

Research on the Collaborative Management Mechanism and Efficiency Improvement of Full-Cycle Investment Plans in the Infrastructure Sector

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Abstract: The coordinated management of full-lifecycle investment plans in the infrastructure sector is a key factor in ensuring the high-quality development of infrastructure. Currently, infrastructure projects face numerous challenges in full-lifecycle management, including gaps between phases, a lack of multi-stakeholder collaboration, and errors in plan execution, which severely hinder overall improvements in investment efficiency. Building upon these issues, this paper conducts research from the dual perspectives of mechanism establishment and efficiency enhancement. On the one hand, it establishes a comprehensive collaborative management mechanism system by addressing aspects such as the design of an integrated full-cycle framework, multi-tiered collaborative organisational structures, the development of digital platforms, and collaborative risk response. On the other hand, it explores effective mechanisms for improving efficiency through standardised process re-engineering, dynamic monitoring and feedback, precise resource allocation, and institutional and talent safeguards, thereby providing a reference for improving the overall level of collaborative management of investment plans in the infrastructure sector.

Keywords: infrastructure sector; full-cycle management; investment planning; collaborative management mechanisms; efficiency enhancement

1. Introduction

Infrastructure development forms the bedrock of national economic growth, and the soundness and rationality of investment plans have a direct bearing on the quality and efficiency of infrastructure projects. However, given the lengthy project cycles, the multitude of stakeholders involved, and the complexity of the management chain, there are significant shortcomings in coordination across all phases of the project lifecycle. This has led to recurring issues such as deviations in the implementation of investment plans and the wastage of resources. Strengthening the collaborative management of full-cycle investment planning and establishing corresponding mechanisms is of great significance for enhancing the overall management standards in the infrastructure sector. This paper examines the current state and challenges of collaborative management, pathways for mechanism development, and directions for improving efficiency, with the aim of providing theoretical guidance and practical insights for enhancing the management of infrastructure investment planning.

2. Current Status and Issues in the Coordinated Management of Full-Cycle Investment Plans in the Infrastructure Sector

2.1 Disjointed Management Across Stages of the Full Cycle and Failure of Information Flow

The full life cycle of an infrastructure project encompasses various stages, including planning, design, construction and operation. These stages should ideally form a closely interconnected management loop; however, in reality, they often operate in isolation from one another. Management units at each stage operate independently, lacking unified standards for information transmission and shared platforms. Consequently, the planning outcomes established in the early stages fail to integrate effectively with subsequent phases, resulting in significant information gaps [1]. When investment plans are transferred between stages, repeated verification and reorganization are commonplace. This not only incurs substantial management costs but also severely disrupts the continuity and effectiveness of plan implementation.

2.2 Absence of Multi-Stakeholder Coordination Mechanisms and Ambiguous Boundaries of Authority and Responsibility

Infrastructure projects generally involve numerous stakeholders, including government regulatory authorities, project owners, design firms, construction contractors and supervision units. Each stakeholder assumes distinct functions with-

in investment plan management and should collectively generate an effective synergy of collaborative management [2]. However, at present, most such multi-stakeholder coordination mechanisms are absent. There are no clear rules regarding responsibilities and coordination between the various participants; consequently, issues such as buck-passing and information asymmetry are particularly prominent. The process of formulating and adjusting investment plans lacks mechanisms for communication and consultation, and feedback channels are obstructed, resulting in a situation where plans are frequently altered without unified coordination.

2.3 Deviations in Investment Plan Execution and Insufficient Capacity for Dynamic Adjustment

During the implementation of infrastructure projects, deviations in the execution of investment plans are a widespread problem. Constrained by various factors such as changes in the external environment, design modifications and fluctuations in input prices, there are often significant discrepancies between actual investment and planned targets [3]. More importantly, the existing management system has limited capacity to identify and address plan deviations; it only reacts passively once deviations have accumulated to a certain extent, and has failed to establish a mechanism for proactive monitoring and timely correction to support the process.

3. Establishing a Coordinated Management Mechanism for Full-Cycle Investment Planning in the Infrastructure Sector

3.1 Designing a Framework for Integrated Full-Cycle Investment Planning Management

The integrated full-cycle management framework constitutes the fundamental institutional arrangement for the coordinated management of infrastructure investment plans. It is essential to break free from the constraints of traditional phased management by integrating all stages — including planning, design, construction and operation — and clarifying the guidelines for formulating investment plans, approval procedures and criteria for adjustments at each stage. This will establish a closed-loop management chain covering the entire process, encompassing plan formulation, allocation and implementation, dynamic monitoring, and deviation correction [4]. By striking a balance between regulatory constraints and flexible management, and by allowing institutional scope for necessary adjustments at each stage, we can effectively consolidate the institutional foundation for full-cycle collaborative management. Only by incorporating investment plans for all stages into a unified framework for control and management can we fundamentally eliminate the systemic risks arising from compartmentalisation.

3.2 Multi-tiered Organisational Structure and Functional Allocation for Collaborative Coordination

A scientifically sound and rational organisational structure is essential to ensure the smooth implementation of multi-stakeholder collaborative management. A clearly defined and mutually supportive organisational system must be established: horizontally, by creating coordination and linkage mechanisms among key stakeholders to promote information sharing and collaborative decision-making; and vertically, by clarifying the division of powers and responsibilities between the decision-making, management and executive levels, and establishing vertical transmission mechanisms [5]. Work responsibilities — such as planning, review and approval, and execution supervision — should be rationally allocated based on the professional strengths of each entity. The coordinating authority of the lead entity must be clearly defined to prevent overlapping functions and vacuums of responsibility. Clear boundaries of authority and responsibility are not only a prerequisite for collaborative efficiency but also key to avoiding buck-passing in decision-making and enhancing overall execution capacity.

3.3 Information Sharing and Collaborative Decision-Making Driven by Digital Platforms

The establishment of a digital platform serves as the technological foundation for breaking down information barriers and achieving collaborative governance. A comprehensive management platform covering the entire lifecycle of infrastructure projects should be created, integrating key components such as investment planning, progress monitoring, cost control and change management. By establishing unified data standards and interface guidelines, information barriers between different stages and entities can be overcome, ensuring that planning data flows freely throughout the entire timeline and is shared in a timely manner. In addition, intelligent decision-support functions provide managers with timely and accurate decision-making criteria, transforming planning management from manual coordination to digital collaboration. The level of digital collaboration capability will directly determine the depth and speed of the modernisation of investment planning management for infrastructure projects.

3.4 Risk Early Warning and Collaborative Response Mechanism for Planning Deviations

Establishing an effective risk early warning and collaborative response system serves as a safeguard to ensure the smooth implementation of investment plans. This involves identifying various risk points that may impact plan execution, creating a risk classification and grading early warning indicator system, and determining early warning thresholds and trigger conditions to ensure that risk signals are promptly communicated to relevant personnel. At the same time, contingency plans should be formulated for various types of deviations, with the responsibilities and action steps of each party during the response and resolution process clearly defined. This ensures that when deviations occur, a concerted effort involving multiple parties can be rapidly mobilised. A tracking and evaluation system for deviation resolution should be established to continuously improve the early warning and response processes. Through ongoing review of the entire response and resolution process, a shift from reactive response to proactive prevention and control can be achieved, thereby building up a body of reusable risk governance experience.

4. Approaches to Improving the Efficiency of Coordinated Management of Full-Cycle Investment Plans in the Infrastructure Sector

4.1 Standardised Process Re-engineering and Optimisation of Cross-Phase Coordination Mechanisms

4.1.1 Standardised Review and Restructuring of Full-Cycle Business Processes

Standardisation lays the foundation for improving collaborative management efficiency. It is necessary to systematically organise all business processes across the entire life cycle of infrastructure projects. Targeted process re-engineering should be undertaken to address key issues such as process redundancy and the absence of standards, thereby establishing a unified system of business standards covering the entire life cycle. With the aim of improving management efficiency, operational procedures at every stage — including the preparation, approval, execution and adjustment of investment plans — must be reviewed. Inefficient stages and redundant tasks should be identified, the sequence of operations optimised, and operational standards, time limits and deliverables defined for each stage, thereby establishing standardised process specifications that are actionable, quantifiable and assessable. The establishment of standardised processes can effectively reduce management costs and accelerate operational speed. Furthermore, it provides all stakeholders with consistent guidelines for conduct, thereby fundamentally reducing collaboration friction caused by differing standards. This ensures that planning management across all stages of the full lifecycle operates within the same regulatory framework, thereby achieving the objective of efficient and orderly implementation.

4.1.2 Optimised Design of Interface Points Between Preliminary Planning and Subsequent Implementation

Efforts should focus on the critical junctures where planning outcomes are transformed into implementation plans. A systematic and standardised handover mechanism should be established to clarify the content, confirmation procedures and accountability for plan handover between stages, ensuring that planning intentions are accurately conveyed to the implementation phase and effectively executed. Dedicated liaison roles or cross-stage coordination teams should be established to track and supervise the handover process at key junctures throughout the entire process, identifying and resolving issues in a timely manner to ensure rigorous and effective coordination. An audit and confirmation system should be established for the handover processes at each stage. Standardised procedures should be employed to guarantee the quality of the handover, eliminate gaps in full-cycle management, and achieve a seamless transition from preliminary planning to subsequent construction. This will fundamentally enhance the overall efficiency of coordinated management of full-cycle infrastructure investment plans and provide a robust guarantee for the achievement of investment objectives.

4.2 Establishment of a System for Dynamic Monitoring and Performance Feedback

4.2.1 Development of a Real-time Monitoring Indicator System for the Investment Plan Implementation Process

Dynamic monitoring serves as a means of ensuring the effective implementation of investment plans. Based on the key focus areas of infrastructure project investment management, a comprehensive monitoring indicator system has been established, covering multiple aspects such as the progress of fund disbursement, physical progress of works, and contract compliance. The measurement methods, warning thresholds and criteria for identifying anomalies for each indicator have been defined to ensure that monitoring activities adhere to uniform and standardised measurement criteria, thereby preventing management confusion arising from differing assessment standards. Building upon this, a digital management platform is utilised to collect and dynamically track all monitoring indicators in real time. This enables the timely identification of

deviation signals arising during implementation, providing objective and accurate information to support management decision-making. It ensures that the entire plan execution process remains in a visualised and controllable state, thereby achieving the objectives of early detection, early warning and early resolution of execution deviations, and guaranteeing that the investment plan proceeds smoothly in accordance with established objectives.

4.2.2 Feedback Pathway from Performance Evaluation Results to Plan Adjustments

A scientific performance feedback mechanism transforms monitoring results into a driving force for plan improvement. A regular performance appraisal system should be established to conduct a comprehensive analysis of the phased implementation of investment plans, objectively evaluate the management performance of all parties involved, and produce evaluative reports with practical guidance, thereby providing a basis for subsequent plan adjustments. More importantly, institutional channels must be established to link performance evaluation results with decision-making on plan adjustments, defining rules for the application of evaluation results and the conditions triggering adjustments, to ensure that issues identified through evaluation are promptly translated into concrete actions for plan improvement. A mechanism for tracking and monitoring the implementation of improvement measures must be established. Performance feedback should be treated as an intrinsic driver for the continuous improvement of investment plans, creating a virtuous cycle where evaluation drives reform and reform enhances efficiency, thereby propelling the continuous advancement of full-cycle investment plan management standards in the infrastructure sector.

4.3 Improving the Efficiency of Resource Allocation and Ensuring Precise Alignment with Investment Plans

4.3.1 Data-Driven Resource Demand Forecasting and Dynamic Allocation

Resource allocation provides the material foundation for the smooth implementation of investment plans. It is essential to fully utilise the management data generated throughout the full-cycle management process, employing scientific methods to conduct in-depth research into the patterns of resource demand for infrastructure projects across different stages and categories. This will enable the development of relatively accurate resource demand forecasting models, providing scientific guidance for forward-looking resource reserves and allocation, and fundamentally avoiding resource misallocation caused by inaccurate demand forecasts. Building upon this, a dynamic resource allocation mechanism must be established. This mechanism should enable timely adjustments to resource allocation plans in response to the phased progress of investment plans and real-time fluctuations in resource demand. This ensures that resource supply for critical stages is prioritised, thereby preventing plan delays and efficiency losses caused by resource misallocation. Ultimately, this achieves the objective of optimising the allocation and efficient utilisation of limited resources throughout the full lifecycle management process.

4.3.2 Synergy Mechanism between Investment Prioritisation and Precise Plan Implementation

A scientific investment prioritisation evaluation system must be established. By comprehensively considering factors such as a project's strategic significance, urgency of construction, and socio-economic benefits, investment arrangements should be reasonably ranked. This ensures that limited funds are concentrated on the most valuable construction tasks, thereby avoiding the fragmentation of funds and reduced returns caused by unclear priorities. Furthermore, a linkage mechanism between investment prioritisation and resource allocation must be established, transforming the results of priority assessments directly into concrete resource allocation plans. This ensures that planning intentions are accurately implemented and eliminates the disconnect between priority determinations and resource allocation. By continuously improving the synergy between resource allocation and plan execution, the effectiveness of resource allocation and the quality of investment plan implementation will be substantially enhanced, thereby laying a solid foundation for the sustained improvement of full-cycle investment management efficiency in the infrastructure sector.

4.4 Enhancing the Institutional Framework and Professional Capacity

4.4.1 Institutional Standards and Evaluation Mechanisms for the Long-Term Operation of Collaborative Management

Institutional safeguards are the fundamental guarantee for the continuous improvement of collaborative management efficiency throughout the investment cycle. Guided by the principles of standardisation and normalisation of collaborative management, a systematic framework of institutional standards should be established, covering all aspects including the delineation of rights and responsibilities, process standardisation, coordination procedures and information management. This will provide clear institutional grounds for all stakeholders to carry out collaborative management tasks, thereby preventing arbitrariness and non-standardisation in management work through institutional means. Institutional development must prioritise both systematic coherence and practicality. It is essential to establish a comprehensive institutional framework

whilst ensuring that each regulation is concrete, feasible and easy to implement; institutional development must not become a tree without roots or a stream without a source. We must improve the performance appraisal mechanism by incorporating the quality and effectiveness of collaborative management into the evaluation systems of all stakeholders and departments. Through clear incentive and constraint mechanisms, we will guide all parties to voluntarily adhere to institutional norms and actively fulfil their collaborative management responsibilities. This will transform collaborative management from external constraint into internal self-discipline, converting institutional constraints into an endogenous driving force for continuously improving management efficiency.

4.4.2 Pathways for Cultivating Multi-skilled Talent and Building Professional Capabilities

Talent support forms the foundation for the continuous improvement of full-cycle collaborative management efficiency. Guided by the urgent need for multi-skilled talent in full-cycle collaborative management, we must systematically plan talent development pathways. The focus should be on cultivating multi-skilled professionals who are familiar with the principles of infrastructure investment management and proficient in modern information technology and collaborative management methods, thereby effectively addressing the current situation where management personnel suffer from a narrow knowledge base and insufficient comprehensive capabilities. Through systematic professional training, the implementation of cross-departmental job rotation and exchange programmes, and the establishment of specialised learning platforms, we will continuously enhance the professional competence and overall calibre of management personnel. This will enable the management team to effectively navigate the complex challenges posed by full-cycle collaborative management, thereby laying a solid talent foundation for the continuous improvement of collaborative management efficiency in full-cycle investment planning, and effectively strengthening the overall capacity and developmental momentum of collaborative management within the infrastructure sector.

5. Conclusion

With the rapid development of modern information technology, the wave of digitalisation — characterised by digitalisation, networking and intelligence — is profoundly influencing and transforming people's lifestyles. Full-cycle investment plan collaborative management in the infrastructure sector is a systematic undertaking that requires coordinated advancement on both the institutional framework and efficiency enhancement fronts. In the face of current prominent issues such as fragmented management, insufficient coordination and execution deviations, the institutional foundation for collaborative management should be consolidated through measures such as establishing an integrated management framework, refining multi-tiered collaborative organisations, advancing the construction of digital platforms and improving risk response mechanisms. At the same time, efforts should be made to systematically enhance the efficiency of full-cycle investment plan management by focusing on standardised process re-engineering, dynamic monitoring and feedback, precise resource allocation, and institutional and talent safeguards. Only by pursuing mechanisms and efficiency in tandem, and advancing institutional frameworks and talent development in unison, can we effectively drive a comprehensive leap in the level of collaborative management of investment plans in the infrastructure sector, thereby providing a robust guarantee for the high-quality development of infrastructure.

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