International Research Journal of Advanced Engineering and Science
ISSN (Online): 2455-9024

Cost Escalation Analysis on the Western Indonesia National Road Improvement Project (WINRIP)

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Abstract—*Escalation or price adjustment is a crucial approach in multi-year construction projects. This is motivated by economic fluctuations that actively trigger price changes for each component of work. Legally, escalation is regulated by the government of the Republic of Indonesia through Presidential Regulation Number 16 year 2018 Article 37. This study aims to examine the escalation index and identify resources that affect cost escalation in the Western Indonesia National Road Improvement Project (WINRIP) package 16 national road construction project, Sumatra Corridor. The price escalation index analysis is carried out using a calculation method based on cost component factors and economic indicator indexes. Secondary data was obtained from monthly statistical bulletins issued by the Central Statistics Agency (BPS). This study shows an increase in the contract value for the construction of the 16 WINRIP Sumatra national road package by 1.364% (equivalent to IDR 2,883.900.000,-) from the initial contract value of IDR 211.374.500.000,- to IDR 214.258.400.000,-. Some of the works that underwent price adjustments were drainage works, earthworks, shoulder pavement works, granulated pavement works, asphalt pavement works, and structural works. The price escalation index analysis also shows that the largest change index is in industrial materials (m2), namely the asphalt pavement division of IDR 1,160,602,211.64, or equivalent to 0.604% of the contract value, and 44.267% of the total value of price escalation.*

Keywords— *Index analysis, price escalation, multi-year, construction projects.*

I. INTRODUCTION

The trend of rising prices for goods and services affects the high and low costs of a project, especially in multi-year contract projects. The contract value in the multi-year project is the contract value based on the price of the year of supply. However, in practice, project costs often do not use the initial price in the year of supply because the price during the implementation period is already different. This situation has an impact on project costs which will increase and harm the contractor if no price adjustments are made. Some literature suggests some guidelines in calculating cost escalation, but for current government projects, escalation calculations have been regulated based on Presidential Regulation No. 16 of 2018 article 37 [1]. In this study, escalation calculations were carried out on multi-year projects with an implementation period of more than 18 months based on government regulations. One of the government projects with multi-year contracts is the construction of the national road package 16 WINRIP Corridor Sumatra carried out by the national private contractor KSO Yasa-Multi. Based on the contract documents, the project implementation time is 24 months.

A multi-year construction project has many risks in the implementation process, one of which is price adjustments or escalation. Escalation is price adjustment (Price Adjustment) of contract component units which include labor, construction materials, energy, and equipment to the contract value at the time of bidding. Price escalation in multi-year projects is caused by fluctuations in the country's economy due to global influences that cause price changes for each component of work when the construction project is in progress. The cost to complete the construction is formed from the volume of work based on the drawings and job specifications as well as the unit price of the work obtained from the unit price analysis. In its application, the price of the work unit must be adjusted to the specified specifications, both in the drawings and requirements, and take into account the technical conditions of the field at the project site to obtain accurate estimation results. The project implementation period also influences construction project costs, especially in multi-year projects. This is due to the uncertainty factor in the fluctuations in the country's economy which in the worst case can cause cost losses in the implementation of construction if the estimation does not consider price adjustments.

Project costs are influenced by many factors, and each factor is interconnected with other factors. Project costs will also change over time. Over time, the factors change, so the costs also change. Kareth et al. [2] explained that the project cost would increase if the project implementation time was slowed or extended, so a price adjustment had to be calculated. Escalation has been widely discussed in various previous studies. Kumalasari & Hapsari [3] researched escalation calculations using leading economic indicators as an alternative to escalation calculations. Touran & Lopez [4] describes a computer model designed to incorporate the effects of rising costs on large construction projects. Fathoni & Hanif [5] studied the cost escalation in multi-year infrastructure projects, namely the Jatigede Reservoir construction project and the Jatibarang Reservoir construction project with the calculation procedure according to Presidential Decree No. 70 of 2012 article 92 paragraph 3. Vamsidhar et al. [6] discuss the rapidly increasing prices of building materials, labor, and construction equipment. The analysis was conducted to determine the percentage increase in construction costs. Finally, Broto [7] conducted a multi-year project cost escalation modeling with a dynamic system approach. This system describes the relationship between factors/variables that can cause cost escalation. These factors are also correlated and have a relationship with each other. In construction projects with long execution times, for

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ISSN (Online): 2455-9024

example in multi-year projects, the condition of each factor always changes over time."

The method applied in various previous studies has weaknesses and strengths, which so far the calculation method using Presidential Regulation Number 16 of 2018 Article 37 is still not widely used. This regulation enhances the previous rule on price escalation. Therefore, this research was conducted using a basic index of bid documents with an index of economic indicators obtained from the monthly statistical bulletin from the Central Statistics Agency (BPS), starting from the 13th month until the completion of the work according to the contract. The construction project that is used as the object of this research is the WINRIP (Western Indonesia National Road Improvement Project) package of the Sumatran Corridor 16 national road construction project (Figure 1). The construction project is carried out by KSO Yasa-Multi, a national private company engaged in construction services. The projects handled generally are bridgework projects, national roads, docks, oil and gas, power plants, and the like, both within Indonesia and internationally.

Fig. 1. Location of Construction Project Package 16 WINRIP, Bengkulu Province, Sumatera

Construction project costs are strongly influenced by the implementation period of the project itself, especially multi-year projects. This is due to the uncertainty in the country's economic fluctuations which can result in the risk of cost losses in the implementation of construction, especially if the bidding costs are not taken into account. In multi-year projects, this variable needs special attention. Multi-year projects with a duration of more than one year will potentially have risks, not only related to economic fluctuations that have an impact on cost escalation, but also from other factors such as bad weather, changes in the scope of work, work delays, labor strikes, and other problems. -technical problems (changes to drawings, specifications, and contracts). These conditions greatly affect the implementation period and project costs if they are not anticipated by cost escalation. Therefore, a price adjustment is needed to be able to calculate the number of escalation costs based on the index in the area where the work takes place. The bid price submitted by the contractor in the tender/auction process consists of construction costs, overhead, and profit. The accuracy of the construction cost estimation increases according to the stages of the project, from planning, and design, to the final estimate at the time of project completion. The accuracy of bid estimates in multi-year projects is very important because it will affect project implementation and become one of the parameters of the contractor's success in implementing the project.

Various factors affect the accuracy of multi-year project cost estimates, one of which is knowledge of the risks to uncertainty about economic inflation that may occur, namely in the form of rising prices for labor, construction materials, and construction equipment. This causes difficulties and even losses for contractors if they are not taken into account during the cost estimation process. Based on this, it is clear that the cost of a multi-year project has a very high complexity, coupled with a lot of work items and resources that must be managed. The contractor must be able to identify and understand the what, who, why, when, where, and how elements of each work item. After that, the contractor must carry out the construction project based on the work method for each work item, as well as develop project resources, carry out quality assurance according to the stages of implementation, and control it so that

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it meets the target time and requirements specified and in accordance with cost, quality, and time. targeted.

This study discusses the factors that affect the increase in the contract value of multi-year construction projects, the percentage difference in the calculation results of the price adjustment of the contract value before and after project escalation, as well as in what type of work the escalation causes the largest cost difference. The results of this study can be considered as input for construction business players in all fields (PSDA, Bina Marga, Cipta Karya) in anticipating risks in construction projects, namely related to calculating resource analysis, preparing a Field Cost Budget (ABL), and avoiding losses. due to inflation. For the Government, this research can be considered an important input in the procurement of goods and services and controlling a project within the scope of cost management.

II. METHOD

This research is a quantitative descriptive study using secondary data [8]. The object of research in this study is a national road and bridge construction project with a multi-year contract in the national road implementation work unit package 16 WINRIP (Western Indonesia National Road Improvement Project) Bengkulu Province Corridor Sumatra. The unit price escalation index analysis was carried out based on Presidential Regulation No. 16 of 2018 Article 37, which is the 13th month (October 2017) to the 26th month (December 2018) at 100% implementation progress. The project under study is a project that has been completed and has been handed over. Changes in the increase in the project contract value are assessed by analyzing the unit price escalation index based on the cost component and index factors. Secondary data (economic indicators) are obtained from monthly statistical bulletins released by the National Central Statistics Agency (BPS) from the 13th month (October 2017) to the 24th month (December 2018). The data analysis method was applied based on the Presidential Regulation of the Republic of Indonesia No. 16 of 2018 Article 37 and project contract documents on SSUK 40 and Project Manual Management (PMM) April Revision 2 of 2017 pages 7-51. For the National Competitive Bidding (NCB) and International Competitive Bidding (ICB) packages, the calculation of price adjustments begins in the 13th month after the date of commencement of work with the basic index being the index in the 12th month. The calculation of price adjustments is carried out by the following formula:

$$Hn = Ho\left(a + b\frac{Bn}{Bo} + c\frac{Cn}{Co} + d\frac{Dn}{Do}\right) \quad \textit{(Eq. 1)}$$

Where:

- Hn = unit price of goods/services (items of work) at the time the work is carried out
- Ho = unit price of goods/services (items of work) at the time of bidding price
- a = Fixed coefficient consisting of profit and overhead (components of profit and overhead than a = 0.15)
- b, c, d = Coefficient of contract components such as labor, materials, work tools, etc. Addition a+b+c+d+…. = 1.00
- Bn, Cn, Dn = component price index at the time the work is carried out
- Bo, Co, Do = component price index in the 12th month after signing the contract.

The price index of the data component of the monthly statistical bulletin on the economic indicators of the Central Statistics Agency (BPS) which consists of the consumer price index (CPI) in 82 regencies and cities throughout Indonesia and the wholesale trade price index (IHPB). The specific explanation is as follows:

- L = Labor. Data obtained from economic indicators table 1.4, page 14 BPS (Bengkulu City Consumer Price Index)
- M1 = Natural Material. Data obtained from economic indicators table 1.9, page 52 BPS (Mining and Quarrying)
- M2 = Industrial Materials. The data is obtained from the economic indicators table 1.15, page 67 of BPS, namely the wholesale price index of building/construction materials (Asphalt/Asphalt)
- M3 = Other materials. The data is obtained from economic indicators table 1.14, page 66 BPS, namely the wholesale price index of building/construction materials (Public Works for Roads, Bridges, and Ports)
- E = Equipment. The data is obtained from the economic indicators table 1.15, page 67 BPS, namely the wholesale price index of building/construction materials (heavy equipment and equipment)
- F = Fuel. The data is obtained from the economic indicators table 1.10, page 54 BPS, namely the price index for wholesale trade in building/construction materials (Petroleum Refining Industry).

The price index used is sourced from BPS Indonesia [9]. If the price index data is not found in the regional statistical report (project location), the price index will refer to the statistical data of the nearest district/city. In addition, price indexes that are not included in the BPS report will be replaced with price index data from the relevant agencies. Adjustment of the unit price of goods/services on the work item will cause a change in the contract value. For this reason, the government has regulated the method of calculating price escalation for multi-year construction projects, namely through Presidential Regulation of the Republic of Indonesia Number 16 of 2018 Article 37. The calculation formula is explained as follows:

$$Pn = (Hn1 \times V1) + (Hn2 \times V2) + \ldots\ldots \text{ dst} \quad \textit{(Eq. 2)}$$

Where:

- Pn = Contract value after adjustment of unit/service price
- Hn = new unit price for each type of work component after the price adjustment
- V = Volume of each type of work component carried out.

From equations 1 and 2, then the magnitude of the change in contract value due to an adjustment in the price of goods/services can be calculated. The formula for calculating changes in contract value is explained as follows:

$$Pe = Pn - Po \quad \textit{(Eq. 3)}$$

Where:

- Pe = Price adjustment value

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- Po = Initial contract value at the time of bidding = (Ho1 x V1) + (Ho2 x V2) + …etcetera
- Pn = Contract value after price adjustment = (Hn1 x V1) + (Hn2 x V2) + …etcetera
- Ho = Contract unit price
- Hn = New unit price after price adjustment
- Vi = Volume of work carried out.

The proposal for calculating price adjustments can be submitted every 6 months or once a year, and/or at the end of project implementation. This is related to the availability of economic indicator index data from the Central Statistics Agency. However, this study uses primary and secondary data on the implementation of 100% work progress, where the project has been completed and the report has been handed over.

III. Result and Discussion

In a construction project, costs are part of a limited resource, so it requires proper management of work methods so that expenses do not exceed the limit. Project costs are the costs required for each work item in completing a construction project. Project costs are grouped into two major groups, namely direct costs, and indirect costs. Direct costs are costs (resources) that are directly related and incurred only to complete activities/works [10]. The components of direct costs are wages/labor costs [11], construction material [10] [12], equipments [13], and sub-contractor costs. In addition, indirect costs are costs related to the staff and employee salaries, employee mobilization and demobilization costs, staff and employee leave costs, utility costs, transportation costs, incentive costs, socialization costs, and general costs outside construction costs [11], [12].

The cost component factor is an index that is compiled when the contract offer is submitted. This component becomes a variable in the calculation of the price escalation index analysis. The cost component factors cover all types of work, but in the analysis, the unit price escalation index is a job that does not experience an unequal unit price and is not a job with a lump unit price. The cost component factors include complex data and can be demonstrated by prior request to the researcher if needed. Furthermore, the unit price of work is data obtained directly from the construction project site, where the unit price of this work is not included in the lame unit price nor is it included in the lump sum work unit price. Table 1 describes the recapitulation of the unit price of work before and after the escalation (price adjustment).

TABLE I. Recapitulation of work unit prices before and after escalation

No	Unit of Construction Work	Total Value of Each Construction Work Unit		
		Price before escalation	Price after escalation	Escalation Value
		IDR	IDR	IDR
1	Stone mix with mortar	7,239,844,482.36	7,309,020,404.97	69,175,922.62
2	U-Shaped drainage channel type DS3	3,488,707,127.34	3,547,470,754.81	58,763,627.47
3	Entrenchment	3,289,955,712.77	3,354,526,576.89	64,570,864.12
4	Class S aggregate foundation layer	3,819,187,454.71	3,973,098,907.02	153,911,452.32
5	Class A aggregate foundation layer	6,967,781,770.52	7,076,130,777.06	108,349,006.53
6	Class B aggregate foundation layer	6,393,839,399.39	6,493,263,602.05	99,424,202.66
7	Laston mixture (AC-WC) aus	5,268,255,213.50	5,525,759,067.60	257,503,854.10
8	Laston mixture (AC-BC) gap	10,407,678,536.58	10,562,808,145.18	155,129,608.60
9	Laston mixture (AC-Base) base	14,135,097,017.31	14,346,144,071.79	211,047,054.48
10	Hard asphalt penetration 60/70	51,172,975,785.43	52,333,577,997.07	1,160,602,211.64
11	Concrete, fc' 20 Mpa (K-250)	5,501,155,460.47	5,784,484,077.51	283,328,617.04
A	Total	117,684,477,960.37	120,306,284,381.96	2,621,806,421.59
B	(PPN) 10 % x A	11,768,447,796.04	12,030,628,438.20	262,180,642.16
C	Total (A + B)	129,452,925,756.41	132,336,912,820.15	2,883,987,063.75
D	Total (Rounded up)	129,452,900,000.00	132,336,900,000.00	2,883,900,000.00

In this analysis and discussion, raw data from the volume of work is not shown in the article but can be requested through a request to the researcher in advance. The data that has been collected is used as a calculation material in the analysis of the work unit price escalation index. The type of work that is used as a sample for the analysis calculation is the laston AC-WC rough gradation, which is in the period April 2018 to August 2018. The laston AC-WC rough gradation work gets a price escalation in accordance with the provisions of the unit price escalation index analysis on the payment certificate, that the escalation calculation is carried out starting from the 13th month until the work progress is 100%. The unit price for the work of Laston Lapis Aus AC-WC is IDR 390.099.90 per ton. Furthermore, the volume of work for AC-WC worn-out lastton work is as follows:

TABLE II. Volume of AC-WC laston work

No.	Description		Volume Laston AC-WC	
			Monthly Statement (MS/MC)	
			Month	Cumulative
18	April	2018	2,956	2,956
19	May	2018	3,660	6,616
20	June	2018	5,723	12,338
21	July	2018	524	12,862
22	August	2018	643	13,505

Based on the data above, the unit price increase against the unit price escalation index for AC-WC worn lastton work for

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the April 2018 period was IDR 404,806.67 in every 1-tonne volume, so the cost increase escalation index was 1.0378.

- April 2018 period (18th Month) volume in payment certificates
  2956.10 tons x 390.099.90 = IDR 1.153.176.318.05 (Before escalation)
- April 2018 period (18th Month) volume in payment certificates
  2956.10 tons x 404.806.67 = IDR 1.196.651.065.24 (After Escalation)

Therefore, it can be identified that the escalation value is IDR 43.474747.19. Complete calculation data on each job is not shown but can be requested if needed. As for the hard asphalt work from the 13th month to the 26th month (100% work progress), the recapitulation of the volume item data shows the total value of payments before price escalation is IDR 5,268,255,213.50, while the total payment after price escalation is IDR 5,525,759,067.60. Thus, the overall escalation value reached IDR 257,503,854.10. Overall, the analysis of the price escalation index based on Presidential Regulation Number 16 of 2018 article 37 shows that the escalation value of national road and bridge construction projects with multi-year contracts in the national road implementation work unit package 16 WINRIP (Western Indonesia National Road Improvement Project) Bengkulu Province Corridor Sumatra is IDR 2,883,900,000.00 with a percentage of 1.36% of the project contract value, which is IDR 211,374,500,000.00.

The next finding is related to the index value factor that affects the escalation value in the 12th month period as the basic index (October 2017) up to the 24th month (December 2018). The first factor is industrial material (m2) of 115.45%. Industrial material with an index factor of m2 is 60/70 penetration asphalt as a road pavement construction material. The second factor is construction equipment fuel (fuel) of 112.82%. Heavy construction equipment is a resource that requires diesel fuel whose price is very volatile, following international prices. The third factor is road and bridge public works material (m3) with a percentage of 106.87%. The fourth factor is the construction equipment (equipment) of 106.25%, namely the rental of construction equipment. The fifth factor is labor wages (labor) of 105.43%. Finally, the sixth factor is all sources of natural material (m1) for project implementation, such as boulder stone, gravel, selected embankment soil, and ordinary embankment, which reached 100.00%. Thus, the most dominant index in influencing the increase in project value based on the type of work in the sequence is asphalt pavement work (0.60%), concrete structure work fc'20 MPa K-250 (0.15%), ordinary excavation work (0.13%), class A aggregate foundation work (0.11%), class B aggregate foundation work (0.08%), class S aggregate foundation layer work (0.08%), intermediate layer concrete (AC-BC) (0.06%), worn layer concrete (AC-WC) (0.05%), AC-Base mortar (0.04%), and masonry with mortar and DS3 type U channel (0.03%). This finding is in line with the factual conditions in the field. In general, the factors that have a significant influence on the value of price escalation are industrial materials, natural materials, fuel and construction equipment, and labor.

Escalation (Price Adjustment) was carried out on the components of labor, internal materials, industrial materials, fuel, and construction equipment against the contract value at the time of bidding [14]. Price adjustments are generally granted to multi-year contracts. Presidential Regulation Number 16 of 2018 Article 37 regulates price adjustments/escalations for projects with an implementation period of more than 18 months. Price adjustments on multi-year projects are very important because they must consider the fluctuations in the country's economy that cause price changes for each component of the work during project implementation. With the implementation of cost escalation, the owner of the construction project must provide funds in accordance with the latest price adjustments. Price adjustments are applied to multi-year construction project contracts, which are in the form of unit price contracts based on the terms and conditions stated in the procurement documents and/or changes to the tender/procurement documents. The procedure for calculating price adjustments must be clearly stated in the procurement/auction document. Price adjustments do not apply to single-year contracts and lump sum contracts as well as work with unequal unit prices. The lame unit price is the bid unit price which exceeds 110% of the HPS unit price after clarification. Previous research that is used as an empirical basis in this study include Broto [7], Morris & Willson [10], Kaliba et al. [15], Shane et al. [16], Callahan [17], Parsons [18], Chang [19], Sapulette [20], Akinci & Fischer [21], Semple et al. [22], Vamsidhar et al. [6], Kumalasari & Hapsari [3], Fatoni & Hanif [5], Bruni et al. [23], and Mentis [24].

IV. Conclusion

This study shows an increase in the value of the contract by 1.364% (equivalent to Rp. 2,883,900,000, -) from the initial contract value of IDR 211,374,500,000,- to IDR 214,258,400,000. Some of the jobs that experienced an increase in price adjustments were drainage works, earthworks, road shoulder works, granulated pavement works, asphalt pavement works, and structural works. The escalation index analysis shows that the largest cost change is in the industrial material component (m2), namely the asphalt pavement work of IDR 1,160,602,211.64, or equivalent to 0.604% of the contract value, and 44.267% of the total price escalation value. Construction implementers are advised to apply work methods according to the schedule and develop resources optimally in project implementation so that work progress is finished on time in accordance with the contract.

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