Evaluation of Urban Spatial Planning Based on Sustainability System Ecology Model

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Abstract. The sustainable urban ecological system is of great significance for building high-quality ecological spaces in cities and realizing regional environmental value innovation. However, there is a lack of systematic evaluation and quantification of ecological sustainable spatial planning indicators today. This study starts from a systematic spatial design strategy and establishes a Sustainable Ecosystem Model (SSEM) to systematically evaluate urban spatial design schemes. Based on the SSEM model, a sustainable spatial planning scheme that conforms to ecological principles and achieves cost reduction and efficiency improvement is constructed. The research process is as follows: firstly, a review of the new features presented by the model framework after its introduction into China; secondly, based on the case of Tianjin Eco-city, an indicator system will be constructed to address the issues; then qualitatively optimize the combination through ecological scenarios; finally, a fixed effects model was used for quantitative detection and evaluation; finally, a sustainable optimization plan for urban spatial ecology was derived. Research results: In the context of rapid urban and community renewal, the problem of ecological development and regional design rebalancing has been solved, reflecting the strategy of model indicators in spatial accessibility and quantitative evaluation. The research conclusion indicates that the combination of SSEM model and fixed effects model provides a technological path and innovative method for the sustainable development of urban ecology. The completeness of ecological resource indicators and the accuracy of quantitative testing in engineering practice have been filled in, reflecting the positive significance of ecological design for urban renewal.

Keywords: spatial research, SSEM, fixed effect model, Tianjin Eco-city

1 Introduction

In recent years, with the deep development of ecological civilization construction in China, delineating the ecological red line, promoting green development, solving the problems of economic development and environmental protection, and creating a "beautiful" ecological landscape have become an important goal of contemporary economic society and urbanization process day by day. The report of the 20th National

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Congress of the Communist Party of China clearly pointed out that the construction of ecological civilization is an inevitable requirement for promoting the formation of green development and lifestyle. The "15th Five-Year Plan" for the development of green buildings and green ecological urban areas will implement at least 100 demonstration constructions of green ecological urban areas [2-4]. The concept of sustainable and systematic development of urban ecology is increasingly valued by urban space and environmental scholars, and its demonstration significance for international green and low-carbon spaces is very significant [5]. The spatial integration of urban ecosystems based on strategic concepts will inevitably drive the value release of regional industries, stimulate industrial potential, and bring new opportunities for the overall improvement of urban ecological regional innovation capabilities[6]. Therefore, the improvement of urban ecosystem framework has important theoretical and practical significance for the realization of innovative cities and ecological civilization construction in China.

2 Literature Review

In terms of the progress of eco-theoretical framework indicators, it originated from (Costanza et al.;1997)[7] (Zhao Yi et al.;2022)[8] Systematically analyze the connotations and characteristics of "ecological products," "ecological product value," and "ecological product value realization," and provide policy requirements for national spatial planning to lead the realization of ecological product value; (Fan Yulong et al.;2023) [9] proposed the theory of ecosystem service network, which integrates the supply and demand of ecosystem services, and promotes the connection between the "one network" of ecosystem services and the "one map" of national spatial planning. (Xiao Xian;2017)[10] applied the spatial pattern of ecosystem services to the space of regional nature reserves; (Peng Jian, Zhao Huijuan, Liu Yanxuan;2017) [11] put forward index screening and ecological resistance surface repair by explaining the regional ecological security pattern. (Cao Qiwen, Zhang Xiwen, Ma Hongkun;2018)[12] constructed the framework and index system of landscape ecological risk assessment based on ecosystem by applying ESRISK framework of ecosystem services to landscape ecological risk research; (Liu Haimeng, Fang Chuanglin, Li Yonghong;2019)[13] put forward the analytical framework for explaining Coupling mechanism ("Coupled Magic Cube CHNC") between urbanization and ecological environment , and discussed the interaction of its indicators, concepts, connotations and evolutionary laws; (Zhang Civilization, Zhang Xiaode;2020) [14] proposed the framework of capitalization of ecological resources, and discussed the value of indicators of new resource management concept in the ecological field; (Guo Mengdi, Han Jichong, Shi Yong, etc.) [15] selected indicators based on DPRISM conceptual framework. An evaluation index system was established to quantitatively study the dynamic process of ecological environment vulnerability. In the above studies, the data expression, strategy and evaluation method of the model framework are emphasized, but the systematic quantification, algorithm and quantitative detection of the indicators of the ecological spatial model are not involved too much.

In terms of practical progress in spatial ecological assessment, AECOM has proposed a sustainability system framework in the planning process to guide and control indicators for community planning. (Peng po, Li Fengyu et al.;2011) [16], after more than a decade of progress, this model has been able to systematically and quantitatively evaluate most functional indicators of urban design (Zhou Qi et al.,2024) [17]. (Li Ruiqian et al.;2020)[18] explored the supporting role of ecosystem services in the construction of spatial planning systems from multiple dimensions; (Li chanxiang, et al;2024)[19] Deepen the connotation of spatial utilization quality from the perspective of carrying objects, activity subjects, and the ability generated by their interaction. (Xie Hualin,2005) [20] put forward the framework of natural elements and policy guidance for sustainable utilization of urban and rural regional ecosystems; (Luo Guangbin et al.;2007) [21] put forward the evaluation index system of ecological environment in Chongqing under the background of urban and rural overall development, which is divided into urban ecological environment subsystem and rural ecological environment subsystem; (Shen Qingji;2012) [22] thoutht that the analysis is made from the indicators, systematicness, coordination and convenience of urban and rural ecological benefits and elaborated the evaluation and analysis framework of urban and rural ecological benefits and spatial programs; (Fan Jie;2015) [23] innovated the early warning system of ecological environment convenient ability, and carried out the technological process of process space early warning from the situation of natural resource utilization and ecological environmental impact based on the relationship between man and land; (Tian Ruomin, etc;2017) [24] used text analysis to analyze ecological issues in urban overall spatial texts; (Xie Yongjun et al.;2021) [25] used measurement methods to enable ecosystem services to effectively expand land space for research; (Zhao Wenwu et al.;2018) [26] proved that the research and practice of land use space in China increasingly depends on the concept and method of ecosystem; however, few studies touch on the systematic and logical nature of ecological perspective and urban spatial assessment methods.

In summary, the urban spatial planning and ecological environment assessment system lacks in the construction of spatial indicators, the qualitative optimization combination of options and the quantitative detection and evaluation of schemes. The solution of this paper is to use ecological indicators in the sustainable system model for reference and use qualitative and quantitative methods to effectively evaluate the spatial planning scheme.

3 Research Design

3.1 Basic Principles of the Model

SSEM modeling process is the application of optimization and consideration of urban ecological space system. Its characteristics are based on the general planning conditions to screen key subject items, quantify each core subject index by ecological expert team, and then establish a conceptual preliminary plan, which is further integrated into the project space, budget and business plan to optimize the options, the best ecosystem integration solution is obtained after evaluation. The purpose is to find the optimal combination of environmental and economic benefits for the record [27-28].

As shown in Figure 1.

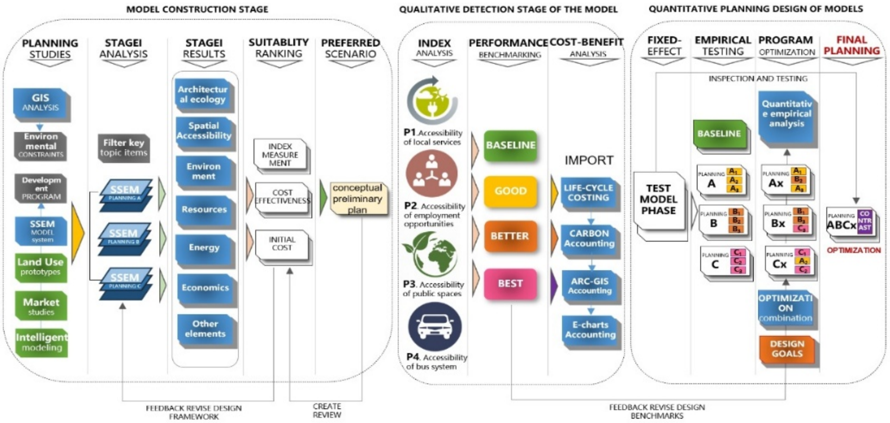

Fig. 1. Optimal combination classification of SSEM models

3.2 Indicator Construction

Fig. 2. Ecometric Diagram of SSEM System Model

SSEM model is composed of water system, environmental protection building system, energy system, social and economic system, trading system, base environment and ecological system and other design indicators. It features with comprehensive, easy to integrate and quantifiable. SSEM balances the deviation of eco-sample indicators in system integration. However, not all urban eco-regions have good basic indicators. SSEM can effectively quantify the spatial eco-indicators of urban areas, deepen the degree of each indicator system, and optimize different alternatives. In the end, the ecological value of regional environment will be enhanced to realize coordinated development of ecological civilization of multifunctional cities. Therefore, the qualitative optimization and quantitative evaluation of ecological indicators are carried out based on the sustainable model. As shown in Figure 2.

4 Model Building

4.1 Model Design

Statistical analysis of fixed-effect model data is more and more widely used in the field of quantitative spatial analysis (Shi Lei; 2008) [29]. It assigns an indicator variable for each subject item, and reflects the influence of groups on response variables by estimating their regression coefficients [30]. For different index cross-sections or different time series and different intercepts of the model, the method of adding regression parameters of index variables into the model is adopted. It is a model with different intercepts for different individuals. The expression is 3:

$$y_{it} = \beta_0 + \beta_1 x_{it} + \beta_2 z_i + u_{it} \tag{1}$$

Where z_i is a potential variable that does not change with time, is not observable, but is related to x . The above formula can be changed to:

$$\begin{aligned} y_{it} &= \beta_0 + \beta_1 x_{it} + \beta_2 z_i + u_{it} \\ &= (\beta_0 + \beta_2 z_i) + \beta_1 x_{it} + u_{it} \\ &= \alpha_i + \beta x_{it} + u_{it} \end{aligned} \tag{2}$$

Because α_i is related to a real (but not observable) variable in each individual, it is used to detect the rationality of the index data in the alternative. At this stage, special emphasis should be placed on the authenticity and rationality of spatial data. The test results are required to be more scientific in order to select the preparatory plan of ecological space.

4.2 Core Advantages

The urban ecological sustainable development indicators of the SSEM system integration model reflect the quantitative characteristics of empirical design, which is in line with the increasing emphasis on comprehensive analysis of data integration in the content and form of urban and rural spatial compilation in China. The thematic indicators in the model become the key system for design and creation, and are the theoretical basis for evaluating the entire space. Secondary indicators are alternative differences that reflect the microstructure of the plan. The steps can be roughly divided into: 1. Model verification stage. After comparing indicators, a preliminary spatial plan is formed. At this stage, it is necessary to consider the design continuity of the surrounding area, the smoothness of the corridor, the rationality of the indicators, and the coordination of resources. 2. Integration model stage. The spatial convenience index evaluates the established scenario system, generally divided into four qualitative levels: baseline\good\better and best. After evaluating the system items in the plan, they are included in the cost and investment benefit calculation, and the cost-benefit ratio is obtained and compared with the project objectives. Then, the system indicators are revised twice to form alternative plans with situational characteristics. 3. Optimize the model stage and the detection model stage, establish a sustainable development plan, and form a sustainable planning scheme and project implementation sequence. The first and second stages are qualitative stages, while the third and fourth stages are quantitative stages.

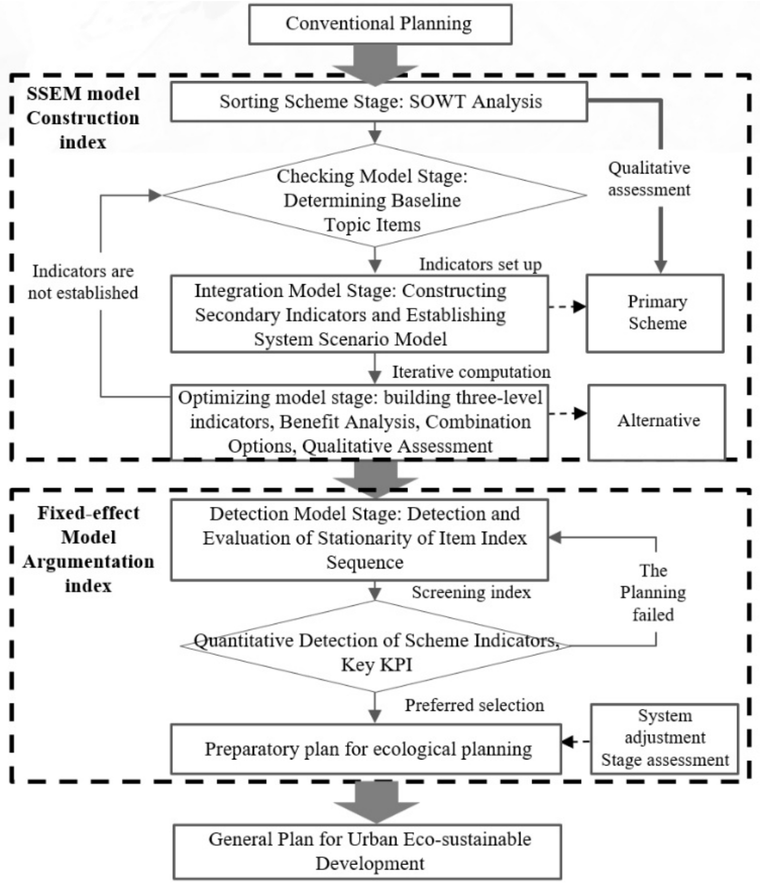

Fig. 3. System Integration Model Workflow of SSEM

The core advantages of the SSEM model are: 1.Breaking through traditional planning boundaries and creating new design forms. To meet the regional development needs of ecological sustainability and composite indicators, comprehensive empirical research integrating landscape, planning, economy, ecology and many other elements is carried out to lay a theoretical and technical foundation for urban areas in higher-level ecological planning, design transformation and development, green and low-carbon industries and other design fields. 2.It breaks through the traditional urban planning that focuses on single indicators, one-way functions, pure space and other factors. It is a comprehensive land spatial assessment tool that reflects the quantitative design of buildings, space, resources, environment, and energy, and explores and enhances the potential for economic, social, and environmental sustainability. Given the length of this article, the focus is on two core advantages: the construction of model indicators and quantitative testing of ecological design engineering. As shown in Figure 3.

5 Taking Tianjin Ecological City as an Example

5.1 Background

Taking Tianjin Eco-city spatial research object[31], its team is of diversified characters: the United States has top-level space office, environmental office, construction office, we have professionals in the municipal space department, ecologists, traffic engineers, building energy and water engineers, etc. Large-scale projects are controlled by the government, the park management committee and the chairman of the cooperation group. The role of space project management is different at different stages, but it runs through the project.

Firstly, according to SWOT analysis, the main ecological challenges facing space are as follows:

(a) Enhancement of ecological benefit cost caused by environmental pressure, such as dry climate in Eco-city ecological community of Tianjin, which considers that construction intervention leads to serious water pollution and needs to consider ecological environment indicators.

(b) The impact of population growth on habitats needs to calculate the economic benefits of low carbon emissions.

(c) Soil salinization is serious, plant growth is limited, the cost of conservation is high, the ecological characteristics are single and fragile, a large number of pollutants accumulated at the end of low biodiversity watershed, which require the construction of landscape and spatial system indicators.

(d) The threat of rapid land development model to the ecological environment: such as resisting urban heat island, degrading pollution, regulating climate, etc. The ecological pressures of water resources management, flood control and sustainable development need to be considered comprehensively. In view of the above problems, the overall idea is to provide corresponding spatial indicators, focusing on quantitative feedback between indicators, ecological indicators system, and program optimization evaluation.

Using SSEM system integration model, the ecological indicators will be modeled and evaluated systematically, and a clear logical structure, scientific and reasonable sustainable scheme will be generated. As shown in Figure 4.

Fig. 4. Tianjin Eco-City Master-plan (excerpt)

5.2 Selection of Indicators

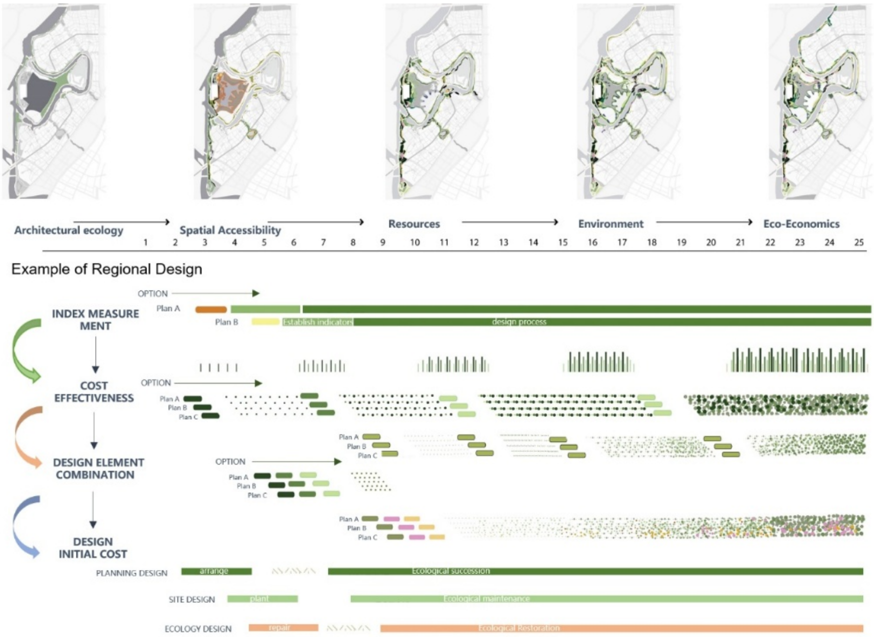

Fig. 5. Construction of SSEM Model Diagram

The index of ecological sustainability of SSEM was constructed. For problem (a), setting up environmental and economic ecological indicators from the perspective of ecological function: dividing communities according to their functions and estimating the reference cost per capita; for problem (b) and (c), setting resources and energy ecological indicators from the perspective of green infrastructure and population structure: the population of Eco-city community will increase by 6 million by 2035, accounting for per capita consumption of electricity and oil; and considering energy structure: LEED

Act takes the lead in incorporating carbon emission reduction strategies into SSEM's energy structure indicators and estimating economic benefits; in view of problem (d), building indicators and spatial accessibility indicators are established from the perspective of construction and development: building and public facilities volume ratio and development amount are established to eliminate the pressure on natural habitats from construction and development. Take these items as first-level options, and then establish the second-level indicators. Establish workflow and use model to carry out work. As shown in Figure 5.

5.3 Data Collection

The vegetation in a region is a comprehensive reflection of the local flora, natural factors such as terrain, climate, soil, and human interference.The typical vegetation types within the base area mainly includeSuaeda heteroptera community: it is accompanied by the grass of alkali grass and salicornia salina, which are distributed in the coastal area. It is the pioneer community of mudflat and the pioneer plant to transform the geographical environment of saline soil. The appearance is a purple red color, as shown in Figures 1 / 2.

Zhangmao community: distributed in coastal areas, not only in patches, but also in small communities distributed in other communities. Outer gray green color, simple structure. As shown in Figure 7/8.

Alkali plant community: distributed in low salinized wetlands, it is an indicator plant for saline alkali soil, with yellow flowers, often embedded in other communities, as shown in Figure 9/10.

Fig. 6. Planning, measurement, and location selection

Data collection is based on two types of objective data and spatial pre-judgment. The selection pattern index of objective data is selected from the information gathering in the spatial area. For example, passenger flow data refers to the selection method of data set in the group intelligence perception of public transport system [32], (Anjian, Peng Zhenlong, Guixiaolin, etc.) [33] in 2019, and advances from the data gathering efficiency, accuracy and migration distance and other indicators. Line comparative analysis. OpenCV is invoked from Python to extract the optimal interval of effective index images from traffic and employee flow monitoring video stream data, including cross-section flow between stations and inbound and outbound flow of stations. In addition to passenger flow data, density data (Shengqiang, Xia Haishan, Liu Xing; 2018) [34] of the actual urban function distribution are also introduced to reflect the accessibility effect and system impact of local service equipment, employment opportunities and public space. According to the research method of Yang Tao, a space syntax scholar, the spatial distribution of various Baidu POI locations in Eco-city, Tianjin shows that the spatial distribution of business functions is generally highly correlated with the distribution of other functions, which can better represent the more dynamic distribution density of business and service employment in the community. The data of "social institutions" in the indicators are measured by the network statistical yearbook of government information disclosure. Python is used to achieve network crawling and stored in the porn catalogue. Seventy percent of the data sets were used as training samples, 15% were used as testing and validation samples. After Market Research and filtering, the training is carried out in a dimensionless and normalized way. The data of spatial prejudgment is embodied in the quantitative indicators of the alternatives. The actual detection will evaluate the quantitative compliance of the indicators of the alternatives based on the comparative study of the two data. As shown in Figure 6.

6 Research Results

6.1 Optimal Spatial Combination

In the optimized combination index, the number of population in the index can guide the land use pattern. Taking the index of "space accessibility" as an example, it can be divided into four secondary indicators: local equipment accessibility, employment opportunity accessibility, public space accessibility and public transport system accessibility. It is further divided into 15 sub-indicators. It means that the distribution of population density in space, working community and bus station all produce a system. The goal of the model is to increase the population density of the office area and make the residents closer to work, thereby reducing the dependence on vehicle use. Quantitative control is completed in combination with different types of construction costs such as residential, commercial, and developers. Taking 400 meters of walking as a comfort measurement index, the improvement ratio of the conceptual space alternatives is obtained, and then the qualitative optimization item combination is formed according to the design of the carbon emission footprint. It can be divided into two parts: lowering the developer's cost to the greatest extent, realizing the best sustainable goal of the eco-city under the premise of controlling the increase of the main developer's cost not more than 1%, and balancing the energy demand and cost control. The cost of controlling the main developer should not increase by more than 3%, and the cost of ecological landscape industry should not increase by more than 5%. The best comprehensive effect item is to achieve the best overall environmental benefit with reasonable investment. Under the premise of controlling the initial cost and the cost of the main developer to increase by no more than 5%, the cost of the eco-landscape industry to increase by no more than 5%, and the investment return period of the non-eco-landscape architecture to be less than 10 years, the project achieves the lowest carbon emission. As shown in Tab.1:

Table 1. SSEM System Topic Item Optimizing Panel and Scheme Selection (Selected Indicators)

Sub-item indicators: secondary code (PTHEMES	*Three-level sub-indicators THEMES*	*Three level code (PP)*	*SELECTED PACKAGES PROGRAMS*		
			Planning A	*Planning B*	*Planning C*
P1. Accessibility of local services	Accessibility of school service	PP1	GOOD	BETTER	*BETTER*
	Accessibility of commercial service	PP2	GOOD	BETTER	*BEST*
	Accessibility of community service	PP3	GOOD	BETTER	*BEST*
	Accessibility of hospital service	PP4	GOOD	BETTER	*BETTER*
	Accessibility of public service	PP5	GOOD	BEST	*BETTER*
P2. Accessibility of employment opportunities	Accessibility of entrepreneurial opportunity	PP6	GOOD	BETTER	*BEST*
	Accessibility of employment opportunities (within 400 meters)	PP7	GOOD	BEST	*BETTER*
	Accessibility of freelance work (400 metres away)	PP8	GOOD	BETTER	*BEST*
P3. Accessibility of public spaces	Accessibility of public spaces	PP9	GOOD	BETTER	*BETTER*
	Accessibility of waterfront space (within 400 meters)	PP10	GOOD	BETTER	*BEST*
	Accessibility of green space (400 metres away)	PP11	GOOD	BEST	*BETTER*
P4. Accessibility of bus system	Accessibility of light rail transit	PP12	BASELINE	BASELINE	*BASELINE*
	Accessibility of transfer hub	PP13	BASELINE	GOOD	*GOOD*
	Accessibility of public transport	PP14	GOOD	GOOD	*GOOD*
	Accessibility of traffic site	PP15	GOOD	BETTER	*BETTER*

After discussion with the owner, based on the concept of cost reduction and efficiency improvement results and schematic diagram, it is more appropriate to qualitatively evaluate the spatial accessibility of option C. The results of index establishment are embodied in the economy, efficiency and linkage of the index.

6.2 Quantitative Detection and Evaluation

In order to ensure the stability of the panel data series of the indicators in the optimization scheme and avoid the "pseudo-regression" problem caused by the non-stationarity of the planning time series, the unit root method is used to test the stability of each index variable before model index detection. The software STATA14.0 is used here, the non-balanced panel data is selected, and the Fisher-ADF is used to finish panel data unit root test . The specific test results are shown in Tab. 2.

Table 2. Unit Root Test Results (excerpts)

Indicator Variables	***p Statistics***	***z Statistics***	***L* Statistics***	***Pm Statistics***	***Conclusion***
Resident Population	88.7712 (0.0000)	-3.4882 (0.0002)	-7.4170 (0.0000)	11.7952 (0.0000)	Stable
High-rise Building Capacity	174.8061 (0.0000)	-7.9869 (0.0000)	-15.8106 (0.0000)	26.1344 (0.0000)	Stable
Net Amount of Residential	78.2638 (0.0000)	-2.9468 (0.0167)	-5.6394 (0.0074)	9.3864 (0.0000)	Stable
JOBS working	68.5095 (0.0000)	-4.4863 (0.0000)	-5.5973 (0.0000)	8.4183 (0.0000)	Stable
Accessibility of employment opportunities	30.7538 (0.0307)	-1.0161 (0.1548)	-1.4092 (0.0826)	2.1256 (0.0168)	Stable
Accessibility of public spaces	32.4871 (0.0268)	-1.9734(0.0024)	-2.0021(0.0432)	1.9836(0.0281)	Stable
Accessibility of the bus system	38.9419 (0.0451)	-2.4829 (0.0007)	-5.8271 (0.0024)	4.468 (0.0000)	Stable
Accessibility of local equipment	53.3819 (0.0381)	-5.6290 (0.0100)	-9.1436 (0.0036)	9.6421 (0.0270)	Stable
Parks and opening spaces	35.1901 (0.0089)	-2.4905 (0.0064)	-2.3826 (0.0106)	2.8650 (0.0021)	Stable
Opening space connectivity	132.1052 (0.0000)	-7.1735 (0.0000)	-11.9754 (0.0000)	19.0175 (0.0000)	Stable
Conservation land	118.0935 (0.0000)	-4.2800 (0.0000)	-9.5295 (0.0000)	16.6822 (0.0000)	Stable
Electricity consumption per capita	108.4703 (0.0000)	-4.4479 (0.0000)	-9.1458 (0.0000)	15.0784 (0.0000)	Stable
Water consumption per capita	122.0941 (0.0000)	-5.7414 (0.0000)	-10.7197 (0.0000)	17.3490 (0.0000)	Stable
Motor mileage per capita	73.5961 (0.0000)	-3.9472 (0.0000)	-6.3782 (0.0000)	23.5386 (0.0000)	Stable
Carbon emissions per capita	186.1466 (0.0000)	-7.1175 (0.0000)	-16.2353 (0.0000)	28.0244 (0.0000)	Stable
Solid Waste	30.2380 (0.0352)	-2.1264 (0.0167)	-1.9890 (0.0261)	2.0397 (0.0207)	Stable
Per capita reference cost	148.1637 (0.0000)	-6.3419 (0.0000)	-12.3674 (0.0000)	34.1549 (0.0000)	Stable

Because the sequence of variables is not stable, the variables of planning indicators are treated differently, and the variables after the difference are tested by unit root. The accompanying probability P values of the test statistic p and Pm of the Fisher-ADF test are both less than 0.05, so the assumption of unit root is rejected, and the P values of statistics satisfy the parameter requirements. This means the indexes of SSEM model are effective, and the results can be used for robustness test analysis. Then, the fixed-effect decision-making evaluation model is used to test 14 sub-items of 5 major items in the spatial alternatives of Eco-city ecological community in Tianjin (excerpts). Based on the original data and index data, the weights of each index of the original planning scheme and the optimized preparatory scheme are calculated by the normative matrix, as shown in Tab.3.

Table 3. SSEM System Subject Item-Alternative Assessment (Provisional 14 items)

THEMES	*1CODE*	*SUB ITEM*	*2CODE*	*UNIT MEASUREMENT INDEX*	*COMPARISONS OF CALCULATION RESULTS OF ALTERNATIVE SCHEMES*	
					Scheme A Weight	*Scheme B Weight*
Architectural ecology	A	Resident Population	A1	Per	0.2470	0.2375
		High-rise Building Capacity	A2	Du	0.0001	0.0012
		Net Amount of Residential	A3	Du	0.0085	0.0421
Spatial Accessibility	P	Accessibility of entrepreneurial opportunity	P1	KM	0.1312	0.1083
		Accessibility of employment opportunities	P2	KM	0.1552	0.1420
		Accessibility of public spaces	P3	KM	0.0778	0.0899
		Accessibility of the bus system	P4	KM	0.2442	0.1074
Environment	E	Parks and opening spaces	E1	HA	0.3071	0.4533
		Opening space connectivity	E2	HA	0.6312	0.6851
		Conservation land	E3	HA	0.06978	0.7452
Resources	R	Electricity consumption per capita	R1	KWHR	0.1014	0.1011
		Water consumption per capita	R2	LITRES	0.1282	0.1180
		Motor mileage per capita	R3	KM	0.1424	0.1300
Energy	C	Carbon emissions per capita	C1	MT	0.0442	0.0304
		Solid Waste	C2	MT	0.0352	0.0382
Economics	S	JOBS working	S1	Per	0.1073	0.1542
	S	Per capita reference cost	S1	RMB\Per	0.0531	0.0427

Contrastive analysis: Tab. 3 shows that the weight of development indicators such as population, net residence, open space and job opportunities in Eco-city community scheme is gradually increasing, and the weight of development indicators such as per capita water consumption, traffic mileage and carbon emissions is gradually decreasing, and per capita parameters are also increasing. In optimization scheme, along with the regional scenario shift from suburb to main urban area, the weight of these eco-natural energy indicators decreases, while the proportion of community energy consumption gradually increases, which indicates that the path dependence of the eco-factor types on the system model is gradually strengthened (such as different types of natural ecological wetlands and urban dissipated energy), and the total price of the system of the ecological indicators of urban public space is increased. The contribution of the value will gradually increase, for example, the proportion of park and open space in the optimization scheme has the largest weight, that is, the optimal state of 45% greening rate. The connectivity coefficient of open space is also very high, reaching 0.68, and the ratio of retained ecological land reaches 0.74. In addition, the weight of high-rise building volume and other indicators is very low, which can almost eliminate its impact.

This form conforms to the logic of Tianjin Eco-city's overall economic and spatial development, so it can be used for the guidance of space landing. At this stage, the results of index evaluation and program construction evaluation are accurate.

7 Conclusion and Discussion

7.1 Research Conclusions

Based on indicators of the ecological sustainable system model, the evaluation of the spatial scheme is discussed, and a perfect system for the evaluation of the ecological sustainable space planning is constructed according to the project case. Quantitative system of six major themes and 17 secondary indicators of environmental protection building, space accessibility, environmental ecology, resource consumption and social economy was constructed. Through qualitative evaluation and quantitative detection of the three indicators, the optimal planning scheme was formed. The core advantages of the model can be summarized as follows: (a) System construction mechanism of indicators. By coordinating land use and sustainable technology, the optimal allocation model of environmental benefits and economic benefits is constructed, and further integrated into project space, public policy, budget valuation and business plan to form alternatives, which is conducive to the effective development of space design. (b) Qualitative combination mechanism of options. Find out the best combination of indicators and related land use options. Small samples are used as study subjects to facilitate qualitative evaluation of the three-level indicators. (c) Quantitative evaluation mechanism of the scheme. Based on the spatial planning elements of the indicators, detection and comparison are carried out. Because SSEM model combined with fixed effect model can fully display the advantages of quantitative and objective data matching and overcome the shortcomings of qualitative and subjective, it is a planning method with clear logic, simple process, simple calculation and better convergence. It provides a new solution method and exploratory thinking for the theory of urban ecological sustainable development in China. The "introduction strategy" of the core mechanism can be adopted (Dou Ruiqi; 2021). [36]

7.2 Policy Suggestion

The context of indicators is of great significance to the integration of ecological structure and spatial mechanism. Constructing multi-disciplinary scenario sub-guidelines of ecological nature, endowing creative indicators such as culture, energy and infrastructure with core values, so as to integrate economic strategy, environmental analysis, traffic design and regional space well [37]. The sustainable advantages of SSEM are reflected not only in the economic aspect, but also in the greenhouse gas reduction strategy, the research and development strategy of public transport system, and the comprehensive "carbon footprint" emission reduction strategy. SSEM helps developers to use spatial processes to reduce carbon emissions is an inevitable requirement for the construction of ecological civilization in China. The economic return of new projects can be achieved through different combinations of environmental benefits and cost models.

Quantitative evaluation of spatial indicators can be used as a basis for the development of large-scale "ecological city" and "resilient city"[38]. Geographic information system-based land use spatial planning method is an innovation of traditional design methods. It quantifies and compares sustainable ecological, spatial, energy consumption, climate and other change parameters. Through a series of evaluation and testing of spatial indicators, as a comprehensive spatial platform, it can not only guide the spatial design process, but also achieve ecological sustainable solutions. To a certain extent, it has solved the deep-rooted problems of urban renewal in China, such as lack of ecological value orientation, inadequate regulation and control of indicators, and fragmentation of specialties (Yang Jianqiang; 2018). [39]

It is worth noting that SSEM should also be compared, revised and optimized with the original scheme after evaluation, and insist that land and space rigid indicators do not drift. On the premise of satisfying all aspects, the sustainable space scheme reflected by SSEM system integration model can bring the greatest energy efficiency advantage into play. SSEM has also tried to be applied to projects of various sizes, such as green space projects, existing communities and brown land management aiming at laying a solid foundation for the implementation of the program. It also provides technical guidance and innovative directions for spatial issues related to urban ecological civilization construction.

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