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Dominant Factors of Change Order and Its Relation to Working Time Performance

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ABSTRACT: Construction projects are complex, unique, dynamic jobs, full of risks and uncertainties because they are related to costs, time, quality, policy and resources. Change order is the impact of the risk of high uncertainty, work that is added or eliminated from the scope of the original contract work that changes the entire value of the contract or the time of completion of work. Based on the high road construction project of the Ministry of PUPR that will be completed, if it is not well anticipated regarding its adverse effects, a Change order can be an obstacle to its implementation, especially project time performance. This study aims to find work items that have changed due to change order events that affect time performance on national road projects, look for Change order causal factors that affect time performance on national road projects, and identify dominant factors of Change order causes which affects the time performance of the National Road project. Data collection techniques used are literature studies and surveys. The analysis method used in searching for dominant factors is Factor Analysis. The results of the study found 123 items that experienced changes. Items that often change are Thermoplastic Road Markings, Medium Quality Concrete Fc '30 MPa, Quality Concrete Medium Fc' 10 MPa, Stone Pair. Furthermore, there were 24 dominant factors that cause Change order that influence the time performance of the National Road project. Of the 24 dominant factors can be grouped into 6 groups of factors and surveys. The analysis method used in searching for dominant factors is Factor Analysis.

KEYWORDS: Dominant factors, change orders, road projects, national roads

I. INTRODUCTION

Construction project is a work filled with a complex, unique, dynamic, high risk, and uncertainties because it is directly correlate with cost, time, quality, laws, and resources. According to Ibbs and Seth (2009) [5], risk and uncertainty can be a factor of failure in construction project. Generally, risk is tied with the probability of events that happens outside the predicted area (Soeharto, 1995)[10]. Asiyanto (2005)[1] states that risks are the probability of an event in an activity, which can have a negative impact on the achievement of established business targets, there are seven possibilities that arise in construction projects, one of them is change order.

Change order is the impact of risk with high uncertainty, added or removed works from the original working contract which change the value of the contract or the time to finish the construction. Jaydeep et al. (2015)[6], says that in every construction project there are many changes, and these changes are called change order. Sandy et al. (2012)[8] says that it is very rare that there aren't any changes in a construction project, but a high amount of change order process in a project is not advisable because the more there is, then the project will have more loses.

The occurrence of change orders on construction projects could have a negative impact directly and/or indirectly, both for the contractor and the owner. The direct effect of change order is the addition of work item costs due to the addition of volume and material, conflict in the implementation schedule, re-work, increased overhead and increasing labour

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costs (Hanna et al, 1999) [4]. The indirect impact of change order is there will be dispute between owner and contractor (Hanna et.al, 1999)[4]. Factors that cause change orders can come from various sources such as project owners, consultants, contractors, subcontractors, natural factors, social factors, policies and others.

Service users/owners have a large part to change order because they don't give enough time to the planning consultant to design the construction project (Ndihokubwoyo and Haupt, 2009) [7]. According to Ibbs (2009)[5] from 54 projects that he researched, change order in construction project can cause lower productivity.

Indonesian Governments under President Joko Widodo has stated under the State Budget and Expenditure Plan ("Rencana Anggaran dan Belanja Negara (RAPBN)") for 2018 still prioritised infrastructure construction according to the plan and have pushed justice and equality to the front. Ministry PUPR gets the largest Ministry / Institution budget allocation for 2018, which is Rp. 106.9 trillion. Of the entire budget, a value of Rp. 41.3 Trillion is used to increase connectivity through the construction of new roads, national road preservation, and toll road development (www.pu.go.id). Because of the many construction projects under the Ministry of PUPR which will be completed, if not well anticipated, change order can be troubling for the construction.

II. LITERATURE REVIEW

Change Order

According to Fisk (2006)[3] change order is an agreement letter between project owner and contractor to boldly state the revision in planning, and the compensation for the contractor when change order happens during construction, which will be rewarded after a working contract between the owner and contractor is signed. Schaufelbeger & Holm (2002)[9] says that change order can be defined as modification of the original contract.

According to the Directorate General of Highways, Ministry of Public Works and Public Housing the meaning of change order is the increase or decrease of works to adjust according to the volume in the field or change in schedule without changing the articles in contract. Based on that understanding, change order can be defined as an agreement between project owners and contractors to revise work (both volume and schedule) according to field conditions. Forms of change order are generally divided into minor changes and major changes.

Type of Change Orders

Formal Changes, these changes are proposed in written text, made by owner for contractor, to change the working field, time schedule, costs, or other matters that are specified on the contract. These formal changes usually concern alternative designs and material specification from a construction and made true through revision on drawing or construction specification. In contract documents there are rules for making formal changes. These rules usually provide one-sided freedom to the owner to change the scope of work and require contractors to follow these changes.

Informal Changes, or known as constructive changes are informal actions that command some modification on the field because of a mistake in some action. Constructive changes are also explained as an agreement of changes between owner and contractor in cost and time (Barrie & Paulson, 1992:453)[2], that is why the contractor is advised to propose the changes on paper. According to Gilbreath, informal changes show a change in the scope of work or working methods due to changes made by the owner for the contractor. Many construction companies use informal field change orders when changes don't affect the number of equipment used and materials on contract. This is more difficult to identify and control, causing contractors to do different work that are different than the one on contract. Informal changes indicate changes in the contractor's scope of work or work method due to the owner's mistakes, third parties such as sub-contractors and suppliers, and all mistakes outside of the contractor.

Process of Change Order

Procedure and steps of change order are (Soeharto, 1995)[10]:

1. Deep evaluation about the need of change in the scope of work.
2. Review the impact caused by the change of the scope of work in cost and schedule
3. Propose the approval to the head project or owner if the change is significant
4. Hold follow-up activities in the form of supervision and special reports to ensure that the changes in the scope of work have been carried out as well as possible.

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III. RESEARCH METHODOLOGY

The research stage is a guide for analysing data in order to study and find the productivity index and influencing factors of bored pile productivity in this project. For this research the strategy is based on Yin (2009)[11] who said there are three factors which influences the types of research strategy, which are

1. The questions asked
2. Scope of control that the researcher has for the events being researched
3. Focus on contemporary rather than historic. Below is a table used to determine the research method

Table. 1 Research Method

Strategy	Form of Question	Researcher has Control Over the Events	Degree of Focus from Similar Past Research
Experiment	How, Why	Ya	Ya
Survey	Who, what, where, how many	Tidak	Ya
Archive Analysis	Who, what, where, how many	Tidak	Tidak
Historical	How, why	Tidak	Tidak
Case Study	How, why	Tidak	Ya

Based on the table 1 above, the most suited method to use is survey because this research needs to answer “what”, “who”, and “how many”. Steps used in this research are:

1. Data Collecting. In this step, all relevant data such as the change order contract to find the most changed items.
2. Finding the factor that caused changed order that impact the time performance of national highway.
3. Making those factors into variables.
4. Turning those variables into questionnaire. Meaning creating the questionnaire based on the variables and the purpose of this research
5. Spread the questionnaire. Spreading the questionnaire to the correct people, such as the qualified worker (with enough experience and education) who worked directly inside the project, very familiar about the subject, or experts within the project or construction field.
6. Run correlation analysis to find the factor which correlate the most with this research’s dependent variable (variable which represent the topic of this research which is change order that influence time performance of construction)
7. Run factor analysis on the results of the survey to find the most dominant on most influential.
8. Find groups of factors from the analysis where change order influenced time performance of construction project of this research project site.

IV. ANALYSIS AND RESULTS

Collecting Data on Contract Change/ Change Order Documents

Data collecting result from 19 document of contract change on national road construction especially on Banten, DKI Jakarta, and West Java, shows there are 123 item change. From that 123 item there are 4 items that changed the most:

1. Thermoplastic Road Marking, 18 changes
2. Concrete fc’ 30 MPa, 15 changes
3. Concrete fc’ 10 MPa, 15 changes
4. Stone fitting, 14 changes

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General Overview of Research Location

Roads in classification are divided into national roads, provincial roads, and district /city roads. The implementation of national roads is the authority of the Ministry of Public Works and Public Housing, and the Directorate General of Highways.

This research was taken in Jabodetabek (Jakarta, Bogor, Depok, Tangerang, and Bekasi) area, included in National Road Implementation Centre VI that organized the national road in Jakarta, Banten, and West Java.

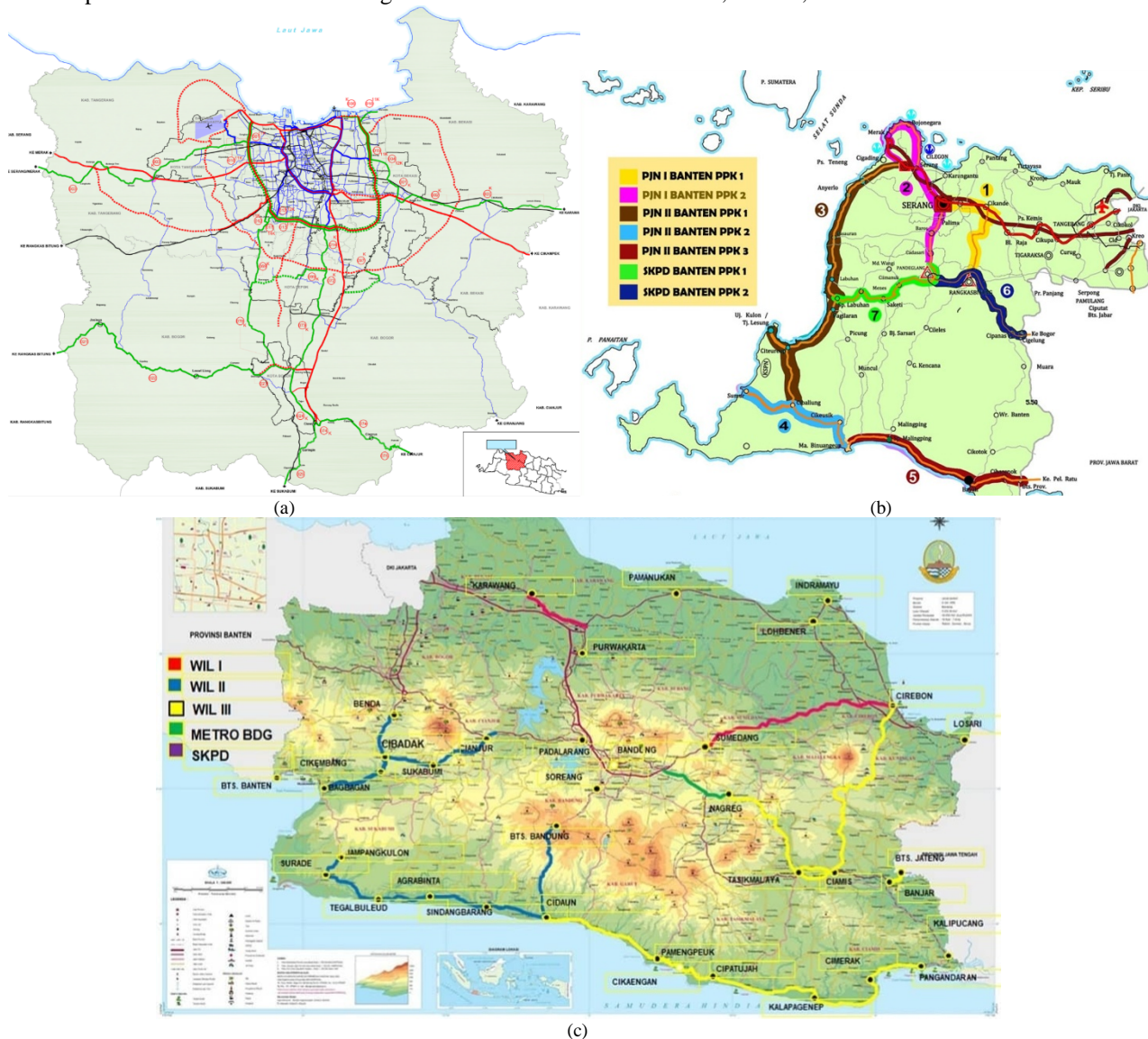


Fig. 1. (a) National Road Section of Jabodetabek (b) National Road Section of Banten (c) National Road Section of West Java

Fig 1. above are the National Road Section for Jabodetabek, Batam, and West Java. For Jabodetabek there are two National Road Implementation Work Unit, namely:

1. Metropolitan Road Implementation Work Unit I
2. Metropolitan Road Implementation Work Unit II.

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For Banten there are three National Road Implementation Work Unit, namely:

1. National Road Implementation Work Unit I Banten Province
2. National Road Implementation Work Unit II Banten Province
3. Area Work Unit Banten Province.

For West Java there are five, namely:

1. National Road Implementation Work Unit I West Java Province
2. National Road Implementation Work Unit II West Java Province
3. National Road Implementation Work Unit III West Java Province
4. Metropolitan Road Implementation Work Unit Bandung
5. Area Work Unit West Java.

Survey Overview

Survey was done through questionnaire method, of which the variable used are factors that makes change order capable of influencing the time performance of a construction project. Before the questionnaire were sent to respondent, the variable within the questionnaire were validated by an expert in this field. Through validation there are several reductions and an added variable inserted into the questionnaire. Fig. 2 below is the general representation of the respondents.

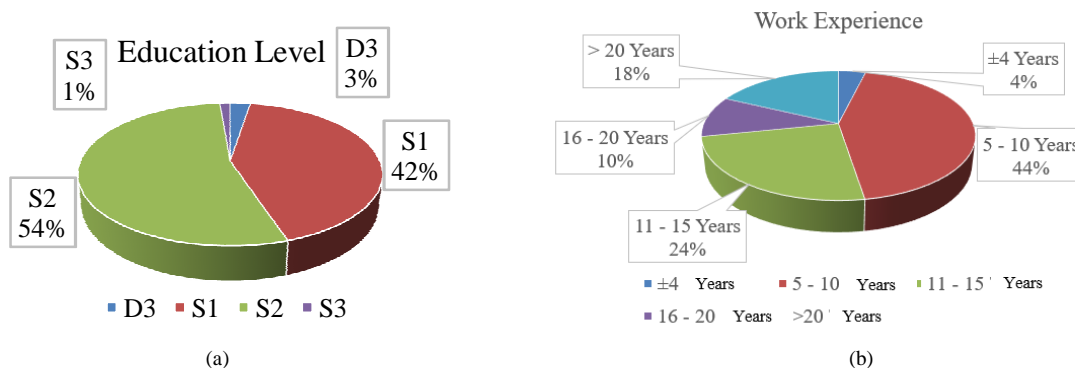


Fig. 2. (a) Education Level of the Respondents (b) Work Experience of Respondents

Based on the survey, there are 78 respondents, with graphics above shows the education level and work experience of the respondents, these respondents are staffs, supervisor, or engineer who works at PUPR where the research was taken.

Validity Test on the Survey

This test was used to see the validity of an instrument for research, in this instance the instruments are the variables inside the questionnaire. This test was done using the Spearman – Brown equation with ordinal scale with the help of a program called IBM SPSS 23. Based on the Spearman Upper Critical Values table (significant to 0.05), the variables is valid if the value is higher than 0.188. This test was done 3 times, with the first two resulted in several variables with values below 0.188, and the third test shows that the variables have higher result than 0.188, which means in this step the variables are valid. Validity test resulted in 44 independent variables to be further analysed

Reliability Test in the Survey

This test is carried out to find out how reliable a questionnaire can be used, meaning that if the survey was done again, the results from the survey will be the same or similar. In this study the reliability test results were 0.958 (in the Cronbach's Alpha column) in the final stage, which indicates that the reliability of the data has entered the Excellent or special category. In the table below is the result of the reliability test at each stage when the validity test is done, can be seen in the Cronbach's Alpha column, the value continues to rise, this shows the elimination of several variables at

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validity test is the right decision because it increased the validity and reliability of the questionnaire. Table 2 below is the table of reliability test.

Table. 2 Reliability Tests

Step 1		Step 2		Step 3	
Cronbach's Alpha	N of Items	Cronbach's Alpha	N of Items	Cronbach's Alpha	N of Items
.955	48	.957	46	.958	45

Correlation Test

Pearson correlation analysis is used to measure whether or not there is a relationship between variables, both the relationship between the independent variable (X) or the relationship between the independent variable (X) and the dependent variable (Y). The results of the questionnaire survey gave results in the form of ordinal scale data (from Likert Scale) while the Pearson correlation analysis could not analyse data with ordinal scale but it could analyse data in interval scale. Data with ordinal scale needs to be converted into interval scale using the method of successive interval. This conversion with the method of successive interval is done using MS. Excel with the Add-ins that are in the MS Excel program. These correlation analyses were done to the 44 independent variables and 1 dependent variable to find the relation between existing variables. Table 3 below is a table with significant relation at 0.05 and 0.01 level between independent and dependent variables, with table 4 is the independent variables for the questionnaire.

Table. 3 Correlation Test Results

Variable		X1	X2	X6	X7	X8	X10
Y	Pearson Correlation	.292**	.392**	.269*	.300**	.262*	.310**
	Sig. (2-tailed)	.009	.000	.017	.008	.021	.006
	N	78	78	78	78	78	78
Variable		X11	X12	X17	X18	X19	X24
Y	Pearson Correlation	.369**	.238*	.255*	.295**	.406**	.376**
	Sig. (2-tailed)	.001	.036	.024	.009	.000	.001
	N	78	78	78	78	78	78
Variable		X26	X27	X33	X34	X35	X37
Y	Pearson Correlation	.280*	.290*	.343**	.269*	.236*	.265*
	Sig. (2-tailed)	.013	.010	.002	.017	.037	.019
	N	78	78	78	78	78	78
Variable		X39	X40	X41	X43	X46	X47
Y	Pearson Correlation	.350**	.300**	.480**	.382**	.296**	.255*
	Sig. (2-tailed)	.002	.008	.000	.001	.009	.024
	N	78	78	78	78	78	78

** . Correlation is significant at the 0,01 level (2-tailed).

* . Correlation is significant at the 0,05 level (2-tailed).

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Table. 4 Variables Notes and Explanation

Var.	Notes	Var.	Notes
Y :	Change Order can influence the Time Performance of National Road	X26 :	Unsuitable material on the field
X1 :	Faults in planning and design	X27 :	Third party interference
X2 :	Faults in volume estimation	X33 :	Work delay because contractor is late
X6 :	There are water precipitation while digging	X34 :	Increasing work speed due to owner's request
X7 :	Work safety consideration	X35 :	Increasing work speed because contractor is late
X8 :	Change in work method	X37 :	Change in design
X10 :	Unclear specification in drawing plan	X39 :	Poor planning and specifications
X11 :	Late in draw approval and contract design and clarification	X40 :	Different interpretations from the planner
X12 :	Late in field access	X41 :	Change in method of implementation
X17 :	Lack of information	X43 :	Things that have not been determined by the owner
X18 :	Mistakes when starting work	X46 :	weather condition
X19 :	Mistakes in human resources supply	X47 :	Late tender/ auction
X24 :	Fault in design		

Factor Analysis

Selected variables from correlation analysis are used in factor analysis. This analysis was used to see the communal values of the variables to determine the significance of the contribution of each variable to the factors obtained. Factor analysis uses matrix components to reduce weak variables (process of elimination). In this analysis varimax rotation is also used to maximize the variance value so that a large loading value is obtained for each factor formed.

The table below shows the value of the MSA (Kaiser-Meyer-Olkin Measure of Sampling Adequacy) KMO of 0.797 which is greater than 0.5, meaning the analysis can continue. The analysis was continued by looking at the anti-image matrices table and seeing whether there was a value of the Measure of Sampling Adequacy under 0.5.

Table. 5 KMO and Bartlett's Tests

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.797
Bartlett's Test of Sphericity	Approx. Chi-Square	1153.566
	Df	276
	Sig.	.000

The result on table 5 above shows no value below 0.5, which indicates that the data used is valid.

The table below which is a communalities variable is useful for explaining how big a variable can explain a factor.

Table. 6 Communalities of each variables

Variable	Extraction	Variable	Extraction	Variable	Extraction	Variable	Extraction
X1	.807	X11	.652	X26	.756	X39	.706
X2	.766	X12	.610	X27	.670	X40	.686
X6	.733	X17	.669	X33	.730	X41	.689
X7	.716	X18	.628	X34	.794	X43	.746
X8	.714	X19	.656	X35	.743	X46	.645
X10	.731	X24	.760	X37	.730	X47	.795

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Based on the extraction value of each variable as seen on table 6 above, it can be concluded that the extraction value at $X_1 = 0.807$, meaning 80.7 %, is the greatest value, which means "planning and design errors" are variables that can explain / have a dominant relationship to the change order factor that can influence the time performance for national road construction projects.

Using total variance analysis, it can be concluded that there are 6 group of components that can be made after the factor analysis is done. After finding there will be 6 group of component factor, then the next step is to find out a variable's location is in what group. To do this is by looking at component matrix or rotated component matrix table. Based on that, the results are:

1. Factor 1: $X_{26}, X_{18}, X_{27}, X_{19}, X_{11}, X_{17}, X_{33}, X_{12}, X_{10}$
2. Factor 2: $X_1, X_{24}, X_2, X_{39}, X_{37}$
3. Factor 3: X_6, X_7
4. Factor 4: X_{34}, X_{35}
5. Factor 5: X_{40}, X_{41}, X_8
6. Factor 6: X_{47}, X_{43}, X_{46}

After grouping each variables into certain group factor, the component transformation matrix for each factor must be bigger than 0.5, and from the results the values are higher than 0.5, meaning that the 6 factors can represent each variables inside them.

V. CONCLUSION

The conclusion that can be drawn from the results of the analysis are:

1. Based on data from 19 Documents for contract change/ change order for Implementation of Roads and National Bridges in Banten, DKI Jakarta, and West Java, there were 123 changed items.
2. There are factors that cause change order which influence the time performance on national road project, which are:
 - a. Based on the results of archive analysis, observation, and discussion with experts, there are 47 factors that causes change order that influence the time performance on national road projects.
 - b. After the correlation analysis, 24 independent variables have strong correlation with the dependent variable (Y), with the dominant variable being the variable X_{41} (Change in method of implementation) with a correlation value of 0.480 with a level of significance 0.01.
3. There are several dominant factors that cause change order that affect the time performance of national road projects, there are:
 - a. Based on factor analysis, the highest extraction value is found at $X_1 = 80.7\%$, which means "planning and design errors" is a variable that can explain / have a dominant factor relationship to the change order factor that can affect the time performance of national road construction projects.
 - b. Through factor analysis, 6 groups of factors were obtained for this study, with the groups formed being:
 - Factor 1: $X_{26}, X_{18}, X_{27}, X_{19}, X_{11}, X_{17}, X_{33}, X_{12}, X_{10}$
 - Factor 2: $X_1, X_{24}, X_2, X_{39}, X_{37}$
 - Factor 3: X_6, X_7
 - Factor 4: X_{34}, X_{35}
 - Factor 5: X_{40}, X_{41}, X_8
 - Factor 6: X_{47}, X_{43}, X_{46}
4. There are 6 groups of factors that cause change order that affect the time performance of national road projects for the 4 items that are often affected.

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