

Cost Control Strategies in the Pre-Construction Period of Highway Construction

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Abstract: Effective cost control in the investment and design phases of highway construction is crucial for managing project expenses. However, current management practices often overlook pre-construction cost management, leading to budget overruns and project delays during later stages. To ensure the smooth execution and cost control of highway construction projects, this paper examines the significance of cost control, evaluates the current state and challenges of highway construction, and proposes strategies for cost management. These strategies aim to establish a robust foundation for cost management in highway projects.

Keywords: Highway construction; Preliminary management; Cost control; Contract management; Investment estimate

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1. Introduction

The scale of highway construction in China has been increasing in the past two decades in light of the rapid development of the industry, which in turn propels the improvement of the national economy. Highway construction is not only the foundation of infrastructure construction but also an important way to improve the national economy. China is characterized by a large population base, limited resources, and a strong demand for road transportation^[1]. Therefore, in recent years, highway construction projects have been rising, resulting in increased market competition. To stand out in the fierce market competition, highway construction enterprises began to focus on the control of project costs, reduce construction expenditures, and enhance the operating profit of enterprises. However, in project cost control, excessive focus on the construction phase often results in insufficient cost management during the early stages, which adversely affects overall cost control effectiveness^[2]. To enhance project cost control, it is essential to implement effective cost management from the early stages of highway construction, thereby developing a scientific cost management model.

2. Importance of cost control in the early stage of highway construction

In highway construction, pre-construction decision-making directly determines the overall effectiveness of the

project and serves as the primary basis for engineering design and construction. Given the significant variations in construction environments, each project must tailor its construction decisions and designs to its specific conditions. Highway engineering in China, characterized by its social welfare benefits, typically has a relatively low financial rate of return. These projects require substantial funding, have long capital operation cycles, and involve different pricing phases throughout construction. Effective cost control for highway projects must span the entire construction process, from pre-decision-making and design stages to the middle construction phase and the completion stage. Cost control at each stage should remain within reasonable limits, with timely corrections for any budget overruns^[3]. Additionally, the reasonable allocation of manpower and material resources is essential to ensure the achievement of project objectives, thereby maximizing both social and economic benefits.

The investment decision and design stage of a highway construction project is a crucial part of preliminary management. Traditionally, in highway project cost management, the capital investment during the early stages is relatively small and the input speed is slow. As the project progresses into the construction phase, investment funds increase significantly, reaching about 70% of the overall project budget. Despite this, early-stage cost control has a more substantial impact on the overall project costs. However, in practice, the construction phase, being the highest cost stage, is often emphasized as the key focus for cost control. This misdirected approach can hinder achieving the desired investment control outcomes. Therefore, it is essential to implement source control from the preliminary stages of the highway project. Effective management of highway project construction funds from the beginning will help improve both the social and economic benefits of the project^[4].

3. Problems of cost control in the early stage of highway construction

3.1. Inadequate feasibility study

The rapid development of China's economy has fueled the expansion of the country's highway engineering sector. However, this growth is often hampered by insufficient highway construction information and inadequate pre-construction feasibility studies. These deficiencies result in a lack of refinement and insufficient depth in the compilation of engineering project proposals^[5]. The feasibility study of a highway project involves calculating traffic volume and socio-economic levels. Considering the proportion of subjective factors in the engineering plan. Problems frequently arise during this process, such as significant deviations between estimated and actual amounts, inaccurate cost estimates, and incorrect estimations of engineering volumes. Additionally, the evaluation of different project proposals often fails to accurately weigh their relative importance. Highway project investments are long-term and subject to unpredictable changes in the market for construction raw materials. These variables introduce risks to project investment, complicating the feasibility analysis and potentially affecting the project's overall viability^[6].

3.2. Poor cost management

Usually, designers would only need to concentrate on design drawings without much consideration of the costs. Meanwhile, budget personnel will emphasize costs without considering the technical aspects. This split management approach hinders coordination and synergy, leading to unclear division of authority and responsibility during the pre-construction phase. Once the design work of a highway project is completed, the project's basic investment is determined by factors such as scale, structure, quality standards, material requirements, and accessory selections. This indicates that the budget and costs for highway projects are largely set once the design is finalized, making later budget adjustments difficult. Therefore, effective project cost management should not rely solely on post-design calculations but should be integrated into the design

phase itself ^[7]. Budgeting corresponds to design and construction costs but cannot fundamentally alter them. Therefore, strengthening cost control during the design stage is crucial for effective cost management in highway engineering. Designers must adhere strictly to construction specifications, typically using the lower limit of engineering safety as a standard. From a designer's perspective, safety takes precedence over economy, which limits their impact on project cost management. However, for highway construction, both safety and cost control are critical management objectives. Additionally, in the design stage, the construction unit often reserves limited time for design work to expedite project initiation. This time constraint makes it challenging to achieve detailed and refined designs. Consequently, designers may opt to increase the project's safety factor, resulting in insufficient cost control and potential investment waste ^[8].

3.3. Unstandardized bidding management contract

In highway engineering projects, human factors significantly influence project bidding. Some projects have predetermined the winning bidder before the bidding process begins, or only a few projects undergo open bidding, while others use a bargaining method that provides flexibility for the chosen bidder. This practice introduces uncertainty in project investment ^[9]. Additionally, contractors often employ highly flexible strategies during bidding, complicating cost control efforts. The engineering construction contract, signed after bidding is complete, must have strictly and reasonably formulated terms. Otherwise, it can lead to economic and liability disputes later on, potentially hindering the smooth implementation of the project.

3.4. Poor time control

In recent years, the scale of China's highway engineering construction projects has been increasing, with improvements in construction speed. However, this has also led to compressed construction periods, particularly during the early stages of projects. Insufficient time for preliminary surveys and feasibility studies results in a lack of in-depth preliminary work, affecting early judgments on project cost control and potentially creating issues later on, which can negatively impact the community. Highway engineering construction is a systematic endeavor that involves numerous preliminary tasks, such as pre-feasibility studies, work reports, and construction drawing measurements. Setting a reasonable construction period is crucial for ensuring project quality and effective cost control. Most highway projects are field constructions, making them susceptible to climate, terrain, and other factors, which complicates control efforts. Delays due to inadequate construction period management inevitably increase construction costs. To mitigate these issues, it is essential to address them during the pre-construction stage. This includes avoiding complex terrain and construction during the rainy season. Blind or poorly planned project control will likely lead to significant construction problems.

3.5. Backward engineering cost management mechanism

Traditional highway construction project cost management in China has relied on budgeting as the core management model, often utilizing quota management in budget calculations. However, this approach is prone to actual cost deviations and struggles to effectively respond to the realities of project execution, thus hindering the ability to grasp cost control outcomes. Effective project cost control requires a robust cost management mechanism. However, China's traditional project cost system fails to meet current efficiency standards and presents numerous issues. Cost control effectiveness for highway projects is typically measured by comparing proposed budgets with actual costs at each stage, making it challenging to generate comprehensive cost control summaries. Identifying specific reasons for uncontrolled cost problems is also difficult under this system. Given the current economic development landscape, project cost management needs to be market-oriented. Traditional cost management mechanisms are ill-equipped to meet these evolving requirements.

4. Cost control strategy for the early stage of highway construction

4.1. Making informed investment estimation

Highway project investment estimation encompasses the entire project lifecycle, from preparation to completion. China's regulations on engineering project investment emphasize the importance of accurate estimation, particularly for fixed asset investments such as construction installation and equipment procurement, as well as working capital management for operational costs post-project completion. Estimating the cost of road construction projects typically involves using a unit composite index, which is derived from multiplying the unit composite index by the volume of work. During the decision-making stage, it is crucial to first approve the design mission statement to control investment estimation errors within 10%. Additionally, determining the project location ensures coordination with engineering planning, selecting appropriate construction equipment and technology, and choosing the most suitable program through thorough comparison. Factors such as price fluctuations and market changes must also be considered. Predicting these invisible factors helps mitigate price discrepancies during construction^[10]. Comparative analysis of various indicators aids in making timely adjustments, particularly when significant discrepancies are detected.

4.2. Strengthening the management of feasibility funds

The feasibility report in highway engineering construction serves as the foundation for project investment and cost management. Therefore, during project investment decisions, it is essential to focus on investment control through thorough assessment and review of the feasibility study report. This involves evaluating the level of technology, construction content, standards, and other aspects to serve as effective gatekeeping for engineering investment decisions. The feasibility study represents a critical link between project proposals, design, and investment estimation. Close coordination and alignment among these components are necessary, and deviations should be controlled within an acceptable range. Establishing a strong connection between project investment estimates and feasibility study estimates is crucial during the engineering feasibility stage. Additionally, it is important to continually supplement factors not initially considered and analyze uncertainty factors to prevent significant design changes in subsequent stages.

4.3. Emphasizing the quality of preliminary geological investigation

Highway engineering traverses various terrains and geological formations. Unlike other construction projects, highways encounter a wide range of geological challenges and require diverse structural solutions. Therefore, it is essential to accurately identify and understand the engineering geological issues to ensure project safety and efficiency. Insufficient recognition of engineering geological problems can lead to safety accidents, resulting in project complications and increased maintenance costs. Surveys are typically conducted in two phases: preliminary survey and detailed survey. The preliminary survey uses information from the project site selection to analyze construction site distribution and stability, laying the foundation for subsequent surveys. It focuses on investigating the project surroundings and external changes. The detailed survey provides technical parameters for subsequent work and evaluates the geological environment of the construction site, aiding in informed decision-making during engineering construction. Both surveys are crucial for mitigating geological risks and ensuring the success of highway projects.

4.4. Improving cost management in the design stage

Cost control during the highway engineering design stage is crucial, as the design program directly impacts project investment. Therefore, ensuring the reasonableness of the design program is essential for effective investment planning and achieving cost control objectives. By combining project construction requirements

with feasibility analysis, staff can develop a sound design program that lays the foundation for subsequent construction work, minimizing losses during project construction and effectively controlling construction costs. The highway design stage is influenced by various factors, and implementing a competition mechanism can incentivize staff to engage in cost control and enhance project supervision. Integrating project limit indicators ensures the quality of the construction project design program and facilitates goal implementation. This approach helps prevent late engineering changes or construction delays, which can lead to increased costs.

4.5. Optimizing the design scheme of highway construction

In preparing the highway engineering design program, thorough investigation and collection of project information are essential. This includes examining hydrological, geological, and transportation conditions surrounding the project construction site. When formulating the engineering program, cost savings should be a crucial consideration, emphasizing the project's economy, safety, and ecological impact. During implementation, the design should be tailored to the local highway environment and transportation needs. Avoid overly prioritizing high strength and large size to prevent unnecessary waste and reduce project area. Additionally, attention to detail is vital, particularly concerning protection, drainage works, and traffic safety facilities. Neglecting these aspects can compromise the quality of the highway's later operation, leading to rework and increased costs.

5. Conclusion

Cost control management in highway construction is a complex process, particularly during the early stages, where numerous factors come into play, increasing the risk of errors in cost management. To address this challenge, it's essential to align with the specific requirements of highway construction and implement scientific cost control measures. This includes optimizing highway construction design, improving feasibility estimation, and adopting effective cost management practices. By doing so, we can enhance the overall level of cost management, create more profit opportunities for enterprises, and maximize social and economic benefits.

Disclosure statement

The author declares no conflict of interest.

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