Anticipation and Solutions for Cost Overruns of Material Costs in Toll Road Construction Projects

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ABSTRACT

This paper presents the results of research on anticipation and solutions for material cost overrun in the open system Toll Road project in Jadebotabek. The purpose of this study is to determine the anticipation and solutions for handling material cost overrun. This study was conducted by surveying 76 correspondents consisting of Managers, Consultants and Contractors involved in the construction of Toll roads in Jadebotabek. The survey results were tested for validity and reliability to determine the dominant factors causing cost overrun, then the development of anticipation and solutions for handling material cost overrun was carried out by a team of experts. The results of the study showed that there were 10 valid factors causing cost overrun with a coefficient value of 0.389 - 0.716 and 13 reliable factors causing cost overrun with a Cronbach's alpha value above 0.700. The results of this study also show that anticipation and solutions for handling material cost overrun in toll road projects are preventive measures to reduce and eliminate the occurrence of cost overrun at the planning stage and at the implementation stage.

Keywords: cost overrun; material costs; anticipation; solution; toll road.

INTRODUCTION

Currently competitive business, especially in the field of toll road construction, demands an increase in the quality of construction service companies. There are several steps that can be taken to improve this quality, for example by taking corrective actions in the operation of construction projects. Corrective actions in the operational phase can be in the form of a Project Control system, which consists of cost, quality and time control. Project cost control consists of controlling the cost of materials, equipment, labor, subcontractors, overhead costs and general conditions. In construction project operations, project cost overruns often occur. One of the variables that most influences project cost overruns is materials. Generally, in toll road construction projects, materials and equipment are the two main components, which are around 50-60% of the total project cost (Soeharto I, 1995).

Based on Kerridge's research in 1987, it was found that material costs can mostly consume 60% of the total cost of a construction project, but this is often ignored. As a comparison, in infrastructure, material management costs at that time were budgeted at 1% of the total project cost, while in the construction of toll roads; The budget used was only 0.15%. Due to ineffective material management at that time, in several cases the construction of office buildings caused an increase in time or delay in work of up to 18% of the expected time, resulting in a cost difference. Project costs can be controlled by taking corrective action on the cost difference.

Material management is defined as a management system that is needed in planning and controlling the quality & quantity of materials, timely placement of equipment, good prices and the right quantity according to needs (Bell LG and G Stukhart, 1986).

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Meanwhile, according to Kini UD, 1999, it is explained that material management is a management system that aims to provide information and take the necessary actions to achieve company goals. which integrates purchasing, shipping, and controlling materials from suppliers. Based on the definition, in general material management can be defined as a process of planning, implementing, and controlling the right material sources with the right quality, at the right time and place, which are suitable for the construction process at minimum cost. The ability to coordinate and integrate the purchase, delivery and control of materials from suppliers is necessary for material cost control (Bell LG and G Stukhart, 1986; Kini UD, 1999; Stonebraker EA, 1994).

Three important phases that hold the key to successful material management are; material purchasing, material usage, waste control and storage (Ahuja HN, 1980).

Cost control is not only to monitor costs & data from the field, but also to analyze data to make corrective actions before it is too late (Soeharto I, 1995). Corrective actions require the ability to make decisions about the steps to be taken, to prioritize how to fix the problem, etc. This paper discusses the main problems of cost overrun in toll road construction material management and to recommend corrective actions against the cost overrun. The scope of this study is limited to the cost overrun of construction materials in the operation phase of high-rise toll road construction projects in Indonesia, especially in Jakarta-Bogor-Tangerang-Depok-Bekasi (Jabodetabek). The topic of this paper is part of a study to provide recommendations for anticipation and solutions to the occurrence of cost overrun in material management in construction project operations in Indonesia.

Material cost control

The purpose of project cost control is to obtain early detection of any possible cost overrun from the budget (excess costs) so that corrective actions can be taken as anticipation. Cost overruns can increase the total cost of a project and minimize profits (Halpin D and W, 1998). Material costs are one of the 6 (six) important components of project costs (Zhan JG, 1998).

This is a major factor in project cost control, and plays an important role in project development & productivity, where material control consists of the relationship between material quality & quantity, delivery, scheduling and cost. Material control includes related factors, namely; quality, quantity, acquisition, schedule and cost. In material control, there are several things to consider: material purchasing, inspection of goods, stock control, storage and maintenance of materials, delivery of materials, and quality assurance/quality control (Soeharto I, 1995; Ahuja HN, 1980; PPm, 1998; Stukhart G, 1995). In the control process, the first thing to do is to monitor the project cost report and analyze cost differences (Kerzner H, 1995). Cost differences based on time identification are divided into 3 layers, namely; differences after the process that occurs and after reality (cost overrun is identified after swelling occurs; swelling before implementation (identified before implementation), and swelling in the implementation process.

According to Johnston EJ, 1987, Hamzah A, 1994 and Ahuja HN, 1976 said, the main reasons for cost overrun in material management are: excess material stock, material damage, material loss, waiting for material to arrive at the location, frequent material transfers, inflation, material, changes in purchasing/purchasing situations starting from the prepared estimates, bulk materials, shortages and changes in the quantity of materials needed, material inefficiency, theft and loss, material delivery, job repairs, delays in updating/posting storage systems, inaccurate work location measurements, material retrieval, inaccurate delivery quantity estimates, uneconomical order quantities, poor delivery times, inadequate equipment/tools needed, increased transportation costs, excessive use of materials at the location, choosing the wrong materials, increased storage costs, poor purchasing power, late payments, and poor purchasing policies. In analyzing cost overrun, we need to identify the main problem first, then take corrective actions to eliminate negative cost overrun, so that cost performance will improve (Zhan JG, 1998).

Corrective action is needed to prevent cost overrun and depends on the cause and effect which is the difference between planning and implementation (Russell AD and A Fayek, 1994).

RESEARCH METHOD

This study consists of 13 indicators of the causes of cost overrun in material management. Determination of indicator variables by conducting a literature review study from several internationally reputable journals which resulted in 13 indicator factors that are in accordance with the study. In data collection, this study uses 2 methods, namely by distributing questionnaires and interviews. At the questionnaire stage, it was distributed to experts in the toll road sector as many as 80 respondents and in the return process as many as 76 respondents, this data has been representative based on the slovin sampling technique. From the first stage data, it is then processed to find valid and reliable indicators, then carried out to the interview stage. At the interview stage with experts or specialists who have experience in toll road construction projects in the Jabodetabek area, to obtain anticipatory actions and solutions to the occurrence of cost overrun of material costs at the planning and implementation stages of toll road construction projects.

RESEARCH RESULTS

The results of the validity test on the factors causing the cost overrun of material costs in the toll road construction project consist of 13 factors. There are 3 invalid question items in number 1 (Theft of material) 9 (late delivery of materials) and 13 (changes in material specifications) because the validity value is <0.300. So there are 10 valid indicators with a coefficient value of 0.389 - 0.716. The results of the validity test of the material variables are presented in table 1 below.

Table 1. Results of the Validity Test of Material Costs

No	Material	Coeffisient	Conbach	Validity
1.	Material theft	0.027	0.300	Invalid
2.	Price increase	0.608	0.300	Valid
3.	Material selection	0.520	0.300	Valid
4.	Errors in managing material storage	0.379	0.300	Valid
5.	Changes in material quantity	0.599	0.300	Valid
6.	Inaccurate in predicting market prices (material prices)	0.444	0.300	Valid
7.	Inaccurate in determining suppliers	0.687	0.300	Valid
8.	Errors in material cost estimation	0.716	0.300	Valid
9.	Delays in material delivery	0.286	0.300	Invalid
10.	Delays in project implementation	0.560	0.300	Valid
11.	Fluctuating material prices	0.592	0.300	Valid
12.	Poor material procurement	0.633	0.300	Invalid
13.	Changes in material specifications		0.300	Invalid

The results of the reliability test using the Cronbach's alpha method, the factors causing the cost overrun of material costs in the toll road construction project consist of 13 factors, all reliable indicators have coefficient values above 0.700, presented in table 2 below.

Table 2. Results of the Material Factor Reliability Test

No	Material	Coefficient	Conbach	Reliability
1.	Material theft	0.721	0.700	Reliable
2.	Price increase	0.718	0.700	Reliable
3.	Material selection	0.855	0.700	Reliable
4.	Errors in managing material storage	0.741	0.700	Reliable
5.	Changes in material quantity	0.831	0.700	Reliable
6.	Inaccurate in predicting market prices (material prices)	0.893	0.700	Reliable
7.	Inaccurate in determining suppliers	0.703	0.700	Reliable
8.	Errors in material cost estimation	0.766	0.700	Reliable
9.	Delays in material delivery	0.761	0.700	Reliable
10.	Delays in project implementation	0.877	0.700	Reliable

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No	Material	Coefficient	Conbach	Reliability
11.	Fluctuating material prices	0.880	0.700	Reliable
12.	Poor material procurement	0.815	0.700	Reliable
13.	Changes in material specifications	0.812	0.700	Reliable

Next, the development of anticipatory actions and solutions for 5 dominant factors of material cost overrun on toll road projects that are valid and reliable is carried out. In this development, it is carried out with a team of experts to obtain recommendations for anticipation and solutions when cost overrun occurs on the Toll Road Project for the planning stage presented in table 3 and the implementation stage presented in table 4 below.

Table 3. Anticipation and Solutions for Material Costs for Toll Road Projects at the Planning Stage

No	Indicator number	Indicators	Anticipation and Solution Planning Stage
1.	5	Change in material quantity	1. Re-evaluate the calculation of material quantities. Use historical data from previous projects or standard guidelines to estimate material requirements more accurately. 2. Utilizing BIM Technology can help in modeling the project in 3D and provide more precise material quantity estimates 3. In budget planning, allocate a reserve fund (contingency) to deal with possible changes in material quantities during the project.
2.	3	Material selection	1. Double-check the project design and specifications of the selected materials. 2. Ensure that the materials are selected based on the functionality and specifications that are truly needed. 3. If possible, create a fixed-price contract with the supplier to lock in the price of the materials for a certain period of time.
3.	6	Material prices are subject to change	1. Conduct comprehensive market research to gain a better understanding of material price trends, demand, and supply. This research should be conducted continuously throughout the planning stage so that material prices can be predicted more accurately. 2. Negotiate with suppliers to obtain fixed-price contracts or forward contracts. 3. Long-Term Contracts with Suppliers: In addition to fixed-price contracts, you can also consider long-term cooperation with trusted suppliers. 4. If there is an indication that material prices will increase, consider making early procurement to lock in prices before they increase.
4.	11	Material prices are subject to change	1. During planning, negotiate long-term contracts with suppliers that lock in material prices. This will help protect the project from material price fluctuations throughout the project period. 2. During the planning stage, analyze the risks associated with material prices and their impact on the project budget. Create a mitigation plan that includes steps that can be taken if material prices

No	Indicator number	Indicators	Anticipation and Solution Planning Stage
			spike. 3. Ensure that risks associated with material price increases are continuously monitored and managed throughout the project. Create mechanisms for evaluating and responding quickly to market changes. 4. Ensure that the client understands that there is a risk that material price fluctuations can affect the project cost. Agree with the client on how to handle material price increases, whether there are cost adjustments or the use of alternative materials.
5.	2	There is an increase in material prices	1. Evaluate the use of alternative materials or more economical construction techniques to reduce costs without sacrificing quality. 2. Review the project design to identify areas where costs can be saved, such as eliminating non-essential elements 3. Conduct regular evaluation and feedback to monitor the impact of actions taken and to adjust as needed.

Table 4. Anticipation and Solutions for Material Costs for Toll Road Projects in the Implementation Phase

No	Indicator number	Indicators	Anticipation and Solution Planning Stage
1.	5	Change in material quantity	1. Ensure that all materials received are strictly checked against the specifications and quality set out in the planning. If there is any discrepancy, immediately make a claim or replacement with the supplier before the material is used in the field. Only use materials that have been certified and meet relevant standards (such as SNI, ASTM, ISO, etc.). 2. If there are changes to the proposed material specifications during the project implementation, the approval process must be carried out quickly and systematically, involving the planning team, implementers, and clients. 3. Negotiate with suppliers to get the best price during the project, especially if there is a change in the amount of material needed. Selecting the right amount of material, according to the project schedule, can avoid waste or additional storage costs. 4. Ensure that the materials received are used efficiently in the field. Ensure that every material used is recorded and compared to the planned amount.
2.	3	Material selection	1. If there are changes in the proposed material specifications during the project implementation, the approval process must be carried out quickly and systematically, involving the planning team, the implementer, and the client. 2. Continue to negotiate with suppliers to get the best

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No	Indicator number	Indicators	Anticipation and Solution Planning Stage
			price during the project, especially if there are changes in the amount of material needed. 3. Ensure that the materials received are used efficiently in the field.
3.	6	Less accurate in predicting the market (material prices)	1. Establishing a fixed-price contract with suppliers before the project begins can protect the project from price fluctuations during implementation. It ensures that the price of materials will not change during the duration of the project. 2. If a fixed-price contract is not possible, include a price escalation clause that limits price increases based on market indexes or inflation, so that price increases remain controlled. 3. For materials that have a significant impact on the project budget, such as steel or other commodities, companies can use a hedging strategy. This allows the company to lock in the future price of the material, protecting against the risk of extreme market fluctuations.
4.	11	Material prices are subject to change	1. Implement Counter1. Negotiate long-term material purchase contracts with suppliers that include price locking for a specified period of time. Helps reduce the risk of material price fluctuations that can cause unexpected cost increases. 2. Add a price escalation clause to the supplier contract, which allows for price adjustments based on an agreed price index (e.g., a raw material index). This allows costs to be adjusted transparently according to uncontrolled market price changes. 3. Avoid relying on a single supplier. By having several alternative suppliers, the company can be more flexible in seeking more competitive prices when prices increase. 4. If the price of the main material changes drastically, consider using alternative materials that are cheaper but still meet the required specifications and quality standards.
5.	2	There is an increase in material prices	1. Review and renegotiate contracts with suppliers or contractors to get better prices or discounts, especially if there are large purchases. 2. Conduct analysis to optimize the use of existing materials. Ensure there is no waste and all materials are utilized efficiently. 3. If possible, make early purchases of materials before prices increase further, taking into account proper storage. 4. Prepare a contingency budget to face possible future price increases, so that the project can continue despite additional costs.

CONCLUSION

From the results of the study, it can be concluded that 1) there are 10 valid factors causing cost overrun with a coefficient value of 0.389 - 0.716 and 13 reliable factors causing cost overrun with a Cronbach's alpha value above 0.700, 2) the results of the study indicate that anticipation and solutions for handling cost overrun of material costs in toll road projects are preventive measures to reduce and eliminate the occurrence of cost overrun at the planning stage and at the implementation stage.

REFERENCES

Soeharto, I. (1995). *Manajemen Proyek dari Konseptual sampai Operasional*. Jakarta, Erlangga.

Kerridge, AF (1987). *Mengelola Material Secara Efektif* Pengolahan Hidrokarbon.

Bell, LC and G. Stukhart (1986). "Atribut Sistem Manajemen Material."*ASCE - Jurnal Teknik dan Manajemen Konstruksi*Nomor 112 (1): 14 – 21

Kini. U, D. (1999). "Manajemen Material: Kunci Sukses Manajemen Proyek, *ASCE - Jurnal Manajemen Teknik* (Januari/Februari): 30. Ahuja, HN (1976). *Pengendalian Kinerja Konstruksi melalui Jaringan* New York, John Wiley dan Sons**:** 528.

Stonebraker, EA (1994). *Strategi Operasional* Massaachusetts, Allyn and Bacon.

Ahuja, HN (1980). *Pengendalian Biaya Konstruksi yang Berhasil* New York, John Wiley dan Sons.

Halpin, D. dan W. (1998). *Manajemen Konstruksi* Amerika Serikat, John Wiley and Sons, Inc.**:**251 - 283.

Zhan, JG (1998). "Model Pengendalian Biaya Proyek." *Jurnal AACE Teknik Biaya* 40 (12): 32

Veronika, Alin, Tesis*Rekomendasi Tindakan Koreksi pada Manajemen Material dalam Pengendalian Biaya Proyek Dengan Menggunakan Sistem Pakar*, tahun 2002

PPm (1998). *Diktat Kursus Lembaga Pendidikan dan Pembinaan Manajemen*. Jakarta.

Stukhart, G. (1995). *Manajemen Bahan Konstruksi*. New York, Marcel Dekker, Inc.

Kerzner, H. (1995). *Manajemen Proyek*, Pendekatan Sistem untuk Perencanaan, Penjadwalan, dan Pengendalian. New York, Van Nostrand Reinhold.

Johnston, EJ (1987). *Kontrol Material di Lokasi*. London, Butterworth.

Hamzah, A. (1994). "Perspektif Praktik Manajemen Material dalam Ekonomi yang Berkembang Pesat. *Manajemen dan Ekonomi Konstruksi*.

Ahuja, HN (1976). *Pengendalian Kinerja Konstruksi melalui Jaringan* New York, John Wiley dan Sons**:**

Russell, AD dan A. Fayek (1994). "Asisten Pemilihan Tindakan Korektif Otomatis." *ASCE-Jurnal Teknik dan Manajemen Konstruksi*120 (No. 1 Maret)