
Study of Variation Orders and Its Impact on Project Performance in Terms of Cost and Implementation Time in The Tenjoresmi Area Arrangement Project

Ana Yuni Martanti^{1*}, Tota Pirdo Kasih², Frans Himawan Tanojo³

^{1,2}Faculty of Engineering, Bina Nusantara University, Jakarta, Indonesia

³Himindo Group, West Jakarta, Indonesia

Email: ana.martanti@binus.ac.id*

ABSTRACT

This research highlights the impact of Variation Orders in construction projects, especially in the Tenjoresmi Area Arrangement. The results of the field study showed that the Variation Order caused significant changes to the Cost Budget Plan (RAB) and the performance of the implementing contractor. Some of the work affected includes changing the brand of air conditioner, replacing the amphitheater with a jogging track, dismantling railings, sanitary dismantling, plumbing dismantling, air conditioning dismantling, removing demolition debris, glass window frames, reinstalling aluminum door and window frames, wall handrails, doors. iron, disposing of excavated gravel, and planting shrubs. RAB analysis revealed changes in cost proportions for various works, such as increases in demolition and architecture and decreases in structures. In October and November, there was a delay in implementing the work due to a contract addendum, which was only approved in mid-October. However, the implementing contractor did not experience financial problems, and even experienced an increase in profit of 0.79%. In conclusion, Variation Orders can affect project time and costs, but flexible contractors can manage them well, and even optimize profits. Effective management is needed to cope with change and ensure the smooth implementation of construction projects.

Keywords: variation order, planned cost budget, project performance, S curve

INTRODUCTION

In a construction project, changes to the work occur very often, this can be caused by not implementing the planning method properly (Chirumalla, 2021; Hutchinson et al., 2024; Pamidimukkala & Kermanshachi, 2021; Schulz et al., 2023; Waqar et al., 2024; Yap et al., 2021). In construction work contracts, the understanding cannot be applied in the same way as with other types of contracts, this is because a construction contract is a contract that has a very

dynamic nature, namely promising an item that does not yet have a form and still requires a process to become the promised form. So that the price of the construction contract will always change from time to time, due to volume adjustments or changes in implementation methods, whether ordered by the service user through change orders or those that are not ordered but must be carried out for project completion (Agha et al., 2020; Arief & Hardjomuljadi, 2020; Herm et al., 2023; Yawalkar et al., 2023). In Government construction projects based on Presidential Regulation of the Republic of Indonesia Number 16 of 2018 concerning Procurement of government goods/services in article 54 paragraph (1) which reads: In the event that there is a difference between the field conditions at the time of implementation and the drawings and/or technical specifications/KAK specified in the Contract document, the PPK together with the Supplier can make changes to the contract, which include: Increasing or reducing the volume of work stated in the contract, Adding and/or reducing types of activities, Changing technical specifications according to field conditions; and/or, Changing the implementation schedule.

Meanwhile, paragraph (2) reads: In the event that the contract changes as intended in paragraph (1) result in an increase in the contract value, the contract changes are implemented with the provision that the addition to the final contract value does not exceed 10% (ten percent) of the price stated in the initial contract.

Variation orders or in government projects better known as change orders usually occur after a joint inspection is carried out and it is found that there are changes to the Bill of Quantities and changes to the design drawings. Based on the Procedures for Quality Assurance and Quality Control of Construction Work at the Ministry of Public Works and Public Housing of the Republic of Indonesia in accordance with the Circular Letter of the Minister of Public Works and Public Housing of the Republic of Indonesia number 15/SE/M/2019, there is a flow chart if this occurs.

Changes in the scope of work, changes in specifications and changes in design are the dominant factors that usually cause variation orders (Cicarelli & Marotta, 2024; Guo et al., 2023; Iskandar et al., 2022; Meyer & Norman, 2020). Amin in 2013 stated that the impact of variation orders occurs on costs, because additional costs have implications for additional work volume (Alsalah et al., 2024; Amin & Zhang, 2013; Khan et al., 2013). Followed by the impact on time, because every time there is an increase in the scope of work or volume of work it will not necessarily have an impact on extending the implementation time (Martanti, 2019; Wang & Azam, 2024). Apart from that, the impact of variation orders also influences the addition or reduction of work volume according to needs and conditions in the field (Huang et al., 2024; Palilati & Musa, 2022; Raihan, 2023; Rong et al., 2024). The project that will be studied in the Engineering Practice Report entitled Study of Work Variation Orders and Their Effect on Project Performance in terms of Cost and Time in Arranging the Tenjoresmi Area, was carried out by PT. Menara Setia is a government project managed by the Building Arrangement Development

Work Unit for the Implementation of Settlement Infrastructure Region I, West Java Province at the Ministry of Public Works and Public Housing. The project location is in Pelabuhan Ratu District, Sukabumi Regency, West Java Province.

The main objective of this research is first, to identify jobs affected by variation orders in the Tenjoresmi Area Arrangement project. Second, to analyze the impact of variation orders on changes in the proportion of the Planned Cost Budget (RAB) for various construction works. Third, to evaluate the impact of variation orders on project performance, both in terms of cost and implementation time. Thus, this report aims to provide a comprehensive understanding of the implications of variation orders in the construction context of the Tenjoresmi Area Arrangement project.

RESEARCH METHODS

Results Of Research On Variation Order Jobs

This research method involves several structured stages to collect and analyze data related to the Tenjoresmi Area Planning project. Initially, the field study was carried out by collecting data directly from the research object, namely the construction project. The aim is to obtain accurate and precise information related to engineering practice reports

Data related to variation order works and the results of calculating the Cost Budget Plan (RAB) for work resulting from variation orders are obtained from the construction contract addendum provided by the implementing contractor. This information is then organized in a table of variation order jobs. Meanwhile, the results of implementation cost calculations in the Engineering Practice Report are represented through a research flow chart.

Further data regarding the implementing contractor's project, such as project information, initial budget, implementation schedule (S curve), project achievements during implementation, and financial data (cash flow) are processed using the Microsoft Access 2010 program. Microsoft Access is used to design, create and managing databases, enabling accurate data processing through mathematical calculations.

From the financing model that has been created, various parameters are calculated, including Cost Variance (CV), Time Variance (Schedule Variance/SV), Cost Performance Index (CPI), and Schedule Performance Index (Schedule Performance Index). /SPI). This method allows in-depth analysis of the cost and time aspects of construction project implementation.

RESULTS AND DISCUSSION

Results Of Research On Variation Order Jobs

In the implementation of field research, the data obtained from the results of technical studies from Construction Management Consultants will be outlined in the table of what variation order works occur in the Tenjoresmi Area Planning project and the technical basis for

the occurrence of the variation order itself. The basis for variation orders and variation order works can be seen in Table 1.

Table 1. Variation order jobs

No.	Dasar <i>variation order</i>	Variation order <i>work</i>
1	Request from Beneficiary Party (Presidential Palace)	<p>For the replacement of the Air Conditioner brand <i>from the original Panasonic to DAIKIN included in the draft work added less with consideration of ease of maintenance and the availability of 24-hour duty technicians and referring to the history of using other brands of Air Conditioners experiencing problems in technical maintenance;</i></p> <p>For the replacement <i>of the amphitheater</i> in the site development area into a <i>jogging track</i>, it was included in the draft work, adding less with consideration of the efficiency of use and handling maintenance by the management with an adjusted design.</p>
2	Increasing volume according to field needs.	Broadly speaking, some contract work items that experience volume additions with varying quantities based on field needs and adjustments to the original plan.
3	Additional work according to field needs	<p>Railing fence demolition work ;</p> <p>Sanitary demolition work;</p> <p>Plumbing demolition work;</p> <p>Air conditioning demolition work;</p> <p>Dismantlement debris work;</p> <p>5 mm glass window sill work and 12 mm <i>tempered</i> glass door type PJ2' complete with accessories;</p> <p>Work on reinstalling existing aluminum door and window frames;</p> <p>Work to reassemble existing Aluminium door and window shutters;</p> <p>Wall handraill work (BSP finish anti-rust paint);</p> <p>Iron door work - PB1 generator house;</p> <p>Work to dispose of the excavated gravel land of the generator house;</p> <p>Bougainvillea sp/<i>Bugenvil</i> shrub planting work;</p>

Results Of Research On The Impact Of Variation Orders On Budget Plans (Rab)

From the calculation of variation order works, a comparison of the proportion of costs in the Cost Budget Plan (RAB) is obtained between the initial contract and the contract addendum from the implementing contractor. A comparison of the proportion of costs can be seen in Table 2.

Table 2. Comparison of the proportion of costs in the Cost Budget Plan (RAB)

No	TYPES OF JOBS	INITIAL CONTRACT	CONTRACT ADDENDUM	VARIETY OF JOBS	PERCENTAGE CHANGE
1	Preparatory Work	Rp. 64.025.000,00	Rp. 64.025.000,00	-	0%
2	Demolition Works	Rp. 57.154.918,00	Rp. 73.395.284,00	Rp. 16.240.366,00	0,15%
3	Structural Work	Rp. 2.882.309.656,74	Rp. 2.442.523.675,30	(Rp. 439.785.981,44)	3,94%
4	Architectural Work	Rp. 1.799.433.052,19	Rp. 2.368.690.198,00	Rp. 569.257.145,81	5.10%
5	Mechanical, Electrical & Plumbing Jobs	Rp. 2.127.148.417,66	Rp. 2.160.735.067,66	Rp. 33.586.650,00	0,30%
6	Site Development Work	Rp. 4.241.100.126,58	Rp. 5.160.708.619,18	Rp. 919.608.492,90	8,23%
	Total Value of Pretax Work	Rp. 11.171.171.171,17	Rp. 12.270.077.844,14	Rp. 1.098.906.672,97	
	Percentage of Work Add/Less		9,84%		

From the table and graph, the comparison of the proportion of costs in the Cost Budget Plan (RAB) as a result of variation orders, there was an additional contract cost (addendum) before tax of Rp. 1,098,907,207.21 or an increase in contract costs of 9.84%. In this project, the contractor plans the overall project implementation budget of Rp. 11,523,145,109.00.

Research Results On The Impact Of Variation Orders On Project Performance In Terms Of Cost And Time

In the implementation of field study research, it was carried out to examine how the project performance of contractors who carry out construction work in terms of cost and time.

Project data obtained from the implementing contractor consists of: project information, budget, schedule of work implementation (S curve), project performance during project implementation, contractor cash flow consisting of cash in and cash out during project implementation, contract addendum. The data was then processed using a financing model created during this study using the Microsoft Access 2010 program. Microsoft Access is used to design, create and manage databases. Microsoft Access is able to provide accurate results from mathematical calculations from project data that has been collected. From the data obtained then processed using a mathematical financing model using the Microsoft Access 2010 program.

The output results of the input data will then become financing information in the form of: Project cost performance evaluation, project cost performance graph, and project results/profit evaluation.

Budget Calculation According to Schedule /PV/ (BCWS) is obtained by planning all project activities based on existing cost budget plans. This planned value can be described like scheduling using an S-curve. The proportion of costs in the monthly period taken from the S-curve scheduling already created by the executing contractor. The Planned Value = PV or Budgeted Cost of Work Schedule (BCWS) shows how much the budget is for a construction work package. PV is structured and linked to the implementation schedule. In PV there is a collaboration between costs, implementation schedules and scope of work carried out, where each work has been given an allocation of costs and implementation schedules and become a benchmark in the implementation of work. Actual Cost (AC) or Actual Cost of Work Performed (ACWP) is the actual cost of work that has been carried out at a certain reporting period. Actual costs are derived from accounting or project financial data as of the reporting date. So ACWP is the actual amount of expenditure or funds used to carry out work in a certain period of time. Budget Cost of Work Performance (BCWP) is the value of work that has been completed within a certain period of time, obtained from weekly or monthly achievement reports. The three indicators show cost variance and time variance. Cost Variance (CV) is a deviation from actual cost expenditure for the implementation of work against the realization of work performance in unit costs. Project data obtained from implementing contractors consists of: project information, budget, work implementation schedule (S curve), project achievements during project implementation, contractor cash flow consisting of cash in and cash out during project implementation, contract addendum. These data are then processed using a financing model

created during this research using the Microsoft Access program. The calculation results are seen in the Table 3.

Table 3 Contractor financing data

Month	Cash In (Rp.)	Planned Value (PV) (Rp)	Actual Cost (AC) (Rp.)	Earned Value (EV) (Rp.)
July	0	2,996,017.73	120,013,564.00	3,435,621.80
August	2,454,015,568.83	87,460,671.38	981,125,696.00	128,835,817.36
September	0	2,578,995,106.85	1,522,066,637.00	3,325,436,497.32
October	3,926,424,910.12	3,750,207,575.72	823,578,004.00	1,007,250,690.23
November	0	3,952,784,466.74	2,226,008,842.00	4,411,461,087.30
December	5,889,637,365.19	1,150,701,270.58	5,759,685,473.00	3,393,658,130.13

From Table 3, the values of Cost Variant (CV) and Schedule Variant (SV) can be calculated in Table 4.

Table 4 Cost Variant and Schedule Variant

Month	Accumulation			CV (Rp.)	SV (Rp.)
	PV (Rp)	AC (Rp.)	EV (Rp.)		
July	2,996,017.73	120,013,564.00	3,435,621.80	-116,577,942.20	439,604.07
August	90,456,689.11	1,101,139,260.00	132,271,439.16	-968,867,820.84	41,814,750.05
September	2,669,451,795.95	2,623,205,897.00	3,457,707,936.48	834,502,039.48	788,256,140.53
October	6,416,659,371.67	3,446,783,901.00	4,464,958,826.70	1,018,174,725.70	-
November	10,372,443,838.42	5,672,792,743.00	8,876,419,714.01	3,203,626,971.01	1,954,700,744.97
December	11,523,145,109.00	11,432,478,216.00	12,270,077,844.14	837,599,628.14	-
					1,496,024,124.41
					746,932,735.14

From Table 4, After calculating the Cost Variant (CV) and Schedule Variant (SV), the Cost Performance Index (CPI) and Schedule Performance Index (SPI) can be seen in Table 5.

Table 5 Cost Performance Index (CPI) and Schedule Performance Index (SPI)

Month	Accumulation			CV (Rp.)	SV (Rp.)
	PV (Rp)	AC (Rp.)	EV (Rp.)		
July	2,996,017.73	120,013,564.00	3,435,621.80	0.03	1.15
August	90,456,689.11	1,101,139,260.00	132,271,439.16	0.12	1.46
September	2,669,451,795.95	2,623,205,897.00	3,457,707,936.48	1.32	1.30
October	6,416,659,371.67	3,446,783,901.00	4,464,958,826.70	1.30	0.70
November	10,372,443,838.42	5,672,792,743.00	8,876,419,714.01	1.56	0.86
December	11,523,145,109.00	11,432,478,216.00	12,270,077,844.14	1.07	1.06

To see a comparison of variance analysis, see Figure 1

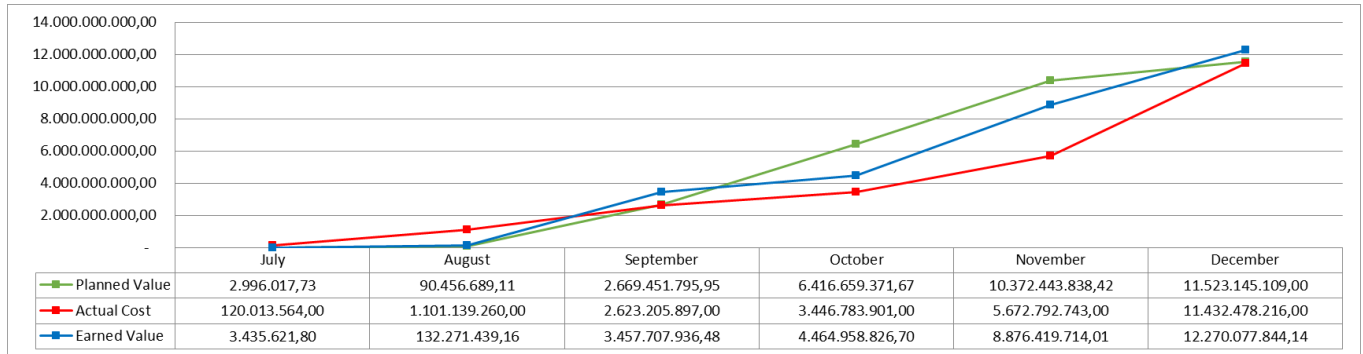


Fig 1. Comparison of variance analysis

Furthermore, the calculation of the Cost Performance Index (CPI) and Schedule Performance Index (SPI) in August, September,

From the calculation results, it was obtained that in the Tenjoresmi Area Planning Project, the performance of the implementing contractor in July and August obtained a CPI value of less than 1 so that in July and August there was a cost overrun or funds spent to finance the project greater than the planned budget. As for the following months, namely September, October and December, the CPI value is greater than 1 so that the funds spent by the implementing contractor are smaller than the planned budget.

The SPI value in July, August and September is greater than 1 so that the performance in terms of time for the executing contractor is faster than the planned schedule. In October and November the SPI value is smaller than 1 so that the performance in terms of time the implementing contractor experienced a delay in the implementation schedule than planned. While in December the implementing contractor can catch up with the delay in work delay, as evidenced by the SPI value in December of more than 1. From the calculation of the project cost evaluation of the Tenjoresmi Area Planning project, information was obtained that there was an increase in profit from previously planned. The increase in profit amounted to Rp. 90,666,893.00 or an increase in profit by 0.79%.

Overview Of Aspects of The Code of Ethics

The implementation of variation orders on the Tenjoresmi Area Planning project can be carried out throughout the project implementation period, but must follow the Procedures for Quality Assurance and Quality Control of Construction Work in accordance with the Circular Letter of the Minister of Public Works and Public Housing of the Republic of Indonesia number 15 / SE / M / 2019 and has been stated in the addendum to the construction work contract. In order to avoid disputes for the implementation of variation orders on the Tenjoresmi Area

Planning project, the concept of prevention that must be implemented by all parties involved, be it implementing contractors, Construction Management Consultants or project owners, is by coordinating related to any changes to be implemented. And the concept of development for each change must be made a technical justification in writing and agreed by all parties involved in it.

Overview From Professional Aspect

In the face of the fact that variation orders are inevitable in construction projects, it is important for the executing contractor to conduct an in-depth study of every detail of the project documents. Work safety and the avoidance of variation orders depend on accuracy in examining drawings for construction before being used as shop drawings. This process involves comparison between drawings for construction with actual field conditions, adjustments to technical specifications, and construction contract documents. The absence of accuracy in this stage can cause variation orders that can affect project performance and costs. In the context of the Tenjoresmi Area Planning project, the implementing contractor implements steps such as making a Request for Information to the Construction Management Consultant to respond to differences between drawings, detailing drawings in shop drawings related to work changes, calculating and planning the cost of changes in the contract addendum, and monitoring project costs using the Microsoft Access program. All of these actions are directed at properly documenting the work of variation orders, maintaining financial control of the project, and anticipating potential cost overruns so that project objectives involving quality, time, and cost can be optimally achieved.

Overview Of Health, Safety, Safety and Environmental Aspects (K3L)

In the implementation of the Tenjoresmi Area Planning project, even though there are many variation orders, aspects of Health, Safety, Security, and Environment (K3L) remain a priority that must be implemented properly. Measures taken to ensure optimal K3L include the creation of a Construction Safety Plan, which involves hazard identification and risk control at each stage of construction work. Furthermore, the implementation of safety induction and safety talk became routine activities, by providing induction to new workers and conducting socialization about construction safety and health to all parties involved. Emergency response plans are prepared to respond to emergencies such as fires, earthquakes, or work accidents, while environmental impact analyses are conducted to identify and control environmental aspects that can affect environmental pollution. Thus, efforts to maintain K3L are maintained considering the complexity of the project and the changes that occur due to variation orders.

CONCLUSION

Based on the results of the discussion and data analysis in the Engineering Practice Report, the following conclusions can be drawn. The works affected by the variation order in the Tenjoresmi Area Planning Project include the demolition of railing fences, sanitary demolition, plumbing demolition, air conditioning demolition, demolition of demolition debris, and changes in the volume of structural and architectural work. There was an increase and decrease in the volume of mechanical, electrical, and plumbing work, as well as the planting of shrubs in site development work.

The effect of variation orders on the implementing contractor's Cost Budget Plan (RAB) shows changes in the proportion of costs to various works. The increase in the proportion of RAB occurred in demolition, architectural, mechanical, electrical, and plumbing works, as well as site development. A decrease in the proportion of RAB costs was recorded in structural work. In addition, there was an increase in the pre-tax contract price of 9.84%, which is recorded in the contract addendum.

Variation orders also affect the performance of the executing contractor in terms of time and cost. The Schedule Performance Index (SPI) analysis shows delays in the execution of work in October and November, due to the new contract addendum passed in mid-October. However, contractors were able to catch up with the delay in December. In terms of cost, the Cost Performance Index (CPI) shows cost overrun in July and August, however, contractors managed to control costs in the following months. Despite the variation orders, the executing contractor did not experience financing constraints and even experienced an increase in profit by 0.79% than planned.

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