

# Analysis of Change Orders Based on the Type of Road Construction

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**Abstract** Change Order is a written and valid work order that changes the scope of the original contract, with compensation agreed upon by the owner and contractor. Changes can be in the form of adding or reducing the scope of work, material changes, or schedule changes. The Change Order that occurred in Banten Province stated the value of the percentage change order for various works on road projects expressed in the type of road construction. The changes that occur are job changes due to added work and changes due to less work. The purpose of this study is to determine the type of road construction that occurs in 5 change order contracts for road construction projects and the results are the largest changes in the type of drainage work construction, both the changes themselves and changes to additional work. Changes due to work are less in the largest type of construction in Condition Returns and Minor Works.

**Keywords** Change order · Road construction project · Banten

## 1 Introduction

Change Order is a common thing that often occurs in construction projects. Almost all existing projects always have change orders, both government projects and private projects. During the implementation of a construction project, these changes can occur either from the contractor or the owner [1]. A Change Order is a written and legal work order that changes the scope of the original contract, with compensation that has been agreed upon by the owner and the contractor. Changes can be in the form of adding or reducing the scope of work, changing materials, or changing schedules [2].

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Goudreau [3] reports that there are five keys that burden the project, namely: payment, authority, change orders, schedule of work and contract documents.

The main cause of delays in 130 projects in Jordan was change orders [4]

Change Order causes costs to cause contract items to swell, planning errors and negligence, as well as changes in scope which can be reduced by sharpening the final results of planning [5].

Research by Sulistio and Waty [1] shows that the percentage of change orders occurred at 28.26% of projects in East Kalimantan in excavation and embankment works on road pavement projects. Research by Waty and Sulistio [6] states that the Change Order effect from the calculation of Change Order for road projects in Banten is: delaying the project completion date, cost overruns, generating claims and disputes, affecting performance and work morale and most contractors incur additional costs.

The average percentage of jobs that experience the biggest change orders in road construction projects that occur in Banten is U-shaped channel work type DS 1 (19.64%) in Waty and Sulistio's research [6]. Seeing the large percentage of change orders in Banten Province, the authors want further researching the types of road construction that occurred in Banten Province, which originated from the contract change orders that occurred.

## 2 Methodology

The object of research regarding changes in the type of road construction occurred as a result of change orders carried out in Banten Province. The road project is one of the prioritized infrastructure projects in Banten Province. Of course, it is very necessary to pay attention to the infrastructure that continues to be built as well as Banten province as the closest province to DKI Jakarta, which has a fairly large percentage of change orders in previous studies.

### 2.1 Data Collection

The research data were obtained from the Public Works Office of Banten Province. In total, the researchers obtained five real project data consisting of 2018 which were analyzed in hard copy and soft copy. The real data is in the form of a contract addendum containing the change order contract. In five projects, there were quite a lot of project changes. This study focuses on the change order contract addendum, which contains project changes and the reasons for the changes and is presented in each change order note, including the following relevant information:

- Changes in overall costs and times;
- Changes in the cost per specific work item;

- Original contract value;
- Type of construction;
- Project description; and
- The reason for each change order.

## 2.2 Data Analysis Method

The data analysis method consists of 5 change order contract data in 2018 at the Banten Province project in the form of project construction change data. The calculation of the change order contract is in the form of additional work changes and fewer work changes in the change order contract that you can see below:

### 1. Change Order Ratio (COR)

This index measures the total cost of the variants of the project where Change orders occur.

$$COR = (\text{the amount of added and less value for the project. Change order/ original contract price}) \times 100\%$$

### 2. Change Order Ratio in Addition (CORA)

This index measures the total cost of the variants of the project where change orders occur.

$$CORA = (\text{the amount of added and less value for the project. Change order/ original contract price}) \times 100\%$$

### 3. Change Order Ratio in Subtraction (CORS) [7]

This index measures the ratio of the total subtraction achieved in change order projects were carried out.

$$CORS = (\text{the amount of work value was less than the projects performed change order/original contract price}) \times 100\%$$

Based on this data, we can find the type of road construction which consists of 11 construction works based on the 2018 Bina Marga specifications [8].

## 3 Result and Discussion

### 3.1 Acquisition of Data

After data collection, five real data were obtained from road projects in Banten Province. Of the five projects obtained, all of which are budget projects from 2018. Of the five projects, the results are as in Table 1.

**Table 1** Project based on balance and addition of budget

No.	Project	Contract	Contract add	Year	Information
1	Road 1	17,891,881.000	17,891,881.000	2018	Balance budget
2	Road 2	28,501,187.000	30,841,291.000	2018	Additional budget
3	Road 3	11,790,233.000	12,969,256.000	2018	Additional budget
4	Road 4	2,647,761.000	2,890,502.000	2018	Additional budget
5	Road 5	7,322,434.000	8,022,434.000	2018	Additional budget

### 3.2 Calculation of the Percentage Change Order for the Banten Road Project

The percentage of Change Order is calculated based on COR, CORA and CORS. Project COR calculation is the ratio of calculating changes in the form of additional funds or reduction of funds or addition of work items or reduction of work items or removal of work items or addition of new work items.

The change order contract can be used to see work that has changed orders which are divided into types of road construction and for daily work items that do not exist, what is used in this study are [8]:

1. Drainage Work
2. Earthworks
3. Road Shoulder Pavement Widening Work
4. Cement Concrete Works
5. Structural Work
6. Asphalt Work
7. Works Restoring and Minor Works
8. Maintenance of Routine Work which consists of
9. Routine Maintenance Work
10. SKH2.10A Road Performance Maintenance
11. SKH 2.10 B Bridge Performance Maintenance.

#### Road Project Work Change Analysis (COR). COR calculation [7]

*Change Order Ratio (COR)*. This index measures the total cost of the variants of the project where Change orders occur.  $COR = (\text{the amount of added and less value for the project. Change order/original contract price}) \times 100\%$

##### 1. Total COR of Each Road Project

Total project COR calculation is the total COR calculation on the project as a whole, which is contained in 10 construction work items which when totaled, will get the total COR value, as can be seen in Table 2.

**Table 2** COR total of each project

Project total COR value	Project name
25.13	1
23.12	2
93.44	3
8.66	4
20.91	5

**Table 3** COR total of the entire road project

Type of constructions	COR
Div. 2 Drainage work	42.50
Div. 3 Earth work	7.01
Div. 4 Road shoulder pavement widening work	3.83
Div. 5 Cement concrete work	7.37
Div. 6 Asphalt work	36.82
Div. 7 Structural work	33.0
Div. 8 Works restoring and minor works	34.42
Div. 10 Routine maintenance work	0
SKH2.10A Road performance maintenance	6.24
SKh1-10b Bridge performance maintenance	0.04
Total	171.27

## 2. Total COR of All Road Projects and COR Average Projects

The total COR of all projects resulted in the largest change order change value in 5 projects was 42.50% for asphalt work and the smallest change in 5 projects was road shoulder widening work 3.83%, so that the total change in 5 projects was 171.27% which occurs because the condition of the project field changes which causes changes in work on the project as in Table 3. Changes in the average change order in all construction projects can be seen in Table 4. The smallest chance of change order in the type of bridge performance maintenance construction was 0.045% and the bigger is Drainage Work was 38.90%.

*Change Order Ratio in Addition (CORA)* [7]. This index measures the ratio of the total work added to projects that are experiencing change orders.  $CORA = (the\ amount\ of\ the\ added\ value\ of\ the\ project\ that\ underwent\ a\ change\ of\ order / original\ contract\ price) \times 100\%$

### 1. Change Order Ratio in Addition (CORA) Total of each Project

CORA total project is a change of work plus the overall change order in one project package, which can be seen in Table 5 on each road project. CORA Total for each project resulted in the largest value of change in Road Project 3 at 51.49% and the smallest on Project 4 at 5.562% that you can see in Table 5. CORA Total Project of 51.49% occurred due to changes in project field conditions which led to changes in work on the project. The conditions in the project field have changed because

**Table 4** Project average COR

Type of construction	Average COR
Div. 2 Drainage work	38.90
Div. 3 Earth work	1.95
Div. 4 Road shoulder pavement widening work	0.97
Div. 5 Cement concrete work	0.66
Div. 6 Asphalt work	17.07
Div. 7 Structural work	11.85
Div. 8 Works restoring and minor works	9.86
Div. 10 Routine maintenance work	
SKh-2.10a Road performance maintenance	6.24
SKh1-10b Bridge performance maintenance	0.04

usually project planning was carried out in the previous year and changed regulations which resulted in changes in work. It occurs because the state of the project field changes, which causes changes to work on the project. Changes of 51.49% are not allowed according to Peraturan Presiden No. 54 of 2010 Article 87 [9], only 10% chance of work is permitted.

## 2. CORA Total of All Road Projects and CORA of Project Average

Changes in work added to change orders for five projects in Table 5 consist of the smallest amount of 0.05% to Cement Concrete work and the largest percentage in Structural Work is 24.74%, so that the total change in added work of 102.97% occurs due to field conditions. Project changes that cause changes to the work on the project. The average CORA of the project also experienced the same thing, namely the type of construction of drainage works experienced the largest change order of 37.72 0% and the smallest change of change order was in the type of bridge performance maintenance construction of 0.045% that can be seen on Table 6.

*Change Order Ratio in Subtraction (CORS)* [7]. This index measures the ratio of the total subtraction achieved in Change order projects were carried out.  $CORS = (\text{the amount of work value was less than the projects performed Change order/original contract price}) \times 100\%$  CORS Total of each Project.

CORS Total Project is a change of work less a project in each project. The CORS Total Project resulted in the largest value of change in Project number 3,

**Table 5** CORA Total of each project

Total CORA (%)	Project name
12.800	1
23.848	2
51.49	3
5.562	4
9.275	5

**Table 6** CORA total of all road project

Type of construction	Amount (%)
Div. 2 Drainage work	41.91
Div. 3 Earth work	3.82
Div. 4 Road shoulder pavement widening work	2.63
Div. 5 Cement concrete work	0.05
Div. 6 Asphalt work	10.50
Div. 7 Structural work	24.74
Div. 8 Works restoring and minor works	12.14
Div. 10 Routine maintenance work	
SKh-2.10a Road performance maintenance	7.15
SKh1-10b Bridge performance maintenance	0
Total	102.97

**Table 7** CORS total for each project

Total CORS	Project name
12.28	1
2.35	2
42.31	3
0	4
9.92	5

amounting to 42.31% and the smallest in Project number 4 by 0%. The total project CORS of 42.31% occurred due to changes in project field conditions which led to changes in work on the project that can be seen in Table 7.

*CORS Total of all Road Projects and Average CORS of Projects.* The calculation of work lacking change orders in 5 projects (all projects) at the smallest is 0% for bridge performance maintenance work and the largest fewer work changes in the condition restoration work and minor work as the highest less work change, namely 23.39% that can be seen on Table 8 and total change is 66.87% that can be seen on Table 8.

The average change in a change order for all construction projects was obtained with the largest result in drainage work of 15.515% and the smallest change in a change order for the bridge maintenance construction type of 0.045% that can be seen on Table 9.

**Table 8** CORS total of all road projects

Type of construction	Amount (%)
Div. 2 Drainage work	15.74
Div. 3 Earth work	3.19
Div. 4 Road shoulder pavement widening work	1.19
Div. 5 Cement concrete work	1.87
Div. 6 Asphalt work	12.03
Div. 7 Structural work	8.25
Div. 8 Works restoring and minor works	23.39
Div. 10 Routine maintenance work	
SKh-2.10a Road performance maintenance	1.20
SKh1-10b Bridge performance maintenance	0
Total	66.87

**Table 9** Average CORS project

Type of construction	Average CORS (%)
Div. 2 Drainage work	15.515
Div. 3 Earth work	1.368
Div. 4 Road shoulder pavement widening work	0.599
Div. 5 Cement concrete work	0.941
Div. 6 Asphalt work	9.732
Div. 7 Structural work	4.277
Div. 8 Works restoring and minor works	10.543
Div. 10 Routine maintenance work	
SKh-2.10a Road performance maintenance	1.198
SKh1-10b Bridge performance maintenance	0.045

#### 4 Conclusion

Analysis of change order for road construction projects in Banten based on the type of road construction derived from the calculation and analysis of change order contracts, both the average and the total obtained are:

1. Biggest work Change on Drainage work
2. Work changes added to the largest change order for Drainage jobs
3. Work changes are less the biggest change order on work Restore Conditions and Minor Work.



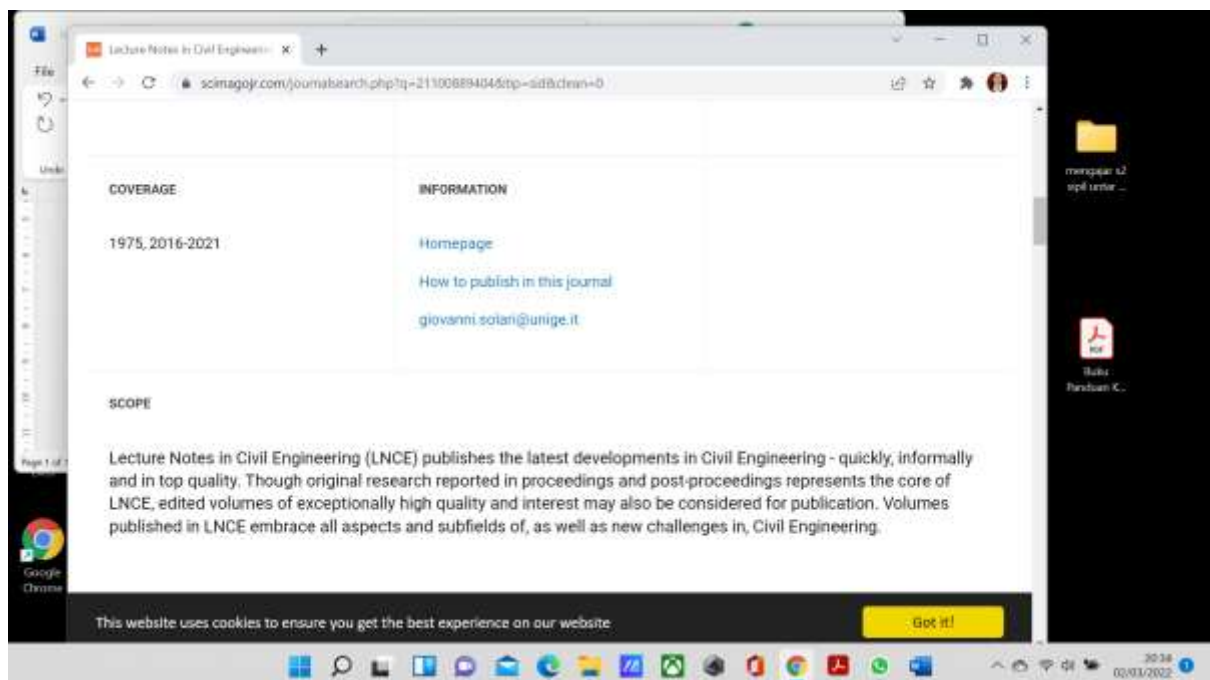
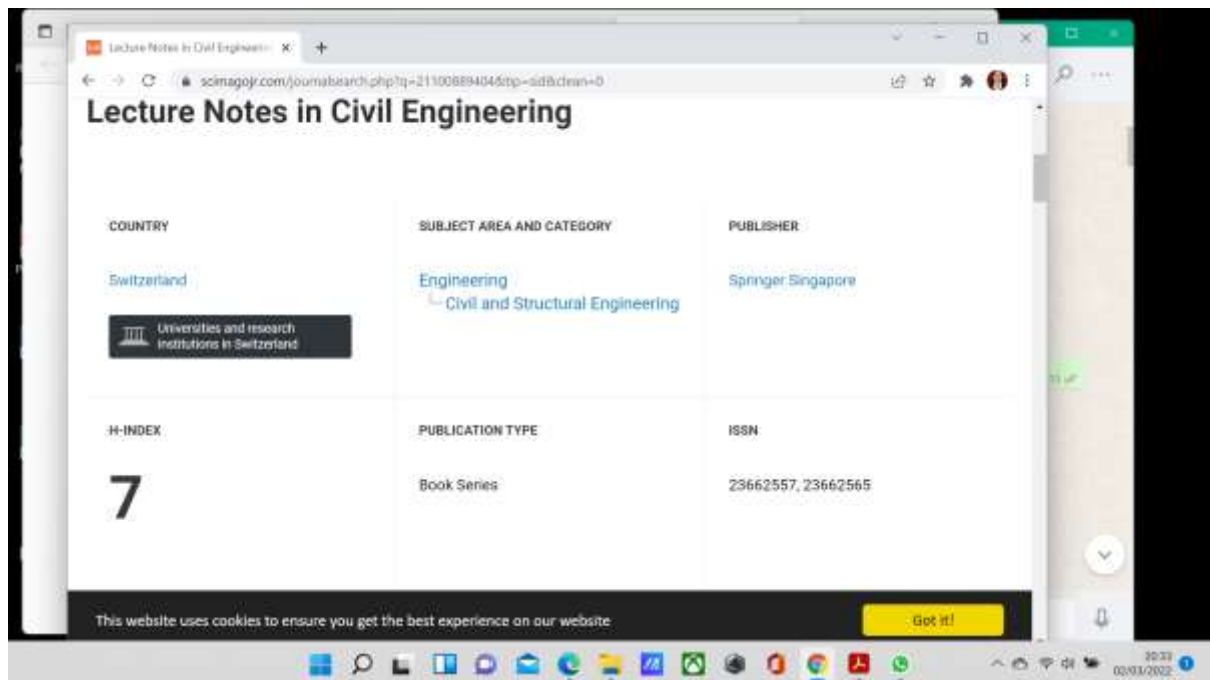
## 5 Suggestion

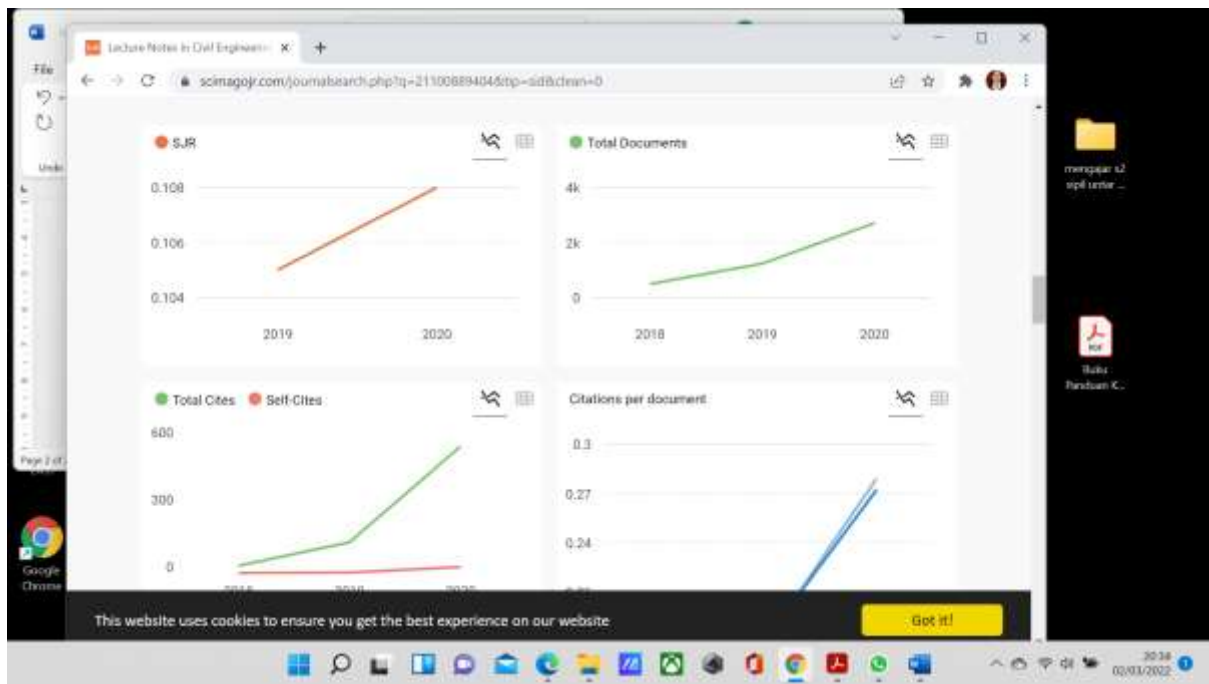
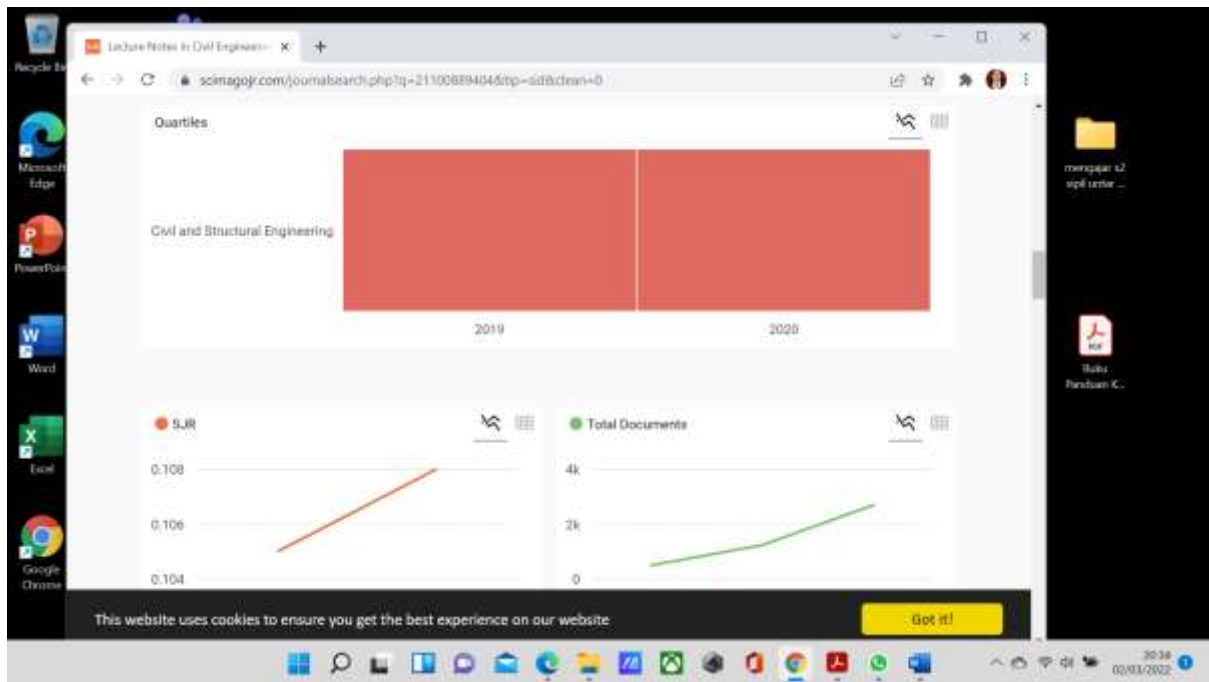
Pay more attention to the type of construction work, Drainage and Restoration of Conditions and Works so that in the following year change orders can be reduced.

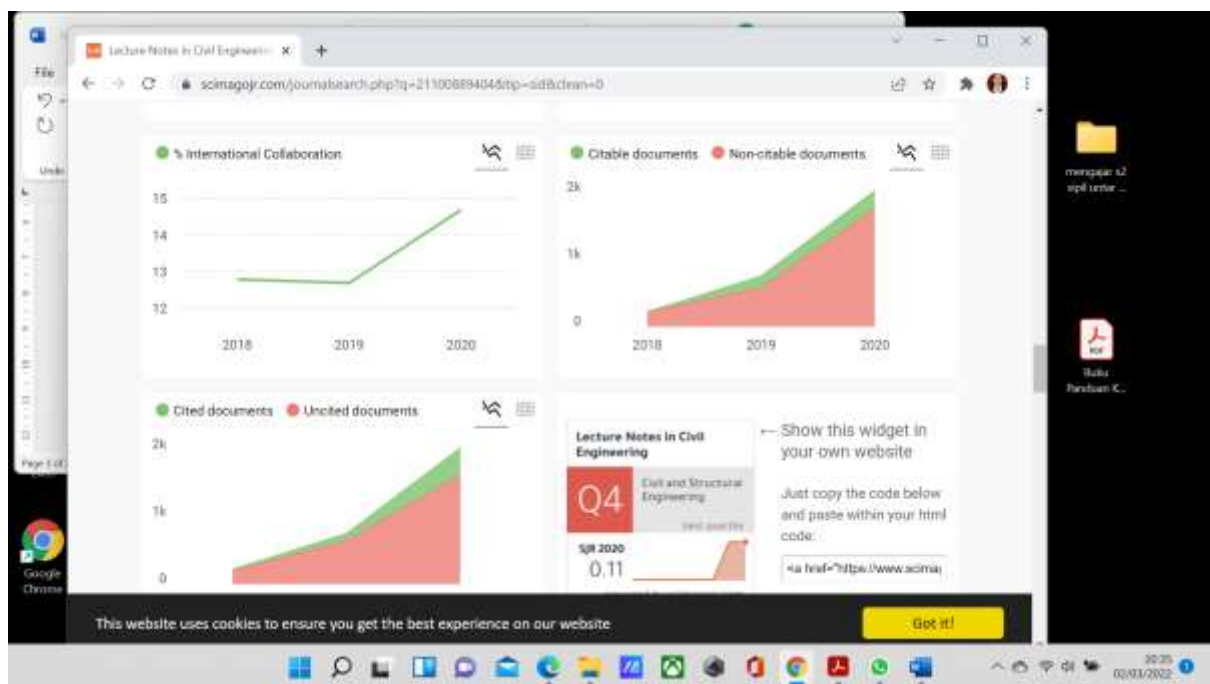
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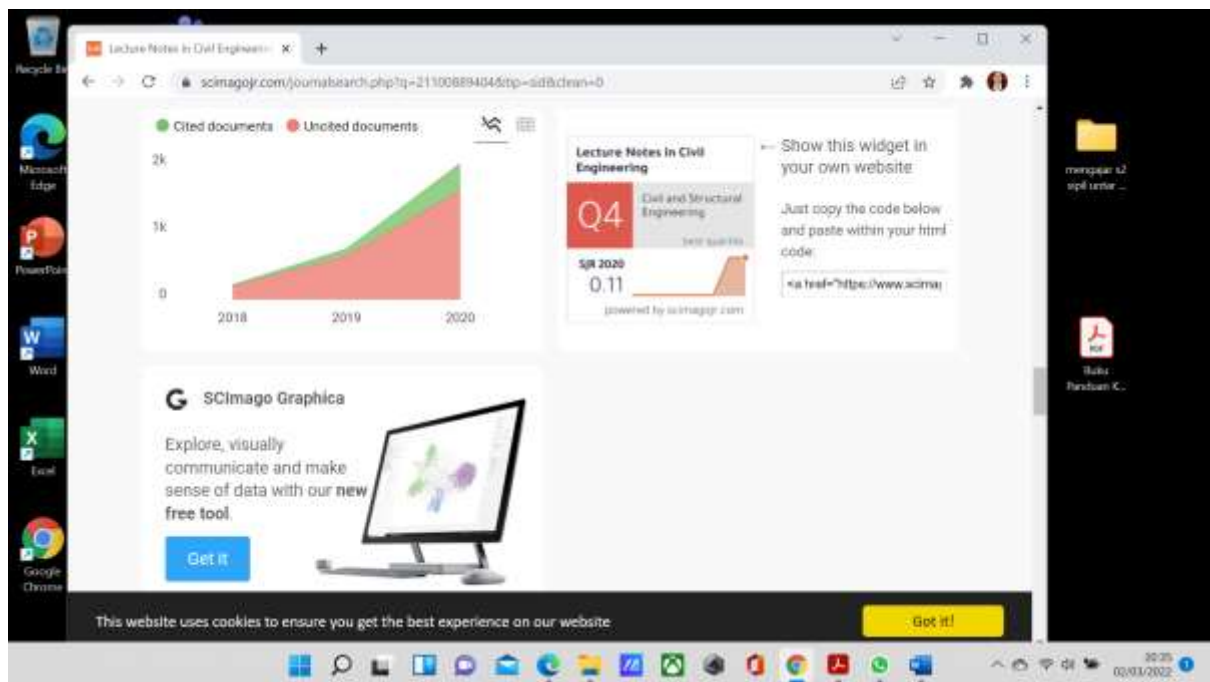
## References

1. Sulistio H. Waty M (2008) Analysis and evaluation change order in flexible pavement (case study: road projects in East Kalimantan). *Media Komunikasi Teknik Sipil* 16(1):31–47
2. Lim M (2013) *Analisa change order pada Proyek Perkerasan Jalan*. Thabi' Press, Bandung
3. Goudreau H (2021) The five key elements of every construction contract—forget them and you're in trouble!. [http://www.hgassociates.com/article\\_contracts.html](http://www.hgassociates.com/article_contracts.html). Accessed 29 Aug 2021
4. Al-Momani AH (2000) Construction delay: a quantitative analysis. *Int J Project Manage* 18(1):51–59
5. Taylor TR, Uddin M, Goodrum PM, McCoy A, Shan Y (2012) Change orders and lessons learned: knowledge from statistical analyses of engineering change orders on Kentucky highway projects. *J Constr Eng Manag* 138(12):1360–1369
6. Waty M, Sulistio H (2020) Perhitungan change order proyek jalan di banten. *Jurnal Muara Sains, Teknologi, Kedokteran dan Ilmu Kesehatan* 4(2):211–220
7. Hsieh TY, Lu ST, Wu CH (2004) Statistical analysis of causes for change orders in metropolitan public works. *Int J Project Manage* 22(8):679–686
8. Direktorat Jendral Bina Marga (2018) *Spesifikasi Umum 2018*. Direktorat Jendral Bina Marga, Departemen Pekerjaan Umum, Jakarta
9. Republik Indonesia R (2010) *Peraturan Presiden Republik Indonesia Nomor 54 Tahun 2010 Tentang Pengadaan Barang/Jasa Pemerintah*. Sekretariat Kabinet RI, Jakarta









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1 1.

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## Abstract

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## References

1. 1.  
Sulistio H, Waty M (2008) Analysis and evaluation change order in flexible pavement (case study: road projects in East Kalimantan). Media Komunikasi Teknik Sipil 16(1):31–47[Google Scholar](#)
2. 2.  
Lim M (2013) Analisa change order pada Proyek Perkerasan Jalan. Thabi' Press, Bandung[Google Scholar](#)
3. 3.  
Goudreau H (2021) The five key elements of every construction contract—forget them and you're in trouble!. [http://www.hgassociates.com/article\\_contracts.html](http://www.hgassociates.com/article_contracts.html). Accessed 29 Aug 2021
4. 4.  
Al-Momani AH (2000) Construction delay: a quantitative analysis. Int J Project Manage 18(1):51–59[CrossRefGoogle Scholar](#)
5. 5.  
Taylor TR, Uddin M, Goodrum PM, McCoy A, Shan Y (2012) Change orders and lessons learned: knowledge from statistical analyses of engineering change orders on Kentucky highway projects. J Constr Eng Manag 138(12):1360–1369[CrossRefGoogle Scholar](#)
6. 6.  
Waty M, Sulistio H (2020) Perhitungan change order proyek jalan di banten. Jurnal Muara Sains, Teknologi, Kedokteran dan Ilmu Kesehatan 4(2):211–220[CrossRefGoogle Scholar](#)
7. 7.  
Hsieh TY, Lu ST, Wu CH (2004) Statistical analysis of causes for change orders in metropolitan public works. Int J Project Manage 22(8):679–686[CrossRefGoogle Scholar](#)
8. 8.  
Direktorat Jendral Bina Marga (2018) Spesifikasi Umum 2018. Direktorat Jendral Bina Marga, Departemen Pekerjaan Umum, Jakarta[Google Scholar](#)
9. 9.

Republik Indonesia R (2010) Peraturan Presiden Republik Indonesia Nomor 54 Tahun 2010 Tentang Pengadaan Barang/Jasa Pemerintah. Sekretariat Kabinet RI, Jakarta [Google Scholar](#)

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