

## ROAD CONSTRUCTION CHANGE ORDER ANALYSIS (TECHNICAL CAUSES AND INITIATORS)

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### ABSTRACT

*During construction, change orders often occur. Change orders that occurred in 10 road construction projects in the DKI Jakarta province were calculated by the job change index. The biggest job change index was in structural work (88.768%), and the average index of additional work changes in asphalt pavement was 77.28%. Producing the largest added job change index in drainage work (26.31%) and less job change index of 87.6% in road performance maintenance work. Also produces the largest average change in return on minor conditions of 107.35%. The technical reasons for the change order in these 10 projects are: Spec and design change group, scope change group, disruption of the project operations group, contract document discrepancies group, incompetent consultant group, document delays group, and client financial changes, and the last is the lack of coordination with the authorities. Initiators causing change orders are contractors, owners, other parties, and consultants.*

**Keywords:** change orders; DKI Jakarta; change index; technical cause of change ; initiator

### 1. INTRODUCTION

Change orders often occur in a project, be it road projects, bridges, or building projects, especially in public/public projects that are the needs of many people. During the implementation of construction, it is influenced by various factors including factors of cost, quality, and time. During construction, several cost and time factors can cause work changes called change orders [1].

Change orders also occur in Indonesia, especially in the province of DKI Jakarta. DKI Jakarta is a province that is the nation's capital with public development and one of them is a road work project that is being worked on and continues to be implemented.

The change order shows that the above problems are not limited to DKI Jakarta province, especially Indonesia in general, but in other countries where many existing public projects have an excessive number of changes during design and construction which lead to project delays, cost overruns, and decreased labor productivity, other issues [2]; [3] reported schedule and relative cost changes of up to 243% and 140%, respectively, caused by change orders in a California highway improvement project. This problem creates a desire to analyze and review the characteristics of the change order and the influencing factors that must be considered to minimize the change order's negative impact. The purpose of this study was to determine changes in road construction work on 10 road projects in DKI Jakarta based on the type of road construction work and find out the technical causes and initiators of the technical causes of the change order along with the technical causes for the change in the work itself.

### 2. LITERATURE REVIEW

Fisk and W.D. Reynolds state that a change order is a technical modification in the form of a change in work either adding or subtracting from a construction contract after the contract is signed [4].

Change orders that occur can be caused by several things, including the technical causes mentioned below which are taken from several countries.

Some of the technical causes of change orders include:

In Jordan, Msallam reported that the top factors that can cause change orders in highway projects are schedule changes, ambiguous design details, changes to plans or scope, conflicts between

document contracts, lack of coordination, safety considerations, client financial problems, and errors in design by the consultant [5].

In another questionnaire survey study Alaryan, showed that the main factors causing change orders in public and private projects were changes in project scope, problems on-site, design errors, omissions, and poorly detailed drawings [6].

In a study in Malaysia, it was reported that unavailable equipment, poor workmanship, design complexity, owner's financial problems, and fast decision barriers were significant factors causing change orders in construction projects [7]; [8].

According to Dickson, states that changes in scope are the third highest (0.762) after project delays and differences in field conditions, as well as a lack of coordination between outside designers and local designers [9].

On the other hand, design changes and image discrepancies are the main causes of change orders in Ghana [10]

Hanif identified the main factors that can cause change orders in hydropower projects as errors and omissions in design, changes in the scope of work, changes in designs, equipment unavailability, and differences between contract documents in Pakistan [11].

Research conducted in three provinces in Indonesia, the biggest cause of change orders [12] are: incompatibility between design drawings and field conditions, contractor delays, and field safety considerations. Then all of the above literature is summarized and grouped into Table 1.

Table 1 Groups of Technical Causes for Changes in Orders for Road Construction Projects

Groups	Description	Research Study							
		1	2	3	4	5	6	7	8
G1	Changes for the sake of scope and bad definition of the scope of work	yes	yes	---	yes	yes	yes	yes	--
G2	Document delays and client financial problems	---	--	yes	--	---	--	--	--
G3	Changes in specs and design	yes	---	---	---	yes	yes	yes	yes
G4	Incompetent consultant	--	--	----	---	---	---	yes	yes
G5 <sup>a</sup>	Unforeseen disruption of project operations	yes	--	yes	yes	yes	--	yes	yes
G6 <sup>b</sup>	Delay / lack of coordination with authorities	--	---	---		yes	--	---	--
G7	Contract document discrepancies	yes	----	---	----	---	---	yes	--

1= (Alnuaimi et al., 2010)

2= (Asamaoh & Offei-Nyako, 2013) [13]

3= (Memon et al., 2014)

4= (Dickson et al., 2015)

5= (Msallam et al., 2015)

6= (Alaryan et al., 2014)

7= (Hanif et al., 2016)

8= (Waty & Sulistio, 2022)

<sup>a</sup> = due to unavailability of heavy equipment, safety considerations, and schedule changes

<sup>b</sup> = including delays and unplanned changes in government regulations

### 3. RESEARCH METHOD

Research data

Primary data

Primary data is data obtained directly in the field, in the form of:

Direct observation in the field

Direct observation in the field by interviewing and conducting discussions and obtaining change order contract data

Data analysis method

Obtain change order contract data for road projects in DKI Jakarta.

From the change order contract, data on changes to construction work contracts can be obtained

Perform change order calculations that occur

Perform calculations of both changes and additional work or less work

Get an analysis of the calculated change order calculation based on the type of construction with the following data analysis below.

Data analysis includes:

1. Calculation of change orders based on the type of road construction

2. The cause of the change order

3. Initiator of change orders

1. The change order calculation discussed is:

a. Change order ratio (COR)

Change Order Ratio (COR)[14]

This index measures the ratio of the total cost variance to the project cost due to change orders.

$COR = \frac{\text{Total value of additions and deductions for a project due to a change order}}{\text{Original tender price}} \times 100\%$

The calculation of the change order (Change Order Ratio) is hereinafter referred to as the change index

b. Change order ratio based on additional costs (CORA) [14]:

CORA: Change Order Ratio in Addition

This index measures the ratio of the addition of the total project cost due to change order.

$CORA = \frac{\text{The amount of additional value for a project due to a change order}}{\text{original tender price}} \times 100\%$

The CORA calculation hereinafter is called the added job change index

c. Change order ratio based on cost reduction (CORS) [14]

CORS: Change the Order Ratio in Subtraction

The index measures the ratio of the total amount of reduction in project costs due to change orders(CORS)

$\text{Amount of reduced value for a project due to a change order} / \text{Original tender price} \times 100\%$

The CORS calculation hereinafter is called the less job change index.

d. Types of road construction are divided into:

1. General

2. Drainage

3. Earthworks

4. Road Shoulder Pavement Widening

5. Grained Concrete Work and Cement Pavement

6. Structural Work

7. Asphalt Work
  8. Condition Return Work and Minor Work
  9. Daily Works
  10. Maintenance of Routine Work consisting of
    - 2.10A Road Performance Maintenance
    - 2.10B Bridge Performance Maintenance
2. Causes of change orders are grouped into 7 seven groups of causes, namely: Group G1 to G7.
3. The initiator of a change order consists of one party, such as the project owner, the implementing contractor, the consultant, or other parties [15].
4. Order Change Analysis Flowchart

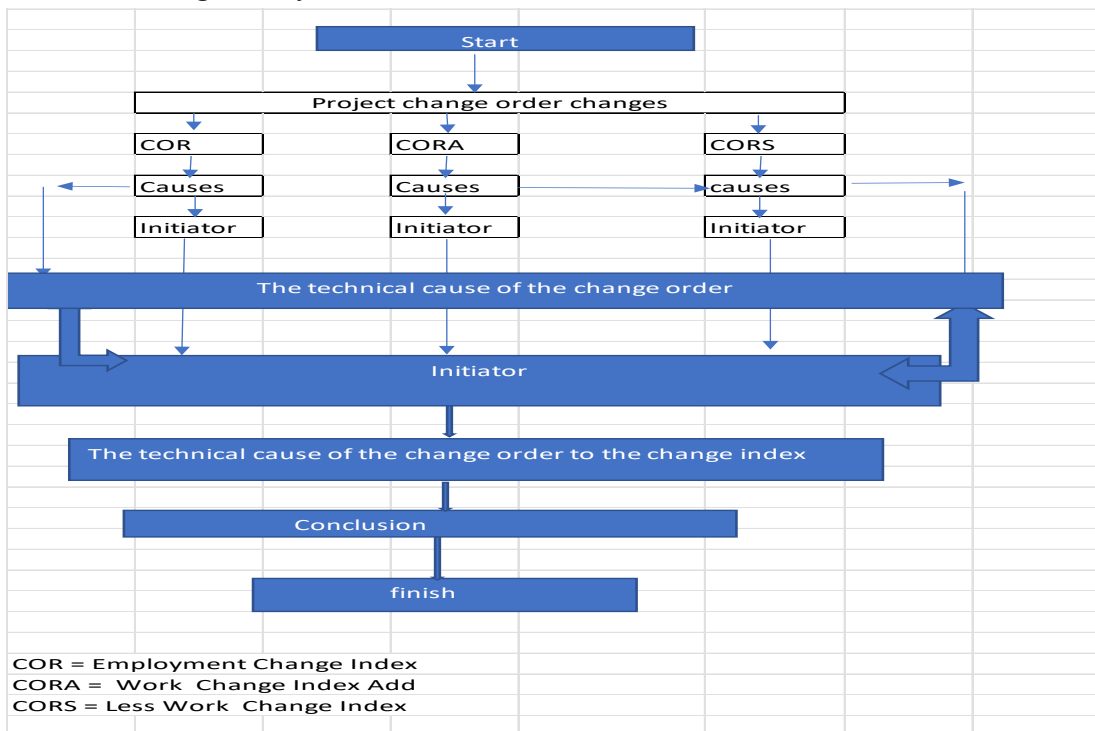


Figure 1 Flowchart of Cause Analysis of Change Order Technique

## 4. RESULTS AND DISCUSSION

### 4.1 Data Acquisition

Of the 10 road construction projects that produced the following data:

Based on the data, there are 4 construction projects that have experienced additional funds, while 6 construction projects have not experienced additional funds. The 4 projects that experienced additional funds were: project 1, project 5, project 6, and project 10 with additions that varied from 2% to 10%, projects 2 to project 4, as well as projects 7 to project 9 did not experience additional funds, with the smallest project budget from 9 billion to 37 billion rupiahs. Calculation of Change Order includes:

The COR of road projects in DKI Jakarta is divided into

1. COR Jakarta
2. CORA Jakarta
3. CORS Jakarta

### 4.2 COR of the Jakarta Project

The COR (Change Order Ratio), hereinafter referred to as the job change index in Jakarta consists of 10 projects tabulated in Figure 2 with the largest change index in structural work of 88,678% which can be seen in Figure 3.

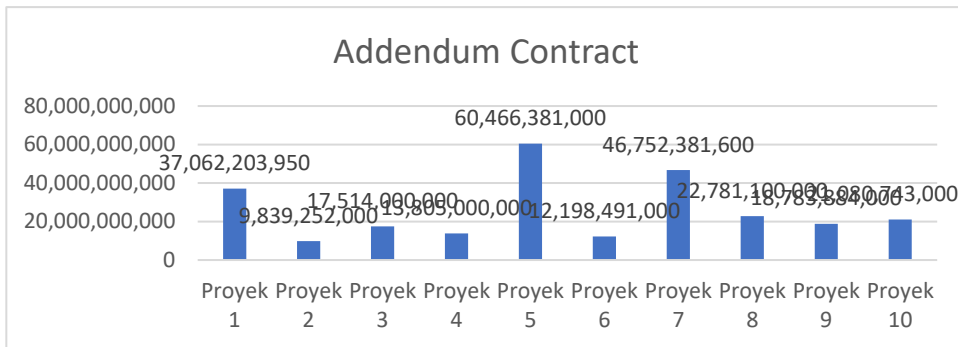


Figure 2. Change Order Addendum Contract and Project Data

From the tabulation of 10 projects, the change index in DKI Jakarta shows that road project 6 has the largest COR with a total change of 179,07% as shown in Figure 4. The change index in Figure 4 shows that the smallest change is 0,04% to the highest calculation, which is 88,678%. The smallest percentage is in Road Shoulder Pavement Widening work and the largest is in Structural work as shown in Figure 3.

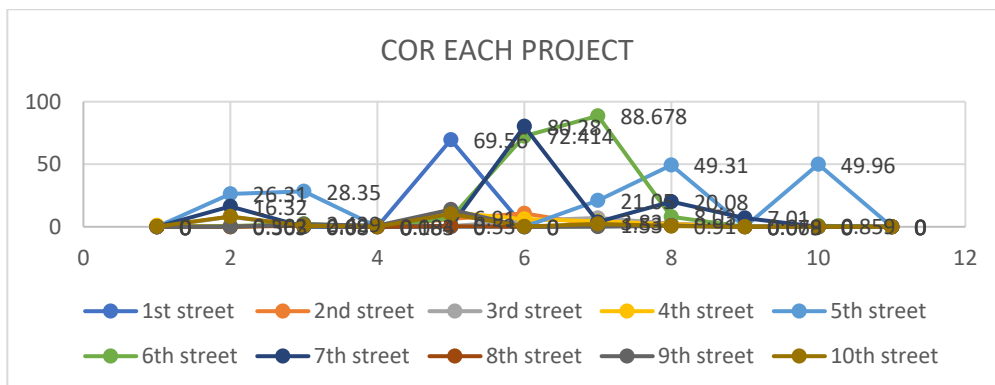


Figure 3. Project Change Index

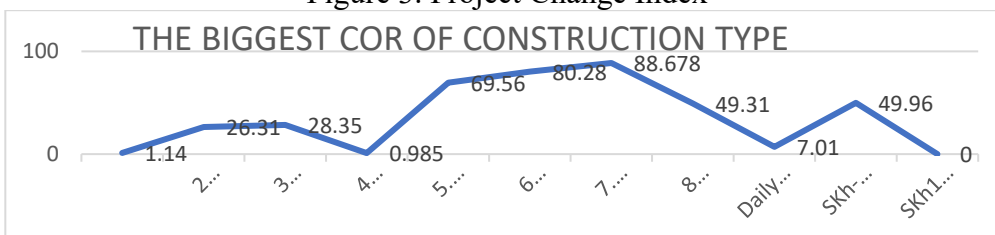


Figure 4. The index of the biggest changes in the type of construction

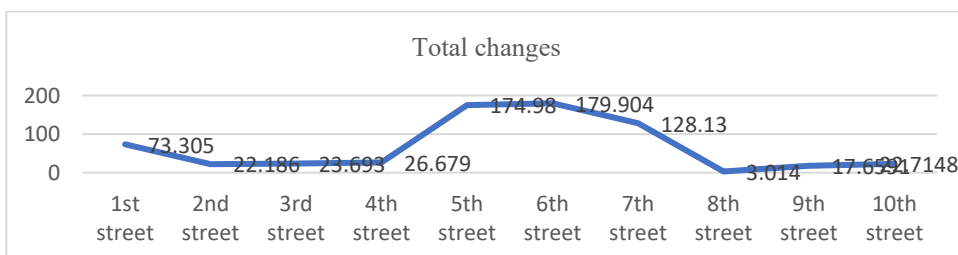


Figure 5. Total Change Index

The average change index in Figure 6 consists of the smallest average change of 0,387% to the highest change order average calculation of 77,28%. The smallest percentage is for Single Road Signs with Engineer Grade Surfaces and the largest is for Hot Mixed Asphalt work with a total change of 321,137% as shown in table 3.

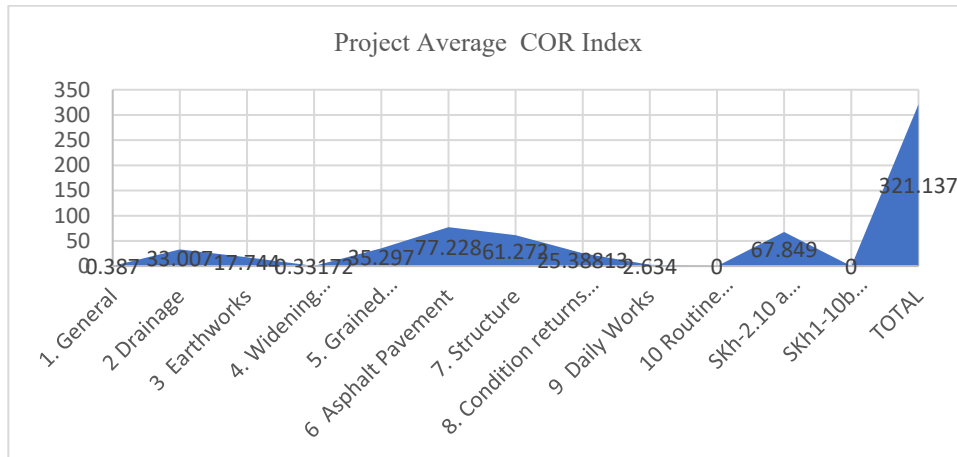


Figure 6. Project Average Change Index

### 4.3 Calculation of Project CORA

The index of added work due to change order (CORA), hereinafter referred to as the index of change of added work, is the largest in road projects 5. The index of added work for Road Project 5, consists of the smallest added work change of 0% to the calculation of the largest added work, namely 26,31%. The smallest percentage is in Public Works and Road Performance Maintenance Bridge Performance Maintenance and the largest is in Drainage work with a total change in added work of 26.31% which can be seen in Figures 7.

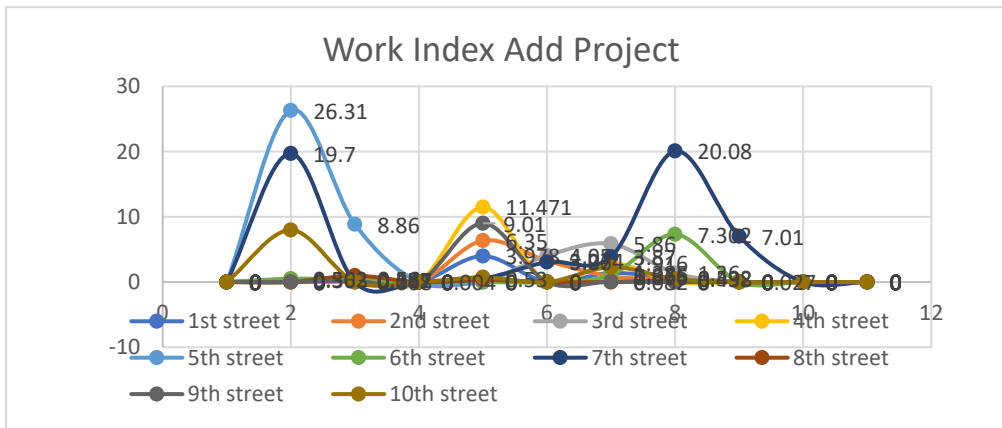


Figure 7. Work Add Project Change Index

The average change-added index for road projects produces the largest added work-change index for asphalt pavements at 83,519% and the smallest added work of 0,144% for Road Shoulder Pavement Widening as shown in Figure 8. The largest added work change index was in Asphalt Pavement work with a total added work change of 214,202%. The largest total change index is in road project 5 of 54,25% change in added work which can be seen in Figure 8.

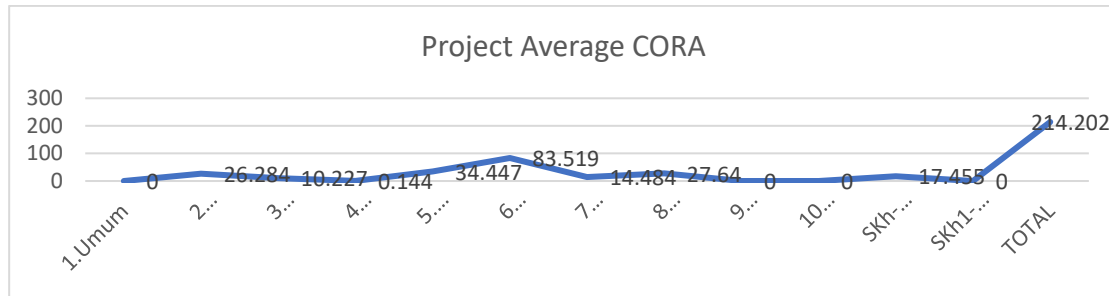


Figure 8 . Average CORA of All Projects

#### 4.4 Calculation of CORS for the Jakarta Project

Calculation of the ratio of underwork due to a change order called CORS, hereinafter referred to as the less work index resulting in road projects 5 with the smallest index results in earthworks of 19,490% and the largest index in road performance maintenance work of 87,601% as shown in Figure 9 .

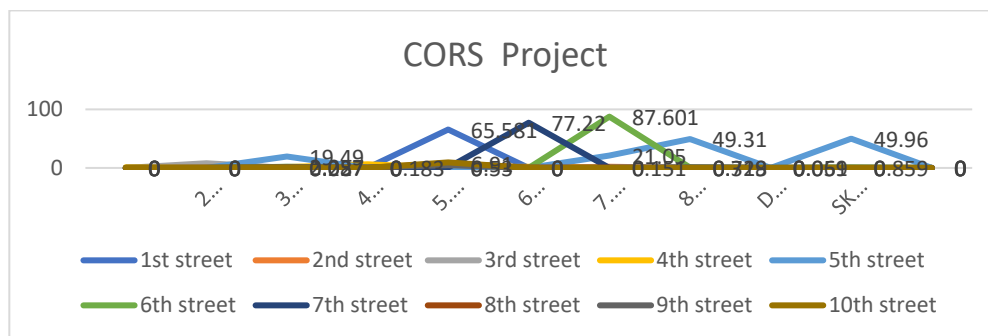


Figure 9. Total Work Index Add All Projects

The average CORS of road projects produces the largest less work change index of 107,35% for minor condition restoration work for roads and the smallest index is 0,0001% for Single Road Signs work with Engineer Grade Surface with a total project change of 266,035%. The largest total change index was in road works with a total change of 139,81% in road project 5.

#### 4.5 Causes of Road Project Change Order Techniques

4.5.1 Causes The change order technique for road projects is divided into 7 groups namely: group G1 to group G7 with the calculation results as below. The cause of the change order for road projects can be seen in Figure 13 for each project which consists of 10 projects with values varying from 0,25 to 0,34 for each type of road construction works

4.5.2 The largest cause of change orders from the group of changes by the scope and poor definition of the scope of work by 25,9% (G1), followed by the second largest by the group of changes in specifications and designs by 22,5% (G3), and the largest third followed by the group of differences in contract documents (G7) of 20,8%, the fourth largest with the G5 group (unforeseen disruption of project operations) of 15%, followed by the group of incompetent consultants and design errors (G4), followed the group of late documents and clients' financial problems (G2) by 5% and finally the coordination group with authorities ranks last (G6) by 2,5% which can be seen in Figure 10.

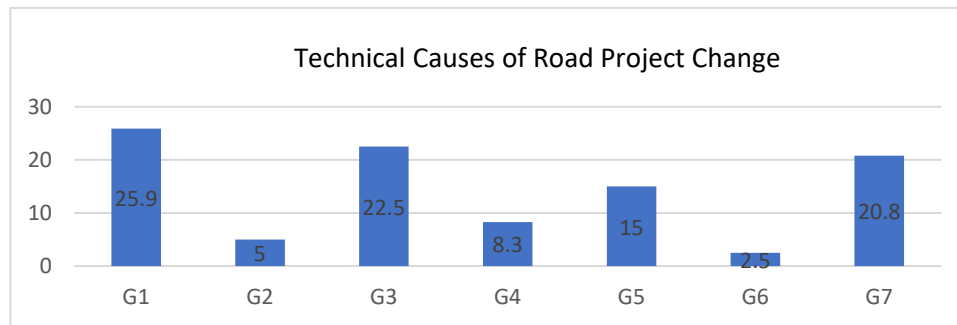


Figure 10. Technical Causes of Road Project Change Order from 7 groups

4.5.1 The technical causes of change orders based on the Change Index are as shown in Table 1 which is explained below.

With reference to table 1 which states that the group of changes for the sake of scope or poor definition of the scope of work is the highest technical cause that contributes to changes in work in road construction projects with the highest score of 183,697%. The group that causes changes in specifications and design ranks second for changes in work with a value of 174.453% of the index of changes in construction work. The group of changes to contract documents as a technical cause of change orders ranks third as a technical cause of the construction work change index with a percentage of 146,82%. The group causing unexpected disturbances from project operations is the cause of technical change orders which ranks fourth with a percentage of 137,047%. The group that causes incompetent consultants and design errors also ranks fifth as a technical cause of change orders for road construction projects with a percentage of 18,405%. The group causing document delays and clients' financial problems is also a technical cause of change orders which ranks second lowest with a percentage value of 11,08%. The group of delays in coordination with authorities ranks lowest as a technical cause of change orders for road construction projects with a percentage of 0,75%.

Table 1. Causes of the change order technique based on the Total Project Change Index

	G1	G2	G3	G4	G5	G6	G7
COR							
73,305	36,6525	0	36,6525	0	0	0	0
22,186	7,54324	0	0	7,32138	0	0	7,32138
23,693	0	0	11,8465	0	11,8465	0	0
26,679	6,66975	6,66975	0	6,66975	0	0	6,66975
174,98	0	0	87,49	0	87,49	0	0
179,904	89,952	0	0	0	0	0	89,952
128,13	32,0325	0	32,0325	0	32,0325	0	32,0325
3,014	0,7535	0	0,7535	0	0	0,7535	0,7535
17,6591	4,414775	4,414775	0	4,414775	0	0	4,414775
22,7148	5,6787	0	5,6787	0	5,6787	0	5,6787
	183,697	11,08453	174,4537	18,40591	137,0477	0,7535	146,8226

4.5.2 The technical causes of change orders based on the Index of Change of Work Added are shown in Figure 15. Calculations are carried out in the same way as the technical causes of change orders on the Index of Change in Total Work, a different calculation is done with the index of total work change added.

Referring to table 2, the group of changes in specifications and design (G3) ranks first in



terms of changes in added work with a value of 43,62% of the index of changes in construction work.

The group of unexpected disturbances/interruptions from project operations (G5) is the technical cause of change orders which ranks fourth with a percentage of 39,945%. The group of changes for the sake of scope or poor definition of the scope of work (G1) as the third highest technical cause contributes to changes in work in road construction projects with the highest score at 34,41239%. Contract document suitability group (G7) as a technical cause of change orders which ranks third as a technical cause of the construction work change index with a percentage of 30,999%. Incompetent consultant groups and design errors (G4) also rank fifth as a technical cause of change orders for road construction projects with a percentage of 9,53518%. The group of delays in documents and client financial problems (G2) is also a technical cause of change orders which ranks second lowest with a percentage value of 5,9%. The group of delays in coordination with authorities (G6) ranks lowest as a technical cause of change orders for road construction projects with a percentage of 0,37%.

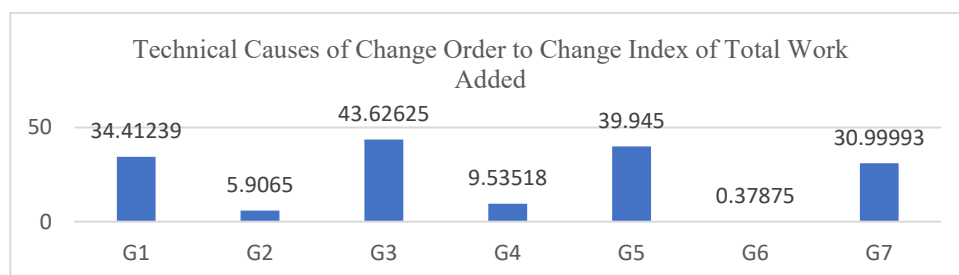


Figure 12. Technical Causes of Change to the Change Index of Total Work Added

4.5.3 The causes of the change order technique based on the Work Change Index are lacking as shown in Figure 13. Table 3 shows that the change in specs and design group (G3) ranks first for less work changes with a value of 133,69% for the construction work change index. The group of changes for the sake of scope or poor definition of the scope of work (G1) as the second highest technical cause contributing to changes in work in road construction projects with the highest score at 115,65%. The group of unexpected disturbances/interruptions from project operations (G5) is the technical cause of change orders which ranks third with a percentage of 98,11%. The group of contract document discrepancies (G7) as a technical cause of change orders ranks fourth as a technical cause of the construction work change index with a percentage of 82,27%. The group of incompetent consultants (G4) also ranks fifth as a technical cause of change orders for road construction projects with a percentage of 8,57%. The group of delays in documents and client financial problems (G2) is also a technical cause of change orders which ranks second lowest with a percentage value of 4,93%. The group lacking coordination with the ruling authority (G6) ranks lowest as a technical cause of change orders for road construction projects with a percentage of 2,31%.

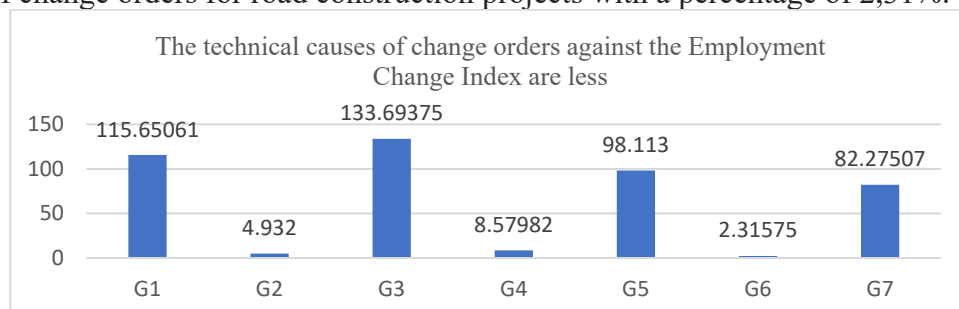


Figure 13. Technical Causes of Change Order to Less Job Change Index

4.5.4 Summary of the technical causes of project change orders

The recapitulation of the technical causes of the project change order to the change index, the added work change index, and the less work index is carried out by calculating the average of the project, the change index, the added work change index, and the less work change index are as shown in Figure 14:

1. Change in specs and design (G3) 93,56%
2. Changes for the sake of scope or poorly defined scope of work( G1)89,91%
3. Unforeseen disruption of project operations (G5)72,52
4. Discrepancies in contract documents (G7) 70,22%
5. Incompetent consultant (G4)11,20%
6. Delays in documents and client financial problems (G2) 6,73%
7. Lack of coordination with authorities (G6) 1,48%

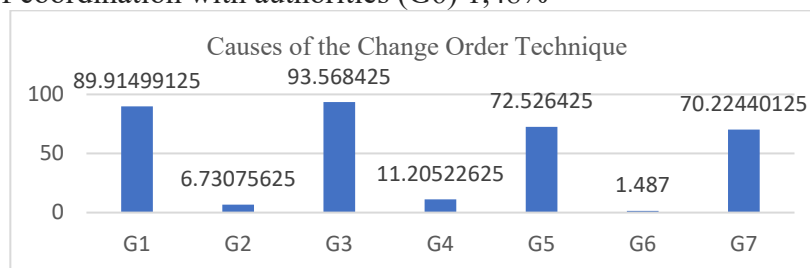


Figure 14. Recapitulation of the Causes of the Change Order Technique

4.6 The technical reasons for a change order based on the initiator are as follows: The technical reasons for the change order for each project based on the initiator are as follows: the owner and contractor as the initiator are ranked highest in the cause of the scope change group (G1) and for the group that causes changes in specifications and design, the initiator is by the owner and consultant and other parties (G3), as well as discrepancies in contract documents (G7) with initiators from contractors and owners and other parties. Furthermore, the group that causes unexpected disturbances from project operations (G5) is carried out by the initiator owner, contractor, consultant, and other parties and the group that causes change orders is incompetent and design consultants (G4) with the initiator of the contractor and consultant and owner. The group that causes the change order of delays and financial problems (G2) is carried out by other party initiators, consultants, and owners, and the last one is the weakest initiator, namely the owner, contractor, and other parties, causing the cause of the group change order to lack coordination with the ruling authority (G6) such as in table 2.

4.6.1 The technical causes of the change order, the job change index based on the initiator is the same as the technical causes of the change order for each project, which can be seen in table 3.

4.6.2 Technical causes of change order index of changes to added work based on the initiator are for the group of changes in specifications and designs initiated by the owner and consultant and other parties (G3) who rank first. Furthermore, the group of unexpected disturbances from project operations (G5) is carried out by the initiator owner, contractor, consultant, and other parties as second order. The owner and contractor as the initiator are ranked third in the cause of the scope change group (G1). Likewise, the discrepancies in contract documents (G7) with initiators from contractors and owners, and other parties occupy fourth place. The consultant group is incompetent (G4) with the initiator of the contractor and consultant and owner ranking fifth, the group of delays in documents and financial problems (G2) is carried out by the initiator of other parties, the consultant and owner ranks second lowest, and the last is the weakest initiator i.e. owners, contractors and other parties giving rise to the causes of group change orders lacking coordination with authorities (G6) as shown in table 4.

4.6.3 The technical cause of change order, the index of changes in work is lacking based on the initiator, the group of changes in specifications and designs initiated by the owner and consultant, and other parties (G3) which ranks first. The owner and contractor as the initiator are ranked second in the cause of the scope change group (G1). Furthermore, the group of unexpected disturbances from project operations (G5) is carried out by the initiator owner, contractor, consultant, and other parties as the third order. Likewise, the discrepancies in contract documents (G7) with initiators from contractors and owners, and other parties occupy fourth place. The consultant group is incompetent and design (G4) with the initiator of the contractor and consultant and owner ranking fifth, the delay in documents and financial problems group (G2) carried out by the initiator of another party, the consultant and owner rank second lowest, and the last is the weakest initiator, namely the owner, contractor, and other parties, causing the cause of group change orders to lack coordination with the authorities (G6) as shown in table 5.

4.6.4 The recapitulation of the technical causes of the change order to the change index, the index of changes to added work, and the index of less work to the initiator are: The initiator who contributed to the technical causes of the road project change order can be seen in Table 2, while the contribution to the technical causes of change orders in the job change index can be seen in table 3, the contribution to the added work change index can be seen in Table 4, and finally the contribution the change index can be seen in table 5.

The four tables show that the highest to lowest average is that the contractor ranks highest as the initiator of the technical cause of the change order (159,85%, followed by the owner (115,57%), other parties rank third (57,08%) ) and consultants occupy the lowest rank (13,84%) as shown in table 6 and figure 14.

Table 2. Contribution of the initiator to the technical causes of the road project change order

	G1	G2	G3	G4	G5	G6	G7	total
owner	12,95	1,25	4,5	2,075	3,75	0,85	8,32	33,695
contractor	12,95	0	9	4,15	7,5	0,825	10,4	44,825
consultant	0	1,25	2,25	2,075	0	0	0	5,575
Other parties	0	2,5	6,75	0	3,75	0,825	2,08	15,905

Table 3. Contribution of the initiator to the technical cause of the change order index of work changes

Causes of change order	G1	G2	G3	G4	G5	G6	G7	
COR								
owner	91,84848	2,771131	34,89074	4,601476	34,26193	0,25619	58,72904	227,359
contractor	91,84848	0	69,78148	9,202953	68,52385	0,248655	73,4113	313,0167
consultant	0	2,771131	17,44537	4,601476	0	0	0	24,81798
Other parties	0	5,542263	52,33611	0	34,26193	0,248655	14,68226	107,0712

Table 4. The contribution of the initiator to the technical cause of the change order index of changes in work added

Causes of change order	G1	G2	G3	G4	G5	G6	G7	
CORA								
owner	17,2062	1,476625	8,72525	2,383795	9,98625	0,128775	12,39997	52,30686
contractor	17,2062	0	17,4505	4,76759	19,9725	0,124988	15,49997	75,02174
consultant	0	1,476625	4,362625	2,383795	0	0	0	8,223045
Other parties	0	2,95325	13,08788	0	9,98625	0,124988	3,099993	29,25236

Table 5. The contribution of the initiator to the technical cause of the change order index of job changes is lacking

Causes of change order	G1	G2	G3	G4	G5	G6	G7	
CORS								
owner	57,82531	1,233	26,73875	2,144955	24,52825	0,787355	32,91003	146,1676
contractor	57,82531	0	53,4775	4,28991	49,0565	0,764198	41,13754	206,5509
consultant	0	1,233	13,36938	2,144955	0	0	0	16,74733
Other parties	0	2,466	40,10813	0	24,52825	0,764198	8,227507	76,09408

Table 6. The average initiator of the change order technique order

Project	COR	CORA	CORS	Average
33,695	230,1301	52,30686	146,1676	115,5749
44,825	313,0167	75,02174	206,5509	159,8536
5,575	24,81798	8,223045	16,74733	13,84084
15,905	107,0712	29,25236	76,09408	57,08066

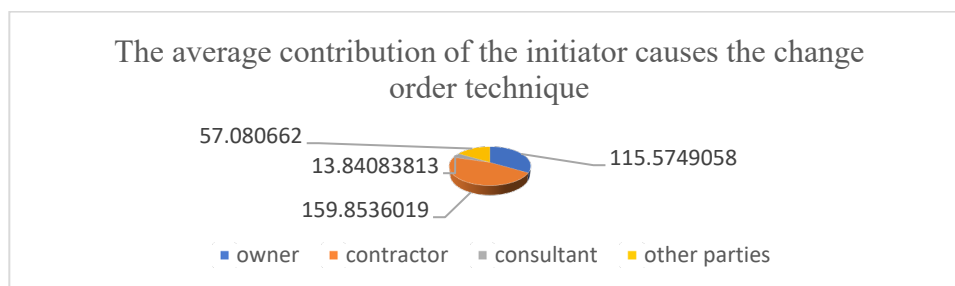


Figure 15. The Average Contribution Of the Initiator Causes the Change Order Technique

5. Causes of the Change Order Technique for the Work Change Index  
As can be seen in Figure 14, the cause of the change order technique is a change in specifications and design with a percentage of 93,56% which indicates that in structural work, drainage work, and road performance maintenance work which is the largest index of work changes, it is necessary to pay serious attention to engineering causes, especially changes in specifications and designs that are the main cause of technical change orders for very large road construction projects. The initiators that cause change orders are owners and consultants and other parties. Asphalt pavement work is work that has the largest average change index, either added work or changes to the work itself, also caused by changes in specifications and design. Minor repair work, which is the biggest change in the job index, is also caused by changes in specifications and design. Not only the group of changes in specs and design but also changes in scope or poor definition of the scope caused a change order in structural work, drainage, and maintenance of road performance by 89,91%. Asphalt work is work that has the largest average change index either added work or changes to the work itself and the index is also caused by changes in the scope. The initiators of the scope change group are the owner and the contractor. Likewise, minor condition restoration work is also caused by scope changes or poor scope definition. Unexpected interruptions/interruptions from project operations (G5) of 72,52% also caused change orders which caused a change index, added work change index and less work index on structural work, drainage, and road performance maintenance had significant construction changes. major also includes asphalt pavement work and minor repair work. The initiator of the cause of the group of unexpected interruptions/interruptions from project operations is the initiator owner, contractor, consultant, and other parties. Contract document discrepancies (G7) of 70,22% caused a very large percentage of change orders

for structural work, drainage, and maintenance of road performance, as well as asphalt pavement work and restoration of minor conditions also caused by discrepancies in contract documents. Initiators of contract document discrepancies are contractors and owners and other parties.

## 5. ANALYSIS

### 5.1 Analysis of Change Index

Based on the 10 projects discussed above, an analysis of the change index is carried out, both the index of changes in jobs added and the index of changes in jobs produces fewer data, namely:

- a. the largest job change index was in the type of structural work at 88,768%,
  - b. the largest average change index of work on the type of asphalt pavement work is 77,28%
  - c. the largest added work change index was in drainage work at 26,31%
  - d. index of change in the average of the largest added work on the type of asphalt pavement work of 83,519%
  - e. the biggest job change index was in road performance maintenance work of 87,6%.
  - f. The average index of less job change is the largest in minor condition return jobs of 107,35%
- Structural work is work that includes work including concrete, prestressed concrete, reinforcing steel, structural steel, cement mortar, empty masonry and gabions, bridge floor drainage, so structural work contributes greatly to the change order change index resulting in a change of 88,768%.

Drainage work is work that includes among others: Ditches and Drains, stone masonry with mortar, concrete culverts, and drainage, porous drainage, which has a contribution of 26,31% of additional work changes.

Road performance maintenance work includes Routine maintenance of Pavement, Road Shoulders, Drainage, and Road and Bridge Equipment contributing to underwork which causes change orders with job changes of 87,6%.

Asphalt pavement work includes the work of: among others, a binder impregnation layer and adhesive layer. Asphalt One Layer (Burtu) and Two Layer Asphalt Laying (Burda), Hot Mixed Asphalt, Lasbutag and Latasbusir, Cold Asphalt Mixed, Macadam Penetration Layers and Maintenance with Asphalt Laminated which contributed to the average change in work added 83,51% on average the change in the work itself was 77,28%.

Restoration work and minor works include: Restoring the Condition of the Old Pavement, Restoring the Condition of the Old Road Shoulders on Asphalt Covered Pavement, Returning the Condition of Ditches, Drains, Excavation, Embankment, and Reforestation, Road Equipment and Traffic Control and Restoration of Contributing Bridges to the average job change index of less than 107,35%.

### 5.2 The initiator's contribution to the technical cause of the change order is:

The highest cause group is changed in specifications and design (G3) which are also influenced by owners, consultants, and other parties who encourage changes in specifications and result in design changes so that the plans that have been determined to be carried out the change. The cause of the second highest change order is the scope change group (G1) which is heavily influenced by the owner and contractor. Owners and contractors are very influential, causing changes in the scope that makes the definition of the scope bad so that the work changes from the initial plan.

Unforeseen interruptions/interruptions in project operations (G5) are also a technical cause of change orders even though they are in third place but are also things that need to be taken into account because they cause changes to construction contracts with the contribution of the initiator from the owner, consultant, contractor and other parties. Group of contract document discrepancies (G7), which causes contract documents to be difficult to

carry out physical work, which causes different interpretations of contract documents between the owner and implementing contractor resulting in changes to construction work and those who contribute to this technical cause are owners, contractors and other parties who ranks fourth highest. The group of incompetent consultants (G4) is also the fifth technical cause that causes changes in construction contracts so it is necessary to re-measure and other survey work which results in changes in work that are also influenced by the contributions of consultants, contractors, and owners. The group of delays in documents and client financial problems (G2) is also a technical cause although it does not have too much influence with contributions from the owner, other parties, and consultants. Document delays are usually due to the mistakes of consultants who are slow to work on or repair, so the owner is also slow which results in financial problems. The owner is also influenced by other parties which is the cause of the second-lowest technical change order. The group lacking coordination with the ruling authority (G6) is the cause of the technical change orders carried out by initiating owners, contractors, and other parties which, although they are the weakest technical causes of change orders, result in changes to construction contracts due to the existence of new rules or regulations so that coordination with the authorities is the necessary authority that causes job changes. Lack of coordination with a number of regulatory authorities resulted in changes to construction contracts. It is necessary to carry out proper cost control for road construction work to avoid the magnitude of the change index, either the change itself or the index of less work or also the index of added work that occurred in the 10 projects above by taking into account the four technical reasons for the change order.

## 6. CONCLUSIONS

### 6.1 Conclusions

1. Based on the 10 projects discussed above, an analysis of the change index is carried out, both the index of changes in jobs added or the index of changes in jobs produces fewer data, namely:

- a. the largest job change index was in the type of structural work at 88,768%,
- b. the largest average change index of work on the type of asphalt pavement work is 77,28%
- c. the largest added work change index was in drainage work at 26,31%
- d. index of change in the average of the largest added work on the type of asphalt pavement work of 83,519%
- e. the biggest job change index was in road performance maintenance work of 87,6%.
- f. The average index of less job change is the largest in minor condition return jobs of 107,35%

2. The cause of the change order

The cause of change orders is the highest group change by scope (G1), followed by changes in specs and design (G3), nonconformance of contract documents (G7), incompetent consultant group (G4), unexpected disturbances/interruptions from project operations (G5), then followed by the delay in documents and changes in client finances (G2) and finally the lack of coordination with authorities (G6).

3. Initiators who contribute the most to change orders are contractors, owners, and other parties and the smallest are consultants.

## 6.2 Suggestions

For the DKI Jakarta area, pay more attention to structural work, drainage work, and road performance maintenance work so that in the following year change orders can be reduced, as well as technical causes for changes in specifications and designs, and changes in scope need to receive important attention.

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