

Research on Economic Evaluation Decision Model Based on Quantitative Analysis in Urban Renewal Work

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Abstract: Urban renewal is a long-term, arduous and complicated systematic project. There are many contradictions in the process of renovation, especially in the inconsistent interests of the government, developers, and property owners. How to balance the demands of all parties and find the balance of interests between them is extremely important. As an effective means to seek the balance of interests of all parties, economic evaluation can use quantitative analysis results to reveal the actual cost value of the renewal project and provide a decision-making basis for the government to approve project development. This paper combines the actual urban renewal work in Zhuhai, based on the established standard index system of urban renewal economic evaluation, establishes a complete urban renewal economic evaluation model through algorithmic analysis and preference, develops an economic evaluation model software system, realizes the standardization and normative management of urban renewal economic evaluation, and solves the problems of urban planning control and management and governance brought by the unreasonable interests of the market main body.

Keywords: Urban renewal; After evaluation model; Economic evaluation software system; Geographic information

1 Introduction

Urban renewal is a long-term arduous and complex systematic project, and there are many contradictions in the process of transformation^[1]. For example, developers, owners and the government have different starting points; the preparation of the economic evaluation report is dominated by the development company, which is relatively random; the psychological expectations of the development company for the floor area ratio value are constantly expanding. How to balance the demands of all parties and find the balance of interests between them is extremely important. As an effective means to seek the balance of interests of all parties, economic evaluation can maximize the guarantee of the construction and maintenance of public welfare urban space and the smooth progress of urban renewal.

Cities at home and abroad have carried out explorations on the economic evaluation of urban renewal projects, and put forward quantifiable indicators for the situation that "economic evaluation is biased towards the practical level". However, these works generally have the problems of over-reliance on market players, lack of effective means, and too many subjective factors. The competent department pays more attention to planning schemes or traffic impacts,

and there is no effective means to efficiently manage and restrain the subject of economic evaluation, leading to one-sided pursuit of economic benefits, making the layout of the land used in the update is unreasonable and the development intensity is too high. Therefore, there is an urgent need to establish a fair and reasonable economic evaluation system and long-term mechanism for urban renewal projects to better assist the government in guiding market operations^[2,4].

Based on the researching of the economic evaluation elements and data standard system of urban renewal projects, this paper innovatively proposing a solution of economic evaluation system for the problem of "investment return-volume ratio and other indicators control" of urban renewal and reconstruction projects. based on computer network technology, database technology, GIS, big data, BIM and other technologies, establish economic evaluation mathematical models, develop economic evaluation model software systems, and use the construction of urban renewal information platforms as the starting point to realize the standardization and standardized management of urban renewal economic evaluation work, speak with data to provide scientific basis for decision-making of auxiliary economic evaluation projects.

2 Overall technical route

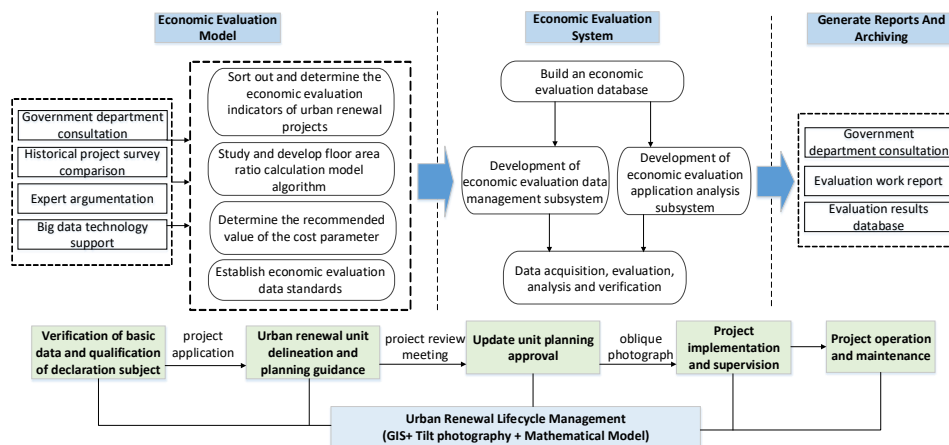


Fig.1 Technical route

This paper takes Zhuhai's urban renewal work as an example, and researches deeply into the establishment of the standard index system for economic evaluation, the optimization algorithm, and then establishes the economic evaluation model for urban renewal projects; and builds an integrated system platform for economic evaluation of urban renewal based on the established economic evaluation platform model (including the declaration system, evaluation system, and supervision system), so as to realize the processing and standardization of the economic evaluation and review work of the urban renewal and reconstruction projects. The platform applies the combination of BIM and GIS technology to the refined management of urban renewal projects, and realizes the dynamic update and maintenance of urban renewal economic

evaluation and urban renewal unit planning information, thus providing comprehensive information on the application, planning, construction, operation and management of urban renewal projects. Full life cycle management, providing services for planning approval, construction management and operation supervision of urban renewal projects. As shown in Fig 1. The economic evaluation system and system construction of urban renewal projects studied in this paper include the following steps:

- (1) Sort out and determine the economic evaluation indicators of urban renewal projects, and establish economic evaluation data standards. And based on big data technology and historical project surveys, the suggested values of cost parameters are determined.
- (2) Based on the research of the economic evaluation index system, the calculation model algorithm of the floor area ratio was formulated.
- (3) Establish an economic evaluation database based on economic evaluation data standards and develop a data update mechanism.
- (4) Developing business system of economic evaluation based on model algorithm and database table.
- (5) Based on the historical data collected by the economic evaluation business system, the regularization and construction of the database, the differential analysis based on the data standard and the check analysis are carried out, and the evaluation work report and the data storage and construction of the evaluation results are automatically exported.

3 Calculation and evaluation standard index system

The establishment of an economic evaluation system for urban renewal according to local conditions is the first step to do a good job in economic evaluation. Urban renewal covers a wide range, including industrial plants, commercial, office, hotel and other properties in the old urban area^[14]. During the actual project implementation process, a comprehensive and in-depth investigation should be conducted on the specific conditions of the old city reconstruction project. Through consultation with relevant government departments, the similar projects that have been transformed are investigated and compared, combined with quantitative and qualitative methods for comprehensive analysis, combing and screening the elements of economic measurement and evaluation, and finally determining all the evaluation indicators involved in the project transformation. See Tab.1 and Tab.2. In addition to the verification of ownership information or declaration plan, this paper also proposes a method to verify the recommended value range of basic data and cost indicators based on big data statistics and analysis technology, and to evaluate the verification and cost data of basic data provided by applicants.

3.1 Economic assessment indicators

Taking the project of demolition and construction of uncompleted tail buildings in Zhuhai as an example, it is divided into two categories, according to the project's basic items and economic calculation items. The project's basic items refers to the basic information of the project, which is based on the project and is oriented to management work, including 10 categories such as the

land area of project ownership. The economic calculation items include five categories: upfront costs, construction and installation costs, decoration costs, participating in the calculation of related rates and development value. The detailed indicators are shown in Tab.s 1 and 2.

Table.1 Basic item category standard data sheet

Category	Unit
1.Area of land formerly owned by the project(A)	square meter
2.“The "supplementary public" area(E)	square meter
3.Public service facilities and other building area(Q)	square meter
4.The construction land area of the project(Deductible E)(H)	square meter
5.Legally recognized area of existing property(J)	square meter
6.Basement floor area(V)	square meter
7.Relocating building area(P)	square meter
8.Scale of financing development(K)	square meter
9.the floor area ratio(W)	
10.Calculate the floor area ratio(plan)(X)	square meter

Table.2 Cost and development value assessment measurement standard data sheet

	Category	Unit
upfront costs(B)	1. Land cost (B1)	RMB
	2. Cost of building Demolition (B2)	RMB
	3. Monetary compensation costs (B3)	RMB
	4. Other upfront costs involved in updating (B4)	RMB
Construction and installation costs(C)	1. Construction and Installation costs for the return of commercial property (C1)	RMB/square meter
	2. Sales of commercial property construction and installation costs (C2)	RMB/square meter

	11. Construction and Installation Fees of public service Facilities (C11)	RMB/square meter
	12. Construction and Installation cost of underground Parking lot (C12)	RMB/square meter
renovation costs(D)	13. Construction and Installation Costs of civil Air Defense Engineering (C13)	RMB/square meter
	1. Decoration Expenses for returning commercial Properties (D1)	RMB/square meter
	2. Decoration Expenses for selling commercial Properties (D2)	RMB/square meter

	11. Decoration Expenses of public service facilities (D11)	RMB/square meter
	12. Decoration cost of underground parking lot (D12)	RMB/square meter
Participate in the calculation of relevant rates	13. Decoration Cost of civil air defense Works (D13)	RMB/square meter
	1. Project Development Management Fee (G)	RMB
	2. Sales Rate (m)	
	3. Sales Tax Rate (M)	
	4. Interest Rate (L)	

	5. Development Cycle (N)	Year
	6. Cost Margin (R)	
development value(Y)	1. Commercial unit price (Y1)	RMB/square meter
	2. Unit price of office sales (Y2)	RMB/square meter
	3. Unit price of housing (Y3)	RMB/square meter
	4. Hotel sales unit price (Y4)	RMB/square meter
	5. Industrial Sales unit price (Y5)	RMB/square meter
	6. Unit price of salable underground parking space (Y6)	RMB/piece

3.2 Basic data assessment based on big data technology

Urban renewal data is the basic work of supporting the scientific development of urban renewal work. This study integrates planning data, land tax and land price, project basic data, patch data, examination and approval data, POI data, cost unit price network capture data and other data, etc. The data constructs the urban renewal big data resource database, which provides powerful data support for urban renewal policy research, planning compilation, economic calculation, and project life cycle dynamic monitoring. The following is an example of basic land price evaluation to illustrate the idea of determining cost parameters based on big data technology.

By collecting various data of different levels, different sections and different types of land types in cities, the status quo of land prices is investigated and recorded, and comprehensive planning data, land use status data, maps and other data form a professional database of urban land prices. Then based on a series of indicators such as land price level, land price change and land price growth rate, a reasonable urban land price evaluation system is established, and the urban land price is evaluated by geostatistical analysis technology and spatial interpolation algorithm, and finally the relevant land price information is generated as the basic. The land price assessment provides the basis. At the same time, a GIS-based urban renewal project economic evaluation management system was established, and the basic land price was quickly updated through the land price dynamic monitoring module. The basic land price assessment flow chart is shown in Fig.2.

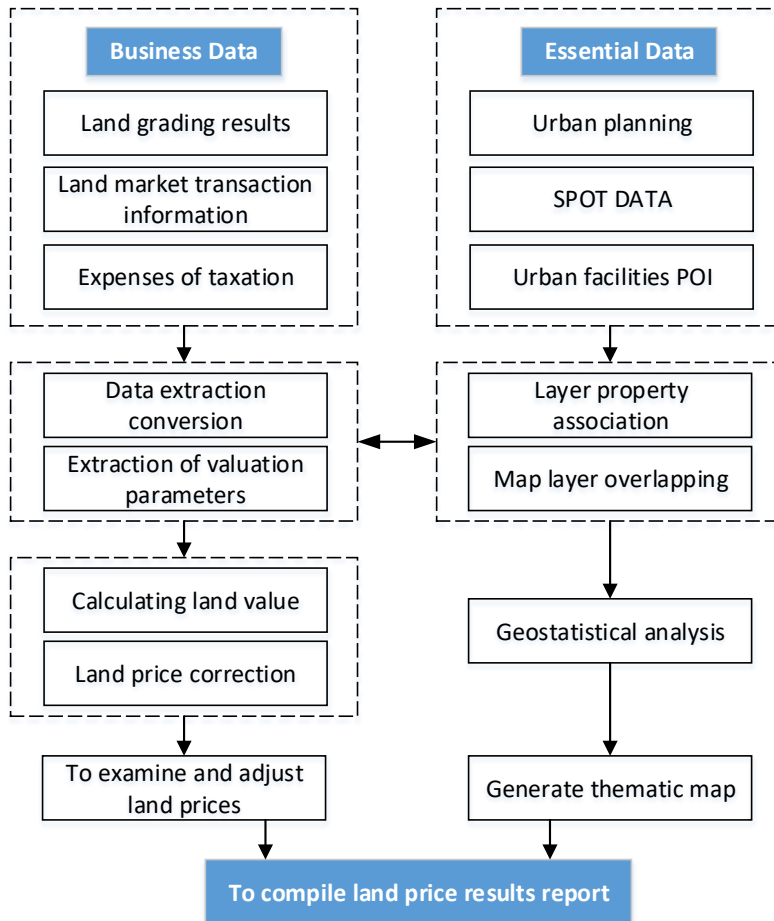


Fig.2 Basic land price assessment flow chart

4 Algorithm Model Based on Standard Index System

On the basis of economic evaluation data standards, after data investigation and sorting, the variable factors of this research are determined by refining the variables related to specific projects. According to the proposed technical ideas, a mathematical model for the measurement and calculation of financing construction scale is deduced. That is, through the calculation of the total cost of the urban renewal projects, as well as the "unfinished building" treatment project, and compare and analyze the sales revenue after the completion of the project update, and then Calculate the total profit and cost profit rate after the renovation of the project. The algorithm flow of the economic evaluation model is shown in Fig.3

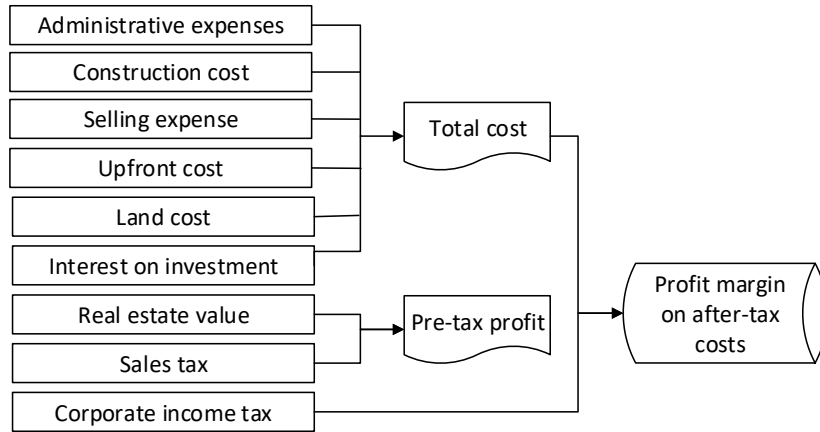


Fig.3 Economic evaluation model algorithm flow

The essence of economic calculation of urban renewal projects is based on the project start time point, and the expected income after the completion of the project construction after a certain period of time and the investment cost of the process are calculated, so it can be used for reference(called the residual method)^[3]. According to the applicable rules of the hypothetical development method in the 《National Standard Real Estate Valuation Regulations of the People's Republic of China》(GB/T 50291-2015), combined with the actual urban renewal work, the following mathematical model is established based on the above economic evaluation standard system.

4.1 Calculating the expected return of the project based on the starting point of the project(see equation (1))

$$\text{Project Expected Revenue} = \text{Property Value after Development (Y)} - \text{Sales Tax (y)} \tag{1}$$

Among them, the value after the development is completed is the value of each type of property including the self-owned portion of the self-owned market entity, which is equal to the sum of the product of the market sales unit price and the corresponding floor area. See equation (2).

$$Y=K_1Y_1+K_2Y_2+K_3Y_3+K_4Y_4+K_5Y_5+K_6Y_6+\dots\dots+K_nY_n = \sum_{i=1}^{i=n} K_nY_n \tag{2}$$

The sales tax is the product of the real estate value after the development is completed and the sales tax rate. See equation (3).

$$y=(K_1Y_1+K_2Y_2+K_3Y_3+K_4Y_4+K_5Y_5+K_6Y_6+\dots\dots+K_nY_n)*M=M*\sum_{i=1}^{i=n} K_nY_n \tag{3}$$

Among them, K1...Kn represents the scale of financing development (including the scale of financing development of commercial properties, office properties, residential properties, hotel properties), Y1...Yn represents the market sales unit price (including commercial property, office property, residential property, hotel property, The market price of the underground parking

space can be sold externally, and M represents the sales tax.

4.2 Calculating the total cost of the whole process of the project based on the starting point of the project

Total project cost (T) = upfront cost (B) + construction and installation costs (C) + renovation cost (D) + management fee + investment interest + sales expense

Among them, the upfront costs include land cost (including taxes and fees that should be borne when the land is acquired), monetary compensation costs, building demolition costs, and other upfront costs involved in the renewal, taking into account project development management expenses and investment interest during the project development cycle. See equation (4).

$$B = (B_1 + B_2 + B_3 + B_4)(1 + G)(1 + L)^N = (1 + G)(1 + L)^N \sum_{i=1}^{i=4} B_n \quad (4)$$

Construction and security cost is the sum of the product of unit price of construction and security cost and construction area of various types of property. After considering the expenditure of project development and management and the investment interest expenditure during the construction and security period, see equation (5) and equation (6):

$$C = (P_1 C_1 + K_1 C_1 + \dots + P_5 C_5 + K_5 C_5 + \dots + P_n C_n + K_n C_n + OC_3 + QC_6 + E_2 C_i)(1 + G)(1 + L)^{\frac{N}{2}} \\ = \left[\sum_{i=1}^{i=n} (P_i C_i + K_i C_i + E_i C_i) + OC_3 + QC_6 \right] (1 + G)(1 + L)^{\frac{N}{2}} \quad (5)$$

$$\sum_{i=1}^{i=n} E_i = E_2 \quad (6)$$

The decoration cost is the sum of the product of unit price and building area of all types of property decoration cost. The calculation formula of project development and management cost expenditure is as follows in equation (7) and equation (8):

$$D = (P_1 D_1 + K_1 D_1 + \dots + P_5 D_5 + K_5 D_5 + \dots + P_n D_n + K_n D_n + OD_3 + QD_6 + E_2 C_i)(1 + G) \\ = \left[\sum_{i=1}^{i=n} (P_i D_i + K_i D_i + E_i D_i) + OD_3 + QD_6 \right] (1 + G) \quad (7)$$

$$\sum_{i=1}^{i=n} E_i = E_2 \quad (8)$$

Sales expenses are calculated by the product of real estate value and sales rate after completion of development. see equation (9):

$$\text{COS}=(K_1Y_1+K_2Y_2+K_3Y_3+K_4Y_4+K_5Y_5+K_6Y_6+\dots+K_nY_n) \quad (9)$$

$$* m=m* \sum_{i=1}^{i=n} K_nY_n$$

Among them, B1...Bn means pre-cost, G means project development management fee, L means interest rate, N means development cycle, P1...Pn means relocation property construction area, C1...Cn means relocation property construction and installation engineering fee, D1...Dn means decoration Cost, O indicates the construction area of public rental housing, Q indicates other building areas such as public service facilities, E indicates “reinforcement” area, and K1...Kn indicates the scale of financing development (including commercial property, office property, residential property, hotel property) The scale of financing development), Y1...Yn indicates the unit price of the market (including commercial property, office property, residential property, hotel property, market price of underground parking space for external sales), M indicates sales tax, and m indicates sales tax rate.

4.3 Calculating project profit and cost profit margin

Uniformly clarify the project profit and cost profit rate based on the above calculation indicators as the final indicator of the economic calculation and evaluation of the urban renewal project. See equation (10) and equation (11) and equation (12) and equation (13):

$$\text{Project profit (Z)} = \frac{\text{project expected income}}{\text{project cost}} \quad (10)$$

$$Z = \sum_{i=1}^{i=n} K_nY_n - M* \sum_{i=1}^{i=n} K_nY_n - (1+G)(1+L)^N * \sum_{i=1}^{i=4} B_n$$

$$- \left[\sum_{i=1}^{i=n} (P_iC_i + K_iC_i + E_iC_i) + OC_3 + QC_6 \right] (1$$

$$+ G)(1+L)^{\frac{N}{2}} \quad (11)$$

$$- \left[\sum_{i=1}^{i=n} (P_iD_i + K_iD_i + E_iD_i) + OD_3 + QD_6 \right] (1$$

$$+ G) - m* \sum_{i=1}^{i=n} K_nY_n$$

$$\begin{aligned}
&=(1-M-m) \sum_{i=1}^{i=n} K_n Y_n - (1+G)(1+L)^N * \sum_{i=1}^{i=4} B_n \\
&\quad - \left[\sum_{i=1}^{i=n} (P_i C_i + K_i C_i + E_i C_i) + O C_3 + Q C_6 \right] (1 \\
&\quad + G)(1+L)^{\frac{N}{2}} \\
&\quad - \left[\sum_{i=1}^{i=n} (P_i D_i + K_i D_i + E_i D_i) \right. \\
&\quad \left. + O D_3 + Q D_6 \right] (1+G)
\end{aligned}$$

Project cost profit margin (R) = project profit / total project cost (12)

$$\begin{aligned}
R &= (1-M) \sum_{i=1}^{i=n} K_n Y_n \\
&\quad / \left\{ (1+G)(1+L)^N * \sum_{i=1}^{i=4} B_n \right. \\
&\quad + \left[\sum_{i=1}^{i=n} (P_i C_i + K_i C_i + E_i C_i) + O C_3 + Q C_6 \right] (1 \\
&\quad + G)(1+L)^{\frac{N}{2}} \\
&\quad + \left[\sum_{i=1}^{i=n} (P_i D_i + K_i D_i + E_i D_i) + O D_3 + Q D_6 \right] (1 \\
&\quad \left. + G) + m * \sum_{i=1}^{i=n} K_n Y_n \right\} - 1
\end{aligned}$$
(13)

Among them, B1...Bn means pre-cost, G means project development management fee, L means interest rate, N means development cycle, P1...Pn means relocation property construction area, C1...Cn means relocation property construction and installation engineering fee, D1...Dn means decoration Cost, O indicates the construction area of public rental housing, Q indicates other building areas such as public service facilities, E indicates "reinforcement" area, and K1...Kn indicates the scale of financing development (including commercial property, office property, residential property, hotel property) The scale of financing development), Y1...Yn indicates the unit price of the market (including commercial property, office property, residential property, hotel property, market price of underground parking space for external sales), M indicates sales tax, and m indicates sales tax rate.

5 Urban Renewal Economic Evaluation Management System

In order to realize the streamlining and automation of economic evaluation work, it is necessary to combine the economic evaluation calculation model with computer technology to develop an economic evaluation system for urban renewal projects. The construction of the urban renewal project economic evaluation system provides an urban renewal big data center and an information sharing platform for urban and rural planning, urban renewal, management and multi-level application service systems, and will be gradually applied to preliminary market analysis, project economic calculation, and project feasibility Research, planning and architectural design, project planning and positioning, taxation, finance, law and other fields.

The system is designed according to the hierarchical architecture, and different functions are logically divided into layers, which is helpful for the research and development and analysis of the system, and also facilitates the maintenance and upgrading of the system. The system can be logically divided into five levels, namely the database layer, management layer, service layer, application layer, and user layer. The overall structure of the system is shown in Fig.4.

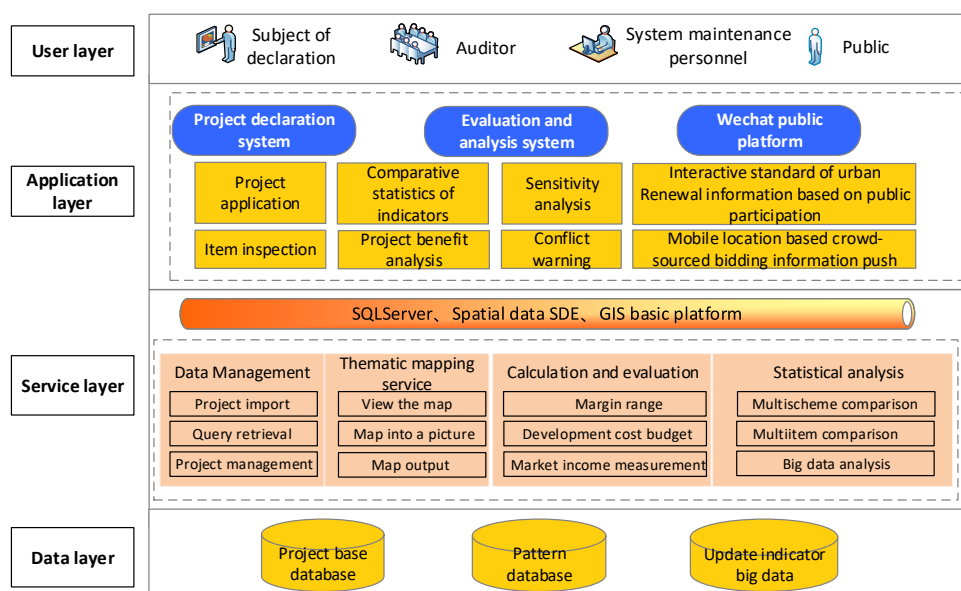


Fig.4 system structure

The features of the software system are as follows.

- (1) Realized the construction of urban renewal data center based on big data

Through the accumulation of updated projects, the cost measurement index system will be gradually refined. By capturing relevant economic calculation parameter values on the Internet and taking advantage of industry advantages, it collects and organizes planning data such as the city's general regulations, control regulations, and special planning, and builds a big data resource center for urban renewal. The combination of manual verification and big data

technology makes the calculation of mathematical model close to the actual cost of project development^[7].

(2) A mathematical model of economic evaluation based on hypothesis development method

The model studied in this question is based on the principle of hypothetical development method. Aiming at the economic benefit evaluation process of urban renewal projects, the specific evaluation methods are studied in depth. By improving the static estimation method, a set of effective mathematical models for economic evaluation of urban renewal projects is established to avoid the arbitrariness of the preparation of the economic evaluation reduces the ever-expanding psychological expectations of development companies and improves the rationality of the economic evaluation. In the past, the review department lacked effective verification methods for the economic evaluation results submitted by the project applicants. This is a research from scratch.

(3) Using an integrated platform for urban renewal full lifecycle management

At present, the urban renewal work pays more attention to the declaration and planning of urban renewal projects (the core link of the competition of interests), and pays insufficient attention to the results of the projects (mainly in the later stages of construction and operation management) (lack of the necessary information perception, collection and corresponding effect evaluation)^[5,8]. This project takes the actual urban renewal work in Zhuhai as an example. Based on cloud technology, Internet of Things + edge computing, GIS technology, and Internet technology, with the help of a closed loop of "hardware + software + technical solutions", it realizes the full life cycle management covering application, planning, construction, operation and management of urban renewal projects, provides services for planning approval, construction management and operation supervision of urban renewal projects, and improves the scientific nature of projects and the efficiency of government decision-making.

(4) Integrated platform for economic evaluation management and analysis of urban renewal projects based on GIS

The work area of the urban renewal project is positioned based on spatial location, establish spatial location relationships and linkage relationships, and make use of "one map and one table" to realize the standardization and process of reviewing and approving the economic evaluation reports of urban renewal projects. Establish a real-time project monitoring station to realize intelligent supervision of project progress and early warning of contradictions in economic evaluation plans through monitoring of indicators and comparison of conflicts; provide comparative analysis of the economic evaluation work of urban renewal projects in both time and space dimensions to form cross-validation. It provides data support and scientific basis for the compilation and review of the economic evaluation report of urban renewal projects^[6,10].

(5) Refined model management based on BIM and 3D GIS

In the actual project economic calculation and evaluation process, it is necessary to determine all the variables involved in the project renovation. How to ensure the accuracy of the provided cost variable values requires refinement and management of the detailed information on the exterior and interior of the renovated building^[9,11]. This research creatively proposes to combine BIM and 3D GIS technology to be applied to the refinement management of urban renewal projects, realizing the dynamic update and maintenance of urban renewal economic evaluation

and urban renewal unit planning information. 3D GIS mainly studies how to model the land or urban buildings where urban renewal projects are located, obtain detailed spatial information of buildings, and implement information query, browsing, and statistical analysis based on GIS technology, but it cannot deeply describe the detailed information inside buildings. BIM is a platform for data inclusion and display with the support of 3D technology, and is a mature application of the full life cycle management mode, which takes the full life cycle of a building as the main line, associates the information needed in all aspects of building production, and forms a building information set, which makes up for the lack of GIS being able to integrate and manage the information of all stages of a building, and thus realizes the fine measurement and management of economic evaluation work. BIM can also be combined with 3D GIS to realize the application of urban public space review, index control, and building area calculation in the approval stage of assisting urban renewal planning schemes^[12,13].

6 Conclusion

Taking the urban renewal work in Zhuhai as an example, this paper, from the perspective of economic evaluation of urban renewal projects, introduces real estate appraisal, urban economics, computer technology, big data, BIM and other technologies into the economic evaluation system of urban renewal, which provides a guarantee for the scientificity and accuracy of economic evaluation. First of all, a standardized measurement and evaluation index system was established, By building an urban renewal big data resource center and combining manual verification with big data technology, the mathematical model calculation was continuously approaching the actual cost of project development. Taking the construction of urban renewal information platform as the starting point, it provides a comparative analysis of the economic evaluation schemes of urban renewal projects in the time dimension and spatial dimension, and combines BIM technology to realize the refined calculation and management of economic evaluation work. Through the WeChat public platform for urban renewal, it provides feasible ways for urban renewal information release, public participation in surveys and interactions, provides a more effective source of real-time information for urban renewal, and also strengthens the research on the behavior of micro-individuals in urban renewal, which is of great practical significance in guiding the formulation of urban renewal strategies.

The economic evaluation calculation model and evaluation system of urban renewal projects provide a guarantee for the urban renewal authorities to check the economic evaluation results, and avoid the arbitrariness of economic evaluation preparation. However, there are still many places to continue research. In future work, we will continue to study the application of BIM ultra-fine models in urban public space review, index control, building area accounting, etc., and establish a dynamic urban sign index evaluation system. Build a more open networked city sharing and co-governance platform to make economic evaluation work more scientific, reasonable and efficient, combine urban renewal with urban renewal unit planning, strengthen research on micro-individuals in urban renewal, and make urban renewal work and systems more humanized^[15].

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