Analysis on the evaluation of urban greenway network construction with AHP method

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Abstract. With the planning and construction of greenway in domestic cities, "city greenway" has been integrated into the lives of the majority of citizens, and gradually presents a trend of diversification. That AHP method was used to analyze the construction and evaluation of the evaluation factor subset of greenway network infrastructure in Luogang Street, Guangzhou. The weight analysis of the evaluation factor subset after the completion of luogang street greenway network is completed by determining the components of the evaluation factor subset and the weight of each factor: P4-Overall greenway construction > P5-Investment in management and maintenance of greenway network after completion > P3-Supporting facilities along the greenway.

Keywords: Analytic Hierarchy Process; Greenway network; Subset, Green way, POE evaluation.

1. Introduction

With rapid urbanization development, urban supporting construction had correspondingly scaled up. The reference words of "Greenway"(European Greenways Association,2000), "urban greenway network"words had appeared in our city life or design work(Wang et al., 2020). Greenway that was defined to the most intuitive bicycle and pedestrian lanes, which has gradually applied to the deeper river protection and animal migration corridors had a constitute element of the greenway (Zhang et al., 2015; Murgui et al., 2017; Yin et al., 2017). On the basis of the greenway system construction, "urban greenway network is defined as located in the city within the scope of administrative sense, known as district scope, from planning, design and management of line the greenway network of land system, which is a kind multiple functions of ecological, recreation, culture, aesthetics, such as disaster prevention way of sustainable land use. As known, Greenways first appeared in Frederick Law Olmsted and his famous Boston Park System plan which was completed in 1867, had used a System accept of green Spaces between 200 and 1,500 feet wide to link several of Boston's larger parks, And with the adjacent river, it has become a ribbon-like waterfront ecological park in the center of Boston(Yin et al., 2017). Although greenway planning mainly focused on "greenway suitability evaluation and greenway use status", especially in the United States, Japan, Singapore and other countries, greenway network construction is relatively mature, which could provide a reference for the study of greenway evaluation. In China, the greenway construction started late, and the region of Guangdong Province was first to lead systematic technical guidance of greenway construction. In 2010, the housing and construction department of guangdong province has issued a "pearl river delta regional greenway (provincial) planning and design technical guidelines"(Guangzhou People's Government of Luogang Street,2012), the people's government of guangzhou post of dill streets. "guangzhou post street urban green space system planning of dill"[9], for the region green construction work smoothly and formulate technical documents. It is planned to take the lead in building 6 regional greenways with a total length of 2,372 kilometers in the Pearl River Delta within 3 years, and put forward the construction target of "basic completion in one year, complete completion in two years, maturity and perfection in three years"(Guangzhou People's

Government of Luogang Street,2012). Over the past two years, the construction of the Pearl River Delta greenway network system has progressed smoothly, and the task of "putting all the greenways in place" in Guangdong Province in two years has been fully completed, initially establishing a network system of organic connections between provincial and city greenways.

The greenway system has been built to a certain scale, but with the continuous use of the greenway system, its existing problems gradually showed its disadvantages, which has a problem of low utilization rate of the greenway is more prominent. To solve this, in recent years, many cities in the Pearl River Delta, including Guangzhou, Dongguan and Zhongshan, have investigated the construction and late management of greenways, and summarized the influencing factors of low utilization of greenways, such as incomplete supporting facilities, unscientific design and inadequate management. To this end, a survey was carried out on luogang subdistrict in guangzhou, and the subdistrict greenway network subset construction and POE method evaluation of luogang subdistrict greenway network in guangzhou were conducted according to the analytic hierarchy process (Pan et al., 2015). After the completion of the network, the subsets were evaluated to improve the entire greenway construction procedure system (Han et al., 2011), so as to provide scientific and reliable information for the decision makers, designers and managers of greenway construction. It is conducive to the sustainable development of greenway system construction, in order to provide a realistic reference for the later progress of the project.

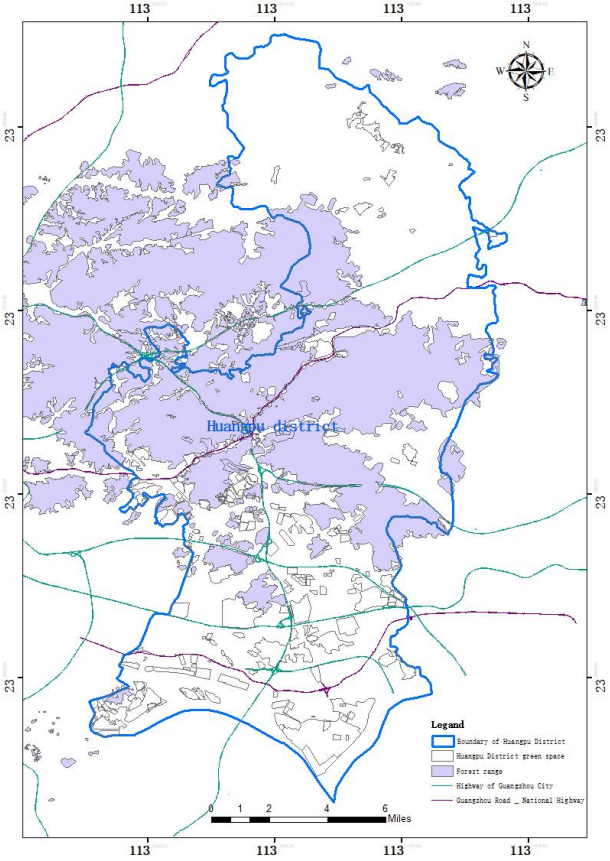


Fig.1 Planning route of survey location

2. Overview of the region

The research object was belonged to the duty of dill in huangpu district street located in guangzhou city, guangdong province, China. It was on the basis of development zone and integrating the surrounding rural areas, which was approved by the State Council, in April, 2005. Luogang sub-district was set up, with a jurisdiction of 393.22 square kilometers(See fig.1). Under the jurisdiction of Xia Gang Street, the statistical data on the size of the permanent resident population in the area under this region (Figure 1, data quoted from Guangzhou Development Zone,

Huangpu District, Guangzhou, 2021 Statistical Bulletin on National Economic and Social Development) showed that the population size was large and the population distribution was balanced, which could provide objective reference for this survey. This survey was mainly conducted using POE method to collect and summarize the data of greenway users' behavior and cognition. The management and maintenance of greenway network were investigated and analyzed by field investigation.

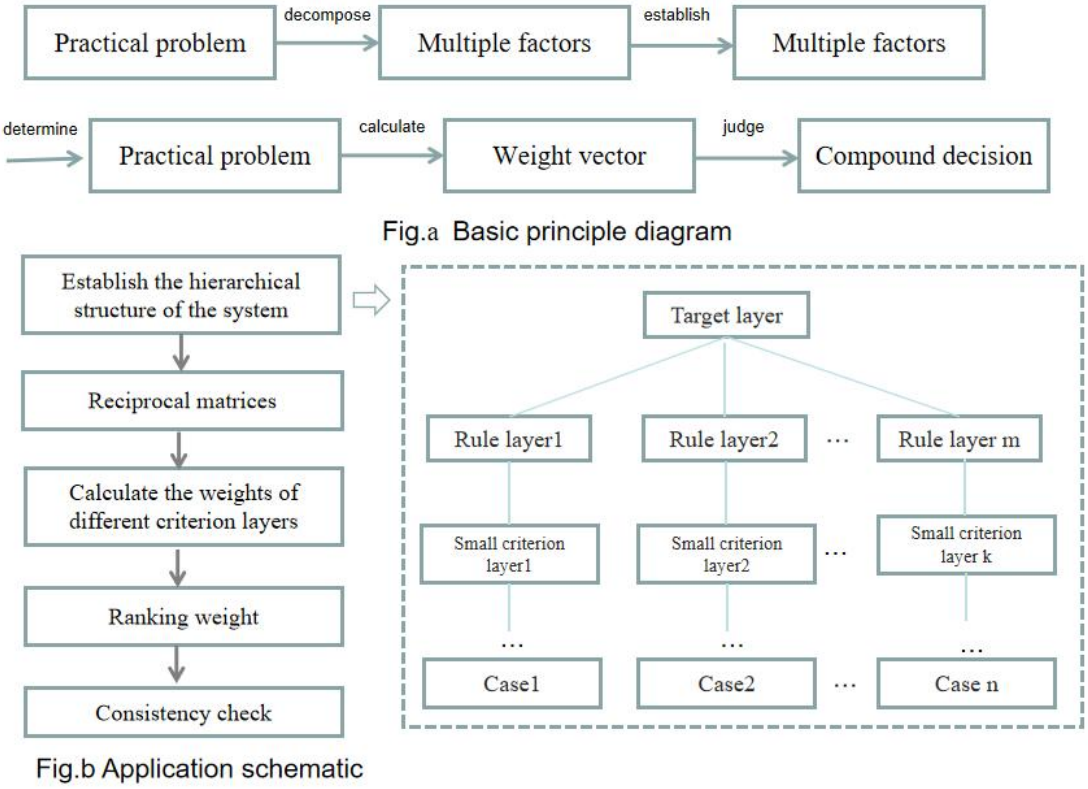
3. Evaluation and analysis with AHP method

3.1 Introduction to AHP Method

Based on the reference of main city greenway network construction (Li, 2019), the suitability evaluation of Guangzhou luogang street had made four main aspects :(1) The population size and distribution of the area. (2) Greenway network construction. (3) Users'behavior and cognition of greenway network. (4) Management and maintenance of greenway network after completion. The AHP decision-making method was used to select the evaluation factors. According to determine the evaluation factors, to complete the building at all levels and the matrix scale fixed value at every level, complete all levels of the weight calculation basis, and pointed to determine the original her post to the streets after the completion of evaluation of the greenway network subset for building the three main aspects of the content hierarchical weight objectively analyzed.

3.2 Selection of evaluation factors

The selection of evaluation factors is based on establishing the hierarchical structure of the system and the key to the construction of the whole evaluation factor subset. According to the size and distribution of population in the selected area, the construction of greenway network, the user's behavior and cognition of greenway network, and the management and maintenance work after the completion of greenway network, these four factors became the main component of the evaluation factor subset, which was the constituent content of "criterion layer" in AHP. Through the determination of the criterion layer had the essential role, it further built the AHP weight analysis system (figs. 2), and designed the target layer J,which included three major factors of item (C) as the criterion layer, rule layer C1-users on the use of the greenway network behavior and cognition, criterion layer C2-the greenway network construction situation, criterion layer C3-after the completion of the greenway network management and maintenance work, and their sub-criterion layer (P for short) : the number of landscapes passed by the P1-greenway on the sub-criterion layer, the accessibility of the P2-greenway on the sub-criterion layer, the supporting facilities along the road of the P3-greenway on the sub-criterion layer, the overall construction of the P4-greenway on the sub-criterion layer, and the management and maintenance investment degree of the P5-greenway network after completion. According to the determination of criterion layer C to target layer J, and sub-criterion layer P to criterion layer C relative scale value of each factor.According to the above steps, the determination of different factor scale values by the expert group, the AHP method system analysis diagram of the topic research was obtained, as shown in each figure below.



Figs. 2 Schematic diagram of AHP method principle and procedur

3.3 Weight analysis of evaluation system

According AHP analytic hierarchy process to establish the operation system, it was used the scale after the assignment and to calculate weight of the criterion layer of C1, C2, C3, and the rule layer (P1, P2, P3, P4, P5) total order weight that completion of evaluation of the greenway network for a subset of the building (see Figs 3). From the matrix, the value of a rule layer C1 could be calculated: The first is P4-greenway overall construction, the second is P5-greenway management and maintenance investment degree after the completion of the greenway network, the third is P3-greenway supporting facilities along the road, the fourth is P2-greenway accessibility, the fifth is P1-greenway landscape quantity, and the C.R. Both are lower than 0.1 and conform to the consistency test (Table 1). Therefore, for the two factors of C2-greenway network construction at the standard layer and management and maintenance of C3-greenway network after completion of the standard layer, The corresponding subcriterion P only keeps three factors: supporting facilities along P3-greenway, overall construction of P4-greenway, and investment degree of management and maintenance after completion of P5-greenway network. The evaluation priority is P4>P5>P3.

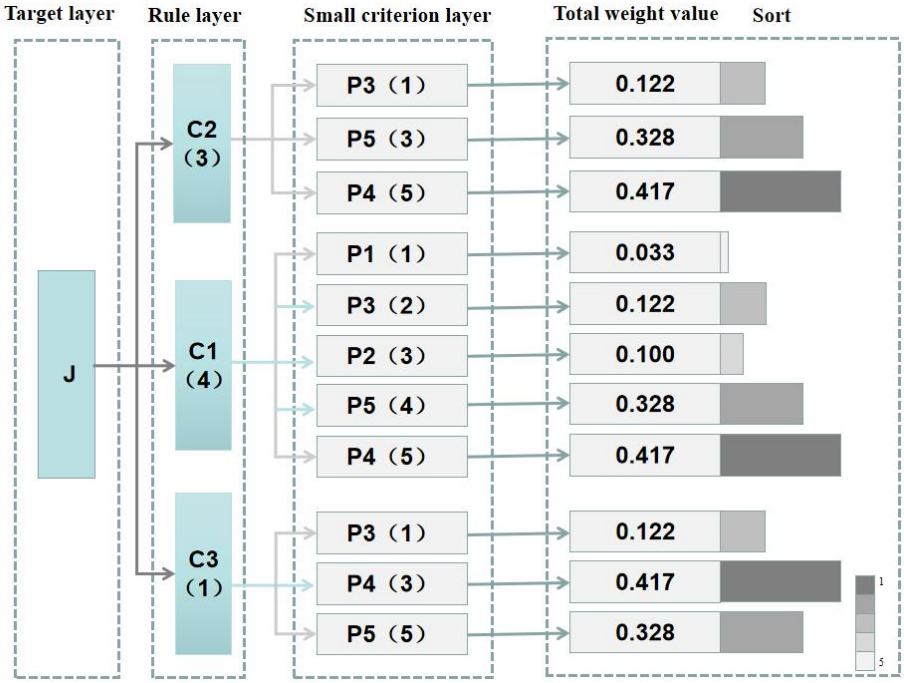


Fig.3 Construction of evaluation factor subset and evaluation weight analysis

Tab. 1 Comparison matrix

	Matrix	Condition	Test
J-C	$A_J=\begin{matrix} J & C_1 & C_2 & C_3 \\ C_1 & 1 & 4/3 & 4 \\ C_2 & 3/4 & 1 & 3 \\ C_3 & 1/4 & 1/3 & 1 \end{matrix}$	$C.I.=\frac{\lambda_J-n}{n-1}=\frac{3-3}{3-1}=0$	$C.R.=\frac{C.I.}{R.I.}=0<0.1$
C1-P	$A_1=\begin{matrix} C_1 & P_1 & P_2 & P_3 & P_4 & P_5 \\ P_1 & 1 & 1/3 & 1/2 & 1/5 & 1/4 \\ P_2 & 3 & 1 & 3/2 & 3/5 & 3/4 \\ P_3 & 2 & 2/3 & 1 & 2/5 & 2/4 \\ P_4 & 5 & 5/3 & 5/2 & 1 & 5/4 \\ P_5 & 4 & 4/3 & 4/2 & 4/5 & 1 \end{matrix}$	$C.I.=\frac{\lambda_1-n}{n-1}=\frac{5-5}{5-1}=0$	$C.R.=\frac{C.I.}{R.I.}=0<0.1$
C2-P	$A_2=\begin{matrix} C_2 & P_3 & P_4 & P_5 \\ P_3 & 1 & 1/5 & 1/3 \\ P_4 & 5 & 1 & 5/3 \\ P_5 & 3 & 3/5 & 1 \end{matrix}$	$C.I.=\frac{\lambda_2-n}{n-1}=\frac{3-3}{3-1}=0$	$C.R.=\frac{C.I.}{R.I.}=0<0.1$
C3-P	$A_3=\begin{matrix} C_3 & P_3 & P_4 & P_5 \\ P_3 & 1 & 1/3 & 1/5 \\ P_4 & 3 & 1 & 3/5 \\ P_5 & 5 & 5/3 & 1 \end{matrix}$	$C.I.=\frac{\lambda_3-n}{n-1}=\frac{3-3}{3-1}=0$	$C.R.=\frac{C.I.}{R.I.}=0<0.1$

4. Conclusion and discussion

The greenway concept has become established in the UK, which was significant in the planning work of 33% or respondents during the past decade and 75% of respondents expect it to be significant(Tom Turner, 2006).To evaluate the landscape quality of college campuses had more ways, and Yan Yusheng et al.(2022) used the AHP&POE combination model to evaluate it and the post-use cognition of green way network was a convenient and successful way that showed that multifunctional objectives of a habitat network were, in principle, a successful model from which different landscape functions and users could benefit. In this study, the evaluation factor subset after

completion is used to construct: greenway network construction; Users'use behavior and cognition of greenway network. Management and maintenance of greenway network after completion. According to the determined evaluation factors, the construction of each level is completed, the matrix scale of each level is fixed, the weight calculation of each level is completed, and the objective weight analysis is performed hierarchically. This is almost the same as the effect of Zhang Hong's evaluation of the park(2020), thinking from different latitudes: 1) from the perspective of the builder; 2) Sketch design from now on; 3) The coordination between garden pavilion color and environment color was discussed by means of landscape visual attraction mechanism; 4) From the user's perspective, etc., combined with greenway network construction and convenient service application.

Through investigation, the law of crowd activities in the park and the satisfaction with the sensory factors, environmental factors, place factors and functional factors in the public space of Luohu Sports and Leisure Park were understood (Mei et al., 2020). Studies have found that the overall spatial environment of the park was related to tourists' pleasant psychological senses, as well as topographic factors and spatial coordination in the objective environment. In some cases, it could lead to optimal solutions for all interests involved. Lai Jiaqing (2019) took the planning route of green-way network in Chengxiang District of Putian City as an example, carried out the overall planning of greenway network from the four aspects of green as the vein, culture as the nexus, user as the base, and slow lane as the medium, and discussed the planning route method of green-way network in historic Jingyuan city. However, this is similar to the cognition of greenway network and the idea of management and maintenance after the completion of greenway network in this study.

In addition, the study on Guangzhou greenway and Lanzhou City Park were also conducted in depth, and the results of the survey have certain reference with the feedback results of 307 respondents in this survey. The connection of historical heritage or cultural values is no specific goal in both approaches. For the multifunctional habitat networks, we founded the discrepancy between the scientific methodology and its practical application, but in Germany, the limits of multifunctionality are the cause of these funda mental difficulties in the structures with appropriate management measures (Opdam et al., 2002). Therefore, after the completion of Luogang street greenway network, this study adopted AHP method to evaluate and found that: P4 > P5 > P3, which directly reflected the users to post street greenway network in use process and a result of the user to post to the streets after the completion of the greenway network utilization of dill decline in cognitive reason and its transportation planning problem. The overall system connectivity of the greenway network in this region were was improved.

Acknowledgements

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