

Bridging the Time Gap: Exploring Escalation Method for Accurate, Precise, Reliable, and Valid Project Budgeting^{1, 2}

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ABSTRACT

The oil and gas industry's inherent volatility, influenced by geopolitical events, supply and demand fluctuations, and economic conditions, poses significant challenges to project schedules and budgets. Accurate project cost prediction is vital for effective project management, particularly in long-term projects in PERTAMINA's downstream sector. Currently, PERTAMINA faces project delays, primarily due to market volatility and lengthy preparatory activities. This time gap results in budget disparities, necessitating an accurate cost escalation method. In current PERTAMINA Downstream project budgeting, cost escalation methods adjust the Owner's Estimate during tender processes but typically only focus on the bidding year, omitting the construction period gap which should also be factored in.

This paper analyzes various benchmarks, including gold price, Big Mac index, US Dollar index, and Indonesia's inflation rate, considered as alternative currencies for precise project budgeting, and selects the most suitable one. Results indicate that the Gold Price emerges as the best benchmark for precise cost escalation due to its consistent growth trend, in line with the RAND Study's insights on the impact of omitting scope and risks.

Keywords: Oil and Gas, Downstream, Cost Estimate, Cost Escalation, Gold Price, Big Mac Index, PERTAMINA

INTRODUCTION

1.1. Oil and Gas Volatile Market in Indonesia

The energy and gas industry is volatile by nature, with prices fluctuating due to geopolitical events, variations in supply and demand, and economic conditions, among

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² This paper was originally prepared during a 6-month long Graduate-Level Competency Development/Capacity Building Program developed by PT Mitrata Citragraha and led by Dr. Paul D. Giammalvo to prepare candidates for AACE CCP or other Certifications. <https://build-project-management-competency.com/our-faqs/>

other factors. “This instability can have substantial effects on project schedules and budgets. For example, volatile costs and labor and material supply uncertainties can jeopardize everything from field operations to project schedules.”³ In addition, a 2022 study by Goldman Sachs suggests that “delays in oil and gas project investment since 2014 could result in significant production losses.”⁴

Even though the downstream market experienced a decline in output due to the COVID-19 outbreak in the first quarter of 2020, “from 2022 to 2027, Indonesia's downstream oil and gas market is expected to grow at a CAGR of over 4%.”⁵ “Several laws and regulations govern Indonesia's downstream oil and gas industry, and the government seeks to encourage downstream development through industrial estates that facilitate the integration of associated processes. However, there are risks and concerns, including long and uncertain negotiation processes for large-scale projects, uncertainty about future policies, and a monopolistic market structure. Given the growth opportunities in this industry, there is an urgent need to expand infrastructure to accommodate this growth.”⁶

These market volatilities can lead to project delays and significant discrepancies between the proposed budget and the actual project costs. “Therefore, accurate project cost prediction is a cornerstone of successful project management in this sector. It allows for effective budgeting, resource allocation, and risk management, ultimately improving project outcomes.”⁷

³ How oil and gas companies can secure supply-chain resilience. (2023, March 6). McKinsey & Company. <https://www.mckinsey.com/industries/oil-and-gas/our-insights/how-oil-and-gas-companies-can-secure-supply-chain-resilience>

⁴ Ziomecki, M. (2023, January 30). Oil and gas: The investment gap dilemma. GIS Reports. <https://www.gisreportsonline.com/r/oil-gas-investment/>

⁵ Mordor Intelligence Research & Advisory. (2023, July). Indonesia Oil and Gas Downstream Market Size & Share Analysis - Growth Trends & Forecasts (2023 - 2028). Mordor Intelligence. Retrieved July 10, 2023, from <https://www.mordorintelligence.com/industry-reports/indonesia-oil-and-gas-downstream-market>

⁶ Overview of Indonesia's downstream oil and gas sector | GBG. (n.d.). GBG Indonesia | Global Business Guide Indonesia.

https://www.gbgindonesia.com/en/energy/article/2014/overview_indonesia_s_downstream_oil_and_gas_sector.php

⁷ Kerzner, H. (2017). Project management: a systems approach to planning, scheduling, and controlling. John Wiley & Sons.

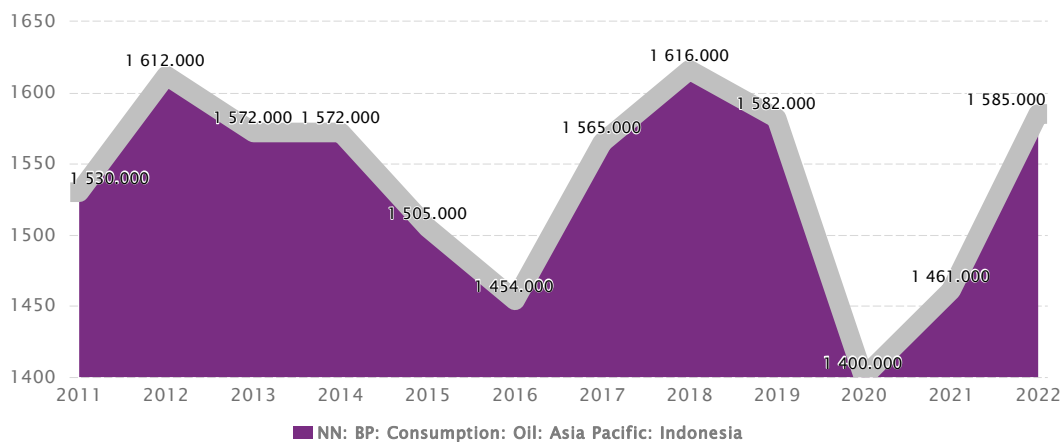


Figure 1 – Oil Consumption in Indonesia (barrel/day)⁸

1.2. GAO Cost Estimating & Assessment Guide

The Government Accountability Office (GAO) of the United States has developed a guide for cost estimating and assessment, which outlines best practices for developing reliable, high-quality cost estimates and effectively managing program costs. The guide presents a 12-step process for cost estimation, which includes defining the estimate's purpose, developing the estimating plan, determining the estimating structure, and more. Understanding and applying these steps can help ensure that cost estimates are comprehensive, well-documented, accurate, and credible. This process can benefit oil and gas projects, where cost estimates must account for many factors and uncertainties.

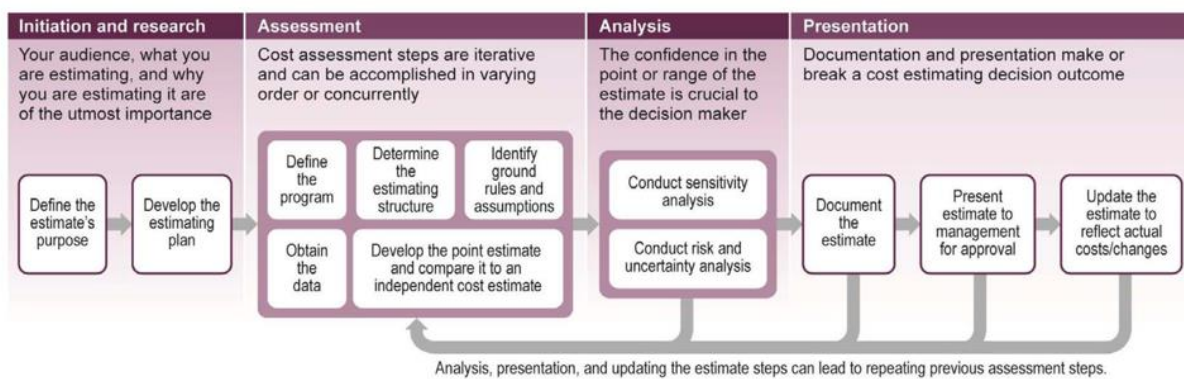


Figure 2 – The Cost Estimating Processes by GAO⁹

⁸ Indonesia | Konsumsi Minyak | 1965 – 2023 | Indikator Ekonomi | CEIC. (2018, June 1). Global Economic Data, Indicators, Charts & Forecasts | CEIC. <https://www.ceicdata.com/id/indicator/indonesia/oil-consumption#:~:text=Konsumsi%20Minyak%20Indonesia%20dilaporkan%20sebesar,Barrel%2FDay%20th%20untuk%202021>

⁹ The United States Government Accountability Office. (2020, March). GAO Cost Estimating and Assessment Guide.

1.3. Cost Escalation

“Accurately predicting project costs is complex, uncertain, and influenced by many variables, including material costs, labor costs, and market conditions. One of the key challenges in this area is accounting for cost escalation, the increase in project costs over time due to factors such as inflation, increased demand, or higher resource costs.”¹⁰

“Cost escalation denotes the rise in the financial resources needed to complete a project beyond what was initially budgeted.”¹¹ “While poor management can lead to cost escalation, studies by the RAND Corporation suggest that it is usually not the primary cause. Instead, factors like remote sites, inadequate manpower planning, misunderstanding of local labor practices, and changing or unclear labor regulations are more significant.”¹²

In PERTAMINA's downstream infrastructure projects, project implementation often lags behind the budget proposal due to lengthy licensing processes, design phases, and other preparatory activities. This time gap can lead to significant discrepancies between the proposed budget and the actual project costs, necessitating a method to accurately predict and account for cost escalation during the project's waiting period.

Based on the explanation above, alternative methods for predicting cost escalation are needed. One such method is the Gold Equivalency Method (GEM), which uses the price of gold as a benchmark to predict cost escalation. “Gold is frequently considered a safe-haven asset and a store of value. Hedge against inflation, making it a potentially useful indicator for cost escalation.”¹³

Other benchmarks that have been suggested for consideration are the Big Mac Index, the United States (US) Dollar Index, and the Indonesian inflation rate. “The Big Mac index measures the purchasing power parity that could potentially be adapted for project cost prediction.”¹⁴ The US Dollar index assesses the dollar's value relative to a group of foreign currencies. “It serves as a significant economic indicator and a benchmark for many commodities that are priced in dollars, including oil and gas.”¹⁵ “On the other hand,

¹⁰ Hwang, B. G., & Leung, H. W. (2013). Possible cost overruns of construction projects. *Journal of Construction Engineering and Management*, 139(3), 272-279.

¹¹ Kaliba, C., Muya, M., & Mumba, K. (2009). Cost escalation and schedule delays in road construction projects in Zambia. *International Journal of Project Management*, 27(5), 522-531. Retrieved from <https://doi.org/10.1016/j.ijproman.2008.07.003>

¹² Merrow EW. *Understanding the outcomes of megaprojects: a quantitative analysis of very large civilian projects*. Santa Monica, CA: The Rand Corporation; 1988.

¹³ Baur, D. G., & Lucey, B. M. (2010). Is gold a hedge or a safe haven? An analysis of stocks, bonds and gold. *Financial Review*, 45(2), 217-229. <https://doi.org/10.1111/j.1540-6288.2010.00244.x>

¹⁴ The Big Mac index. (2022, July 21). *The Economist*. <https://www.economist.com/big-mac-index>

¹⁵ What is the U.S. dollar index (USDX) and how to trade it. (2006, June 19). Investopedia. <https://www.investopedia.com/terms/u/usdx.asp>

the Indonesian inflation rate reflects the rate of increase in the general level of prices for products and services in Indonesia. High inflation can erode purchasing power and create uncertainty in economic planning.”¹⁶

Drawing from the paragraph above, the following research questions can be framed:

- a. What are the current methods for cost escalation in project budgeting in Indonesia’s downstream oil and gas sector?
- b. Which method or benchmark/index emerges as best for cost escalation in the Author's company?

METHODOLOGY

This paper will use the structured procedure analysis of Engineering Economics as the methodology for analysis. The methodology being developed is shown in the Figure 3.

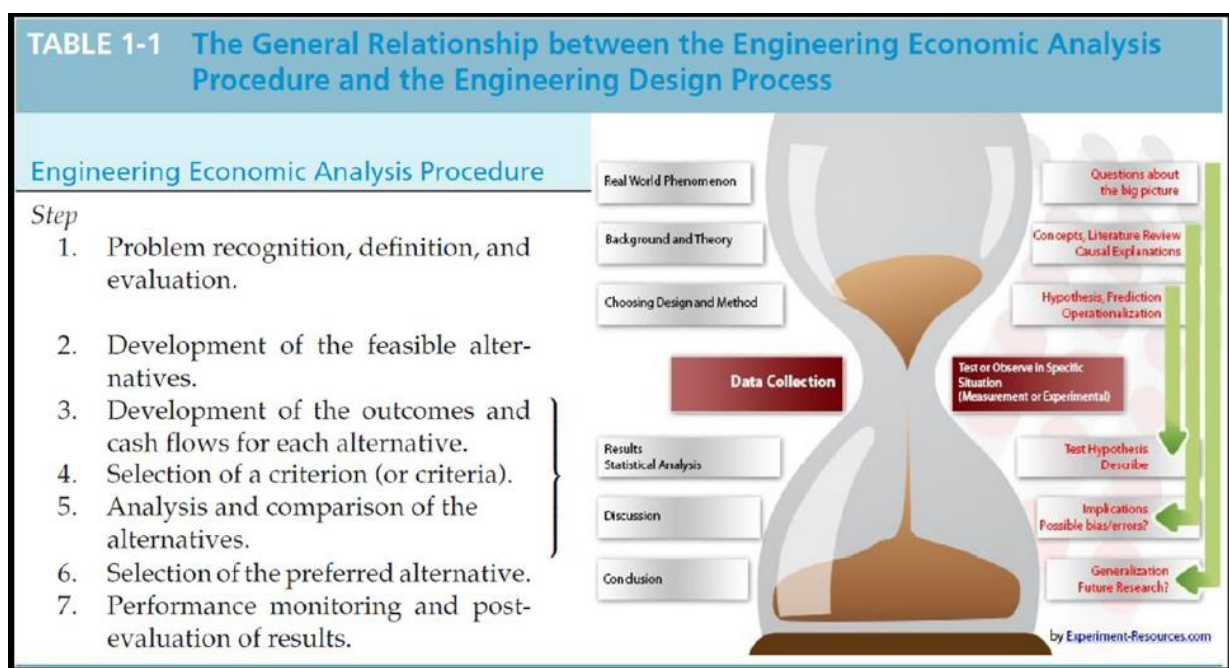


Figure 3 – Engineering Economic Analysis Procedure¹⁷

¹⁶ Inflasi. (n.d.). <https://www.bi.go.id/id/fungsi-utama/moneter/inflasi/default.aspx>

¹⁷ Sullivan, G. W., Wicks, M. E., & Koelling, C. P. (2019). Engineering Economy 16th Edition. Chapter 2 Cost Concepts and Design Economics, Page 31.

Step 1 – Problem Definition

PERTAMINA is currently facing project management challenges, experiencing delays due to market volatility, management decisions, licensing, design, and preparations. This results in a time gap that creates significant disparities between the initially proposed budget and the actual costs incurred as the project progresses. Case examples can be seen in Table 1.

No	Project Name	Estimated Cost	Year	Adjusted Cost	Year	Lowest Bidder	Deviation	Tender Status
		(\$) A	Created B	(\$) C	Adjusted D	(\$) E	Between Column A & C (%)	
1	Downstream 1	2,366,000	2021	2,562,000	2023	2,511,000	8%	SUCCEEDED
2	Downstream 2	867,000	2021	908,000	2023	905,000	5%	SUCCEEDED
3	Downstream 3	1,319,000	2020	1,723,000	2023	1,682,000	31%	SUCCEEDED
4	Downstream 4	1,287,000	2020	1,494,000	2023	1,488,000	16%	SUCCEEDED
5	Downstream 5	526,000	2021	580,000	2023	575,000	10%	SUCCEEDED
6	Downstream 6	509,000	2021	575,000	2023	572,000	13%	SUCCEEDED
7	Downstream 7	975,000	2021	1,105,000	2023	1,101,000	13%	SUCCEEDED
8	Downstream 8	1,231,000	2021	1,346,000	2023	1,341,000	9%	SUCCEEDED
9	Downstream 9	41,354,000	2017	45,497,000	2023	45,235,000	10%	SUCCEEDED
10	Downstream 10	77,252,000	2017	91,210,000	2023	91,207,000	18%	SUCCEEDED
11	Downstream 11	220,000	2020	-	-	246,000	-	FAILED
12	Downstream 12	267,000	2020	-	-	484,000	-	FAILED
13	Downstream 13	532,000	2020	-	-	770,000	-	FAILED
14	Downstream 14	696,000	2021	-	-	1,563,000	-	FAILED
15	Downstream 15	234,000	2021	-	-	397,000	-	FAILED

Table 1 – Original and Adjusted Project Cost¹⁸

Table 1 presents project data from PERTAMINA (Downstream 1 to 10) where Owner's Estimate (OE) adjustments were made without altering the scope. Failure to apply OE adjustments or consider escalation led to tender failures as shown in projects Downstream 11 to 15. However, recent adjusted OE only accounts for prices during the bidding year, overlooking the time gap during construction, which requires escalation consideration. "The Cost Guide developed by GAO step 6 – obtain the data, inflation adjustment is an important step in cost estimating. Adjusting for inflation correctly is necessary to make a reliable cost estimate."¹⁹

There is currently **NO** particular method nor standard procedure in PERTAMINA that accommodates the time gap between the bidding and construction phases. Meanwhile, the cost escalation approach is essential for PERTAMINA to anticipate and manage financial fluctuations during the project's preparatory stages. Therefore, there is a

¹⁸ By Author

¹⁹ The United States Government Accountability Office. (2020, March). GAO Cost Estimating and Assessment Guide.

pressing need for PERTAMINA to develop a reliable method that can accurately predict and accommodate cost increases during the waiting period of the project.

This paper will explore an escalation method for precise, reliable, and valid project budgeting, considering various alternative benchmarks such as the gold price, the Big Mac index, the US Dollar index, and Indonesia's inflation rate. Subsequently, the most suitable alternative benchmark will be selected to forecast or escalate the budget for current projects which has not been adjusted, as shown in Table 2.

No	Project Name	Estimated Budget Before Escalation (\$)	Budget Year Created	Estimated Project Start	Project Duration	Estimated Project Finish	Project Midpoint	Estimated Budget After Escalation (\$)
1	Downstream A	38,735,000	2022	Dec-23	18 Months	Jun-25	Sep-24	
2	Downstream B	27,730,000	2022	Oct-23	22 Months	Aug-25	Sep-24	
3	Downstream C	72,029,000	2022	Mar-24	30 Months	Sep-26	Jun-25	
4	Downstream D	37,096,000	2022	Jan-24	18 Months	Jul-25	Oct-24	?
5	Downstream E	25,353,000	2022	Dec-23	24 Months	Nov-25	Nov-24	
6	Downstream F	95,438,000	2022	Feb-24	24 Months	Jan-26	Jan-25	

Table 2 – Company Internal Project Budget (Baseline)²⁰

Note that to enhance output escalation for any projects requiring adjustments, the company needs to analyze the escalation results against theoretical quality control metrics:

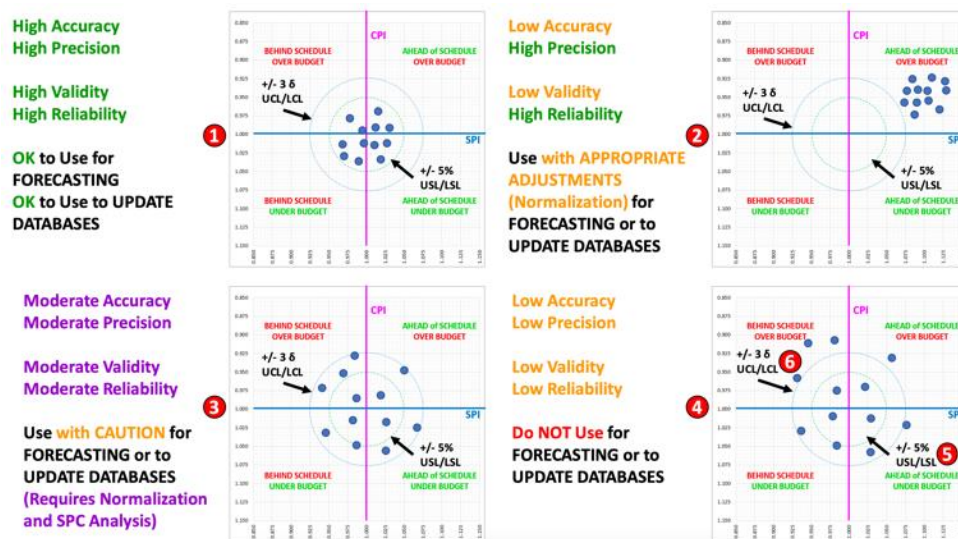


Figure 4 – Quality Metrics for Cost and Productivity Data²¹

²⁰ By Author

²¹ Giammalvo, P. D. (2023). The Futility of Integrated Master Plans Prepared by Planner/Schedulers with Little or No Hands-on Field Experience, *PM World Journal*, Vol. XII, Issue IX, September. <https://pmworldlibrary.net/wp-content/uploads/2023/09/pmwj133-Sep2023-Giammalvo-futility-of-master-plans-prepared-with-little-or-no-hands-on-experience.pdf>

- How **VALID** is the estimate when benchmarked against the target value?
- How **ACCURATE** is the estimate when benchmarked against the target value?
- How **RELIABLE** is the estimate when benchmarked against the target value?
- How **PRECISE** is the estimate when benchmarked against the target value?"²²

Step 2 – Development of Alternatives

In Indonesia, recent studies conducted by Santoso et al. and Meiyannur et al. showed that “the price of a multiyear project can be adjusted using a price index by the terms of the contract by adjusting the price index based on Regulation of The President of Indonesia No.16 of 2018 on Government Procurement.”²³ ²⁴ However, “the adjustment can only be done by the 13th month after the date of commencement of work”²⁵ and may result as cost overrun in Owner’s perspective.

Therefore, forecasting the project budget is essential to mitigate additional costs due to price changes during construction. In the budgeting forecast or cost escalation process, it is necessary to have an alternative benchmark that exhibits predictability, meaning it follows a consistent pattern. As mentioned, four distinct indices/prices are assessed using historical data spanning 20 years (2003-2022) to evaluate their predictability. The four indices/prices under consideration are as follows:

1. Indonesia’s Inflation Rate

“The inflation rate signifies the annual percentage growth of a broad index of money prices. In general, costs and prices are influenced by inflation or deflation resulting from local and global factors.”²⁶ Researchers have been investigating and publishing journals on the impact of various factors on inflation volatility. They

²² Giammalvo, P. D., & PTMC. (2021). Unit 10 – Managing Cost Estimate. Retrieved from <https://build-project-management-competency.com/1-4-1-10-unit-10/>. Figure 26.

²³ Meiyannur, A., & Wulandari, D. A. (2022). Cost Escalation Analysis (Price Adjustment) on Multi Years Infrastructure Projects(Plural Years)(Case Study: Kalimati Long Storage Development Project For Raw Water in Sidoarjo Regency. *IJTI (International Journal of Transportation and Infrastructure)*, 5, 86-92. Retrieved from <https://jurnal.narotama.ac.id/index.php/ijti/article/view/1810/1404>

²⁴ Santoso, Lalu Mulyadi, Tiong Iskandar, & Lies K. Wulandari. “Cost Escalation Analysis on The Western Indonesia National Road Improvement Project (WINRIP),” *International Research Journal of Advanced Engineering and Science*, Volume 00, Issue 00, pp. xx-xx, 2022. Retrieved from <http://arsitektur-lalu.com/wp-content/uploads/2022/04/Cost-Escalation-Analysis.pdf>

²⁵ Regulation of The President of The Republic of Indonesia No. 16 of 2018 on Government Procurement

²⁶ Selappan, H.K. (2013). Exploring Gold as Alternative Currency for Cost Estimation in Telecommunication. *PM World Journal*, 1(4). Retrieved from <https://pmworldlibrary.net/wp-content/uploads/2013/01/PMWJ4-Nov2012-SELLAPPAN-Gold-AlternativeCurrencyForProjectEstimation-Featured-Paper.pdf>

highlight “variables like money supply, exchange rates, interest rates, and gross domestic product as influential factors in their studies.”²⁷

2. The US Dollar Index²⁸

“The US Dollar Index measures the dollar's value relative to a group of foreign currencies. Significant foreign currencies reflect changes in the dollar's value. The following currencies are supported: GBP, EUR, JPY, CND, SEK, and CHF. Exchange rates are currently used to calculate the US Dollar Index. The index began with a basis of 100 in 1973, and all subsequent values are relative to this base. This index is a viable alternative for determining the index's trend and predictability.”

3. Gold Price

“Gold has been considered a reserve of value for many years. As a physical commodity, it cannot be printed like currency, and its value is unaffected by government interest rate decisions.”²⁹ This makes the gold price a feasible alternative for analysis. In addition, “Zimbabwe's central bank has introduced gold coins that were initially intended to diminish the demand for US dollars and serve as a retail investment for value preservation. Zimbabwean economist suggests that a portion of government employees' salaries could be paid in gold coins, in response to the sharp depreciation of the local currency, leading to price hikes and reduced purchasing power for workers.”³⁰

4. Big Mac Index³¹

The Economist introduced the Big Mac Index. The Big Mac™ Index offers a novel, albeit somewhat playful, perspective on evaluating whether currencies are trading at their “appropriate” value. This unique economic measure is founded on the principle of Purchasing-Power Parity (PPP), a theory positing that the worth of a

²⁷ Setiartiti, L. & Hapsari, Y. (2019). Determinants of Inflation Rate In Indonesia. *Jurnal Ekonomi & Studi Pembangunan*, 20(1), 112-123. Retrieved from <https://journal.umy.ac.id/index.php/esp/article/view/5016/4589>

²⁸ Asmoro, CCE., T. H. (2013). Exploring Gold Equivalency for Forecasting Steel Prices on Pipeline Projects. *PM World Journal*, 2(5).

²⁹ Chen, J. (2012, March 7). Safe haven: Definition and examples in investing. Investopedia. Retrieved from <https://www.investopedia.com/terms/s/safe-haven.asp>

³⁰ Zimbabwean economist says portion of civil servants' salaries must be paid in gold coins. (2023, July 15). The Zimbabwe Mail. <https://www.thezimbabwemail.com/economic-analysis/zimbabwean-economist-says-portion-of-civil-servants-salaries-must-be-paid-in-gold-coins/>

³¹ Selappan, H.K. (2013). Exploring Gold as Alternative Currency for Cost Estimation in Telecommunication. *PM World Journal*, 1(4). Retrieved from <https://pmworldlibrary.net/wp-content/uploads/2013/01/PMWJ4-Nov2012-SELLAPPAN-Gold-AlternativeCurrencyForProjectEstimation-Featured-Paper.pdf>

currency can be derived from a select basket of commodities, in this case, a hamburger.

Step 3 – Development of Prospective Outcomes

In the charts below, regression analysis is used as a statistical tool to analyze historical data and find patterns. The four charts below show the trends discovered using polynomial regression 6th-order analysis. The 6th-order polynomial regression is chosen because it yields the highest R² value among other trendline options in Microsoft Excel.

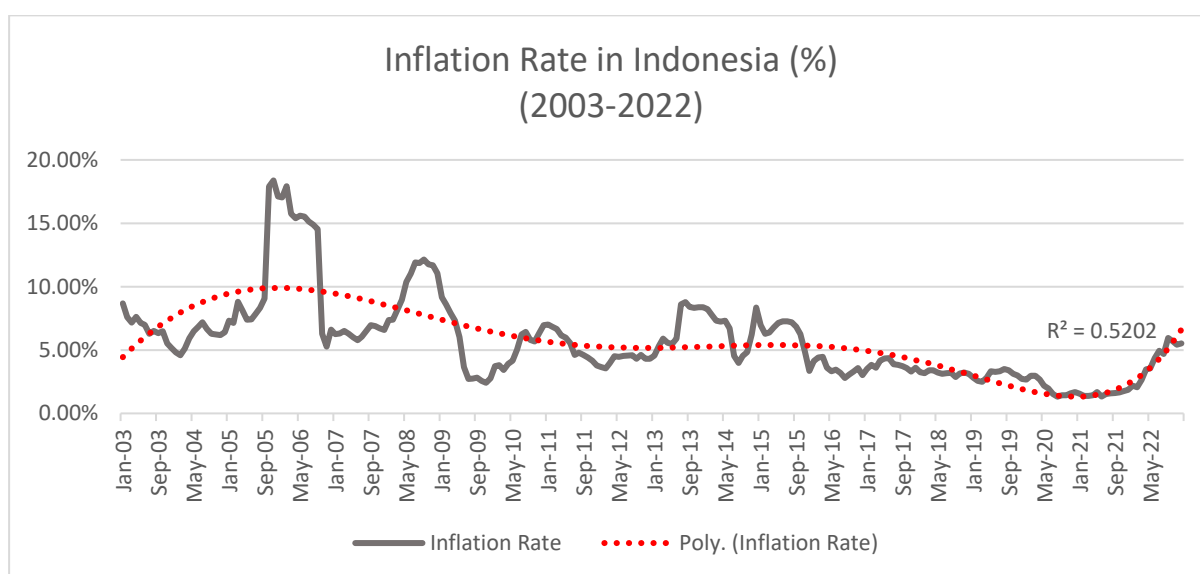


Figure 5 – Indonesia’s inflation rate (%)³²

³² Indikator. (n.d.). Retrieved July 20, 2023, from <https://www.bi.go.id/id/statistik/indikator/data-inflasi.aspx>

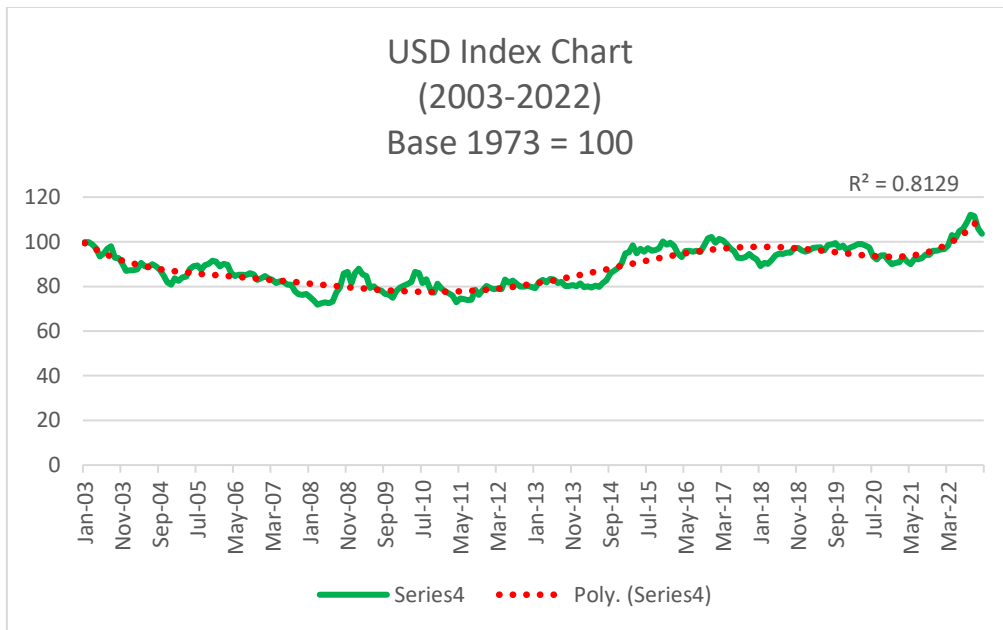


Figure 6 – The US Dollar index³³

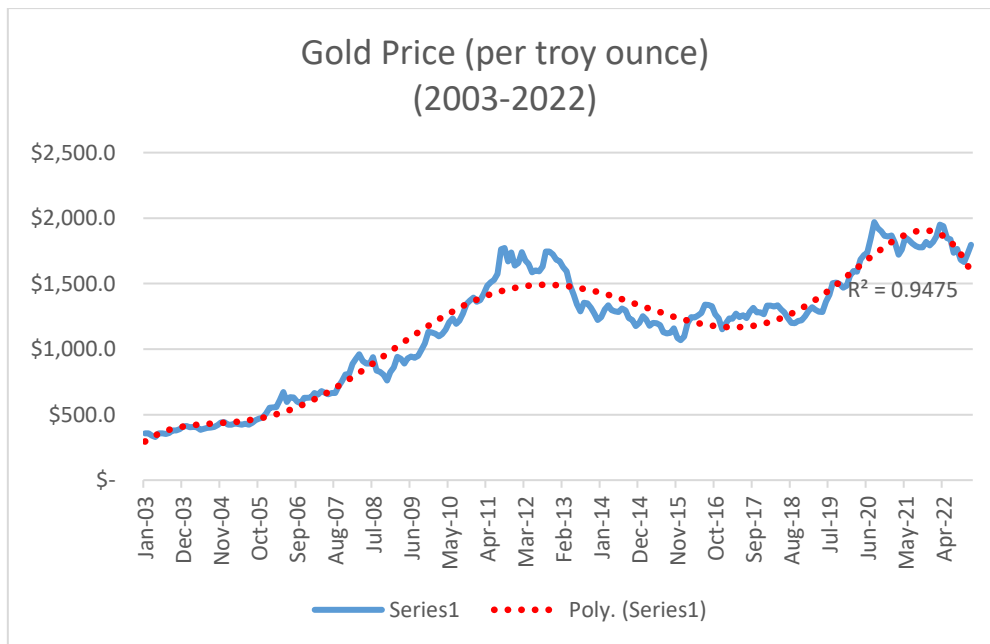


Figure 7 – Gold price (USD per troy ounce)³⁴

³³ U.S. dollar index (DXY). (2023, August 14). MarketWatch.

<https://www.marketwatch.com/investing/index/dxy/download-data?startDate=5/3/1999&endDate=06/23/2023>

³⁴ Historic Gold Price Data. (n.d.). Retrieved July 20, 2023, from <https://auronum.co.uk/gold-price-news/historic-gold-price-data/>

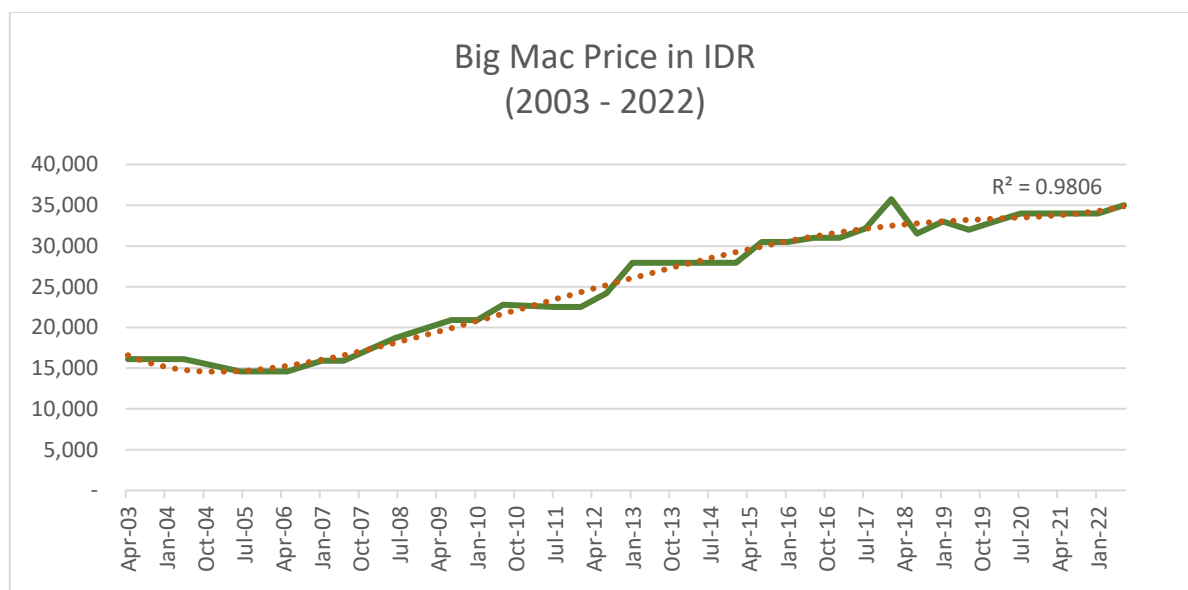


Figure 8 – Big Mac index in IDR³⁵

Step 4 – Selection of Decision Criterion

The criteria used for the selection of the best alternative benchmark will be the predictability of the data to allow accurate forecasting. “In the case of regression analysis, the criterion for selection was the calculation of the Coefficient of Determination (R^2) ranging from 0 to 1 using MS Excel Charts. The higher the value of R^2 , the more in sync the movement of securities with the index and vice-versa.”³⁶ Table 3 presents the outcomes for each available option.

Type of Index	Currency	R^2 Value
Indonesia Inflation Rate	N/A	0.52
US Dollar Index	N/A	0.812
Gold Price (per troy ounce)	USD	0.947
Big Mac Index	IDR	0.98

Table 3 – Regression Model Result³⁷

“In non-linear regression analysis, the selection of the “best fit” is based on a high R^2 value.”³⁸ Based on the result from Table 3, the **Big Mac Index (IDR)** and the **Gold Price (USD per troy ounce)** are selected as they demonstrated an R^2 value of 0.98 and 0.947

³⁵ NASDAQ data link. (n.d.). https://data.nasdaq.com/data/ECONOMIST/BIGMAC_IDN-big-mac-index-indonesia

³⁶ What is R-squared? (2003, November 25). Investopedia. <https://www.investopedia.com/terms/r/r-squared.asp>

³⁷ By Author

³⁸ What is R-squared? (2003, November 25). Investopedia. <https://www.investopedia.com/terms/r/r-squared.asp>

respectively, indicating a solid fit with the polynomial trend line and the ability to be represented by a mathematical model.

“To explore an escalation method that is accurate, precise, reliable, and valid, it is necessary to forecast the Big Mac Index and Gold Price to the **midpoint of the proposed project schedule**, to prevent underestimation actions related to inflation during the construction years.”³⁹ This aligns our cost forecasts with actual expenses, influenced by dynamic economic conditions and other factors. The longest project duration midpoint is June 2025, while the shortest is September 2024. To illustrate the cost escalation method, the Author will use the midpoint between these dates, pinpointing **January 2025 as the designated midpoint**.

The next step is to forecast future outcomes of the Big Mac Index and Gold Price using regression analysis. “Regression analysis will be utilized as a tool to forecast the indices as it is commonly used in forecasting and financial analysis”⁴⁰ and used by previous researchers.^{41 42} “To use regression model for forecasting, R^2 matters a lot.”⁴³ “The R^2 value assesses how well the best-fit line fits the data. It ranges from 0 to 1, with higher values indicating a stronger alignment between the model's predictions and the real observations.”^{44 45}

Then, to carry out an analysis that is accurate, precise, reliable, and valid, the Author applies “Managing Risk and Opportunity Step 11.10 to 11.13,”⁴⁶ This involves categorizing each output benchmark currency into three categories: Low, Medium, and High, to perform a more reliable modeling. However, in this paper, the Author has chosen to categorize and perform probability distribution only for the benchmark price. This approach does not encompass categorizing and performing probability distribution for

³⁹ Yonathan, S. (2023, July 1). *W3.0_SY_Predicting vapor recovery unit cost for feasibility study (AACE class 4) in 2024 using big Mac index*. RETRO MERCI. https://retromerci2023.wordpress.com/2023/07/02/w3-0_sy_predicting-vapor-recovery-unit-cost-for-feasibility-study-aace-class-4-in-2024-using-big-mac-index/

⁴⁰ *Regression basics for business analysis*. (2009, July 19). Investopedia.

<https://www.investopedia.com/articles/financial-theory/09/regression-analysis-basics-business.asp#:~:text=key%20takeaways,could%20affect%20sales%2C%20for%20example>

⁴¹ Selappan, H.K. (2013). Exploring Gold as Alternative Currency for Cost Estimation in Telecommunication. *PM World Journal*, 1(4). Retrieved from <https://pmworldlibrary.net/wp-content/uploads/2013/01/PMWJ4-Nov2012-SELLAPPAN-Gold-AlternativeCurrencyForProjectEstimation-Featured-Paper.pdf>

⁴² Asmoro, CCE., T. H. (2013). Exploring Gold Equivalency for Forecasting Steel Prices on Pipeline Projects. *PM World Journal*, 2(5).

⁴³ The University of Pennsylvania School of Arts and Sciences. (n.d.). *Introduction to Time Series Regression and Forecasting (SW Chapter 14)* [PowerPoint slides].

https://www.sas.upenn.edu/~fdiebold/Teaching104/Ch14_slides.pdf

⁴⁴ Kumar, A. (2023, April 4). *Mean squared error or R-squared - Which one to use? - Data analytics*. Data Analytics. <https://vitallflux.com/mean-square-error-r-squared-which-one-to-use/>

⁴⁵ The United States Government Accountability Office. (2020). *GAO Cost Estimating and Assessment Guide: Best Practices for Developing and Managing Capital Program Costs*, page 125.

⁴⁶ PTMC, & Giammalvo, P. D. (2021). 1.4.1.6 Unit 6- Managing Risk and Opportunity. <https://build-project-management-competency.com/1-4-1-6-unit-6/>. Page 17-18.

each CAPEX in every Downstream Project, as that would not be feasible within the scope of this study without significantly lengthening the paper.

To select the appropriate benchmark currency, this study uses probability distribution for risk and uncertainty analysis. “This approach helps evaluate the realism of the budget and assess the likelihood of meeting estimated program costs.”⁴⁷ “NASA also utilizes probabilistic analysis for budget accuracy and improved performance by addressing uncertainties in costs and schedules.”⁴⁸ “The Lognormal distribution method is applied for risk analysis based on GAO's guidance, as it suits modeling real-world phenomena with non-negative values.”⁴⁹ “GAO recommends higher confidence level estimates (70 or 80 percent) for managing risks in high-risk programs to enhance budget success and manage unforeseen risks, avoiding contingency depletion and re-baselining, but excessive budgeting can constrain funding for other projects.”⁵⁰ Consequently, **the P80 of the forecasted benchmark price is chosen** to escalate CAPEX in the 6 Downstream Projects, based on the rationale that a higher P-value allows a more robust contingency, offering protection against potential budget shortfalls.

FINDINGS

Step 5 – Analysis and Comparison Alternatives

a. Forecasting Big Mac Price

Based on the same chart from Figure 8, the Big Mac's price will be forecasted to the designated midpoint in January 2025. Figure 9 displays a plot showing the regression using various polynomial degrees, including linear, 2nd-order polynomial, 3rd-order polynomial, 4th-order polynomial, 5th-order polynomial, and 6th-order polynomial.

⁴⁷ The United States Government Accountability Office. (2020). GAO Cost Estimating and Assessment Guide: Best Practices for Developing and Managing Capital Program Costs, page 152.

⁴⁸ NASA Cost Estimating Handbook. (2023). Retrieved from <https://www.nasa.gov/content/cost-estimating-handbook>

⁴⁹ Limpert, E., Stahel, W. A., & Abbt, M. (2001). *Log-normal distributions across the sciences: Keys and clues*. *BioScience*, 51(5), 341. [https://doi.org/10.1641/0006-3568\(2001\)051\[0341:lnats\]2.0.co;2](https://doi.org/10.1641/0006-3568(2001)051[0341:lnats]2.0.co;2)

⁵⁰ The United States Government Accountability Office. (2020). GAO Cost Estimating and Assessment Guide: Best Practices for Developing and Managing Capital Program Costs, page 173.

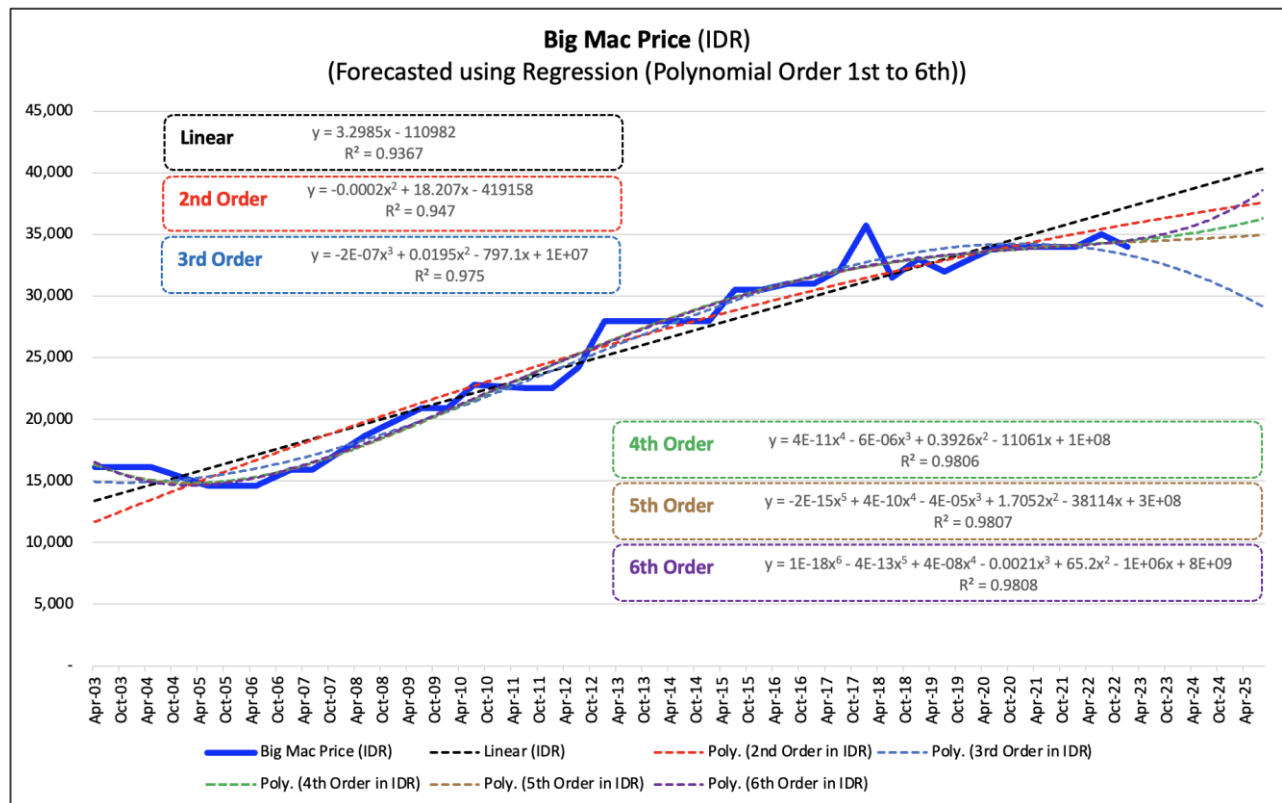


Figure 9 – Forecasting Big Mac Price to July 2025⁵¹

Based on the regression in Figure 9, the results show that the 3rd-degree polynomial line exhibits “a declining trend, which is not desirable in forecasting.”⁵² Therefore, only positive trendlines are considered in this analysis. The regression outcomes depicted in Figure 9 are presented in Table 4.

Regression	Trend	R ² Value
Linear	Positive	0.9367
2nd Deg. Polynomial	Positive	0.947
3rd Deg. Polynomial	Negative	0.975
4th Deg. Polynomial	Positive	0.9806
5th Deg. Polynomial	Positive	0.9807
6th Deg. Polynomial	Positive	0.9808

Table 4 – Regression Forecasting Big Mac Price Model Results⁵³

⁵¹ By Author

⁵² Setting negative forecast values to zero (SAP library - Business intelligence). (n.d.).

https://help.sap.com/saphelp_snc700_ehp01/helpdata/en/cf/d5e13ffb118f15e1000000a155106/content.htm#:~:text=Negative%20forecast%20values%20can%20be,model%20with%20a%20trend%20component

⁵³ By Author

From the results in Table 4, the 6th-degree polynomial model exhibits the highest R² value (0.9808), whereas the 1st-degree or linear model records the lowest value (0.9367). To predict the Big Mac Price for January 2025, the Author transforms the 1st January 2025 date into a numerical value (45658) using Microsoft Excel. Subsequently, the LINEST function in Microsoft Excel is employed to generate polynomial equations ranging from linear (1st-degree) to 6th-degree polynomial models, as illustrated in Figure 9.

LINEST FUNCTION

CATEGORY	Designated Midpoint	Big Mac Price (IDR)
Linear	Jan-25	38,752
2nd POLY	Jan-25	39,176
3rd POLY	Jan-25	31,424
4th POLY	Jan-25	31,844
5th POLY	Jan-25	39,039
6th POLY	Jan-25	39,404

Table 5 – Big Mac Price on 1st January 2025 using LINEST Function⁵⁴

Based on the results in Table 5, it is evident that the 4th-degree polynomial line also shows a negative trend. “If the forecast is constructed using an inaccurate time series as its foundation, the resulting projection will likely be corrupted. This concept is often summarized as *“Garbage In, Garbage Out”*.”⁵⁵ Therefore, based on the findings, only four regression models are selected: Linear, 2nd-degree polynomial, 5th-degree polynomial, and 6th-degree polynomial.

Table 6 displays the Low, Medium, and High values that correspond to the results in Table 5. The Low value represents the lowest Big Mac Price, the Medium value signifies the average of all positive trendlines, and the High value denotes the highest Big Mac Price obtained from the calculations.

BASELINE (DEC 2022) (IDR)	FORECASTED BIG MAC PRICE (IDR)		
	LOW	MEDIUM	HIGH
34,000	38,752	39,093	39,404

Table 6 – Forecasted Big Mac Price on 1st January 2025⁵⁶

⁵⁴ By Author

⁵⁵ The problem with negative values in time-series forecasting – Anamind advanced analytical planning. (2020, April 15). Anamind. <https://www.anamind.com/anamind-blog/problem-time-series-forecasting/>

⁵⁶ By Author

Subsequently, the Lognormal Distribution method is employed for probability distribution. The outcome of calculating the projected Big Mac Price for January 2025 is presented in Table 7 and Figure 10. The P80 value is chosen as determined in Step 4.

FORECAST IN JANUARY 2025	
CATEGORY	BIG MAC PRICE
LOW	IDR 38,752
MEDIUM	IDR 39,093
HIGH	IDR 39,404
LN LOW	10.565
LN MEDIUM	10.574
LN HIGH	10.582
LOG NORMAL ANALYSIS	
MIN	10.565
MOST LIKELY	10.573
MAX	10.582
MEAN	10.573
ST. DEV	0.008
P80 ESTIMATION USING LOG NORMAL (LOGINV 0.8)	IDR 39,354
LN P80	10.580

Table 7 – Lognormal Calculation of the Big Mac Price and Result of P80⁵⁷

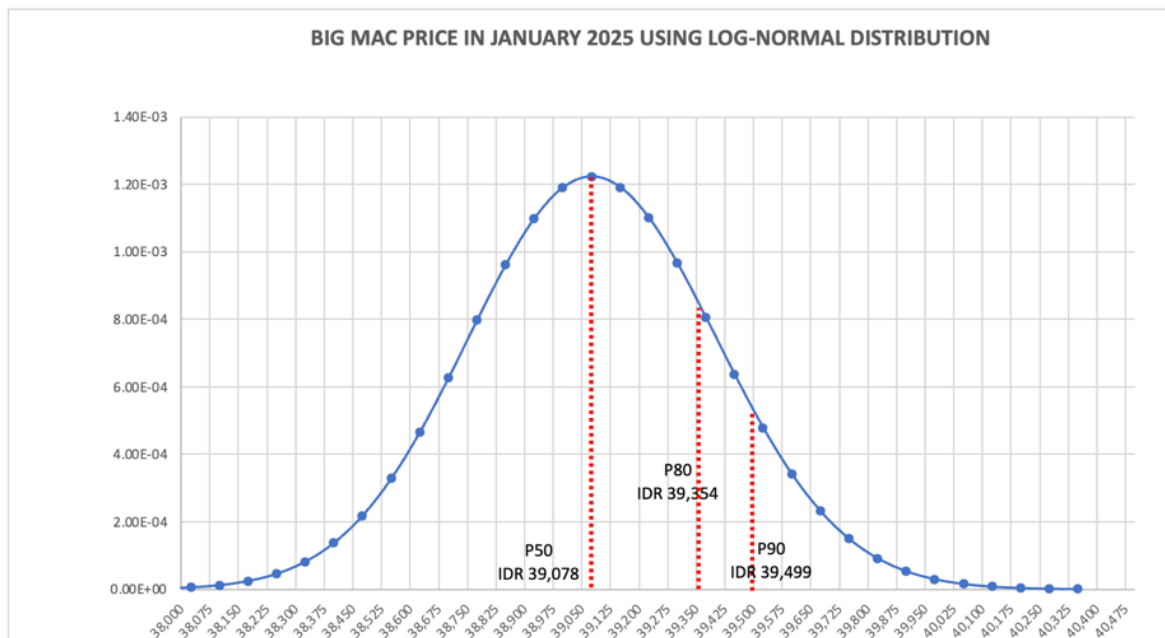


Figure 10 – Lognormal Distribution Curve of Forecasted Big Mac Price⁵⁸

⁵⁷ By Author

⁵⁸ By Author

Based on the calculation results, the P80 value of Big Mac Price in January 2025 is **IDR 39,354**.

b. Forecasting Gold Price

Forecasting the Gold Price follows the same steps as forecasting the Big Mac Index. According to the chart in Figure 7, the Gold price will be projected to reach the designated midpoint in January 2025. Figure 11 depicts a plot illustrating regression with multiple polynomial degrees: Linear, 2nd-order polynomial, 3rd-order polynomial, 4th-order polynomial, 5th-order polynomial, and 6th-order polynomial.

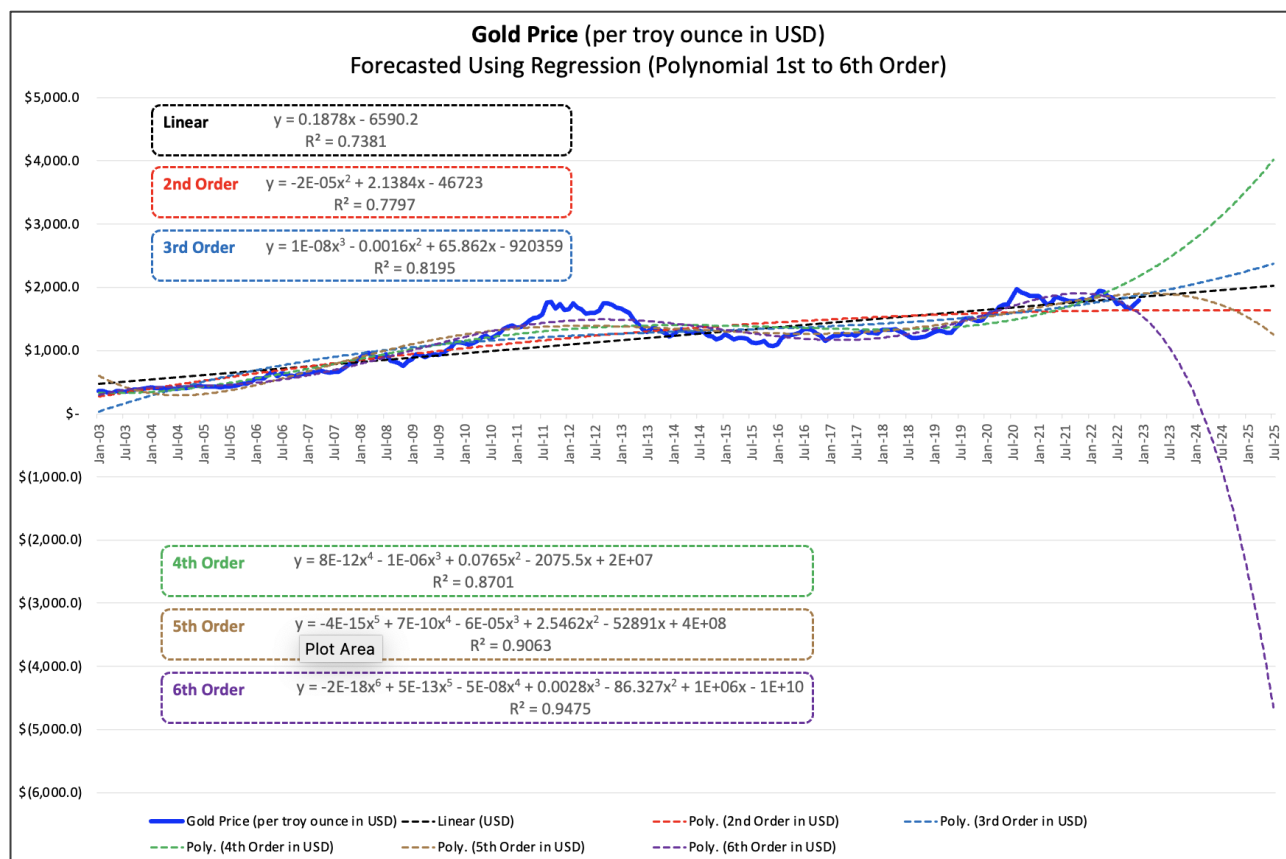


Figure 11 – Forecasting Gold Price to July 2025⁵⁹

The preceding regression analysis in Figure 11 indicates that the 2nd-degree, 5th-degree, and 6th-degree polynomial lines portrays a downward trend, which is undesirable for accurate forecasting. Consequently, solely positive trendlines are

⁵⁹ By Author

considered in this analysis. The regression results depicted in Figure 11 are showcased in Table 8.

Regression	Trend	R ² Value
Linear	Positive	0.7381
2nd Deg. Polynomial	Negative	0.7797
3rd Deg. Polynomial	Positive	0.8195
4th Deg. Polynomial	Positive	0.8701
5th Deg. Polynomial	Negative	0.9063
6th Deg. Polynomial	Negative	0.9475

Table 8 – Regression Forecasting Gold Price Model Results⁶⁰

Based on the outcomes presented in Table 8, it is evident that the 4th-degree polynomial model displays the highest R² value (0.8701), while the 1st-degree or linear model registers the lowest value (0.7381). The LINEST function in Microsoft Excel is engaged to formulate polynomial equations spanning from linear to 6th-degree polynomial models, as illustrated in Table 9.

LINEST FUNCTION

CATEGORY	Designated Midpoint	Gold Price (USD)
LINEAR	Jan-25	\$ 1,987
2nd POLY	Jan-25	\$ 1,634
3rd POLY	Jan-25	\$ 2,258
4th POLY	Jan-25	\$ 3,547
5th POLY	Jan-25	\$ 1,529
6th POLY	Jan-25	\$ 1,303

Table 9 – Gold Price on 1st January 2025 using LINEST Function⁶¹

Only three regression models are opted for: Linear, 3rd-degree polynomial, and 4th-degree polynomial. Table 10 presents the Low, Medium, and High figures that align with the outcomes illustrated in Table 9.

BASELINE (DEC 2022) (USD/TROY OUNCE)	FORECASTED GOLD PRICE (USD PER TROY OUNCE)		
	LOW	MEDIUM	HIGH
1797.5	1,964	2,186	3,263

Table 10 – Forecasted Gold Price on 1st January 2025⁶²

⁶⁰ By Author

⁶¹ By Author

⁶² By Author

Next, using the Lognormal Distribution model to establish the probability distribution, the result of computing the forecasted Gold Price for January 2025 is exhibited in Table 11 and Figure 12.

FORECAST IN JANUARY 2025	
CATEGORY	GOLD PRICE
LOW	\$ 1,987
MEDIUM	\$ 2,258
HIGH	\$ 3,547
LN LOW	7.594
LN MEDIUM	7.722
LN HIGH	8.174
LOG NORMAL ANALYSIS	
MIN	7.594
MOST LIKELY	7.830
MAX	8.174
MEAN	7.866
ST. DEV	0.292
P80 ESTIMATION USING LOG NORMAL (LOGINV 0.8)	\$ 3,332
LN P80	8.111

Table 11 – Lognormal Calculation of Gold Price and Result of P80⁶³

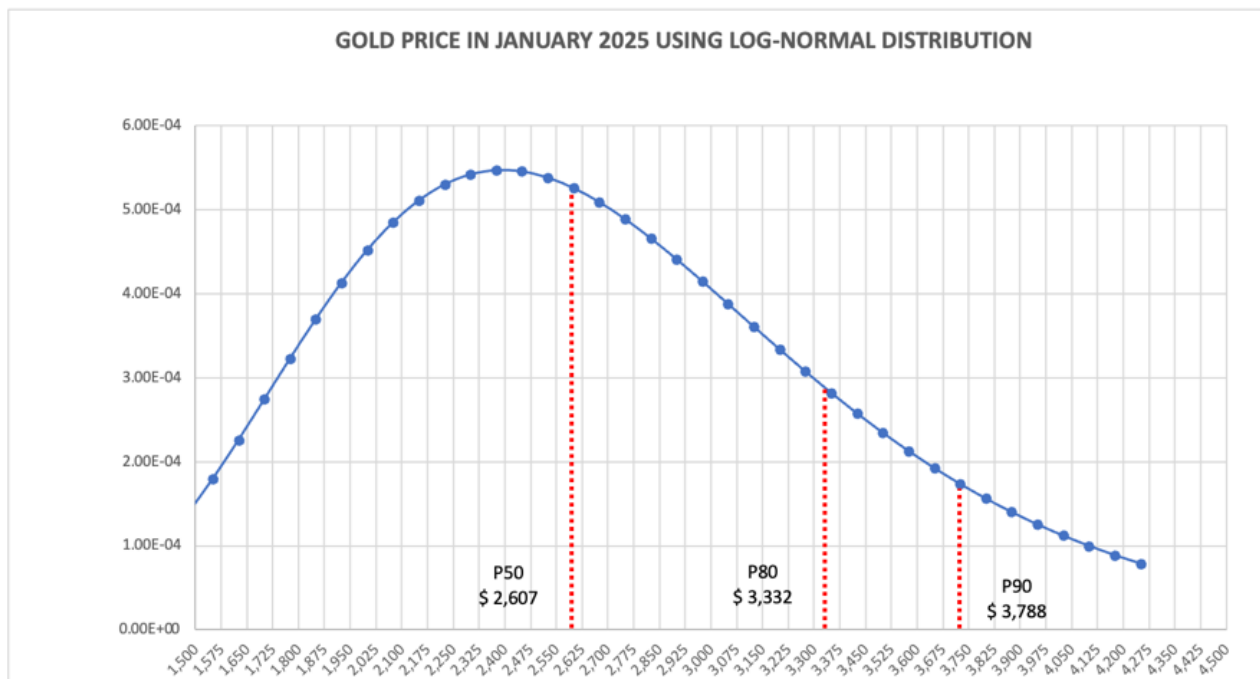


Figure 12 – Lognormal Distribution Curve of Forecasted Gold Price⁶⁴

⁶³ By Author

⁶⁴ By Author

Based on the calculation results, the P80 value of Gold Price (USD per troy ounce) in January 2025 is **\$ 3,332**.

Step 6 – Selection of Preferred Alternative

Based on computation and analysis on Step 5, the escalated CAPEX for Downstream Projects using each benchmark prices at P80 probability are shown in Table 12.

No	Project Name	BASELINE CAPEX (2022) (\$)	Budget Year Created	Designated Midpoint	ESCALATED CAPEX (USD)	
					BIG MAC PRICE	GOLD PRICE
1	Downstream A	38,735,000	2022	Jan-25	44,834,403	71,811,885
2	Downstream B	27,730,000	2022	Jan-25	32,096,502	51,409,412
3	Downstream C	72,029,000	2022	Jan-25	83,371,040	133,536,550
4	Downstream D	37,096,000	2022	Jan-25	42,937,318	68,773,298
5	Downstream E	25,353,000	2022	Jan-25	29,345,208	47,002,626
6	Downstream F	95,438,000	2022	Jan-25	110,466,136	176,935,141

Table 12 – Results of Cost Escalation of Downstream Projects Using Forecasted Big Mac Price and Gold Price as Benchmarks⁶⁵

Based on the results above, employing the Big Mac Price as an alternative currency resulted in an increase of 13.6% from the baseline CAPEX value of 2022. In contrast, utilizing the Gold Price leads to a CAPEX adjustment increase of 73.8%.

“Utilizing the Big Mac Index for extensive industrial or commercial construction endeavors is not advised. Prudent judgment dictates that the labor costs of skilled professionals such as welders or heavy equipment operators vastly differ from those of individuals engaged in burger preparation. Furthermore, the materials employed in construction markedly contrast with those used in food production.”⁶⁶

On the other hand, “Gold holds a broader intrinsic value compared to the Big Mac, which is influenced by supply and demand dynamics. Gold is often viewed as a safeguard

⁶⁵ By Author

⁶⁶ PTMC & Giammalvo, P. D. (2021). Unit 13 - Managing Database. <https://build-project-management-competency.com/1-4-1-13-unit-13/>. Figure 24 through 28.

against inflation.”⁶⁷ “As a result, fluctuations in gold prices can function as early indicators of changes in overall price levels, including wages and those within construction costs.”⁶⁸

Based on the rationale above and the intended application of the analytical findings in the construction industry, the Author has opted to utilize the simulated outcome value derived from **the Gold Price Index**. While the increased CAPEX may appear elevated compared to utilizing the Big Mac Price as a benchmark, it is deemed acceptable “to account for unforeseen risks that may arise during program advancement. This approach also serves to diminish the probability of necessitating a program re-baseline due to premature depletion of the program's contingency before its completion.”⁶⁹

Step 7 – Performance Monitoring and Postevaluation Results

Table 12 shows a notable contrast in forecasted costs using the alternative currencies between the Gold Price Index and the Big Mac Index. This divergence might stem from the Gold Price Index having a steeper price growth trajectory compared to the more gradual increase seen with the Big Mac Index.

⁶⁷ Yonathan, S. (2023, July 10). *W4.0_SY_Predicting vapor recovery unit cost for feasibility study (AACE class 4) in 2024 using gold price index and compare it with previous big Mac index*. RETRO MERCI. https://retromerci2023.wordpress.com/2023/07/10/w4-0_sy_predicting-vapor-recovery-unit-cost-for-feasibility-study-aace-class-4-in-2024-using-gold-price-index-and-compare-it-with-previous-big-mac-index/

⁶⁸ Artono, M. (2020). *W4.0_MA_Predicting Indonesia Minimum Monthly Wages Using Gold Price Equivalency*. Retrieved from https://2020vaccineaace.wordpress.com/2020/09/29/w4-0_ma_predicting-indonesia-minimum-monthly-wages-using-gold-price-equivalency/

⁶⁹ The United States Government Accountability Office. (2020). *GAO Cost Estimating and Assessment Guide: Best Practices for Developing and Managing Capital Program Costs*, page 173.

How Do We Underestimate?

- Let Me Count The Ways -

1. **OMIT PROBABLE SCOPE** from estimate
 2. **OMIT POSSIBLE RISKS** from analysis
 - Internal & External
 3. **UNREALISTIC, OPTIMISTIC** assumptions
- } RAND Study – Reason for 74% of Cost Growth
4. **Use historically LOW ESCALATION** projections
 - RAND Study – Reason for 11.2% of Cost Growth
 5. **Issue cost estimates in BASE YEAR** dollars
 - Estimates should be in then year dollars (escalated to year in which it is spent)
 6. **Many estimates NOT PREPARED BY A BONA FIDE ESTIMATOR**
 - Everyone's a estimator
 - Being certified no guarantee of having necessary experience
 7. **REWARD failure, PUNISH honesty**
 8. **NOT ENOUGH TIME** to prepare **CREDIBLE** estimates
 - Time often spent doing "what if" exercises, or splitting dollars into arbitrary buckets

"I reject a system that rewards failure and protects a person from its consequences"

- Barack Obama -

Figure 13 – Factors causing inaccuracy of estimates^{70 71}

Considering the reasoning and how these findings apply to the construction industry, the Author has chosen to employ the simulated outcome from the Gold Price Index. Furthermore, the RAND Study stated that omitting probable scope from the estimate and possible risks from the analysis, along with unrealistic assumptions, contributes to 74% of cost growth. The result of the RAND study is considered to be related to the escalated CAPEX obtained in Table 12 using the Gold Price.

CONCLUSION

The aim of this study is to address all the following questions:

- a. **What are the current methods for cost escalation in project budgeting in Indonesia's downstream oil and gas sector?**

In Oil and Gas Downstream project budgeting, cost escalation methods involve Owner's Estimate (OE) adjustments during tender processes, addressing the time

⁷⁰ Butts, G. (2010, February). Mega Projects Estimate - A History of Denial.

⁷¹ Wisnugroho, J. (2020). Indonesia Oil & Gas Cost Estimating vs International "Best-Tested and Proven" Practices – A Benchmarking Study; *PM World Journal*, Vol. IX, Issue II, February. Retrieved from <https://pmworldlibrary.net/wp-content/uploads/2020/02/pmwj90-Feb2020-Wisnugroho-benchmarking-indonesia-og-cost-estimating-vs-international3.pdf>

gap between cost estimation and bid acceptance. However, the adjusted OE method focuses solely on the year of bidding, omitting the construction period gap, which should be considered for escalation. In the context of Indonesia, recent studies by Santoso et al. and Meiyannur et al. in infrastructure sectors highlight the potential to adjust multiyear project prices using a contract-based price index, as outlined in Regulation of The President of The Republic of Indonesia No. 16 of 2018 on Government Procurement. Notably, this adjustment takes place by the 13th month after work commencement, potentially leading to cost overruns due to the adjustment delay from the Owner's perspective.

b. Which method or benchmark/index emerges as the best fit for cost escalation in the Author's company?

Selection of Feasible Benchmark:

Four distinct indices are assessed to identify a suitable alternative benchmark for cost escalation, including:

- The inflation rate in Indonesia
- The US Dollar Index
- The price of gold
- The Big Mac Index

This evaluation aimed to pinpoint an alternative benchmark that exhibits a consistent and predictable pattern over time.

Determination of Optimal Benchmark:

To determine the optimal benchmark, a Regression analysis was performed, with the selection criterion concentrating on the Coefficient of Determination (R^2) value, which indicates alignment between the best-fit line and the data points. Greater R^2 values indicate a more precise fit. The Big Mac Index (measured in IDR) and the Gold Price Index (measured in US dollars per troy ounce) emerged as the two leading candidates, as they demonstrated R^2 values (0.98 and 0.947, respectively), indicating a substantial correlation to the trend line.

Preferred Option:

The Gold Price Index was the superior benchmark for cost escalation in the Author's organizational context. The Gold Price Index's consistent growth trend and alignment with broader price patterns, including construction costs, affirm its

suitability as the preferred benchmark for accurate cost escalation in the organization's projects.

Although the higher escalated CAPEX may seem steep compared to using the Big Mac Price as a benchmark, it's considered justified to accommodate unexpected risks during program progression. This aligns with the findings of the RAND Study, which emphasized that failing to include probable scope and potential risks, coupled with unrealistic assumptions, leads to a significant 74% cost growth.

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About the Author



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Glenn Cahya Dwi Ramadhan is an engineer with a proven track record of eight years of professional experience in construction and holding various roles in the oil and gas downstream sectors, including marine operations, strategic budgeting, and project management. Currently, he is employed as an engineer at Indonesia's national oil company, specializing in berthing facilities and other downstream infrastructure design. He earned his bachelor's degree in Mechanical Engineering from Universitas Indonesia (UI) and is currently pursuing a master's degree in Management at the same institution. Glenn is currently enrolled in a distance learning mentoring program led by Dr. Paul D. Giammalvo, CDT, CCE, MScPM, MRICS, and GPM-m Senior Technical Advisor, PT Mitratata Citragraha, with the goal of achieving Certified Cost Professional certification from AACE International.

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