Comparison of change order risk identification road construction projects

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Abstract. Almost all existing projects always have change orders, both government projects and private projects. During the implementation of a construction project, changes can occur either from the contractor or from the owner. The object of research regarding change order risk identification was carried out in West Java Province and risk identification in the provinces of DKI Jakarta and Banten. Collecting data on real data on road construction projects from 2013-2018. Data analysis was carried out by looking at the similarities and differences between the two change order risk identification. The number of change order identification for DKI Jakarta and Banten Provinces was 732 construction changes, while for West Java change order risk identification there were 322 construction changes. The number of construction works that experienced risk identification in the Provinces of DKI Jakarta and Banten was 31 construction works, while there were 21 construction works in the province of West Java. Identification of the average risk of changing jobs in DKI Jakarta and Banten was 45.75 changes in work, while the province of West Java experienced a change of 32.2 changes in construction work. Comparison of DKI Jakarta's risk identification is 53% greater than West Java's risk identification.

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, changes can occur either from the contractor or from the owner [1].

Shrestha et al. [2] explain that there are five road maintenance works that are often carried out selected to identify causes and Change Order prevention measures; namely chip seals, striping, asphalt overlays, slope repairs, and debris removal.

Changes during construction are inevitable in most construction projects and change orders are a matter of correcting or modifying the initial design or scope of work [3]. Waty and Sulistio's research [4] was to find out the type of road construction that occurred in five change order contracts for road construction projects and the result was the biggest change in the type of drainage construction work.

The average percentage of work that experienced the largest change order for road construction projects that occurred in Banten was: U-shaped canal work type DS 1 (19.64%) and in Jakarta hot mix asphalt work (44.72%) in the research of Waty and Sulistio [5].

The average percentage of work that experiences the largest change order in road construction projects in West Java is a hot asphalt mixture 17.99% [6].

Identification of change order risks in West Java which shows the magnitude of the risk of change orders in road projects in West Java for asphalt Emulsion Absorb Layer and Precast Curb stone is 100 %, as well as the magnitude of change order risk identification in DKI Jakarta and Banten is 93.75% for work thermoplastic marking. Previous research has determined the risk identification of change orders for road construction projects in DKI Jakarta and Banten and the West Java province.

This study's purpose was to compare change order risk identification that occurred in DKI Jakarta, Banten with change order risk identification in West Java province.

2 Literature review

2.1 Risk identification

Risk identification is a process that systematically and continuously identifies, categorizes, and assesses the initial significance of the risks associated with a construction project [7].

The complexity stemming from the dynamic interaction between various global, country, and project-specific factors requires a systematic, comprehensive, and proactive risk management process for international construction projects. The

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risk management process is generally defined as an iterative process that starts with the identification of risk factors, followed by a qualitative and/or quantitative assessment of the impact of the risk on the project, and finally, the development of a risk mitigation strategy to maintain an optimal, risk control structure among project participants [8-10].

Several authors (e.g., Al-Bahar and Crandall [7], Wang et al. [9], and [11]) have emphasized the importance of the risk identification phase, as subsequent phases (assessment, analysis, etc.) based on identified risk factors.

2.2 Change order risk identification

Based on the research of Taylor et al. [12] states that the analysis and results of research in Kentucky which identified change orders had a trend based on work bidding items, namely contract negligence which was usually caused by work negligence, work items that changed, contract costs that were swell, in this case, there is an increase in contract funds, a request from the owner that causes a change in the entire work in the contract. The definition of a project construction contract here is the reduction of several work items from the initial contract resulting in a change in the contract which causes the project performance to decrease.

Research on the identification of change orders that pose a big risk to work in the upper right quadrant, namely asphalt foundations and guardrails that receive the greatest risk in Fig. 1 [12].

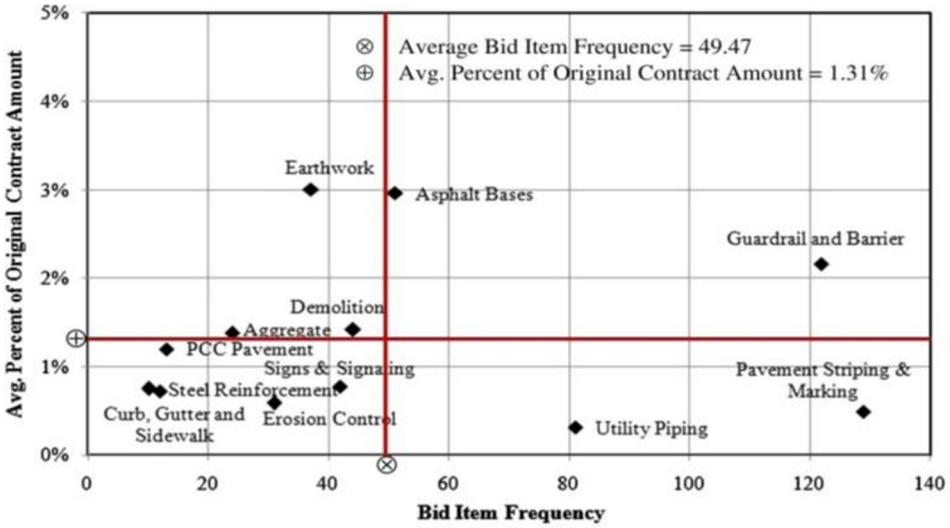

Fig. 1. Identification of risk change order [12].

3 Methodology

3.1 Data collection

Data collection by obtaining secondary data, namely real project data from the 2013 to 2018 fiscal year, namely 16 projects in Jakarta and Banten and 10 projects in West Java.

3.2 LORR (likelihood of risk realization)

LORR which stands for the term above states that the risk is likely to occur during the project cycle which is more commonly referred to as frequency because it involves the frequent occurrence of change order intensity. The frequency of risk

realization is marked with a value from zero to five [13]:

0 = Not applicable to the project (0% chance)
1 = Very low chance (<10% chance)
2 = Low chance (10%-35% chance)
3 = Moderate chance (35%-65% chance)
4 = High chance (65%-90% chance)
5 = Very high chance (> 90% chance)

With reference to the literature, if the frequency is above 35% it is an opportunity that must be considered, especially in terms of risk.

3.3 Data analysis

Data analysis was carried out in the following way:

1. Identification of change order risk in West Java Province.
2. Identification of change order risks for DKI Jakarta and Banten provinces.
3. Comparison of change order risk identification in West Java with DKI Jakarta and Banten.

4 Result and discussion

4.1 Risk identification for West Java Province

West Java risk identification resulted in 322 works changes and 21 construction works including:

- Asphalt Emulsion absorbs Layer

- Precast Kerb Type 2
- Stone masonry with mortar
- Low strength concrete f'c 15 MPa
- Stone Masonry
- Thermoplastic road markings
- Cement Concrete Pavement
- Hot Asphalt Mix for minor work
- Asphalt excavation with Cold Milling Machine
- Selected of Landfill

4.2 Risk identification change order for DKI Jakarta and Banten

Identification of change order risk for DKI Jakarta and Banten provinces resulted in 732 work changes, which can be seen in Table 1.

Risk identification is obtained from the frequency of changes above 35% which is a medium frequency that tends to increase the occurrence of change orders. The results of risk identification were obtained for 31 construction work items, with the highest percentage being for Thermoplastic Road Marking work, followed by 30 other construction work items.

Table 1 Total road construction project change.

Num	The project name	Number of Changes
1	Road Project 1	56
2	Road Project 2	60
3	Road Project 3	40
4	Road Project 4	10
5	Road Project 5	39
6	Road Project 6	31
7	Road Project 7	30
8	Road Project 8	34
9	Road Project 9	62
10	Road Project 10	127
11	Road Project 11	45
12	Road Project 12	88
13	Road Project 13	16
14	Road Project 14	22
15	Road Project 15	38
16	Road Project 16	34
Total changes		732

4.3 Total change of work in DKI Jakarta and Banten

There are 127 change orders in project No. 10 (Table 1) have been identified as the highest order of change in 16 road construction projects in DKI and Banten provinces based on total work changes.

Road project number 10 obtained 60 additional works and 61 less jobs and 3 additions of new work items and 3 omissions of work items as shown in Table 1, namely, among others:

1. Excavation for drainage and channels
2. Masonry masonry with mortar
3. Reinforced concrete pipe culvert with an inside diameter of 20 cm
4. U-shaped channel Type DS 1
5. U-shaped channel type DS 1 (30x30cm/HD & Channel Cap)
6. U-shaped channel type DS 3 A
7. Concrete K 250 (f'c 20) for minor concrete drainage
8. Concrete K 250 (f'c 20) for minor concrete drainage structures (ist)
9. Reinforcing steel for minor concrete drainage structures
10. Reinforcing steel for minor concrete drainage structures (ist)
11. Drainage
12. Ordinary Excavation (Ist)
13. Common Dig
14. Asphalt Pavement Excavation with Cold Milling Machine
15. Asphalt pavement excavation without Cold Milling Machine
16. Grained Pavement Excavation
17. Grained Pavement Excavated (ist)
18. Concrete Pavement Excavation
19. Ordinary Stockpiles from Excavated Sources
20. Ordinary Stockpiles from Excavated Sources (ist)
21. Grain Selected Excavation (Measured over the bed of the truck)
22. Road Agency Preparation
23. Class A Aggregate Underlay
24. Class B Aggregate Base
25. Lean Concrete Underlay
26. Class A Cement Treated Base (CTB)

Changes in work can occur in additional work, less work, removal of work, and the addition of new items. A work change can occur in several places, for example, at a certain point there is additional work, on the other hand, items are omitted or new items can also be added. So there are many works changes.

4.4 Total changes in road construction in West Java Province

Changes in road construction projects resulted in a total of 322 construction work changes in 10 road projects in West Java province (Table 2). The project that experienced the biggest change was road project number 4 with a total of 68 changes in road construction work.

In road project 4, there were 20 additional works and 32 less works and 14 additions of new work items, and 2 omissions of work items as shown in Table 2, namely, among others:

1. Excavation for Drainage Ditches and Drains
2. Masonry with Mortar
3. U-shaped channel type DS 2
4. U-shaped channel type DS 3
5. Concrete K 250 for minor structural design
6. Steel reinforcement for drainage structure
7. Layer cement concrete foundation

Table 2. Total changes in road construction projects.

Num.	The project name	Number of Changes
1	Road Project 1	36
2	Road Project 2	20
3	Road Project 3	38
4	Road Project 4	68
5	Road Project 5	37
6	Road Project 6	49
7	Road Project 7	18
8	Road Project 8	20
9	Road Project 9	19
10	Road Project 10	17
Total changes		322

8. Lean concrete foundation layer
9. Normal Excavation
10. Structural excavation
11. Porous material for filtering material
12. Box Culvert
13. Provision of a niche foundation
14. Asphalt pavement layer without cold machine
15. Concrete pavement excavation
16. Selected pile of land
17. Class A Aggregate Base Layer
18. Class S Aggregate Base
19. Cement Concrete Pavement for Opening Traffic Concrete Age More than 1 day and less than 3 days
20. Layer cement concrete foundation
21. Lean concrete foundation layer
22. Adhesive Coating – Emulsion Asphalt
23. Modified Wear Coated Laston (AC-WC Mod) fine/coarse gradation
24. High-strength concrete (f'c) 45 MPa
25. Medium-quality concrete (f'c 30 MPa) for bridge floors
26. Low-quality concrete f'c 20 MPa
27. Low-quality concrete f'c 15 MPa
28. Low-quality concrete f'c 10 MPa
29. Expansion joints movable
30. Expansion joints fixed
31. Laying elastometry

Work changes can occur in additional work, less work, job removal, and the addition of new items. A work change can occur in several places, for example, at a certain point there is additional work, on the other hand, items are omitted or new items can also be added. So there are many job changes.

4.5 Identification of change order risk road construction project

Road Construction Project Risk Identification consists of change order risk identification for DKI Jakarta and Banten Provinces and risk identification for West Java Province

4.5.1 DKI Jakarta Province and Banten Province

Identification of change order risks resulted in 31 construction works identified as risks for change orders for road construction projects in the provinces of DKI Jakarta and Banten Province that can you see on Table 3.

Table 3. Risk identification of road construction work change orders.

Num	Type of work	Percentage
1	Excavations of drainage and waterways	50%
2	Masonry with mortar	50%
3	Cement Concrete Pavement for traffic opening, Concrete age is more than 1 day and less than 3 days	56%
4	Normal Excavation	50 %
5	Class A. Aggregate Foundation Layer	68 %
6	Class S. Aggregate Foundation Layer	56%
7	Road body preparation	56%
8	Thermoplastic Road Marking	93,75%
9	Concrete Block Pavement on Sidewalks and Medians	50%
10	Anti Peeling Ingredients	62,5%
11	Liquid Asphalt Adhesive Coating	62,5%
12	Stone couple	62.5%
13	Lean Concrete Base Layer	56%
14	Laston Lapis Aus (AC-WC)	68%
15	Medium Quality Concrete f'c> 20 MPa	75%
16	Low-Quality Concrete f'c 10 Mpa	68%
17	Asphalt Pavement Excavation Without Cold Milling Machine	75%
18	Plain U 24 Reinforcement Steel	68%
19	Ordinary landfill	56%
20	Selected pile of land	50 %
21	Grain Pavement Excavation	50 %
22	Precast Kerb Type 2	56%
23	Type 6. Precast Kerb	56%
24	Precast Kerb Type 7a	56%
25	Precast Kerb Type 7b	56%
26	Precast Kerb Type 7c	56%
27	Foreman	37,5 %
28	Worker	37,5%
29	Carpenter, mason	37.5 %
30	Hot Asphalt Mix	37,5%
31	Liquid Asphalt Adhesive Coating	37,5%

The types of construction work that experienced the largest change order identification based on their percentage were (defined as the 10 largest):

1. Thermoplastic Road Markings
2. Medium Quality Concrete f'c 20 MPa

3. Asphalt Pavement Excavations Without Cold Milling Machine
4. Reinforcing steel plain U 24
5. Laston Coated Wear (AC-WC)
6. Low-quality concrete f'c 10 MPa
7. Anti-flaking ingredient
8. Liquid Asphalt Coating
9. Stone Couple
10. Class A Aggregate Underlay

4.5.2 West Java Province road construction project

Identification of risk change orders get 21 works that are identified as risks for change order road construction projects (Table 4).

Table 4. Identification of change order risk.

Num	Type of work	Frequency (%)
1	Asphalt Emulsion absorbs Layer	100
2	Precast Kerb Type 2	100
3	Masonry with mortar	90
4	Low-strength concrete f'c 15 MPa	90
5	Stone couple	90
6	Thermoplastic Road Marking	80
7	Cement concrete pavement	80
8	Hot Mix Asphalt for minor works	80
9	Asphalt excavation with Cold Milling Machine	80
10	Selected pile of land	80
11	B Grade Top Foundation	70
12	Laston Lapis Aus	70
13	Excavation for sewers and waterways	70
14	Hectometer Peg	70
15	S Grade Top Foundation	60
16	Laston Layer Between (AC-BC)	60
17	Low-strength concrete f'c 10 MPa	60
18	Class A . Top Foundation	50
19	Steering Peg	40
20	Concrete Demolition	40
21	Kerb and median painting	40

Types of construction work that get the biggest risk identification in West Java province, the 10 biggest are:

1. Emulsion Asphalt Absorb Coating
2. Precast Kerb type 2
3. Masonry masonry with mortar
4. Low-quality concrete f'c 15 MPa
5. Stonemasonry
6. Asphalt mixture for minor work
7. Paved excavation with Cold Milling Machine
8. Selected landfill
9. Cement concrete pavement
10. Thermoplastic Road Markings

The comparison of the two results in the similarity of the 10 types of construction work that have experienced the greatest identification in construction work as follows:

1. Thermoplastic Road Markings
2. Stonemasonry

The comparison of the two that produces differences in the 10 biggest construction work risk identification is:

1. Medium Quality Concrete f'c 20 MPa
2. Asphalt Pavement Excavations Without Cold Milling Machine
3. Reinforcing steel plain U 24
4. Laston Coated Wear (AC-WC)
5. Low-quality concrete f'c 10 MPa
6. Anti-flaking ingredient
7. Liquid Asphalt Coating
8. Class A Aggregate Base
9. Emulsion Asphalt Absorb Layer
10. Precast Kerb type 2
11. Masonry masonry with mortar
12. Low-quality concrete f'c 15 MPa
13. Asphalt Mixture for minor work
14. Paved excavation with Cold Milling Machine
15. Hoard of Choices
16. Cement concrete pavement

4.6 Comparison of change order risk identification in DKI Jakarta and Banten Provinces with the identification of the risk of change orders in West Java

4.6.1 Comparison of the change order risk identification for DKI Jakarta and Banten Provinces

Comparison of the change order risk identification for DKI Jakarta and Banten Provinces with the most important change order risk identification for West Java can be seen in Table 4.

Types of construction work that get the biggest risk identification in West Java province, the 10 biggest are:

1. Emulsion Asphalt Absorb Coating
2. Precast Kerb type 2
3. Masonry masonry with mortar
4. Low-quality concrete f'c 15 MPa
5. Stonemasonry
6. Asphalt mixture for minor work
7. Paved excavation with Cold Milling Machine
8. Selected of landfill
9. Cement concrete pavement
10. Thermoplastic Road Markings

The comparison of the two results in the similarity of the 10 types of construction work that have experienced the greatest identification in construction work as follows:

1. Thermoplastic Road Markings
2. Stonemasonry

The comparison of the two that produces differences in the 10 biggest construction work risk identification is:

1. Medium Quality Concrete f'c 20 MPa
2. Asphalt Pavement Excavations Without Cold Milling Machine
3. Reinforcing steel plain U 24
4. Laston Coated Wear (AC-WC)
5. Low-quality concrete f'c 10 MPa
6. Anti-flaking ingredient
7. Liquid Asphalt Coating
8. Class A Aggregate Base
9. Emulsion Asphalt Absorb Layer
10. Precast Kerb type 2
11. Masonry masonry with mortar
12. Low-quality concrete f'c 15 MPa
13. Asphalt Mixture for minor work
14. Paved excavation with Cold Milling Machine
15. Selected of landfill
16. Cement concrete pavement

4.7 Comparison *of change order risk* identification *in DKI Jakarta and Banten Provinces*

Comparison of change order risk identification in DKI Jakarta and Banten Provinces with the identification of the risk of change orders in West Java.

4.7.1 Comparison of the change order risk identification for DKI Jakarta and Banten Provinces

Comparison of the change order risk identification for DKI Jakarta and Banten Provinces with the most important change order risk identification for West Java can be seen in Table 5.

a) The number of change order identification for DKI Jakarta and Banten Provinces was 732 construction changes, while for West Java change order risk identification there were 322 construction changes.
b) The number of construction works that experienced risk identification in DKI Jakarta and Banten Provinces was 31 construction works in 16 projects, while in West Java province there were 21 construction works in 10 construction projects
c) The top five were taken for the construction work that received the greatest risk identification in the provinces of DKI Jakarta and Banten, namely: Thermoplastic Road Markings, Medium Quality Concrete f'c > 20 MPa, Asphalt Pavement Excavated Without Cold Milling Machine, Plain U 24 Reinforcing Steel and Wear Coated Laston (AC-WC), while the construction work that experienced change order risk identification in West Java province was also taken the five largest were Emulsion Asphalt Absorb Layer, Type 2 Precast Curb, Stone masonry with mortar, Low-quality concrete f'c 15 MPa and Stone masonry.

Table 5. Comparison of risk identification in Jakarta, Banten, and West Java.

Num	Describe	DKI Jakarta and Banten	Jawa Barat
1	Number of changes	722	322
2	Amount of construction work	31	21
3	Biggest change	Thermoplastic road markings (93,75)	Asphalt Emulsion Absorb Coating (100%) Precast Curb (100%)
4	Second biggest change	Pavement Excavation (75%)	1. Masonry masonry with mortar (90%) 2. Low-quality concrete f'c 15 Mpa (90%) 3. Stone masonry (90%)
5	The third biggest change	1. Asphalt pavement excavation without Cold Milling Machine (75%) 2. Medium-quality concrete (75%)	3. Thermoplastic road marking (80%) 4. Cement concrete pavement (80%) 5. Hot mix bitumen(80%) 6. Asphalt excavation with Cold Milling Machine (80%)
4	Smallest change	1. Foreman (37.5%) 2. Workers (37.5%) 3. Carpenters, bricklayers (37.5%) 4. Hot mix bitumen (37.5%) 5. Liquid asphalt adhesive impregnation layer (37.5%)	1. Referrer benchmark (40%) 2. Demolition of concrete (40%) 3. Kerb and median painting (40%)
5	The same type of construction	1. Thermoplastic road markings 2. Stone pair	1. Thermoplastic road markings 2. Stone pair
6	Number of projects	16	10
7	Average job/project change	45.75 change of work	32.2 work change

4.7.2 Comparison to the identification of non-essential risks

Identification of change order risk for the provinces of DKI Jakarta and Banten resulted in foreman,

work, carpenter, bricklayer, hot mix asphalt, and liquid asphalt adhesive impregnation layer with each risk value of 37.5%.

Identification of change orders in West Java province resulted in the work of guideposts, demolition of concrete, and painting of curbs and medians with the smallest risk value of 40% each.

4.8 Comparisons based on the biggest change in risk identification for each province

Comparisons based on the biggest change in risk identification for each province are:

1. Change order risk identification for DKI Jakarta and Banten.
   Identification of the biggest work change risks in road construction projects in the provinces of DKI Jakarta and Banten are: 127 changes in construction work while in road construction projects in the province of West Java there are 68 changes in construction work.
   Identification of change order risks for the in very large changes, namely 127 work changes with very many and very diverse work changes where almost all construction work experienced changes either adding work, reducing work, adding new items or removing work items , and if sorted from the highest to the lowest order are major road rehabilitation, minor road rehabilitation, road maintenance, and bridge maintenance.
2. Identification of West Java change order risk.
   While the road projects that experienced the greatest risk identification were in West Java, not all of the work underwent changes so there were not many changes compared to risk identification in the provinces of DKI Jakarta and Banten because the biggest changes were only 68 construction changes and also road projects were road construction projects and not road maintenance project.

4.9 Cost changes

The order of change in risk identification for DKI Jakarta and Banten resulted in a very large cost change with a percentage of 25.5%, while the risk identification change order for West Java resulted in a change in costs with a percentage of 8%.

5 Analysis

The first, second, and third largest percentages can be seen that the change order risk identification in West Java exceeds the risk identification percentage in Jakarta and Banten.

The average work change in DKI Jakarta and Banten was 45 work changes, while West Java province experienced 32 work changes.

The top five were taken for the construction work that received the greatest risk identification in the provinces of DKI Jakarta and Banten, namely: Thermoplastic Road Markings, Medium Quality Concrete f'c > 20 MPa, Asphalt Pavement Excavated Without Cold Milling Machine, Plain U 24 Reinforcing Steel and Wear Coated Laston (AC-WC) , while the construction work that experienced change order risk identification in West Java province was also taken the five largest were Emulsion Asphalt Absorb Layer, Type 2 Precast Curb, Stone masonry with mortar, Low-quality concrete f'c 15 MPa and Stonemasonry

Equation of works that experience change order risk identification in two areas, namely work:

1. Thermoplastic Road Markings
2. Stonemasonry

The largest number of changes in project risk identification in DKI Jakarta and Banten was very large (127 work changes) compared to West Java risk identification which only experienced a change of 68 work changes with a ratio of 53% greater than West Java risk identification.

5.1 Comparison of construction work

Identification of the DKI Jakarta change order risk resulted in major changes that varied from less work, additional work, addition of new items and removal of work items, while the identification of West Java change orders resulted in major changes but did not vary only in certain works.

5.2 Comparison to cost:

Risk identification for DKI Jakarta and Banten resulted in a very large cost change with a percentage of 25.5% for 16 projects so that it can be said that the change order risk identification for DKI Jakarta resulted in an average road construction project resulting in an additional contract budget change of 1.6%. , while the identification of the West Java change order risk resulted in a change in costs by a percentage of 8% in 10 projects resulting in an additional contract budget of 0.8% per project.

6 Conclusion

The conclusion based on the results of the discussion and analysis above is that a comparison of change order risk identification in DKI Jakarta and Banten Provinces with West Java change order risk identification is:

a) The total identification of change risks in the DKI Jakarta and Banten Province change orders was 732 construction changes while in the West Java change order risk identification there were 322 construction changes
b) The number of construction works that experienced risk identification in DKI Jakarta and Banten Provinces was 31 construction works in 16 projects, while in West Java

province there were 21 construction works in 10 projects.

c) The similarity of the work that experienced a large risk identification in the two project areas was the work of thermoplastic road markings and stone masonry.

d) The final results show that the first, second, and third largest percentages can be seen that the change order risk identification in West Java exceeds the risk identification percentage in Jakarta and Banten, even though the number of job changes in DKI and Banten is very large, almost 53% exceeds the risk identification in West Java.

e) The average job change in DKI Jakarta and Banten was 45 work changes, while West Java province experienced only 32 work changes.

f) Identification of the DKI Jakarta change order risk resulted in an average road construction project resulting in a change in the addition of a contract budget of 1.6%, while the identification of the West Java change order risk resulted in a cost change of 8% for 10 projects resulting in an additional contract budget of 0.8% per project.

7 Suggestion

Based on the above conclusions, it is recommended: Pay more attention to the work of Thermoplastic Road Markings and masonry in order to reduce risk identification in road construction projects.

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