occupation and education, and gender is not one of the influencing factors of sponge City cognition.

In order to further get the public's understanding of the main functions and facilities of sponge City, this paper excludes 45 respondents who have never heard of sponge city. The specific results are shown in Table 4 and table 5.

Table 4: Citizens' cognition of the main functions of sponge City

Alleviate urban waterlogging	Improve the utilization rate of urban water resources	Improve the urban ecological environment	Beautify the urban landscape	Don't know the main functions
157	177	172	114	44

From table 4, it can be seen that among the 242 respondents, 64.88% believed that sponge city has the function of alleviating urban waterlogging, 73.14% believed that it has the function of improving the utilization rate of urban water resources, 71.07% said that they knew that sponge city has the function of improving the urban ecological environment, 47.10% knew that it has the function of beautifying the urban landscape, and 18.18% said that they did not know the function of sponge city. From the results, it can be concluded that people's cognition of the main functions of sponge city is not comprehensive, and the work of popular science sponge city should continue.

Later, the research conducted an investigation on the understanding of common sponge facilities. If you don't

know that the corresponding facilities are sponge cities, it is calculated as 1 point. If you have a certain understanding, it is calculated as 2 points. It is very clear that the corresponding

facilities are sponge facilities, it is calculated as 3 points. The cognitive score of sponge city related facilities is shown in Table 5.

Table 5: understanding of sponge city related facilities (number of people)

Sponge city related facilities	I don't know about this	Have a certain understanding	It is very clear that the facility is a sponge facility	Comprehensive score
Wetland	36	130	76	2.16
Permeable pavement	28	122	92	2.26
Green roof facilities	34	132	76	2.17
Infiltration facilities such as sunken green space and rainwater garden	30	120	92	2.26
Landscape water	38	122	82	2.18
Transmission facilities such as grass planting ditch	42	122	78	2.15
Storage facilities such as water reservoir and rainwater tank	44	104	94	2.21
Vegetation buffer zone and other sewage interception and purification facilities	38	140	64	2.11
Biological detention facilities	46	124	72	2.12

Table 6: Citizens' satisfaction evaluation of sponge city related facilities

Sponge city related facilities	dissatisfied	Not satisfied	General	Quite satisfied	Very satisfied	Comprehensive score
Wetland	16	8	66	110	42	3.64
Permeable pavement	10	22	78	80	52	3.59
Green roof facilities	10	12	100	86	34	3.50
Infiltration facilities such as sunken green space and rainwater garden	8	14	68	108	44	3.69
Landscape water	8	12	68	92	62	3.78
Transmission facilities such as grass planting ditch	12	12	82	96	40	3.58
Storage facilities such as water reservoir and rainwater tank	10	20	88	80	44	3.53
Vegetation buffer zone and other sewage interception and purification facilities	6	14	86	88	48	3.65
Biological detention facilities	22	16	70	92	42	3.48
Comprehensive satisfaction						3.60

Generally speaking, the citizens have a better understanding of sponge city related facilities, among which the scores of permeable pavement, infiltration facilities and storage facilities are the highest, while the scores of other facilities are relatively low. In the process of building a sponge City, it is also necessary to continue to carry out scientific publicity in various aspects, strengthen the level of public awareness, so as to achieve the purpose of better promoting the construction of sponge city.

5. Analysis of Citizens' Satisfaction with Sponge City Related Facilities

5.1 Sample Data Analysis

The basic service object of sponge city is urban residents, and the satisfaction of citizens is one of the important indicators to measure the effectiveness of sponge city construction. Therefore, in the research process, the satisfaction of residents is included in the comprehensive benefit index of sponge city construction to reflect the core value of "people-oriented" [11]. By understanding the feedback of citizens, we can intuitively understand the effect of sponge city in practical application, including the performance of rainwater collection, storage, purification, utilization and urban waterlogging alleviation. The comprehensive analysis of the satisfaction of the public and the improvement measures played a role in the detection of omissions.

In the process of this study, the citizens' satisfaction with the existing sponge city related facilities was divided into 5

grades from "not satisfied" to "very satisfied", with 1~5 scores respectively. The specific results are shown in Table 6.

Now, the comprehensive satisfaction of citizens with sponge city related facilities is 3.60, and the overall satisfaction is not ideal.

6. Measures to Improve the Citizens' Satisfaction with Sponge City

6.1 Strengthen the Research on Sponge City, Adjust and Clearly Define the Path of Theoretical Guidance

Sponge city is a product of interdisciplinary, which needs multi-disciplinary exploration. At present, the theory of sponge city is still in the initial stage of exploration, and a large number of completed projects are needed as the basis to constantly adjust and define the future development path. While continuing to strengthen interdisciplinary cooperation and form a joint force to jointly promote the development of sponge city research, sponge city also needs to keep up with the pace of the times, constantly update technology, explore the feasibility of large-scale promotion of new technology, promote the innovation and development of disciplines, and provide strong persuasion and effectiveness for theoretical research. In this process, we should adhere to the ecological principle, pay attention to the comfort, quality and happiness of the living environment of residents, and promote the sustainable development of sponge city concept.

6.2 Enrich Popular Science Channels and Improve the Popularity of Sponge City

Among the 242 people who knew the concept of sponge City, 45.45% of them learned about the concept of sponge city in news reports, 55.37% of them knew the concept through online social media, 33.47% of them learned the information from government propaganda, 27.69% of the citizens had an impression on sponge city through participating in community activities, 32.23% of them came into contact with sponge city in conversation with their relatives and friends, and 5.79% of the citizens learned about relevant knowledge through school courses.

As shown in Figure 3, from this data, we can see that social

media publicity is the most effective way to improve the popularity of sponge city. In the future, we can increase the publicity on social media to achieve the purpose of more efficient science popularization of sponge city. News report is a channel to improve the visibility and reliability of sponge city. Because of its special nature of representing authority, it is more persuasive than social media. As the basic unit of grassroots governance, the community is an important position for science popularization. It should do a good job in life science popularization and put forward suggestions for the development of convenience facilities in sponge city from the perspective of residents' daily needs.

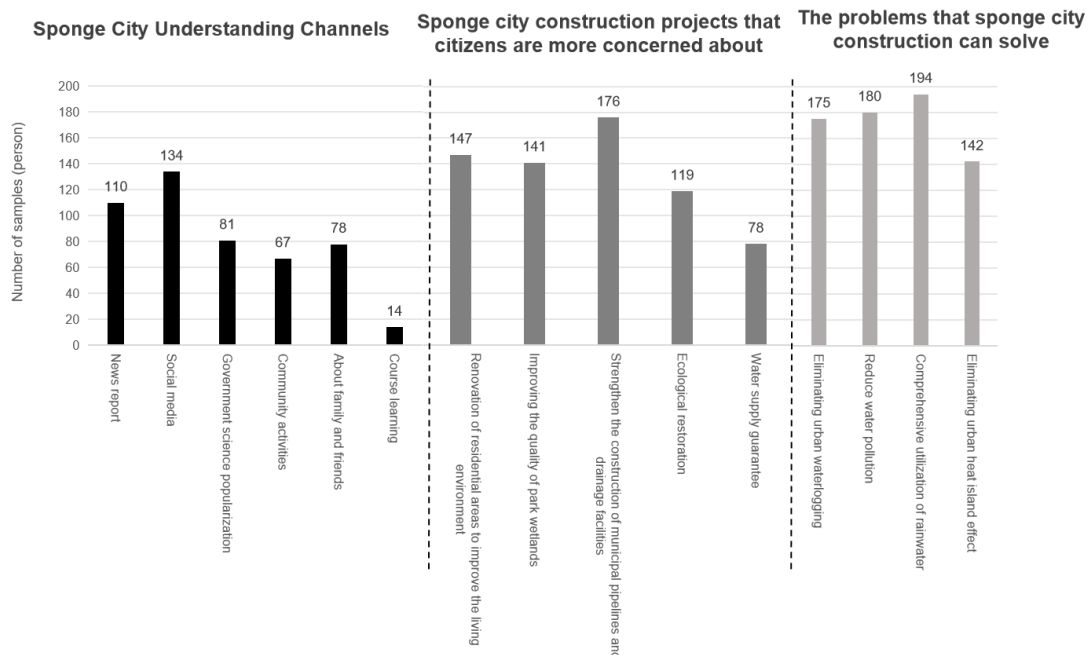


Figure 3: survey of citizens in sponge city (number of people)

6.3 Widely Listen to and Fully Respect the Opinions and Opinions of the Public

According to the statistics in Figure 3, strengthening the municipal management and the construction of drainage facilities are the most concerned projects of the public; The projects to improve the people's happy living standards, such as the renovation of building districts, the improvement of the living environment, and the improvement of the quality of Park wetlands, are also the contents of the public's concern. People generally hope that the construction of sponge city can solve urban waterlogging, reduce water pollution, eliminate the urban heat island effect and improve the comprehensive utilization rate of rainwater.

From the acceptance results of the national sponge city construction pilot, the sponge city construction has achieved good improvement results in eliminating black and smelly water bodies, repairing urban water ecology, protecting water environment and other aspects, with positive ecological and social benefits [12]. In the final analysis, this is because the fundamental purpose of the construction of the sponge city is to provide a habitat with high quality and good sustainability for human life. Therefore, in the construction of sponge City, the opinions and opinions of citizens should be widely heard and fully respected in the planning stage, and gradually implemented after scientific analysis and comprehensive evaluation, so as to achieve the purpose of sponge city

construction.

6.4 Plan the City Reasonably and Put the Concept of Sponge City in Place

At present, the practice of sponge city concept in China is still in an emerging stage, and the successful implementation of a series of demonstration projects is urgently needed as the practice cornerstone. Through practice feedback, the theoretical framework is constantly revised, and the direction is clear.

From the perspective of urban planning, it is even more necessary to integrate the wisdom of ecology, water conservancy engineering and urban planning in the blueprint of the overall layout of the city, and jointly outline a urban framework that not only adapts to the natural environment but also promotes ecological balance. The principle of sponge city should be fully considered in the scientific division of urban functional areas, so as to ensure that different regions can play their own functions and at the same time jointly improve the overall toughness of the city. The concept of sponge city should find a foothold in urban space. It needs to follow the pace of technological progress, actively explore and apply new technologies in urban rainwater collection, purification and reuse systems to drive urban sustainable development through innovation.

7. Conclusion

This paper focuses on the perception and satisfaction of sponge city construction from the perspective of city democracy, builds a model to analyze, and evaluates the satisfaction of citizens with the effectiveness of sponge city construction and the reasons behind it. Through the combination of quantitative analysis and qualitative feedback, we found that although the public knows the basic concept of sponge City, there is still room for improvement in common facilities and specific functions. In the future, with the progress of technology, the improvement of policies and the improvement of public awareness, the construction of sponge city will usher in a broader development prospect and contribute to the sustainable development of the city.

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