Anticipation and Solution of Equipment Cost Overrun Factor in Toll Road Construction Project

Muhammad Nafhan Isfahani1, Dr. Ir. Antonius M.T2, Dr. Ir. Kartono Wibowo M.T(3)
Doctoral Program of Civil Engineering, Sultan Agung Islamic University (UNISSULA), Semarang, Indonesia
Email: nafhanisfahani@gmail.com

Abstract

This paper presents the results of research on the anticipation and solution of handling excess material costs on open system toll road projects in Jadebotabek. The purpose of this study is to determine the anticipation and solution of handling excess material costs. This research was conducted by conducting a survey to 76 respondents consisting of Managers, Consultants and Contractors involved in the construction of toll roads in Jabodetabek which is a coastal area. The results of the survey were tested for validity, reliability and mean to determine the dominant factors causing excess costs, then the preparation of anticipation and solutions for handling excess equipment costs by a team of experts. The results showed that there were 12 valid factors causing cost overruns with a coefficient value of 0.385 - 0.577 and 13 reliable factors causing cost overruns with a Cronbach's alpha value above 0.700. The results of this study also show that anticipation and solutions to handling equipment cost overruns on coastal toll road projects are preventive actions to reduce and eliminate the occurrence of cost overruns at the planning stage and at the implementation stage.

Keywords: cost overrun equipment, Anticipation and Solution, Toll Road

Introduction

Toll road infrastructure development is a vital part in supporting economic growth and community mobility, especially in metropolitan areas such as Jabodetabek (Jakarta, Bogor, Depok, Tangerang, and Bekasi). However, in its implementation, toll road projects often face challenges in terms of cost efficiency, especially those related to equipment factors. One of the main problems that arise is cost overrun, which can have an impact on delays in project completion and financial losses for both contractors and project owners (Kaming et al., 1997).

Factors equipment has been identified as one of the significant contributors to cost overruns in construction projects. Issues such as machine availability, operating costs, machine breakdowns, as well as sub-optimal management and maintenance can cause deviations in cost overruns from the planned budget (Azis, 2008). The study by Memon et al. (2011) also showed that delays in equipment procurement and inefficiencies in the use of heavy equipment are the main cause of major causes of cost escalation in construction projects in the Southeast Asian region.

In the Greater Jakarta area, with a high level of project complexity and tight time pressure, the challenges in equipment management become even more crucial. Several previous studies (Susilawati et al., 2015; Nurhayati et al., 2020) highlighted that the lack of careful equipment planning and the absence of a data-driven monitoring system can exacerbate the risk of cost overruns.

Given the importance of toll road projects in supporting regional connectivity and national logistics efficiency, systematic efforts are needed to identify the causes of cost overruns related to equipment factors, and formulating strategies, anticipation and applicable solutions in the field. This research aims to analyze the equipment factors that cause cost overrun on toll road projects in the Jabodetabek area, as well as provide strategic recommendations in the form of mitigative solutions that can be implemented by project stakeholders. With a data-driven approach and a review of best practices, this practices,) results research is expected to make a real contribution to improving the cost efficiency of toll road infrastructure projects in Indonesia.

The topic of this paper is part of the research to provide recommendations for anticipation and solutions to the occurrence of equipment management cost overruns in toll road projects.

Equipment Cost Control

Equipment cost control is one of the important elements in construction project management, especially in large-scale projects such as toll roads. Inefficiency in managing equipment can lead to waste of resources, time delays, and significant cost overruns (Abd Majid & McCaffer, 1997). Therefore, a systematic and sustainable approach is required in controlling equipment costs so that the project can run according to the planned budget.

One of the effective methods in controlling equipment costs is through accurate planning of equipment needs, including the determination of the type, number, and duration of tool usage adjusted to the project work schedule. According to Kaka & Price (1991), errors in estimating equipment requirements can lead to an excess of unused equipment or a shortage of equipment which has an impact on work delays.

In addition, cost control can also be done through scheduled equipment maintenance and preventive maintenance. A study by Chan and Kumaraswamy (1997) showed that a high frequency of equipment breakdowns due to lack of maintenance can increase operational costs and slow down the construction process. Therefore, the implementation of an information technology-based asset management system can help monitor the condition of the equipment in real-time and organize maintenance schedules automatically (Azis, 2008).

The use of an equipment cost monitoring and evaluation system on a regular basis is also very important. Memon et al. (2011) emphasized that without regular and accurate cost reporting, deviations from budget will be difficult to detect early on. Therefore, the use of project management software such as Primavera or Microsoft Project can assist in recording and reporting equipment costs in an integrated manner.

Research Methods

This research consists of 23 indicators that cause cost overruns in material management. Determination of indicator variables by conducting a literature review study of several internationally reputable journals which resulted in 13 indicator factors that are in accordance with the research. In collecting data, this research uses 2 ways, namely by distributing questionnaires and interviews. At the questionnaire stage distributed to experts in the field of toll roads as many as 80 respondents and in the process of returning as many as 76 respondents, this data is already representative based on the slovin sampling technique.

From the first stage data is then processed to find valid and reliable indicators and then proceed to the interview stage. At the interview stage with experts or experts who have experience in the field. in toll road construction projects in the Jabodetabek area, to obtain anticipatory actions and solutions to the occurrence of cost overruns on equipment factors at the planning and implementation stages of toll road construction projects.

Research Results

The validity test on the equipment factor for cost overruns in toll road construction projects consists of 15 question indicators. There are 3 items invalid questions at number 2 (high equipment mobilization costs), 6 (errors in equipment investment) and 9 (Tools work too heavy) because the validity value is <0.300. So there are 12 valid question indicators with a coefficient value of 0.385 - 0.577. The results of the external variable validity test are presented in table 1

Table 1 Equipment Validity Test Results

No	Equipment Factor	Coefficient Value	Validity Threshold	Validity
1	Equipment purchase/rental price	0.529	0.300	Valid
2	High mobilization/demobilization costs	0.234	0.300	Not Valid
3	Equipment delivery delays	0.548	0.300	Valid
4	Machine selection	0.390	0.300	Valid
5	Equipment storage errors	0.385	0.300	Valid
6	Errors in equipment investment	0.216	0.300	Not Valid
7	High rental costs	0.422	0.300	Valid
8	Inadequate equipment capacity	0.577	0.300	Valid
9	Equipment working too heavily	0.239	0.300	Not Valid
10	Low equipment lifespan	0.518	0.300	Valid
11	Poor equipment maintenance	0.429	0.300	Valid
12	Inappropriate equipment repair	0.516	0.300	Valid
13	Limited funding sources for equipment	0.476	0.300	Valid
14	Equipment availability	0.576	0.300	Valid
15	High frequency of equipment repair	0.712	0.300	Valid

The results of the reliability test using the Cronbach's alpha method of the factors causing the cost overrun of equipment on toll road construction projects consist of 15 factors, there are 2 reliable indicators with coefficient values above 0.700, presented in table 2 below

Table 2 Reliability Test Results of Equipment Factors

No	Equipment Factor	Cronbach's Alpha	Reliability
1	Equipment purchase/rental price	0.711	Reliable
2	High mobilization/demobilization costs	0.234	Not Reliable
3	Equipment delivery delays	0.728	Reliable
4	Machine selection	0.761	Reliable
5	Equipment storage errors	0.766	Reliable
6	Errors in equipment investment	0.216	Not Reliable
7	High rental costs	0.685	Not Reliable
8	Inadequate equipment capacity	0.717	Reliable
9	Equipment working too heavily	0.766	Reliable
10	Low equipment lifespan	0.518	Reliable
11	Poor equipment maintenance	0.429	Not Reliable
12	Inappropriate equipment repair	0.516	Reliable
13	Limited funding sources for equipment	0.476	Reliable
14	Equipment availability	0.576	Reliable
15	High frequency of equipment repair	0.712	Reliable

The development of anticipation strategies and solutions to cost overruns due to equipment factors in toll road projects in the Jabodetabek area was carried out based on input from expert respondents who have more than 15 years of experience in the field of infrastructure construction management. The experts consist of project managers, heavy equipment planners, as well as academics who understand the dynamics of toll road projects in dense urban areas such as Jabodetabek.

Based on the results of interviews and structured questionnaires, the experts agreed on tables 3 and 4 below

Table 3 Anticipation and Solution for Toll Road Project Equipment

No	**EQUIPMENT**	Anticipate Cost Overrun	Library
1	Equipment delivery delays	Develop a schedule of construction equipment needs according to the project stages. Establish lead times for equipment procurement and delivery based on vendor data. Identify critical equipment that will affect the critical path of the project. equipment)	(Doloi et al., 2012)
2	Errors in organizing equipment storage	Design storage procedures for heavy and light types of equipment to prevent damage. or missing.	(Navon, R. (2005)
3	High rental costs	Using the usage schedule optimization model tools for avoid idle time	(Cheng et al., 2005)
4	Tools working too heavy	Determine the optimal working capacity of tools according to specifications manufacturer	(Elazou ni, A, & Abou Zeid, 20 03)
5	Poor tool maintenance	Develop a schedule for preventive maintenance of equipment schedule).	(Hegaz y, T., & Ayed, A. - 1998)
6	Limited funding sources for equipment	Ensure equipment cost estimates take into account actual project needs (quantity, rental duration, operating costs).	(Creedy -, et al, 2010)
7	High frequency of tool repair	Establish a regular preventive maintenance schedule (based on working hours or cycles). use of tools).	(Al- Najjar, 2007)
8	High equipment mobilization/demo bilization costs	Develop an efficient machine logistics plan, including routes, times and methods of transportation. Combining mobilization schedule with work breakdown structure and cash flow. project	(Musa, et.al 2005)
9	Machine selection	Engage a technical team or vendor to conduct a tool feasibility study. Get technical advice on tool specifications as needed project	(Chan, Tal 2002)
10	Errors in equipment investment	Application of Life Cycle Cost (LCC) Analysis Before Investment and Feasibility Study of Equipment Investment based on Demand Project	(Ransberg, etal 2008)
11	Tool capacity is not suitable	Assessment of Economic Life of Tools Before Purchase Tool Selection Based on Total Cost of Ownership (TCO)	(Ransberg, etal 2008)
12	Tool repair is not appropriate	Establish tool repair procedures based on manufacturer's recommendations and guidelines technical	(Sherwi n, 2000)
13	Equipment availability	Integrate equipment requirements in the schedule work (WBS & CPM)	(Elazou ni & AbouRi zk, 2001)

By adopting this experience-based approach and expert input, it is expected that toll road projects in Jabodetabek can reduce the risk of cost overruns caused by equipment factors more significantly and systematically.

Conclusion

From the research results it can be concluded:

1) There are 15 factors causing cost overrun valid with a coefficient value of 0.385 - 0.577 and there are 13 indicators causing cost overrun realiable with Cronbach's alpha value above 0.700.
2) The results showed that the anticipation and solution to the cost overrun of variable equipment in toll road projects are preventive measures to reduce and eliminate the incidence of cos overrun at the planning stage and at the implementation stage.

Bibliography

Suryanto, E., & Widodo, A. (2020). The Effect of Cost Overruns in Construction Projects and Solutions to Overcome the Problem. Journal of Construction Management, 18(4), 250-263.

Pratama, R., & Utomo, H. (2019). Cost Overruns and their Impact on Construction Project Success. Journal of Civil Engineering and Construction, 22(3), 112-124.

Okonkwo, C., Evans, U., & Ekung, S. (2022). Unearthing direct and indirect material waste-related factors underpinning cost overruns in construction projects. International Journal of Construction Management, 23, 2298 -. 2304. https://doi.org/10.1080/15623599.2022.2052431.

Uvarova, S., Belyaeva, S., Orlov, A., & Kankhva, V. (2023). Cost Forecasting for Building Materials under Conditions of Uncertainty: Methodology and Practice. Buildings. https://doi.org/10.3390/buildings13092371.

Sepasgozar, S., Costin, A., Karimi, R., Shirowzhan, S., Abbasian, E., & Li, J. (2022). BIM and Digital Tools for State-of-the-Art Construction Cost Management. Buildings. https://doi.org/10.3390/buildings12040396.

, Y., & Susetyo, B. (2019). Factors Affecting Cost Overrun of RC-PIER Jabodebek LRT Project: A Case Study of Cawang, Indonesia. International Journal of Engineering Research and Advanced Technology. https://doi.org/10.31695 /ijerat.2019.3436.

Więcek, D., Wiecek, D., & Dulina, Ľ. (2020). Materials Requirement Planning with the Use of Activity Based Costing. Management Systems in Production Engineering, 28, 3 -.

8. https://doi.org/10.2478/mspe-2020-0001.

Awati, M., Dita, N., Putra, P., & Oktrify, M. (2024). Material Planning Analysis with Material Requirement Planning Method in High-rise Building Projects. Sustainable Civil Building Management and Engineering Journal. https://doi.org/10.47134/scbmej.v1i3.2438.

Asare, S., Fobiri, G., & Bondinuba, F. (2024). Enhancing fairness, transparency and accountability during tendering under Ghana's procurement system: a systematic review. Built Environment Project and Asset Management. https://doi.org/10.1108/bepam-04-2024-0107.

Chen, Q., Adey, B., Haas, C., & Hall, D. (2020). Using look-ahead plans to improve material flow processes on construction projects when using BIM and RFID Technologies. Construction Innovation. https://doi.org/10.1108/c i-11-2019-0133.

Noori-Daryan, M., Taleizadeh, A., & Jolai, F. (2017). Analyzing pricing, promised delivery lead time, supplier-selection, and ordering decisions of a multi-national supply chain under uncertain environment. International Journal of Production Economics.

https://doi.org/10.1016/J.IJPE.2017.12.019.

Sweis, G., Sweis, R., Abu Hammad, A., & Shboul, A. (2008). Delays in construction projects: The case of Jordan. International Journal of Project Management.

Doloi, H., Sawhney, A., Iyer, K. C., & Rentala, S. (2012). Analyzing factors affecting delays in Indian construction projects. International Journal of Project Management.

Assaf, S. A., & Al-Hejji, S. (2006). Causes of delay in large construction projects. International Journal of Project Management.

Kusumanugraha, Y. (2018). The Evaluation of Foreman Competency Suitability on Consumer Complaints. Journal of Civil Engineering and Planning. https://doi.org/10.15294/JTSP.V20I2.16172.

Putri, R.D. (2020). Analysis of Factors Causing Delays in the Cibitung-Cilincing Toll Road Project. Politeknik Negeri Jakarta.

Widodo, T. (2021). Overtime Policy Analysis on Construction Projects: Cost vs Benefit. Scientific Journal of Civil Engineering.

Azhar, S. (2011). Building Information Modeling (BIM): Trends, Benefits, Risks, and Challenges for the AEC Industry. Leadershipand Management in Engineering, 11, 241-252.

Kaming, P.F., Olomolaiye, P., Holt, G.D., & Harris, F.C. (1997). Factors influencing construction time and cost overruns on high-rise projects in Indonesia. Construction Management and Economics, 15, 83- 94.

(Navon, R. (2005). Automated project performance control of construction projects. Automation in Construction).

(Cheng et al., 2005. Automation in Construction) DOI:10.1016/j.autcon.2005.01.002

Elazouni, A., & Abou Zeid, M. (2003). Resource scheduling using combined simulation and genetic algorithms. Automation in Construction, 12(3), 329-343.
https://doi.org/10.1016/S0926 5805(03)00003-6

Hegazy, T., & Ayed, A. (1998). Neural network model for parametric cost estimation of highway projects. Journal of Construction Engineering and Management, 124(5), 357-363. https://doi.org/10.1061/(ASCE)0733 -9364(1998)124:5(357)

Creedy, G. D., Skitmore, M., & Wong, J. K. W. (2010). Evaluation of risk factors leading to cost overrun in delivery of highway construction projects. Journal of Construction Engineering and Management, 136(5), 528-537. https://doi.org/10.1061/(ASCE)CO.1943-7862.0000150

Al-Najjar, B. (2007). The lack of maintenance and not maintenance which costs: A model to describe and quantify the impact of vibration-based maintenance on company's business. International Journal of Production Economics, 107(1), 260-.273.
https://doi.org/10.1016/j.ijpe.2006.0 9.005

Musa, R. A., Abdul-Kadir, M. R., & Jaafar, M. S. (2005). Delays and cost overruns in construction of public projects in Malaysia. International Journal of Project Management, 23(4), 283-295. https://doi.org/10.1016/j.ijproman.2004.10. 03

Chan, D. W. M., & Kumaraswamy, M. M. (2002). Compressing construction durations: Lessons learned. from Hong Kong building projects. International Journal of Project Management, 20(1), 23-35. https://doi.org/10.1016/S0263 7863(00)00032-6

Gransberg, D. D., & Molenaar, K. R. (2008). Life-cycle cost analysis for construction equipment procurement. Journal of Construction Engineering and Management, 134(10), 800-808. https://doi.org/10.1061/(ASCE)0733 -9364(2008)134:10(800)

Elazouni, A., & AbouRizk, S. (2001). Integrating simulation and optimization of construction planning. Journal of Construction Engineering and Management, 127(2), 132-141. https://doi.org/10.1061/(ASCE)0733 - 9364(2001)127:2(132)

Enshassi, A., Mohamed, S., & Abushaban, S. (2009). Factors affecting the performance of construction projects in the Gaza Strip. Journal of Civil Engineering and Management, 15(3), 269-280. https://doi.org/10.3846/1392 3730.2009.15.269-280

Olawale, Y. A., & Sun, M. (2010). Cost and time control of construction projects: Inhibiting factors and mitigating measures in practice. Construction Management and Economics, 28(5), 509-526. https://doi.org/10.1080/0144619090 3521510

Assaf, S. A., & Al-Hejji, S. (2006). Causes of delay in large construction projects. International Journal of Project Management, 24(4), 349-.357. https://doi.org/10.1016/j.ijproman.20 05.11.010

Alaghbari, W., Kadir, M. R. A., Salim, A., & Ernawati. (2007). The significant factors causing delay of building construction projects in Malaysia. Engineering, Construction and Architectural Management, 14(2),192-206. https://doi.org/10.1108/09699980710731308

Kaming, P. F., Olomolaiye, P. O., Holt, G. D., & Harris, F. C. (1997). Factors influencing construction time and cost overruns on high rise projects in Indonesia. Construction Management and Economics, 15(1), 83-94. https://doi.org/10.1080/0144619973 73132

Zwikael, O. (2009). Critical planning processes in construction projects. Construction Innovation, 9(4), 372-.387. https://doi.org/10.1108/14714170910995951

Hidayat, B., & Egbu, C. (2010). A literature review of the issues and challenges of public-private partnership (PPP) projects in Indonesia. RICS COBRA Conference, 1-10. [https://www.arcom.ac.uk/docs/proceedings/ar2010-915- 924_Hidayat_Egbu.pdf]

Aulia, S. M. (2024). Land Acquisition Mechanism in the Construction of the Blang Bintang - Kuta Baro Toll Road. Ar-Raniry State Islamic University