Cost management in a government infrastructure project

Feng Cheng

1 Lingnan University, Hong kong, China
chengfeng2@ln.hk

Abstract: *This study explores cost management in government infrastructure projects, analyzes the composition of direct/indirect costs, and proposes lifecycle management strategies (reserving 15%-20% contingency funds in the planning phase, setting cost evaluation weights in bidding, implementing information-based monitoring during construction, and controlling operation and maintenance costs in the operational phase). Using the Beijing Daxing International Airport case, it validates the role of lifecycle management in resource optimization and cost-effectiveness. Recommendations include strengthening risk assessment, adopting technological applications, and promoting multi-stakeholder collaboration.*

Keywords: *Government infrastructure projects; Cost management; Life cycle; Resource allocation; Information-based monitoring; Contingency fund; Cost-effectiveness*

1. Introduction

1.1 Brief overview of the topic from the point of project

Project cost refers to the total expenses incurred to achieve the project objectives, covering two major components: direct costs and indirect costs. Among them, direct costs are closely related to the products and services delivered by the project. Expenses like the cost of raw materials, labor costs (that is, the salaries of the staff directly engaged in the production of project products), and equipment rental fees (specifically, the rental costs of the equipment dedicated to this project), etc., all fall within the category of direct costs.

At the sametime, although indirect costs have no direct connection with products and services, they are an indispensable part to ensure the smooth operation of the project as a whole. Expenditures such as the rent of the office space of the project management team and utilities are classified as indirect costs. Project cost reflects the strategic goals, missions, and established business plans of the project engineering organization. Therefore, on the one hand, efforts should be made to conduct data collection, carryout cost accounting accurately, and exercise strict cost control; on the other hand, all members of the project team should always stay vigilant about fund management and maintain a clear awareness of it.

1.2 Importance of the topic and objective of work

1.2.1 Importance

Typically, government infrastructure projects involve a large amount of resource input, including funds, materials, manpower, and equipment, etc. If the costs can be managed effectively, resources will be able to be allocated and utilized reasonably. Through cost management, the required resources can be accurately calculated and allocated, which can improve the overall utilization efficiency of resources. Since public resources are limited, the government needs to allocate them carefully. Cost management helps to determine the priority among numerous infrastructure needs and

allocate resources to the parts of the projects that are in the most urgent need and can generate the greatest benefits. Through cost-benefit analysis, priority is given to using funds in infrastructure construction with high engineering difficulties to ensure that every expenditure of public funds can exert the maximum social value.

Infrastructure projects usually have long construction periods and large scales, and are prone to be affected by various uncertain factors, such as natural disasters, policy changes, and fluctuations in market prices. The cost management system can deal with these risks through risk assessment and reserving emergency funds. For example, during the construction of a water conservancy project, if natural disasters like floods cause damage to the project, the pre-set emergency costs can be used to repair the project, ensuring that the project can continue without being forced to stop due to a shortage of funds. Cost management can providestable financial support for the project. During the implementation of the project, funds are disbursed in an orderly manner according to the cost plan, which can ensure that there is sufficient funding for each construction stage and avoid project delays or quality degradation caused by a breakin the capital chain.

1.2.2 Objectives

Government infrastructure projects require a large amount of capital investment. In the early stage of project planning, one of the core purposes of cost management is to accurately assess the total cost of the project and determine whether it aligns with the government's current fiscal budget and economic affordability. Through detailed cost estimations that cover expenditures in all aspects such as construction, equipment procurement, and operation and maintenance, the cash flow throughout the entire project life cycle is simulated, and economically unfeasible plans are eliminated to prevent the waste of financial resources caused by blind project initiation.

There are numerous variables during the construction period of infrastructure projects. Fluctuations in the prices of raw materials, design changes, and geological problems may all lead to a rise in costs. The aim of cost management is to closely monitor the trend of costs throughout the whole process, set a red line for cost control, and use information-based means to monitor expenditure in real time. Once cost deviations are detected, the reasons will be quickly analyzed and strategies will be adjusted accordingly.

Moreover, most infrastructure projects are livelihood projects that attract high public attention and great public expectations. Cost management helps projects to be completed and delivered on time and with high quality. People can truly enjoy benefits such as convenient travel, comfortable medical treatment, and pleasant leisure, and can intuitively perceive the efficiency of the government in handling affairs and its sincerity in providing services, thus strengthening the government's credibility. Efficient cost management can also free up more financial funds, which can be invested in other projects for improving people's livelihoods, science, education, culture, and health, expand the scope of public services, and enhance people's well-being in all aspects.

1.3 The plans on the topic

1.3.1 The project preliminary planning stage

Assemble a professional estimation team covering multiple fields, which includes experts in engineering technology, cost estimation, economics, etc. Refer to the data of previous similar projects and adopt a combined approach of analogous estimation,parametric estimation and bottom-up estimation to accurately predict the costs of various parts of the project, such as land acquisition, building construction, equipment procurement, installation and commissioning, as well as future operation and maintenance costs.

In view of the project characteristics and potential risk points, an additional 15% - 20% emergency reserve fund will be reserved to deal with uncertain factors such as unclear geological conditions and policy changes.

1.3.2 The project bidding and procurement stage

Establish and improve the bid evaluation system, incorporating the rationality of cost quotations, cost reduction potential, and past performance in cost control into the bid evaluation indicators, with the weights set at 40%, 30%, and 30% respectively, to select contractors and suppliers with strong comprehensive capabilities and excellent cost control.

Draft strict contract terms, stipulating pricing models such as fixed lump sum, adjustable unit price, and cost plus fee, and select them flexibly according to the risk characteristics of the project. Clear adjustment mechanisms shall be set for fluctuations in raw material prices and design changes.

1.3.3 The project construction stage

Build an informatized cost monitoring platform to integrate data such as finance, project progress, and material procurement. Update the actual project cost on a daily basis and generate a cost analysis report every week to visually present the cost trends, deviations, and reasons.

Establish a design change approval process, which requires that change applications can only be implemented after being reviewed and approved by multiple parties including designers, cost estimators, and supervisors. For major changes (changes whose amount exceeds 10% of the original contract value), a new cost-benefit assessment and approval are required.

1.3.4 The project completion acceptance and operation stage

Strictly calculate the final cost of the project based on the contract, change documents, site visas and the actual completed quantities of the project. Organize cross- checks among multiple parties such as cost estimators, auditors and construction units to ensure the accuracy of the settlement amount.

Formulate standards and budgets for operating costs, covering aspects like equipment maintenance, energy consumption and staff salaries, and monitor daily operating expenditures. Introduce energy-efficient equipment and optimize operating processes to reduce operating costs and improve the utilization efficiency of facilities.

2. Literature Review

Researchers generally focus on how to use scientific methods and tools, such as parametric estimation, analogous estimation, etc., combine historical data with the characteristics of projects to predict project costs more accurately. They also emphasize the whole life cycle cost control from project planning, design, construction to operation and maintenance, rather than just focusing on the costs in the construction stage. Rama, D., & Andrews, J. D. (2016) think that In order to achieve the required levels of safety and availability at the lowest possible costs in a sustainable manner, it is necessary to take into account the interdependencies among the timing and choices of activities for multiple assets. Frangopol, Dan M (2019) thinks that carrying out cost- effective maintenance and management of civil infrastructure, it is necessary to balance the structural performance and the total accumulated costs over the entire life cycle. Most existing maintenance and management systems have been developed on the basis of minimizing life cycle costs. However, the single maintenance and management solution obtained in this way may not necessarily lead to satisfactory long-term structural performance. Nama (2022) thinks that cost control implies the correct allocation of resources, calculating resource utilization and the shortest working time, rejecting repetitive activities and their automation. Some optimization techniques include: using cloud solutions that help minimize capital costs, dynamic scaling that helps handle fluctuating workloads, and software license costs. Moreover, through analysis, the use of data analysis can assist organizations in tracking usage and identifying areas of inefficiency where corrective actions need to be taken. Zack Beveridge (2024) thinks that Through implementing comprehensive planning, robust contract management, detailed cost tracking, efficient resource

utilization, proactive risk management, value engineering, change control processes and regular audits, project managers can ensure that projects stay within budget while meeting quality and schedule objectives. Junyong Yu.(2024) thinks that The highway construction in our country is booming. However, the cost management is complicated, so it is necessary to build a scientific performance evaluation system to conduct comprehensive supervision and evaluation on the project cost.

3. Analysis and Discussion

3.1 Detailed analysis

Government infrastructure projects aim to improve public services, promote regional economic development and social stability. They cover many fields such as transportation facilities, municipal public utilities, water conservancy and hydropower, including highways and bridges, urban water supply and drainage, large reservoirs and so on. These projects usually have a large investment scale, a long construction period and involve a complex array of stakeholders. Therefore, efficient cost management is particularly crucial.

Planning is the starting point of a project, covering aspects such as project feasibility studies, survey and design. Feasibility studies require a large amount of manpower and material resources. It is necessary to collect data on regional economy, population, geology and so on, and hire experts to evaluate the technical and economic feasibility of the project. Survey and design are related to the project layout and construction blueprint. High-quality design cannot only meet the functional requirements but also reduce the cost of later changes. The fees are charged according to the complexity and scale of the project.

This is the major part of the cost, including the procurement of building materials, the lease and use of mechanical equipment, the payment of labor costs and so on. The cost of materials fluctuates with the market. The prices of bulk commodities such as steel and cement are significantly affected by supply and demand and the macro-economy. The lease period of mechanical equipment depends on the construction progress, and the entry and exit fees for large equipment are also a considerable expense. The labor cost depends on the labor market situation and the difficulty of the construction process, and technicians are paid higher salaries.

The whole process of project promotion cannot be separated from management, involving the salaries of management personnel, the lease of office space, the supervision fees of the project and so on. Professional management teams are responsible for coordinating all parties, controlling the construction quality and progress. Supervisors supervise whether the construction is in compliance with regulations to ensure that the project is constructed according to the drawings and avoid rework and waste. The fees are extracted at a certain percentage of the total project price.

3.2 Real-life example

This report takes the example of Beijing Daxing International Airport. The cost management in it has a lifecycle and is a model of lifecycle cost management. It covers technologies in multiple fields and has an investment of over 80 billion yuan. The airport needs to take into account functionality, aesthetics and advanced nature, so the requirements for cost management are extremely high.

3.3 Discussion on the finding

The construction of Beijing Daxing Airport not only focused on the costs during the construction stage but also took full account of the costs in the operation and maintenance stages, reflecting the concept of life cycle cost management. From the preliminary planning and design, through the construction process, to the later operation and maintenance, meticulous cost planning and

control were carried out in each stage to ensure the maximization of cost-effectiveness throughout the airport's life cycle. For example, in the selection and procurement of facilities and equipment, both the initial investment costs and the long-term operation, maintenance costs and energy consumption costs were taken into consideration.

4. Conclusion

4.1 Main point

Cost management in government infrastructure projects is of utmost significance. Through comprehensive cost management strategies implemented across the project life cycle, from initial planning to final operation, it is possible to enhance resource utilization efficiency, ensure stable financial support, and boost the government's credibility. For instance, in the case of Beijing Daxing International Airport, a lifecycle cost management approach was adopted, which considered not only the construction costs but also the long-term operational and maintenance expenses. This led to a maximization of cost-effectiveness throughout the airport's lifespan.

4.2 Lesson learned

In the project management course, I learned how to identify that the project cost consists of direct costs (such as the costs of raw materials, labor, equipment rental, etc., which are directly related to the project deliverables) and indirect costs (such as the rent of the office space of the project management team, utilities, etc., which are required to maintain the overall operation of the project but are not directly related to the products or services). I also understood the role and impact of different cost elements in the project. Moreover, I realized that cost management aims to maximize the cost- effectiveness of the project, ensure that the project is completed within the approved budget, and at the same time improve the utilization efficiency of resources. Effective cost management can help the project allocate resources reasonably under limited resources, deal with the challenges brought by the characteristics of long project cycle, large scale and many uncertain factors, ensure the stable progress of the project, enhance the government's credibility, and make public resources play the greatest social value.

4.3 Recommendations for future applications

To address these challenges, future government infrastructure projects should focus on continuous improvement in cost management. This can be achieved by strengthening risk assessment and contingency planning to better handle uncertainties. Moreover, the application of advanced technologies, such as artificial intelligence and big data analytics, can enhance the accuracy of cost estimation and monitoring. Finally, promoting greater collaboration and communication among all project stakeholders can help to streamline processes and reduce costs. By implementing these recommendations, future government infrastructure projects can achieve more efficient cost management and deliver greater value to society.

References

[1] Frangopol, D. M., & Liu, M. (2019). Maintenance and management of civil infrastructure based on condition, safety, optimization, and life-cycle cost. Structures and infrastructure systems, 96-108.

[2] Junyong Yu.(2024).Research on Performance Evaluation of Full Process Cost

[3] Management in Expressway Projects. Journal of Statistics and Economics(3),

[4] Nama, P. R. A. T. H. Y. U. S. H. A. (2022). Cost management and optimization in automation infrastructure. Iconic Research and Engineering Journals, 5(12), 276-285. Rama, D., & Andrews, J. D. (2016). Railway infrastructure asset management: the whole-system life cost analysis. IET Intelligent Transport Systems, 10(1), 58-64.

[5] Zack Beveridge.(2024).Cost Management Strategies for Large-Scale Construction Projects. Design Cost Data(5),41.