Assessing Owner-Side Front-End Schedule Readiness for Sanction-Quality Decisions in Indonesia's Downstream Oil and Gas Projects[1, 2]

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ABSTRACT

Despite the availability of internal procedures, scheduling software, and international references, EPC projects in Indonesia's downstream oil and gas sector continue to experience significant schedule delays. This paper examines the extent to which the Company's current front-end scheduling practices can support sanction-quality decisions rather than merely meet procedural compliance requirements.

By using a seven-step engineering economic analysis procedure, this paper compares current practices (Internal procedures and practices) with GAO-16-89G, AACE, NDIA predictive measures, NASA JCL, and performance-based EVM principles as benchmarks. Furthermore, to refine the analysis, six selected alternatives were evaluated using compensatory and non-compensatory Multi-attribute decision-making (MADM) models.

By analyzing data from 15 EPC projects completed by the Company, this paper reveals a clear picture of worsening project completion problems, with an average schedule delay of 276%, nearly tripling the original duration. This problem stems in part from weak early-stage readiness, which is characterized by four key structural gaps that will be explored further in this paper.

Using the MADM technique, we identified Alternative 6 (A6), the Performance-Based EVM, as the most preferred alternative. To obtain clearer, more practical results, we conducted an additional backtest, which showed that implementing the P50-adjusted baseline would significantly reduce the average schedule delay.

Keywords: *Front-end scheduling; schedule readiness; project control; sanction decision; WBS/CBS integration; downstream oil and gas*

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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/. 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.

INTRODUCTION

A: Organizational context and direction of the problem

Giammalvo candidly highlights a harsh but important reality that "despite more than five decades of formal project management practice, supported by leading global professional bodies such as PMI, IPMA, AACE, and AIPM, as well as numerous regional and local organizations, project failure remains a recurring and well-documented problem."[3] Figure 1 highlights this problem clearly. Even in a mature professional environment, the Australian project management community reports that "only 36% of projects were reported as on budget and only 32% as on time, while stakeholder satisfaction and delivery against business goals were also below 50%."[4] Based on this pattern, we can see that the continuous deterioration of project performance is not solely due to a lack of professional tools, methods, or language, but rather to the inability to integrate these tools into a coherent decision-support system.

Figure 1 Project Delivery Performance According to KPMG and AIPM Survey Results [5]

This broader picture is consistent with international evidence. Memon et al. report that, "around 70% of construction projects experience delays of 10% to 30% of planned

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[3] 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, 12(9).
[4] KPMG & Australian Institute of Project Management. (2022, November). *The state of project management in Australia 2022*. KPMG.
[5] Australian Institute of Project Management (AIPM). (2023, January 10). *Australian Institute of project management report*. Feature Communications. https://featurecommunications.com.au/australian-institute-of-project-management-report/

duration."[6] The report is consistent with Kearney's findings: "Six out of ten capital projects were either over budget or behind schedule." [5] This evidence indicates that delay and cost growth are not isolated exceptions; they are recurring conditions in capital project delivery.

In Indonesia's downstream oil and gas sector, the pattern is worse, not better. Wisnugroho found that "56% of projects experienced cost and schedule overruns of at least 10%, while 36% experienced overruns of up to 25% across 45 projects."[7] More recent evidence reported by Zilikram shows that "out of 48 projects valued at not less than $500 million, 73% experienced overruns of up to 25%, 6% exceeded 25%, and 75% suffered schedule delay exceeding 125% of the original schedule."[8] This is not merely evidence of weak execution. Projects are still being approved on front-end assumptions, schedules, and budgets that are not yet credible enough to support realistic commitments.

Therefore, scheduling is not treated here as a narrow problem of monitoring progress on calendar days, but rather as a problem of controlling projects at an earlier stage. The US Government Accountability Office emphasizes that "cost estimates are not credible if they ignore the costs associated with schedule delays." [9] Therefore, throughout this paper, the concepts of schedule, cost, and risk are treated as a causally interconnected system. Mistakes in early project planning will have a long-term domino effect, starting with weak scope definition, which directly leads to low estimate maturity, which in turn creates uncertainty and impacts schedule delays, ultimately driving cost and risk growth. Figure 1 clearly illustrates this problem.

Ultimately, this illustration shows that overly long schedules do not create additional slack but, on the contrary, tend to increase costs and risks, reduce productivity and flexibility, and lead to missed opportunities. When schedules are delayed, flexibility is reduced, revenue periods are pushed back, windows of opportunity narrow, and value is diminished.

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[6] A. H. Memon, A. Q. Memon, S. H. Khahro, and Y. Javed, "Investigation of Project Delays: Towards a Sustainable Construction Industry," *Sustainability* 15, no. 2 (2023): 1457, https://doi.org/10.3390/su15021457.
[7] J. Wisnugroho, "Indonesia Oil & Gas Cost Estimating vs International 'Best-Tested and Proven' Practices: A Benchmarking Study," *PM World Journal* 9, no. 2 (2020).
[8] Zilikram, M. F. (2025). *Developing Risk-Based Integrated Cost & Schedule Estimation Model To Improve Project Budget Accuracy In Indonesia's Downstream Oil & Gas Industry*. Institut Teknologi Bandung
[9] U.S. Government Accountability Office, *Schedule Assessment Guide: Best Practices for Project Schedules* (GAO-16-89G) (Washington, DC: U.S. Government Accountability Office, 2015).

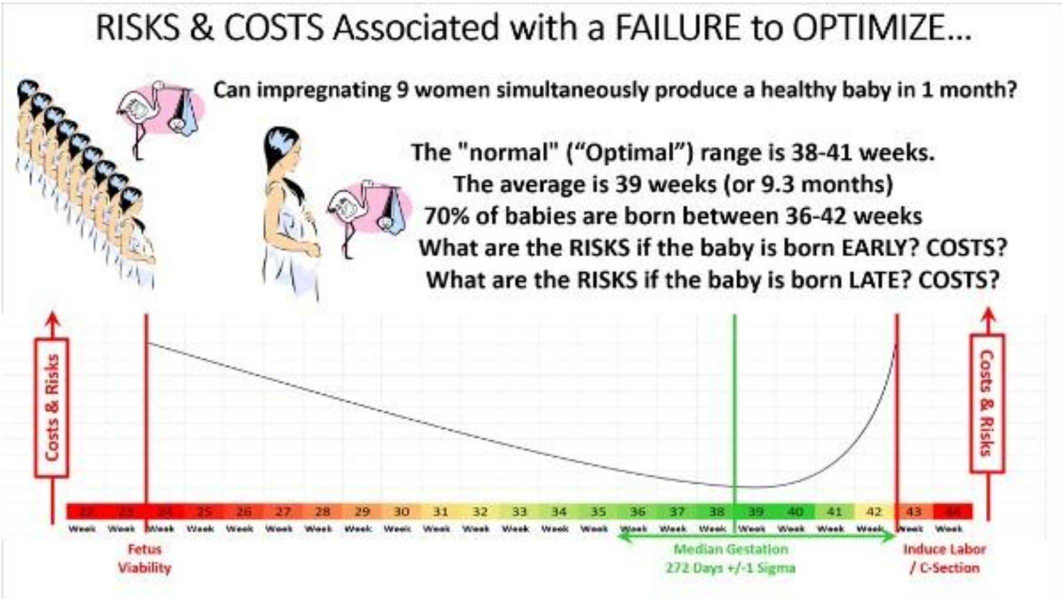

***Figure 2. Forcing time shifts the consequence into cost and risk*[10]**

Figure 2 makes this point visually. When we plot the RISKS and COSTS to both the baby and the mother, we end up with a classic "Bathtub" or "U" shaped curve. Both extremes - finishing too early or too late relative to the feasible optimum drive cost and risk upward. The implication is unmistakable: time cannot be treated as a stand-alone variable. Unrealistic deadlines set by management lead to higher costs and risks.

B: Existing Practice, Capability Development, and Current Limitations

The Company has formally established part of its front-end scheduling practices through an internal document called Tata Kerja Individu (TKI) Penyusunan Jadwal Proyek[10]. This document provides a standardized approach for developing project schedules. It references recognized guidelines, including the GAO Schedule Assessment Guide and relevant AACE-recommended practices. This is a meaningful step forward because it shows that front-end scheduling is no longer being treated entirely as an ad hoc activity.

However, standardizing forms, completing checklists, and ensuring technical elements are in place aren't what building an integrated control system is all about. Current TKIs define success too narrowly, requiring the schedule to align with the project scope. While a project schedule aligned with the scope is necessary, it isn't sufficient on its own to make high-quality, agreeable decisions. As the AACE TCM Framework demonstrates, this weakness is most significant in the early stages, when management influence is strongest, and spending is still low. Without proper integration of scope, cost, schedule, and responsibilities through a traceable WBS and CBS—as defined in the TCM

[10] Giammalvo, P. D. (2023). The futility of integrated master plans prepared by planner/schedulers with little or no hands-on field experience

Framework's project control process map (Section 7.1)—that early influence loses its effectiveness.[11]

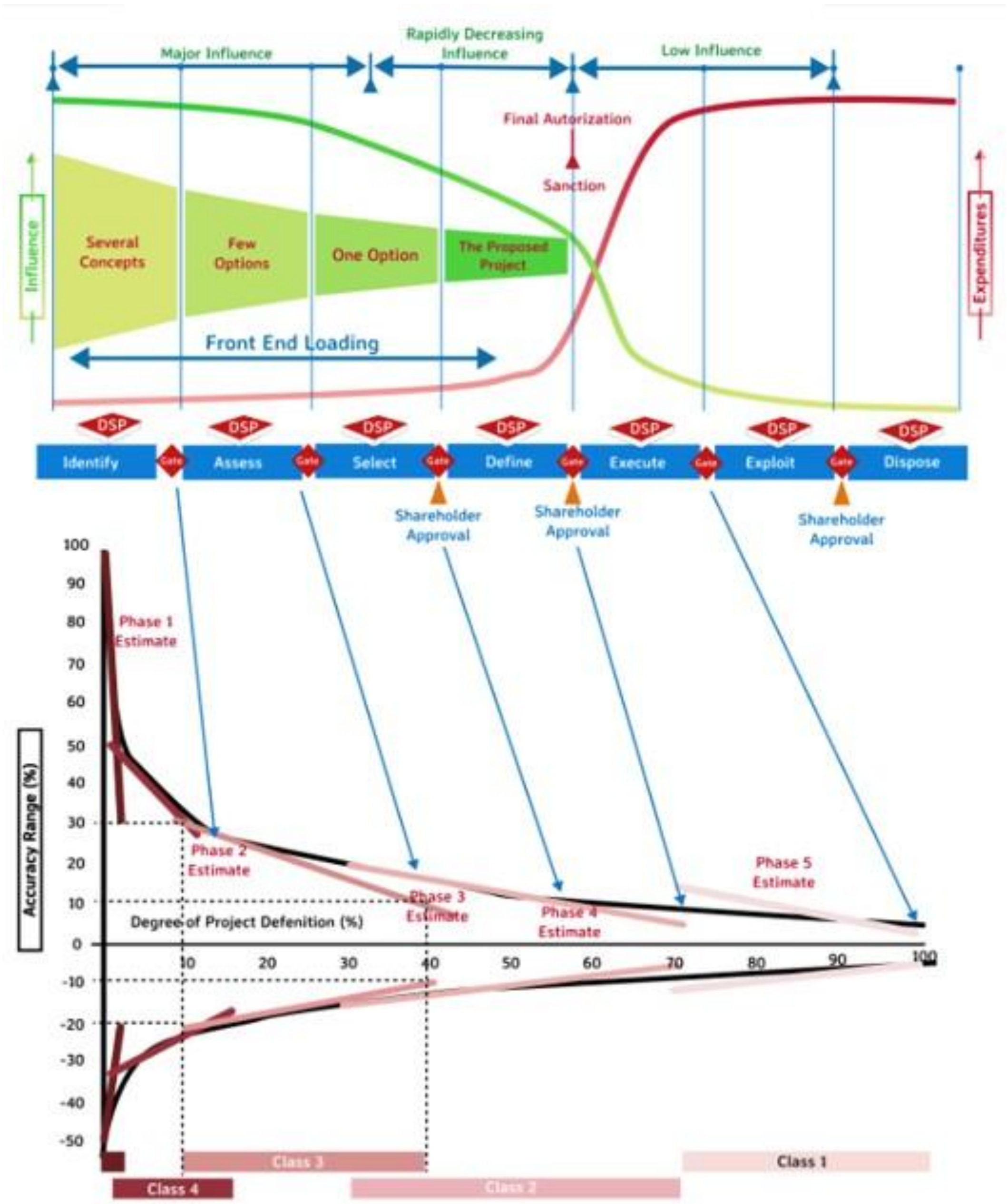

Figure 3. Front-end loading, project definition maturity, and estimate accuracy across the project life span.[12]

[11] AACE International, *Total Cost Management Framework: An Integrated Approach to Portfolio, Program, and Project Management*, 2nd ed. (Morgantown, WV: AACE International, 2015).
[12] Giammalvo, P. D. (2022). Integrated Asset, Portfolio, Program and Project Management Model

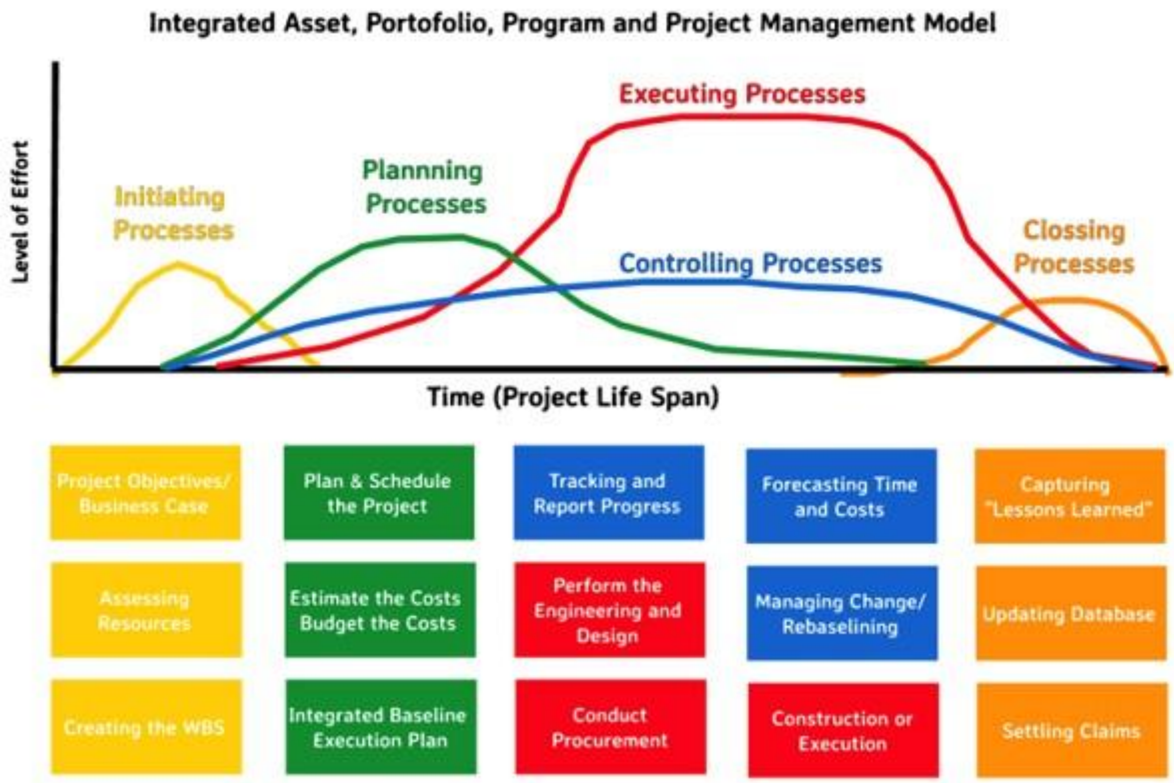

Figure 4. Project management process groups and their relative effort over time[13]

C: Conceptual Gap and Framework

If project delays persist for years, as described above, it's clear that this is a more fundamental issue: mindset. Trying to improve the appearance of control without improving the fundamental quality of the planning itself will not produce change. A neat template won't save you from weak assumptions. Good, regular reporting won't save you from weak logic. A weak schedule is still a weak schedule.

This paper, therefore, rejects the idea that front-end scheduling can be treated as an isolated technical task. It is part of an integrated front-end control system that is credible only when FEL logic is explicit, when scope, cost, schedule, and risk are developed as a single, connected basis, and when the whole structure is traceable through WBS/CBS logic from the sanction level down to work packages and activities. [14]

[13] Giammalvo, P. D. (2022). Integrated Asset, Portfolio, Program and Project Management Model. Retrieved from https://build-project-management-competency.com/1-4-1-1-unit-1/
[14] U.S. Government Accountability Office, *Cost Estimating and Assessment Guide: Best Practices for Developing and Managing Program Costs* (GAO-20-195G) (Washington, DC: U.S. Government Accountability Office, 2020).

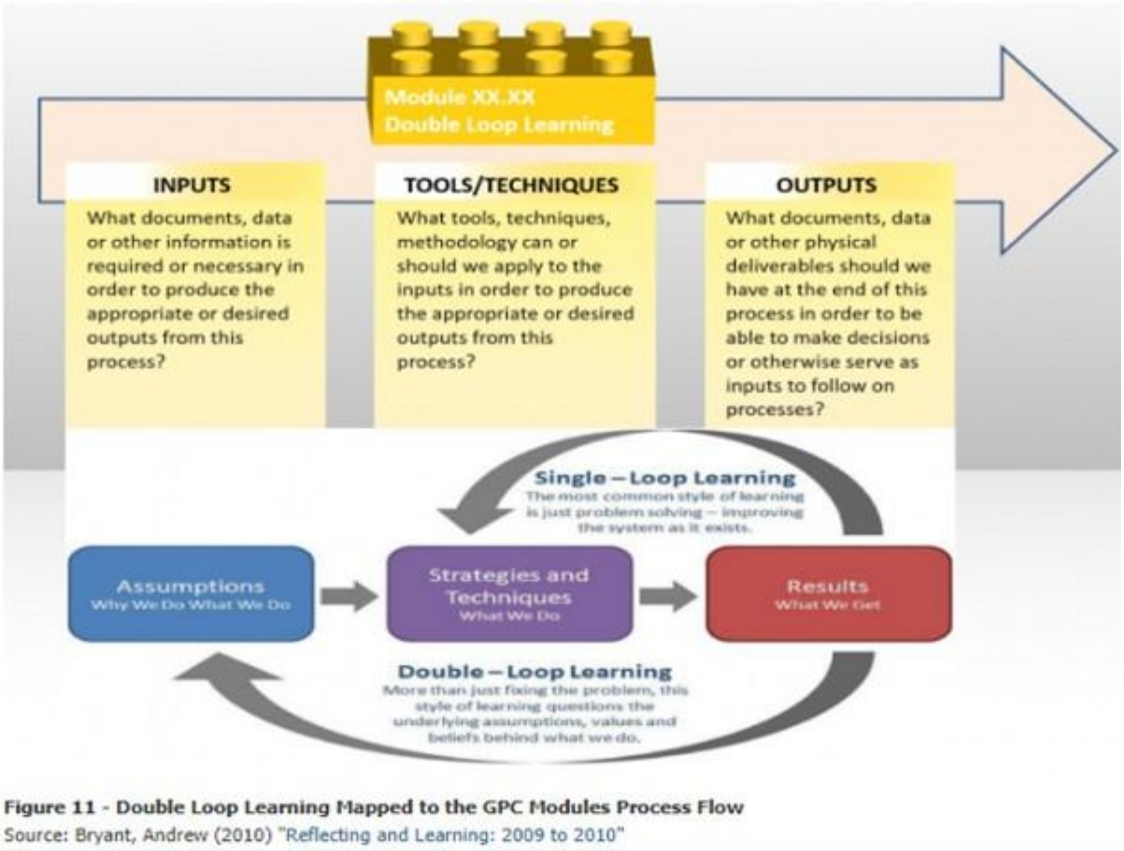

Figure 5. PDCA and double-loop learning for continuous improvement in project control. [15]

Implicitly, the AACE TCM framework has based project control on PDCA, but PDCA alone is insufficient to explain why repeated schedule failures persist even after stringent standards are established and training is introduced. [16] Argyris double-loop learning provides the explanation: PDCA controls performance within an existing system, while double-loop learning tests whether the assumptions and planning logic of that system are themselves adequate. [17]

Giammalvo reinforces this through "five fundamental truths of schedule management: no battle plan survives first contact with the enemy; plans are useless, but planning is essential; amateurs study strategy while professionals study logistics; reality eats strategy for breakfast; and the devil lies in the details." [18]

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[15] Giammalvo, P. D. (2022). Closing the loop—"Lessons learned" and continuous process/quality improvement [Instructional graphic]. Build Project Management Competency.
[16] AACE International. (2015). *Total cost management framework: An integrated approach to portfolio, program, and project management* (2nd ed.)
[17] Argyris, C. (1977). Double loop learning in organizations. *Harvard Business Review, 55*(5), 115–125.
[18] 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, 12*(9), p. 3.

This fact explains why PDCA corrections don't work when the underlying assumptions aren't questioned—the schedule's alignment with operational reality will derail any plan whose logic isn't questioned.

D: Research question

Based on the previous discussion, the question has changed. The issue is no longer limited to whether the company has the tools, standards, and trained personnel. The company already has them. The question goes deeper: do they operate as an integrated, credible, traceable, and appropriate control system for decision-making in downstream oil and gas projects? Therefore, the questions asked are fourfold:

1. Are the Company's current front-end scheduling practices fit for purpose as a basis for sanction-quality decisions, or do they remain primarily compliance-oriented?
2. What best-tested and proven benchmark should be used to assess those practices?
3. What structural gaps between current internal practice and that benchmark most plausibly explain recurring schedule unreliability and weak front-end readiness?
4. What direction should the Company take to move its scheduling standards, from procedural compliance to strategic schedule readiness?

METHODOLOGY

At the methodological stage, this study adopted a seven-step engineering economic analysis procedure, as per Sullivan.[19] This is directly consistent with Sullivan's Table 1-1, which outlines the relationship between Engineering Economic Analysis and the Scientific Method, providing logical structure and numerical rigor. Figures 6, 7, and 8 illustrate this procedure and the complete research flowchart.

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

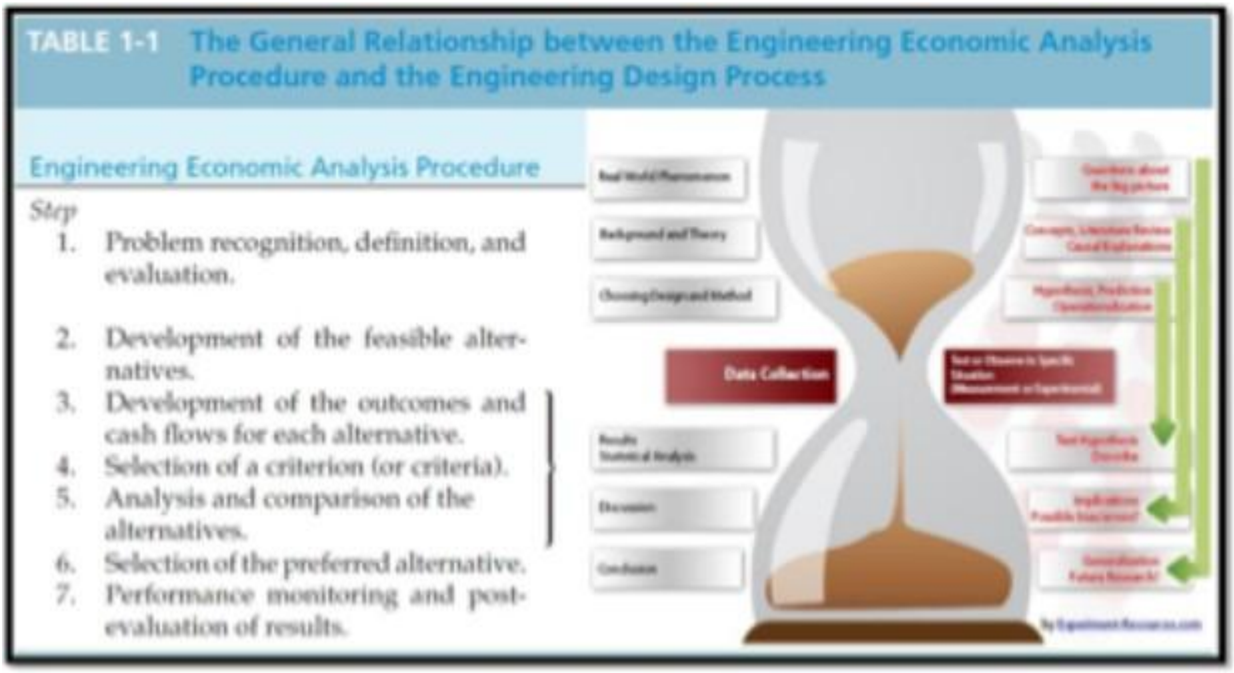

Figure 6. Engineering Economic Analysis Procedure & Step of the Scientific Process[20]

[20] Wijoseno, T. (2023). Modifying The Lang Factor using Process Plant Project Data Cost in PERTAMINA for more Precision, Valid, & Reliable AACE Class 4 Estimation Purpose in Indonesia; *PM World Journal*, Vol. XII, Issue VI, June.

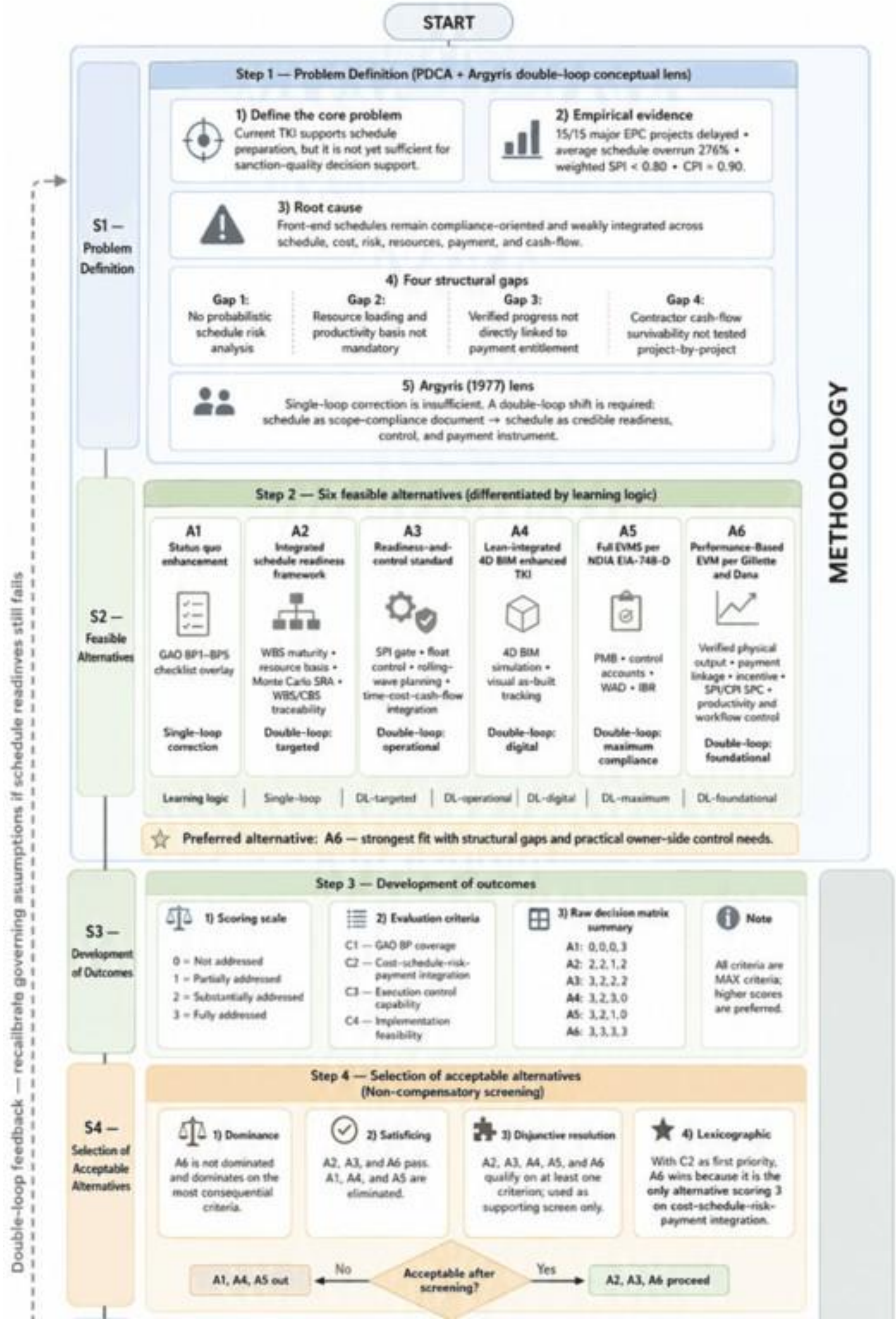

Figure 7. Research flowchart for the methodology stage (Steps 1–4).[21]

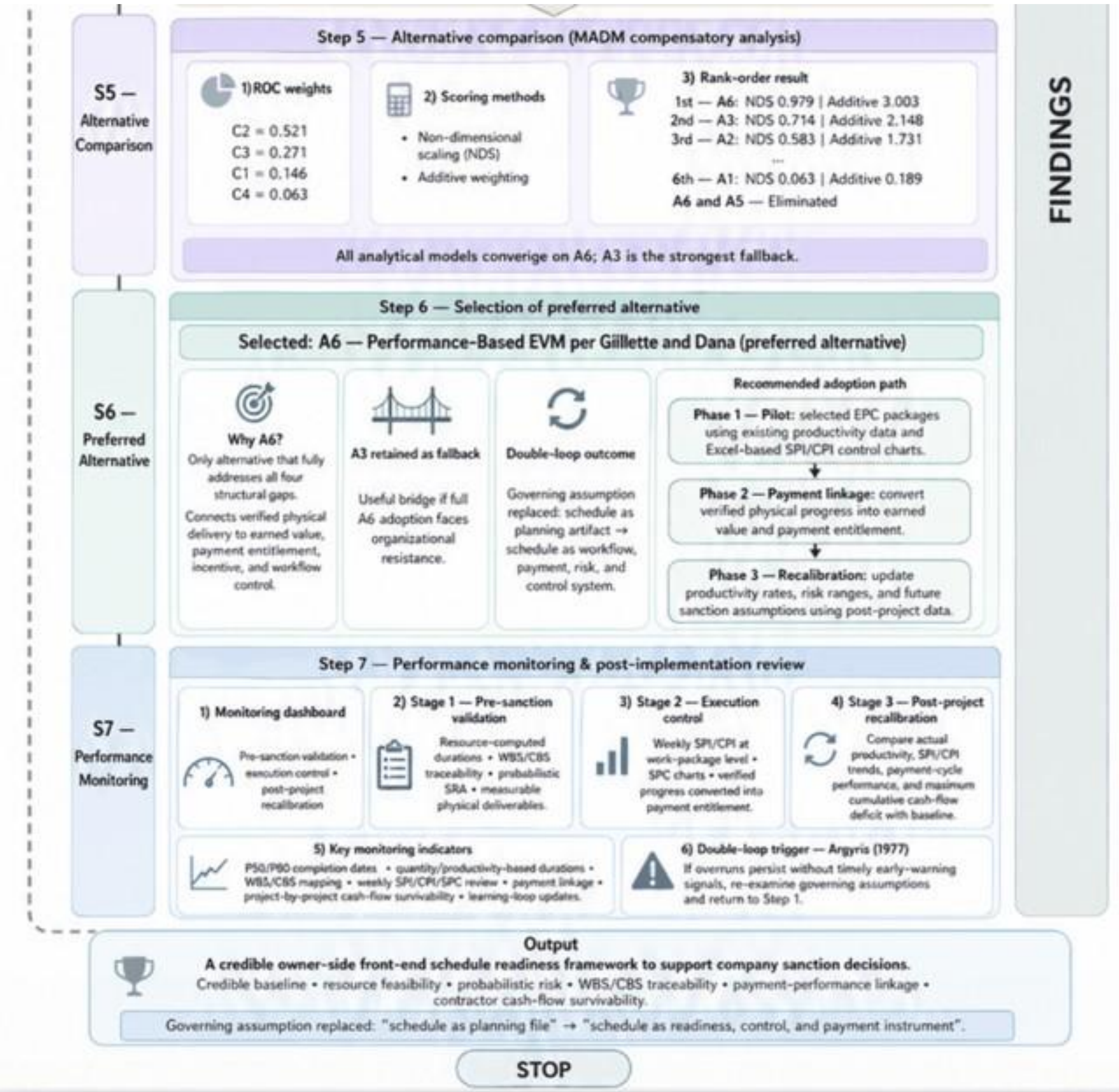

Figure 8. Research flowchart for the findings and output stage (Steps 5–7)[22]

[21] By Author
[22] By Author

Step 1 — Problem Definition

The core issue is that the company's current front-end scheduling system cannot support decision-making on approval quality. The Project Schedule Development Institute (TKI) has indeed defined scheduling success as conformance to the project scope [23] — but this is not sufficient, as a schedule worthy of approval must also demonstrate: (a) WBS completeness at a minimum of the AACE Class 3 maturity definition; (b) a critical path driven by clear and well-founded logic, not dates dictated by milestones; (c) resource- and productivity-based duration; (d) cost-risk integration; and (e) horizontal and vertical traceability down to the work package level.

The company has used various scheduling tools, including MS Project, Primavera P6, MS Excel, and WBS templates. Therefore, the repeated failures stem not from a lack of tools but from the lack of integrated front-end control logic that links schedule quality to approval readiness, and from the lack of action to treat schedule, cost, and risk as a single system.

[23] Company. (2026). Tata kerja individu: Penyusunan jadwal proyek [Internal work instruction]

Table 1. Performance of the Company's 15 Highest-Value EPC Projects Completed from 2021 to 2024 [24]

15 / 15	276%	116%	2,4x
Projects delayed (100%)	Avg schedule overrun (median 233%)	Avg cost increase (median 110%)	Schedule / cost ratio

	PROJECT	INITIAL (DAYS)	FINAL (DAYS)	SCHEDULE DELAY	INITIAL (M USD)	FINAL (M USD)	COST CHANGE	YEAR
1	EPC Refrigerated LPG Terminal Revitalization	610	2.774	455%	33,32	57,49	173%	2023
2	EPC AFT Hydrant System Upgrade	851	3.622	355%	12,84	15,29	119%	2024
3	EPC Aviation Fuel Depot Relocation and Pipeline	731	1.540	211%	10,66	10,65	100%	2024
4	EPC Aviation Fuel Depot Development	730	1.989	272%	17,79	18,65	105%	2023
5	EPC LPG Storage Tank, Piping, and Instrumentation	610	1.421	233%	15,66	17,72	113%	2022
6	EPC Aviation Fuel Depot Relocation and Development	670	1.893	283%	22,50	27,58	123%	2024
7	EPC LPG Storage Tank Construction	517	836	162%	15,23	16,68	110%	2021
8	EPC Pressurized LPG Terminal Development	550	1.787	325%	11,24	11,59	103%	2024
9	EPC Aviation Fuel Storage Tank Development	551	2.112	383%	4,28	4,70	110%	2023
10	EPC Pressurized LPG Terminal Expansion	550	1.046	190%	12,51	13,76	110%	2022
11	EPC Fuel Storage Tank Farm Development	730	1.620	222%	6,42	6,88	107%	2023
12	EPC Fuel Pipeline Expansion	1.005	1.534	153%	40,75	54,76	134%	2024
13	EPC Pressurized LPG Terminal	548	705	129%	11,01	12,09	110%	2021
14	EPC Aviation Fuel Tank Farm Development	450	1.389	309%	4,30	4,69	109%	2023
15	EPC Fire Water Storage Tank Improvement	180	424	236%	0,66	0,63	95%	2024
	Portfolio average (n = 15)	**619**	**1.806**	**276%**	**13,95**	**18,21**	**116%**	**—**

Schedule		Cost	
>300% (extreme)	(extreme)		
200–300% (high)	(high)	>130% (high)	(high)
110–199% (moderate)	(moderate)	110–130% (moderate)	(moderate)
<110% (low)	(low)	<110% (low)	(low)

Source: Author (2026) based on Company EPC project completion data (2021–2024). Contract values in million USD.

Table 1 makes this concrete. Of the 15 companies' high-value EPC projects completed between 2021 and 2024, not even one was delivered on time. The average final duration reached 1,806 days, compared with an initial plan of 619 days — a portfolio-wide schedule overrun of 276%. Individual delays ranged from 129% (Project 13) to 455% (Project 1); the median delay of 233% indicates the portfolio's central tendency rather than an outlier effect. Evidence from Zilikram further confirms that "across 48 Company projects, the weighted average SPI was below 0.80, while CPI averaged 0.90."[25]

A closer look reveals that cost growth tells a very different story. The average contract value increased by only 116%, yet the schedule-to-cost growth ratio was 2.4x, illustrating the asymmetry identified in Humphreys' causal sequence: "technical or execution issues typically first emerge as schedule variances and then evolve into cost variances."[26] Zilikram discovered that "only 23% completed on time, 75% experienced schedule delays exceeding 125%, [and] 63% remained on budget," reiterating the same pattern.[27] Project 15 was completed at 95% of its original contract value. Yet, it was completed 236% behind schedule. This indicates that cost discipline does not shield projects from schedule failure if the initial planning basis is insufficient.

The damage is not limited to project completion. Delays in implementing EPC can delay CAPEX realization, so financing can proceed even when assets are unproductive, delaying operational benefits and causing opportunity losses. Internal company information indicates that CAPEX realization only reached 45-47% of the target in 2022-2024, resulting in a cumulative gap of approximately US$20.7 billion. EPC procurement accounted for 27.5% of investment project constraints, of which 42.6% were due to delivery delays or supplier capacity failures. [28] From a practical viewpoint, the company approved not just weak schedules, but projects in which the contractor's supply chain capacity and funding were unproven.

The question is not whether the TKI is poorly written — it is not. The question is whether the TKI's governing assumptions about what a front-end schedule is for are adequate. As Argyris explains, "continuous failure of this kind does not reflect poor execution but flawed governing assumptions embedded in the method itself."[29] Four structural gaps

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[24] By Author
[25] Zilikram, M. F. (2023). Benchmarking Indonesia's downstream oil & gas construction: Evaluating project scheduling and cost estimating processes against global "best-tested and proven" practices. *PM World Journal, 12*(10).
[26] Humphreys, G. C. (2018). *Project management using earned value* (4th ed.). Humphreys & Associates, Inc.
[27] Zilikram, M. F. (2023). Benchmarking Indonesia's downstream oil & gas construction: Evaluating project scheduling and cost estimating processes against global "best-tested and proven" practices. *PM World Journal, 12*(10).
[28] Internal Source. (2024). CAPEX realization performance 2022–2024 [Internal Company Report]. Also: EPC procurement constraint data [Internal Company Report].
[29] Argyris, C. (1977). Double loop learning in organizations. *Harvard Business Review, 55*(5), 115–125.

define the problem, presented in Table 2, not as isolated deficiencies but as a causally connected system.

Table 2. Four Structural Gaps in the Company's Current Front-End Scheduling System[30]

Gap	Label	Structural failure
1	Probabilistic schedule risk gap	No quantitative Schedule Risk Analysis required; all sanctioned durations remain deterministic P0 single-point estimates with no probabilistic buffer.
2	Resource feasibility gap	Resource loading and productivity-based duration calculation (Duration = Volume ÷ Productivity Rate, per Lampiran 7) remain advisory rather than mandatory.
3	Payment-performance linkage gap	Verified physical progress is not directly converted into timely payment entitlement; contractors are incentivized to report progress, not deliver it.
4	Contractor cash-flow survivability gap	Contractor funding adequacy is not tested against the project-specific maximum cumulative cash-flow deficit before sanction is approved.

Step 2 — Identify the Feasible Alternatives

Six alternatives for upgrading the Company's front-end schedule readiness were identified, ranging from a single-loop procedural correction to a foundational performance-based EVM system grounded in over 120 years of tested practice. The alternatives are summarized in Table 3 and described in sections 2.1 through 2.6.

[30] By Author

Table 3.Six Feasible Alternatives for Front-End Schedule Readiness Upgrade[31]

Alt.	Method	Primary reference	Loop type
A1	Status quo enhancement	GAO-16-89G (BP 1–5 only); Company TKI (2026)	Single-loop correction
A2	Integrated schedule readiness framework	GAO-16-89G (BP 1–10); AACE TCM §7.1; NASA CEH JCL; NDIA EIA-748-D (partial)	Double-loop: targeted
A3	Readiness-and-control standard	GAO-16-89G; NDIA IPMD Guide; Giammalvo (2023b); Humphreys (2018); Zilikram & Yudoko (2026)	Double-loop: operational
A4	Lean-integrated 4D BIM enhanced TKI	Mayouf et al. (2024); Vassena et al. (2023)	Double-loop: digital
A5	Full EVMS per NDIA EIA-748-D	NDIA EIA-748-D (32 guidelines); GAO-20-195G; Abba (2024)	Double-loop: maximum
A6	Performance-based EVM per Gillette & Dana	Gillette & Dana (1909); Taylor (1911); Fayol (1916); Gilbreth (1917); Giammalvo (2023a, 2024); Taybi (2019)	Double-loop: foundational

2.1 Status Quo Enhancement

Alternative A1 retains the existing TKI in its current form and supplements it with a pre-sanction schedule quality checklist derived from GAO-16-89G Best Practices 1 through 5. No structural change is made to the TKI's governing logic, gate criteria, or definition of scheduling success. It represents a single-loop correction in Argyris's terms: "improving documentation discipline within existing assumptions without questioning whether those assumptions are adequate." [32]

2.2 Integrated Schedule Readiness Framework

In Alternative A2, the TKI is revised to introduce four mandatory pre-approval gates:

1. Ensuring the completeness of the minimum WBS to define the project at the AACE Class 3 level.
2. Attachment 7 of the existing TKI, which was originally. Recommended; it is now mandatory, with duration calculated as Duration = Volume ÷ Productivity Level.

[31] By Author
[32] Argyris, C. (1977). Double loop learning in organizations. Harvard Business Review, 55(5), 115–125.

3. Using Monte Carlo Schedule Risk Analysis to generate P50 and P80 completion probabilities consistent with NASA's Joint Confidence Level (JCL) methodology.

4. WBS/CBS traceability to the minimum Level 3 at the sanction level.

2.3 Readiness and control standard

Essentially, Alternative A3 builds on the four mandatory points of the previous Alternative A2 and adds:

1. Meet an SPI Value ≥ 0.95 as an explicit pre-sanction gating criterion according to the NDIA IPMD threshold criteria.

2. Providing a real-time float management gateway that requires resolution of negative float before sanction.

3. Implementing mandatory one-week-behind/three-week-ahead rolling wave planning aligned with Giammalvo's (2023b) five fundamental truths of schedule management.

4. Optimizing the integration between time, cost, and cash flow with SRA output at P50 and P80 as a formal contingency basis, which was validated by Zilikram and Yudoko (2026) with an accuracy of ±0.6%.

2.4 Lean Integrated 4D BIM enhanced TKI

Alternative A4 combines all the mandatory stages of A3. It adds a 4D BIM simulation platform, integrated with WBS activities, to the 3D object model for visual simulation of the construction sequence and real-time as-built tracking. Mayouf et al. (2024) demonstrated that "lean-integrated 4D BIM materially improves scheduling by integrating construction, operations, HSE visibility, and time-phased planning capabilities into a single environment."[33] Vassena et al. (2023) further demonstrated that "SLAM-based 4D monitoring provides reliable as-built progress capture for complex EPC structures."[34]

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[33] Mayouf, M., Jones, J., Elghaish, F., Emam, H., Ekanayake, E. M. A. C., & Ashayeri, I. (2024). Revolutionising the 4D BIM process to support scheduling requirements in modular construction. Sustainability, 16(2), 476. https://doi.org/10.3390/su16020476

[34] G. P. M. Vassena, L. Perfetti, S. Comai, S. Mastrolembo Ventura, and A. L. C. Ciribini, "Construction Progress Monitoring Through the Integration of 4D BIM and SLAM-Based Mapping Devices," *Buildings* 13, no. 10 (2023): 2488, https://doi.org/10.3390/buildings13102488

2.5 Full EVMS pe NDIA EIA 784 D

Alternative A5 is fully compliant with the Earned Value Management System as per NDIA EIA-748-D. It implements Performance Measurement Baselines, Control Accounts, Work Authorization Documents, and Integrated Baseline Reviews as the formal sanctioning commitment structure. The IPPM framework developed by Abba (2024) expands on this by "incorporating the disciplines of Technical Management and Schedule/Resource Management into the core of EVM" [35]— representing the most rigorous compliance-based integration of schedule, cost, and risk currently codified in international best practice.

2.6 Performance-Based EVM per Gillette Dana

To understand this alternative, let's take a moment to revisit one of the earliest practical examples of performance-based control. What was it? The incentive pay system was documented by Gillette and Dana in 1909. The basic idea is natural, simple, yet powerful: to make payments based on verified physical progress, not simply on time spent or reports submitted. To strengthen its position, this logic aligns with the scientific management tradition of researchers such as Taylor (1911), Fayol (1916), and Gilbreth (1917), in which work is planned, measured, verified, and compensated based on observable performance. Under Alternative A6, the schedule becomes more than just a tool for monitoring time. It becomes an instrument for controlling the flow of payments.

SPI and CPI are tracked using Shewhart–Deming 3-sigma Statistical Process Control Charts. At the same time, the Estimate of Completion (EAC) is predicted using a polynomial trendline in Excel, with a target R^2 of at least 0.90. The incentive plan—Taylor Plan, Gantt Plan, or Merrick Plan—is defined at the pre-sanction stage and embedded in the contract. [36] This system has been used continuously by the private sector for more than 120 years. It applies to all project sizes and contract types, including the lump-sum EPC contracts that dominate Indonesia's downstream oil and gas sector today.

Step 3 — Development of the Feasible Alternatives

Based on the structural gaps identified in Step 1 and the benchmark standards established in Step 2, four evaluation criteria were formulated. Each criterion is scored using a 0–3 scale (MAX direction). The definitions of the criteria and the Decision Matrix are presented in Tables 4, 5, and 6.

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[35] Abba, W. F. (2024). Modernizing earned value management (2nd ed.). PM World Journal, 13(2).

***Table 4. Scoring Scale*[36]**

Score	Meaning
0	Not addressed
1	Partially addressed
2	Substantially addressed
3	Fully addressed

***Table 5. Evaluation Criteria*[37]**

Crit.	Label	Definition and scoring basis
C1	GAO-16-89G BP coverage (0–3)	Score 0 = BP 1–5 only; Score 3 = all 10 BPs including mandatory BP3 (resource loading) and BP8 (SRA). GAO-16-89G states: *"If resources are not assigned to schedule activities, it implies that an unlimited number of resources is available, which is not realistic."*
C2	Cost-schedule-risk integration at pre-sanction (0–3)	Score 0 = no integration; Score 3 = full integration including performance-based incentive payment mechanism linked to verified physical delivery — consistent with GAO-20-195G and Gillette & Dana (1909).
C3	Execution control: float, rolling wave, real-time SPI/CPI (0–3)	Score 0 = no execution control; Score 3 = full SPC-based workflow optimization with forward-looking polynomial EAC ($R^2 \geq 0.90$). Consistent with Giammalvo (2023a) and Humphreys (2018).
C4	Implementation feasibility within 18 months using existing tools (0–3)	Score 0 = 24+ months or new system procurement required; Score 3 = pilot feasible in 6–12 months using Lampiran 7 and Excel only.

[36] By Author
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Table 6. Decision Matrix: Raw Performance Scores[38]

Alt.	Method	C1 (0–3)	C2 (0–3)	C3 (0–3)	C4 (0–3)	Scoring notes
A1	Status quo enhancement	0	0	0	3	C1=0: BP1–5 only; BP3, BP8 absent. C2=0: no integration. C3=0: milestone-only. C4=3: no change needed.
A2	Integrated readiness framework	2	2	1	2	C1=2: BP1–9. C2=2: P50/P80 SRA. C3=1: milestone tracking only. C4=2: 12 months.
A3	Readiness-and-control standard	3	2	2	2	C1=3: all 10 BPs. C2=2: no incentive payment. C3=2: SPI gate + float + rolling wave. C4=2: 18 months.
A4	4D BIM enhanced TKI	3	2	3	0	C1=3: inherits A3. C2=2: no payment reform. C3=3: 4D spatial. C4=0: 24+ months; BIM procurement.
A5	Full EVMS EIA-748-D	3	2	1	0	C1=3: 32 EVMS criteria. C2=2: payment divorced from delivery. C3=1: backward-looking. C4=0: 24+ months.
A6	Gillette & Dana EVM	3	3	3	3	C1=3: Lampiran 7 mandatory + SRA. C2=3: payment = verified delivery + incentive plan. C3=3: SPC + rolling wave + EAC. C4=3: pilot 6–12 months; no new software.

Step 4 — Selection Criteria

A two-stage MADM analysis was conducted: non-compensatory models for initial screening, followed by compensatory models for final ranking. This approach is consistent with Sullivan et al. (2023, Chapter 14). The priority order of criteria — C2 (1st)

[38] By Author

→ C3 (2nd) → C1 (3rd) → C4 (4th) — reflects the research finding that cost-schedule-risk integration and execution control are the most consequential gaps in the current TKI.

4.1 Non-Compensatory Models

Four non-compensatory models were applied in sequence. The minimum acceptable threshold for satisficing is Score ≥ 1 on every criterion.

Table 7. Non-Compensatory Model Summary[39]

MADM Model	A1	A2	A3	A4	A5	A6	Key finding
Dominance	ELIM.	Retained	Retained	Retained	ELIM.	No elim.	A6 uniquely scores 3-3-3-3 and dominates all others. A1 and A5 eliminated.
Satisficing (≥1 all criteria)	ELIM.	Retained	Retained	ELIM.	ELIM.	Retained	A1 fails C1,C2,C3. A4 and A5 fail C4. A2, A3, A6 pass all thresholds.
Disjunctive (≥2 on ≥1 criterion)	ELIM.	Retained	Retained	Retained	Retained	Retained	A1 scores 0 on C1,C2,C3 — no criterion ≥ 2. All others qualify.
Lexicographic (C2→C3→C1→C4)	Elim.	Elim. C2	Elim. C2	Elim. C2	Elim. C2	WINNER	C2: A6 = 3, all others ≤ 2. Decisive at first criterion.

4.2 Compensatory Models

ROC weights are derived from the priority order using the formula

"W(k) = (1/n)Σ(1/j) for j = k to n"[40]
C2 = 0.521, C3 = 0.271, C1 = 0.146, C4 = 0.063.

Two compensatory models are applied only to A2, A3, and A6 —the three alternatives retained after satisficing.

[39] By Author
[40] Sullivan, W. G., Wicks, E. M., & Koelling, C. P. (2023). Engineering economy (17th ed.). Pearson, Chapter 14, ROC weight formula.

Table 8. ROC Weights of Compensatory Analysis

Model	Type	A2	A3	A6
Non-dimensional scaling	Compensatory	3rd (0.583)	2nd (0.714)	1st (0.979)
Additive weighting V(A) = Σ[W(k) × Score(k)]	Compensatory	3rd (1.731)	2nd (2.148)	1st (3.003)

From the comparison above, Alternative A6 outperforms the other six analytical models, while A3 ranks second and is the strongest alternative in the short term as a backup if A6 implementation encounters resistance or obstacles within the organization. These assessment results are consistent across the elimination and trade-off assessment models, indicating that the selection is robust and does not rely on a single analytical method.

FINDINGS

Step 5 — Analysis of Alternatives

After presenting all the data and assessment results for all possible alternative options, we can guide our preference based on the most pressing advantage currently: the ability to directly address the largest unresolved failure mechanism: the separation between verified field performance and contractor payment. While the use of A5 (ANSI/EIA-748-D EVMS) improves auditability and variance reporting, it does not alter the logic of performance-based payment. Therefore, we conclude that A6 is superior.

Table 9. Structural Comparison ; A5 vs A6[41]

Dimension	A5 Full EVMS per NDIA EIA-748-D	A6 Performance-based EVM per Gillette & Dana
Orientation	Audit and compliance — backward-looking	Workflow optimization — forward-looking
Payment logic	Divorced from performance; milestone-based	Directly linked to verified physical delivery
Time focus	Variance reporting after the fact	Statistical process control of workflow in real time
Tools required	Formal EVMS governance; 24+ months	Excel + Lampiran 7 + SPC charts; pilot 6–12 months
Contract fit	Large cost-plus / government acquisition	Lump-sum and unit-rate EPC — dominant in Indonesia
Incentive alignment	None for contractor efficiency	Taylor / Gantt / Merrick incentive plans at pre-sanction
Contractor cash flow	Not addressed	Prompt payment clause eliminates cash starvation
Strategic value	Better reporting	Better control — changes what scheduling is for

Furthermore, Alternative A6 is considered significantly more strategic because it not only requires the Company to adopt a Company report but also changes the fundamental assumptions governing the objectives of schedule control. Under A6, the schedule becomes a production and payment control system, not merely a system in which work is planned based on measurable results, verified in the field, converted to earned value, and paid for without administrative delay.

This directly addresses all four gaps defined in Step 1. Empirical benchmarks show that this direction is achievable: as Giammalvo points out, "the implementation of EVM according to Gillette and Dana in the context of the Indonesian EPC (Freeport McMoran Indonesia) resulted in a direct project cost reduction of 57%, a productivity increase of up to 700% on the night shift, and savings of USD 65 million over 4 years in a PMO whose structure had remained unchanged for 21 years." [42]

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[41] By Author
[42] Giammalvo, P. D. (2025). Earned value management — The truth, the whole truth. Medium. https://project-doctor.medium.com/earned-value-management-the-truth-the-whole-truth-05c0722c16c9

Step 6 — Selection of the Preferred Alternative

Based on the MADM results, the preferred alternative is A6, the Performance-based EVM, per Gillette and Dana.

A6 was validated through a back-test applied to the Company's 15 highest-value EPC projects (Table 1, Step 1). The back-test compares the TKI P0 sanctioned baseline against the A6 P50-adjusted baseline, calculated as P50-adjusted duration = Original P0 duration ÷ 0.60 (historical SPI per Zilikram, 2023). The P50 adjustment is the minimum correction that the A6 framework would have imposed had it been applied at the front end, consistent with AACE Class 3 probabilistic estimating requirements. Results are presented in Table 10

Table 10. Back-Test Results [43]

Proj.	P0 sanctioned (days)	A6 P50-adj. (days)	Actual (days)	Overrun vs P0	Overrun vs P50-adj.	Diagnostic
P1	364	607	1,657	+355%	+173%	Scope explosion not captured at FEL-2. SPI gate triggers within Q1.
P2	546	910	1,988	+264%	+118%	P50-adj. more credible; residual reflects execution-stage procurement risk.
P3	730	1,217	1,825	+150%	+50%	P50-adj. within AACE Class 3 upper bound (+30% high). Back-test passes.
P4	547	912	1,460	+167%	+60%	Slightly above Class 3 bound; rolling wave would narrow gap further.
P5	485	808	912	+88%	+13%	A6 effectively forecasts actual outcome. SPI gate does not trigger.
P6	456	760	1,642	+260%	+116%	Residual overrun above P50 — addressable by A6 prompt-payment clause.
P13	365	608	837	+129%	+38%	Best performer: +38% approaches AACE Class 3 accuracy range.
Portfolio avg.	619 days	1,007 days	1,806 days	+276%	+79% ↓	A6 reduces apparent overrun by 197 percentage points at sanction — before any execution change.

The back-test yields three findings.

[43] By Author

First, replacing P0 baselines with A6 P50-adjusted baselines at sanction reduces the average baseline error from +276% to +79% — a 197-percentage-point improvement achieved at the front-end planning stage, before any execution changes.

Second, the SPI ≥ 0.95 gate would have triggered a management alert on the three worst-performing projects (P1, P2, P6) within the first quarter of execution.

Third, for lower-complexity projects (P3, P5, P13), the A6 P50-adjusted baseline produces estimates within or close to AACE Class 3 accuracy—consistent with Zilikram and Yudoko's (2026) validation result of ±0.6% at P50.

However, A6 should not be implemented solely as theory and paperwork. It requires testing. Furthermore, A3 should be retained as a backup alternative in case organizational resistance hinders the immediate adoption of A6. While this is not desirable, it is always a good idea to have a backup plan. This is not the desired end state, but it is the most powerful short-term bridge because it improves schedule readiness, resource feasibility, SPI control, and rolling wave execution discipline.

Step 7 — Performance Monitoring and Post-Implementation Review

The A6 framework we introduce here is an initial adjustment based on insights from project data covering 2021 to 2025 and information from the productivity database in *Lampiran 7*. As our Company's portfolio grows, we will implement this performance monitoring framework to ensure it remains effective and relevant.

There are three key points to add as a basis for improvement. First, compare our schedule against the Monte Carlo P50 Method baseline before approving the project. Next, at the end of the first quarter of construction, conduct an assessment using the actual Schedule Performance Index (SPI). Finally, upon project completion, review and compare the predictions against the final actual duration. Furthermore, we should observe to identify recurring patterns of overestimation or underestimation at these stages. This information and data will help expand the productivity database and refine the SPC specification limits for future projects.

Table 11. Three Progressive Tracking Stages for A6 Performance Monitoring[44]

Stage	Tracking point	What is measured	Acceptable threshold	Action if exceeded
1	Pre-sanction gate (FEL-2 / Class 3 approval)	P50 Monte Carlo vs. P0 baseline. SPI ≥ 0.95 verified. WBS/CBS Level 3 confirmed. All Lampiran 7 rates documented.	P50 within −10% to +30% of P0 (AACE Class 3 range). SPI ≥ 0.95. All Lampiran 7 rates used.	If P50 > +30%: escalate to sponsor before sanction. If SPI < 0.95: delay sanction pending float resolution.
2	End of Q1 construction (first SPC review)	SPI and CPI plotted on 3-Sigma SPC chart and Bullseye chart. Polynomial EAC ($R^2 \geq 0.90$) generated. Rolling wave plan verified current.	SPI ≥ 0.95. CPI ≥ 0.95. All readings within ±3σ UCL/LCL. EAC converging toward P50 baseline.	If SPI < 0.95: identify root cause. Activate prompt-payment review if CPI decline correlates with payment delay.
3	Project completion (post-completion SPC validation)	Final SPI and CPI vs. P50 baseline. SPC accuracy classification per Giammalvo (2023a): High/Low Accuracy × High/Low Precision matrix.	Final SPI ≥ 0.90 vs. P50. Classification: Quadrant 1 (High Accuracy + High Precision) or Quadrant 3.	Quadrant 1 or 3: update Lampiran 7. Quadrant 4: investigate root cause before database inclusion.

To obtain well-directed improvement steps, the Pareto Principle (80/20 rule) is applied to the GAO-16-89G gap analysis from Step 3. The two most consequential gaps — BP3 (assigning resources) and BP8 (schedule risk analysis) — together account for approximately 39% of the total structural deficit and are assigned as Priority 1 interventions under A6. The post-implementation review should therefore focus on measured improvement, not procedural issuance: the +276% baseline accuracy gap identified in Step 1 and confirmed by the back-test in Step 6 is the reference point against which all improvement should be measured.

CONCLUSION

This paper evaluates the adequacy of a company's early-stage scheduling practices as a basis for quality and approval-worthy investment decisions. Empirical evidence from 15 completed EPC projects, with an average portfolio-wide schedule delay of +276% and no on-time completions, indicates that these practices are ineffective. The four research questions stated in the Introduction are addressed directly below:

1. **Are the Company's current front-end scheduling practices fit for purpose as a basis for sanction-quality decisions, or do they remain primarily compliance-oriented?**

   In practice, these practices still relate to procedural compliance. TKI successfully developed a schedule consistent with the project plan, but failed to develop one

[44] By Author

credible enough to support investment commitments. Four structural gaps may explain this failure: the lack of probabilistic schedule risk analysis, the consultative nature of resource feasibility reviews, the lack of verified payment-progress linkages, and the lack of project-specific cash-flow feasibility testing.

2. **What best-tested and proven benchmark should be used to assess those practices?**

   A comparison with GAO-16-89G, the AACE TCM Framework, the NDIA IPMD predictive measures, and the NASA JCL shows that, however, no single standard covers all four structural gaps outlined above. The performance-based EVM model of Gillette & Dana (1909), validated in the Indonesian context, has been used in the private sector for over 120 years and has been documented by Giammalvo (2023a and 2025). This model has the highest level of integration among probabilistic hazard risk, resource feasibility, verified progress, and payment controls, and thus represents the clearest and most widely accepted EVM standard to date for integrating these components.

3. **Which structural gaps between current internal practices and the benchmark most likely explain the unreliability of the current schedule?**
   In the GAO-16-89G gap assessment, the Pareto analysis identified BP3 (resource allocation) and BP8 (schedule risk analysis) as the two highest-priority gaps, accounting for approximately 39% of the total structural deficit. It is these two gaps that underlie the adoption of the deterministic P0 baseline (since P0 is statistically likely to underestimate the real duration of most projects).

4. **What direction should the Company take to move its scheduling standards from procedural compliance to strategic schedule readiness?**

   The MADM analysis identified Alternative A6, performance-based EVM, as the option to replace its scheduling standards. This direction was validated through back testing: replacing P0 with the A6 baseline adjusted to P50 reduced the average schedule error from +276% to +79%, and this was achievable in the early planning phase, before any changes to implementation. As mentioned previously, A3 is retained as a backup. A pilot implementation is required before the full portfolio is launched. It is important to measure success against the +276% baseline error specified in Step 1, rather than procedural compliance.

Future studies should cover three gaps that the current study could not thoroughly fill with the data available:

1. A cash flow viability model of lump-sum EPC contracts (as quantified).
2. Statistical validation of the *Lampiran 7* productivity database.

3. A live A6 pilot demonstration with three-sigma SPC charts derived from actual execution of projects.

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