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Study on the Evaluation Indicator System for Integrated Livability in the Yangtze River Delta Demonstration Area and Regional Synergy

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Abstract: *The construction of the Yangtze River Delta Ecological Green Integrated Development Demonstration Zone is the need to implement the important development strategy of Yangtze River Delta integration. Livability is an important starting point of 'eco-green', which is an important embodiment of the people-centered approach to scientific development. Taking the road of sustainable development, the sustainable construction of regional integration is the scientific road and the inevitable choice for the construction of the demonstration area. Based on the general background of the integration construction of the Yangtze River Delta Demonstration Zone, this paper constructs the evaluation index system related to livability by considering the construction standards of livable cities and combining the big data word frequency analysis method. The weights of the indicators are determined by the CRITIC entropy weighting method, and the degree of integrated development of the demonstration area is evaluated by the coupled synergy degree model, which analyses the livability and degree of synergy of the districts and counties in the Yangtze River Delta Demonstration Area. The following conclusions are drawn: among the demonstration zones, Qingpu District has a stronger livability capacity, and Wujiang District is the weakest; the degree of coordination of livability capacity building in the demonstration zones has gradually changed from primary dysfunction to intermediate coordination, and the degree of construction coupling is at a high coupling stage, with a greater mutual influence, and the overall trend of development is orderly, with better development potential.*

Keywords: *demonstration area; integration; liveability; evaluation indicators; CRTTIC*

1. Introduction

The construction of livable cities is a product of the post-industrialization stage of cities, emphasizing good human and social environments, ecological and natural environments, clean and efficient production environments, and spatial environments. It complements the integrated construction of the demonstration area and is both the outcome and an important means of the construction of the demonstration area. Therefore, the construction of livable cities in demonstration zones needs to break through traditional concepts and establish a multidimensional evaluation index system.

In recent years, scholars at home and abroad have conducted extensive research on urban livability evaluation systems [1-4]. Domestic scholars such as Yuan et al [5] measured the development index by using the entropy method from a macro perspective in combination with the resilience and livability of the Yangtze River Delta urban agglomeration; Wuhai Daily [6] proposed to enhance residents' happiness by improving the housing environment and infrastructure; and Tang Jie [7] analyzed the construction of beautiful rural villages in Jiangsu Province and put forward a development path based on livability. In addition, Wu et al [8] measured the efficiency of green development in the Yangtze River Delta through the DEA-Malmquist model; and Wang Teng et al[9] investigated the driving role of urban innovation linkages on the integration of the Yangtze River Delta.

Foreign scholars such as SalznaoE [10] elaborated on the connotation of the livable city from the perspective of sustainable development; MahmoudiM [11] analyzed the relationship between the physical attributes of Kuala Lumpur's main roads and the perception of livability through structured observation and questionnaires; and Bonaiuto [12] pointed out that the quality of life in the city is closely related to the quality of the environment of the inhabitants, the dependence of neighbors, and the satisfaction with the residence.

Based on the elaboration of the connotation of a livable city and related theories by scholars at home

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and abroad, and based on the construction of a related indicator system, this paper establishes a livable city indicator system consisting of 5 first-level indicators and 25 second-level indicators and strives to comprehensively and systematically reflect the main areas and development trends related to the construction of livable cities in the Yangtze River Delta Integration Demonstration Zone.

The purpose of this paper is to create a new paradigm of harmonious livability between man and nature. It builds a modern infrastructure system that is convenient, green, intelligent, and safe, establishes a multi-level, cross-regional, and high-level public service network, creates a cultural marking place that highlights the characteristics of the Jiangnan water town, promotes the organic integration and balanced development of urban and rural areas, and creates a high-quality living environment for residents. The innovations are: (1) constructing the livability evaluation indexes of the whole region of the Yangtze River Delta Demonstration Zone; (2) firstly, this paper empowers the indexes through the improved entropy CRITIC method; (3) using the coupling synergy model to establish the coupling synergy indexes of the three regions, which is a more objective response to the integration and regional synergy of the Yangtze River Delta Demonstration Zone.

2. Construction of the indicator system

In the process of the integration of the Yangtze River Delta Demonstration Zone, the construction of livable cities is not only one of the outcomes but also an important way and means to realize the integration process. Therefore, the construction of livable cities in the Demonstration Zone should break through the traditional concept of livable cities, consider the construction of livable cities comprehensively, and establish evaluation indexes for the livability of cities in various aspects.

Based on the previous research of various experts and scholars, this paper constructs the evaluation index system from five aspects: the level of cultural brand construction of Jiangnan Water Town, public service guarantee, emergency management program, the level of new infrastructure construction, and people's living standard. The characteristics of the evaluation indicators are: (1) the five secondary indicators include all aspects of livable city construction and city evaluation, and the overall response to the connotation and characteristics of livable cities; (2) this evaluation indicator system designs three levels of objectives from both macro and micro perspectives. The construction of specific indicators is shown in Table 1.

Table 1 Livability Indicator System

Class I	Specific indicator (II)	Measurement indicator (III)	Unit of measure
Livable	Jiangnan Waterfront Branding	Intangible Cultural Heritage	Item
		The growth rate of income from cultural and tourism industries	%
		Cultural heritage sites	Item
	Public Services	Number of primary and secondary schools in urban and rural areas	Institution
		Number of full-time teachers	People
		Number of students	Person(s)
		Sports and cultural facilities	Sets
		Number of health centers and hospitals in urban and rural areas	Sets
		Number of beds	Person
		Number of doctors	People
	Emergency Management	Timeliness of notification	
		Reasonableness of relief arrangements	
		Satisfaction of the public	
	New Infrastructure Construction	Total number of fiber-optic coverage subscribers	Ten thousand households
		Total number of public transport passengers	Million
		Number of mobile phones	Million households
	People's Life	Labour Force Employment Ratio	Percent
		GDP per capita	Yuan
		Value added of tertiary industry	Billion
		Per capita disposable income of urban residents	Yuan

Most of the data come from the time series data of the comprehensive regional development of ‘two counties and one district’ from 2012 to 2019. The raw data are mainly taken from the ‘National Economic

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and Social Development Statistical Bulletin of Jiashan County', 'The National Economic and Social Development Statistical Bulletin of Wujiang District of Suzhou City', 'The National Economic and Social Development Statistical Bulletin of Qingpu District of Shanghai City', and the statistical yearbooks of various cities (e.g., 'Statistical Yearbook of Qingpu District', 'Statistical Yearbook of Qidong', 'Statistical Yearbook of Suzhou City', 'Statistical Yearbook of Shanghai City', 'Statistical Yearbook of Jiaxing City'), and some of them come from the annual reports of water resources and environmental quality reports of various cities. Water Resources Annual Report and Environmental Quality Report, etc. In addition, through the collection of various types of information, the keywords that can reflect their degree of concern are collated and summarised, and the specific keywords are shown in Table 2.

Table 2 Keywords for Attention Indicators

Attention indicators	Keywords
Water Township Construction Concerns	Tourism, heritage, intangible culture, culture
Public Service Concerns	Schools, teachers, students, sports and cultural facilities, health care
Emergency Management	Rescue, emergency
New Infrastructure	Networks, public transport, mobile phones
Living Standard	Employment, livelihoods, population income, services

According to the keywords, the frequency of words is counted: if the words 'Yangtze River Delta', 'demonstration zone', 'Qing Wu Jia', 'integration', etc. are not involved, 1 point will be scored. If it does not involve 'Yangtze River Delta', 'Demonstration Zone', 'Qing Wu Jia', 'Integration', etc., it will be counted as 1 point, if it involves, it will be counted as 2 points, and finally, the attention data will be adjusted by hand and used for the subsequent evaluation analysis.

3. Evaluation process

This paper combines the entropy weight method to determine the weight of each indicator based on the CRITIC method and adopts the coupling synergy model to measure the integration development degree of the demonstration area, and the formula for the coupling coordination degree is as follows:

$$\begin{cases} D = \sqrt{CT} \\ C = 5\dfrac{\sqrt[5]{U_1U_2U_3U_4U_5}}{(U_1+U_2+U_3+U_4+U_5)} \\ T = \alpha U_1 + \beta U_2 + \gamma U_3 + \delta U_4 + \varepsilon U_5 \end{cases} \quad (1)$$

Where: D is the degree of coupling coordination; C is the coupling degree of each subsystem; T is the coordination index of each subsystem; U_m denotes the integrated utility value of each subsystem, which is calculated as follows:

$$U_m = \sum_{j=1}^{n} \lambda_j x'_{irj} \ (m = 1,2,3,4,5) \quad (2)$$

Where λ_j is the comprehensive weight of each index, and $\sum_{j=1}^{n}\lambda_j = 1$; , β, γ, δ and ε are the coefficients of the importance of the five subsystems of the new urbanization, this study believes that the five subsystems of the new urbanization are equally important, so $\alpha = \beta = \gamma = \delta = \varepsilon = 0.2$. $0 \le D \le 1$, the greater the value indicates that the degree of coordination of various systems within the new urbanization is better. The larger the value, the better the degree of coordination among the systems within the new urbanization.

The objective weight of each indicator of livability is obtained through the entropy weight improvement CRITIC method. From the calculation of the indicator weight data and standardized data, according to the formula (2) can get the evaluation value of the ability of the livability of each region, the results are shown in Table 3:

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Table 3 Evaluation of livability by region

certain year	region	Livability
2018	Jiashan county	0.439207104
2018	Wujiang suburban	0.329809685
2018	Qingpu district	0.422915570
2019	Jiashan county	0.478132637
2019	Wujiang suburban	0.463349381
2019	Qingpu district	0.574266446
2020	Jiashan county	0.601565391
2020	Wujiang suburban	0.522065731
2020	Qingpu district	0.641379335

As shown in Table 3, Wujiang District has a weaker ability to live in a livable environment, while Qingpu District is more advanced and the overall level continues to improve. Qingpu District always performs outstandingly, Jiashan County is second, and Wujiang District is relatively weak. Since the construction of the demonstration area, the livability capacity of each area has been on an upward trend, with Jiashan County improving rapidly and gradually approaching Qingpu District, while Wujiang District has a slower growth rate and a gap with the former two.

According to the calculation results of this paper on the construction of science, technology, and innovation capacity in the three areas of the integration demonstration zone (Table 4), the coupling degree of the three areas of the demonstration zone in 2018-2020 is calculated using the coupling degree model to be between 0.991298 and 0.996357, which is in the stage of high-level coupling. This indicates that the three places have a strong mutual influence role and the overall development shows an orderly trend.

Table 4 Livability coupling

Certain year	2018	2019	2020
Coupling degree	0.991298	0.995446	0.996357

The coupling degree mainly reflects the degree of mutual influence between the three areas of the demonstration area's livability capacity building, and cannot reflect the coordinated development of the three. Therefore, to reflect the coupling and coordination relationship and coordinated development between the three areas of livability capacity building in the demonstration area, this paper introduces the CCD model and calculates the degree of coupling and coordination between the three areas of livability capacity building in the demonstration area based on the coupling degree obtained from the previous calculation. Taking 2018 as an example, according to the previous calculation results, it is known that the coupling degree of the three areas of the demonstration area in 2018 for the construction of living livability capacity is 0.991298, the evaluation value of Jiashan County's living livability capacity in 2018 is 0.439207104, the evaluation value of Qingpu District's living livability capacity is 0.42291557, and the evaluation value of Wujiang District's living livability capacity is 0.329809685, α, β and γ represent the coefficients to be determined for the livability of Jiashan County, Qingpu District and Wujiang District, respectively. $\alpha = \beta = \gamma = 1/3$ because the livability of the three districts is not prioritized and is regarded as equally important. (The coupling coordination degree can be calculated by substituting the above values into the formula (2) and the coupling coordination degree formula (1).

After calculation, the coupling coordination degree of the three regions of the demonstration area for capacity building for livability in 2018 is 0.627862, and it can be learned from the coupling coordination level table that its coupling coordination level belongs to the primary dysfunction. According to the above method, this paper calculates the coupling coordination degree of the three areas of the demonstration area's livability capacity building in 2018, 2019, and 2020 in turn. The results of the coupling coordination degree calculation and the grading of the three areas of the demonstration area's livability capacity building from 2018 to 2020 are shown in Table 5:

Table 5 Livability coupling harmonization degree

Certain year	2018	2019	2020
Coupling coherence	0.627862	0.709189	0.765633
Level of coordination	Primary coordination	Medium level coordination	Medium level coordination

The degree of coordination of the construction of the integrated demonstration area has gradually changed from primary dysfunction to intermediate coordination, which is because the proposal, implementation, and landing of a large number of demonstration area construction plans have led to the

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gradual joint development of the livability areas in the demonstration area, and the implementation of various types of policies has gradually revitalized the vitality of science and technology innovation in the demonstration area, which has led to the enhancement of the overall livability capacity of the demonstration area through the breaking of the resource barriers and opening up of the paths to be shared. According to the results of the analysis of the coupling and coordination relationship of the three areas of the demonstration area, the best state of the coupling and coordination of the three areas of the demonstration area from 2018 to 2020, the coupling and coordination of the three areas of the demonstration area, but there is still a big distance from the high-quality coordination, and all kinds of livability policy tools are still in the planning and starting stage, and there is still a lot of way to go to the concrete landing. The government should increase the construction of higher indicators, such as the number of fiber-optic coverage, public service attention, etc., to increase its attention and investment. It is hoped that there is room for further development and improvement in the coupling and coordination relationship in the future of the demonstration area.

4. Conclusions

Livability is an important part of the construction of integrated demonstration zones, a key step towards a better life for the people in the integrated demonstration zones, and a fundamental part of the construction and development of the integrated demonstration zones. This paper makes a comprehensive summary of the connotation of livability in integration demonstration zones, and at the same time, according to the construction requirements of the integration of demonstration zones, it constructs an indicator system of livability in demonstration zones from five aspects. At the same time, considering the availability and scientificity of the indicator data, the specific measurement indicators of the evaluation indicators of the above five major areas are identified separately, and the CRITIC entropy weighting method is used to determine the weights of the indicators, and the coupling synergism model is used to evaluate the degree of integrated development of the demonstration area, and the following conclusions are drawn: the livability capacity of Qingpu District is stronger in the demonstration area, and Wujiang District is the weakest; the degree of coordination of the construction of the livability capacity of the demonstration area has gradually shifted from primary to intermediate level, and the construction coupling degree is at the high coupling stage, with greater mutual influence. Gradually changed to intermediate coordination, the construction coupling degree is in the high coupling stage, the mutual influence is large, and the overall development trend is orderly.

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