Study of Xiamen Citizens' Cognition of Roof Greening Based on Internet Questionnaire

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Abstract. A network survey was conducted in this study with public insights such as comprehension, late management, cost assumption, expectation, design, of greening. The results reflect that, on the whole, there still exists insufficient and incomplete knowledge of citizens for top greening, due to their limited access to top greening. To be specific, some citizens are concerned about the water loss and burden of top greening, while some are inclined to show a high level of acceptance and expectation for top greening, and also a high degree of recognition for the improvement of the ecological environment, the urban landscape as well as physical and mental health. Additionally, a majority of citizens are willing to bear a certain degree of cost for top greening of their homes. It is believed that the design of top greening should first and foremost meet the functions of rest and appreciation, while taking into account the coordination and integration with the surrounding environment, so as to provide comfortable and pleasant space for fast-moving urban life. The above results provide valuable reference and direction for future development and design optimization of top greening in Xiamen.

Keywords: Green roof · Xiamen · Cognition · Questionnaire survey

1 Introduction

Xiamen, as a spacious sea park city in China, has been actively committed to optimizing the urban view and promoting the 3D greening development. In 2020, the green space rate in the built-up region of this island is 38%, with a green coverage rate of 43%, with a per capita public green space of 13 m^2. However, as a result of a new round of urban construction in Xiamen, the land for landscaping in cities is becoming increasingly scarce, leading to a decline in the greening index in central areas of cities instead of rising. Actually, the construction of an ecological space network is an effective and feasible measure under the constraints of scarce ecological space and scarce land resources. Based on this, it is necessary for Xiamen to vigorously promote top greening since it can economically and rapidly increase the multi-dimensional ecological space to its utmost extent, in addition to avoiding high cost of removal, which is a beneficial complement to the green space system.

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Through a questionnaire survey conducted by Yan and Qiao [1] on the awareness of roof greening among Jiaozuo citizens, it can be found that it is 51% of citizens who are concerned about roof collapse, and 59% focus on the water loss and infestations caused by cultivation. Another 46.4% of citizens were uneasy about roof greening, but 90.9% expressed a desire for a green ceiling in their living and working spaces, 80.9% for their own roofs, and 82.1% for their homes as well. The above data indicate that despite questionable and unstable attitudes of members of the public towards top greening, there still has a strong expectation that top greening will be incorporated into homes and work spaces. In addition, there are cognitive investigations on house top greening in Shanghai [2], Nanjing [3], Hangzhou [4], Changsha [5], Xian [6] and Hefei [7] as examples, of which studies from the perspective of citizens are common.

With rapid economic development and changeable ecological environment in China, urban ceiling greening will usher in unprecedented opportunities. However, there is still a gap in the perception and related research on ceiling greening among urban people. In this study, a questionnaire survey was performed among citizens of Xiamen against the background that Xiamen attaches great importance to the development of urban solid greening, so as to provide useful suggestions for the improvement of urban environment and the integration of ceiling greening into citizens' daily environment in the future.

2 Method

A survey of local residents in Xiamen was carried out on the online platform of "WENJUANXING" (www.wjx.cn), starting from April to June, 2019 as the survey period. The questionnaire includes respondents' attributes (8 items), cognition of roof greening (15 items), satisfaction evaluation (1 item), management and expense commitment (2 items) and suggestions (3 items), with a total of 28 questions.

3 Results and Analysis

3.1 Interviewee Attributes

A total of 150 participants were included in this questionnaire, containing 87 men (58%) and 63 women (42%), with close ratio of men to women, and 150 valid questionnaires were collected, with a recovery rate of 100%. Respondents are of all ages, mostly young people, who generally enjoy high education level, accounting for 87.34% with a bachelor's degree or above. Meanwhile, all interviewees' occupations are widely distributed, involving employees from all walks of life. Among them, 84% of respondents have lived in Xiamen for more than 3 years and 53.33% in Xiamen for more than 10 years.

3.2 Environment Cognition

Urban greening is especially important in the dense construction of modern cities. 53.33% of the citizens polled believed greening was extremely important to urban environment construction, with 36.67% opting for "importance". In other words, 90% of

citizens approved of the importance of urban greening. Compared with the questionnaire survey results of Yan and Qiao [1] on roof greening in Jiaozuo, Henan Province in 2011, and Yin [2] on Shanghai, the proportion of people in favor of greening in this questionnaire has increased. It may be due to an increase in overall public perception of ceiling greening or possible differences in cognitive levels among urban areas.

3.3 Level of Understanding

Regarding the question of whether they have seen or touched roof greening in their work or living places, more than half of the participants chose "Yes", accounting for 50.67% (Table 1), which indicated that the construction of roof greening in Xiamen has accumulated a certain foundation of mass cognition, but 49.33% of the citizens still answered "No", revealing that they had no more chances to understand roof greening. As shown by the data on the degree of public knowledge about top greening of Xiamen City in Table 1, public awareness of top greening varies, with the largest number of people saying "Know it", accounting for 28.67%, followed by people who "don't know", with a proportion of 28%. Even the number of people who "don't know at all" accounts for 14%. It can be found that there is a low level of knowledge among members of the public about top greening, which demonstrates the great necessity of further strengthening the publicity and promotion of top greening to raise public awareness of top greening.

Among citizens who were aware of the effectiveness and role of house-top greening, 77.33% of citizens expressed recognition for its role in improving the physical environment, and 72% provided support for the aesthetic effect of the urban view intensified by house-top greening. In addition, up to 71.33% of interviewees also were in positive agreement with the advantage of housetop greening in improving both physical and mental experience of citizens, based on such a consensus that it is conducive to releasing the pressure on life and work, creating the relaxed atmosphere, and inspiring people to enjoy and pursue for more rich and enjoyable life. In addition, just a handful (4.67% of them) believed that ceiling greening is ineffective.

3.4 Worries and Concerns

As shown in Table 2, although the public is aware of the benefits of roof greening, there are still some people expressing their urgent worries about it. It has been shown previously that an awareness of ceiling greening among citizens needs to be enhanced, from which it can also be effectively reflected. The top two items of concern for people are "water leakage" (74.67%) and "overload collapse" (62.67%). At present, with mature roof greening construction technologies developed in China, water leakage caused by greening plants and roof collapse by overload can be avoided under the premise of strict construction according to relevant technical standards. In 2011, the investigation on Jiaozuo City performed by Yan and Qiao [1] revealed similar problems, showing a high worry rate. In essence, both issues reflect a lack of in-depth knowledge of top greening of most citizens, which requires continuous efforts for strengthening people's systematic understanding and scientific awareness of top greening.

In addition, 61.33% of citizens believe that roof greening faces a certain risk of cyclone, given that Xiamen is located on the Southeast Coast, which is a high-risk region

Table 1. Public Understanding and Cognition to Roof Green (n = 150)

Q12. Have you seen or come into contact with roof greening in your work and life?		
Yes	76	50.67%
No.	74	49.33%
Q14. How well do you know about roof greening?		
Knowing very well	13	8.67%
Understand	43	28.67%
It's hard to tell	31	20.67%
Not understand	42	28%
Have no idea	21	14%
Q16. What do you think are the effects and functions of roof greening?		
Utilization for self and soul	107	71.33%
Improvement of the physical environment	116	77.33%
An increase in the aesthetic sensitivity of the urban view	108	72%
Building protection	56	37.33%
Increase the green space	72	48%
Improvement of the ecological environment	61	40.67%
Enhance the image of the city	73	48.67%
Noise reduction	43	28.67%
No effect	7	4.67%

influenced by cyclones. It was a major impact on top greening of the houses that were damaged by 90% of the damaged areas of greening in Xiamen City in 2016, especially those self-built houses with lower wind resistance suffering more losses. Consequently, it is necessary to put forward more requirements on the wind resistance of masonry greening in Xiamen City, especially in the case of no feedback on cyclone-related issues in other similar studies in China.

3.5 Degree of Demands

45.33% of citizens mentioned that roof is required for urban greening of Xiamen, and 18% thought it was needed, while it was only 11.33% who argued that roof construction is not necessary in the city. In particular, as for roof greening of the buildings they work in, the proportions of citizens "willing" and "very willing" account for 74.6% and 28.67%, respectively, with just 12% denying it. The first two attitudes directly reflect citizens' desire for roof greening, which is consistent with the results of the questionnaire on roof greening in Jiaozuo City [1]. Meanwhile, high acceptance and expectation of the public for roof greening can also be reflected, which lays a certain foundation for future construction and active promotion of roof greening.

Table 2. Worries and Concerns about Roof Greening (n = 150)

Q17. What worries and concerns do you think about roof greening?		
Fertilization and maintenance of plants in the late stage	77	51.33%
Construction cost issues	58	38.67%
Overload collapse problem	94	62.67%
Mosquitoes cause problems	92	61.33%
Leakage Problem	112	74.67%
The hidden risk of cyclone	92	61.33%
Stuck draining problem	73	48.67%
Other	2	1.33%

3.6 Importance of City View

The urban view is not only the external embodiment of the living space of urban citizens, but also the direct image of the city to the outside. As a part of the urban landscape, whether top greening is significant for the improvement of the urban view of Xiamen has also become an important basis for the development of top greening in Xiamen. As presented in Table 3, 52% of citizens consider that top greening is crucial for the urban landscaping of Xiamen, and 23.33% insist it is of great importance, with a total of 75.33% of people holding a positive view, indicating that most citizens are positive in believing that top greening will bring an active role in effectively enhancing the urban landscaping of Xiamen. The urban well-being index is also an indicator of urban life. Besides, 44% of citizens consider that ceiling greening is essential for the improvement of the urban well-being index in Xiamen, and 24% of citizens claim it "very important". No matter the purpose is to diversify the city landscape or enhance the urban well-being index (HFSI), top greening plays a positive role in the perception of most citizens, reflecting a higher basis for public recognition for the implementation of top greening by the Xiamen municipal government.

3.7 Management and Cost Basis

Members of the public differ in their views on the management and cost bearing of the construction of top greening. The number of people who argue that the late management of roof greening should be handed over to the property for unified management is the highest, accounting for 49.33%, followed by people willing to co-manage with the property, with the proportion of 21.33%, showing that members of the public are more likely to be involved in the management of ceiling greening. As for the cost of roof greening construction, 44% of the citizens indicated their willingness to bear a small part of the cost, while 42% of the citizens explicitly refused to bear the cost (Table 4). Generally speaking, most citizens expect the property to undertake roof greening management, with a tendency to bear less or no construction cost of roof greening, which is consistent with the questionnaire results of the previous study [1]. The above

Table 3. Importance of Ceiling Planting to Enhancement of City Environment and Well-being Index (n = 150)

Q24. Do you think the roof greening is important for improving Xiamen's urban environment?		
Very important	35	23.33%
Important	78	52%
It's hard to tell	27	18%
Not important	8	5.33%
Very unimportant	2	1.33%
Q25. Do you think that roof greening is important for improving Xiamen's urban happiness index?		
Very important	36	24%
Important	66	44%
It's hard to tell	39	26%
Not important	7	4.67%
Very unimportant	2	1.33%

Table 4. Cost Bearing of Roof Greening (n = 150)

Q20. Would you like to bear the construction cost if the roof greening of the building you live in?		
Wish to bear the full cost	6	4%
Willing to bear part (large) of the cost	14	9.33%
Willing to bear part (same) of the costs	66	44%
Unwilling to bear the expenses	63	42%
Other	1	0.67%

results can provide constructive ideas for the promotion and construction of roof greening in other cities.

4 Design Understanding and Proposals

Therefore, this survey has also been conducted in consideration of issues that may be experienced in the selection of function types and building types for further promotion of top greening. The most important thing is whether the design of roof greening should pay attention to the coordination with the surrounding urban environment. As presented in Table 5, as many as 86% of the citizens agree that the design of roof greening should consider the coordination with the surrounding environment, while only 4.67% of the citizens hold a negative attitude, which indicates that the coordinated design of roof greening landscape and the surrounding urban environment is the expectation of citizens.

In a survey on functional demands of the future construction of ceiling greening in Xiamen, the first and foremost consideration of citizens is the functions of the rest space of ceiling greening (74%). Over half of them approve, accounting for 74% and 58%, respectively. It shows that the construction of ceiling greening in Xiamen should take the "people-oriented" design concept as the core, and maximize resource allocation, so as to meet the needs of citizens for rest and enjoyment as much as possible. In a survey on the building types the public expects to adopt for future roof greening in Xiamen, the top three with high support rates were public buildings such as cultural and educational (71.33%), medical (66%) and administrative offices (47.33%), followed by 56% for the roofs of commercial buildings. Also, the support rate for residential buildings reached 47.33%. This reveals that citizens are more inclined to green more open roofs, such as public and commercial structures, to obtain high degree of satisfaction of enjoyable resting space and broad view. To a certain extent, the above results vividly convey the expectation of Xiamen citizens on the direction of top greening construction, which will serve as a reference for the specific promotion direction of top greening in Xiamen in the future.

Table 5. Public Demand for Design and Function of Roof Green (n = 150)

Q26. Do you agree that the design of roof greening should consider the coordination with the surrounding visual environment?		
Very well agreed	52	34.67%
Approved	77	51.33%
It's hard to tell	14	9.33%
Disapproved	6	4%
Very disapproving	1	0.67%
Q22. What kind of function do you want to use when building roof greening in the future?		
Appreciation	87	58%
Rest	111	74%
R&D	18	12%
Comprehensiveness	54	36%
Encouragement	68	45.33%
Planting property	51	34%
Other	0	0%
Q23. Which building facilities in Xiamen do you want to have roof greening in the future?		
Living building	71	47.33%
Commercial Building	84	56%
Administrative office building	91	60.67%

(*continued*)

Table 5. (*continued*)

Medical building	99	66%
Cultural architecture	107	71.33%
Other		2%

5 Conclusion and Discussion

Through the online questionnaire survey on the cognition, satisfaction, management and expense of roof greening, this study summarizes and analyzes these data, and draws the following conclusions: 1. With limited opportunities to gain insight into roof greening, nearly half of Xiamen citizens still claim that they have never touched or seen roof greening in their working and living places, which reflects the predicament of small coverage space and low recognition rate of roof greening in Xiamen; 2. People's cognition of roof greening is biased, lacking scientific and systematic knowledge about roof greening, such as some people's worries about water leakage and load problems of roof greening; 3. Xiamen citizens not only show a high degree of acceptance and expectation of roof greening, but also a high degree of recognition of roof greening in improving the ecological environment, enhancing the urban landscape as well as boosting physical and mental health. Furthermore, most citizens are willing to pay a certain amount of expenses for residential roof greening; 4. The public insists that the design of roof greening should put a priority on satisfying the functions of rest and viewing, while considering the coordination and integration with the surrounding environment, in order to provide a pleasant dwelling space for fast-paced urban life.

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