Cost Overrun and Cause in Korean Social Overhead Capital Projects: Roads, Rails, Airports, and Ports

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Abstract: Changes during the life cycle of a project promote cost overrun due to cost increases, time schedule delays, and benefit shortfalls. Specifically, cost overruns are usually due to inefficient budget usage by the national government for social overhead capital (SOC) investments. This paper aims to establish the cost overrun relating to transport policy in an institutional context, discuss the general causes and identify possibilities for their reduction in Korean SOC project preparation and decision making. The establishment of cost overrun probability distributions for a number of reference classes requires access to credible data for a sufficient number of projects within the same reference classes for statistically meaningful conclusions to be drawn. Cost data were available for a total of 161 completed projects. The results indicated that 95 and 100% of road and rail projects, respectively, had a maximum cost overrun of 50%. The causes of cost overruns can be grouped into several major categories: Changes in the scope, delays during construction, unreasonable estimation and adjustment of project costs, and no practical use of the earned value management system.

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Introduction

Most social overhead capital (SOC) projects change in scope, from identification to implementation and evaluation, during the project cycle. These changes are often due to uncertainty during the process of preparing a project, from developing an idea into a detailed proposal which has to consider all the technical, economic, financial, social, and institutional aspects of the project. The changes during the life cycle of a project give rise to cost overrun due to cost increases, time schedule delays, and benefit shortfalls. Specifically, cost overruns are usually due to inefficient budget usage by the national government for SOC investments. In order to reduce cost overruns, the national government has input to implement procedures to deal with midproject changes in infrastructure planning. The tendency toward a cost overrun during infrastructure planning may be curtailed through well-structured institutional incentives and well-designed processes for project documentation, appraisal, and approval. This paper aims to establish the cost overrun in transport policy in an institutional context, discuss the general causes, and identify possibilities for their reduction in Korean SOC project preparation and decision making.

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Methodology and Data

The establishment of cost overrun probability distributions for a number of reference classes requires access to credible data for a sufficient number of projects within the same reference classes for statistically meaningful conclusions to be drawn. Herein, cost overrun is defined as the difference between the actual and estimated costs as a percentage of the estimated cost, with all costs calculated in constant prices. Actual costs are defined as the accounted costs actually spent, as determined at the time of project completion. Estimated costs are defined as the budgeted or forecasted costs at the time of project approval, which are typically similar to costs presented in the business case for a project.

Sample projects were selected on the basis of data availability during the period between 1985 and 2005. Projects for inclusion in the sample considered all those for which construction cost development data were available. Cost data were collected from the Ministry of Construction and Transportation (MOCT) and the Ministry of Maritime Affairs and Fisheries (MOMF). Cost data were available for a total of 161 completed projects, including 138 road, 16 rail, 2 airport, and 5 port projects (see Table 1).

Empirical Results

Table 2 shows the cost overruns for the 161 projects. According to the total project cost management system of the Korean Ministry of Planning and Budgets, changes in total project cost are essentially not permitted except in very limited circumstances. In every case, the cost overruns, which are the differences between the estimated and actual costs, were due to changes in the project concept and design, the addition of new facilities or project timeline delays.

The total and average cost overruns for roads projects were $2,635 million and $19 million, respectively, and those of rail projects were $7,287 million and $455 million, respectively. From

Table 1. Applied Sources of Reference Data

Category	Type of project	Source
Roads	Highways (16), trunk roads (119), and local roads (3)	Reference class of 138 road projects in MOCT and local governments
Rails	Metro (5), high speed rail (1), and subway (10)	Reference class of 16 rail projects in MOCT and local governments
Airport	Inchon International Airport, Yangyang International Airport	Reference class of airport projects in MOCT. Two cases are all of completed airport projects in Korea since 1985.
Ports	Subproject for port including quays, piers, bridges, etc.	Reference class of five infrastructures of port projects in MOMF

the total cost of overruns for the 161 projects, \$11,986 million, it is easy to see that rail project cost overruns were responsible for a significant proportion of the total cost overruns.

Roads and rail projects are representative of the many types of SOC projects within Korea. Figs. 1 and 2 show the cost overrun distributions for road and rail projects, respectively. For road projects, 95% have a maximum cost overrun of 50%, with common causes including an increase in capacity after the feasibility study or during construction, adjusted supervision fees due to design changes, cost increases due to changes in construction methods, increases or decreases in compensation, lane addition, and changes of a bedrock line.

For rail projects, 100% have a maximum cost overrun of 50%, with common causes including long delays due to changes in scheme design, track changes, the inclusion of additional stations, adjusted supervision fees, railroad line extensions, compensation increases and decreases, unexpected changes to the construction environment and unit cost increases The probability distributions for road and rail cost overruns are shown in the following.

Due to the very small sample sizes for airport and port projects, it was not possible to generalize the cost overruns associated with these kinds of projects. However, some of the major causes of the cost overruns in these samples, including runways, airport terminals, subsidiary facilities, additions, and an increase in capacity after the feasibility study or during construction, increased costs due to the introduction of a new system and the addition of a new embankment, are presented in this paper.

Key Causes of Cost Overruns

The causes of cost overruns can be grouped into several major categories: Changes in the scope of the project, construction delays, unreasonable estimation and adjustment of the project cost, and no practical use of the earned value management system. Overwhelming empirical evidence shows that many psychological, political, and economic reasons are not fully reflected as risk factors in the project budget, with similar trends shown for European and North American projects (see Table 3.)

Changes of Project Scope: New Addition, Extension, Capacity Increase

SOC projects are inherently risky due to their long planning horizons and complex interfaces. The project scope or level of ambition will often change significantly during project development and implementation. In Korea, the common causes of scope changes are new lane additions, bedrock line changes, railroad line extensions, track changes, an increase in capacity after the feasibility study or during construction, and the addition of new stations, runways, airport terminals, subsidiary facilities, etc. In particular, the Kyung-Bu rapid-transit railway project and Inchon International Airport project are illustrative of many scope changes, which were due largely to inadequate planning and feasibility studies, but were promoted due to political interests. Many political projects do not observe the proper implementation

Table 2. Cost Overruns of Projects

Category	Cost overrun rate (%)	Project number	(%)	Estimated cost (\$ million) (*A*)	Actual cost (\$ million) (*B*)	Constant cost of *B* (\$ million) (*C*)	Difference (\$ million) (*C-A*)
Road	Roads total	138	(100)	24,639.7	31,681.8	27,292.9	2,635.2
	>75	4	(3)	170.3	318.3	315.5	145.2
	50–75	3	(2)	107.3	200.2	171.9	64.6
	25–50	27	(20)	2,204.0	3,216.7	2,924.4	702.4
	0–25	86	(62)	15,070.7	19,487.3	17,018.7	1,948.0
	<0	18	(13)	7,087.4	8,459.3	6,862.4	−225.0
Rail	Rails total	16	(100)	15,295.5	27,695.0	22,582.8	7,287.3
	25–50	10	(62)	10,356.1	21,253.4	17,122.7	6,766.6
	0–25	5	(31)	4,759.4	6,241.1	5,290.2	530.8
	<0	1	(6)	180.0	200.5	169.9	−10.1
Airport	Airports total	2	(100)	2,961.6	5,989.0	4,750.0	1,788.4
	64	1	(50)	2,710.0	5,632.3	4,457.6	1,747.6
	16	1	(50)	251.6	356.7	292.4	40.8
Port	Ports total	5	(100)	758.8	1,145.0	1,034.2	275.4
	>100	1	(20)	121.9	412.1	344.4	222.5
	25–0	4	(80)	636.9	732.9	689.8	52.9
Total		161		43,655.6	66,510.8	55,659.9	11,986.3

Note: Source=data of MOCT and MOMF.

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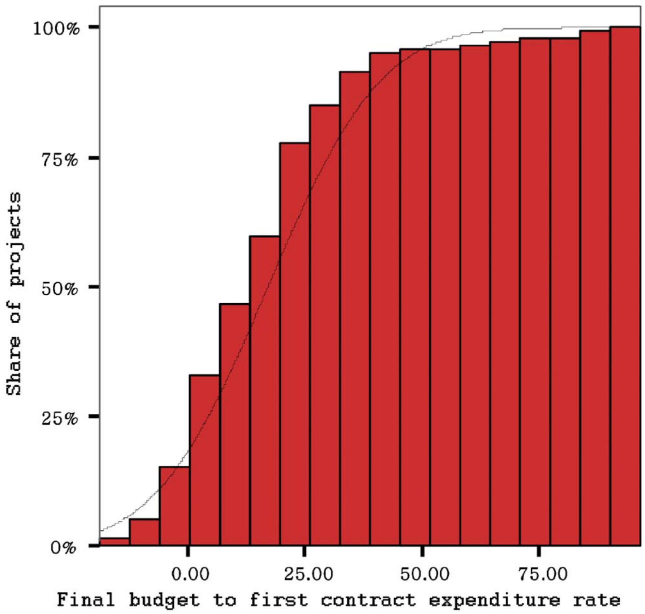

Fig. 1. Cost overrun distribution of roads

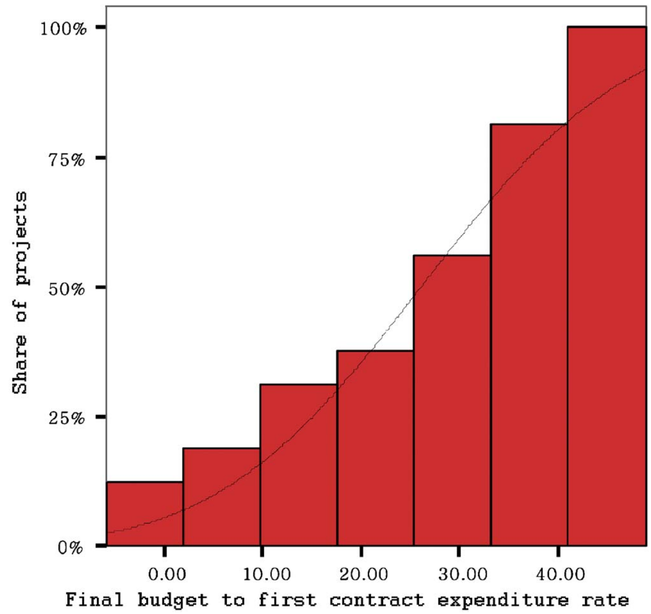

Fig. 2. Cost overrun distribution of rails

procedures due to urgent policy concerns. Overdemand frequently occurs during the feasibility study of a project, which gives rise to an excess total project cost; and countries around the world experience identical situations. In the analysis of Mott Macdonald of nonstandard civil engineering, the inadequacy of a business case was identified as the key driving factor behind cost increases.

Delay of Construction

Delays in construction result not only from changes in the scope but also compensation changes, unexpected changes in the construction environment and insufficient budgets for construction. According to the report of the Korean Board of Audit and Inspection (2005), because of the simultaneous execution of 39 rail projects without any order of priority, the total project times would increase by at least a factor of 2, from 9.5 to 18.9 years for rail projects; from 6.5 to 13.4 years for highway projects; and from 6.6 to 14 years for roads. Efficient budgeting requires a rational investment priority order and strategic implementation based in that order.

Irrational Estimation and Adjustment of Project Cost

In Korea, the estimated total costs of SOC projects have been determined in "Pumsem," which is a unit cost table. Recently, however, the accuracy and reliability of Pumsem have been called into question, leading the government to implement its previous lowest bid price method, which has various inherent problems and cannot yield the best value. The lowest bid price is often less than 50% of the estimated total cost. This lowest bid price system has been a significant cause of cost overruns, which encourages corner cutting and unsound construction methods. Another significant cause of project cost overruns is the system used for dealing with inflation. When work is contracted out to a construc-

Table 3. Causes for Cost Escalation in Transport Projects

Type	Korea	Europe and North America[a]
Concept changes	Changes of project scope (new addition, extension, capacity increase)	Standards (changed requirements such as speed, road width, road type)
		Routing (changed routing)
		Norms (changed safety or building norms)
Environment	Unexpected changes in construction environment	Environment (tighter environmental standards)
		Geotechniques (complex or extensive works on geotechniques, water or mountain)
		Archaeology (unexpected archaeological finds)
Costs	Irrational estimation and adjustment of project cost	Expropriation costs (under estimated expropriation costs)
		Construction costs (business cycle or competitive situation)
		Calculation approach (calculation based on everything going as planned)
Others	No practical use of earned value management system	Complex interfaces (urban environment, link to existing infrastructure)
		New or unproven technology (limited experience base)
		Delays due to weather

[a]Bent Flyvbjerg and COWI (2004).

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tion company, the total cost is set as the unit price. However, if inflation is above 3%, the construction company request adjusting the total cost and the government must then adjust by an extent more than 3% due to articles on the Office of Supply Administration. This adjustment leads to large changes in the total project cost during the construction period. In order to solve these problems, objective cost evaluation criteria and a rational adjustment method are needed.

No Practical Use of Earned Value Management System

According to the Construction Technology Management Act, a construction company must report construction progress to the owner every week or month, but the report need not furnish detailed expenditure information. Because the large majority of owners treat these reports with only a perfunctory inspection, they are not used for efficient management of the project costs. Thus, owners do not strive to find solutions to cost overruns until the construction is complete. Although in Korea, the different units of accounting between the construction progress system and construction cost management system are blocking the use of earned value management; therefore an effort to link these progress reports with cost control is required.

Propositions to Diminish Cost Overrun

The decision makers of SOC projects must all work within the same framework. However, their roles in the decision-making process and individual interests can lead to the involvement of particular political agendas. Therefore, in order to achieve successful public SOC management, an institutional setting is required for the implementation of an effective integrated system including appraisal, monitoring, and evaluation.

In order to create an effective integrated system, the total project cost must initially be redefined as the life cycle cost, which is the total cost throughout the entire life cycle of a project, including planning, design, acquisition, support, and any other costs directly attributable to owning or using the asset, rather than the simple construction cost. Second, those in charge must provide guidance for appraisal manuals; therefore, a system must be created that monitors every phase of the project, which must pay attention to the impact analysis and postcompletion project evaluation. Finally, line ministries must structure and build a public information and data management system for cataloging data from all phases of the project. Decision makers and researchers can then use this information to realistically estimate new project costs and effectively manage public investment.

Lessons from Korea

The findings presented previously should not be seen as final conclusions but rather as preliminary observations about a developing country, which is currently going through rapid changes. Therefore, the lessons that follow should also be seen as tentative. To achieve successful SOC projects, a government must control the causes of cost overruns and estimate the acceptable degree of uplifts for optimistic bias and realistic budgeting. In Korea, the causes of cost overruns can be grouped into several major categories: Changes in the scope of a project, delays in construction, unreasonable estimations and adjustments of the project costs, and no practical use of the earned value management system. In the case of roads, 95% of projects have a maximum cost overrun of 50%; whereas, 100% of the rail projects have a maximum cost overrun of 50%. The degree and causes of cost overrun in 161 road, rail, airport, and port projects could provide information to other countries about uncertain aspects inherent in the preparation of large transportation projects.

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