Integrating Analogous Estimation and Earned Value Management for Cost and Schedule Performance Evaluation of an Oil Well Workover Project

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Abstract

Oil well workover projects are critical operations in the petroleum industry, as they restore well productivity, extend asset life, and maintain production efficiency. However, these projects are subject to operational uncertainties, equipment-related risks, and unexpected subsurface conditions that may affect cost and schedule performance. This study evaluates the time and cost performance of an oil well workover project by integrating Analogous Estimation during planning with Earned Value Management (EVM) during execution.

A case study was conducted using data from a real workover project with a planned duration of 30 days and a Budget at Completion (BAC) of USD 1,956,000. Historical data from similar workover operations were used to establish the initial project baseline. During execution, performance was assessed using EVM indicators, including PV, EV, AC, CV, SV, CPI, SPI, EAC, and VAC.

The results showed that an equipment-related delay reduced SPI to 0.83 and CPI to 0.74, indicating significant schedule delay and cost inefficiency. Following corrective actions, both SPI and CPI improved to 0.99 by Day 18, demonstrating substantial recovery in project performance. The findings indicate that integrating Analogous Estimation with EVM provides an effective framework for project estimation, early detection of performance deviations, and timely corrective decision-making throughout the project lifecycle.

المستخلص

تُعد مشاريع إصلاح وصيانة آبار النفط من العمليات الحيوية في صناعة البترول، لما لها من دور في استعادة إنتاجية الآبار وإطالة العمر التشغيلي للأصول والحفاظ على كفاءة الإنتاج. إلا أن هذه المشاريع تتعرض لشكوك تشغيلية ومخاطر مرتبطة بالمعدات وظروف غير متوقعة تحت سطح الأرض، مما قد يؤثر في التكلفة والجدول الزمني. تهدف هذه الدراسة إلى تقييم الأداء الزمني والتكلفة لمشروع إصلاح وصيانة بئر نفطي من خلال دمج أسلوب التقدير بالمقارنة (Analogous Estimation) خلال مرحلة التخطيط مع إدارة القيمة المكتسبة (EVM) أثناء التنفيذ.

اعتمدت الدراسة على حالة عملية لمشروع إصلاح وصيانة بئر نفطي بمدة مخططة قدرها 30يومًا وميزانية عند الإكمال (BAC) تبلغ 1,956,000 دولار أمريكي .وتم استخدام بيانات تاريخية من عمليات مماثلة لوضع خط الأساس الأولي للمشروع. وخلال التنفيذ، تم تقييم الأداء باستخدام مؤشراتEVM ، بما في ذلك PV – EV – AC – CV – SV – CPI – SPI – EAC –VAC.

أظهرت النتائج أن تأخيرًا مرتبطًا بالمعدات أدى إلى انخفاض SPI الى 0.83 و CPI إلى 0.74، مما يعكس تأخرًا ملحوظًا وعدم كفاءة في التكلفة. وبعد تنفيذ الإجراءات التصحيحية، تحسن المؤشران إلى 0.99 بحلول اليوم 18، مما يدل على تحسن كبير في أداء المشروع. وتؤكد النتائج أن دمج التقدير بالمقارنة مع EVM يوفر إطارًا فعالًا للتقدير، والكشف المبكر عن الانحرافات، ودعم اتخاذ الإجراءات التصحيحية في الوقت المناسب

Introduction

Oil well workover projects play a fundamental role in maintaining and enhancing hydrocarbon production by restoring well integrity, improving production performance, and extending the operational life of mature oil fields. Unlike routine drilling operations, workover projects are characterized by high operational uncertainty due to changing well conditions, equipment availability, reservoir behavior, and unforeseen technical challenges. These uncertainties can result in deviations from the planned project schedule and budget, making effective project planning, estimation, and performance control essential for successful project execution.

In the petroleum industry, project success is commonly assessed based on the ability to achieve planned objectives within the approved budget and schedule while maintaining safety and operational quality. Consequently, project managers **require** reliable estimation techniques during the planning phase and effective performance monitoring tools during project execution to identify deviations, manage risks, and support timely decision-making.

Among the various project estimation techniques, **Analogous Estimation** is widely used during the early planning stage because it utilizes historical information from previously completed projects to estimate similar project duration and cost. Although this technique is practical and time-efficient, its accuracy depends largely on the similarity between historical and current projects.

For project monitoring and control, **Earned Value Management (EVM)** has become one of the most widely recognized performance measurement techniques. EVM integrates project scope, schedule, and cost into a single management framework, allowing project managers to evaluate current performance, identify deviations, and forecast future project outcomes using quantitative performance indicators.

Although both Analogous Estimation and Earned Value Management have been extensively discussed in project management literature, limited research has investigated their combined application in **oil well workover projects**. Integrating these two approaches may provide a more comprehensive framework that improves both planning accuracy and project performance control throughout the project lifecycle.

Therefore, this study investigates the integration of Analogous Estimation and Earned Value Management to evaluate the time and cost performance of a real oil well workover project. The study also analyzes project deviations and demonstrates how combining historical estimation with performance measurement can support more effective project management decisions in petroleum operations.

1. Research Problem

Oil well workover projects frequently experience cost overruns and schedule delays due to technical uncertainties, equipment failures, changing well conditions, and unforeseen operational risks. Although many petroleum companies rely on historical experience for project planning, project performance is often monitored using conventional cost reports that fail to integrate schedule progress with actual expenditures. As a result, project managers may not detect performance deviations until they become significant, reducing their ability to implement timely corrective actions.

Furthermore, while Analogous Estimation is widely used for preliminary cost and duration estimation, and Earned Value Management (EVM) is recognized as an effective project performance measurement technique, limited studies have investigated the integration of these two approaches in oil well workover projects.

Accordingly, the research problem addressed in this study is the lack of an integrated framework that combines historical project estimation with quantitative project performance measurement to improve cost and schedule control in oil well workover operations.

2. Research Objectives

The primary objective of this study is to evaluate the effectiveness of integrating Analogous Estimation and Earned Value Management (EVM) in improving cost and schedule performance evaluation for oil well workover projects.

The specific objectives are:

1. To estimate the project cost and duration using Analogous Estimation based on historical workover projects.
2. To evaluate project cost performance using Earned Value Management indicators.
3. To assess project schedule performance throughout project execution.
4. To identify the main causes of cost and schedule deviations.
5. To forecast the final project cost using Earned Value Management forecasting techniques.
6. To recommend corrective actions that improve project performance and support decision-making in future workover projects.

3. Research Methodology

This study adopted a **descriptive analytical approach** using a **case study methodology** to evaluate the performance of a real oil well workover project. The research integrates Analogous Estimation during the planning stage with Earned Value Management during project execution to provide a comprehensive assessment of project cost and schedule performance.

Historical information obtained from previously completed workover projects was used to estimate the project's baseline cost and duration through Analogous Estimation. Subsequently, actual project execution data were collected and analyzed using Earned Value Management performance indicators.

The project performance assessment was based on the calculation of Planned Value (PV), Earned Value (EV), Actual Cost (AC), Cost Variance (CV), Schedule Variance (SV), Cost Performance Index (CPI), Schedule Performance Index (SPI), Estimate at Completion (EAC), Estimate to Complete (ETC), and Variance at Completion (VAC). The results were interpreted to identify project deviations, evaluate management performance, and develop practical recommendations for improving future workover project planning and execution.

4. Literature Review

4.1 Project Cost Management

Project Cost Management is one of the fundamental knowledge areas in project management and aims to ensure that projects are completed within the approved budget while achieving their technical and operational objectives. According to the **Project Management Institute (PMI, 2021)**, project cost management includes the processes required to plan, estimate, budget, finance, fund, manage, and control project costs throughout the project life cycle.

Effective cost management involves four principal processes:

- Plan Cost Management
- Estimate Costs
- Determine Budget
- Control Costs

These processes establish the project cost baseline and provide the necessary framework for monitoring expenditures, controlling budget deviations, and supporting informed managerial decisions during project execution.

In oil and gas projects, particularly oil well workover operations, cost management is especially challenging due to operational uncertainties, fluctuating service costs, equipment availability, and unexpected subsurface conditions. Consequently, accurate cost estimation and continuous cost control are essential for minimizing financial risks and ensuring successful project delivery.

4.2 Analogous Estimation

Analogous Estimation is one of the most commonly used estimation techniques during the early stages of project planning. It estimates the expected project cost, duration, or required resources by comparing the current project with previously completed projects that share similar technical, operational, and environmental characteristics. According to the **Project Management Institute**

(PMI, 2021), this technique relies on expert judgment supported by historical project data and is particularly valuable when detailed project information is limited.

The primary advantage of Analogous Estimation is its speed and practicality, allowing project managers to establish an initial project baseline with relatively little effort. However, its accuracy depends on the quality and relevance of historical data, as well as the degree of similarity between the reference projects and the project being estimated. Consequently, organizations with comprehensive project databases generally achieve more reliable estimates than those relying solely on expert opinion.

Analogous Estimation can be particularly useful in oil well workover projects because many workover operations involve recurring activities such as rig mobilization, tubing replacement, well stimulation, completion repairs, and testing. Historical information from previous workover campaigns provides a practical basis for estimating project cost and duration while reducing planning time and improving budgeting accuracy.

4.3 Earned Value Management (EVM)

Earned Value Management (EVM) is an integrated project performance measurement methodology that combines project scope, schedule, and cost into a single management framework. Unlike traditional cost monitoring methods, which compare actual expenditures with the project budget, EVM evaluates the value of work actually completed against both the planned schedule and the actual cost incurred.

According to **Fleming and Koppelman (2010)**, Earned Value Management enables project managers to measure current project performance objectively while forecasting future cost and schedule outcomes before project completion. This capability allows organizations to detect performance deviations early and implement corrective actions before they significantly affect project objectives.

EVM is a well-established project performance measurement and control methodology and is discussed within the project management standards and literature associated with PMI. **(PMI, 2021)** for monitoring project performance. It has been successfully implemented across various industries, including construction, manufacturing, defense, information technology, and petroleum engineering, due to its ability to provide reliable quantitative indicators for project control and decision-making.

For oil well workover projects, where operational conditions can change rapidly because of equipment failures, well integrity issues, or unexpected subsurface conditions, EVM provides an effective mechanism for continuously evaluating project performance and identifying deviations that require immediate management attention.

4.4 EVM Performance Indicators

The effectiveness of Earned Value Management depends on several key performance indicators that measure project progress from both financial and scheduling perspectives.

- **Planned Value (PV)**

Planned Value represents the authorized budget assigned to the work scheduled to be completed by a specific reporting date. It serves as the project's planned performance baseline.

- **Earned Value (EV)**

Earned Value represents the budgeted value of the work that has actually been completed. It measures project progress in monetary terms using the original project budget rather than actual expenditures.

- **Actual Cost (AC)**

Actual Cost is the total expenditure incurred for the work performed during the reporting period. It reflects the real financial resources consumed by the project.

- **Cost Variance (CV)**

Cost Variance measures the difference between Earned Value and Actual Cost.

- **CV > 0:** Project is under budget.
- **CV = 0:** Project is on budget.
- **CV < 0:** Project is over budget.

- **Schedule Variance (SV)**

Schedule Variance measures the difference between Earned Value and Planned Value.

- **SV > 0:** Project is ahead of schedule.
- **SV = 0:** Project is on schedule.
- **SV < 0:** Project is behind schedule.

- **Cost Performance Index (CPI)**

The Cost Performance Index evaluates cost efficiency by comparing the value of completed work with the actual expenditure.

- **CPI > 1:** Efficient cost performance.
- **CPI = 1:** Performance meets the planned budget.
- **CPI < 1:** Cost performance is inefficient.

- **Schedule Performance Index (SPI)**

The Schedule Performance Index measures schedule efficiency by comparing completed work with planned work.

- **SPI > 1:** Project is progressing faster than planned.
- **SPI = 1:** Project is on schedule.
- **SPI < 1:** Project is progressing slower than planned.

5.5 EVM Forecasting Techniques

One of the major strengths of Earned Value Management is its ability to forecast future project performance based on current execution trends. These forecasting indicators enable project managers to estimate the project's expected final cost and determine whether corrective actions are required.

The most commonly used forecasting indicators include:

- **Estimate at Completion (EAC):** Predicts the total expected project cost at completion based on current project performance.
- **Estimate to Complete (ETC):** Estimates the additional cost required to complete the remaining project work.
- **Variance at Completion (VAC):** Measures the expected difference between the approved project budget and the forecasted final project cost.
- **To Complete Performance Index (TCPI):** Indicates the level of cost efficiency that must be achieved during the remaining work to complete the project within the approved budget.

These forecasting metrics provide project managers with valuable information for proactive decision-making, enabling timely corrective actions that minimize cost overruns and schedule delays.

5.6 Research Gap

Existing studies have extensively examined Earned Value Management for project performance monitoring and forecasting, while other studies have addressed workover operations, rig scheduling, and historical data-based estimation. However, limited attention has been given to integrating Analogous Estimation with EVM within a single framework for oil well workover projects. This gap is particularly relevant in workover operations, where historical similarities can support initial estimation, while continuous EVM monitoring can identify deviations during execution.

6. Previous Studies

Numerous studies have demonstrated the effectiveness of Earned Value Management (EVM) in improving project performance measurement and supporting project control across various engineering sectors. However, only a limited number of studies have investigated the integration of project estimation techniques with EVM, particularly in petroleum workover projects.

Mayo-Alvarez et al. (2022) conducted a systematic review of Earned Value Management applications and concluded that EVM is one of the most reliable methodologies for monitoring project cost and schedule performance. Their study emphasized that the integration of performance indicators such as the Cost Performance Index (CPI) and Schedule Performance Index (SPI) enables project managers to identify deviations early and improve decision-making throughout the project life cycle.

Similarly, **Proaño-Narváez et al. (2022)** highlighted the practical application of EVM in construction projects and reported that continuous monitoring of earned value indicators significantly improves project control, particularly in projects exposed to uncertainty and changing execution conditions.

López Pascual et al. (2021) proposed an enhanced Earned Value Management model that incorporates additional performance indicators to improve forecasting accuracy. Their findings demonstrated that advanced EVM models provide more reliable estimates of project completion cost and schedule than traditional monitoring techniques.
From the perspective of project estimation, the **Project Management Institute (PMI, 2021)** identifies Analogous Estimation as one of the standard estimation techniques for developing preliminary project budgets and schedules using historical information from similar projects. Likewise, **Kerzner (2022)** emphasized that historical project databases significantly improve estimation accuracy when combined with systematic project performance measurement.
Despite these contributions, previous studies have primarily focused on either project estimation or project performance measurement independently. Very limited research has investigated the integration of **Analogous Estimation** and **Earned Value Management** within the context of **oil well workover projects**, where operational uncertainty and rapid decision-making are critical to project success.

Therefore, this study contributes to the existing literature by proposing an integrated framework that combines historical project estimation with quantitative performance measurement to improve cost and schedule management in oil well workover operations.

7. Case Study

7.1 Project Description

The case study presented in this research focuses on a real oil well workover project undertaken to restore well productivity and improve operational performance. The project included several workover activities, such as rig mobilization, well intervention, tubing operations, equipment replacement, well testing, and final demobilization.

Oil well workover projects differ from conventional construction projects because they are highly sensitive to operational conditions, equipment availability, and well integrity requirements. Unexpected technical issues may arise during execution, requiring additional resources, increasing operational costs, and extending the planned project duration. Consequently, effective project planning, reliable estimation, and continuous performance monitoring are essential to ensure successful project delivery.

The project was planned using **Analogous Estimation**, where historical information from previously completed workover projects with similar operational characteristics was used to develop the initial estimates of project duration and cost. During execution, project performance was monitored using **Earned Value Management (EVM)** to evaluate cost and schedule performance identify deviations from the approved baseline, and support **timely management decision-making**.

The approved project baseline consisted of:

- **Project Type:** Oil Well Workover Project
- **Project Duration: 30 Days**
- **Budget at Completion (BAC): USD 1,956,000**

7.2 Project Schedule and Baseline Budget

Based on historical workover data and expert judgment, the project was divided into five major execution phases, as presented in **Table 1**.

Table 7.2 Project Schedule and Baseline Budget

Project Phase	Duration (Days)	Schedule (%)	Budget (USD)
Mobilization and Site Preparation	3	10%	195,600
Well Intervention Operations	9	30%	586,800
Workover and Equipment Replacement	12	40%	782,400
Well Testing and Completion	4	13.3%	260,148
Demobilization and Project Closeout	2	6.7%	131,052
Total	**30**	**100%**	**1,956,000**

The project baseline established through Analogous Estimation served as the reference for evaluating project performance during execution. The estimated budget and schedule were subsequently used in the Earned Value Management analysis to determine project deviations, forecast completion performance, and assess overall project efficiency.

8. Application of Analogous Estimation and Earned Value Management

8.1 Project Baseline Development Using Analogous Estimation

The project baseline was established using the **Analogous Estimation** technique based on historical data from similar oil well workover projects. This approach was used to estimate the project duration and budget before execution. The approved baseline consisted of a **30-day project duration** and a **Budget at Completion (BAC) of 1,956,000 USD**.
The cumulative Planned Value (PV) was distributed according to the approved project schedule, as presented in **Table 8.1** and illustrated by the baseline S-Curve (**Figure 8.1**). The baseline represents the planned cost distribution throughout the project lifecycle and serves as the reference for evaluating project performance using Earned Value Management (EVM).

Table 8.1 Planned Value (PV) Baseline Data

Day	PV
0.00	0.00
2	10,000.00
5	200,000.00
8	760,000.00
12	1,100,000.00
15	1,200,000.00
18	1,500,000.00
23	1,901,000.00
27	1,950,000.00
30	1,956,000.00

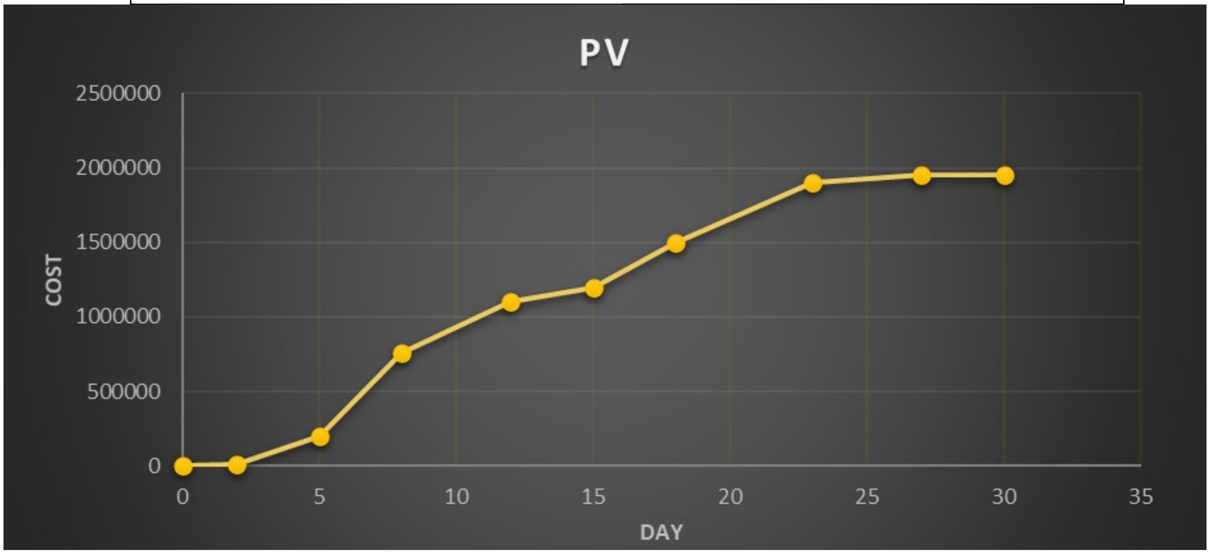

Figure 8.1. Baseline S-Curve (Planned Value)

8.2 Equipment Delay Scenario

Although the project baseline assumed uninterrupted execution, oil well workover projects are inherently exposed to operational risks that may adversely affect project performance. To evaluate the impact of such disruptions, an equipment delay scenario was developed in which the delivery of critical workover equipment was delayed during the execution phase. This interruption reduced productivity while project expenditures continued to increase due to rig standby costs, labor expenses, equipment rental, and operational support services.

Table 8.2. Project Performance Data During Equipment Delay Scenario

Day	PV	EV	AC
0	-	-	-
2	10,000.00	10,000.00	12,000.00
5	200,000.00	195,000.00	205,000.00
8	760,000.00	735,000.00	820,000.00
12	1,100,000.00	1,000,000.00	1,250,000.00
15	1,200,000.00	1,100,000.00	1,450,000.00
18	1,500,000.00	1,250,000.00	1,700,000.00
23	1,901,000.00	1,650,000.00	1,950,000.00
27	1,950,000.00	1,800,000.00	2,030,000.00
30	1,956,000.00	1,850,000.00	2,100,000.00

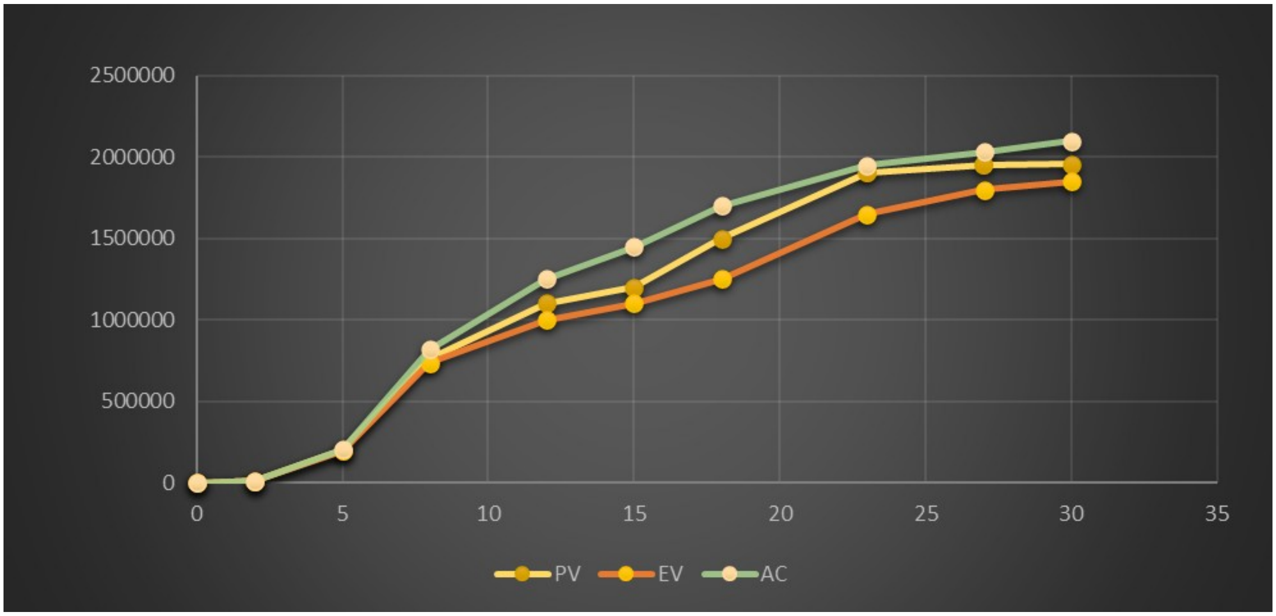

Figure 8.2. S-Curve for Equipment Delay Scenario

As illustrated in Figure X.2, the Planned Value (PV), Earned Value (EV), and Actual Cost (AC) curves remained relatively close during the early stages of execution. However, after Day 8, the delayed delivery of critical equipment caused a significant reduction in project progress, resulting in an increasing gap between the three performance curves.

The largest deviation occurred on **Day 18**, where project performance indicators were calculated as follows:

- **Planned Value (PV):** 1,500,000 USD
- **Earned Value (EV):** 1,250,000 USD
- **Actual Cost (AC):** UD 1,700,000 USD

The corresponding Earned Value Management indicators were:

- **Schedule Variance (SV) = −250,000 USD**
- **Cost Variance (CV) = −450,000 USD**
- **Schedule Performance Index (SPI) = 0.83**
- **Cost Performance Index (CPI) = 0.74**

Based on the current cost performance, the project completion forecast was calculated using the Estimate at Completion (EAC):

EAC=BAC / CPI=1,956,000 / 0.74= 2,643,243 USD

Accordingly, the expected Variance at Completion (VAC) was:

VAC=BAC−EAC=−687,243 USD

These results indicate that the project was significantly behind schedule and over budget. If no corrective actions had been implemented, the project would have exceeded its approved budget by approximately **35%** while experiencing substantial schedule slippage.

8.3 Project Recovery Phase

A recovery scenario was subsequently developed to evaluate the potential effect of corrective actions on project performance. The recovery plan included accelerated equipment procurement, improved supplier coordination, optimized resource allocation, activity resequencing, and controlled overtime during critical activities.

Table 8.3. Project Performance Data After Recovery Actions

Day	PV	EV	AC
0	0	0	0
2	10,000.00	10,000.00	10,500.00
5	200,000.00	195,000.00	202,000.00
8	760,000.00	750,000.00	765,000.00
12	1,100,000.00	1,080,000.00	1,110,000.00
15	1,200,000.00	1,180,000.00	1,210,000.00
18	1,500,000.00	1,485,000.00	1,505,000.00
23	1,901,000.00	1,890,000.00	1,905,000.00
27	1,950,000.00	1,950,000.00	1,955,000.00
30	1,956,000.00	1,956,000.00	1,956,500.00

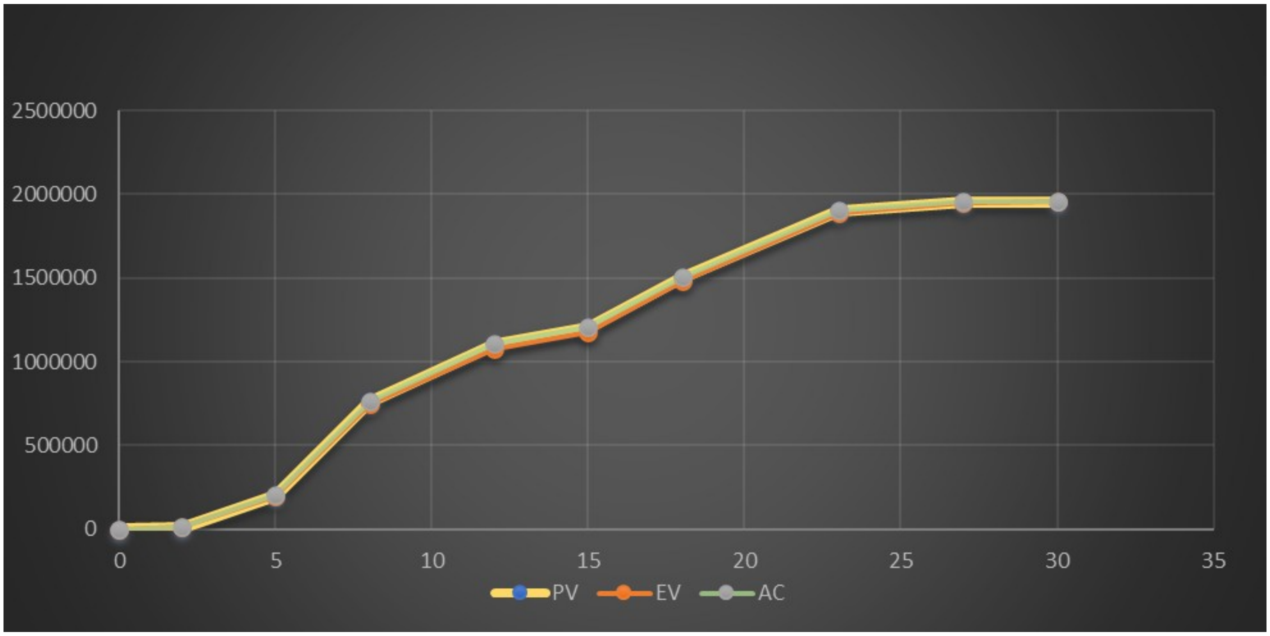

Figure 8.3. Recovery S-Curve

The recovery actions produced a noticeable improvement in both schedule and cost performance. By **Day 18**, the performance indicators had improved considerably:

- **Planned Value (PV):** 1,500,000 USD
- **Earned Value (EV):** 1,485,000 USD
- **Actual Cost (AC):** 1,505,000 USD

The corresponding Earned Value indicators were:

- **Schedule Variance (SV)** = **−15,000 USD**
- **Cost Variance (CV)** = **−20,000 USD**
- **Schedule Performance Index (SPI)** = **0.99**
- **Cost Performance Index (CPI)** = **0.99**

The improvement in SPI and CPI indicates that the corrective measures successfully restored project performance and minimized the impact of the equipment delay.

At project completion (30 Days), all planned work had been completed, resulting in:

- **PV = 1,956,000 USD**
- **EV = 1,956,000 USD**
- **AC = 1,956,500 USD**

The final project performance indicators were:

- **SV = 0 USD**
- **CV = −500 USD**
- **SPI = 1.00**

- **CPI = 0.9997**

These results demonstrate that the project was completed according to the planned schedule, with only a negligible cost overrun of **500 USD**, representing less than **0.03%** of the approved project budget.

8.4 Comparative Performance Evaluation

To assess the effectiveness of the implemented recovery strategy, the project performance before and after corrective actions was compared using the principal Earned Value Management indicators.

Table 8.4. Comparison of Project Performance Before and After Recovery

Indicator	Equipment Delay	Recovery Phase	Improvement
SV	-250,000 USD	-15,000	94.0%
CV	-450,000 USD	-20,000	95.6%
SPI	0.83	0.99	+19.3%
CPI	0.74	0.99	+33.8%

The comparison demonstrates the effectiveness of the recovery strategy in bringing project performance **closer to the approved baseline**. Schedule deviation was reduced by approximately **94%**, while cost deviation decreased by nearly **96%**. Likewise, both the Schedule Performance Index and Cost Performance Index improved substantially, indicating that project performance **approached the approved baseline**.

These findings demonstrate that continuous project monitoring using Earned Value Management **can enable early identification of performance deviations and support timely corrective actions**. Furthermore, **integrating Analogous Estimation with Earned Value Management offers an integrated framework** for planning, monitoring, and controlling oil well workover projects under uncertain operating conditions.

8.5 Discussion of Results

The results of this case study indicate that integrating Analogous Estimation with Earned Value Management (EVM) provides a practical approach to planning and monitoring oil well workover projects**.** Analogous Estimation established a realistic project baseline using historical project data, while EVM enabled continuous monitoring of project performance through quantitative cost and schedule indicators.

The equipment delay scenario demonstrated how operational disruptions can rapidly lead to schedule delays and cost overruns. Conversely, the recovery scenario showed that timely corrective actions significantly improved project performance, reducing both schedule and cost deviations and restoring alignment with the approved baseline.

These findings are consistent with previous studies, which emphasize that EVM supports early detection of project deviations and improves decision-making through continuous performance monitoring. The proposed integration enhances estimation accuracy, strengthens project control, and provides project managers with reliable information for responding to operational risks and improving project outcomes.

9 Corrective Action Plan

The Earned Value Management analysis identified both cost overruns and schedule delays during project execution. Based on these findings, several corrective actions are recommended to improve project performance and minimize further deviations.

9.1 Resource Optimization

To recover schedule delays, project management should optimize the allocation of critical resources by improving equipment utilization, minimizing rig idle time, and ensuring the timely availability of materials and specialized personnel. Efficient resource allocation can significantly improve schedule performance without substantially increasing project costs.

9.2 Enhanced Cost Control

Since the project exhibited inefficient cost performance, stricter financial monitoring procedures should be implemented. Daily cost tracking, regular comparison of actual expenditures with the project baseline, and continuous monitoring of high-cost activities will enable early identification of budget deviations and facilitate timely corrective actions.

9.3 Risk Management Improvement

Unexpected operational events are common in oil well workover projects. Therefore, project managers should maintain an updated risk register, conduct periodic risk assessments, and establish contingency plans for equipment failures, well integrity issues, and unforeseen operational conditions. Integrating risk management with project performance monitoring enhances organizational readiness and reduces the likelihood of significant project disruptions.

9.4 Continuous Performance Monitoring

Project performance indicators should be reviewed regularly throughout project execution. Continuous calculation of CPI, SPI, and forecasting metrics allows management to detect performance deterioration early and implement corrective measures before deviations become critical.

10 . Recommendations

Based on the findings of this study, the following recommendations are proposed:

1. Petroleum companies should integrate **Analogous Estimation** with **Earned Value Management** as a standard practice for planning and controlling oil well workover projects.
2. Historical project databases should be continuously updated to improve the accuracy of analogous cost and schedule estimates.
3. Earned Value Management indicators should be calculated periodically throughout project execution rather than only at project completion.
4. Risk management activities should be integrated into project planning to reduce the impact of operational uncertainties on project performance.
5. Project managers should establish formal performance review procedures whenever significant deviations in CPI or SPI are detected.
6. Future workover projects should incorporate lessons learned from completed operations to improve estimation accuracy and project control effectiveness.

11 . Conclusion

This study presented an integrated approach for evaluating the cost and schedule performance of an oil well workover project by combining **Analogous Estimation** with **Earned Value Management (EVM)**. Analogous Estimation was employed during project planning to establish the initial project baseline using historical workover data, while Earned Value Management was applied during project execution to monitor performance and evaluate project progress.

The results demonstrated that the project experienced both cost overruns and schedule delays, as indicated by the calculated Cost Performance Index (CPI) and Schedule Performance Index (SPI). Forecasting indicators further suggested that the final project cost would exceed the approved budget if the current performance trend continued.

The study confirms that integrating historical estimation techniques with quantitative performance measurement provides project managers with a more comprehensive decision-support framework. The proposed approach enhances estimation accuracy, facilitates early identification of project deviations, and supports timely corrective actions, thereby improving the overall management of oil well workover projects.

Unlike previous studies that primarily examined Earned Value Management as a project control tool, this research demonstrates the practical benefits of integrating Analogous Estimation with EVM. The proposed framework enhances both project planning and performance monitoring, providing a more comprehensive approach to managing oil well workover projects under uncertain operating conditions.

Future research may extend this work by applying the proposed framework to multiple workover projects and comparing its effectiveness with other project estimation and performance measurement techniques in the petroleum industry.

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