

Validating Front-End Loading Maturity Using Earned Value for Downstream Oil and Gas Capital Investment Decisions^{1, 2}

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ABSTRACT

Downstream oil and gas projects are capital-intensive, interface-heavy, and highly dependent on credible front-end planning before capital approval. This paper examines how Front-End Loading (FEL) maturity can be defined, assessed, and validated using Earned Value Management (EVM) indicators to support downstream oil and gas capital investment decisions. Using the seven-step Engineering Economy process, the study compares five analytical alternatives through a two-stage Multi-Attribute Decision Making (MADM) approach: non-compensatory screening and compensatory additive weighting. The selected alternative is an integrated FEL–EVM validation model combining FEL maturity, CPI, SPI, EAC, TCPI, and WBS-level variance review. Four anonymized 2024 downstream oil and gas project cases are tested using EVM-derived maturity and baseline accuracy proxy scores. The findings show that CPI or SPI alone may mislead decision-makers, while the integrated model provides stronger evidence of baseline credibility. The paper concludes that linking FEL maturity to EVM performance strengthens phase-gate governance, baseline control, and the quality of capital investment decisions.

Keywords: Front-End Loading, Earned Value Management, CPI, SPI, Capital Investment Decisions, Downstream Oil and Gas, Phase-Gate Governance, Baseline Credibility

INTRODUCTION

A. Downstream Oil and Gas Infrastructure in Indonesia

¹ How to cite this paper: Bernadeth, V. G. (2026). Validating Front-End Loading Maturity Using Earned Value for Downstream Oil and Gas Capital Investment Decisions; *PM World Journal*, Vol. XIII, Issue VII, July.

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/>

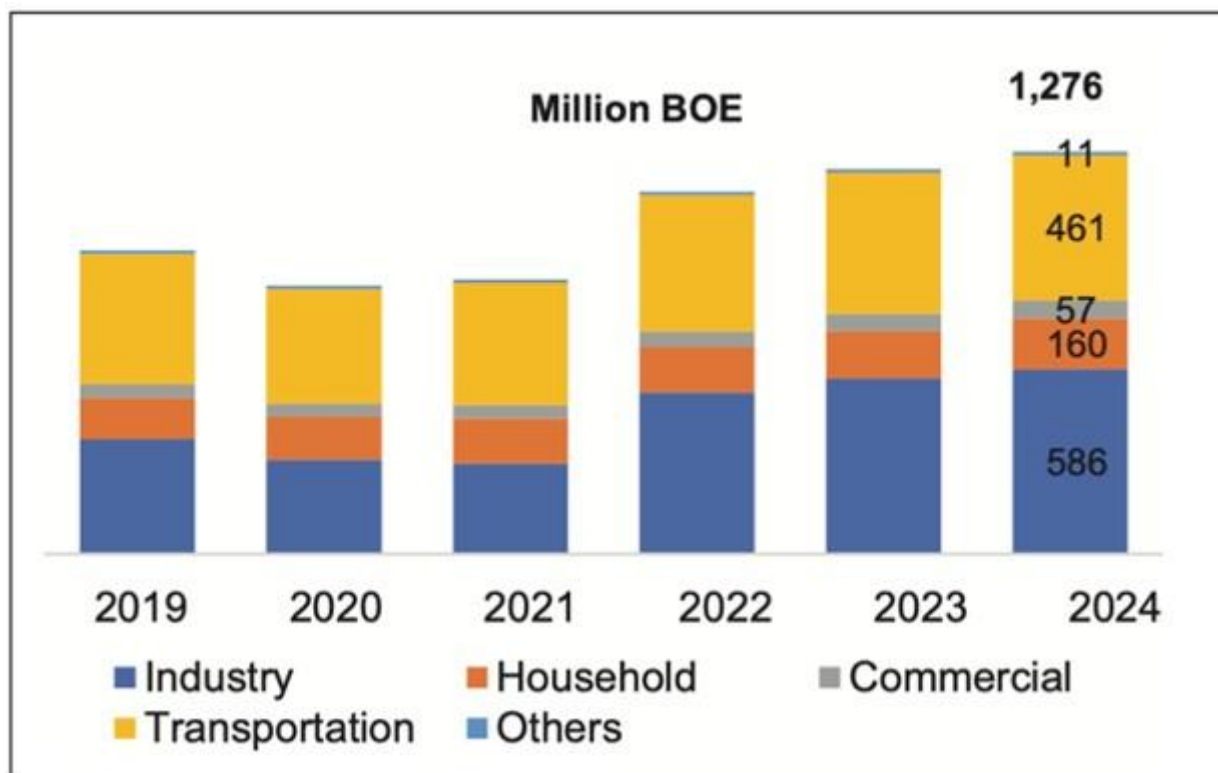


Figure 1 – Indonesia’s Energy Consumption³

Data from the Ministry of Energy and Mineral Resources shows that “energy consumption in Indonesia reached 1,276 million BOE in 2024 with an increase of 4.53%.”⁴ Pradibta explains that “Indonesia relied heavily on oil as the main source of energy supplier for all its economic activities.”⁵ Therefore, large capital downstream infrastructure projects is strategically important and should not be treated merely as construction activities, but as capital investments whose planning quality directly affects long-term operational performance and national supply capability.^{6,7}

³ Ministry of Energy and Mineral Resources, Republic of Indonesia. (2024). Handbook of Energy & Economic Statistics of Indonesia 2024.

<https://www.esdm.go.id/id/publikasi/handbook-of-energy-economic-statistics-of-indonesia>

⁴ Ibid

⁵ Pradibta, I. (2024).

Developing a standardized, multidimensional WBS/CBS coding structure for storage tanks. PM World Journal, 13(3).

<https://pmworldlibrary.net/wp-content/uploads/2024/03/pmwj139-Mar2024-Pradibta-Standardized-Multidimensional-WBS-CBS-for-Storage-Tanks.pdf>

⁶ Ministry of Energy and Mineral Resources Republic of Indonesia. (2024). Loc. Cit

⁷ Pradibta, I. Loc. Cit

B. Project Performance Challenges and the Importance of Front-End Loading

Despite its strategic importance, Wisnugroho reports “56% of projects experience a 10% cost and schedule overrun, and around 36% experience cost and schedule overrun up to 25% at 45 projects”⁸. Zilikram states, “Indonesia’s downstream oil and gas construction practices still lag behind international best-tested and proven practices”⁹. Mukuka, Aigbavboa, and Thwala state that “schedule overruns in construction projects reduce productivity and weaken overall project performance”¹⁰. These findings suggest that project underperformance is not caused only by poor field execution but originates earlier when projects are authorized with incomplete scope definition, weak schedule logic, immature cost estimates, or insufficient owner decision readiness¹¹¹²¹³.

The Construction Industry Institute defines Front End Planning as “a disciplined process for improving project definition before execution”¹⁴. Organizations commonly use the term Front-End Loading (FEL) to describe the same underlying logic¹⁵¹⁶. The MacLeamy Curve shows that “the opportunity to influence project outcomes is highest early in the project lifecycle, while the cost of change rises sharply once detailed design and construction are underway”¹⁷ as shown in Figure 2. This concept matters because

⁸ Wisnugroho, J. (2020). Indonesia Oil & Gas Cost Estimating vs International “Best-Tested and Proven” Practices – A Benchmarking Study; *PM World Journal*, Vol. IX, Issue II, February. <https://pmworldlibrary.net/wp-content/uploads/2020/02/pmwj90-Feb2020-Wisnugroho-benchmarking-indonesia-og-cost-estimating-vs-international3.pdf>

⁹ 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*, Vol. XII, Issue X, October. <https://pmworldjournal.com/article/benchmarking-indonesias-downstream-oil-gas-construction>

¹⁰ Ibid

¹¹ Mukuka, M., Aigbavboa, C., & Thwala, W. (2015). Effects of construction projects schedule overruns: A case of the Gauteng Province, South Africa. <https://doi.org/10.1016/j.promfg.2015.07.988>

¹² Zilikram, M. F. Loc. Cit.

¹³ Wisnugroho, J. (2020). Loc. Cit.

¹⁴ Construction Industry Institute. Front End Planning. <https://www.construction-institute.org/front-end-planning>

¹⁵ Brindley Engineering. (n.d.). Front-end loading (FEL) process overview.

<https://www.brindleyengineering.com/knowledge-center/insights/front-end-loading-fel-process-overview/>

¹⁶ Merrow, E. W. (2011). Industrial Megaprojects: Concepts, Strategies, and Practices for Success.

¹⁷ MacLeamy, P. (2004). The MacLeamy Curve. <https://www.msa-ipd.com/MacleamyCurve.pdf>

downstream oil and gas projects are capital-intensive, interface-heavy, and vulnerable to rework if owner decisions remain vague or fragmented at the time of sanction¹⁸.

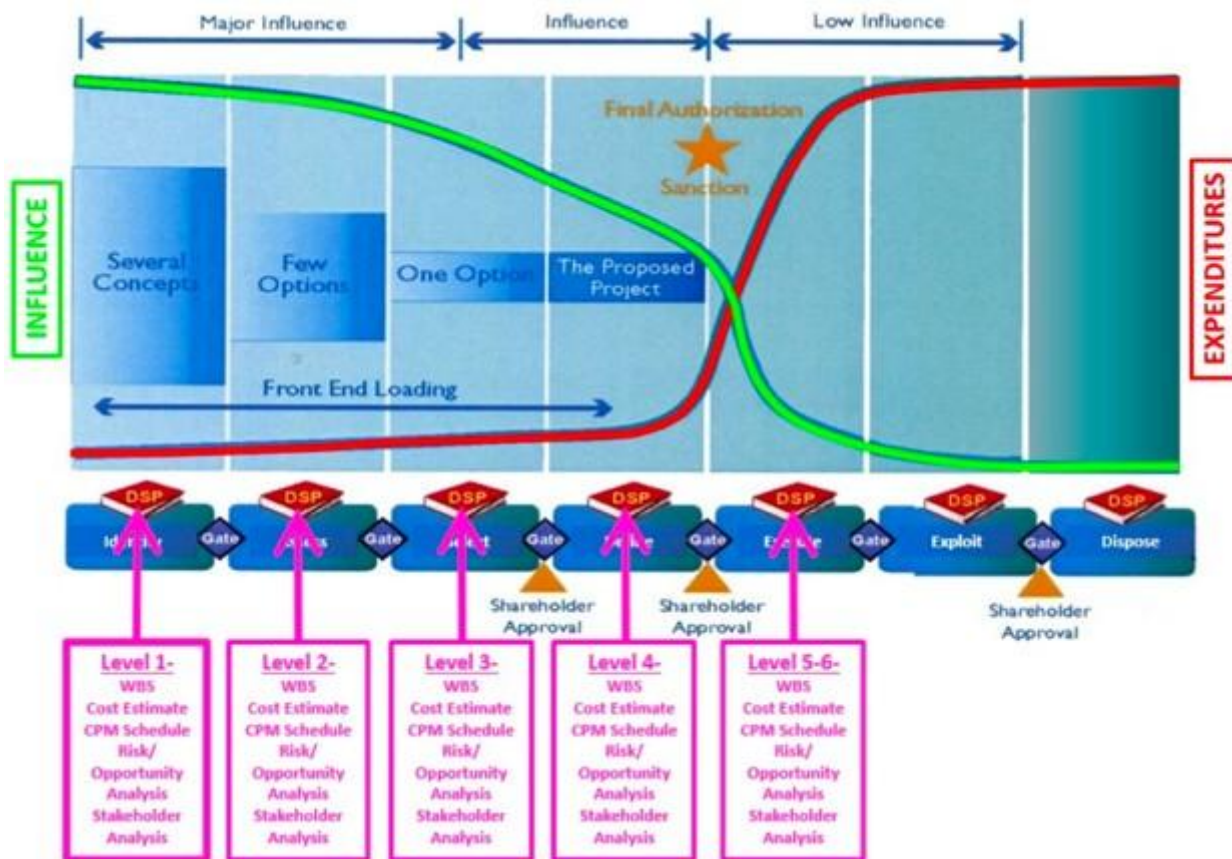


Figure 2 - Decision Support Package (DSP) Content Across Phase Gates Illustrated¹⁹

¹⁸ Zilikram, M. F. Loc. Cit.

¹⁹ Giammalvo, P. D., & PTMC Team. (2021–2024). Loc. Cit.

Giammalvo and the PTMC Team explain that a proper Decision Support Package should contain, at minimum, as shown in Figure 4²⁰.

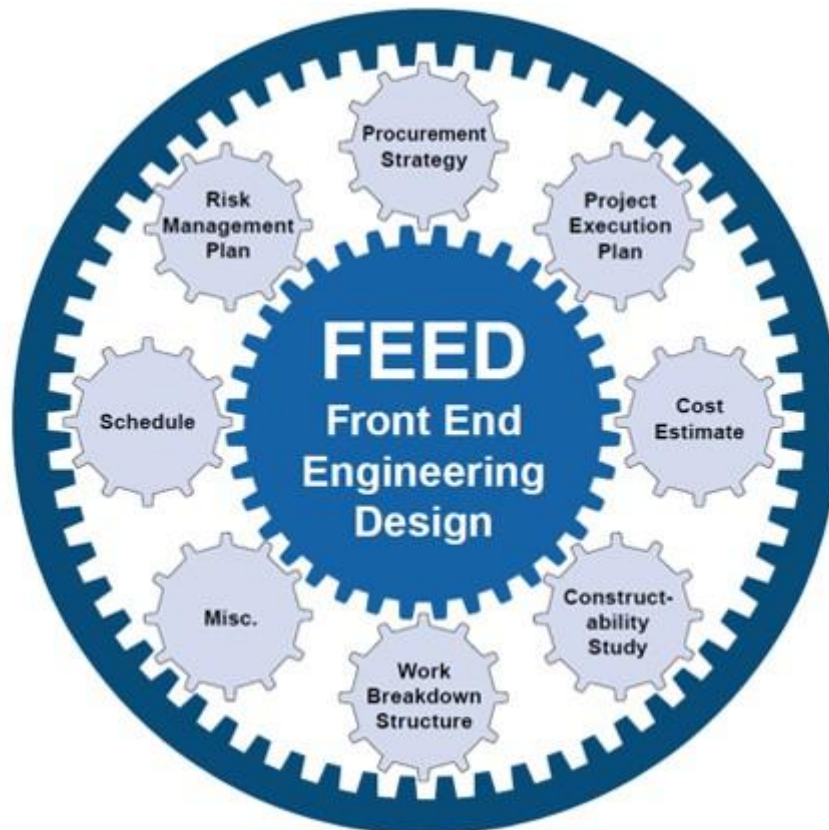


Figure 3 - The Project Definition Package²¹

Merrow argues that “stronger front-end definition improves the probability of better downstream project performance”²². Accordingly, FEL should be treated as a structured readiness process, not an administrative checkpoint²³. The phase-gate concept further

²⁰ Giammalvo, P. D., & PTMC Team. (2021–2024). Loc. Cit.

²¹ Ibid

²² Merrow, E. W. (2011). Loc. Cit.

²³ Giammalvo, P. D., & PTMC Team. (2021–2024). Loc. Cit.

strengthens this logic by requiring increasing levels of maturity before advancing project commitments.²⁴²⁵

Guild of Project Controls Combined Asset and Project Phase Gate Names:	Deliverables from Each Phase (Decision Support Package- DSP)				Primary Purpose of each Phase	Other Commonly Used Phase Gate Names
	WBS	Risk/ Opportunity Analysis	Schedule Level Accuracy Range from PSO	Cost Estimate Level Accuracy Range from PSO		
Phase 1	Level 1	Business Risk/ Opportunity	Level 1 +100% to -20%	Level 1 +100% to -20%	To explore several concepts, ideas, options or alternatives	Concept, Prefeasibility, Appraise, Assess, Identify, Rough Order of Magnitude; FEL 1, FED 1
Phase 2	Level 2	Technical Risk/ Opportunity	Level 2 +60% to -15%	Level 2 +60% to -15%	To narrow down the alternatives to the top 2-3 "better" options	Feasibility, Conceptual Design, Pre-Feed, Select, FEL 2, FED 2
Phase 3	Level 3	Procurement Risk/ Opportunity	Level 3 +30% to -10%	Level 3 +30% to -10%	To select the "best" single option and "initiate" the project	Design, Feed, Define, Develop, FEL 3, FED 3
Phase 4	Level 4	Constructability Risk/ Opportunity	Level 4 +15% to -5%	Level 4 +15% to -5%	To refine and plan the project scope, cost, time and risks, and validate assumptions	Define, FEL 4
Phase 5	Level 5	SH&E Risks Cost & Schedule, Resource and Quality Risks/ Opportunity	Level 5 +5% to -5%	Level 5 +5% to -5%	To execute the project plan to create whatever benefit or business objectives (the "product" of the project) the project was undertaken to achieve	Execute
Phase 6	N/A	Business Risk/ Opportunity	N/A	N/A	To exploit the PRODUCT of the PROJECT (the new Asset)	Operate
Phase 7	N/A	Business Risk/ Opportunity	N/A	N/A	To decommission, dismantle or otherwise DISPOSE of the ASSET	Dismantle, decommission, recycle, sell

Figure 4 – Phase-Gate Summary²⁶

The GAO defines WBS as "a framework for planning and assigning responsibility for work necessary to accomplish a program's objectives"²⁷. Giammalvo and the PTMC Team emphasize that "developing and expanding standardized and multi-dimensional Work Breakdown Structures and Cost Breakdown Structures" is essential to effective project controls²⁸. That connection matters because a weak WBS usually leads to weak scope visibility, accountability, and alignment between schedule and estimate, thereby weakening baseline credibility before execution begins²⁹³⁰.

C. Earned Value Management as a Performance Indicator

While FEL is intended to improve planning quality before execution, management still needs a reliable way to measure whether that planning strength is reflected in actual

²⁴ ITAC. (n.d.). Front-end engineering design: FEL1, FEL2, FEL3. <https://itac.us.com/front-end-engineering-design-fel1-fel2-fel3/>

²⁵ H+M Industrial EPC. (n.d.). FEL deliverables for capital project success. <https://www.hm-ec.com/blog-posts/fel-deliverables-for-capital-project-success-hm>

²⁶ Ibid

²⁷ U.S. Government Accountability Office. (2020). GAO Cost Estimating and Assessment Guide: Best Practices for Developing and Managing Program Costs (GAO-20-195G). <https://www.gao.gov/assets/gao-20-195g.pdf>

²⁸ Giammalvo, P. D., & PTMC Team. (2021–2024). Loc. Cit.

²⁹ U.S. Government Accountability Office. (2020). Loc. Cit.

³⁰ Giammalvo, P. D., & PTMC Team. (2021–2024). Loc. Cit.

project delivery performance. Humphreys explains that Earned Value Management integrates “scope of work, a scheduled time frame in which the work must be accomplished, and a budget to perform the work”³¹. Geneste similarly states that EVM integrates “the three related components of project performance: scope, schedule, and cost”³². In this study, EVM provides a disciplined way to determine whether execution is in accordance with the approved baseline³³. Humphreys identifies the three core earned value data elements as “Budgeted Cost for Work Scheduled (BCWS), Budgeted Cost for Work Performed (BCWP), and Actual Cost of Work Performed (ACWP)”³⁴ as shown in Figure 5. This support CPI ($CPI = BCWP / ACWP$) and SPI ($SPI = BCWP / BCWS$), where GAO states that “the CPI metric is a measure of cost expended for the work completed” and that “the SPI metric is a measure of the amount of work accomplished versus the amount of work planned”³⁵. EVM is therefore used as the downstream evidence needed to test whether stronger FEL maturity is associated with better execution performance after baseline approval. Geneste explains that if $SPI < 1$, “it indicates a delay,” while if $CPI < 1$, “the project has cost more than planned”³⁶. This translate performance status into a form that management can interpret consistently over time, across work packages, and across projects³⁷.

³¹ Humphreys & Associates. Basic concepts of Earned Value Management. <https://www.humphreys-assoc.com/basic-concepts-of-earned-value-management-evm/>

³² Geneste, S. (2019). The True Origins of EVM: A historical approach to scheduling and incentive schemes, PM World Journal, Vol. VIII, Issue IX, October. <https://pmworldlibrary.net/wp-content/uploads/2019/10/pmwj86-Oct2019-Geneste-the-true-origins-of-evm.pdf>

³³ NASA. (2018). Loc. Cit.

³⁴ Humphreys & Associates. Loc. Cit.

³⁵ Ibid

³⁶ Geneste, S. Loc. Cit.

³⁷ Ibid

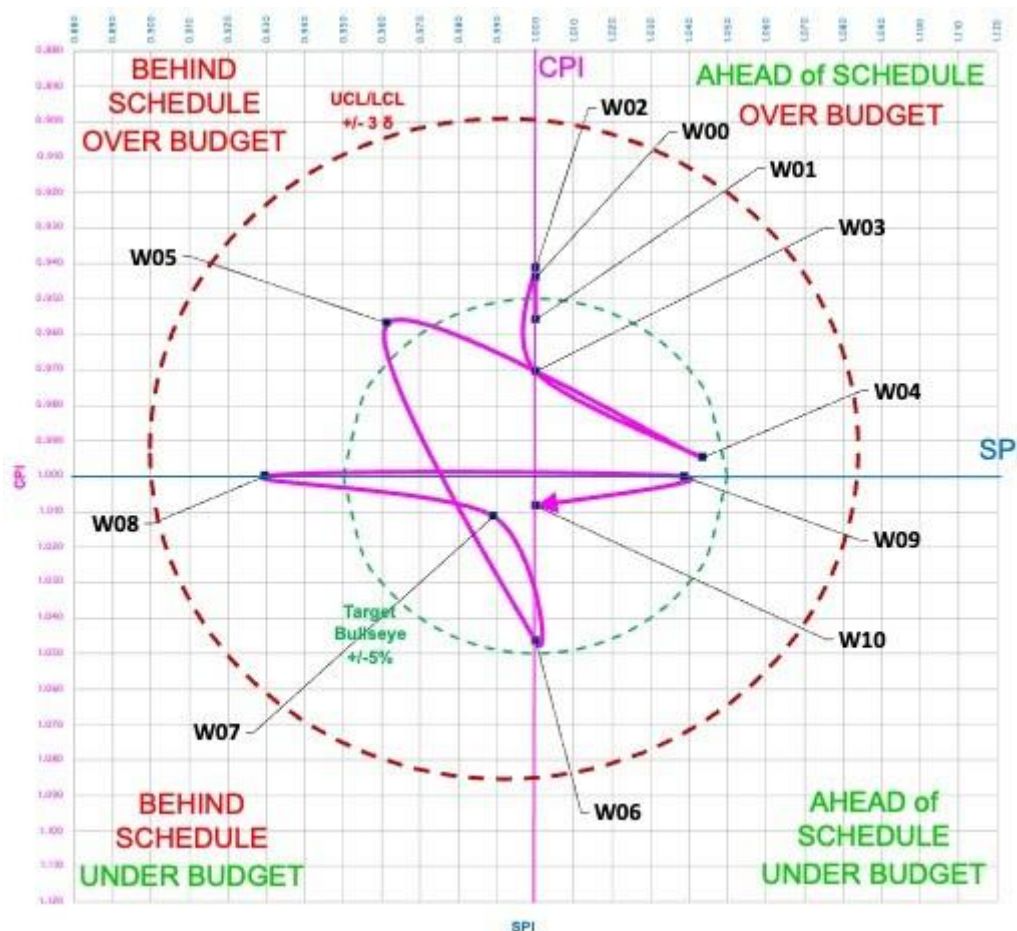


Figure 6 - CPI and SPI Interpretation Matrix³⁹

Fleming and Koppelman explain “earned value as an operational method for comparing work status against the approved baseline”⁴⁰, while NASA emphasizes that an EVM should support “variance analysis, forecasting, baseline control, and corrective action during execution”⁴¹. FEL is conducted before a major capital commitment and seeks to improve project readiness, scope definition, and baseline credibility. EVM operates after the baseline is approved and seeks to measure whether actual execution conforms to that plan. This means EVM provides the downstream evidence needed to test whether stronger FEL maturity leads to more stable and more reliable delivery outcomes⁴². Pangestu shows that “disciplined earned value practice, combined with timely contractor payment, can improve productivity and management responsiveness in capital-intensive projects”⁴³. For that reason, this paper uses BCWS, BCWP, ACWP, SPI, and CPI as the

³⁹ by Author

⁴⁰ Fleming, Q. W., & Koppelman, J. M. (2016). Loc. Cit.

⁴¹ NASA. Loc. Cit.

⁴² U.S. Government Accountability Office. Loc. Cit.

⁴³ Pangestu, S. A. (2024). Enhancing Productivity in Greenfield Mining Projects through Earned Value Management and Timely Contractor Payments; PM World Journal, Vol. XIII, Issue X

<https://pmworldlibrary.net/wp-content/uploads/2024/11/pmwj146-OctNov2024-Pangestu-Enhancing-Productivity-in-Greenfield-Mining-Projects-1.pdf>

primary performance indicators for evaluating the execution consequences of front-end maturity⁴⁴⁴⁵.

D. Research Gap, Objective, and Contribution

Giammalvo and the PTMC Team use the phrase "best tested and proven practices"⁴⁶ to require organizations to integrate governance, scope definition, planning, scheduling, budgeting, progress measurement, and change control into a single decision system.⁴⁷ This study identifies three key gaps, as shown in Table 1

Table 1 – Research Gap⁴⁸

No.	Research Gap	Description
1	Strategic Gap	Weak linkage between capital investment decisions and execution outcomes
2	Planning Gap	Limited measurement of FEL maturity
3	Control Gap	Lack of integration between FEL and EVM indicators

Accordingly, this paper evaluates whether higher levels of FEL maturity are associated with improved project performance as measured through EVM indicators.

Therefore, the questions to support this study are as follows:

1. How can FEL maturity be defined and assessed?
2. How can CPI and SPI be used to validate the credibility of front-end planning?
3. How can this relationship improve capital investment decision-making?

This study aims to provide practical insight into stronger project governance practices in Indonesia’s downstream oil and gas sector⁴⁹ and provide a decision-support framework for evaluating the effectiveness of early-stage planning in capital-intensive projects. According to Engineering Economy practice, “owner organizations may rely on ‘benefit measurement methods,’ constrained optimization methods, logical framework approaches, informal executive judgement, or even the do-nothing alternative when making capital decisions”⁵⁰. However, this paper focuses more narrowly on FEL maturity as the leading readiness condition and on EVM indicators as the downstream evidence to validate whether planning quality was credible in practice⁵¹.

⁴⁴ NASA. Loc. Cit.

⁴⁵ U.S. Government Accountability Office. Loc. Cit.

⁴⁶ Giammalvo, P. D., & PTMC Team. (2021–2024). Loc. Cit.

⁴⁷ Ibid

⁴⁸ By Author

⁴⁹ Giammalvo, P. D., & PTMC Team. (2021–2024). Loc. Cit.

⁵⁰ Sullivan, W. G., Wicks, E. M., & Koelling, C. P. (2019). *Engineering economy* (17th ed.). Pearson.

⁵¹ U.S. Government Accountability Office. (2015). Loc. Cit.

METHODOLOGY

For this study to be carried out systematically, rationally, and reasonably, the paper adopts the seven-step Engineering Economy procedure presented by Sullivan, Wicks, and Koelling⁵², as shown in Figure 5.

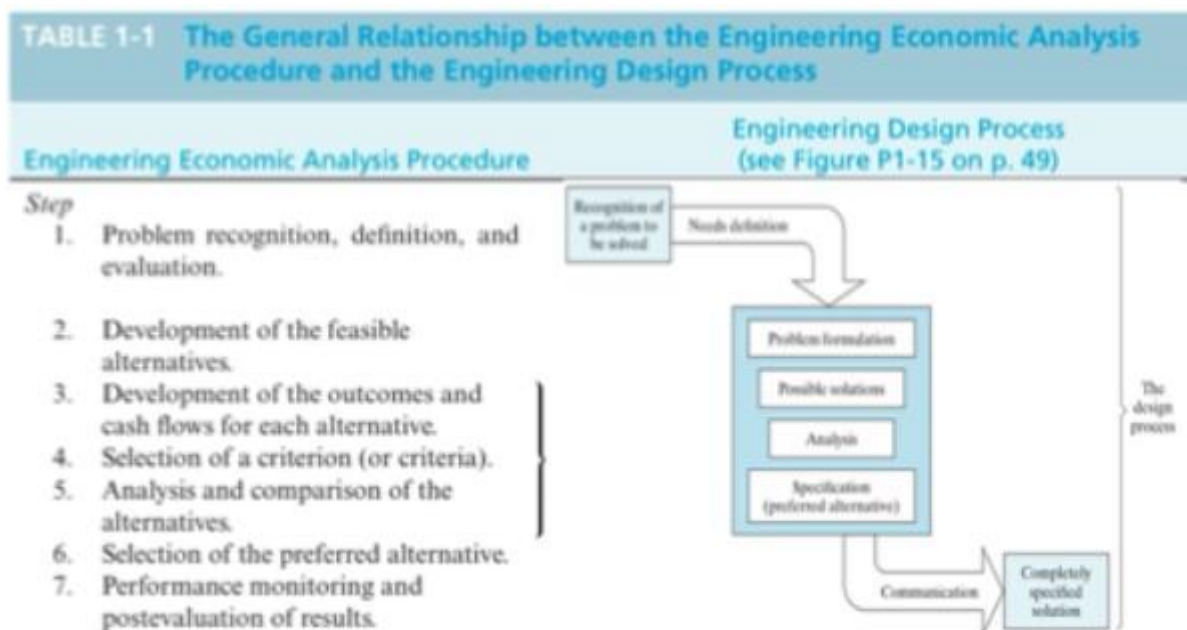


Figure 7 – Engineering Economic Analysis Procedure⁵³

Step 1 - Problem Definition

Downstream oil and gas investment projects involve large capital expenditure, long development timelines, and complex technical interfaces. In Indonesia, however, cost and schedule overruns remain a recurring problem in capital projects. Wisnugroho and Zilikram’s findings indicate that poor project outcomes may not originate solely in the construction phase. Instead, they may begin earlier, when a project is authorized without a sufficiently mature scope definition, risk visibility, schedule logic, estimate quality, and governance discipline⁵⁴⁵⁵. Giammalvo and the PTMC Team identify recurring root causes such as “omitted probable scope,” “omitted possible risks,” unrealistic assumptions, and inadequate time to prepare credible estimates⁵⁶. Therefore, the practical problem addressed in this paper is whether weak FEL maturity contributes to weak execution outcomes in downstream oil and gas capital projects.

⁵² Ibid

⁵³ Ibid

⁵⁴ Wisnugroho, J. Loc. Cit.

⁵⁵ Zilikram, M. F. Loc. Cit.

⁵⁶ Giammalvo, P. D., & PTMC Team. (2021–2024). Loc. Cit.

This study aims to develop a more defensible basis for evaluating the relationship between FEL maturity and EVM performance indicators in downstream oil and gas projects⁵⁷. The purpose of this study is to:

1. define and assess FEL maturity in a structured and measurable way before major capital is committed⁵⁸;
2. determine whether stronger FEL maturity is associated with stronger earned value cost and schedule performance⁵⁹;
3. support stronger capital investment decision-making by linking front-end readiness with measurable downstream project outcomes⁶⁰.

Step 2 - Identify The Feasible Alternative

Sullivan, Wicks, and Koelling explain that the "development of the feasible alternatives" step requires the analyst to identify realistic solution paths that address the problem defined in Step 1⁶¹. In this study, the problem is not just broad project selection. The problem is how to define and assess FEL maturity and then determine whether downstream earned value indicators can validate planning quality. Therefore, the feasible alternatives are presented here as analytical approaches for linking front-end readiness to execution-stage performance rather than as general capital-budgeting methods alone⁶². The five feasible alternatives are shown in Table 2

⁵⁷ Ibid

⁵⁸ ITAC. Front-End Engineering Design: FEL1, FEL2, FEL3. <https://itac.us.com/front-end-engineering-design-fel1-fel2-fel3/>

⁵⁹ NASA. Loc. Cit.

⁶⁰ Giammalvo, P. D., & PTMC Team. (2021–2024). Loc. Cit.

⁶¹ Sullivan, W. G., Wicks, E. M., & Koelling, C. P. Loc. Cit.

⁶² Ibid

Table 2 Feasible Alternatives⁶³

No.	Alternative	Analytical Description	Primary Validation Basis
1	Stand-Alone FEL Maturity Assessment Model	Evaluates front-end readiness using FEL maturity elements, including governance discipline, phase-gate deliverables, WBS quality, risk/opportunity visibility, schedule readiness, and estimate readiness.	Front-end readiness profile only
2	FEL Maturity with CPI Validation Model	Links FEL maturity as the leading readiness condition with CPI as the lagging cost-performance indicator during execution.	Cost Performance Index (CPI)
3	FEL Maturity with SPI Validation Model	Links FEL maturity as the leading readiness condition with SPI as the lagging schedule-performance indicator during execution.	Schedule Performance Index (SPI)
4	FEL Maturity with CPI & SPI Dual Validation Model	Combines CPI and SPI to test whether stronger FEL maturity is associated with both cost and schedule efficiency.	CPI + SPI
5	Integrated Model: FEL Maturity, CPI, SPI, and Supporting Indicators	Integrates FEL maturity with CPI, SPI, and selected supporting indicators such as EAC, TCPI, and WBS-level variance review to explain both performance status and potential root causes.	CPI + SPI + Supporting Indicators

To support that comparison, this study adopts the CII view that FEL should be evaluated not only in terms of “maturity” but also in terms of “accuracy,” as illustrated in the “Maturity-Accuracy Matrix (Cost Change Performance)” in Figure 8⁶⁴. In parallel, Figure 9⁶⁵ shows that FEL maturity is not a single-variable concept, but a structured construct comprising “Basis of Project Decision,” “Basis of Design,” and “Execution Approach,” each supported by specific categories and elements⁶⁶. This CII structure strengthens the stand-alone FEL maturity model by giving it a more explicit internal definition, while the CPI-, SPI-, dual-validation, and integrated models extend that definition by testing whether stronger FEL maturity is also reflected in downstream cost and schedule performance^{67,68,69,70}.

⁶³ By Author

⁶⁴ Construction Industry Institute. (2018). Front End Engineering Design (FEED) Maturity and Accuracy Total Rating System (MATRS) (Implementation Resource 331-2). The University of Texas at Austin

⁶⁵ Ibid

⁶⁶ Ibid

⁶⁷ Humphreys & Associates. Loc. Cit.

⁶⁸ Geneste, S. Loc. Cit.

⁶⁹ NASA. Loc. Cit.

⁷⁰ U.S. Government Accountability Office. Loc. Cit.

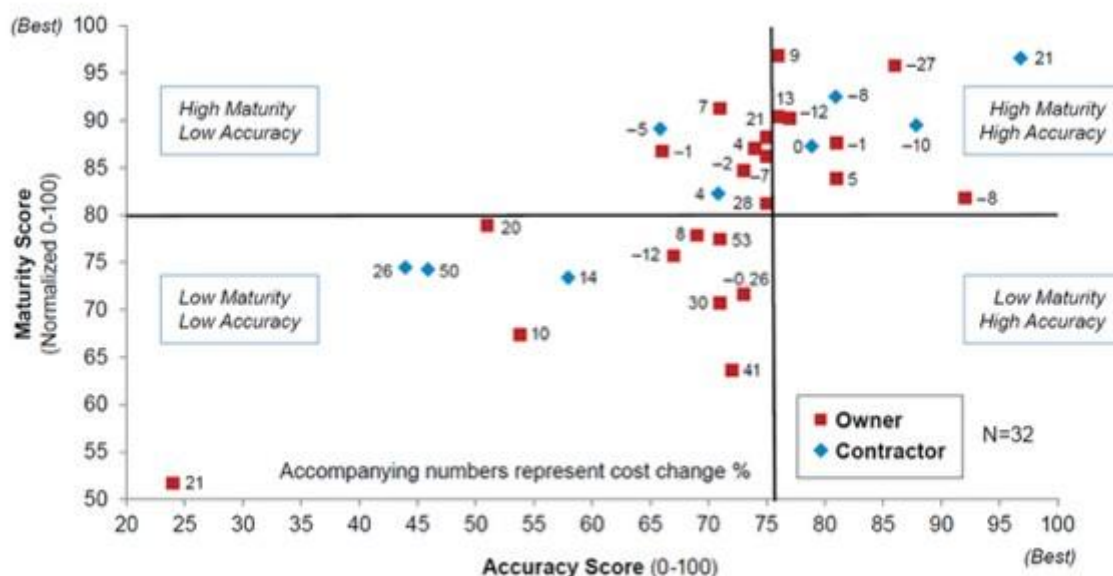


Figure 1.3. Maturity-Accuracy Matrix (Cost Change Performance)

Figure 8 – CII Maturity-Accuracy Matrix for FEL Assessment⁷¹

Taken together, these alternatives provide a feasible analytical basis for examining whether stronger FEL maturity can be linked to better execution performance and, ultimately, to better capital investment decision-making. This framing is also consistent with IPA’s stage-gated explanation of “FEL 1 (Business Planning),” “FEL 2 (Scope Development),” and “FEL 3 (Project Definition),” in which project definition becomes progressively stronger prior to authorization⁷².

⁷¹ Construction Industry Institute. Loc. Cit.

⁷² Ibid

I. BASIS OF PROJECT DECISION	
<p>A. Manufacturing Objectives Criteria</p> <ul style="list-style-type: none"> A1. Reliability Philosophy A2. Maintenance Philosophy A3. Operating Philosophy <p>B. Business Objectives</p> <ul style="list-style-type: none"> B1. Products B2. Market Strategy B3. Project Strategy B4. Affordability/Feasibility B5. Capacities B6. Future Expansion Considerations B7. Expected Project Life Cycle B8. Social Issues 	<p>C. Basic Data Research and Development</p> <ul style="list-style-type: none"> C1. Technology C2. Processes <p>D. Project Scope</p> <ul style="list-style-type: none"> D1. Project Objectives Statement D2. Project Design Criteria D3. Site Characteristics Available vs. Required D4. Dismantling and Demolition Requirements D5. Lead/Discipline Scope of Work D6. Project Schedule <p>E. Value Engineering</p> <ul style="list-style-type: none"> E1. Process Simplification E2. Design and Material Alternatives Considered/Rejected E3. Design for Constructability Analysis
II. BASIS OF DESIGN	
<p>F. Site Information</p> <ul style="list-style-type: none"> F1. Site Location F2. Surveys and Soil Tests F3. Environmental Assessment F4. Permit Requirements F5. Utility Sources with Supply Conditions F6. Fire Protection and Safety Considerations <p>G. Process/Mechanical</p> <ul style="list-style-type: none"> G1. Process Flow Sheets G2. Heat and Material Balances G3. Piping and Instrumentation Diagrams (P&IDs) G4. Process Safety Management (PSM) G5. Utility Flow Diagrams G6. Specifications G7. Piping System Requirements G8. Plot Plan G9. Mechanical Equipment List G10. Line List G11. Tie-in List G12. Piping Specialty Items List G13. Instrument Index 	<p>H. Equipment Scope</p> <ul style="list-style-type: none"> H1. Equipment Status H2. Equipment Location Drawings H3. Equipment Utility Requirements <p>I. Civil, Structural, and Architectural</p> <ul style="list-style-type: none"> I1. Civil/Structural Requirements I2. Architectural Requirements <p>J. Infrastructure</p> <ul style="list-style-type: none"> J1. Water Treatment Requirements J2. Loading/Unloading/Storage Facilities Requirements J3. Transportation Requirements <p>K. Instrument and Electrical</p> <ul style="list-style-type: none"> K1. Control Philosophy K2. Logic Diagrams K3. Electrical Area Classifications K4. Substation Requirements/Power Sources Identified K5. Electrical Single Line Diagrams K6. Instrument and Electrical Specifications
III. EXECUTION APPROACH	
<p>L. Procurement Strategy</p> <ul style="list-style-type: none"> L1. Identify Long Lead/Critical Equipment and Materials L2. Procurement Procedures and Plans L3. Procurement Responsibility Matrix <p>M. Deliverables</p> <ul style="list-style-type: none"> M1. CADD/Model Requirements M2. Deliverables Defined M3. Distribution Matrix 	<p>N. Project Control</p> <ul style="list-style-type: none"> N1. Project Control Requirements N2. Project Accounting Requirements N3. Risk Analysis <p>P. Project Execution Plan</p> <ul style="list-style-type: none"> P1. Owner Approval Requirements P2. Engineering/Construction Plan and Approach P3. Shutdown/Turnaround Requirements P4. Pre-Commissioning Turnover Sequence Requirements P5. Startup Requirements P6. Training Requirements

Figure 9 – CII FEL Maturity Sections, Categories, and Elements⁷³

⁷³ Construction Industry Institute. Loc. Cit.

Step 3 - Development of The Outcome for Each Alternative

This study develops the expected outcome of each alternative in terms of what it can reveal about front-end readiness, execution performance, and managerial usefulness in downstream oil and gas projects, as shown in Table 3.

Table 3 - Development of The Outcome for Each Alternative⁷⁴

No.	Alternative	Analytical Focus	Expected Outcome	Evaluation Strength	Key Limitation
1	Stand-Alone FEL Maturity Assessment Model	Measures FEL readiness through governance, phase-gate deliverables, WBS quality, risk visibility, schedule readiness, and estimate readiness.	Produces a structured front-end maturity profile before capital commitment.	Strong diagnostic clarity for assessing readiness and decision basis, including "Business Case, WBS, Risk/Opportunity Assessment, CPM Schedule, Cost/Resource Budget, and Stakeholder Analysis".	Does not validate whether FEL maturity improves execution performance.
2	FEL Maturity with CPI Validation Model	Links FEL maturity with CPI as the lagging cost-performance indicator.	Produces a cost-efficiency signal between front-end readiness and execution cost performance.	Strong for evaluating budget control, estimate credibility, and cost efficiency using BCWS, BCWP, and ACWP.	Under-represents schedule performance.
3	FEL Maturity with SPI Validation Model	Links FEL maturity with SPI as the lagging schedule-performance indicator.	Produces a schedule-efficiency signal between front-end readiness and progress performance.	Strong for identifying delay sensitivity and schedule slippage; EVM integrates "scope, schedule, and cost".	Under-represents cost performance.
4	FEL Maturity with CPI & SPI Dual Validation Model	Combines CPI and SPI to validate both cost and schedule performance.	Produces a balanced execution-performance view across cost and schedule dimensions.	More robust than single-index models because it tests baseline credibility in both cost and schedule terms.	Limited to core EVM indices and may not fully explain root causes.
5	Integrated Model: FEL + CPI + SPI + Supporting Indicators	Combines FEL maturity, CPI, SPI, and supporting indicators such as EAC, TCPI, and WBS-level variance.	Produces comprehensive performance validation linking planning quality with execution outcomes.	Strongest analytical depth and decision usefulness; CPI and SPI "can be used independently or together," supported by deeper variance analysis.	Requires higher data availability and more analytical effort.

Step 4 - Selection of The Criteria

These steps use a two-stage MADM structure: non-compensatory screening followed by compensatory additive weighting.⁷⁵ The criteria are adjusted to align with the CII Front-End Planning framework, particularly the CII FEL maturity structure and the Maturity–Accuracy Matrix to test whether the project definition is accurate, reliable, traceable, and capable of supporting credible execution performance⁷⁶.

⁷⁴ By Author

⁷⁵ Ibid

⁷⁶ Construction Industry Institute. Loc. Cit.

Stage 1 – Must-Pass Screening Criteria (score: 0 = fail, 1 = pass)

Table 4 - Must Pass Screening Criteria⁷⁷

No.	Must-Pass Criterion	Pass Requirement	Reference Basis
1	FEL maturity structure	The alternative must address the main CII FEL areas: Basis of Project Decision, Basis of Design, and Execution Approach.	CII FEL maturity framework
2	Maturity–accuracy logic	The alternative must recognize that maturity alone is insufficient unless the planning basis is also accurate and reliable.	CII Maturity–Accuracy Matrix
3	Baseline traceability	The alternative must be traceable to the WBS, schedule, estimate, risk basis, and approved baseline.	GAO states that reliable estimates should be “well documented” and traceable to source data
4	Performance evidence	The alternative must use measurable evidence to support decision-making, either from FEL documents, EVM indicators, or both.	NASA states that EVMS supports “variance analysis, forecasting, baseline control, and corrective action”

Threshold rule: any alternative scoring **0** on one or more Stage 1 criteria is eliminated from further analysis.⁷⁸

⁷⁷ by Author

⁷⁸ Sullivan, W. G., Wicks, E. M., & Koelling, C. P. Loc. Cit.

Stage 2 – Weighted Comparison Criteria (score: 1–5 each)

Table 5 - Weighted Evaluation Criteria⁷⁹

No.	Criterion	Weight	Analytical Rationale
1	FEL maturity coverage	0.20	Measures how well the model covers the CII FEL areas: Basis of Project Decision, Basis of Design, and Execution Approach.
2	Accuracy and baseline reliability	0.20	Reflects the CII Maturity–Accuracy Matrix, which shows that a project may appear mature but still perform poorly if the underlying basis is inaccurate.
3	Traceability and auditability	0.15	Measures whether the model can be traced to the WBS, schedule, estimate, risk register, and approved baseline. GAO requires reliable estimates to be “well documented”.
4	Cost-performance validation strength	0.15	Measures how strongly the model validates execution cost performance using CPI or related indicators. EVM uses BCWS, BCWP, and ACWP to support cost-performance measurement.
5	Schedule-performance validation strength	0.15	Measures how strongly the model validates schedule performance using SPI or related schedule indicators. GAO defines SPI as a measure of work accomplished versus work planned.
6	Corrective and decision usefulness	0.15	Measures whether the model supports management action through variance analysis, forecasting, baseline control, and corrective action.
Total		1.00	

Table 6 - Scoring Scale⁸⁰

Score	Interpretation	Meaning
1	Very weak	Criterion is barely addressed.
2	Weak	Criterion is partially addressed but lacks analytical strength.
3	Moderate	Criterion is adequately addressed.
4	Strong	Criterion is clearly addressed and useful for decision-making.
5	Very strong	Criterion is fully addressed and provides high analytical value.

Each surviving alternative will be rated on a **1–5 scale** for each criterion, converted to nondimensional scores, multiplied by the weights above, and then summed. The highest total score identifies the strongest alternative for detailed comparison in Step 5.

⁷⁹ By Author

⁸⁰ By Author

FINDING

Step 5 - Analysis of Alternative

Step 5 applies the criteria developed in Step 4 to compare the five feasible alternatives. Sullivan, Wicks, and Koelling explain that this step requires the “analysis and comparison of the alternatives” before selecting the preferred option⁸¹.

A. Result of MADM Analysis

The MADM analysis is conducted in two stages. First, the alternatives are screened using must-pass criteria to ensure that each model is analytically acceptable. Second, the alternatives are scored using weighted criteria aligned with the CII FEL maturity framework and the CII Maturity–Accuracy Matrix⁸².

Table 7 – Must Pass Criteria Analysis⁸³

No.	Alternative	FEL Structure	Maturity–Accuracy Logic	Baseline Traceability	Performance Evidence	Analytical Justification	Result
1	Stand-Alone FEL Maturity Assessment Model	Pass	Pass	Pass	Partial	Meets FEL readiness and traceability requirements, but provides only front-end diagnosis without CPI/SPI validation. Retained as a benchmark comparator.	Proceed as benchmark
2	FEL Maturity with CPI Validation Model	Pass	Pass	Pass	Pass	Links FEL maturity to cost-performance validation through CPI, providing measurable execution evidence.	Proceed
3	FEL Maturity with SPI Validation Model	Pass	Pass	Pass	Pass	Links FEL maturity to schedule-performance validation through SPI, testing planned versus accomplished work.	Proceed
4	FEL Maturity with CPI & SPI Dual Validation Model	Pass	Pass	Pass	Pass	Validates FEL maturity across both cost and schedule dimensions, improving baseline credibility assessment.	Proceed
5	Integrated Model: FEL + CPI + SPI + Supporting Indicators	Pass	Pass	Pass	Pass	Integrates FEL maturity, CPI, SPI, and supporting indicators to strengthen variance analysis, forecasting, and corrective action.	Proceed

⁸¹ Sullivan, W. G., Wicks, E. M., & Koelling, C. P. Loc. Cit.

⁸² Construction Industry Institute. Loc. Cit.

⁸³ by Author

Table 8 - Scoring Analysis⁸⁴

No	Criteria	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5
1	FEL Maturity Coverage	5	4	4	4	5
2	Accuracy / Baseline Reliability	3	4	4	4	5
3	Traceability & Auditability	4	4	4	4	5
4	Cost Validation	1	5	2	5	5
5	Schedule Validation	1	2	5	5	5
6	Corrective & Decision Usefulness	2	3	3	4	5

Table 9 - Weight Scoring Analysis⁸⁵

No	Criteria	Weight	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5
1	FEL Maturity Coverage	0.20	1.00	0.80	0.80	0.80	1.00
2	Accuracy / Baseline Reliability	0.20	0.60	0.80	0.80	0.80	1.00
3	Traceability & Auditability	0.15	0.60	0.60	0.60	0.60	0.75
4	Cost Validation	0.15	0.15	0.75	0.30	0.75	0.75
5	Schedule Validation	0.15	0.15	0.30	0.75	0.75	0.75
6	Corrective & Decision Usefulness	0.15	0.30	0.45	0.45	0.60	0.75
Total Score			2.80	3.70	3.70	4.30	5.00
Rank			5	3	3	2	1

The MADM result shows that Alternative 1 provides strong front-end diagnostic value but does not validate execution performance. Alternatives 2 and 3 validate only one performance dimension, either cost or schedule. Alternative 4 is stronger because it combines CPI and SPI, but it remains limited to the two core EVM indices. Alternative 5 is the most robust because it integrates FEL maturity, baseline reliability, CPI, SPI, and supporting indicators such as EAC, TCPI, and WBS-level variance review. This makes it the strongest alternative for linking planning quality with measurable execution performance⁸⁶⁸⁷⁸⁸.

⁸⁴ By Author

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⁸⁶ Construction Industry Institute. Loc. Cit.

⁸⁷ U.S. Government Accountability Office. Loc. Cit.

⁸⁸ NASA. Loc. Cit.

B. Case Study Analysis

To test the preferred analytical model, this paper uses four anonymized 2024 downstream oil and gas project cases: Project A, Project B, Project C, and Project D, attached as APPENDIX A. The dataset provides BCWS, BCWP, ACWP, SPI, and CPI from M1 to M11. M11 is used as the terminal comparison point because it represents the latest available cumulative performance position in the dataset.

The purpose of this case study is not to replace a formal CII/PDRI FEL assessment. Instead, it uses an EVM-derived proxy scoring method to position the four projects on the CII Maturity–Accuracy Matrix. This approach is appropriate because the dataset does not include formal gate-review or PDRI scores, but it does include earned value evidence that can test whether the approved baseline behaved reliably during execution. The CII Maturity–Accuracy Matrix supports this logic because project readiness should be evaluated through both maturity and accuracy, not maturity alone⁸⁹.

In this study, the two proxy dimensions are defined as follows:

Table 10 – Proxy Dimension⁹⁰

Proxy Dimension	Role in This Study	Evidence Used
EVM-derived FEL maturity proxy score	Apparent strength of project definition, progress measurement discipline, and baseline control behavior	BCWP movement, SPI trend, CPI trend, and progress measurement consistency
EVM-derived baseline accuracy proxy score	Reliability of the approved baseline when tested against actual execution performance	M11 CPI, M11 SPI, BCWP–BCWS alignment, and trend stability

Table 11 – Case Study Data of Oil & Gas Downstream Projects⁹¹

Project	BCWS M11	BCWP M11	ACWP M11	SPI M11	CPI M11	EVM Position
A	229	83	87.80	0.36	0.94	Severely behind schedule; slightly over budget
B	596	504	405.14	0.84	1.24	Behind schedule; under budget
C	321	324	324.00	1.01	1.00	On schedule; on budget
D	150	111	143.08	0.74	0.78	Behind schedule; over budget

The M11 data shows four distinct performance patterns. Project C is the most stable case because BCWS, BCWP, and ACWP remain closely aligned. Project B is cost-efficient

⁸⁹ Construction Industry Institute. Loc. Cit.

⁹⁰ By Author

⁹¹ By Author

but behind schedule. Project A shows severe schedule underperformance, while Project D is both behind schedule and over budget.

Table 12 - Proxy Method Weight Scoring⁹²

Score Type	Checklist Item	Weight	Evidence Used
FEL maturity proxy	Scope / WBS definition signal	20	Stability of earned value recognition and work-package progress behavior
FEL maturity proxy	Schedule baseline readiness	20	SPI trend and schedule performance consistency
FEL maturity proxy	Cost / resource baseline readiness	20	CPI trend and cost-control behavior
FEL maturity proxy	Risk / change readiness signal	20	Late-period disruption or stability in CPI/SPI behavior
FEL maturity proxy	Progress measurement discipline	20	Regularity of BCWP updates from W0 to W10
Baseline accuracy proxy	Schedule accuracy signal	25	W10 SPI closeness to or above 1.00
Baseline accuracy proxy	Cost accuracy signal	25	W10 CPI closeness to or above 1.00
Baseline accuracy proxy	BCWP–BCWS alignment	25	Earned value alignment with planned value at W10
Baseline accuracy proxy	Trend stability / baseline credibility	25	CPI/SPI consistency from M1 to M11

This proxy method is used only as an analytical bridge between available EVM data and the CII maturity–accuracy concept. It is not presented as a substitute for a formal CII/PDRI score.

Table 13 - Case Study Analysis⁹³

Project	EVM-Derived FEL Maturity Proxy Score	EVM-Derived Baseline Accuracy Proxy Score	FEL Matrix Quadrant	Key M11 Evidence	Analytical Reading
A	53	40	Low Maturity / Low Accuracy	SPI = 0.36; CPI = 0.94	Severe schedule underperformance and weak EV/PV alignment indicate poor readiness and low baseline reliability.
B	72	78	Low Maturity / High Accuracy	SPI = 0.84; CPI = 1.24	Cost performance is strong, but schedule performance remains weak; accuracy exists mainly in the cost dimension.
C	90	93	High Maturity / High Accuracy	SPI = 1.01; CPI = 1.00	Planned value, earned value, and actual cost are closely aligned, indicating stable baseline credibility.
D	82	49	High Maturity / Low Accuracy	SPI = 0.74; CPI = 0.78	Progress measurement appears active, but M11 deterioration shows weak baseline accuracy.

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⁹³ By Author

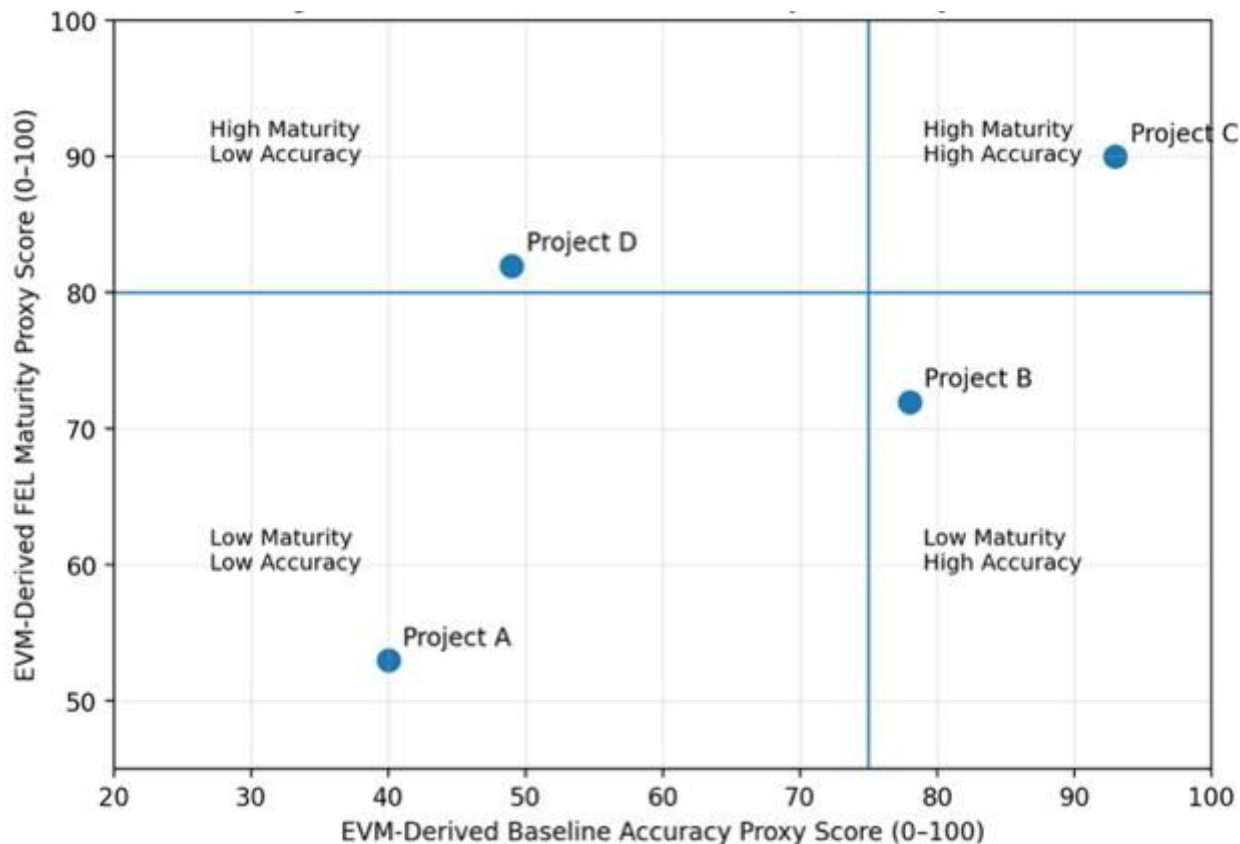


Figure 10 – EVM Derived FEL Maturity vs Baseline Accuracy Proxy Score⁹⁴

C. Comparison of Case Study Outcomes

Table 14 - Comparison of Case Study Outcomes⁹⁵

Case	Project	FEL Condition	Matrix Position	CPI-SPI Signal	Main Finding	Management Implication
1	D	High maturity / Low accuracy	Mature but unreliable	SPI = 0.74; CPI = 0.78	Active reporting does not prevent poor performance if the baseline is inaccurate.	Revalidate baseline accuracy, schedule logic, and cost assumptions before approval or continuation.
2	C	High maturity / High accuracy	Mature and reliable	SPI = 1.01; CPI = 1.00	Baseline is credible and execution remains aligned with plan.	Use as benchmark for FEL maturity, baseline reliability, and EVM monitoring.
3	A	Low maturity / Low accuracy	Weak and unreliable	SPI = 0.36; CPI = 0.94	Severe schedule underperformance indicates weak readiness and low baseline credibility.	Return to FEL development and prepare a recovery baseline before further commitment.
4	B	Low maturity / High accuracy	Partially accurate but incomplete	SPI = 0.84; CPI = 1.24	Strong cost performance does not offset weak schedule maturity.	Investigate schedule logic, sequencing, resource loading, and critical path realism.

The comparison shows that Project C is the strongest case because it combines high maturity, high accuracy, and stable CPI/SPI performance. Project D shows that maturity

⁹⁴ By Author

⁹⁵ by Author

without accuracy can create false confidence. Project A confirms that weak maturity and weak accuracy produce poor schedule performance. Project B shows that strong cost performance does not automatically mean the project is ready, because schedule performance remains below plan.

Overall, the 2024 case-study data support the MADM result. A stand-alone FEL assessment is not enough, and a single CPI or SPI validation is also insufficient. The preferred model should integrate FEL maturity, CII maturity–accuracy logic, CPI, SPI, and supporting indicators. Therefore, Alternative 5: Integrated Model with FEL Maturity, CPI, SPI, and Supporting Indicators provides the strongest basis for linking front-end planning quality with measurable execution performance⁹⁶⁹⁷⁹⁸.

Step 6 - Selection of the Preferred Alternative

After completing the analysis in step 5. This selection is based on two findings: first, Alternative 5 achieved the highest MADM score; second, the case-study data show that project performance cannot be interpreted reliably using FEL maturity, CPI, or SPI in isolation.

Table 15 – Selection of the Preferred Alternatives⁹⁹

Selection Basis	Key Result	Implication
MADM score	Alternative 5 ranked highest with a total score of 5.00	Provides the most complete analytical structure for linking FEL maturity, baseline accuracy, and execution performance
CII maturity–accuracy logic	Project readiness must consider both maturity and accuracy	Prevents overreliance on document completion alone
EVM validation	CPI and SPI test cost and schedule performance against the approved baseline	Converts planning quality into measurable execution evidence
Supporting indicators	EAC, TCPI, and WBS-level variance strengthen diagnosis	Supports “variance analysis, forecasting, baseline control, and corrective action”
2024 case-study evidence	Projects A–D show different CPI/SPI patterns at M11	Confirms that single-indicator analysis can mislead decision-makers

The 2024 case-study data strengthen the selection. Project C shows the desired condition, with SPI = 1.01 and CPI = 1.00, indicating alignment between planned value, earned value, and actual cost. Project B shows that strong CPI alone is not sufficient because CPI = 1.24 is favorable, but SPI = 0.84 indicates a schedule delay. Project A

⁹⁶ Construction Industry Institute. Loc. Cit.

⁹⁷U.S. Government Accountability Office. Loc. Cit.

⁹⁸ NASA. Loc. Cit.

⁹⁹ by Author

shows the opposite risk, where CPI = 0.94 appears near the target, but SPI = 0.36 indicates severe schedule underperformance. Project D confirms that apparent maturity without accuracy remains risky, with SPI = 0.74 and CPI = 0.78 at W10.

Therefore, Alternative 5 is selected because it directly supports the objective of this paper: evaluating whether front-end planning quality is mature, accurate, traceable, and validated by measurable execution performance. It also aligns with GAO's requirement that reliable estimates should be "well documented"¹⁰⁰, NASA's emphasis on "variance analysis, forecasting, baseline control, and corrective action"¹⁰¹, and NDIA's use of predictive measures for proactive program management¹⁰².

Step 7 - Performance Monitoring

Step 7 converts the selected alternative into a repeatable control-and-learning system. Sullivan, Wicks, and Koelling describe this stage as "performance monitoring and post evaluation of results"¹⁰³. Since Step 6 selected the Integrated Model with FEL Maturity, CPI, SPI, and Supporting Indicators, monitoring should be applied as a phase-based governance cycle, not as a one-time assessment.

The purpose of this step is to ensure that front-end planning quality is tested before sanction, validated during execution, and improved after completion. This is consistent with the CII maturity–accuracy logic, where project readiness must be evaluated through both maturity and accuracy¹⁰⁴. It also aligns with NASA's expectation that EVMS should support "variance analysis, forecasting, baseline control, and corrective action"¹⁰⁵.

¹⁰⁰ U.S. Government Accountability Office. Loc. Cit.

¹⁰¹ NASA. Loc. Cit.

¹⁰² National Defense Industrial Association, Integrated Program Management Division. (2021). *A guide to managing programs using predictive measures*.

<https://www.ndia.org/divisions/ipmd/division-guides-and-resources>

¹⁰³ Sullivan, W. G., Wicks, E. M., & Koelling, C. P. Loc. Cit.

¹⁰⁴ Construction Industry Institute. Loc. Cit.

¹⁰⁵ NASA. Loc. Cit.

Table 16 – Phase-Based Monitoring for Integrated Model¹⁰⁶

Phase	Control Question	Primary Evidence	Key Indicator	Management Decision
FEL / Pre-Sanction	Is the project mature and accurate enough to proceed?	Formal CII/FEL checklist, WBS, risk register, schedule basis, estimate basis	FEL maturity and accuracy score	Proceed, revise, or hold
Baseline Approval	Is the baseline reliable and traceable?	WBS alignment, BCWS baseline, BOE, schedule logic, risk allowance	Baseline quality review	Approve baseline or require correction
Execution Monitoring	Is actual performance aligned with the approved baseline?	BCWS, BCWP, ACWP, CPI, SPI	CPI and SPI trend	Continue, investigate, or correct
Recovery / Forecasting	Can the project still meet cost and schedule targets?	EAC, ETC, TCPI, critical path review, WBS-level variance	Recovery feasibility	Recovery plan or rebaseline request
Closeout / Post-Evaluation	Did FEL maturity and accuracy predict actual performance?	Final CPI/SPI, final cost, final duration, change causes	FEL-to-EVM comparison	Lessons learned and checklist calibration

This phase-based logic prevents the model from becoming a reporting exercise. Before sanction, the focus is on readiness. At baseline approval, the focus shifts to traceability and reliability. During execution, CPI and SPI validate whether the baseline is performing. During recovery, EAC, TCPI, critical path review, and WBS-level variance determine whether the correction is realistic. After closeout, the results are used to improve future gate decisions.

¹⁰⁶ by Author

Table 17 - Monitoring Indicators for the Selected Model¹⁰⁷

Monitoring Area	Indicator	Analytical Purpose	Warning Signal
FEL maturity	Formal CII/FEL checklist score	Tests completeness of front-end definition	Score below threshold
Baseline accuracy	Estimate basis, schedule logic, risk allowance	Tests whether maturity is supported by reliable assumptions	Weak BOE, unrealistic logic, or unsupported allowance
Schedule quality	Critical path, logic links, float, constraints	Tests whether SPI is based on a credible schedule	Invalid logic or unrealistic critical path
Cost performance	CPI, cost variance, ACWP trend	Measures cost efficiency of completed work	CPI < 1.00
Schedule performance	SPI, schedule variance, milestone trend	Measures work accomplished against work planned	SPI < 1.00
Forecasting	EAC, ETC, TCPI	Tests final cost and recovery feasibility	EAC growth or unrealistic TCPI
Root-cause control	WBS-level variance and change-cause coding	Identifies whether variance comes from missed FEL, execution issue, or valid scope change	Repeated variance in the same WBS area
Post-evaluation	Initial FEL score vs final CPI/SPI	Tests whether front-end readiness predicted delivery performance	Gap between readiness score and actual outcome

GAO defines SPI as a measure of work accomplished compared with work planned, while CPI measures cost performance for completed work¹⁰⁸. However, the 2024 case-study data show why these indicators must be monitored together. Project B showed strong cost performance but weak schedule, while Project A showed severe schedule underperformance, despite CPI being closer to the target. This confirms that a single indicator may mislead decision-makers.

For future research, the EVM-derived proxy scoring used in this paper should be validated using a formal CII-based checklist. The current case study demonstrates the concept using available project-control data, but a stronger empirical test would score FEL maturity and accuracy before execution, then compare the matrix position with CPI, SPI, EAC, TCPI, and WBS-level variance during delivery. This would allow owner

¹⁰⁷ by Author

¹⁰⁸ U.S. Government Accountability Office. Loc. Cit.

organizations to test whether formal front-end maturity and accuracy scores can predict downstream project performance.

Overall, Step 7 closes the governance loop. FEL maturity becomes the leading readiness condition, baseline accuracy becomes the credibility test, EVM indicators become the execution validation mechanism, and post-evaluation becomes the learning process. This makes the selected model suitable not only for monitoring current projects, but also for improving future capital investment decisions¹⁰⁹¹¹⁰¹¹¹.

CONCLUSION

This paper addressed the following research questions:

1. How can FEL maturity be defined and assessed?
FEL maturity should be defined as the extent to which a downstream oil and gas project has developed a reliable, traceable, and decision-ready front-end basis before major capital commitment. It should not be assessed only by the existence of documents, but by the quality and integration of the business case, WBS, risk/opportunity assessment, CPM schedule, cost/resource budget, stakeholder analysis, and execution strategy. The CII maturity–accuracy logic is therefore important because a project may appear mature, but still unreliable if the underlying planning basis is inaccurate¹¹².
2. How can CPI and SPI be used to validate the credibility of front-end planning?
CPI and SPI can be used to validate the credibility of front-end planning by testing whether the approved baseline performs during execution. CPI indicates whether completed work is being delivered within the planned cost basis, while SPI indicates whether earned progress is consistent with planned progress¹¹³. However, the case study shows that CPI or SPI alone can mislead decision-makers. A project may look cost-efficient but remain schedule-weak or appear active in progress reporting while still having an unreliable baseline. Therefore, CPI and SPI should be used together with EAC, TCPI, and WBS-level variance review to support “variance analysis, forecasting, baseline control, and corrective action”¹¹⁴.
3. How can this relationship improve capital investment decision-making?
The relationship improves capital investment decision-making by converting FEL and EVM into a closed governance loop. FEL tests readiness before sanction, EVM

¹⁰⁹ U.S. Government Accountability Office. Loc. Cit.

¹¹⁰ Construction Industry Institute. Loc. Cit.

¹¹¹ NASA. Loc. Cit.

¹¹² Construction Industry Institute. Loc. Cit.

¹¹³ U.S. Government Accountability Office Loc. Cit.

¹¹⁴ NASA. Loc. Cit.

validates execution after baseline approval, and post-evaluation feeds lessons learned back into future phase-gate decisions. This strengthens owner decision quality by linking front-end readiness with measurable downstream performance evidence. For future application, the proposed model should be further tested using formal CII FEED MATRS or PDRI scoring combined with actual project CPI and SPI data.

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APPENDECIES

APPENDIX A – Downstream Oil & Gas Project Data 2024

CASE STUDY	BCWS M1	BCWS M2	BCWS M3	BCWS M4	BCWS M5	BCWS M6	BCWS M7	BCWS M8	BCWS M9	BCWS M10	BCWS M11
A	197	197	197	197	229	229	229	229	229	229	229
B	498	498	498	527	556	585	596	596	596	596	596
C	276	276	291	309	312	321	321	321	318	317	321
D	97	97	97	97	97	97	97	97	97	97	150

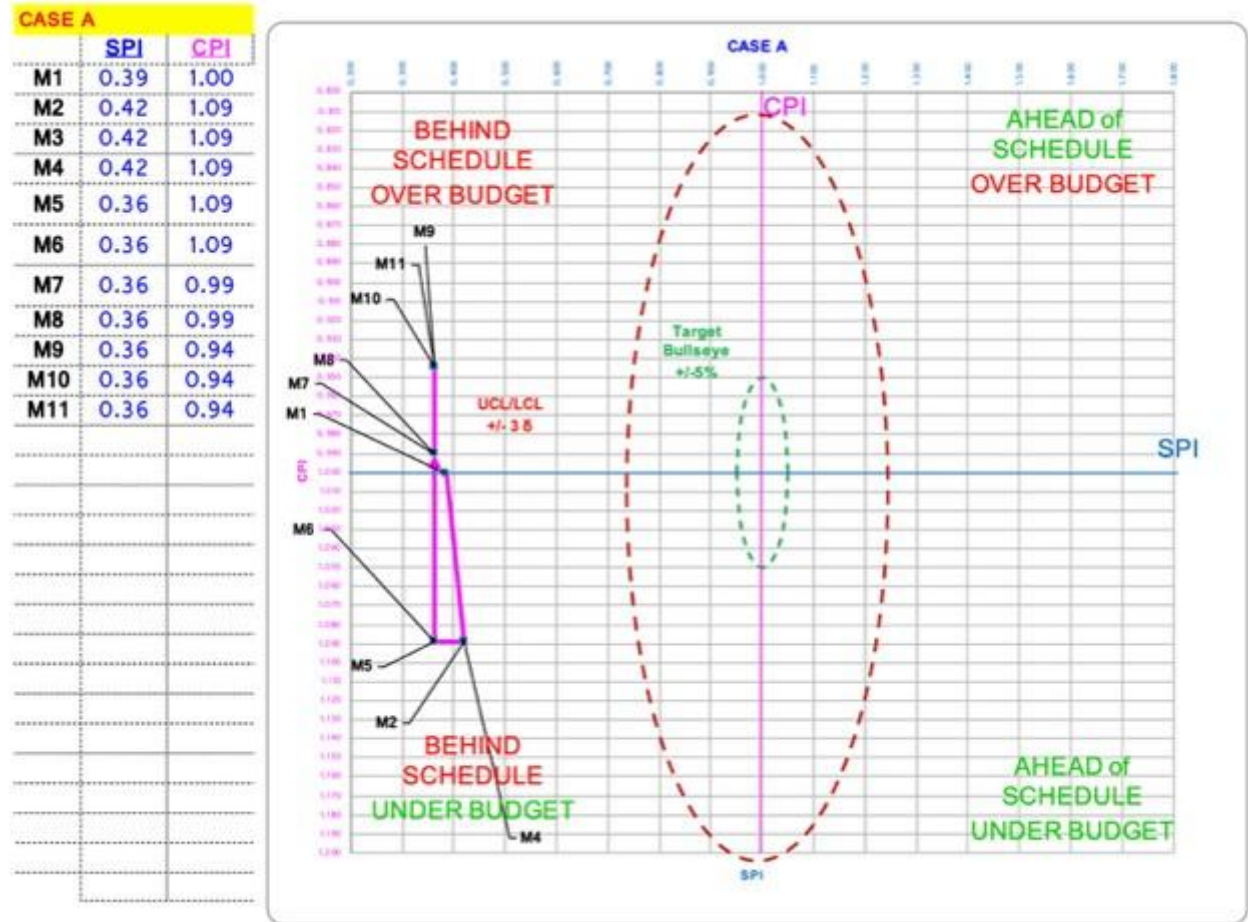
CASE STUDY	BCWP M1	BCWP M2	BCWP M3	BCWP M4	BCWP M5	BCWP M6	BCWP M7	BCWP M8	BCWP M9	BCWP M10	BCWP M11
A	76	83	83	83	83	83	83	83	83	83	83
B	416	469	492	500	504	504	504	504	504	504	504
C	285	285	300	300	300	300	300	300	318	320	324
D	92	94	95	96	99	102	102	105	106	107	111

CASE STUDY	ACWP M1	ACWP M2	ACWP M3	ACWP M4	ACWP M5	ACWP M6	ACWP M7	ACWP M8	ACWP M9	ACWP M10	ACWP M11
A	76.14	76.14	76.14	76.14	76.14	76.14	83.72	83.72	87.80	87.80	87.80
B	347.06	347.06	347.06	347.06	347.06	405.14	405.14	405.14	405.14	405.14	405.14
C	287.85	293.55	303.00	303.00	303.00	303.00	303.00	318.00	318.00	323.20	324.00
D	100.81	106.64	107.60	110.86	119.18	125.51	133.21	134.32	135.61	137.93	143.08

CASE STUDY	SPI M1	SPI M2	SPI M3	SPI M4	SPI M5	SPI M6	SPI M7	SPI M8	SPI M9	SPI M10	SPI M11
A	0.39	0.42	0.42	0.42	0.36	0.36	0.36	0.36	0.36	0.36	0.36
B	0.84	0.94	0.99	0.95	0.91	0.86	0.84	0.84	0.84	0.84	0.84
C	1.03	1.03	1.03	0.97	0.96	0.93	0.93	0.93	1.00	1.01	1.01
D	0.95	0.97	0.97	0.98	1.02	1.04	1.04	1.08	1.09	1.10	0.74

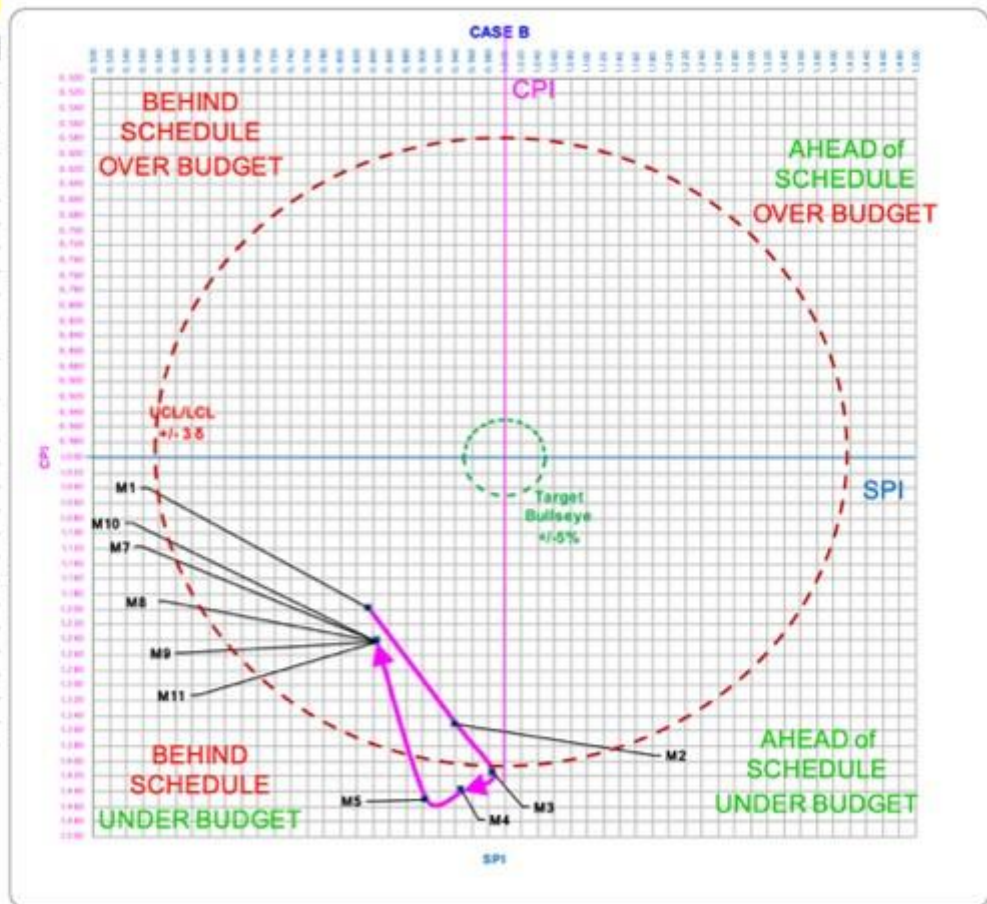
CASE STUDY	CPI M1	CPI M2	CPI M3	CPI M4	CPI M5	CPI M6	CPI M7	CPI M8	CPI M9	CPI M10	CPI M11
A	1.00	1.09	1.09	1.09	1.09	1.09	0.99	0.99	0.94	0.94	0.94
B	1.20	1.35	1.42	1.44	1.45	1.24	1.24	1.24	1.24	1.24	1.24
C	0.99	0.97	0.99	0.99	0.99	0.99	0.99	0.94	1.00	0.99	1.00
D	0.91	0.88	0.88	0.86	0.83	0.81	0.76	0.78	0.78	0.77	0.78

APPENDIX B

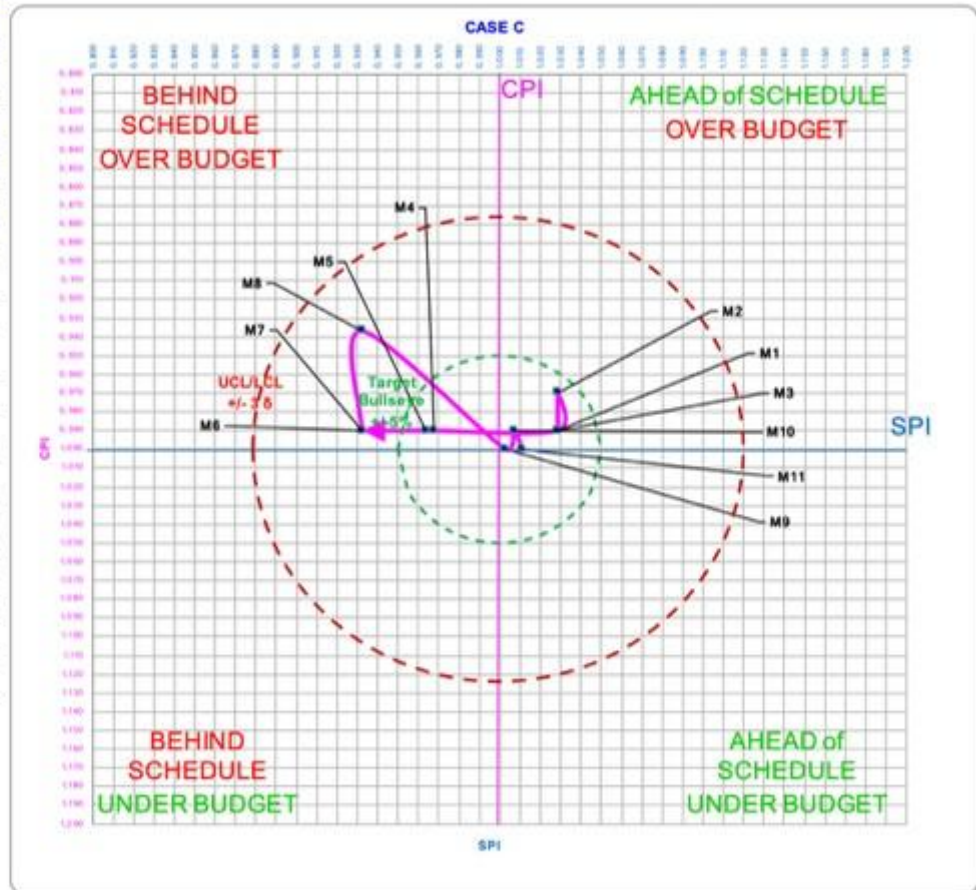


CASE B

	SPI	CPI
M1	0.84	1.20
M2	0.94	1.35
M3	0.99	1.42
M4	0.95	1.44
M5	0.91	1.45
M6	0.86	1.24
M7	0.84	1.24
M8	0.84	1.24
M9	0.84	1.24
M10	0.84	1.24
M11	0.84	1.24

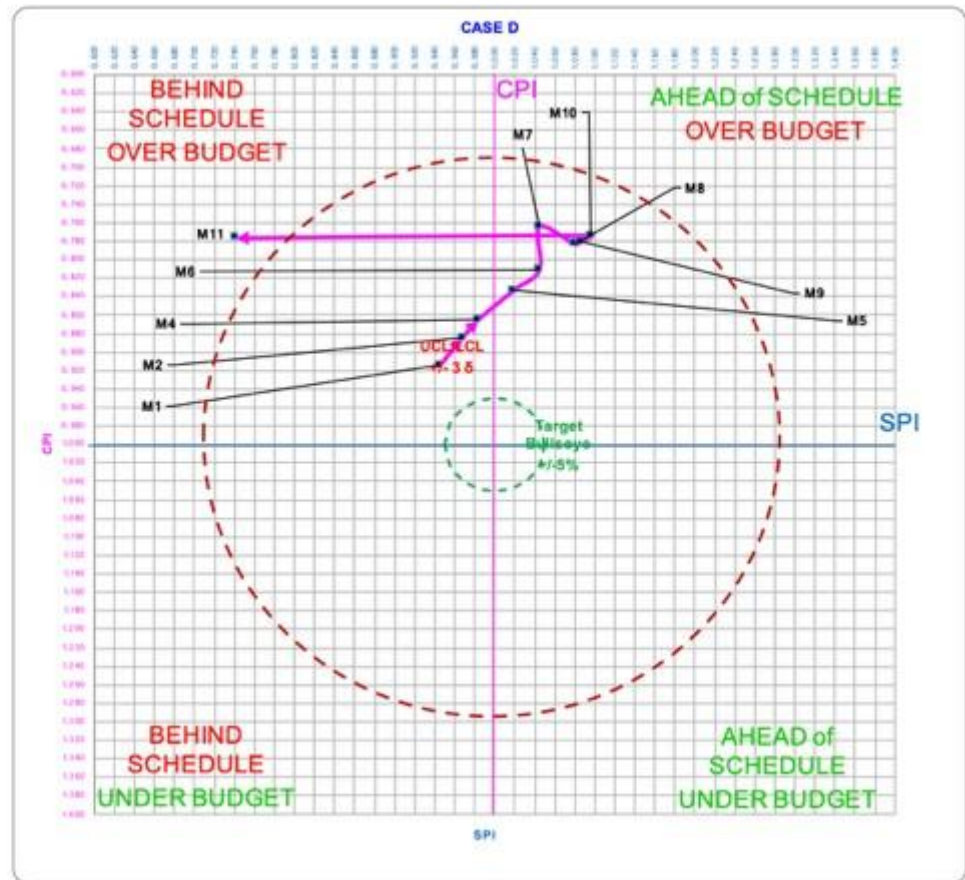


CASE C		
	SPI	CPI
M1	1.03	0.99
M2	1.03	0.97
M3	1.03	0.99
M4	0.97	0.99
M5	0.96	0.99
M6	0.93	0.99
M7	0.93	0.99
M8	0.93	0.94
M9	1.00	1.00
M10	1.01	0.99
M11	1.01	1.00



CASE D

	SPI	CPI
M1	0.95	0.91
M2	0.97	0.88
M3	0.97	0.88
M4	0.98	0.86
M5	1.02	0.83
M6	1.04	0.81
M7	1.04	0.76
M8	1.08	0.78
M9	1.09	0.78
M10	1.10	0.77
M11	0.74	0.78



About the Author



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Vanessa Graciela Bernadeth is an engineer with professional experience in project management, budgeting, payment control, and facilities management in the downstream oil and gas sector. Currently, she works as an engineer at the national oil company of Indonesia. Several projects and assignments have been supported in various downstream oil and gas facilities, including fuel terminal and related infrastructure, with a focus on project scheduling, project management, cost monitoring, and facilities reliability. She holds a bachelor's degree in civil engineering from Universitas Gadjah Mada and has international academic exposure through an exchange program at Ehime University, Japan. She is attending a distance learning mentoring course, under the tutorage of Dr. Paul D. Giammalvo, CDT, CCE, MScPM, MRICS, GPM-m, Senior Technical Advisor at PT Mitratata Citragraha to attain Certified Cost Professional (CCP) certification from AACE International.

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