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Analysis of Potential Factors on Contract Change Order (CCO) and Quality Performance and Design of Sicco Innovations in Road Infrastructure Projects in Tangerang

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ABSTRACT
This study examines the factors influencing Contract Change Orders (CCO) and their relationship with quality performance in road infrastructure projects in Tangerang Regency. Based on DBMSDA data from 2022 to 2024, there were notable changes in contract values, especially in projects exceeding 1 billion IDR. The findings reveal that policy changes, specification adjustments, and planning errors are key contributors to CCO occurrences. Using SmartPLS 4.0 and the Structural Equation Modeling (SEM) method, the research analyzes the interrelationships between variables and their impact on project quality performance. The results demonstrate that effective coordination and strong planning significantly improve quality outcomes, while the scope of CCO directly influences overall project results. To support better governance, the study also proposes the development of a digital application for managing CCO submissions to enhance efficiency, transparency, and monitoring within the approval process. Overall, this research provides useful insights for stakeholders in infrastructure development to optimize project implementation, minimize risks, and improve quality performance in road construction projects.

KEYWORDS *Contract Change Order; Quality Performance; Road Infrastructure; Policy Changes; Specification Changes; Planning.*

INTRODUCTION

One of the infrastructure development strategies in Indonesia stipulated in the 2020-2024 National Medium-Term Development Plan (RPJMN) is to improve connectivity between regions both through land, sea and air (Bahri et al., 2018; Bappenas, 2020; Leone, 2023; Yuningsih et al., 2024). Regional connectivity strategy through land through improving road infrastructure, one of which is road construction (RPJMN INDONESIA, 2019). This RPJMN can be implemented effectively with the support of increasing infrastructure development in Indonesian regions both from the Regency/City to the Provincial Level. Tangerang Regency is one of the areas within the scope of Banten Province. Achievements in 2019 were recorded at 3,387 km of new roads have been built and 94% of the stable condition of the road has been met. This is done to support the 2020-2024 RPJMN (RPJMN Indonesia, 2019)

The average national road stability has indeed exceeded 92%. However, the condition of the stability of regency/city roads, especially the Java island area, is only 62.26%. Meanwhile, out of a total of 6 provinces on the island of Java, Banten province with a score of 78.1% is ranked number 4, the percentage of stability of regency/city roads before DI Yogyakarta is in 5th position. Tangerang Regency is one of the areas within the scope of Banten Province that contributes to the RPJMN, in this case the most highlighted is the level of stability of regency/city roads.

The quality of roads, especially roads under regional authority, is still low. (Final Draft of the 2025-2045 RPJPN). The stable condition of the road, especially the road with the authority of the district/city, cannot be separated from the quality of the road construction and maintenance process so that the road can function according to the planned lifespan. Therefore, in the process of road infrastructure development, it must be accompanied by good planning and construction processes in accordance with the applicable SOPs and Regulations.

A construction project is an effort to achieve a result in the form of a building or infrastructure. Every construction project requires project management to manage resources in the project so that the three limitations (cost, quality and time) can be met (Fahirah & Nirmala, 2023; Indah Prasetiya Rini, 2019; Margareth & Simanjuntak, 2010). These three limitations are parameters in the implementation of projects that are often associated as project objectives. Project resource management needs to be carried out appropriately so that the three project constraints (triple constraints) can be fulfilled (right cost, right quality and on time (Indah Prasetiya Rini, 2019; Jusmidah, 2016; Wijaya et al., 2015).

Every activity in a construction project requires careful and structured planning by paying attention to the three limitations, namely cost, quality and time. However, in the process of implementing a construction project, it is often faced with problems, namely the occurrence of changes during the construction contract period where the change can be caused by various parties involved in the implementation of the construction project. This causes a change in design or a change in specifications which is commonly called a variation order/contract change order (Nurmala & Hardjomuljadi, 2015).

Variation Order / Contract Change Order is something that always happens in every construction project, in some studies it has been found to be one of the factors causing claims. Variation orders or change orders always have implications for cost and time, regardless of the variation, there will be risks to the work being done both in the delay of work and additional costs that must be borne (Nurmala & Hardjomuljadi, 2015). A Contract Change Order (CCO) is a written change between the owner and the contractor to change the condition of the initial contract documents, by increasing or decreasing the volume of work (Nursyamsi, 2021).

In projects organized by the Government, variation orders (VO) or contract change orders (CCO) have been regulated in article 87 of Presidential Regulation Number 12 of 2021 concerning Amendments to Presidential Regulation Number 16 of 2018 which reads "paragraph (1): in the event that there is a difference between field conditions at the time of implementation, with drawings and/or technical specifications specified in the Contract Document, PPK together with the Goods/Services Provider may make changes to the contract which include: Increasing or decreasing the volume of work listed in the contract; Increase and/or subtract the type of work; Changing the technical specifications of the work according to the needs of the field; or Change the implementation schedule. In the event of a change in work that results in an increase in the contract price, the contract change is carried out with the provision that the final contract price does not exceed 10% (ten percent) of the price listed in the initial contract and the availability of the budget (Presidential Regulation Number 12, 2021).

Based on the DBMSDA report from 2022 to 2024, road infrastructure development projects in Tangerang Regency show significant contract changes, with variations divided into four categories of project values. Of the total 154 activities, 33 projects with a contract value of more than 1 billion experienced a Contract Change Order (CCO) due to the implementation of a balanced budget system, which required a reduction in road lengths to accommodate new works such as the installation of soil retaining pavement. This phenomenon prompted the need for a research entitled "Analysis of Potential Factors on the Scope of CCO and Quality Performance with Application Systems in Road Infrastructure Projects in Tangerang Regency," which aims to identify the causes of CCO and evaluate project planning and implementation to improve construction quality.

The study also addresses the challenges in managing CCO submissions that are still hardcopy-based, emphasizing the need for a more efficient digital system. By formulating the main questions regarding the variables that cause CCO and the design of applications for document control, this study is expected to provide effective recommendations for road construction in Tangerang Regency as well as guidelines for local governments and the private sector in the implementation of infrastructure projects.

METHOD

The design of this study was a quantitative approach that aimed to analyze the influence of certain variables on the performance of road infrastructure projects in Tangerang Regency. The research method was described through a flowchart illustrating the steps of research implementation, including data collection and analysis techniques. The research subjects consisted of road infrastructure projects across 29 sub-districts in Tangerang Regency, with the research period running from August to December 2024.

The research population included all parties involved in road infrastructure development, such as technical directors of the Highway Agency, construction service providers, and supervision consultants. The sample comprised 100 respondents representing the population, determined by calculations suitable for multiple linear regression analysis. The data analysis technique employed Partial Least Square (PLS), which allows testing causal relationships between variables. Data processing was carried out using SmartPLS software through several stages, including validity and reliability tests, as well as external model analysis to examine relationships between latent variables and their indicators.

RESULTS AND DISCUSSION

Discussion Data Analysis with SEM-PLS

Questionnaire data has been collected by the researcher and will be processed and analyzed using "Structural Equation Modelling" (SEM). This method seems to be able to dominate the use of path analysis and multiple regression that has been used so far. This is because this analysis is more comprehensive. The analysis of this method is more comprehensive because each value in each question of each latent variable or factor or in this method referred to as an observed variable or a sub-factor of a latent variable can be analyzed comprehensively. The researcher used SEM SMART-PLS software version 4.0 as an aid to the process of this analysis method.

The purpose of using SmartPLS 4.0 is to estimate the relationship in the form of causal predictive between the variables of CCO Scope (X1), Planning (X2), Policy Change (X3), Specification Change (X4), Coordination of Related Parties (X5), and Quality Performance (Y1). In SEM, there are 3 (three) activities at the same time, namely checking the validity and reliability of instruments (confirmatory factor analysis), testing the relationship model between variables (path analysis), and obtaining a model that is suitable for prediction (structural model and regression analysis). A complete modeling in dasamya consists of a measurement model and a structural model or causal model.

The measurement model is carried out to produce an assessment of the validity and validity of the discriminator, while the structural model, which is a modeling that describes the hypothesized relationships. In the research process, it has been explained about the flow of thought in building a hypothesis in the form of a relationship model.

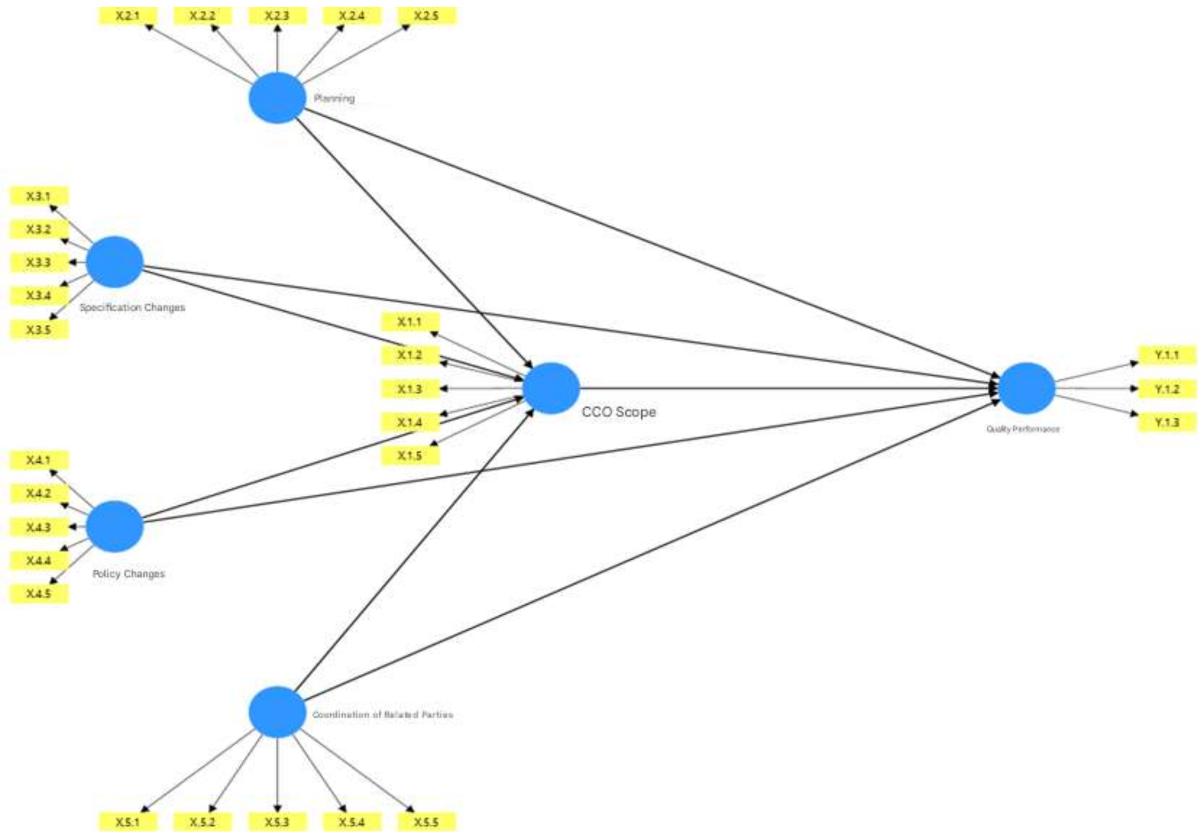

Figure 1. Smart-PLS Research Model
Source: Processed Author, 2025

The primary data from the Google Form questionnaire answers which are compiled in tabulation form are then stored in Comma Delimited (csv) format. Indicators that are the interests of stakeholders become manifest variables of the stakeholder variable which becomes an unobserved variable. The primary data in csv format is then entered into the SmartPLS 4.0 program. The contrast variables are then drawn with the help of the menu found in SmartPLS 4.0. Then the data in the indicators window is dragged and directed to the appropriate variable.

From the image above, the blue one is the latent variable and the yellow one is the indicators. From the image above, it can be seen that all indicators reflect their respective variables with the following variable (X) details:

A. CCO Scope (X1)

Addition of pavement work to hold the ground of the road. Addition/decrease of road length or road width. Changes in the work of the box culvert channel into the river stone channel. Addition of limestone work. Addition of excavation and earthenware work

B. Planning (X2)

Planning errors. Errors and omissions in the determination of Volume estimation. Incompatibility between the design drawings and the field conditions. Design changes. Unclear plan drawing details.

C. Policy Changes (X3)

The instructions to the contractor differ from what is specified in the contract document. Work delays for some reason. Project location changes. Delays in granting permissions, approvals and Decisions. Project owner request for optimization

D. Specification Change (X4)

Presence of a change order in the image or specification. Things that have not been determined by the owner. Specification changes by consultants. Conditions during surveys and implementation are different. Flooding occurred during the implementation of the project

E. Coordination of Related Parties (X5)

Changes in design by supervision consultants. Errors and omissions in the design of the planning consultant. Errors in the execution of the work. Error calculation of MC-0 volume under field conditions. There is a request from residents to reduce the width because it is within the boundaries of their land

F. Quality Performance (Y1)

Quality of work according to contract and KAK documents. The results of the work are better because field engineering and engineering justification are carried out. The quality of the work results is not good because the length of road handling is not as planned

Table 2. Multicollinearities

	VIF
Coordination of Related Parties -> Quality Performance	1.176
Coordination of Related Parties -> Scope of CCO	1.161
Planning -> Quality Performance	1.684
Planning -> the Scope of the CCO	1.554
Policy Changes -> Quality Performance	1.837
Policy Changes -> Scope of CCO	1.167
Specification Changes -> Quality Performance	2.408
Specification Changes -> CCO Scope	1.633
Scope of CCO -> Quality Performance	3.683

Source : Processed Author, 2025

Outer model

Evaluation measurement in this study has three tests, namely convergent validity, discriminant validity and reliability test. Before performing the test, the correlation between the variable and its indicator can be seen from the loading factor. In addition, the loading factor is used to evaluate the validity and reliability of the factors formed (Hair et al., 2019). The loading factor is presented as follows:

Tabel 3. Outer Loading

	Outer loadings
X.1.1 <- Scope of CCO	0.700
X.1.2 <- Scope of the CCO	0.900
X.1.3 <- Scope of the CCO	0.835
X.1.4 <- Scope of CCO	0.901
X.1.5 <- Scope of CCO	0.810
X.2.1 <- Planning	0.830
X.2.2 <- Planning	0.891
X.2.3 <- Planning	0.845
X.2.4 <- Planning	0.877
X.2.5 <- Planning	0.831
X.3.1 <- Specification Changes	0.955
X.3.2 <- Specification Changes	0.862
X.3.3 <- Specification Changes	0.917
X.3.4 <- Specification Changes	0.939
X.3.5 <- Specification Changes	0.872
X.4.1 <- Policy Changes	0.784
X.4.2 <- Policy Changes	0.839
X.4.3 <- Policy Changes	0.920
X.4.4 <- Policy Changes	0.810
X.4.5 <- Policy Changes	0.885
X.5.1 <- Coordination of Related Parties	0.805
X.5.2 <- Coordination of Related Parties	0.814
X.5.3 <- Coordination of Related Parties	0.768
X.5.4 <- Coordination of Related Parties	0.801
X.5.5 <- Coordination of Related Parties	0.738
Y.1.1 <- Quality Performance	0.856
Y.1.2 <- Quality Performance	0.900
Y.1.3 <- Quality Performance	0.886

Source : Processed Author, 2025

From the table above, it can be seen that all indicators have a loading factor value above 0.70. So, the test can be continued to the next stage.

1. Validitas convergence

Convergent validity testing is used to find out whether the data used in the study is valid or not, using the measurement tool used, namely a questionnaire. The convergent validity can be seen through the AVE values generated. The AVE value can be said to be valid if it is more than 0.5 (>0.5) (Hair et al., 2019). The AVE value can be seen in the table below:

Tabel 4. Hasil Average Variance Extracted (AVE)

	Average Variance Extracted (AVE)
Quality Performance	0.776
Coordination of Related Parties	0.617
Planning	0.731
Policy Changes	0.721
Specification Changes	0.828
Scope of CCO	0.693

Source : Processed Author, 2025

The table above shows the result of the AVE value on each latent variable having a value of > 0.5. Therefore, all indicators used can represent the variables well. The greatest value is found in the Specification Change variable, which means that the indicators in that variable can be larger to represent the model well.

2. Validitas discriminant

Discriminant validity testing is used to find out the extent to which a construct differs from other constructs. The value obtained by correlation between the same construct should not be smaller than the correlation with different constructs (Hair et al., 2019). The results of the discriminant validity can be seen in the results of the Fornell Larcker Criterion and the value of cross loadings as follows:

Table 5. HTMT Results

	Heterotrait-Monotrait ratio (HTMT)
Coordination of Related Parties <-> Quality Performance	0.657
Quality Performance <-> Planning	0.757
Planning <-> Coordination of Related Parties	0.405
Changes to the Quality Performance <-> Policy	0.437
Changes to the Policy <-> Coordination of Related Parties	0.183
Planning Policy Changes <->	0.171
Changes in Specifications <-> Quality Performance	0.559
Changes to the Specification <-> Coordination of Related Parties	0.279
Changes to Planning <-> Specifications	0.585
Specification Changes <-> Policy Changes	0.398
CCO Scope <-> Quality Performance	0.788
Scope of CCO <-> Coordination of Related Parties	0.333
Scope of CCO <-> Planning	0.580
Scope of CCO <-> Policy Change	0.709
Scope of CCO <-> Specification Change	0.802

Source : Processed Author, 2025

Table 6. Criterion Larcker results

	Quality Performance	Coordination of Related Parties	Planning	Policy Changes	Specification Changes	Scope of CCO
Quality Performance	0.881					
Coordination of Related Parties	0.579	0.786				
Planning	0.677	0.361	0.855			
Policy Changes	0.386	0.127	0.157	0.849		
Specification Changes	0.505	0.262	0.550	0.371	0.910	
Scope of CCO	0.695	0.307	0.531	0.634	0.737	0.833

Source : Processed Author, 2025

Table 6 is the result of the Fornell-Larcker Criterion value which shows that the correlation value obtained between the construct and the construct itself is not smaller than the correlation value of the construct with the other construct. This means that there are differences between the constructs used in the study. In addition to the Fornell-Larcker Criterion value, the validity of the discriminant can also be seen from the Cross loading value as follows:

Appendix 2. Shows the result of the Cross loading value. Cross loading is used to find out that indicators in latent variables can distinguish or connect well with indicators in other variables (Hair et al., 2019). The results show that the value produced between the indicator and the latent variable itself is not smaller than the correlation value of the indicator with other latent variables. Therefore, it can be stated that it has met the measurement model and no indicators must be removed.

3. Reliability Test

Reliability tests are used to assess the consistency of an instrument in producing the same data under the same conditions as well. Therefore, the data produced can be trusted and used for research purposes. This is to minimize bias and errors in measurement. The results of the reliability test can be seen from the results of Cronbach's Alpha and Composite Reliability values. The reliability of a variable is said to be good if it has a Composite Reliability value of more than 0.7 and Cronbach's Alpha value ranges from 0.6 to 0.7 or more than that (Hair et al., 2019).

Tabel 7. Construct Reliability and Validity

	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)	Average variance extracted (AVE)
Quality Performance	0.856	0.866	0.912	0.776
Coordination of Related Parties	0.847	0.861	0.890	0.617
Planning	0.908	0.915	0.931	0.731
Policy Changes	0.902	0.909	0.928	0.721
Specification Changes	0.947	0.948	0.960	0.828
Scope of CCO	0.887	0.893	0.918	0.693

Source : Processed Author, 2025

The table above shows the Cronbach's Alpha and Composite Reliability values of each variable. The Composite Reliability value indicates that most have values greater than 0.7. This shows that the data produced is reliable and can be used for research. So is the value of Cronbach's Alpha which shows everything ranges from 0.6 to 0.7 or more than that.

Model Struktural (Inner model)

Structural or inner models are used to find out how well the designed model can explain the correlations between latent variables in the study (Hair et al., 2019). Structural model evaluation can be carried out by testing the Coefficient of Determination (R2), Path coefficient (β), and Predictive Relevance (Q2).

1. Coefficient of Determination (R2)

Coefficient of Determination (R2) is used to show how much independent variables affect dependent variables (Hair et al., 2019). The results obtained are as follows:

Tabel 8. Coefficient of Determination (R2)

	R-square	R-square adjusted
Quality Performance	0.720	0.707
Scope of CCO	0.728	0.719

Source : Processed Author, 2025

Based on the results of the determination coefficient (R^2) test presented in Table 4.10, it is known that the R-square value for the Quality Performance variable is 0.720 and the R-square adjusted value is 0.707. This shows that 72.0% of the variation in quality performance can be explained by the regression model used, while the remaining 28.0% is explained by factors outside the model. The adjustment of the R^2 value to adjusted R^2 was carried out to accommodate the number of predictors in the model, so that the smaller but still high adjusted R^2 value (70.7%) confirms that the model is quite robust and statistically relevant in explaining the relationship between independent variables and dependent variables.

Meanwhile, for the CCO Scope variable, the R-square value was 0.728 and the adjusted R-square was 0.719. This means that approximately 72.8% of the variation in the scope of the CCO can be explained by the model, and a very close adjusted R^2 value (71.9%) indicates that the addition of independent variables in the model does not cause overfitting, but rather substantially improves the predictive quality of the model. Overall, the two high R^2 values illustrate that the model has strong explanatory power and is able to capture most of the data variations that occur in both dependent variables, which is important for inferential validity in the context of this study.

2. F Square

In addition to assessing whether or not there is a significant relationship between variables, a researcher should also assess the magnitude of the influence between variables with Effect Size or f-square (Wong, 2013). The value of f square is 0.02 as small, 0.15 as medium, and value 0.35 as large. Values less than 0.02 can be ignored or considered to have no effect (Sarstedt et al., 2017). The value of f square can be seen in the table below:

Table 9. F Square

	f-square
Coordination of Related Parties -> Quality Performance	0.328
Coordination of Related Parties -> Scope of CCO	0.014
Planning -> Quality Performance	0.311
Planning -> the Scope of the CCO	0.084
Policy Changes -> Quality Performance	0.002
Policy Changes -> Scope of CCO	0.574
Specification Changes -> Quality Performance	0.041
Specification Changes -> CCO Scope	0.474
Scope of CCO -> Quality Performance	0.235

Source : Processed Author, 2025

Based on the interpretation of the f-square value which refers to the criteria from Sarstedt et al. (2017), namely 0.02 (small), 0.15 (medium), and 0.35 (large), the test results shown in Table 7 show the effect size of each latent variable on the dependent variable in the structural model. The f-square value of 0.328 for the relationship between the Coordination of Related Parties to Quality Performance indicates a near-large effect, indicating that coordination has a substantive contribution to improving performance quality. In contrast, the value of 0.014 for the coordination relationship to the CCO Scope is below the minimum threshold of effect (0.02), so it can be considered weak or even negligible. Meanwhile, Planning has a moderate effect on Quality Performance (0.311), but only has a small effect on CCO Scope (0.084).

Furthermore, the Policy Change has almost no impact on Quality Performance (0.002) because it is well below the minimum threshold value, but it has a very large influence on the CCO Scope with an f-square value of 0.574, making it one of the dominant factors in influencing the scope of contract changes. Changes in Specifications were recorded to have a small effect on Quality Performance (0.041) and a large effect on CCO Scope (0.474), indicating that technical changes have a significant influence on work limitations and contractual scope. Finally, the CCO Scope variable itself showed a moderate influence on Quality Performance (0.235), which implies that changes in the project scope are significantly correlated with project quality outcomes. These findings emphasize the importance of coordination and planning management, as well as the need to mitigate the effects of changing policies and specifications on aspects of the scope and quality of overall project performance.

3. Path coefficient (β)

The path coefficient test serves to determine the direction of the relationship between the variables used in the study. The value of the path coefficient in the range of -0.1 to 0.1 is considered negative and inversely proportional. Meanwhile, the value that is considered positive and directly proportional must be greater than 0.1 (Hair et al., 2019).

Table 10. Path coefficient (β)

	Path coefficients
Coordination of Related Parties -> Quality Performance	0.329
Coordination of Related Parties -> Scope of CCO	0.065
Planning -> Quality Performance	0.383
Planning -> the Scope of the CCO	0.188
Policy Changes -> Quality Performance	0.034
Policy Changes -> Scope of CCO	0.426
Specification Changes -> Quality Performance	-0.167
Specification Changes -> CCO Scope	0.459
Scope of CCO -> Quality Performance	0.492

Source : Processed Author, 2025

Based on the results of the path coefficient test as shown in Table 4.12, the interpretation of the relationship between variables can be explained scientifically by referring to the guidelines from Hair et al. (2019), where the value of the path coefficient (β) between −0.1 and 0.1 is considered weak or even shows an inversely proportional negative relationship, while a value above 0.1 indicates a positive relationship that is directly proportional and statistically substantive. In this context, the variable of Coordination of Related Parties has a fairly strong positive influence on Quality Performance (β = 0.329), but its influence on the CCO Scope is very weak (β = 0.065), so it can be substantively negligible. Planning made a strong positive contribution to Quality Performance (β = 0.383) and a moderate influence on CCO Scope (β = 0.188), suggesting that planning activities play an important role in improving quality, although their contribution to change control is more limited.

Policy changes show a weak influence on Quality Performance (β = 0.034), which suggests that even if policies change, their impact on quality is not significant. However, the effect on the CCO Scope is quite high (β = 0.426), which indicates that policy changes have more impact on expanding or adjusting the scope of work. On the other hand, Specification Changes have a negative effect on Quality Performance (β = −0.167), which indicates that specification changes tend to interfere with or reduce the quality of work, but on the other hand contribute positively to the CCO Scope (β = 0.459), because the change in specifications requires adjustments to the scope of project implementation. Finally, the CCO Scope variable itself showed a very strong positive influence on Quality Performance (β = 0.492), which confirms that clarity and control in the scope of change have a crucial role in maintaining and improving the quality of the final results. Thus, overall, the planning and management of the scope of the CCO are the dominant factors in influencing the quality performance of the project.

4. T-statistic

The t-test in the study shows how much the independent variable affects the dependent variable. The result of the t-test if greater than 1.96 is considered significant and with an alpha value of 5%. Therefore, the criteria for rejecting or accepting the hypothesis, if the p< value is 0.05, then the hypothesis is accepted. Conversely, if the p-value > 0.05 then the hypothesis is rejected (Hair et al., 2019).

Table 11. Direct Effects

	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values
Coordination of Related Parties -> Quality Performance	0.329	0.328	0.075	4.408	0.000
Coordination of Related Parties -> Scope of CCO	0.065	0.068	0.063	1.036	0.300
Planning -> Quality Performance	0.383	0.387	0.111	3.455	0.001
Planning -> the Scope of the CCO	0.188	0.187	0.092	2.045	0.041
Policy Changes -> Quality Performance	0.034	0.036	0.051	0.656	0.512
Policy Changes -> Scope of CCO	0.426	0.424	0.075	5.698	0.000
Specification Changes -> Quality Performance	-0.167	-0.156	0.116	1.444	0.149
Specification Changes -> CCO Scope	0.459	0.458	0.088	5.216	0.000
Scope of CCO -> Quality Performance	0.492	0.479	0.153	3.215	0.001

Source : Processed Author, 2025

Tabel 12. Indirect Effects

	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values
Coordination of Related Parties -> Scope of CCO -> Quality Performance	0.032	0.033	0.035	0.934	0.351
Planning -> Scope of CCO -> Quality Performance	0.092	0.089	0.055	1.667	0.096
Policy Changes -> Scope of CCO -> Quality Performance	0.210	0.206	0.083	2.543	0.011
Specification Change -> Scope of CCO -> Quality Performance	0.226	0.214	0.071	3.189	0.001

Source : Processed Author, 2025

Based on the results of the hypothesis test analysis using the partial least squares structural equation modeling (PLS-SEM) approach, several significant and insignificant findings were obtained that indicated the strength and direction of influence between variables in the research model. Significance testing was carried out by comparing the t-statistic value to the critical limit of 1.96 and the p-value to the significance level of 5% ($\alpha = 0.05$), as explained by Hair et al. (2019), that an influence is said to be significant if the t-statistic > 1.96 and the p-value < 0.05.

The results of the direct effect test showed that the Relevant Parties Coordination variable had a significant effect on Quality Performance ($t = 4.408$; $p = 0.000$), but did not have a significant effect on the CCO Scope ($t = 1.036$; $p = 0.300$). This suggests that cross-party coordination can improve performance quality directly, but not strong enough to influence the expansion of the scope of contract changes (CCOs). On the other hand, Planning had a significant effect on both variables, namely Quality Performance (t = 3.455; p = 0.001) and CCO Scope (t = 2.045; p = 0.041), which shows that good planning not only encourages performance improvement, but also has an impact on project scope management.

Meanwhile, Policy Changes did not have a significant direct effect on Quality Performance (t = 0.656; p = 0.512), but had a very significant effect on CCO Scope (t = 5.698; p = 0.000), suggesting that the new policy had more impact on the modification of the scope of work than on quality directly. Specification changes also had no direct effect on Quality Performance (t = 1.444; p = 0.149), but significantly affected CCO Scope (t = 5.216; p = 0.000), indicating that technical specification had more impact on scope adjustment than yield quality. The CCO Scope variable was proven to have a significant effect on Quality Performance (t = 3.215; p = 0.001), indicating that a well-managed change in scope can have a positive impact on project quality output. In the path of indirect effects (mediation), only part of the relationship is significant.

For example, the CCO Scope → Policy Change pathway → Quality Performance (t = 2.543; p = 0.011) and Specification Change → CCO Scope → Quality Performance (t = 3.189; p = 0.001) showed significant indirect influences, meaning that although they do not have a direct impact on quality, these two variables can improve performance quality through scope changes. Meanwhile, the indirect influence of Coordination of Related Parties and Planning on Quality Performance through the CCO Scope was not significant, with p = 0.351 and 0.096, respectively. This shows that the mediating effect of the scope of CCO is not strong enough in bridging the influence of these two variables on quality performance.

Overall, these findings imply that although not all causal relationships are proven to be significant, change scope management (CCO) plays an important role as a mediator between policy and technical factors towards improving project quality. Therefore, organizations involved in the implementation of construction or public procurement projects need to pay special attention to coordination mechanisms, initial planning, and management of policy changes and specifications to optimize project outcomes.

5. Predictive Relevance (Q2)

Predictive relevance (Q2) is a test that is carried out to find out the extent to which the model in the study can accurately predict dependent variables. In other words, the value of the Q2 test results shows how well the observed value was produced. The high Q2 value indicates that the research model has a good ability to predict dependent variables (Hair et al., 2019). Here are the test results from Q2:

Tabel 13. Predictive Relevance (Q2)

	SSO	SSE	Q^2 (=1-SSE/SSO)
Quality Performance	342.000	162.430	0.525
Coordination of Related Parties	570.000	331.244	0.419
Planning	570.000	233.790	0.590
Policy Changes	570.000	241.079	0.577
Specification Changes	570.000	154.606	0.729

	SSO	SSE	Q² (=1-SSE/SSO)
Scope of CCO	570.000	263.383	0.538

Source : Processed Author, 2025

The higher the Q^2 value, the better the model's ability to explain the variability of the data (Hair et al., 2019). From these results, the Specification Change variable showed the highest Q^2 value of 0.729, indicating a very strong predictive ability. It was followed by Planning ($Q^2 = 0.590$), Policy Change ($Q^2 = 0.577$), CCO Scope ($Q^2 = 0.538$), and Quality Performance ($Q^2 = 0.525$), each of which was in the category of good predictive ability (> 0.35 according to Chin, 1998's criteria). Meanwhile, the Coordination of Related Parties obtained a Q^2 value of 0.419, which, although lower than other variables, remains within the limits of adequate predictive interpretation. Overall, the Q^2 values show that the model has substantial predictive relevance and is worthy of being used as a basis for drawing theoretical and practical conclusions about the relationships between variables in this study.

CCO BM Appsheet Application

AppSheet is designed to empower business users (often called "citizen developers") to solve their own operational problems quickly and efficiently, without having to rely on IT teams or professional programmers. This CCO BM appsheet is expected to help control Contract Change Orders that have been uncontrolled to be effective and efficient online/online and can be monitored directly by PPKo. The following is a procedural explanation of using the CCO BM Appsheet application.

1. How to Apply for a CCO from PPTK
   The CCO BM Appsheet can be accessed by the Technical Implementation Officer of Activities (PPTK) by accessing the link via smartphone. Here is the link: https://www.appsheet.com/start/af6be93a-51d5-4511-ae51-6076fe365dd8
   The link can be directly accessed with the google email on the smartphone so that the application can be accessed without installation first.
2. User Interface in the form of a CCO proposal form
   Filling out the form or input CCO data per activity can be done with an easy-to-understand user interface so that there is no need for complicated tutorials to use this application. Here is what the application looks like.

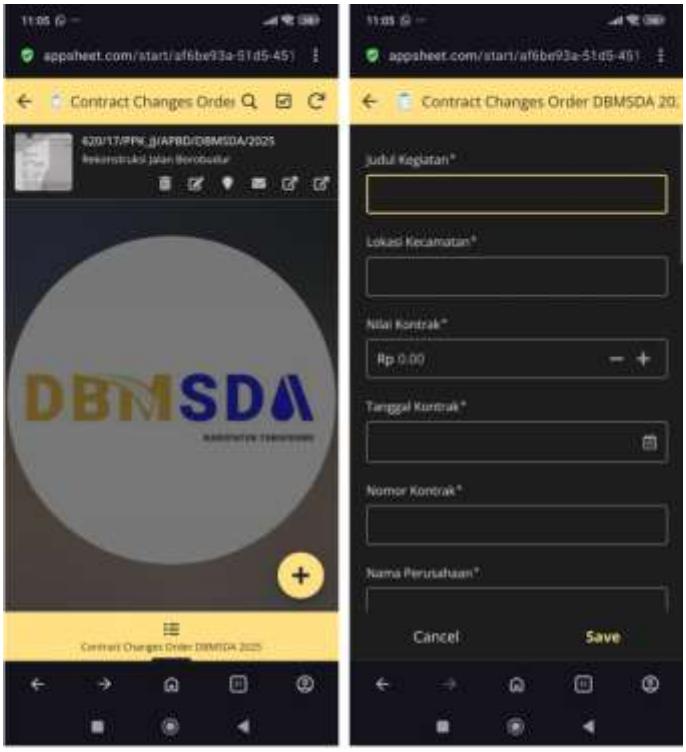

Figure 2. CCO BM Appsheet Application View
Source : Processed Author, 2025

After accessing the link in the first stage, the CCO BM Appsheet Application will appear with a view as shown in Figure 4.8 (on the left). Next, input the title of the project or road infrastructure activity by pressing the (+) sign on the application so that it will appear in Figure 4.8 (right). All questions starting from the title of the activity, the location of the sub-district must be filled in so that it is not empty because it will not be able to be input in the database. In total, there are 20 steps or input columns that must be filled in according to the details of the activities that will be submitted by the CCO. Here is an advanced view of the CCO BM Appsheet App.

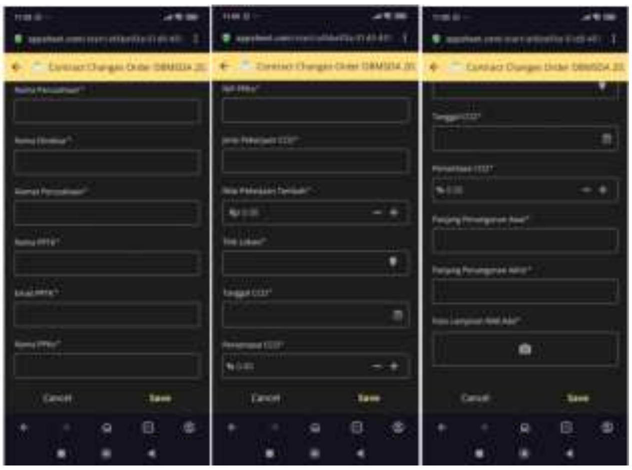

Figure 3. CCO BM Appsheet Application View (Advanced)
Source : Processed Author, 2025

In the final stage of the BM CCO Appsheet Application, PPTK must upload the results of the calculation of the CCO RAB that has balanced the budget and proof of technical justification as the final requirement for submitting a CCO. Click Save to send the CCO proposal to the PPKo so that it can be reviewed and considered for approval.

3. Database of proposed CCO Activities
   All the results of the CCO input activities will be entered into the online Spreadsheet Database. PPKo assisted by operators will inform all CCO submissions for activities that have been entered. PPKo will select the activities to be approved for the CCO to carry out based on the percentage of items added to the contract value, work items plus and under, proof of attachment of logical and reliable technical justification.
4. Output of the CCO Activity Proposal Document
   After PPKo reviews the activities to be approved or not, the operator will run the CCO BM Appsheet to send to the PPTK email the results of the PPKo approval automatically. CCO documents will be received by the CCTK automatically in the email entered into the CCO BM Appsheet application. An example of the results of the CCO Approval Document can be seen in attachment 4.

Potential Factors or Variables That Cause Contract Change Orders in Road Infrastructure Projects in Tangerang Regency

The results of the study show that the potential factors that cause CCO in road infrastructure projects are Policy Change (X4), Specification Change (X3) and Planning (X2). These three variables were proven to be valid based on the results of running the SmartPLS 4.0 program which showed a Statistical T Value greater than 1.99 and a P Value < 0.05. This policy change factor (X4) supports the results of research from Agustina Dwi Kuswandari, et al. (2018) Factors that often occur when a CCO (Contract Change Order) is the occurrence of repeated coordination with the owner when carrying out work and research from Zenteno and Agus Suroso (2021), Factors that cause contract change orders in toll road projects in succession include construction factors, Stakeholders, contract documents, and design in this case stakeholders are part of the policy change of the service owner/user.

This Specification Change Factor (X3) supports the results of research from Adnan Enshassi et al (2010) Given the factors related to consultants, the most important cause of contract change orders is design changes by a consultant and the results of research from Bintang Putra Nusantara (2023), 3 factors cause CCO, namely: consultant factors such as lack of planning preparation or incompatibility with field conditions.

This Planning Factor (X2) supports the results of research from Candra Dharmayanti (2018), there are 22 factors that cause CCO, while the most dominant factor based on the RII value is the incompatibility factor between the image and the field conditions (X1.8) with an RI value of 0.735. And the results of the research from Hendra Prasetya and Irfan Prasetya (2022), The results show that the dominant factor that causes CCO is the construction factor consisting of planning and design errors, as well as the difference between drawings and field conditions.

Dominant Variables that Cause Contract Change Order to Quality Performance in Road Infrastructure Projects in Tangerang Regency

The results of the study show that the scope of CCO, coordination of related parties and planning have a significant influence on CCO in road infrastructure projects in Tangerang Regency. This CCO Scope variable supports the results of research from Yogi Iskandar, et al. (2022) influential CCO factors including changes in the scope of work, changes in specifications, design changes by consultants, changes in site conditions, natural disasters or floods. This is in accordance with the indicators in the CCO Scope variable, including all changes related to the scope of work on road infrastructure projects in Tangerang Regency.

This indicator often occurs in road infrastructure projects in Tangerang Regency so that it greatly affects the quality of development. The variables of Coordination of Related Parties and Planning support the results of research from Ana Yuni Martanti (2018), 5 (five) dominant factors causing CCO are the request of project owners to optimize building functions, inconsistencies between drawings and field conditions, the existence of design/drawing errors from planning consultants, and significant volume differences between drawings.

Meanwhile, planning, policy changes and changes in specifications have a significant impact on the scope of the CCO. This means that all decisions made by supervision consultants and service users play a role in increasing and decreasing the scope of CCO which will later affect the performance of the quality of road stability in Tangerang Regency.

Draft application for submitting Contract Change Order proposals on road infrastructure projects in Tangerang Regency

Based on the results of the research on the application used to control the Contract Change Order at the Highway and Water Resources Office, especially in the field of roads and bridges, namely the use of the AppSheet application. This application is a no-code application development platform acquired by Google so that its use is very close to daily digital activities. This application is expected to help control the existing Contract Change Order in all Road Infrastructure projects in Tangerang Regency. Contract Change Orders that have not been directly controlled by PPKo will later be monitored directly online with direct approval from PPKo. This Appsheet application will make the procedure for submitting Contract Change Order proposals in road infrastructure projects more effective and efficient. This is because the application input is directly entered into the Database which can later be directly accessed by PPKo for approval.

CONCLUSION

The analysis identified policy changes, specification changes, and planning as key factors influencing the scope of Contract Change Orders (CCO) and quality performance in Tangerang Regency's road infrastructure projects, validated via SmartPLS 4.0 with T-statistics above 1.99 and P-values below 0.05. These factors contributed to reducing main road plans under the balanced budget principle, undermining road stability targets aligned with the RPJMD and RPJMN. Dominant variables included CCO scope (T-statistic of 3.215), stakeholder coordination, and planning, with CCO indicators encompassing additions like pavement, road length, and channels. The BM CCO AppSheet application in the Highway Service promises efficient CCO control. For future research, longitudinal studies could track the postimplementation impact of digital tools like BM CCO AppSheet on CCO reduction and long-term road quality across multiple Indonesian regencies.

REFERENCES

Bahri, S. K., Ai, S., Palupi, S. R., Alita, W. N., & Purwati, Y. (2018). Keterkaitan RPJMN tahun 2015–2019 dan RPJMD Provinsi Jawa Tengah tahun 2013–2018. *Jurnal Mahasiswa Administrasi Negara (JMAN), 2*(1).

Badan Perencanaan Pembangunan Nasional Republik Indonesia. (2020). *The national medium-term development plan 2020–2024*. Indonesian National Development Planning Board.

Candra Dharmayanti, G., Wiryasa, N. M. A., & Janasuputra, I. B. (2021). Faktor penyebab contract change order dan pengaruhnya terhadap kinerja pelaksanaan proyek konstruksi di lingkungan Pemerintah Kabupaten Badung. *Jurnal Spektran, 9*(2), 141–148. http://ojs.unud.ac.id/index.php/jsn/index

Enshassi, A., Arain, F., & Al-Raee, S. (2010). Causes of variation orders in construction projects in the Gaza Strip. *Journal of Civil Engineering and Management, 16*(4), 540–551. https://doi.org/10.3846/jcem.2010.60

Fahirah, F., & Nirmala, N. (2023). Pengaruh pengalaman tenaga kerja terhadap produktivitas tenaga kerja proyek konstruksi gedung bertingkat di Kota Palu. *Rekonstruksi Tadulako: Civil Engineering Journal on Research and Development, 4*(1). https://doi.org/10.22487/renstra.v4i1.544

Iskandar, Y., Susetyo, B., & Suroso, D. A. (2022). Pengaruh contract change order (CCO) terhadap kinerja biaya pada proyek hunian bertingkat tinggi. *Jurnal Konstruksia, 13*(2), 55–64.

Jusmidah. (2016). Analisis produktivitas tenaga kerja pada proyek konstruksi. *PENA Teknik: Jurnal Ilmiah Ilmu-Ilmu Teknik, 1*(1).

Kuswandari, A. D., Koesmargono, A., & Ervianto, W. I. (2018). Pengaruh dampak contract change order terhadap kinerja kontraktor proyek (studi kasus: Rehabilitasi Jembatan Ngablak). *Jurnal Teknik Sipil, 14*(4), 255–262.

Leone, Government of Sierra. (2023). *Sierra Leone's medium-term national development plan 2019–2023*.

Margareth, L., & Simanjuntak, M. R. A. (2010). Pengaruh produktivitas tenaga kerja terhadap kinerja proyek bangunan tinggi di DKI Jakarta. *Konferensi Nasional Teknik Sipil (KoNTekS 4)*.

Nurmala, A., & Hardjomuljadi, S. (2015). Penyebab dan dampak variation order (VO) pada pelaksanaan proyek konstruksi. *Jurnal Kontruksia, 6*(1).

Nursyamsi. (2021). *Analisa faktor penyebab contract change order pada proyek peningkatan jalan di Sulawesi Selatan*.

Nusantara, B. P. (2023). Evaluasi penerapan contract change order sebagai solusi permasalahan perubahan lingkup kontrak. *Jurnal Teknik Sipil, 19*(2), 204–222. https://doi.org/10.28932/jts.v19i1.4508

Prasetya, H., & Prasetia, I. (2022). Analysis of the causes of change order in housing project implementation in Banjarmasin (case study on Citra Land housing). *International Journal of Innovative Science and Research Technology, 7*(6), 694–701. https://www.ijisrt.com

Rencana Pembangunan Jangka Menengah Nasional Republik Indonesia. (2019). *Rencana pembangunan jangka menengah nasional 2020–2024*.

Rini, I. P. (2019). Pengaruh produktivitas tenaga kerja terhadap kinerja waktu proyek pada bangunan bertingkat. *Jurnal Infrastruktur, 3*(2). https://doi.org/10.35814/infrastruktur.v3i2.715

Wijaya, A., Arpan, B., & Mulyani, E. (2015). Efektivitas tenaga kerja pada proyek bangunan. *Jurnal Mahasiswa Teknik Sipil Universitas Tanjungpura, 1*(1).

Yuni, A., Himindo, M. P., Mandiri, C., & Barat, J. (2018). Analisis faktor penyebab contract change order dan pengaruhnya terhadap kinerja kontraktor pada proyek konstruksi pemerintah. *Rekayasa Sipil, 7*(1), 32–42.

Yuningsih, N. Y., Kartini, D. S., Akbar, I., Saefulrahman, I., & Rudiana. (2024). Analysis of conformity of the Regional Medium-Term Development Plan (RPJMD) West Bandung Regency 2018–2023 with the National Medium-Term Development Plan (RPJMN) 2020–2024. *AIP Conference Proceedings, 2952*(1). https://doi.org/10.1063/5.0214407