
Beyond Gold Price Indexation: INKINDO Billing Rate as Labor Escalation Factor for Indonesian CAPEX Estimates^{1,2,3}

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ABSTRACT

An Indonesian downstream oil and gas company uses a single Gold Price index across all Class 3 CAPEX cost types, including the labor stream. Gold price movements are unrelated to how Indonesian engineering wages are set, so this practice skews labor escalation estimates in the wrong direction. This paper tests five Indonesian price series — INKINDO SBOB, BPS CPI, Gaji PNS, GDP Deflator, and IHPB Konstruksi — over 2007–2025 using MADM scoring, Pearson correlation, back casting, and PPP real-wage analysis. INKINDO SBOB comes out on top ($S_i = 0.8250$; rank 1) as the only series showing positive real-wage growth above the GDP Deflator after 2013 (+1.45 pp/yr). The CAGR coherence test passes: P-50 = 4.628%/yr, divergence 0.41 pp against historical CAGR. A PPP-adjusted comparison with the 2023 AACE salary survey puts Indonesian engineering professionals roughly 30% below the global median — wage-pressure macro indices miss this entirely. The paper provides an escalation factor table for mid-years 2027–2031 at five probability levels, enabling practitioners to replace the Gold Price proxy with a rate that fits.

Keywords: *Engineering Wage Index, Class 3 Cost Estimate, Purchasing Power Parity, Multi-Attribute Decision Making, Real-wage Growth Analysis, Escalation Index Selection, Back-casting validation*

INTRODUCTION

A. Industry Context & the Escalation Imperative

Capital expenditure (CAPEX) estimation in the downstream oil and gas sector is performed under structural uncertainty, in which energy price volatility, currency

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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 Mitra 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/>.

³ AI-assisted tools were used to support language editing and readability improvement under the author's oversight and control. All analytical content, data interpretation, and conclusions are the author's own.

movements, and geopolitical disruptions interact to alter procurement costs over the multi-year window between estimate preparation and construction completion. As shown in Figure 1, according to EIA data⁴, Brent crude swung 136% between the 2020 COVID-19 pandemic and the 2022 Ukraine war. This volatility has continued into the present writing period: following disruptions in the Strait of Hormuz, Brent surged to USD 94 per barrel on March 9, 2026. Brent is a legitimate CAPEX cost driver that influences petroleum-derived material prices, contractor pricing power, and project sanctioning conditions.

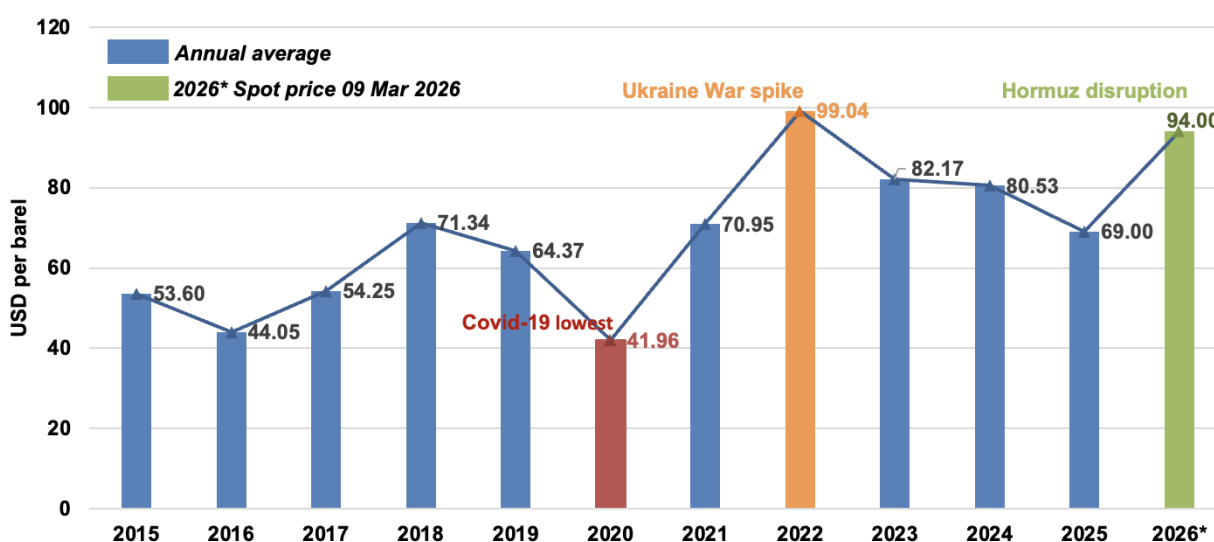


Figure 1. Brent Crude Oil Price—Annual Average 2015 to March 2026^{5,6,7}

Figure 2 reveals that the Indonesian rupiah depreciated by 26.6% over the same period from IDR 13,389 to IDR 16,950 per US dollar — directly inflating the IDR cost of imported equipment and foreign-currency procurement.

⁴ U.S. Energy Information Administration (EIA). Crude oil prices: Brent—Europe (2015–2024): <https://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=RB RTE&f=A>

⁵ U.S. Energy Information Administration (EIA). Crude oil prices: Brent—Europe (2015–2024): <https://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=RB RTE&f=A>

⁶ EIA (2025a). Crude oil prices fell in 2025 amid oversupply (2025 annual avg USD 69/bbl): <https://www.eia.gov/todayinenergy/detail.php?id=66944>

⁷ EIA (2025b). Short-term energy outlook, March 2026 (2026 spot USD 94/bbl on 9 Mar 2026): <https://www.eia.gov/outlooks/steo/>

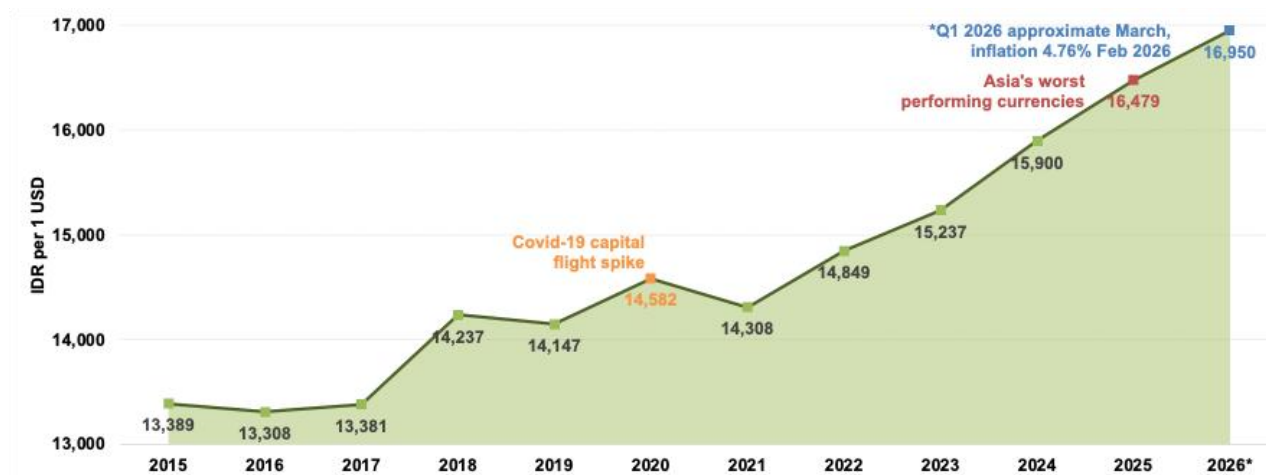


Figure 2.IDR Exchange Rate (USD/IDR)-Annual Average 2015-2025 & March 2026 Approximate (Higher Value=Depreciation)^{8,9,10}

Gold Price, by contrast, appreciated 333% from USD 1,160 to USD 5,021 per ounce, as shown in Figure 3, driven entirely by safe-haven capital flows and central bank accumulation¹¹, with no structural relationship to engineering materials, equipment, or labor costs.

⁸ Bank Indonesia. Exchange rate statistics (2015–2024): <https://www.bi.go.id/en/statistik/indikator/kurs-transaksi.aspx>

⁹ Exchange-Rates.org (2025). IDR to USD historical exchange rates 2025 (2025 annual avg IDR 16,479): <https://www.exchange-rates.org/exchange-rate-history/idr-usd-2025>

¹⁰ EBC Financial Group (2025, Dec 9). Why is Indonesia currency so weak against the US dollar: <https://www.ebc.com/forex/why-is-indonesia-currency-so-weak-against-the-us-dollar>

¹¹ World Gold Council (2026). Gold demand trends: Q4 and full year 2025 (2025 annual avg): <https://www.gold.org/goldhub/research/gold-demand-trends/gold-demand-trends-full-year-2025>

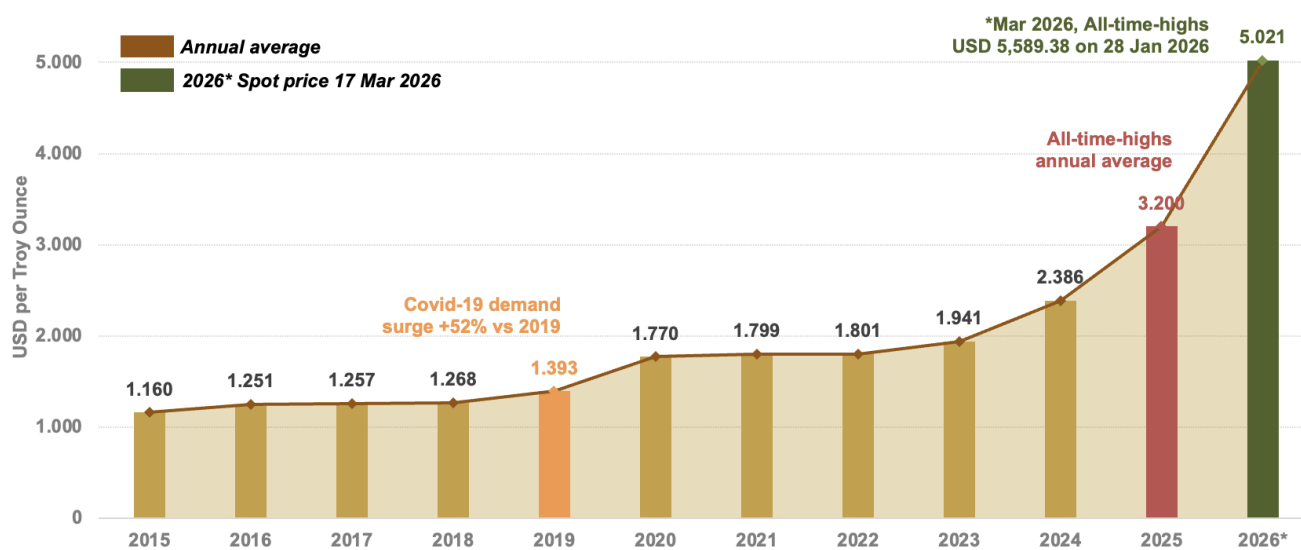


Figure 3. Gold Price-Annual Average 2015-2025 & March 2026 Spot^{12,13,14,15}

Figure 4 presents the three series on a common index scale with 2015 as the base year, enabling direct comparison. By March 2026, the divergence between the gold index and the other two series reaches its widest point in the dataset. Because these series move in structurally different directions, the choice of index materially determines the direction and magnitude of the forecast error in escalation. AACE RP 18R-97 defines “Class 3 accuracy ranges of - 20% to + 30%”¹⁶ — a band already wide enough that an inappropriate index widens it further.

The GAO twelve-step process addresses escalation index selection at Step 6 — “obtain the data” — ahead of Step 7 “develop the point estimate” and Step 9 “risk and uncertainty analysis”¹⁷, recognizing that a flawed basis propagates error through every downstream calculation. When gold, which appreciated by 333% while Brent averaged USD 68, and the rupiah, which depreciated only 26.6%, is applied uniformly as a labor escalation

¹² World Gold Council. (2024). Gold price data: Historic gold prices. <https://www.gold.org/goldhub/data/gold-prices>

¹³ World Gold Council. Gold price data: Historic gold prices (2015–2024): <https://www.gold.org/goldhub/data/gold-prices>

¹⁴ World Gold Council (2026). Gold demand trends: Q4 and full year 2025 (2025 annual avg): <https://www.gold.org/goldhub/research/gold-demand-trends/gold-demand-trends-full-year-2025>

¹⁵ Fortune. (2026, March 13). Current price of gold as of March 13, 2026. <https://fortune.com/article/current-price-of-gold-03-13-2026/>

¹⁶ AACE International. (2020). Recommended practice no. 18R-97: Cost estimate classification system – as applied in engineering, procurement, and construction for the process industries (Rev. 4). AACE International.

¹⁷ GAO. (2020). Cost estimating and assessment guide: Best practices for developing and managing program cost estimates (GAO-20-195G). U.S. Government Accountability Office. <https://www.gao.gov/products/gao-20-195g>

index, the estimate absorbs financial market noise, lacks a structural relationship to domestic engineering wage movements, and ultimately introduces systematic bias.

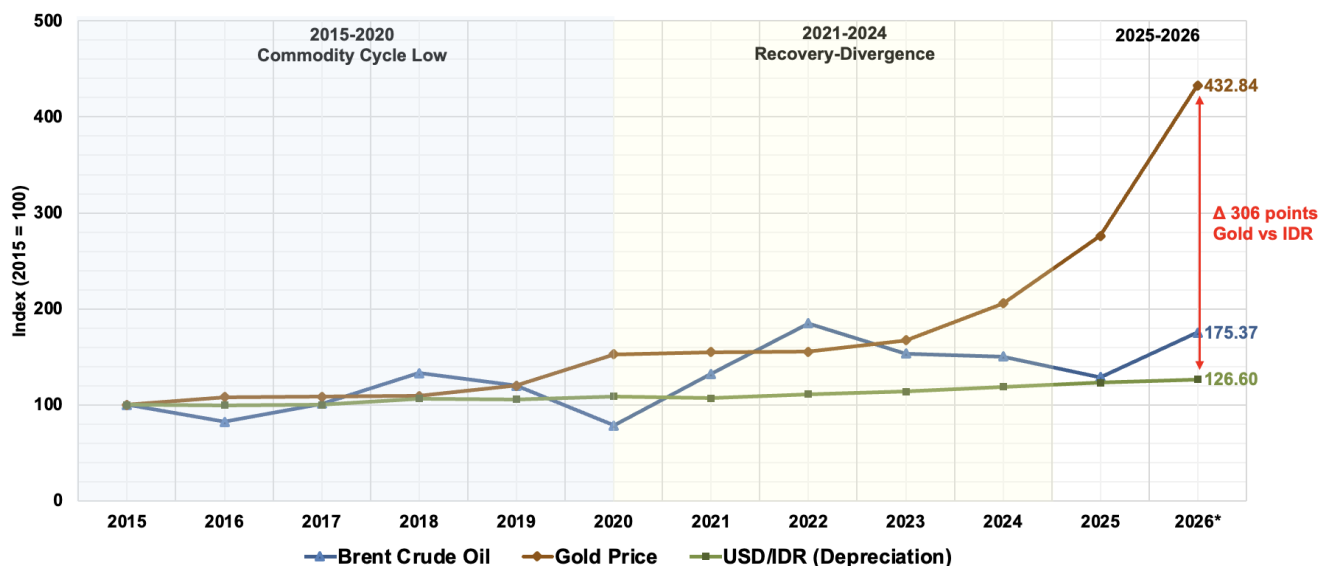


Figure 4. Composite Index-Brent Crude Oil, USD/IDR Exchange Rate, Gold Price 2015 to March 2026¹⁸

B. The Methodological Gap

The application of a single index to all cost elements violates established cost escalation methodology. AACE RP 58R-10 states that “each good and service may constitute a distinct micro-economy with its own escalation situation”¹⁹, requiring index selection specific to the major cost types present in the estimate. AACE RP 68R-11 reinforces this by requiring the “use of indices appropriate to each cost account and addressing differential price trends between accounts”²⁰ — a specification that uniform single-index application cannot satisfy. Sullivan, Wicks, and Koelling establish that price indices for different cost categories reflect distinct underlying economic forces²¹. In EPC projects, this means material prices follow commodity markets and supply chains, while engineering labor pay is shaped by local regulations, skill availability, and contract terms — none of which have a structural link to global commodity indices. These institutional

¹⁸ By Author.

¹⁹ AACE International. (2011). Recommended practice no. 58R-10: Escalation estimating principles and methods using indices. AACE International.

²⁰ AACE International. (2012). Recommended practice no. 68R-11: Escalation Estimating Using Indices and Monte Carlo Simulation. AACE International.

²¹ Sullivan, W. G., Wicks, E. M., & Koelling, C. P. (2023). Engineering economy (17th ed.). Pearson Education.

frameworks reflect principles that apply across project types and jurisdictions, including the Indonesian EPC environment addressed in this paper.

The DOE Cost Estimating Guide explicitly recognizes that "the learning curve applies only to direct labor input"²² and materials and overhead will not necessarily be affected in the same way. This structural difference carries through to escalation index selection when cost drivers diverge across estimate components. The NASA Cost Estimating Handbook reinforces this by documenting contractor labor rates and inflation factors as separate line items in the basis of estimate, each requiring independent documentation and rationale²³.

The Gold Price has no structural relationship to Indonesian engineering wage formation. When gold appreciated sharply in 2020 and in 2023–2026, the derived factor overstates labor cost growth; when gold stagnated between 2011 and 2018 while engineering wages continued to rise, it understated them. Because the error direction cannot be predicted in advance, no conservative correction is available without disaggregating the estimate and applying a purpose-built labor index. Two practitioner papers in PM World Journal are relevant here. Rachman shows that choosing the right index is fundamental to producing credible cost forecasts for Indonesian upstream projects²⁴, and Wisnugroho's benchmarking of Indonesian downstream cost estimating against international best practices identified inadequate escalation treatment as one of eight documented root causes of cost estimate inaccuracy in the industry²⁵. Neither study, however, evaluated sector-specific labor indices as candidates for the escalation factor — a gap this paper directly addresses.

C. The Candidate Labor Indices

Five price series constitute the candidate pool for evaluation as labor wage escalation indices, representing the complete set of publicly available Indonesian price series that plausibly measure domestic labor or general price escalation. No comparative evaluation is made at this stage; that assessment is reserved for the Methodology section.

²² U.S. Department of Energy. (2011). Cost estimating guide (DOE G 413.3-21). Office of Management, U.S. Department of Energy. <https://www.directives.doe.gov/directives-documents/400-series/0413.3-EGuide-21>

²³ NASA. (2015). NASA cost estimating handbook (Version 4.0). National Aeronautics and Space Administration. <https://www.nasa.gov/content/cost-estimating-handbook>

²⁴ Rachman, A. (2020). Using cost indices. PM World Journal, IX(II), February. <https://pmworldjournal.com/article/using-cost-indices>

²⁵ Wisnugroho, J. (2020). Indonesia oil & gas cost estimating vs international "best-tested and proven" practices — A benchmarking study. PM World Journal, 9(2). <https://pmworldlibrary.net/wp-content/uploads/2020/02/pmwj90-Feb2020-Wisnugroho-benchmarking-indonesia-og-cost-estimating-vs-international3.pdf>

Consumer Price Index (CPI). Published monthly by Badan Pusat Statistik (BPS) and reported by Bank Indonesia; measures price changes across a representative household consumption basket.

Civil Servant Salary Index (Gaji PNS). Determined by Presidential Regulation (Peraturan Pemerintah); it applies uniformly to all Indonesian civil servants.

GDP Deflator. Derived from BPS national accounts; included as a reference benchmark rather than a selection candidate, serving specific analytical functions detailed in the Methodology.

Wholesale Price Index — Construction Sub-Index (IHPB Konstruksi). Published monthly by BPS; measures wholesale price changes of construction materials, making it the most construction-sector-adjacent macro index available and therefore the strongest potential macro substitute for a purpose-built labor index.

INKINDO Billing Rate Series (SBOB). Published annually by Ikatan Nasional Konsultan Indonesia (INKINDO); establishes minimum remuneration rates for engineering and consulting professionals across all 34 Indonesian provinces, segmented by educational qualification, years of experience, contract type, and regional classification.

D. Research Question

This paper is guided by three research questions, sequenced to mirror the paper's analytical logic: first, establishing which index is most appropriate; then validating its empirical properties; and finally determining how it should be applied in practice.

1. Among the five price series, which is most appropriate for labor wage escalation in Class 3 CAPEX estimates, evaluated through a multi-attribute framework encompassing sector specificity, PPP real-wage alignment, predictive accuracy, correlation, data completeness, and institutional credibility?
2. Does the INKINDO Billing Rate Series demonstrate sufficient empirical validity — evidenced through positive real-wage growth above the GDP Deflator and CAGR coherence across the 2007–2025 study window — to justify adoption in Indonesia's downstream oil and gas CAPEX estimates?
3. What is the recommended escalation factor, probability level, and confidence range for a Class 3 CAPEX application, derived using an empirical distributional approach?

METHODOLOGY

This paper will follow the methodology as illustrated in Figure 5 below:

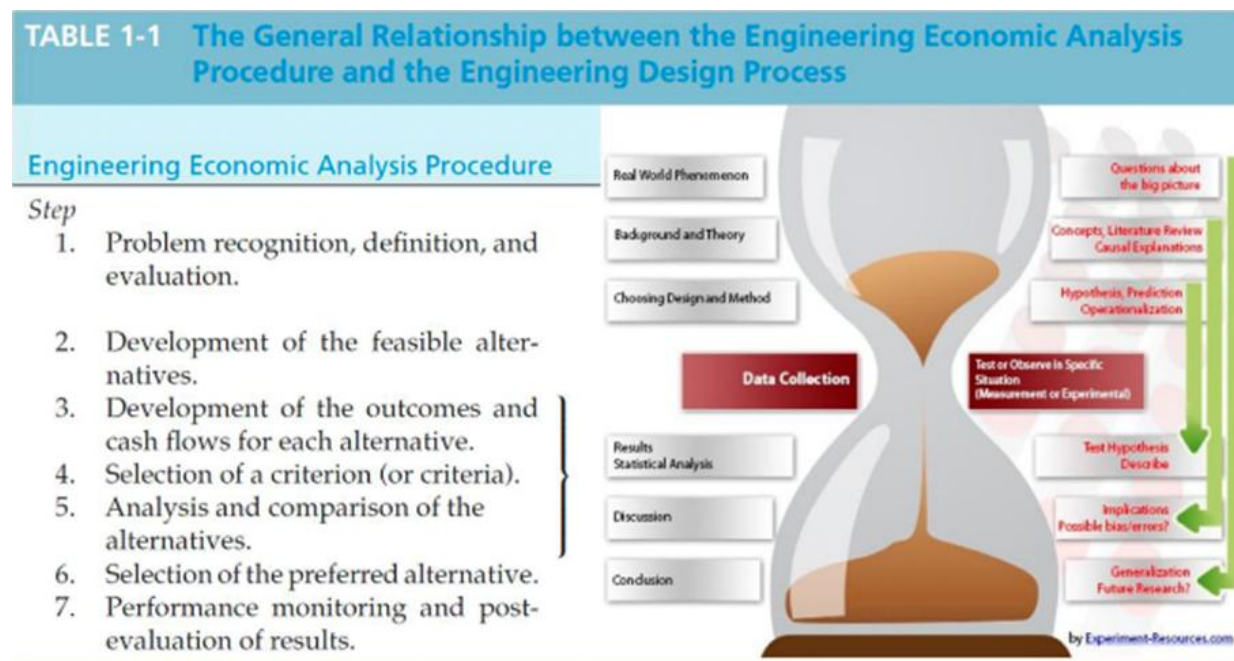


Figure 5. Engineering Economic Analysis Procedure^{26,27}

Step 1 - Problem Definition

Using a single Gold Price index for all CAPEX cost types treats commodity procurement and professional labor as the same, even though their price drivers are completely different. AACE RP 58R-10 recognizes that “each major cost type may constitute a distinct micro-economy with its own escalation situation”²⁸, warranting its own dedicated index. AACE RP 68R-11 reinforces this by requiring the “use of indices appropriate to each cost account and addressing differential price trends between accounts”²⁹ — a requirement that uniform single-index application structurally cannot satisfy. This separation is independently affirmed in the institutional and theoretical literature reviewed previously. Under a unified Gold Price basis, accelerating wage growth goes undetected when gold stagnates, and financial-market appreciation inflates the labor component

²⁶ Sullivan, W. G., Wicks, E. M., & Koelling, C. P. (2023). *Engineering economy* (17th ed.). Pearson Education.

²⁷ Shuttleworth, M. (2008, February 2). What is research? <https://explorable.com/what-is-research>

²⁸ AACE International. (2011). Recommended practice no. 58R-10: Escalation estimating principles and methods using indices. AACE International.

²⁹ AACE International. (2012). Recommended practice no. 68R-11: Escalation estimating using indices and Monte Carlo simulation. AACE International.

when gold surges — neither condition recoverable without cost-type disaggregation. A fit-for-purpose escalation instrument for the labor category must therefore be identified from among the publicly available Indonesian price series that directly or proximately measure the cost of professional engineering labor — an index selection problem that requires structured comparative evaluation across multiple performance criteria.

Research objectives

Based on the problem above, this study pursues three objectives:

- 1) To evaluate five price series — INKINDO SBOB, BPS CPI, Gaji PNS, GDP Deflator, and IHPB Konstruksi — against engineering billing rate movements over the 2007–2025 study window using NDI, correlation, back-casting, and PPP real-wage analysis, and to select the most appropriate through a five-criterion MADM framework.
- 2) To assess the empirical validity of the INKINDO Billing Rate Series as a dedicated labor wage escalation instrument, through evidence of sustained positive real-wage growth above the GDP Deflator and coherence between the empirical P-50 annual rate and the historical compound annual growth rate across the study window.
- 3) To derive and publish a statistically defensible escalation factor lookup table for the labor component of Class 3 CAPEX estimates, expressed across empirically derived probability levels for construction mid-years 2027 through 2031.

Step 2 - Identify The Feasible Alternative

Five price series satisfy three common feasibility criteria: (a) publicly available and independently verifiable, with interpolated values for years of non-publication documented and flagged; (b) annual observations spanning 2007–2025 providing at least 18 data points; and (c) coverage of a price or cost dimension with at least a theoretical relationship to engineering labor costs. One series — the GDP Deflator — is included not as a selection candidate but in three roles: as the economy-wide PPP reference benchmark, as a back-casting comparator establishing the macro proxy performance floor, and to give the non-dimensional scaling a meaningful bound. The remaining four constitute the active selection candidates evaluated against the criteria above. Table 1 summarizes their institutional sources, measurement bases, frequencies, and coverage windows. Each candidate's structural characteristics are described in the Introduction; the entries below note only the methodological considerations relevant to this study.

Table 1. Summary of candidate indices³⁰

Index	Source Institution	Frequency	Window	Sector Specificity	Measurement Basis
Consumer Price Index (CPI)	BPS / Bank Indonesia	Monthly	2007–2024*	General economy	Household consumption basket: food, housing, transport, healthcare, education
Civil Servant Salary (Gaji PNS)	State Secretariat (Perpres)	Annual	2007–2025	Government sector	Government-administered wage scale; adjusted by Presidential Regulation
GDP Deflator	BPS National Accounts / World Bank WDI	Annual	2007–2025**	Economy-wide	Implicit price deflator: nominal GDP / real GDP at constant prices
IHPB Bahan Bangunan/ Konstruksi	BPS	Monthly	2007–2025	Producer / construction materials	Price changes at wholesale level; Bahan Bangunan/Konstruksi sub-index; chain-linked across base-year transitions
INKINDO SBOB (Billing Rate)	INKINDO	Annual	2007–2025***	Engineering consultancy	Minimum monthly remuneration for professional engineering consultants; sector-specific; legally underpinned by PUPR Decree 19/PRT/M/2017

Note: SBOB = Standar Biaya Orang Bulan. IHPB = Indeks Harga Perdagangan Besar. *CPI 2025 full-year average not yet published by BPS at time of writing; series truncated at 2024 (18 annual observations). **GDP Deflator 2025 derived from BPS national accounts press releases. ***INKINDO series contains five linear interpolations for years 2009, 2012, and 2020–2022 (no INKINDO publication during COVID-19); confirmed-observation details in Table 2.

Step 3 - Development of The Alternative

3.1 Data collection and series construction

All five-price series are compiled for 2007 to 2025, yielding 18 to 19 annual observations per series. The INKINDO SBOB series is based on annual PDF publications covering: S1/Setara educational level, 5 years of professional experience, NCB contract class, DKI Jakarta province. The series contains 14 confirmed annual readings and five linear interpolations: years 2009 and 2012 (no PDF available) and years 2020–2022 (no INKINDO publication during COVID-19), anchored at confirmed endpoints of

³⁰ By Author.

IDR25,000,000/month in 2019 and IDR27,650,000/month in 2023. The GDP Deflator 2025 value is derived from BPS national accounts press releases^{31,32} using the formula:

$$(\text{Nominal GDP}_{2025} / \text{Nominal GDP}_{2024}) \div (1 + \text{Real growth}_{2025}) - 1 = 2.37\%.$$

All derivations and interpolations are documented with data-quality flags. Table 2 summarizes the data construction for each series.

³¹ BPS-Statistics Indonesia. (2026). Berita Resmi Statistik: Pertumbuhan ekonomi Indonesia 2025. <https://www.bps.go.id/id/pressrelease/2026/02/05/2546/>

³² BPS-Statistics Indonesia. (2025). Berita Resmi Statistik: Pertumbuhan ekonomi Indonesia 2024. <https://www.bps.go.id/id/pressrelease/2025/02/05/2408/>

Table 2. Data construction summary^{33,34,35,36,37,38}

Index	Confirmed Observation*	Treatment Notes	Unit / Specification
INKINDO SBOB	14 of 19	5 interpolated: 2009, 2012, 2020–2022 (COVID gap); linear interpolation anchored at 2019 and 2023 confirmed endpoints	IDR/month; S1/Setara, 5yr exp., NCB, DKI Jakarta
BPS CPI	18 of 18	2025 full-year not yet published by BPS; series truncated at 2024	Annual avg of monthly Y-o-Y (%)
Gaji PNS	19 of 19	Zero-change years 2014–2023 (except 2015); +29.9% step-change in 2024	Avg. Golongan IIIC and IVC reference grades (IDR/month)
GDP Deflator	19 of 19	2007–2024: World Bank WDI (NY.GDP.DEFL.KD.ZG). 2025: derived from BPS BRS — (23,821.1/22,139.0) / 1,0511 – 1 = 2.37%	Annual % change
IHPB Konstruksi	18 of 19	2009 NDI by constant-growth interpolation (base break 2000=100→2005=100); 4 base-year transitions chain-linked; 2025 by chaining 2018=100→2023=100	Bahan Bangunan/Konstruksi sub-index; annual % change

Note: *years with directly sourced (non-interpolated, non-derived) values out of 19 annual study-period years (2007–2025). NDI = Non-Dimensional Index. BRS = Berita Resmi Statistik.

3.2 Historical analysis and non-dimensional indexing

Annual year-on-year (Y-o-Y) percentage changes are computed for each series as $[(V_t/V_{t-1}) - 1] \times 100$. Each series is then converted to a Non-Dimensional Index (NDI) with 2017 as the reference year ($NDI_{2017} = 1.0000$), following the non-dimensional scaling convention described in Sullivan et al (2023)³⁹. For value-based series (INKINDO SBOB,

³³ INKINDO. (2025). Pedoman standar minimal tahun 2025: Remunerasi/biaya personil (billing rate) dan biaya langsung untuk badan usaha jasa konsultansi. Ikatan Nasional Konsultan Indonesia

³⁴ Republic of Indonesia, Ministry of Public Works and Housing. (2017). Peraturan Menteri PUPR No. 19/PRT/M/2017 tentang standar remunerasi minimal tenaga kerja konstruksi.

³⁵ BPS-Statistics Indonesia. (2025). Consumer price index. Badan Pusat Statistik. <https://www.bps.go.id>

³⁶ Republic of Indonesia. (2024). Peraturan pemerintah nomor 5 tahun 2024 tentang penghasilan pegawai negeri sipil. State Secretariat of the Republic of Indonesia.

³⁷ World Bank. (2026). Inflation, GDP deflator (annual %) — Indonesia. World Development Indicators (NY.GDP.DEFL.KD.ZG). <https://data.worldbank.org/indicator/NY.GDP.DEFL.KD.ZG?locations=ID>

³⁸ BPS-Statistics Indonesia. (2025). Wholesale price index — Indeks Harga Perdagangan Besar (IHPB) bahan bangunan/konstruksi. Badan Pusat Statistik. <https://www.bps.go.id>

³⁹ Sullivan, W. G., Wicks, E. M., & Koelling, C. P. (2023). Engineering economy (17th ed., Ch. 13 & 14). Pearson Education.

Gaji PNS), the NDI is computed directly as V_t/V_{2017} ; for rate-based series (CPI, GDP Deflator, IHPB), annual Y-o-Y rates are chained forward and backward from the 2017 base. By the end of the study window, the four series with 2025 observations span a range of 0.1415 NDI units, as shown in Figure 6 and Table 3, with CPI ending in 2024 due to publication timing.

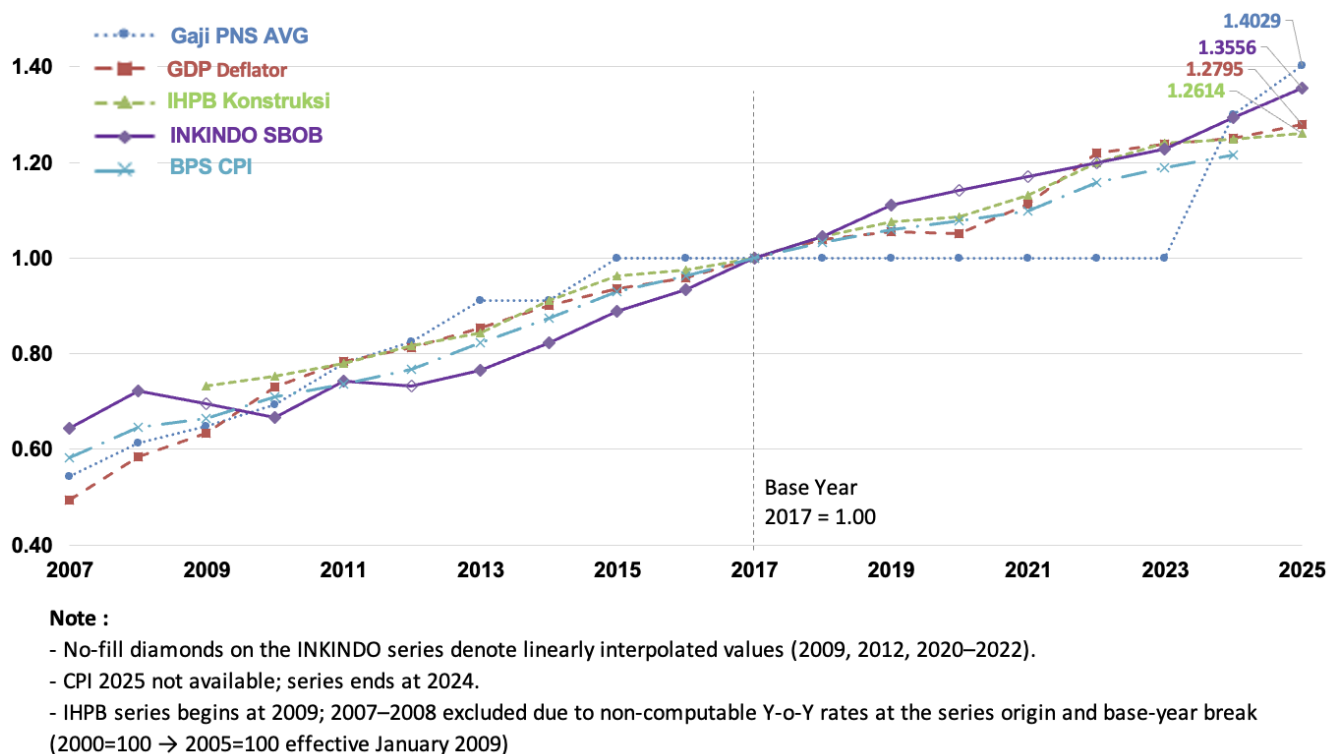


Figure 6. Non-Dimensional Index trajectory⁴⁰

⁴⁰ By Author.

Table 3. Non-Dimensional Index values⁴¹

Year	INKINDO SBOB	BPS CPI	Gaji PNS Avg	GDP Deflator	IHPB Konstruksi
2007	0.64	0.58	0.54	0.49	-
2009	<i>0.69</i>	0.66	0.65	0.63	0.73
2010	0.67	0.71	0.69	0.73	0.75
2012	0.73	0.77	0.82	0.81	0.82
2013	0.76	0.82	0.91	0.85	0.84
2015	0.89	0.93	1.00	0.94	0.96
2017	1.00	1.00	1.00	1.00	1.00
2019	1.11	1.06	1.00	1.05	1.08
2021	1.17	1.10	1.00	1.11	1.13
2023	1.23	1.19	1.00	1.24	1.24
2024	1.29	1.22	1.30	1.25	1.25
2025	1.36	-*	1.40	1.28	1.26

Note: Green shading = base year 2017 (all indices = 1.00 by definition). Italic values in INKINDO column = linearly interpolated years. *CPI 2025 not published by BPS at time of writing.

3.3 Correlation analysis

The author computed Pearson correlation coefficients between each candidate index Y-o-Y series and INKINDO SBOB Y-o-Y (n = 15–18 per pair; Figure 7). INKINDO SBOB is the reference series — the direct measure of engineering consulting labor costs — and is not evaluated against itself. As shown in Figure 7, IHPB produces the strongest association with INKINDO (r = +0.48, moderate), while GDP Deflator is negligible (r = +0.004); the four macro indices are strongly cross-correlated with each other (r = +0.72 to +0.78), confirming they track the same inflationary signal rather than engineering labor dynamics. The absence of any strong correlation (r ≥ 0.70) between INKINDO and any

⁴¹ By Author.

macro proxy is the first line of empirical evidence for the paper’s core argument, corroborated by the back-casting validation below.

Index	INKINDO (Y-o-Y %)	CPI (Y-o-Y %)	Gaji PNS (Y-o-Y %)	GDP Deflator (Y-o-Y %)	IHPB (Y-o-Y %)
INKINDO	1.00	0.32	0.21	0.00	0.48
	n=17	n=17	n=18	n=18	n=17
CPI	0.32	1.00	0.20	0.77	0.78
	n=17	n=17	n=17	n=18	n=16
Gaji PNS	0.21	0.20	1.00	0.12	0.11
	n=18	n=17	n=18	n=18	n=17
GDP Deflator	0.00	0.77	0.12	1.00	0.72
	n=18	n=18	n=18	n=18	n=17
IHPB	0.48	0.78	0.11	0.72	1.00
	n=17	n=16	n=17	n=17	n=17
Interpretation Guide					
≥ 0,70	Strong positive		Candidate strongly tracks INKINDO		
0,50–0,69	Moderate positive		Reasonable proxy candidate		
0,30–0,49	Weak positive		Limited tracking; possible co-movement		
< 0,30	Negligible		No meaningful tracking relationship		

Figure 7. Pearson correlation matrix and interpretation guide⁴²

3.4 Back-casting validation

The back-casting procedure tests whether any of the four macro proxies can adequately substitute for INKINDO as the direct labor cost measure. Each candidate’s historical growth rates are applied to project INKINDO values over rolling 1-, 2-, and 3-year horizons for 2007–2025. For each year-pair (t_1, t_2), the author compares what each index would have predicted against what INKINDO actually recorded and computes the prediction error as $\Delta EF = EF_{\text{actual}} - EF_{\text{index}}$ in percentage points. Figure 8 presents two panels: Panel A shows RMSE by index and forecast horizon; Panel B shows the empirical

⁴² By Author.

percentile position of actual INKINDO Y-o-Y growth within each index’s distribution. Tables 4 and 5 summarize the key statistics.

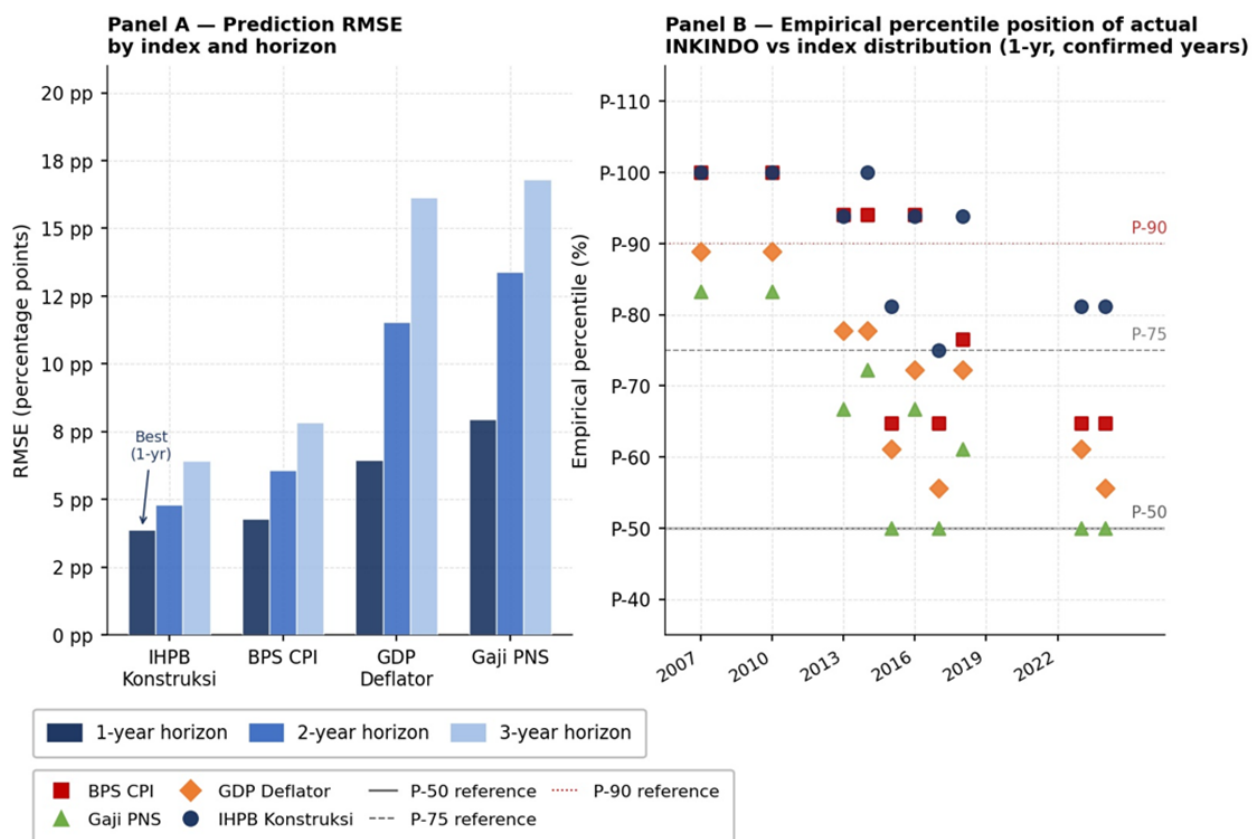


Figure 8. Back-casting validation results⁴³

IHPB Konstruksi is the best-performing proxy at the 1-year horizon (RMSE=3.888pp, MAE=3.203pp; Table 4), yet a positive MBE (+0.863pp) confirms actual INKINDO growth consistently exceeds IHPB. The empirical percentile analysis (Table 5) shows actual INKINDO growth exceeded IHPB at a median of the 93.8 percentile and CPI at the 85.3 percentile across confirmed years — confirming that any macro proxy applied at P-50 systematically understates Indonesian engineering labor escalation — by 3.9 pp/yr at best (IHPB, 1-year RMSE) and 7.9 pp/yr at worst (Gaji PNS, 1-year RMSE).

⁴³ By Author.

Table 4. Back-casting prediction error statistics by candidate index and forecast horizon⁴⁴

Candidate Index	RMSE 1-yr (pp)	MBE 1-yr (pp)	RMSE 2-yr (pp)	RMSE 3-yr (pp)
IHPB Konstruksi	3.888	+0.863	4.800	6.434
BPS CPI	4.279	-0.189	6.086	7.853
GDP Deflator	6.458	-1.217	11.534	16.145
Gaji PNS	7.953	-1.360	13.393	16.808

Note: RMSE = Root Mean Squared Error in percentage points (pp). MBE = Mean Bias Error; Positive = index under-predicted INKINDO growth.

Table 5. Empirical percentile position & recommended adjustment P-level⁴⁵

Candidate Index	Median P% (Empirical)	Range (P% Across Years)	Recommended P-level	Implication for CAPEX Estimation
IHPB Konstruksi	P-93.8	P-75 to P-100	P-95	Using IHPB at P-50 understates INKINDO escalation by approx. 3 pp/yr
BPS CPI	P-85.3	P-65 to P-100	P-85	Using CPI at P-50 understates labour escalation by approx. 3–4 pp/yr
GDP Deflator	P-72.2	P-55 to P-90	P-70	$r \approx 0$ vs INKINDO; structurally unsuitable regardless of P-level applied
Gaji PNS	P-63.9	P-50 to P-85	P-65	Erratic pattern: 2015–2023 freeze then 2024 +29.9% step-change decouples from INKINDO

Note: Median P% = median empirical percentile of actual INKINDO Y-o-Y vs candidate index distribution, across $n=10$ confirmed years. Recommended P-level rounded to nearest P-5. Green = best proxy candidate. Red = structurally unsuitable index.

3.5 Real-wage growth analysis

A purchasing power parity (PPP) check is done by computing the real growth differential for each candidate: $\text{Real growth}(t) = \text{Nominal Y-o-Y}(t) - \text{GDP Deflator}(t)$. For an index to qualify as a sector-specific instrument, it needs to show consistently positive differential above general inflation. The GDP Deflator carries 0.00 real differential by construction and serves as the benchmark against which all candidates are evaluated.

The full-period analysis (2008–2025, $n = 17-18$ per index; IHPB excludes 2008 per Section 3.1) is compressed by Indonesia’s commodity super-cycle of 2008–2010, during which the GDP Deflator was elevated (18.15%, 8.27%, 15.26%). The post-2013 window

⁴⁴ By Author.

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(2014–2025, n = 11–12 per index) provides the cleaner reference period, covering the post-boom stabilization phase and all confirmed INKINDO observations. Table 6 presents the summary statistics for both windows.

Table 6. Real-wage growth analysis⁴⁶

Candidate Index	Full-period Mean Real Growth (pp/yr)	Post-2013 Mean Real Growth (pp/yr)	Years Above GDP Deflator	PPP Adequacy Assessment
INKINDO SBOB	-1.22 (n=18)	+1.45 (n=12)	11 of 18	Positive post-2013 real growth (+1.45pp/yr); above GDP Deflator in 10 of 12 post-boom years. Only candidate demonstrating consistent real appreciation in engineering professional labour costs.
BPS CPI	-1.43 (n=18)	+0.08 (n=11)	9 of 18	Near-zero post-2013 real growth (+0.08pp/yr); by construction tracks general consumer price levels.
Gaji PNS	+0.14 (n=18)*	+0.50 (n=12)*	7 of 18	Post-2013 mean distorted by single 2024 regulatory step-change (+29.0pp). Excluding 2024, post-2013 mean = -2.05pp/yr. Salary freeze 2014–2023 produces systematic real-wage erosion in 9 consecutive years.
IHPB Konstruksi	-0.65 (n=17)	-0.03 (n=12)	8 of 17	Post-2013 mean ≈0.00pp/yr; tracks general price inflation without real premium. Measures wholesale construction material prices, not professional labour remuneration — structural misalignment with target cost category.
GDP Deflator	0.00 (benchmark)	0.00 (benchmark)	—	Reference series used as deflator; real growth relative to itself = 0.00 by definition. Included as benchmark to contextualise all candidate assessments.

Note: * Gaji PNS post-2013 mean is distorted by the 2024 regulatory step-change (PP No. 5/2024, +29.9% nominal). Excluding 2024, post-2013 mean = -2.05pp/yr, confirming systematic real-wage erosion during the 2014–2023 salary freeze regime.

INKINDO SBOB is the only candidate with consistently positive mean real growth post-2013 (+1.45 pp/yr; above the GDP Deflator in 10 of 12 years), confirming real appreciation in engineering professional labor costs beyond general inflation. BPS CPI produces near-zero real growth (+0.08 pp/yr, n = 11), consistent with a broad consumer basket. IHPB Konstruksi converges to zero (-0.03 pp/yr), tracking general inflation rather than engineering labor. Gaji PNS records +0.50 pp/yr, but this is entirely driven by the 2024 step-change (+29.9% nominal; real

⁴⁶ By Author.

differential +29.01 pp); excluding 2024, the series averaged –2.05 pp/yr across the 2014–2023 freeze regime — a politically administered scale, not a market-responsive instrument. These findings ground the C1 (Sector Specificity) scores in the MADM evaluation.

Step 4 - Selection of The Criteria

To select the best escalation index from the five price series, this paper use a Multi-Attribute Decision-Making (MADM) approach following Sullivan et al. (2023), Chapter 14⁴⁷. Two evaluation methods are applied one after another — non-compensatory first, then compensatory. The non-compensatory phase applies the lexicographic rule, ranking alternatives by the highest-weighted criterion first and resolving ties using lower-weighted criteria. All five price series — including the GDP Deflator as the MADM lower anchor — proceed to the compensatory phase without elimination, preserving the anchor’s function of bounding the non-dimensional scale. The compensatory phase applies additive weighting, computing a composite score S_i for each alternative as the sum of weighted, non-dimensionally scaled attribute scores. The non-compensatory ranking serves as a robustness check: convergence with the additive weighting result confirms the selection; divergence triggers further examination before a final recommendation.

4.1 Criteria and weights

The author defines five criteria to compare the price series against each other. Criteria weights are assigned by informed judgment, reflecting each criterion’s relative analytical primacy, and sum to 1.00. C1 (Sector Specificity) carries the highest weight and is empirically grounded in the real-wage growth analysis in Step 3; all other criteria draw on the correlation and back-casting results of the same step. Table 7 presents the five criteria, their definitions, weights, and rationale.

⁴⁷ Sullivan, W. G., Wicks, E. M., & Koelling, C. P. (2023). *Engineering economy* (17th ed., Ch. 14). Pearson Education.

Table 7. MADM criteria & weights for escalation index selection⁴⁸

Code	Criterion	Definition and Measurement	Weight (w)	Rationale
C1	Sector specificity	Degree to which the index directly measures professional engineering consultant remuneration at the specified grade in Indonesia, rather than a broader cost basket. PPP real-wage growth analysis (Table 6) provides empirical grounding: a qualifying index must generate positive real growth above the GDP Deflator consistently across the study window.	0.30	Highest weight; captures the fundamental adequacy of the index for the stated purpose and is anchored in the real-wage growth evidence in Step 3
C2	Predictive accuracy	Inverse of RMSE (pp) from 1-year backcasting validation (2008–2025). Scaled so that lower RMSE yields higher score	0.25	Quantifies retrospective tracking performance against actual INKINDO annual movements
C3	Correlation with INKINDO Y-o-Y	Pearson r between candidate index annual % change and INKINDO annual % change over the study window (n = 17–18)	0.20	Measures co-movement in direction and magnitude of annual labour cost change (Sullivan et al., 2023, Ch. 13)
C4	Data completeness and continuity	Proportion of 2007–2025 window covered by confirmed (non-interpolated, non-derived) observations	0.15	Reflects reliability of the series for sustained multi-year application without imputation
C5	Institutional credibility	Credibility and international citability of publishing institution; legal underpinning of the rate-setting methodology	0.10	Ensures the selected index is defensible in peer-reviewed publication and regulatory contexts

Note: Weights are normalised to 1.00. C1 carries the highest weight because it captures the fundamental adequacy of the index for the stated purpose: a sector-specific labour price instrument directly calibrated to the engineering consultancy market.

⁴⁸ By Author.

4.2 Computation procedure

Table 8 shows how the computation works for each alternative: first, non-dimensional scaling, then additive weighting. The alternative with the highest composite score S_i is selected; the complete scoring matrix is presented in the Finding section.

Table 8. MADM Computation procedure⁴⁹

Step	Formula	Notation
Non-dimensional scaling	$Z_{ij} = (x_{ij} - x_{j,\min}) / (x_{j,\max} - x_{j,\min})$	x_{ij} = raw score of alternative i on criterion j ; $x_{j,\min}$ and $x_{j,\max}$ = minimum and maximum raw scores across all five price series on criterion j ; for C2, $x_{ij} = 1/\text{RMSE}$ before scaling
Additive weighting	$S_i = \sum w_j \cdot z_{ij}$	w_j = criterion weight (Table 7); highest S_i = selected alternative

FINDINGS

Step 5 - Analysis of Alternative

Table 9 presents the complete MADM scoring matrix. Raw scores for each criterion are defined as follows: C1 is the post-2013 mean real-wage growth differential above the GDP Deflator, with Gaji PNS scored on its freeze-regime adjusted mean (-2.05 pp/yr, excluding the non-recurring 2024 Presidential Regulation step-change); C2 is the inverse of the 1-year back-casting RMSE (1/RMSE) so that lower prediction error yields a higher score, with INKINDO SBOB assigned the ceiling value as the reference series; C3 is the Pearson correlation coefficient with INKINDO SBOB Y-o-Y, with INKINDO assigned unity; C4 is the proportion of confirmed, non-interpolated observations across 2007–2025; and C5 is an institutional credibility score on a 1–10 scale reflecting publishing independence, legal underpinning, and international citability. All raw scores are converted to non-dimensional scaled values z_{ij} , as shown in Table 8. The GDP Deflator anchors the lower bound of the scale on C1 and C3 and is not a candidate for adoption.

INKINDO SBOB achieves the highest composite score ($S_i = 0.8250$), substantially ahead of BPS CPI ($S_i = 0.4463$). INKINDO scores at the ceiling on C1, C2, and C3 — the three empirically grounded criteria carrying a combined weight of 0.75 — reflecting its unique status as the only series directly measuring engineering professional remuneration. Its floor score on C4 is correctly registered: five of nineteen observations are linearly

⁴⁹ By Author.

interpolated, the lowest confirmed-observation ratio of all alternatives. This weakness is transparently surfaced rather than concealed, demonstrating that the MADM framework is not engineered to guarantee INKINDO wins on every dimension. Gaji PNS ranks last ($S_i = 0.1622$), consistent with its character as a politically administered scale rather than a market-responsive instrument.

The non-compensatory lexicographic phase independently produces an identical ranking. Both methods converge on INKINDO SBOB: the selection is confirmed without further examination.

Table 9. MADM Scoring matrix – Scale scores (z_{ij}) and Composite results⁵⁰

Criterion	w	INKINDO SBOB		BPS CPI		Gaji PNS		GDP Deflator		IHPB Konstruksi	
		z_{ij}	$w_j \cdot z_{ij}$	z_{ij}	$w_j \cdot z_{ij}$	z_{ij}	$w_j \cdot z_{ij}$	z_{ij}	$w_j \cdot z_{ij}$	z_{ij}	$w_j \cdot z_{ij}$
C1 — Sector Specificity	0.30	1.0000	0.3000	0.6088	0.1826	0.0000	0.0000	0.5862	0.1759	0.5782	0.1735
C2 — Predictive Accuracy	0.25	1.0000	0.2500	0.1235	0.0309	0.0000	0.0000	0.0334	0.0084	0.1504	0.0376
C3 — Correlation	0.20	1.0000	0.2000	0.3141	0.0628	0.2110	0.0422	0.0000	0.0000	0.4789	0.0958
C4 — Data Completeness	0.15	0.0000	0.0000	0.8000	0.1200	0.8000	0.1200	1.0000	0.1500	0.6000	0.0900
C5 — Institutional Credibility	0.10	0.7500	0.0750	0.5000	0.0500	0.0000	0.0000	1.0000	0.1000	0.2500	0.0250
Composite Score $S_i = \sum w_j \cdot z_{ij}$	1.00		0.8250		0.4463		0.1622		0.4342		0.4218
Composite Score Rank		1		2		5		3		4	
Lexicographic Rank (C1 → C2 → C3 tie-break)		1		2		5		3		4	

Step 6 - Selection of the Preferred Alternative

INKINDO SBOB is selected as the dedicated labor wage escalation index for the company’s Class 3 CAPEX estimates, answering RQ1. The selection is supported by convergent MADM methods and grounded in empirical evidence spanning the full 2007–2025 study window.

Empirical validity is confirmed through two tests, answering RQ2. First, the PPP real-wage growth analysis in Section 3.5 confirms INKINDO SBOB is the only candidate with consistently positive mean real growth post-2013 (+1.45 pp/yr; above the GDP Deflator in 10 of 12 years), establishing genuine real appreciation in engineering professional labor costs beyond economy-wide inflation. Second, a CAGR coherence test compares the empirical P-50 against the historical compound annual growth rate. The INKINDO NDI moves from 0.6444 in 2007 to 1.3556 in 2025, yielding a historical CAGR of

⁵⁰ By Author.

4.218%/yr over 18 growth periods, computed as $((1.3556 / 0.6444)^{(1/18)} - 1) \times 100$. The empirical P-50 of 4.628%/yr diverges by only 0.41 percentage points — reflecting mild positive skew in the Y-o-Y distribution where a small number of high-growth years marginally elevate the median above the geometric rate. This divergence is well within any defensible coherence threshold: CAGR coherence: Pass (divergence = 0.41 pp).

The escalation factor distribution is derived empirically from 18 confirmed annual Y-o-Y observations of INKINDO SBOB from 2007 to 2025. The mid-year construction timing convention follows AACE RP 68R-11, with the baseline set at mid-2026 — the compilation date of the INKINDO 2026 publication. Table 10 presents the full empirical distribution statistics.

Table 10. INKINDO SBOB empirical Y-o-Y distribution 2007 - 2025⁵¹

Statistic	Value (%/yr)	Notes
Minimum	- 4.000	2010
P-10	-1.992	
P-25	2.533	
P-50 (median)	4.628	Recommended
P-75	6.953	
P-90	9.076	
Maximum	12.069	2008
Mean	4.876	
Historical CAGR	4.218	(18 periods)
CAGR vs P-50 divergence	0.41 pp	PASS

Step 7 - Performance Monitoring

The escalation factors are summarized in two lookup tables for the labor component of Class 3 CAPEX estimates, answering RQ3. Factors are stated as cumulative percentage changes from mid-2026 (Table 11) and as multipliers applied to the base-year labor cost estimate (Table 12). For an unbiased central estimate, P-50 is recommended. For a conservative estimate providing protection against persistent real wage appreciation — consistent with the post-2013 finding that INKINDO real growth exceeded general inflation in 10 of 12 years (Section 3.5, Table 6) — P-75 is recommended. Negative P-10 values reflect empirical occurrences in the historical distribution and require explicit, documented justification based on the estimate before application.

⁵¹ By Author.

Table 11. Escalation factors from mid-2026 as cumulative percentage changes⁵²

Construction Mid-Year	P-10	P-25	P-50	P-75	P-90
Mid-2027 (1 yr)	-1.99%	2.53%	4.63%	6.95%	9.08%
Mid-2028 (2 yr)	-3.94%	5.13%	9.47%	14.39%	18.98%
Mid-2029 (3 yr)	-5.86%	7.79%	14.54%	22.34%	29.77%
Mid-2030 (4 yr)	-7.73%	10.52%	19.84%	30.85%	41.55%
Mid-2031 (5 yr)	-9.57%	13.32%	25.38%	39.95%	54.40%

Table 12. Escalation factors from mid-2026 as multipliers⁵³

Construction Mid-Year	P-10	P-25	P-50	P-75	P-90
Mid-2027 (1 yr)	0.980	1.025	1.046	1.070	1.091
Mid-2028 (2 yr)	0.961	1.051	1.095	1.144	1.190
Mid-2029 (3 yr)	0.941	1.078	1.145	1.223	1.298
Mid-2030 (4 yr)	0.923	1.105	1.198	1.309	1.416
Mid-2031 (5 yr)	0.904	1.133	1.254	1.400	1.544

Global PPP Benchmarking

To contextualize the INKINDO selection within the global engineering compensation landscape, the 2023 INKINDO target specification — S1/Setara, five years of experience, DKI Jakarta — is benchmarked against the AACE 2023 Annual Salary Survey. The confirmed 2023 annual rate of IDR 331,800,000 (IDR 27,650,000/month × 12) is converted using an estimated 2023 PPP conversion factor of approximately IDR 4,380 per international dollar, derived from the World Bank 2020⁵⁴ confirmed value of IDR 4,673.93 adjusted for 2021–2023 differential CPI inflation between Indonesia and the United States. The PPP-adjusted equivalent is approximately INT\$75,800 per year.

Figure 9 presents the AACE 2023 salary distribution across all respondents (Giammalvo & Malindra, 2026)⁵⁵, showing a mean of \$115,830, a median of \$108,000, and a mode of \$92,500 within a ±1σ range of \$52,113 to \$179,547. The PPP-adjusted INKINDO rate of INT\$75,800 sits approximately 30% below the global median, and below the mode, but within the ±1σ range. This gap is consistent with the real wage pressure documented in Section 3.5: INKINDO's post-2013 real growth of +1.45 pp/yr above the GDP Deflator reflects the upward pull of an internationally mobile talent market. For Indonesian

⁵² By Author.

⁵³ By Author.

⁵⁴ World Bank. (2024). PPP conversion factor, GDP (LCU per international \$) — Indonesia. World Development Indicators (PA.NUS.PPP). <https://data.worldbank.org/indicator/PA.NUS.PPP?locations=ID>

⁵⁵ Giammalvo, P. D., & Malindra, A. (2026). AACE annual salary survey results — what do they tell us? What don't they tell us? Part 1 of a 2-part paper. Medium / PM World Library. <https://www.academia.edu/164712197>

downstream operators, this positioning confirms that the labor escalation rate embedded in Class 3 CAPEX estimates must account for sector-specific wage appreciation that broad macro indices structurally cannot capture. Systematic underestimation of this rate carries the downstream risk of budget shortfalls in retaining credentialed engineering personnel whose globally recognized qualifications make international relocation a financially rational option.

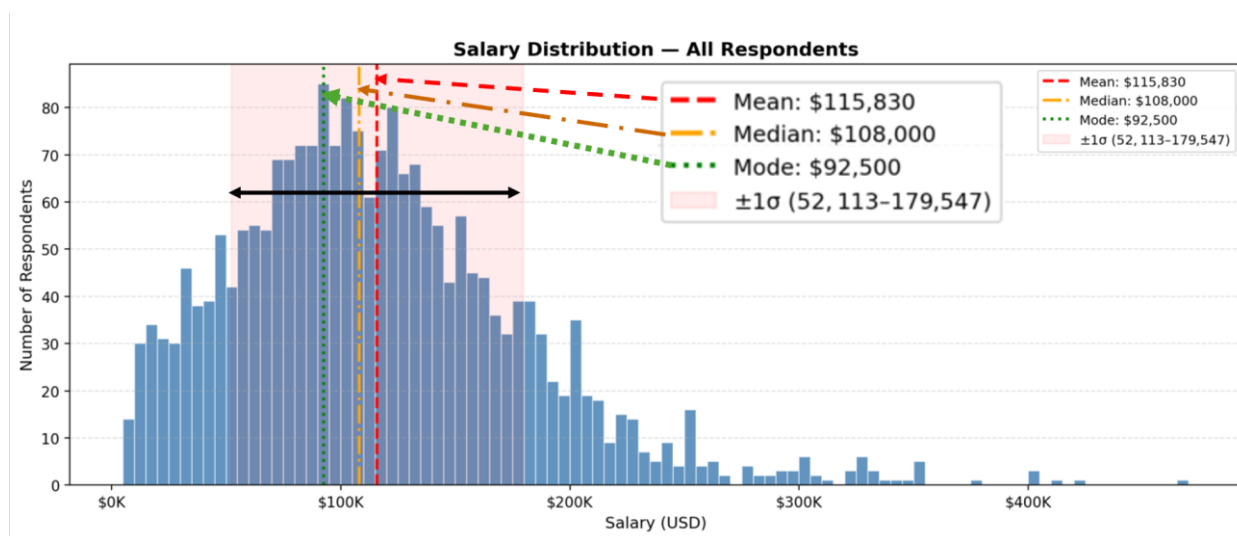


Figure 9. AACE 2023 salary distribution across all respondents⁵⁶

CONCLUSION

This paper addressed the systematic bias arising from applying the Gold Price index uniformly to both the material and labor components of an Indonesian downstream oil and gas company's Class 3 CAPEX estimates. Drawing on the engineering economic analysis procedure of Sullivan et al. and the GAO twelve-step cost estimating framework, a structured five-criterion MADM evaluation was conducted across five publicly available Indonesian price series — INKINDO SBOB, BPS CPI, Gaji PNS, GDP Deflator, and IHPB Konstruksi — over the 2007–2025 study window.

The global PPP benchmarking in Step 7 situates these findings in a broader context: at INT\$75,800 per year in PPP terms, the INKINDO target specification sits approximately 30% below the AACE 2023 global median of \$108,000. This gap confirms the structural upward wage pressure that a Gold Price index cannot detect or track — a consequence of an internationally mobile engineering talent market that responds to regional and

⁵⁶ Giammalvo, P. D., & Malindra, A. (2026). AACE annual salary survey results — what do they tell us? What don't they tell us? Part 1 of a 2-part paper. Medium / PM World Library. <https://www.academia.edu/164712197>

international compensation differentials rather than gold market dynamics. Practitioners applying the Gold Price uniformly to the labor stream are introducing directional bias whose sign and magnitude are determined by financial market forces entirely external to the domestic engineering labor market.

The global PPP benchmarking in Step 7 situates these findings in a broader workforce context: at INT\$75,800 per year in PPP terms, the INKINDO target specification sits approximately 30% below the AACE 2023 global median of \$108,000. This gap confirms the structural upward wage pressure that a Gold Price index cannot detect or track — a consequence of an internationally mobile engineering talent market that responds to regional and international compensation differentials rather than to dynamics in the gold market. Practitioners applying the Gold Price uniformly to the labor stream are not introducing random error; they are introducing directional bias whose sign and magnitude are determined by financial market forces entirely external to the domestic engineering labor market.

Four limitations apply. First, five INKINDO observations are linearly interpolated. Second, the 18-year study window will get stronger as more annual publications come in. Third, the EF lookup table only covers Indonesia's downstream oil and gas sector and the target INKINDO specification; and the materials escalation stream remains outside the scope of this paper.

Future Research

Two priority directions are identified. First, extending the PPP benchmarking in Step 7 to Southeast Asian regional sub-samples would more precisely characterize the competitive wage environment driving Indonesia's post-2013 real wage appreciation, enabling a more defensible basis for projecting whether the +1.45 pp/yr trend will continue, moderate, or accelerate — a question directly relevant to the forward reliability of the EF lookup table. Second, applying the same MADM framework to the materials escalation stream would produce a fully disaggregated CAPEX escalation methodology, removing the remaining Gold Price dependency from Indonesian downstream estimating practice. The EF lookup table should be updated annually as new INKINDO publications become available.

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