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Analysis of Contract Change Order (CCO) Factors, Cost and Time Factors Affecting Bore Pile Work (Case Study of Cisauk Fly over Construction Project): A Systematic Literature Review

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ABSTRACT: Almost all projects, whether government or private, experience change orders requested by either the contractor or the owner. In construction projects, change orders are regulated by contract provisions, which often result in project outcomes that deviate from the initial plans. This research aims to identify and analyze the factors that cause and influence Contract Change Orders (CCOs) on the cost and schedule of bore pile work for the Cisauk flyover construction project in Tangerang Regency. The study was conducted by distributing questionnaires to respondents involved in the Cisauk flyover construction project. The research employed quantitative analysis, with data from the questionnaires processed using the IBM SPSS program. The analysis methods included validity testing, reliability testing, normality testing, and factor analysis. From the study results, the ranking of each factor will be determined, and the dominant factors influencing the occurrence of Contract Change Orders (CCOs) will be identified.

KEYWORDS: Contract Change Order, SPSS, Construction.

I. INTRODUCTION

In every project, change orders are a common occurrence. Change orders refer to modifications made to the work after the contract has been signed by the owner and contractor. These changes can occur at any stage of a construction project—early, middle, or late stages [1].

In government-organized projects, Contract Change Orders (CCOs) are regulated under Article 87 of Presidential Regulation Number 4 of 2015, which amends Presidential Regulation Number 54 of 2010. The regulation states: Paragraph (1): In cases where field conditions during implementation differ from the drawings and/or technical specifications specified in the Contract Documents, the Commitment Making Official, together with the Goods/Services Provider, may make changes to the contract, including:

a) Increasing or decreasing the volume of work stated in the contract;
b) Adding or reducing types of work;
c) Changing the technical specifications of the work to meet field requirements; or
d) Modifying the implementation schedule.

Adjustments to the work or design review process are often unavoidable to address actual field conditions. For the Cisauk flyover construction project, a design review was necessary due to the presence of an existing traffic road at the bridge location. Clearance considerations were required to avoid disrupting existing traffic. Additionally, since the flyover intersects with a railroad, the structure's position had to meet specific clearance requirements: a minimum vertical clearance of 6.2 meters from the railhead, lateral clearances of at least 10 meters from the outer rail axle, and a minimum vertical clearance of 1.5 meters between the top pile cap and the existing road embankment. These requirements align with the Minister of Transportation Regulation Number PM 36 of 2011 on intersections between railroad infrastructure and other structures. The Cisauk flyover construction project is a strategic regional initiative in Tangerang Regency, aimed at alleviating congestion in the area. The project's foundation uses bore piles, with the initial contract specifying a volume of 870 meters, which was later revised to 948 meters. Analyzing the impacts of these changes on cost and schedule is essential to enable stakeholders—including Commitment Making Officials, service users, service providers, and other construction project participants—to take appropriate steps and implement effective solutions to manage Contract Change Order (CCO) issues. These issues often result in deviations from the original project plan and objectives.

Figure 1. Initial Condition of Work

Figure 1 depicts the initial condition of the work in the Cisauk District area of Tangerang Regency. The Cisauk flyover construction project is a regional strategic initiative in Tangerang Regency, aimed at alleviating congestion in the area.

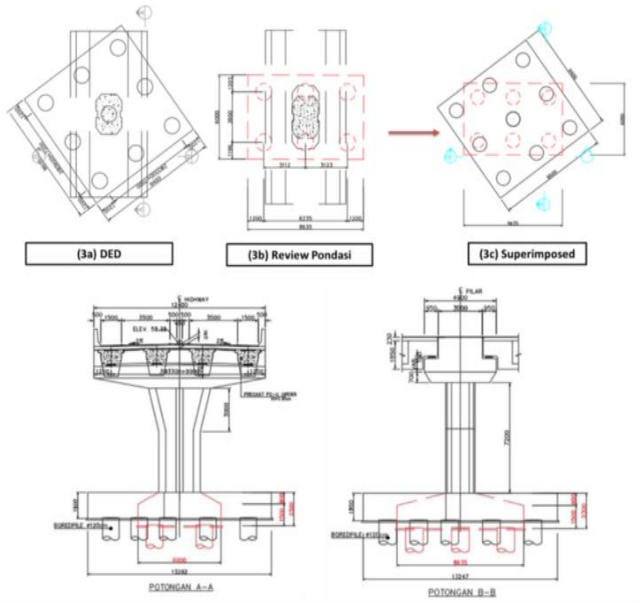

Figure 2. Adjustment of Foundation Piles on Pillar 2 and Pillar 3

In Figure 2, adjustments to the foundation piles on Pillar 2 and Pillar 3 are shown. The changes are detailed in Figure 3(a), Foundation Review, and further illustrated in Figure 3(c), Superimpose. The foundation of the Cisauk flyover uses bore piles, with the initial contract specifying a volume of 870 meters, which was later revised to 948 meters.

The objectives of this research are as follows:

1. To evaluate the changes in bore pile work on the Cisauk flyover construction project.
2. To identify the factors causing change orders and their impact on cost and time performance in the Cisauk flyover construction project.
3. To analyze the effects of change orders on cost and time performance values in the Cisauk flyover construction project.

II. RESEARCH METHOD

The research method involves quantitative analysis and the processing of questionnaire data using the IBM SPSS program. The analysis includes a questionnaire validity test, questionnaire reliability test, normality test, and factor analysis test. The study examines the impact of change orders on the performance of flyover construction infrastructure projects by analyzing the factors causing change orders. The survey method formulates the study into two interrelated variables:

a) Dependent variable: Project performance, which is affected by change orders.

b) Independent variable: The factors influencing change orders within the contract system. These factors include:
   1. Contract Document Factors
   2. Planning and Design Factors
   3. Owner Involvement Factor
   4. Environmental or External Condition Factors
   5. Contractor Factors
   6. Resource Factors

The variables used in this research are based on previous studies related to factors causing contract change orders. Before finalizing these variables, they will be consulted with a supervisor to ensure alignment with the study's objectives and relevance to real-world conditions.

The research variables include the following problem variables:

1. What constraint factors result in a change order for bored pile work in the Cisauk flyover construction project?
2. How does the change order affect the cost of bored pile work in the Cisauk flyover construction project?
3. How does the change order affect the time duration of the bored pile work in the Cisauk flyover construction project?

Variable Indicator

X1. Contract Documents
- X1.1 Incomplete contract (Ayu & Rudi, 2021)
- X1.2 Contract documents are not detailed (Hansen, 2020)
- X1.3 Lack of understanding of contractors in examining drawings and contract documents (Ana Yuni, 2018)
- X1.4 The article on change orders is not clearly stated in the construction contract (Ana Yuni, 2018)
- X1.5 Updates on applicable regulations (Researcher, 2023)

X2. Planning and Design
- X2.1 Errors in planning drawings (Putri & Mega, 2021)
- X2.2 Errors in design (Putri & Mega, 2021)
- X2.3 Incomplete planning (Putri & Mega, 2021)
- X2.4 Delay in design approval (Putri & Mega, 2021)
- X2.5 Mismatch between design drawings and field conditions (Putri & Mega, 2021)
- X2.6 Changes in planning drawings (Putri & Mega, 2021)
- X2.7 Errors in determining safety factor coefficients (Researcher, 2023)

X3. Owner Involvement
- X3.1 Lack of control (Putri & Mega, 2021)
- X3.2 Things that have not been determined by the owner (Putri & Mega, 2021)
- X3.3 Regulatory policies from the owner Delays in schedule from the owner. (Putri & Mega, 2021)
- X3.4 Failure of the owner to provide sites, tools, materials (Putri & Mega, 2021)
- X3.5 Postponement of work due to owner's request (Putri & Mega, 2021)
- X3.6 Further coordination to be taken (Researcher, 2023)

X4. Environmental or External Conditions
- X4.1 Socio-cultural conditions of the community around the project (Ida Ayu, et. al., 2016)
- X4.2 Central/local government policies issued after contract signing that affect project objectives (cost, quality, and time) (Ida Ayu, et. al., 2016)
- X4.3 Reduced/delayed part of construction due to environmental issues. (Putri & Mega, 2021)
- X4.4 Request of local officials/government CSR (Corporate Social Responsibility) (Putri & Mega, 2021)
- X4.5 Third party intervention (Ida Ayu, et. al., 2016)
- X4.6 Land acquisition issues (Mafriyal, et. al., 2018)
- X4.7 Addition of construction support facilities (Researcher, 2023)

X5. Contractors
- X5.1 Inadequate coordination between contractors (Riswandi, et. al. 2021)
- X5.2 Improper handling of project progress by contractors (Riswandi, et. al. 2021)
- X5.3 Ineffective quality control by contractors. (Riswandi, et. al. 2021)
- X5.4 Lack of contractor team work in the execution of work (Mafriyal, et. al., 2018)
- X5.5 Lack of communication between field implementers and supervisory/planning consultants (Mafriyal, et. al., 2018)
- X5.6 Delays due to repeated work. (Mafriyal, et. al., 2018)
- X5.7 Lack of labor that masters the field of work (Researcher, 2023)
- X5.8 Poor contractor cash flow management (Researcher, 2023)

X6. Resources
- X6.1 Low worker expertise (Septian & Ayu. 2021)
- X6.2 Lack of worker experience (Septian & Ayu. 2021)
- X6.3 Failure to supply skilled labor. (Septian & Ayu. 2021)
- X6.4 Excessive amount of overtime work (Septian & Ayu. 2021)
- X6.5 Labor disputes (Septian & Ayu. 2021)
- X6.6 Lack of understanding and implementation of SMK3L (Researcher, 2023)
- X6.7 Insufficient number of labor personnel (Researcher, 2023)

The research flowchart can be seen in Figure 3.

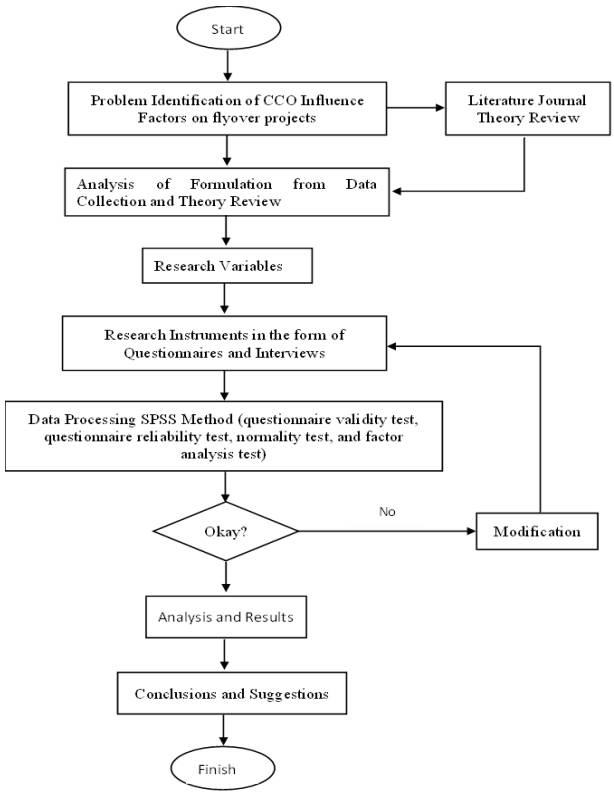

Figure 3. Flowchart of the Research

III. RESULT AND DISCUSSION

Research conducted by Mega and Hendrik (2020) on road projects in Banten analyzed five road projects using actual case studies and questionnaires employing a six-point Likert scale. To determine the ranking of factors influencing the causes of change orders, the effects of change orders, and the parties benefiting from change orders, the Relative Importance Index (RII) was calculated. The most significant effects of change orders on projects were found to be schedule delays, cost overruns, and disputes. Contractors were identified as the primary beneficiaries of change orders, followed by consultants and owners [1].

According to research conducted by Z. Tenno and Agus (2021), change orders (CCO) impact cost increases due to factors such as contract documents, stakeholders, design, and construction. The most critical variable affecting cost increases was the construction variable, with a T-test value of 2.830, a significance level of 0.007, and a regression coefficient of 0.103. The research showed that change orders simultaneously affected the cost performance of toll road projects by 80.9%, with the remaining 19.1% attributed to factors outside the analyzed regression model [2].

In the Bung Karno Stadium (Gelora Bung Karno/GBK) Aquatic Stadium renovation project, Hansen et al. (2020) identified six causes and one impact of change orders that occurred during the project. Based on these findings and a systematic approach, the research proposed a framework to minimize the impact of change orders. This framework aims to improve contract management practices

and can be applied in other countries facing similar challenges [3].

Research by Edwin and Mega (2020) produced four correlation results using Pearson correlation analysis in the SPSS program. The correlation analysis between the work weight and CORA (Contract Order Risk Assessment) in Project 1 showed no significant correlation. However, in Project 2, a significant correlation was found at the 95% confidence level. Additionally, the correlation of work weight with CORS (Contract Order Risk Score) in Project 2 demonstrated a strong and significant relationship. Meanwhile, the correlation analysis of work weight and CORS in Project 1 revealed a highly significant relationship at the 99% confidence level [4]. Similarly, research by Ronaldo and Mega (2020) on two rigid pavement road projects found significant correlations and strong relationships between CORA and work weight for both projects. However, the correlation between CORS and the work weight of Project 1 showed no relationship, while a significant correlation was observed for Project 2 [5].

Research conducted by Hendy and Hendrik (2020) on building construction projects found that change orders impacted costs due to additional work items. In terms of quality, change orders caused a decline in building standards due to increased work volume. Regarding time, project delays were attributed to changes in already-completed work [6].

Ivana and Mega (2021) studied water construction projects in the DKI Jakarta area to identify causal factors of change orders. Using a questionnaire distributed to water construction workers in the region, the study ranked factors based on importance using the RII method. After testing the validity and reliability of the questionnaire, it was found that coordination with utility systems (RII = 0.6842) was the primary causal factor of change orders in DKI Jakarta water construction projects [7].

Research by Dian et al. (2019) highlighted the significant influence of change orders on development projects. Change orders were found to affect costs by 95%, leading to changes in supplier and vendor procurement, additional overtime costs, reduced contractor profits, and cost overruns, with a correlation value of 0.835. The impact of change orders on quality was 89%, resulting in non-compliance with work objectives and construction reliability. However, the research also noted improvements in construction outcomes due to more detailed field engineering and justification, with a correlation value of 0.753 [8].

According to Sudiarsa et al. (2021), the dominant factor in Variation Orders is the recommendation or direct request from the Owner and Planning Consultant, with 14 Site Instructions issued out of a total of 16 Site Instructions [9]. Meanwhile, the results of research by Shrestha and Fathi (2019) indicate that Variation Orders have a much lower effect on the cost performance of Design-Build (DB) projects and no impact on the schedule performance of DB projects, unlike in Design-Bid-Build (DBB) projects [10].

The research by Aslah et al. (2022) found that the project duration, which initially extended to 140 days after the Contract Change Order (CCO), was reduced to 90 working days after implementing schedule crashing for masonry and concrete work [11]. Research conducted by Earned et al. (2019) identified changes in field conditions, non-conformities with the original contract design, global material price fluctuations, and government policy changes as key factors causing CCOs [12].

Similarly, the results of research by Apriani et al. (2022) reveal that factors causing CCOs related to time extensions for the work executor also significantly affect project costs [13]. According to Khamim and Harsanti (2019), technical, administrative, and personnel factors leading to addendums influence the effectiveness of achieving project goals [14]. Palilati et al. (2022) concluded that Variation Orders lead to increases and reductions in work volume based on needs and field conditions, with percentage values of 29.72% and 30.05%, respectively [15].

Setyawan et al. (2020) found that CCOs occur due to design changes, primarily caused by insufficiently detailed soil investigations and field suitability assessments, resulting in increased time and costs [16]. According to Ma'rifah (2020), the impact of CCOs on supervision consultants is highly detrimental in terms of both cost and time. Supervision consultants incur higher operational costs due to extended work periods [17].

Research by Setiawan et al. (2019) highlights that change orders caused delays in project completion, extending the timeline from May 2017 to January 2018. A key design change was the modification of canopy materials from concrete to perforated steel and aluminum sheets, initiated by the owner [18]. The analysis by Ardine and Sulistio (2020) identified two significant factors influencing change orders: construction-related factors and administrative factors [19].

In terms of cost and percentage, the sequence of changes in highway projects is significantly higher than in water and wastewater projects. The Design-Build (DB) method offers various benefits depending on project type. However, a detailed study analyzing hard project cost data, change orders, and schedule impacts of DB highway, water, and wastewater projects has not been conducted previously [20].

Additionally, there was no correlation found between low bids and the percentage of change orders. This study could not confirm the hypothesis that contractors deliberately create bid discrepancies to leverage change orders during construction [21].

1. Identification of Research Articles

This section discusses the identification of articles based on the year of publication, research methods, and research objects used. The results are presented in Figure 4.

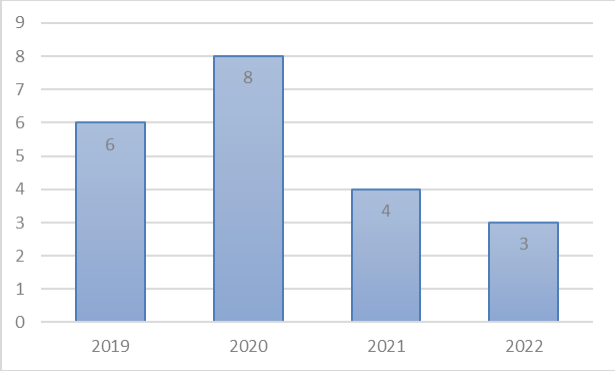

Figure 4. Research Journals by Year of Publication

From Figure 4 above, it can be seen that there are 21 journals: 6 journals from 2019, 8 journals from 2020, 4 journals from 2021, and 3 journals from 2022.

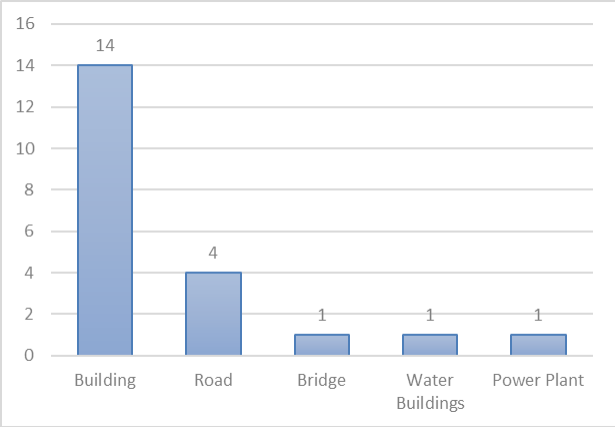

Figure 5. Research Journal by Type of Work

From Figure 5 above, it can be seen that the journal publications are categorized based on the type of work. A total of 21 journals were analyzed: 14 journals discuss change orders in building projects, 4 journals focus on road infrastructure projects, 1 journal on bridge infrastructure, 1 journal on water construction projects, and 1 journal on power plant projects. The research methods used are shown in Figure 6 below.

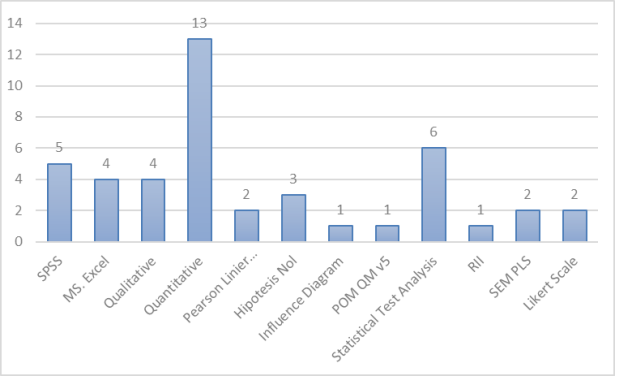

Figure 6. Research Method Used

Figure 6 above illustrates the research methods used in previous research journals. It shows that 5 journals used SPSS, 4 journals utilized Microsoft Excel, 4 journals employed qualitative data collection methods, 13 journals used quantitative data collection methods, 2 journals applied Pearson linear correlation methods, 3 journals used null hypothesis testing, 1 journal employed influence diagrams, 1 journal used POM QM v5, 6 journals conducted statistical test analysis, 1 journal used RII, 2 journals utilized SEM PLS, and 2 journals applied the Likert Scale.

IV. CONCLUSIONS

Based on the results and discussion presented earlier, the following conclusions can be drawn;

1. The types of work discussed include infrastructure projects (roads and bridges), buildings, water structures, and power plants.
2. The research journals analyzed were published between 2019 and 2022.
3. The research methods employed include both qualitative and quantitative approaches, supported by primary and secondary data processed using software/tools such as SPSS, SEM-PLS, Microsoft Excel, and others,
4. Each project site exhibits unique work characteristics and challenges, with varying causal factors for CCO. However, the dominant factors contributing to CCO include contract document factors, planning and design factors, owner involvement factors, environmental or external condition factors, contractor factors, consultant factors, and resource factors.

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