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Establishment and Application of Spatial Distribution Model of Roof Greening Based on GIS Technology

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Abstract

The stage from the beginning of the 21st century to now is the stage of the scale development of roof greening(RG) in China. With the continuous progress of urban construction, on the one hand, the ecological environment is deteriorating, on the other hand, the available green space in the urban center area becomes more and more scarce. The development of this contradiction promotes the rapid development of RG. RG plays an important role in enriching urban landscape, increasing urban green quantity, reducing urban heat island effect, conserving rainwater and reducing temperature, and creating a new green space for the city, including leisure, entertainment and ecology, and improving urban ecological landscape. This paper mainly studies the establishment and application of spatial distribution(SD) model of RG Based on GIS technology. Through understanding the SD design of RG, the paper investigates and analyzes the status quo of green space of roof, macro layout and the integration of multiple functional spaces. This paper studies and establishes a multiobjective optimization model of SD of RG, and analyzes the purification effect of RG on rainwater pollutants and the overall performance of ecosystem service equity. The results show that 26.31% of the people think that the degree of RG is insufficient, and 5.14% think that RG is scarce. In the cognition of the status of RG space, 12.41% of people don't care about RG, 8.69% think it is face engineering, and even 9.31% think it is a waste of resources, which indicates that the promotion of RG needs to be improved.

Keywords: Roof Greening, Spatial Distribution, GIS Technology, Application Research

1. Introduction

Although greening can alleviate the deterioration of the ecological environment, in the city's centralized commercial areas, buildings are often dense, people flow is large, and the area of land available for greening is becoming smaller and smaller. People have no comfortable and green space to relax their mind and mind after shopping and leisure. However, it is difficult to open up people's green public rest places on the flat ground of the central commercial area. On the one hand, most of the planned commercial areas are located in the central part of the city, so-called "land is only gold", and the development of green rest places alone not only takes up a lot of space, but also the income problem is not well solved [5-6]; for the built urban commercial district, it is impossible to demolish the existing buildings for the construction of green rest space. So, the effective way to solve this problem is to create green public leisure space in the centralized commercial area by RG. The RG in the centralized commercial area can not only increase the urban green quantity, but also open up people's leisure space. It can be said that it can be said that two things can be achieved in one stroke [9-10].

In the study of the establishment and application of the RG SD model, many scholars at home and abroad have studied it and achieved some results. Yu n proposed that RG can increase green area, improve local ecological environment, reduce heat island effect, regulate air humidity, improve air quality, reduce urban pollution, store rainwater, reduce flood discharge pressure of municipal pipelines, save land, make green roof spaces become stepping stones in urban ecosystem, and improve ecosystem [11]. IRGA P pointed out that the powerful data acquisition, storage, display, editing, analysis, processing, output and application functions of GIS have become the most effective technology and method to solve the problem of spatial layout, and the accessibility spatial analysis technology of GIS, as the research of RG service radius, can better reflect the current situation of RG service level [12].

The main content of this paper is the establishment and application of the RG SD model based on GIS technology. The main research methods are questionnaire survey, data analysis and chart analysis. In this paper, through understanding the roof green space distribution design, understanding the investigation and analysis of the current situation of the roof green space, macro layout and multifunctional space integration. In this paper, the multi-objective optimization model of RG SD is established, and the optimal location scheme of RG layout is explored by GIS. The purification effect of RG on rainwater pollutants and the overall analysis of ecosystem service fairness performance are also analyzed. At the same time, this paper uses questionnaire surveys to study people's awareness of the roof green space distribution and status cognitive analysis, through the collection of data to form a chart, to intuitively understand people's attitude to the roof green space.

2. Literature Review

Roof greening is a widely accepted method for increasing the environmental and aesthetic value of buildings, as well as for reducing the urban heat island effect and improving air quality. The use of Geographic Information Systems (GIS) technology has become increasingly popular in the planning and management of roof greening projects. A number of studies have been conducted on the establishment and application of spatial distribution models for roof greening using GIS technology. These studies have generally focused on the use of GIS to analyze the suitability of different roof surfaces for greening, as well as to plan and design green roof systems. One study by [13] used GIS to analyze the suitability of different roof surfaces for greening in the city of Xiamen, China. The study found that the majority of the city's flat and gently sloping roofs were suitable for greening, and that these roofs could provide a significant amount of green space if properly utilized.

Another study by [14] used GIS and remote sensing to analyze the potential for green roof development in the city of Changsha, China. The study found that the city had a high potential for green roof development, and that the use of GIS and remote sensing could be useful for the planning and management of green roof projects. A study by [15] has investigated the use of GIS and remote sensing in the assessment of the suitability of different roof surfaces for greening in the city of Baghdad, Iraq. The study found that GIS and remote sensing could be used to identify suitable roof surfaces for greening, and that the use of these technologies could help to improve the planning and management of green roof projects in the city. In general, these studies have found that GIS technology can be effectively used to analyze the suitability of different roof surfaces for greening, as well as to plan and design green roof systems. They have also demonstrated that the use of GIS and remote sensing can be helpful in the assessment and management of potential green roof projects in different cities.

Overall, the use of GIS technology in the establishment and application of spatial distribution models for roof greening is an effective way to improve the environmental and aesthetic value of buildings, as well as to reduce the urban heat island effect and improve air quality. Studies have shown that GIS can be an effective tool for assessing the suitability of roof surfaces for greening, and for planning and managing green roof projects.

Additional studies have also investigated the use of GIS technology in the establishment and application of spatial distribution models for roof greening. A study by [16] used GIS to analyze the potential for green roof development in the city of Hangzhou, China. The study found that GIS could be used to identify suitable roof surfaces for greening, and that the use of GIS could help to improve the planning and management of green roof projects in the city. Another study by [17] used GIS and remote sensing to investigate the potential for green roof development in the city of Nanjing, China. The study found that GIS and remote sensing could be used to identify suitable roof surfaces for greening, and that the use of these technologies could help to improve the planning and management of green roof projects in the city. A study by [18] investigated the use of GIS and remote sensing in the assessment of the suitability of different roof surfaces for greening in the city of Beijing, China. The study found that GIS and remote sensing could be used to identify suitable roof surfaces for greening, and that the use of these technologies could help to improve the planning and management of green roof projects in the city. A study by [19] has used GIS to analyze the potential of green roof development in the city of Chengdu, China. The study found that GIS could be used to identify suitable roof surfaces for greening, and that the use of GIS could help to improve the planning and management of green roof projects in the city.

These studies demonstrate that GIS technology can be effectively used to identify suitable roof surfaces for greening and to plan and design green roof systems [20]. They also show that GIS can be helpful in the assessment and management of potential green roof projects in different cities. However, it's important to note that the studies are mainly focused in China, and it is not clear if the same results can be replicated in other regions and climates, more research is required to test the generalizability of the findings.

2.1. RG Space Distribution Design

Investigation and analysis of the current situation of green space on the roof

Make clear the current situation of green space in this area, investigate the scale, quantity and distribution of green space, and analyze the current characteristics and existing problems. The types of green space in urban centers mainly include green space Park, street green space, road green space, roof green space, air courtyard and so on. Different types of green space play different roles in beautifying the urban landscape. For example, in high-density urban central business districts, it is difficult to form large-scale centralized green space. Street greening, large-scale RG and air courtyard play a more prominent role; the green space on the roof and the courtyard space in the air can beautify the urban landscape and allocate the houses reasonably top green space also has an important impact on the improvement of commercial value.

Macro layout

The macro layout of green space on the roof includes some more specific contents. Firstly, it puts forward the requirements for the layout of green space on the roof of the whole area, and determines the criteria and requirements for the setting of green space on the roof according to the road nature, street scale and landscape planning requirements. Secondly, according to different sections, it can be divided into key and non key areas for planning control.

Multiple functional space composite integration

The significance of space compound design lies in the Limited space-time conditions, according to the characteristics of the building and urban public space, it gives it different levels and different nature of use functions, and gives full play to the potential economic and social benefits of space. The roof green space can not only be used as single building space, but also used as urban public facilities construction, which realizes the innovation and derivation from the function of single building to the two-way development of urban function. Through RG, the urban public space is introduced into the interior of the building. Through the intermediary role of green space, the urban public space will flow, penetrate and continue to the interior of the building. The combination of space and terrain, the special properties of underground, semi underground, ground, building and building roof are used to give the composite functions in planning space.

2.2. Multi Objective Optimization Model of SD of RG

How to improve the service level of RG, improve the convenience and comfort of residents to enjoy the RG and the service equalization, this paper proposes a multi-objective RG distribution model, which optimizes the spatial location layout through multiple problem objectives in the aspect of RG location. In the site selection planning, the pedestrian distance of residents is mainly considered. The shorter the distance from home to RG is better, it is better to reach the nearest RG within half an hour. At the same time, when the residents arrive at the RG, the number of residents is moderate and comfortable. The optimization of space layout of RG is a multi-objective decision-making problem, such as the largest number of people around the RG Service, the shortest walking distance between residential land and RG, the maximum possible saving of land resources and the maximum ecological function. Different requirements need to define the constrained targets of multi-objective model and select quantitative data simulation related factors. The relationship between these factors is complex. Most of the methods of RG distribution are the basic models to achieve single objective optimization. It is difficult to ignore the solutions that achieve multi-objective optimization but not the optimal ones. Therefore, this paper, referring to the basic location model, combined with the quantitative analysis results of the social service level of RG in the research area, and guided by fairness and efficiency, environmental protection and economic saving, proposes to construct a multi-objective optimization model for the research of RG layout without changing the status quo and combining the position of the candidate points of RG, the paper explores the optimization of the RG layout in the research area by GIS.

2.3. Algorithm Analysis of Purification Effect of RG on Rainwater Pollutants

RG can not only increase the urban green area and reduce the heat island effect, but also regulate and store the rainwater, weaken the total amount of roof rainwater runoff, reduce the pollutant concentration of roof rainwater runoff, and reduce the pressure of urban drainage systems. Among them, the purification effect of RG on rainwater pollutants is a key point in the application of RG. This paper describes the purification effect of roof runoff by calculating the average concentration of pollutants in roof rainwater runoff EMC. Among them, the total amount of pollutants in stormwater runoff is m, the total volume of pollutants in stormwater runoff is V, the pollutant concentration changing with stormwater runoff time is C, and the runoff changing with stormwater runoff time is Q (t).

2.4. Algorithm Analysis of Purification Effect of RG on Rainwater Pollutants

This paper studies the quantitative index of social equity performance evaluation of SD of RG ecosystem, because the economic Gini coefficient refers to the similarity between the connotation of income distribution and ecosystem service distribution, the characteristics of the quantifiable quality and value of ecosystem service as the end products of ecosystem provide theoretical basis for Gini coefficient in the application of ecosystem service fairness evaluation. The higher the Gini coefficient is between 0 and 1, the more obvious the aggregation is, the more uneven the distribution is.

3. Methodology

3.1. Subject

The proposed inventory management strategy in this study is based on cluster grouping, which identifies similar elements among distinct SKUs in a warehouse. Each cluster is built using variables with distinct features, which distinguishes it from the other clusters. A worldwide food corporation was utilized as a case study for this research, which focuses on the manufacturing of food and beverages, specifically studying the challenges of a business unit in Mexico. This business unit, which is based in Mexico, specializes in beverage preparation and bottling. In a make-to-order environment, the said company's inventory management is carried out through internal warehouses (placed within the facilities) and external warehouses (positioned outside the facilities). Figure 1 depicts warehouse logistics with the production department acting as an internal client.

3.3. Experimental Process Steps

This paper studies the establishment and application of the RG SD model based on GIS technology. The main research methods of this paper are questionnaire survey, data analysis and chart analysis. In this paper, through understanding the roof green space distribution design, understanding the investigation and analysis of the current situation of the roof green space, macro layout and multi-functional space integration. In this paper, the multi-objective optimization model of RG SD is established, and the optimal location scheme of RG layout is explored by GIS. The purification effect of RG on rainwater pollutants and the overall analysis of ecosystem service fairness performance are also analyzed. At the same time, this paper uses questionnaire surveys to study people's awareness of the roof green space distribution and status cognitive analysis, through the collection of data to form a chart, to intuitively understand people's attitude to the roof green space.

4. Experimental Study and Analysis on SD of RG

4.1. People's Awareness of the Green Space of Roof

In order to promote and implement the important position of RG in the residents' thoughts, make the residents correctly realize the importance and necessity of house greening, and understand people's awareness of the space of RG. This paper uses the questionnaire method to select 200 people as the sample through the form of an online questionnaire. The results are analyzed by collecting and sorting out the data of 200 people. The results are shown in Table 1.

Table. 1. People's recognition of green space on roof

Degree	Enough	Commonly	Insufficient	Rare
Number	16.37	52.18	26.31	5.14

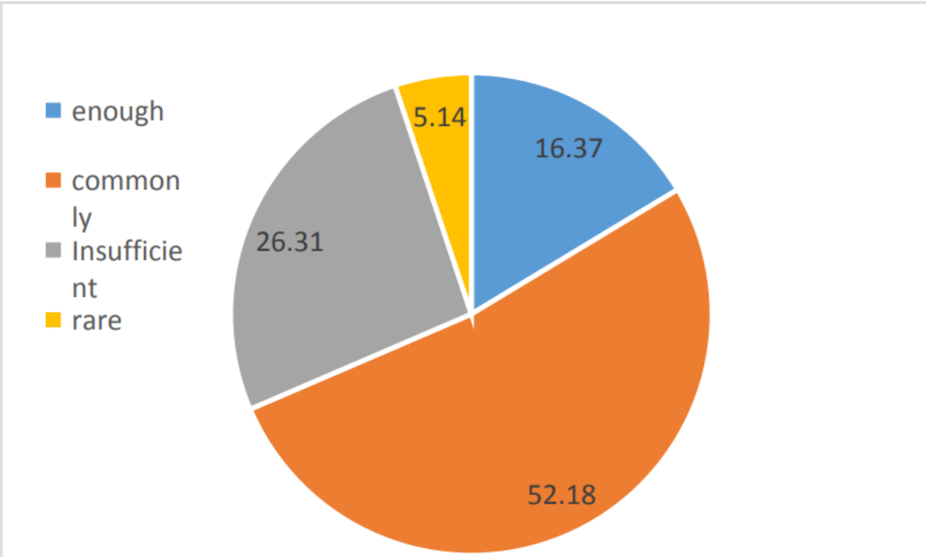

Fig. 1. People's recognition of green space on roof

As can be seen from Figure 1, 16.37% of the people think that RG is enough, 52.18% think that the degree of RG is average, 26.31% think that the degree of RG is insufficient, and 5.14% think that RG is scarce. Therefore, the promotion of RG needs to be improved.

4.1. People's Cognition of the Status of Roof Green Space

Most people don't have a comprehensive understanding of RG, and they don't have a good understanding of the important role of RG in all aspects of life. In order to understand the status of RG space in people's mind, this paper uses a questionnaire survey method to select 200 people as the survey sample in the form of online questionnaire, by collecting and sorting out the questionnaire data of 200 people, the results are analyzed, and the results are shown in Table 2.

Table. 2. People's recognition of green space on roof

attitude	favorable	imperative	indifferent	formalism	waste
Number	46.12	23.47	12.41	8.69	9.31

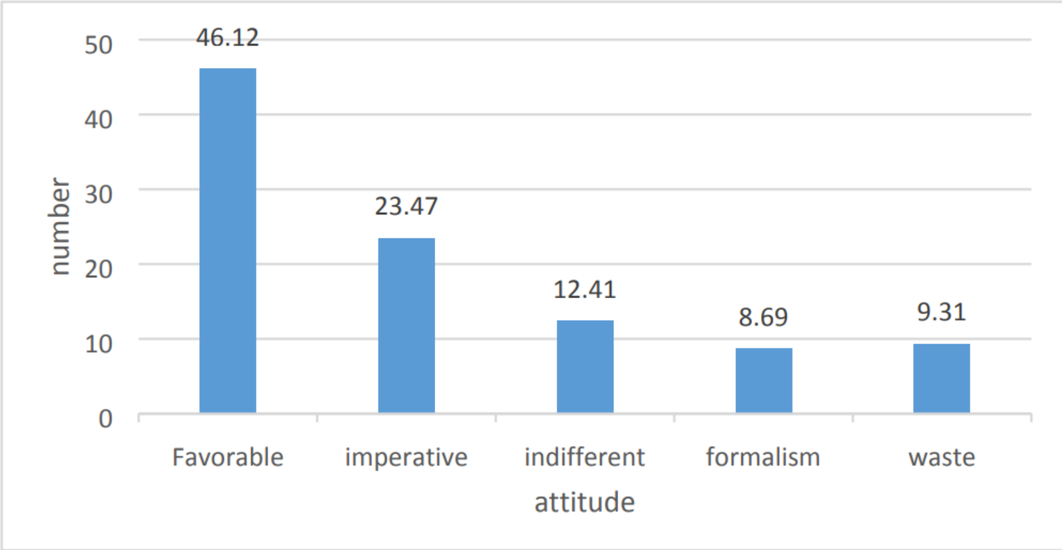

Fig. 2. People's cognition of the status of roof green space

From Figure 2, it can be seen that 46.12% of people think it is advantageous to implement RG in the cognition of the status of RG space, 23.47% think it is important to implement RG, 12.41% of people don't care about RG, 8.69% think it is face engineering, and even 9.31% think it is a waste of resources. Therefore, the construction of RG is a priority for the construction of RG, it is also necessary to increase the popularization of significance to promote RG.

5. Conclusion

To a certain extent, RG can make up for the lack of urban greening, increase green activity space for people in urban life, and alleviate urban ecological problems and heat island effect. The establishment and application of the RG SD model can help to find the appropriate RG building configuration faster, design the RG SD reasonably, and explore the appropriate RG layout and site selection with the help of GIS technology, so as to realize the application of RG SD model. In this paper, through the investigation and analysis of the current situation of green space on the roof, the macro layout and the integration of multi-functional space to understand the green space design on the roof. In this paper, the multi-objective optimization model of RG SD is established, and the optimal location scheme of RG layout is explored by GIS. The purification effect of RG on rainwater pollutants and the overall analysis of ecosystem service fairness performance are also analyzed.

The use of Geographic Information Systems (GIS) technology in the establishment and application of spatial distribution models for roof greening is a widely accepted and effective method for increasing the environmental and aesthetic value of buildings, as well as for reducing the urban heat island effect and improving air quality. Studies have shown that GIS can be used to analyze the suitability of different roof surfaces for greening, as well as to plan and design green roof systems. The use of GIS and remote sensing can also be helpful in the assessment and management of potential green roof projects in different cities. However, more research is still needed to evaluate the long-term effects of GIS-based roof greening projects and to explore the potential challenges and limitations of using GIS technology in this field. Overall, it is clear that GIS technology has the potential to play a significant role in the sustainable development of urban areas through the promotion of roof greening.

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