ISSN 2616-5767 Vol.9, Issue 3: 22-26, DOI: 10.25236/AJETS.2026.090303

Research on Innovation Mode of Construction Project Cost Management under the Background of Urban Renewal

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Abstract: *In the process of urban transformation dominated by stock development, the traditional project cost management model based on new projects is difficult to adapt to the characteristics of urban renewal, such as fuzzy boundaries, diverse subjects and complex cost structure. The purpose of this article is to build an innovative model of cost management that integrates the whole life cycle perspective and dynamic control ability, and respond to the governance needs in the renewal practice through the dual path of institutional coordination and technical empowerment. The research adopts the method of theoretical construction, systematically analyzes the new requirements of urban renewal for cost management, and then designs a management framework covering the whole process of planning, design, implementation and operation and maintenance, and deeply discusses the institutional interface and technical carrier supporting the implementation of this framework. Only by changing the cost management from a static accounting tool to a value coordination mechanism and embedding an elastic contract arrangement and a multi-source data fusion platform can we effectively balance public interests, market efficiency and financial sustainability. This model reconstructs the logic of the generation and circulation of cost information, and also provides structural support for the risk sharing and consensus reaching of urban renewal projects.*

Keywords: *Urban renewal; Construction project cost management; Whole life cycle; Dynamic regulation; Institutional coordination*

1. Introduction

Under the background of rapid urbanization and redevelopment of stock space, urban renewal has gradually evolved from the early physical space repair to a systematic project covering functional reconstruction, value regeneration and institutional adjustment [1]. This transformation reshapes the organizational logic and implementation rhythm of construction projects, and poses a profound challenge to the traditional construction project cost management paradigm [2]. The existing cost management system is mostly based on the linear project logic in the era of incremental expansion. Its static estimation, stage fragmentation and information island characteristics are difficult to adapt to the complex attributes of urban renewal projects, such as fuzzy boundaries, diversified interests, high technical integration and frequent uncertainties [3]. In scenes such as the renovation of historic blocks, the revitalization of industrial remains and the renovation of old residential areas, the project content often changes frequently due to property rights negotiation, cultural security constraints or community feedback [4]. This dynamic nature makes the cost composition highly nonlinear, exposing the lag and rigidity of the traditional quota pricing model.

In recent years, scholars at home and abroad have launched a multi-dimensional discussion on the cost control in urban renewal. Some studies try to introduce the concept of life cycle cost, emphasizing the integration of pre-planning, design optimization, construction execution and post-operation and maintenance into a unified accounting framework [5]. Another study focuses on the application potential of digital technologies such as BIM and GIS in cost dynamic simulation, trying to improve the prediction accuracy through information integration [6]. These explorations mostly stay in the local improvement at the tool level, and have not yet formed a systematic cost management theory that is compatible with the logic of urban renewal governance [7]. There is still a lack of explanatory and operational theoretical construction in key links such as institutional coordination mechanism, multi-agent cost sharing rules and risk sharing model. Existing literature often regards cost as a technical subsidiary issue, ignoring its structural role in resource allocation, power and responsibility

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definition and policy implementation, resulting in a significant gap between theoretical supply and practical demand [8].

This article aims to respond to the above theoretical gaps and put forward an innovative model of construction project cost management facing the complex situation of urban renewal. This model is not simply to superimpose new technologies or processes, but to redefine the functional orientation of cost management in urban renewal from the perspective of the integration of system, technology and process. Firstly, the research analyzes the unique cost generation mechanism and uncertainty sources of urban renewal projects, and then constructs a management framework that integrates dynamic regulation ability, multi-source data collaboration and flexible contract arrangement. On this basis, this article focuses on how to guide multi-subjects to reach a consensus in cost allocation and risk allocation through system design, and realize cross-stage and cross-system cost information communication with the help of semantic alignment and intelligent modeling technology. Through this study, it is expected to provide theoretical support for building a more resilient, fair and efficient urban renewal cost management system.

2. New requirements of urban renewal for project cost management

Urban renewal projects are significantly different from traditional new projects in goal orientation, implementation logic and participation structure, which puts forward multi-dimensional new requirements for project cost management. First, the project boundary is highly dynamic. The object of renewal often involves fragmentation of property rights, restrictions on the protection of historic buildings or changes in community demands, which leads to frequent adjustments in the construction content during the implementation process, and the traditional static pricing model based on fixed drawings and bill of quantities is difficult to apply. Secondly, the cost composition is characterized by compounding [9]. In addition to the regular Jian 'an expenses, non-standard expenses such as relocation compensation, cultural value restoration, public space construction and post-operation subsidies need to be considered as a whole. These factors often lack a unified pricing basis, and there are significant differences in different regional policy contexts. Thirdly, the risk allocation mechanism tends to be complex. With the participation of government, social capital, indigenous people and professional institutions, there are structural differences on cost control objectives, risk tolerance and income expectation, so it is urgent to establish transparent and negotiable rules for cost co-governance. The nonlinearity in time dimension also poses a challenge [10]. The urban renewal cycle is long, the phases are intensive, and the pre-planning and post-operation and maintenance are highly coupled, which requires the cost management to change from phase separation to the whole process, so as to realize the continuous feedback and dynamic calibration of cost information.

3. Cost management framework integrating life cycle and dynamic regulation

In the face of the characteristics of urban renewal projects, such as vague boundaries, complex cost structure and multiple subjects, the traditional cost management model centered on construction stage has become weak [11]. At present, it is urgent to build a new cost management framework that integrates the whole life cycle perspective and dynamic control ability. The framework should not only run through the complete chain from pre-planning to post-operation, but also respond to the uncertainty in the implementation process. It is not simply to extend the management cycle, but to reconstruct the generation logic, circulation mechanism and decision-making function of cost information through the cooperation of system design and technical tools. Its core lies in transforming cost management into the integration of pre-guidance and process adjustment, and making cost control a value coordinator throughout the whole project cycle. Structurally, the framework includes three nested subsystems: target layer, process layer and support layer. The target layer focuses on the setting of value orientation, defines the priority weights of different update types in publicity, economy and sustainability, and provides a principle basis for subsequent cost allocation. The process layer breaks the traditional five-stage separation mode, establishes a four-stage closed loop of planning, design, implementation and operation and maintenance, and sets up dynamic calibration nodes at the interfaces of each stage. The support layer is based on multi-source heterogeneous data fusion platform, and systematically integrates BIM three-dimensional model, policy and regulation library, market index and community feedback text and other multiple information sources. Through the semantic alignment mechanism for structural analysis, the platform transforms unstructured data into quantifiable cost impact factors, providing real-time, complete and explanatory data support for subsequent dynamic regulation.

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The framework emphasizes the role of flexible contracts in cost management. The government and the implementing entity can preset some price adjustment situations in the contract, and agree on the corresponding cost sharing ratio and adjustment procedures to avoid the deadlock of cooperation caused by rigid pricing. At the same time, the rolling budget mechanism in time dimension is introduced, and the cost forecast interval of the next 12 months is updated every quarter based on the latest progress, instead of relying on the one-time lump sum price. This mechanism not only retains the binding force of fiscal discipline, but also reserves space for reasonable changes. Figure 1 lists the key control points of life cycle cost management in typical urban renewal projects and their dynamic response strategies.

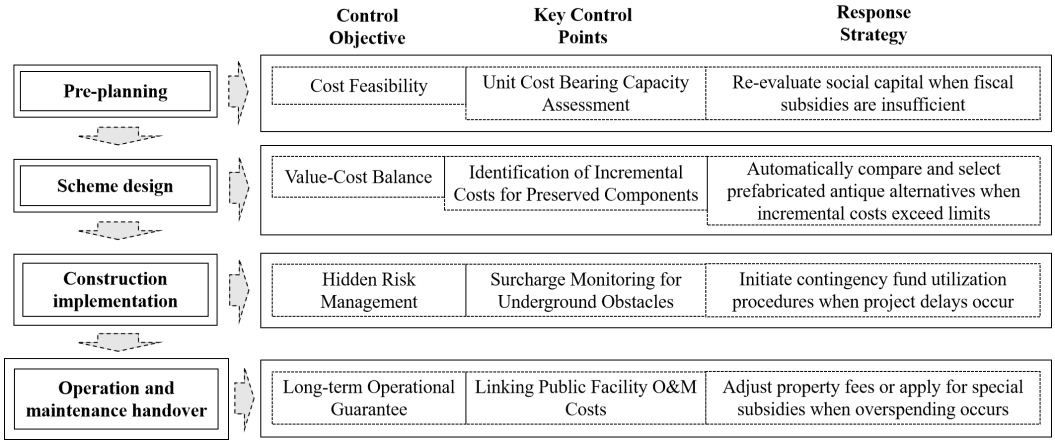

Figure 1 Full-cycle Control Points and Response Mechanisms for Cost in Urban Renewal

The operational efficiency of the framework ultimately depends on the deep coupling of institutional rules and technical capabilities. On the one hand, it is necessary to clarify the legal boundary of dynamic price adjustment through local regulations or updated guidelines. On the other hand, it is necessary to build an intelligent decision-making prototype system that supports real-time semantic retrieval and trend deduction, so that cost management can truly become a governance tool with both toughness and efficiency in urban renewal.

4. Innovation path of institutional synergy and technological empowerment

System coordination and technology empowerment constitute the dual pillars of the innovative mode of project cost management under the background of urban renewal. It is difficult to deal with the intertwined policy uncertainty, subject heterogeneity and cost complexity in updating projects by relying solely on technical tools or institutional design. Only through deep coupling of the two can we build a new management path with adaptability and operability. At the institutional level, it is necessary to break through the traditional fragmented governance pattern dominated by administrative lines and establish a cross-departmental, cross-level and cross-subject cost co-governance mechanism. On the technical level, it is necessary to go beyond isolated software applications and turn to a systematic architecture that supports semantic interoperability, dynamic deduction and intelligent decision-making. The coordination of the two is to realize the structural remodeling of management logic through the two-way feedback of rule embedding and data driving.

In the dimension of institutional coordination, the first task is to clarify the boundaries of power and responsibility of multiple subjects in the formation and sharing of cost. The government is no longer just an approver or funder, but should assume the role of rulemaker and builder of coordination platform. Social capital needs to bear reasonable risks within the framework of contract, and at the same time get the space of cost adjustment based on performance. On the other hand, community organizations and original property owners express substantive opinions on public space investment and compensation standards through participatory budget mechanism. Therefore, we can explore the system of updating the unit cost responsibility list, divide all kinds of cost items into three categories according to their nature: public responsibility, market responsibility and shared responsibility, and solidify them in local updating regulations. In addition, relevant authorities should take the lead in building a regional urban renewal cost information sharing platform. The platform is operated by the departments of housing and construction, finance and natural resources, and regularly publishes the cost benchmark index and dynamic adjustment coefficient of typical projects, thus effectively

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alleviating the decision-making deviation and resource mismatch caused by information asymmetry.

Technology empowerment focuses on building an intelligent infrastructure that supports dynamic regulation. Based on the multi-source heterogeneous data fusion framework, the infrastructure integrates geometric information of BIM model, policy text semantics and community public opinion data, and generates a unified cost impact factor vector through semantic alignment mechanism. On this basis, the forecasting module based on time convolution network (TCN) is deployed to perform rolling deduction on key cost nodes. This kind of technical ability must be embedded in the institutional process, such as writing the system early warning threshold into the annex of the updated project contract to make it legally effective. In order to present the specific interface and implementation carrier of system and technology collaboration, Figure 2 summarizes four typical collaboration scenarios and their operating mechanisms.

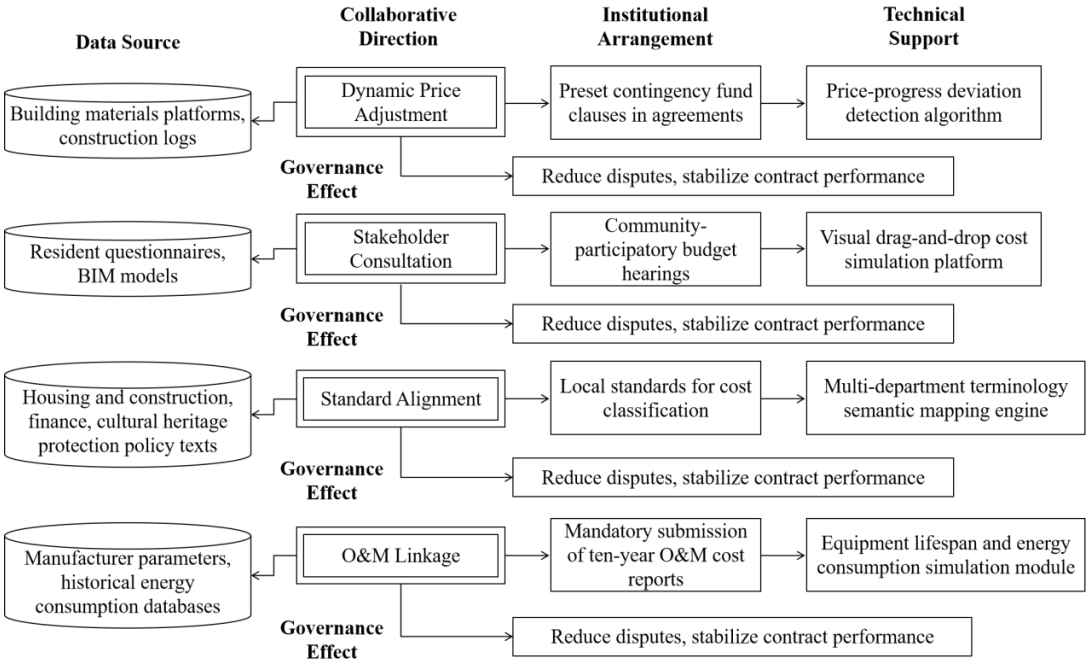

Figure 2 System-Technology Collaborative Interfaces

The deepening of the above path finally points to a new governance paradigm with computable system and regulatable technology. Institution provides legitimacy boundary and application scenario for technology, while technology injects accuracy and responsiveness into institution. Together, they promote the project cost management from empirical judgment to rule-driven and from static control to dynamic coordination, thus truly serving the core goal of urban renewal and high-quality development.

5. Conclusions

Focusing on the paradigm transformation of construction project cost management under the background of urban renewal, this study puts forward a set of innovative paths with both theoretical depth and practical orientation. The traditional cost system has obvious limitations in the face of high uncertainty of renewal projects, and its core crux lies in stage separation, information island and institutional rigidity. In view of this, this article constructs a management framework that integrates life cycle and dynamic regulation, and realizes the transformation from post-engagement control to process guidance by setting rolling budget mechanism, cost sensitivity calibration node and flexible price adjustment clause. The research reveals the mutual relationship between institutional synergy and technological empowerment. On the one hand, by updating the unit cost responsibility list, participatory budget hearing and other system designs, the boundaries of powers and responsibilities of multiple subjects are clarified. On the other hand, relying on multi-source heterogeneous data fusion platform and intelligent deduction engine, it provides computable support for dynamic decision-making. The four types of collaborative interface mechanisms listed in this article further verify the operability of this path. For example, the early warning algorithm of building materials price fluctuation is embedded in the unforeseen expenses clause of the contract, which not only guarantees the reasonable income of social capital, but also maintains financial discipline. The research also emphasizes that the

ISSN 2616-5767 Vol.9, Issue 3: 22-26, DOI: 10.25236/AJETS.2026.090303

pre-binding and visual simulation of long-term operation and maintenance costs can help to avoid the inertia deviation of re-construction and light operation. This model has obvious potential in improving cost transparency, reducing cooperation friction and enhancing policy adaptability. Future work can focus on the adaptability test of local laws and regulations and the deployment of prototype systems, so as to promote the transformation of theoretical achievements into governance effectiveness.

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