Tikrit Journal of Engineering Sciences (2024); 31(3): 32-43
DOI: http://doi.org/10.25130/tjes.31.3.4

IRAQI Academic Scientific Journals

ISSN: 1813-162X (Print); 2312-7589 (Online)
Tikrit Journal of Engineering Sciences
available online at: http://www.tj-es.com

TJES Tikrit Journal of Engineering Sciences

Evaluation Performance for Iraqi Oil Projects Using Earned Value Analysis

Nidal Adnan Jasim *[a], **Abdulrahman Adnan Ibrahim** [b], **Wadhah Amer Hatem** [c]

[a] Department of Civil Engineering, College of Engineering, University of Diyala, Diyala, Iraq.
[b] Department of Civil Engineering, College of Engineering, University of Tikrit, Tikrit, Iraq.
[c] Middle Technical University, Baghdad, Iraq.

Keywords:
Earned Value Management (EVM); Schedule Performance Index (SPI); Cost Performance Index (CPI); To-Complete Cost Performance Indicator (TCPI); Oil Projects; Refineries.

Highlights:

- *Evaluation performance for Karbala Refinery Project.*
- *Earned Value Management (EVM) was used to evaluate performance measurement.*
- *The construction tasks for the Karbala refinery project are late but it is still within the budget.*

ARTICLE INFO

Article history:

Received	09 July	2023
Received in revised form	27 Aug.	2023
Accepted	26 Sep.	2023
Final Proofreading	31 Jan.	2024
Available online	06 July	2024

Citation: Jasim NA, Ibrahim AA, Hatem WA. **Evaluation Performance for Iraqi Oil Projects Using Earned Value Analysis**. *Tikrit Journal of Engineering Sciences* 2024; **31**(3): 32-43.
http://doi.org/10.25130/tjes.31.3.4

*Corresponding author:

Nidal Adnan Jasim
Department of Production Engineering and Metallurgy, University of Technology, Baghdad, Iraq.

Abstract: Poor performance measuring procedures in the oil and gas sector can result in project cost overruns, schedule delays, and scope expansions. Earned value management, an integrated project planning and control system that monitors cost and schedule performance, makes it possible to identify performance issues early and adopt corrective measures quickly. This study aims to thoroughly comprehend the differences between actual and planned expenses, as well as the potential use of Earned Value Management (EVM) to compare and analyze the available data and to assess the effectiveness of EVM when applied to a real project in helping a project manager achieve success in terms of budget utilization and schedule compliance. For this purpose, data were collected from the Karbala Refinery Project, which is one of the vast and modern projects of the State Company for Oil Projects (SCOP), the Iraqi Ministry of Oil, based on (84) monthly reports starting on (June 26, 2015) up to (August 25, 2022). The data was arranged in a spreadsheet format suitable for statistical analysis using Microsoft Office Excel, and the earned value was analyzed and its indexes. The results showed that the earned value indexes Cost Performance Index (CPI), the Schedule Performance Index (SPI), and the To-Complete Cost Performance Indicator (TCPI) achieved for the task construction of the Karbala refinery project were as follows: 1.029, 0.991, and 0.237, respectively, which means that the construction task for the Karbala refinery project is late and still within the budget.

تقييم أداء مشاريع النفط العراقية باستخدام تحليل القيمة المكتسبة

نضال عدنان جاسم[١]، عبد الرحمن عدنان ابراهيم[٢]، وضاح عامر حاتم[٣]
[١] قسم الهندسة المدنية، كلية الهندسة، جامعة ديالى، ديالى، العراق.
[٢] قسم الهندسة المدنية، كلية الهندسة، جامعة تكريت، تكريت، العراق.
[٣] الجامعة التقنية الوسطى، بغداد، العراق.

الخلاصة

يمكن أن تؤدي إجراءات قياس الأداء الضعيفة في قطاع النفط والغاز إلى تجاوز تكاليف المشروع وتأخيرات الجدول الزمني وتوسيع النطاق. إدارة القيمة المكتسبة، هي عبارة عن نظام متكامل لتخطيط ومراقبة المشروع يراقب التكلفة وجدول الأداء الزمني تجعل من الممكن تحديد مشكلات الأداء مبكرًا واعتماد التدابير التصحيحية بسرعة. تهدف هذه الدراسة إلى الفهم الشامل للاختلافات بين النفقات الفعلية والمخطط لها، وكذلك الاستخدام المحتمل للقيمة المكتسبة لمقارنة وتحليل البيانات المتاحة ولتقييم فعاليتها عند تطبيقها على مشروع حقيقي في مساعدة مدير المشروع على تحقيق النجاح في شروط استخدام الميزانية والالتزام بالجدول الزمني. لهذا الغرض تم جمع البيانات من مشروع مصفاة كربلاء وهو من المشاريع الضخمة والحديثة لشركة المشاريع النفطية (سكوب) وزارة النفط العراقية من (٨٤) تقريرا شهريا ابتداءً من تاريخ (٢٦ حزيران ٢٠١٥) حتى (٢٥ أب ٢٠٢٢)، وترتيبها في شكل جدول مناسب للتحليل الإحصائي ثم تم تحليل القيمة المكتسبة وحساب فهارسها. أظهرت النتائج أن مؤشرات القيمة المكتسبة مؤشر أداء التكلفة، مؤشر أداء الجدول الزمني، ومؤشر أداء التكلفة الإجمالية المحققة لمشروع مصفاة كربلاء كانت: ١,٠٢٩ و٠,٩٩١ و٠,٢٣٧ على التوالي، وهذا يعني أن مشروع مصفاة كربلاء متأخر عن الجدول الزمني. ولكنه لايزال ضمن الميزانية.

الكلمات الدالة: إدارة القيمة المكتسبة (EVM)، مؤشر أداء الجدول الزمني (SPI)، مؤشر أداء التكلفة (CPI)، مؤشر أداء التكلفة إلى الاكتمال (TCPI)، مشاريع النفط، المصافي.

1.INTRODUCTION

Managing projects is challenging for many project managers. It can be due to ineffective project monitoring and control or a lack of organizational skills. Accurate performance metrics like cost and schedule performances are essential to support decision-making and ensure predictable project outcomes. The proper use of EVM processes and tools in each project phase increases the likelihood of meeting its cost and budget commitments, which improves stakeholder credibility, according to the Association for the Advancement of Cost Engineering's recommended practices [1,2]. Earned value measures how well a project is doing in terms of cost and schedule. It compares how much of the planned work was done and its cost to an integrated schedule and budget plan. EVM gives project managers and the organization early warning signals that let them respond quickly to signs of poor performance and improve the chances that the project will be successful [3,4]. Analyzing a project's Earned Value is essential for measuring its execution. It is one of the program management strategies that uses "work in progress" to determine the project's future. Its concept is based on comparing actual accomplished work to a planned baseline. It aids in setting standards for evaluating project performance, controlling time and expense limits, and identifying the activities that may need to be modified as the project progresses [5,6]. Some approaches used to measure the performance of Iraqi oil projects are imprecise and unreliable. To help a project manager succeed in budget utilization and schedule adherence, this study's main objective is to evaluate how well EVM performs when used on a real project. Through comparison and analysis of the available data, this study aims to fully understand the disparities between actual and budgeted expenses. The research structure following the introduction is as follows: The study's methodology is described, and the selected case study (Karbala Refinery Project) is illustrated. Then, this study's results were obtained using the earned value management approach for measuring the performance of the Karbala Refinery project by analyzing earned value and calculating its indexes using Microsoft Office Excel. Finally, the results of this study were explained. According to the study, EVM has several benefits for project managers, including the ability to identify schedule delays in a timely manner, estimate cost overruns, examine deviations in project cost and schedule performance, and forecast schedule and cost outcomes.

2.LITERATURE REVIEW

Jaber et al. [7] applied the EVM methodology in wastewater treatment plant projects to predict performance through indicators like CPI, SPI, and TCPI. Araszkiewicz and Bochenek [8] introduced the Earned Value Method (EVM) as a work progress control method that, despite its advantages, is still often underutilized in construction projects. Susilowati and Kurniaji [9] applied the EVM methodology in an integrated development project of malls and hotels for measuring performance through indicators like CPI and SPI. Hussien and Jasim [10] proposed a tool integrating the BIM technique with EVM. This tool includes several features that assist project managers in avoiding errors during project progress stages by detecting conflicting parts that create time delays and cost deviations. Ugural and Burgan [11] assessed a bridge project's performance using the evaluate project performance (EVA) technique. The study found that the CPI and SPI were less than 1.0, indicating that the project could unsuccessfully be completed. Overruns in terms of cost and time were also clearly stated. Bonny et al. [12] used the Earned Value approach to calculate the efficiency of time and cost and the final project completion

time for the Well Pad stockpiling and compaction project in the Rokan Riau Oil and Gas Block environment.

3.EXPERIMENTAL AND METHODOLOGICAL WORK

The authors will review the suggested case study and the research methodology used in this part.

3.1.Research Methodology

The research methodology involved the following points:

1- The Karbala Refinery Project was selected as a case study to apply EV.
2- Data were described and identified.
3- Data were collected in a spreadsheet format suitable for statistical analysis.
4- EV was analyzed, and its indexes were calculated (CPI, SPI, and TCPI).

3.2.Case Study Background

The project of Karbala Refinery is selected as a case study to achieve the goal of the research, being one of the huge projects. The refinery's schedule and planning budget were studied and followed up on implementation professionally using advanced computer programs by the implementing agency. The implementing agency used the Primavera program to develop the detailed structure of the various project activities, schedule them, and distribute the responsibilities and resources needed to determine the initial budget for the project through its various stages and start implementing the project and preparing the reports on the project's progress. The Project is 25 km south of Karbala City, Iraq (100 km south of Baghdad City). Oil was pumped to the Karbala refinery for the first time on (September 25, 2022). Operating the Karbala strategic refinery was on (October 20, 2022). Other Karbala Refinery's details are summarized below in Table 1. The Karbala refinery project has advantages and differences compared to other Iraqi refineries. Below is a summary of these features:

- The largest design capacity of the distillation tower.
- The lowest waste percentage.
- The largest complexity factor, i.e., the refinery's complexity factor reached (11.5).
- It greatly reduces the import of Gasoline, the most expensive product, and the import of other oil derivatives.
- The specifications of the products are within Euro 5, while the rest of the Iraqi refineries operate within Euro 3 or Euro 4.

3.2.1.Project Scope Description

The construction site of the Karbala Refinery consists of the following main facilities, as shown in Fig. 1:

- Power and Steam generation (GT combined cycle) 4 x 55 MW
- Wastewater Treatment
- Utility units
- Tank Farm
- Telecommunication system
- Refinery products Depot
- Sulphur Solidification and Bagging and Asphalt Plant
- Fuel oil pipeline to Al-Khairat power station
- Crude and Natural Gas pipelines and receiving facilities.
- Water intake facilities (Euphrates River intake and supply/return pipelines)
- Construction camp, temporary facilities, and early works.

Table 1 Project Background Information (Ministry of Iraqi Oil/ Karbala Refinery Project Authority).

Item Name	Details
Project Name	Karbala Refinery Project
Project Location	25 km South of Karbala City, Iraq (100 km South of Baghdad City)
Employer	State Company for Oil Projects (SCOP) / Oil Ministry
Contractor	The Korean Consortium Headed by Hyundai HDGSK JV (HDEC + GS + SK + HEC)
Consultant	TechnipFMC
Refinery Area	3 km x 2 km
Site Area	5 km x 2 km
Production Capacity	140,000 BPSD
Type of Contract	EPC (design, purchase, and construction)
Contract Signing Date (EPC)	15/4/2014
Actual start date	28/5/2014
Duration of the Original Contract	54 Months
Planned Completion Date	16/2/2022 + 1 year (trial operation)
Expected Completion Date	31/7/2023
Contract Amount	6,641,089,012 $
The Value of the Original Contract	6,023,000,000 $
FEED Contractor	Technip Italy S.p.A (2009-2010)
Licensors	UOP, Axens, Haldor Topsoe, Poener, Tecnimont

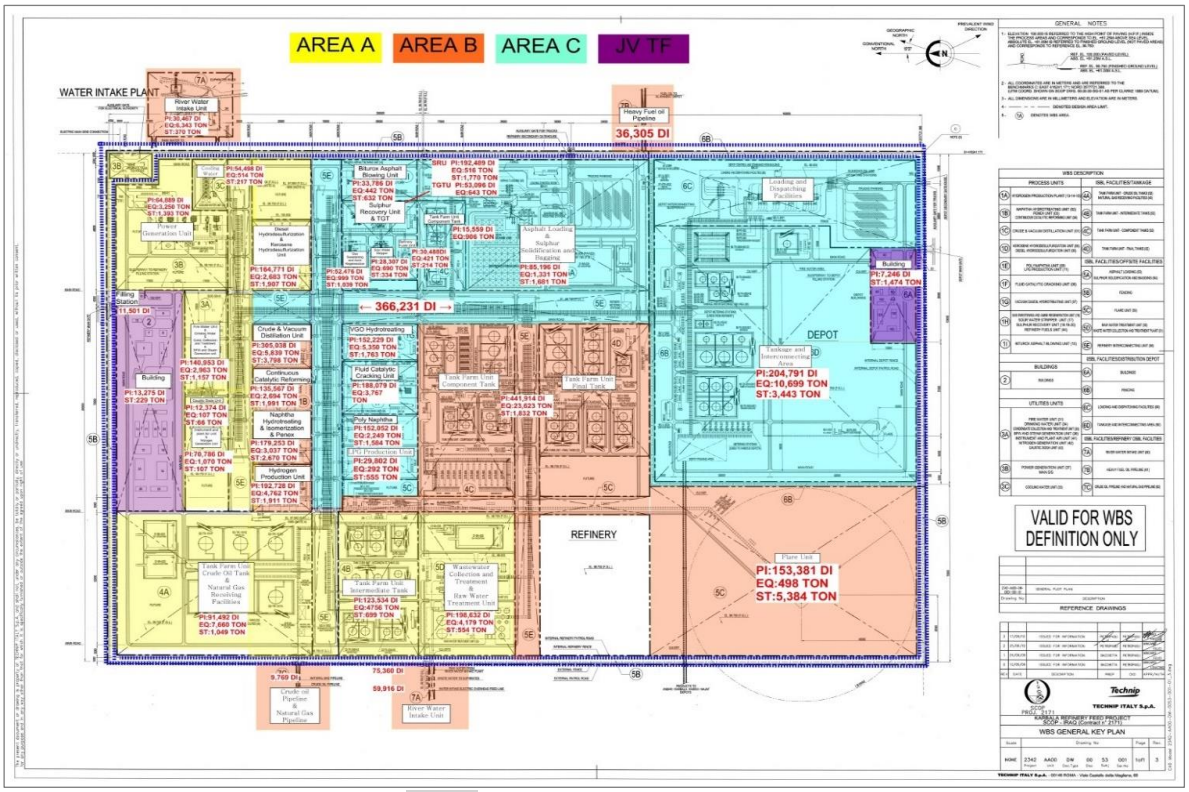

Fig. 1 Construction Site Layout.

3.2.2.The Refinery Facilities Units

The Refinery facilities consist of the following units:

- Crude and Vacuum Distillation
- Naphtha Hydrotreating
- Isomerization
- Catalytic Reforming
- Kerosene Hydrodesulfurization
- Diesel Hydrodesulfurization
- VGO Hydrotreating
- Fluid Catalytic Cracking
- Poly Naphtha
- Asphalt Blowing
- Tail Gas Treatment

Figure 2 displays the units' diagram of the Karbala Refinery project. Fig. 3 and Fig. 4 show three-dimensional (3D) and site photos of the Refinery Facilities Units.

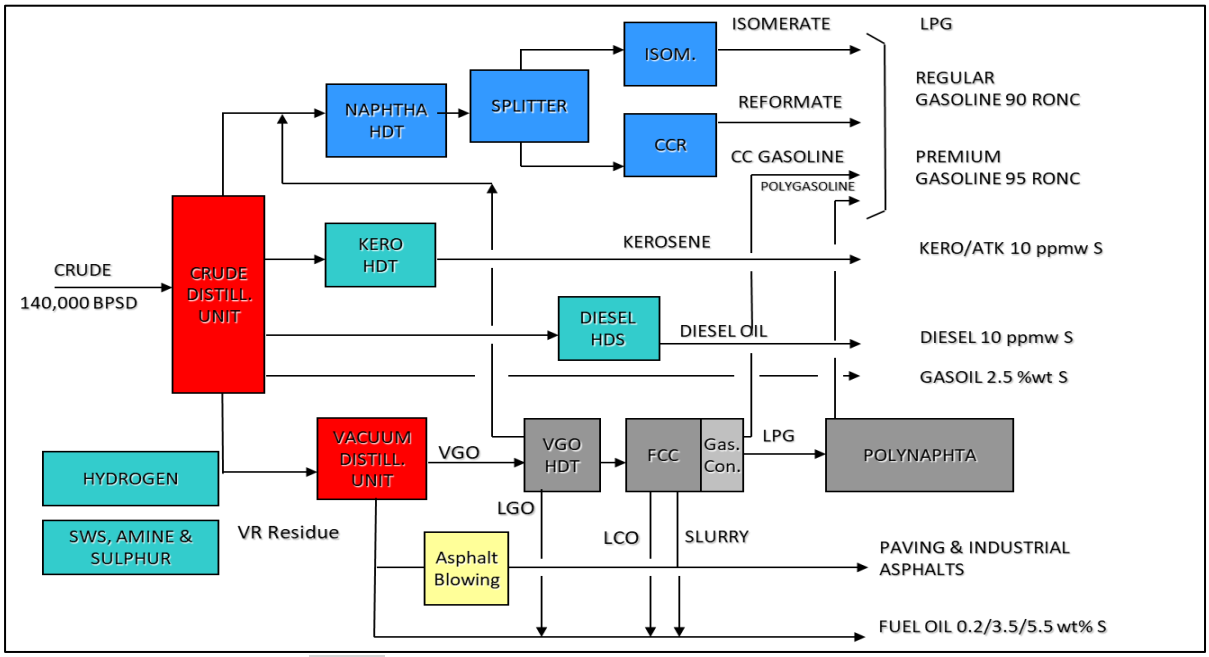

Fig. 2 Units Diagram of Karbala Refinery Project.

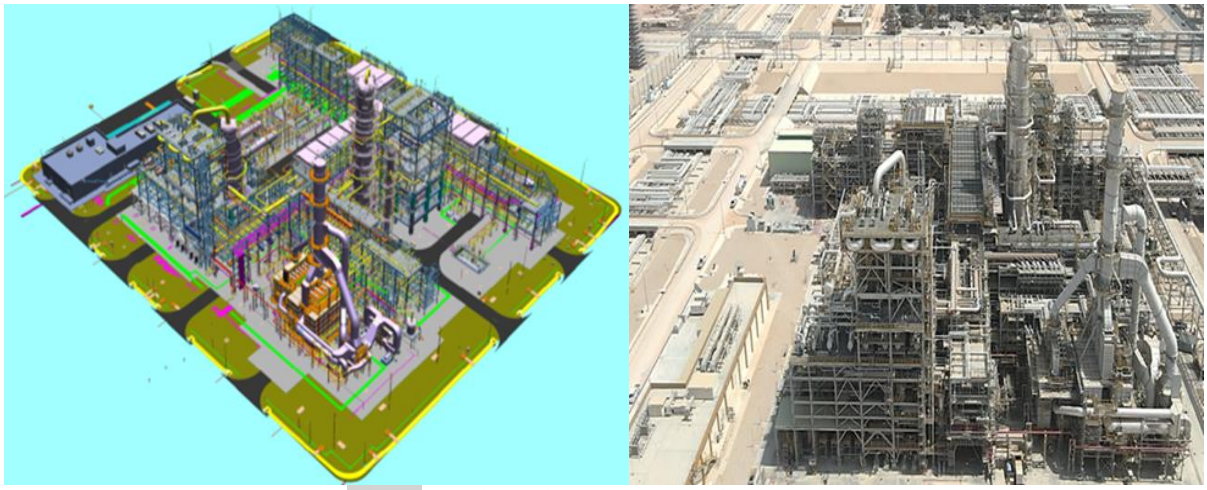

Fig. 3 Crude and Vacuum Distillation Unit.

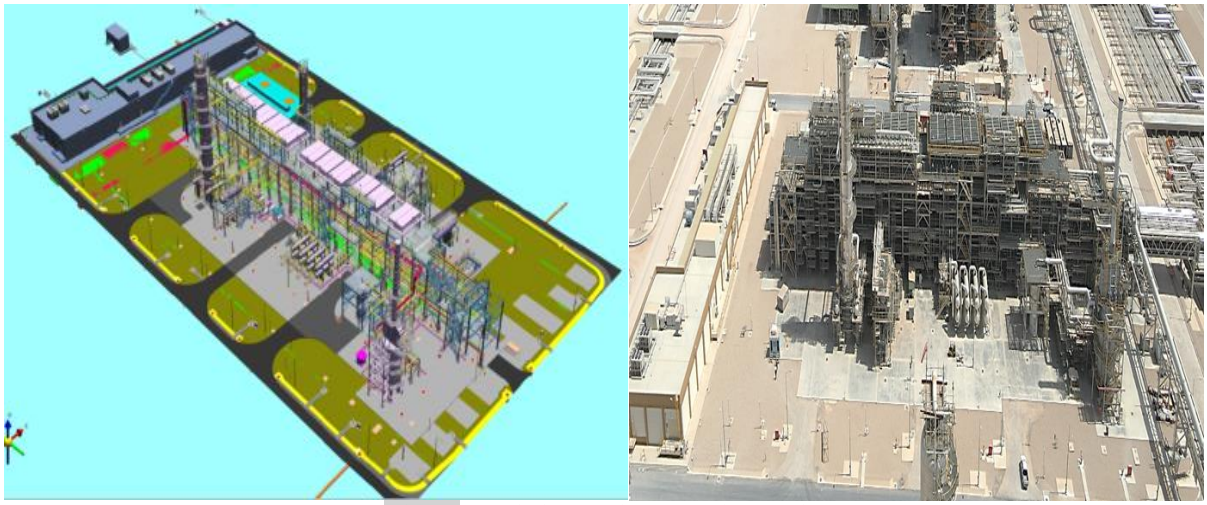

Fig. 4 Naphtha Hydro Treating Unit.

3.2.3.The Importance of the Karbala Refinery

The construction of the Karbala Refinery is very important for the following reasons:

- When the refinery is commissioned, its productivity will cover its implementation costs. The refinery will be a very large economy during the first two years. Also, importing billions of dollars in products would be stopped, and product-producing profitability would be achieved for the coming years.
- The refinery follows the most famous international environmental legislation, such as the International Finance Corporation and the (United States of America) US Environmental Protection Agency, to control the proportions of gaseous, solid, and liquid pollutants, making it one of the most distinguished refineries in the region.
- The refinery uses zero-liquid disposal technology by treating the refinery's liquid waste using advanced technologies, recovering the largest amount of water and its recycling in the refinery, which significantly reduces consumption of water withdrawn from the Euphrates River, which is a technique used for the first time in Iraqi refineries.
- The refinery contains a huge system for pumping and storing products, as the number of all project tanks (the refinery and warehouses) reached (144 tanks) of different sizes, ensuring the provision of additional quantities of white products and liquefied gas (LPG) in addition to an integrated system to transport these products to warehouses either through a large network of conveyor tubes or by loading them with trucks.
- Electric power generation station: It consists of four generating units with a total capacity of 200 megawatts, which allows it to be self-sufficient in electrical energy; the surplus strengthens the national grid.
- The water intake station on the Euphrates River, with an area of 35,000 m^2 with a pumping capacity of 1,200 m^3/ hour, is about 33 km from the refinery.

4.DATA COLLECTION OF KARBALA REFINERY

The scope of work in the Karbala Refinery was divided into the following tasks: Project Management, Engineering, Procurement, Construction, and Commissioning.

As shown in Table 2, the total completion percentage of the project until July 31, 2022= 96.17%, including the following ratios:

- The overall completion rate for Project Management =95.26%
- The overall completion rate for designs (Engineering) = 99.50%
- The overall completion percentage of the Procurement = 99.56%
- The overall completion rate for Construction = 96.43%
- The overall completion rate for Commissioning = 28.01%
- The value of the original contract for the Karbala refinery project is (USD 6,023,000,000), divided as shown in Table 3.

(89) reports, i.e., from (September 26, 2014) to (August 25, 2022), of the Karbala refinery project, have been obtained from the Karbala Refinery Project Authority, the State Company for Oil Projects (SCOP), Ministry of Iraqi Oil. After reviewing the reports and studying them extensively, the reports that will be considered were determined, starting from commencing the construction work on (June 26, 2015) up to (August 25, 2022). The three basic values, which include Planned Value (PV), Actual Cost (AC), and Earned Value (EV) of the acquired value methodology, were obtained from the construction progress certificate reports and invoices amounting to (84) reports. Table 4 shows the Construction Progress summary for the period from (03-Apr.-2020) to (30-Apr.-2020), as an example. Table 5 shows the method of extracting Planned Value (PV) and Earned Value (EV) from the monthly report No. (61) for the period (April 03, -2020) to (April 30, 2020), as shown by Eq. (1) and Eq. (2) [13,14]:

1) **Planned Value (PV) = % Completed Planned * BAC** **(1)**
PV= 84.63%* 1,797,500,000 = USD 1,521,224,250
2) **Earned Value (EV) = % Completed Actual * BAC** **(2)**
EV=86.06% * 1,797,500,000 = USD 1,546,928,500
3) Actual cost was obtained from monthly invoices available to the Karbala Refinery Project Authority. Actual Cost (AC)=1,419,186,960 USD

In the same way, the values of (PV, EV, and AC) were extracted from all reports for the Karbala Refinery Project.

Table 2 Overall Progress and Schedule.

Task	Overall Progress & Schedule					Cut off July 31, 2022		
	Weight	Up to June 30, 2022		During Period		Cumulative Percentage		
		Plan	Actual	Plan	Actual	Plan	Actual	Variance
Project Management	5.00%	100%	95.09%	0.00%	0.17%	100%	95.26%	-4.74%
Engineering	8.00%	100%	99.50%	0.00%	0.00%	100%	99.50%	-0.50%
Procurement	35.00%	100%	99.56%	0.00%	0.00%	100%	99.56%	-0.44%
Construction	49.61%	100%	96.36%	0.00%	0.07%	100%	96.43%	-3.57%
Commissioning	2.39%	100%	28.01%	0.00%	4.00%	100%	32.01%	-67.99%
Grand Total	100%	100%	96.03%	0.00%	0.14%	100%	96.17%	-3.83%

Table 3 The Original Contract Value Divided According to the Task.

Task	Amount
Engineering	USD 898,000,000
Procurement	USDS3,264,000,000
Construction	USD 1,797,500,000
Commissioning	USD 63,500,000
Total	USD6,023,000,000

Table 4 Construction Progress Summary Period: 03 -Apr.-2020 - 30- Apr.-2020.

ODE	DISCIPLINE	Weighted Value (%)	Reporting Period Percentage		Cumulative Percentage		Reporting Period Weighted Percentage		Cumulative Weighted Percentage	
			Planned	Actual	Planned	Actual	Planned	Earned	Planned	Earned
		1	2	3	4	5	6 = (1) *(2)	7 = (1) *(3)	8 = (1) *(4)	9= (1) *(5)
RM	Rotating Equipment	0.53%	0.76%	0.67%	97.29%	94.73%	0.00%	0.00%	0.52%	0.50%
MS	Stationary Equipment	5.23%	0.71%	0.36%	99.34%	98.07%	0.04%	0.02%	5.20%	5.13%
PI	Piping	32.06%	2.47%	1.65%	92.86%	92.88%	0.79%	0.53%	29.78%	29.78%
EL	Electrical	9.63%	5.81%	3.92%	83.05%	85.55%	0.56%	0.38%	7.99%	8.24%
IN	Instrument	6.61%	6.85%	6.61%	64.10%	76.80%	0.45%	0.44%	4.24%	5.08%
CI	Civil	22.72%	0.82%	0.24%	93.07%	92.87%	0.19%	0.05%	21.15%	21.10%
AR	Architecture	8.63%	0.85%	0.16%	98.91%	97.76%	0.07%	0.01%	8.54%	8.44%
SS	Steel Structure	3.47%	0.14%	0.10%	99.69%	99.25%	0.00%	0.00%	3.45%	3.44%
FP	Fire Proofing	0.84%	0.86%	1.86%	2.60%	10.28%	0.01%	0.02%	0.02%	0.09%
IS	Insulation	5.98%	5.94%	5.25%	19.74%	28.89%	0.36%	0.31%	1.18%	1.73%
PA	Painting	2.29%	4.24%	2.08%	86.62%	90.12%	0.10%	0.05%	1.98%	2.06%
PC	Pre-Commissioning	2.00%	6.07%	4.98%	29.25%	23.77%	0.12%	0.10%	0.59%	0.48%
Total		100.00%	2.68%	1.91%	84.63%	86.06%	2.68%	1.91%	84.63%	86.06%

Table 5 Construction Cost Summary Period: 03 -Apr.-2020 - 30- Apr.-2020.

Code	Discipline	Weighted Value (%)	Contract Value (USD)	Cumulative Percentage (%)		Cumulative Value (USD)		Cumulative Value AC (ACWS)
			BAC	PLANNED	ACTUAL	PV (BCWS)	EV (BCWP)	
		1	2	4	5	6 = (2) *(4)	7= (2) *(5)	
RM	Rotating Equipment	0.53%	9569364.989	97.29%	94.73%	9310035.198	9065059.454	7555336.861
MS	Stationary Equipment	5.23%	94069699.41	99.34%	98.07%	93448839.39	92254154.21	74271204.86
PI	Piping	32.06%	576360490.1	92.86%	92.88%	535208351.1	535323623.2	455056073.3
EL	Electrical	9.63%	173030748.3	83.05%	85.55%	143702036.4	148027805.1	136613619.8
IN	Instrument	6.61%	118875760.7	64.10%	76.80%	76199362.58	91296584.18	93856428.02
CI	Civil	22.72%	408424807.2	93.07%	92.87%	380120968	379304118.4	322465179.7
AR	Architecture	8.63%	155140443.1	98.91%	97.76%	153449412.3	151665297.2	122488619.6
SS	Steel Structure	3.47%	62285658.74	99.69%	99.25%	62092573.2	61818516.3	49176631.26
FP	Fire Proofing	0.84%	15034889.29	2.60%	10.28%	390907.1215	1545586.619	11870552.89
IS	Insulation	5.98%	107545817.1	19.74%	28.89%	21229544.29	31069986.55	84911054.89
PA	Painting	2.29%	41133299.04	86.62%	90.12%	35629663.63	37069329.1	32476128.86
PC	Pre-Commissioning	2.00%	36029022.25	29.25%	23.77%	10538489.01	8564098.588	28446129.93
Total		100.00%	1797500000	84.63%	86.06%	1521224250	1546928500	1419186960

5.EARNED VALUE ANALYSIS

Table 6 shows the Earned Value Analysis for the Karbala Refinery project up to August 25, 2022, from which the following results can be concluded:

1) Budget at Completion (BAC)= USD 1,797,500,000
2) Actual Cost (AC)= USD 1,730,683,450
3) Planned Value (PV) = USD 1,797,500,000
4) Earned Value (EV)= USD 1,728,476,000

Figure 6 shows these values over the life of the project. Eq. (3) and Eq. (4) were used to calculate the cost variance and schedule variance for the Karbala Refinery up to August 25, 2022, as shown in Table 6 [15]:

1) **Cost variance** $(CV) = EV - AC$ **(3)**
CV=USD 1,781,682,000 – USD 1,730,683,450
CV= USD 50,998,550
2) **Schedule variance** $(SV) = EV - PV$ **(4)**
SV=USD 1,781,682,000 – USD 1,797,500,000
SV=- USD 15,818,000

The value of cost variance (CV) equals (USD 50,998,550). This positive value means that the project is under a budget. However, the schedule variance (SV value) equals (- USD 15,818,000). This negative value means that the project is behind schedule. Therefore, the actual cost is less than planned, and the activities have been completed in more time than planned durations. Figure 6 shows the variances in costs and scheduling for the Karbala Refinery project from the starting date up to August 25, 2022.

Table 6 Earned Value Analysis for the Karbala Refinery up to August 25, 2022.

Report No.	Date	P%	Cumulative PV (USD)	A%	Cumulative EV (USD)	Cumulative AC (USD)	BAC (USD)	CV (USD)	SV (USD)
1	26 Jun -30 July 2015	1.01%	18,154,750	0.24%	4,314,000	0	1,797,500,000	4,314,000	- 13,840,750
2	31 July - 27 Aug 2015	1.49%	26,782,750	0.45%	8,088,750	5,392,500	1,797,500,000	2,696,250	- 18,694,000
3	28 Aug - 24 Sep 2015	2.13%	38,286,750	0.86%	15,458,500	10,392,500	1,797,500,000	5,066,000	-22,828,250
4	25 Sep - 29 Oct 2015	3.19%	57,340,250	1.28%	23,008,000	14,392,500	1,797,500,000	8,615,500	-34,332,250
5	30 Oct - 26 Nov 2015	4.33%	77,831,750	1.81%	32,534,750	23,392,500	1,797,500,000	9,142,250	- 45,297,000
6	27 Nov - 10 Dec 2015	4.91%	88,257,250	2.07%	37,208,250	26,671,250	1,797,500,000	10,537,000	- 51,049,000
7	11 Dec - 28 Jan 2016	7.28%	130,858,000	3.35%	60,216,250	40,253,750	1,797,500,000	19,962,500	- 70,641,750
8	29 Jan - 25 Feb 2016	9.15%	164,471,250	4.93%	88,616,750	89,535,510	1,797,500,000	- 918,760	- 75,854,500
9	26 Feb - 31 Mar 2016	12.58%	226,125,500	8.10%	145,597,500	89,535,510	1,797,500,000	56,061,990	- 80,528,000
10	01 Apr - 28 Apr 2016	15.94%	286,521,500	10.42%	187,299,500	138,627,270	1,797,500,000	48,672,230	- 99,222,000
11	29 Apr - 26 May 2016	19.65%	353,208,750	10.96%	197,006,000	163,173,150	1,797,500,000	33,832,850	- 156,202,750
12	27 May - 30 Jan 2016	24.81%	445,959,750	11.60%	208,510,000	168,565,650	1,797,500,000	39,944,350	- 237,449,750
13	01 Jul - 28 Jul 2016	28.55%	513,186,250	12.14%	218,216,500	191,623,590	1,797,500,000	26,592,910	- 294,969,750
14	29 Jul - 25 Aug 2016	32.62%	586,344,500	12.63%	227,024,250	203,896,530	1,797,500,000	23,127,720	- 359,320,250
15	25 Aug - 29 Sep 2016	38.05%	683,948,750	13.32%	239,427,000	203,896,530	1,797,500,000	35,530,470	- 444,521,750
16	30 Sep - 27 Oct 2016	42.09%	756,567,750	13.96%	250,931,000	216,169,470	1,797,500,000	34,761,530	- 505,636,750
17	28 Oct - 24 Nov 2016	46.87%	842,488,250	14.59%	262,255,250	216,169,470	1,797,500,000	46,085,780	- 580,233,000
18	25 Nov - 29 Dec 2016	52.79%	948,900,250	15.52%	278,972,000	248,502,510	1,797,500,000	30,469,490	- 669,928,250
19	30 Dec - 26 Jan 2017	57.18%	1,027,810,500	16.13%	289,936,750	260,775,450	1,797,500,000	29,161,300	- 737,873,750
20	27 Jan - 23 Feb 2017	61.91%	1,112,832,250	16.79%	301,800,250	273,048,390	1,797,500,000	28,751,860	- 811,032,000
21	24 Feb - 30 Mar 2017	68.08%	1,223,738,000	17.31%	311,147,250	273,048,390	1,797,500,000	38,098,860	- 912,590,750
22	31 Mar - 27 Apr 2017	72.86%	1,309,658,500	17.72%	318,517,000	285,321,330	1,797,500,000	33,195,670	- 991,141,500
23	28 Apr - 25 May 2017	77.26%	1,388,748,500	18.07%	324,808,250	289,527,480	1,797,500,000	35,280,770	- 1,063,940,250
24	26 May - 29 Jun 2017	82.38%	1,480,780,500	18.13%	325,886,750	301,800,420	1,797,500,000	24,086,330	- 1,154,893,750
25	30 Jun - 27 July 2017	87.00%	1,563,825,000	18.41%	330,919,750	301,800,420	1,797,500,000	29,119,330	- 1,232,905,250
26	28 July - 31 Aug 2017	91.98%	1,653,340,500	18.78%	337,570,500	301,800,420	1,797,500,000	35,770,080	- 1,315,770,000
27	1 Sep - 28 Sep 2017	95.03%	1,708,164,250	19.17%	344,580,750	312,585,420	1,797,500,000	31,995,330	- 1,363,583,500
28	29 Sep - 26 Oct 2017	97.13%	1,745,911,750	19.54%	351,231,500	337,962,135	1,797,500,000	13,269,365	- 1,394,680,250
29	27 Oct - 30 Nov 2017	98.89%	1,777,547,750	20.06%	360,578,500	337,962,135	1,797,500,000	22,616,365	- 1,416,969,250
30	1 Dec - 28 Dec 2017	99.59%	1,790,130,250	20.63%	370,824,250	350,235,075	1,797,500,000	20,589,175	- 1,419,306,000
31	28 Dec - 25 Jan 2018	99.88%	1,795,343,000	21.09%	379,092,750	350,235,075	1,797,500,000	28,857,675	- 1,416,250,250
32	26 Jan - 22 Feb 2018	99.99%	1,797,320,250	21.48%	386,103,000	362,508,015	1,797,500,000	23,594,985	- 1,411,217,250
33	23 Feb - 29 Mar 2018	100.00%	1,797,500,000	22.05%	396,348,750	362,508,015	1,797,500,000	33,840,735	- 1,401,151,250
34	30 Mar - 26 Apr 2018	100.00%	1,797,500,000	22.82%	410,189,500	374,780,955	1,797,500,000	35,408,545	- 1,387,310,500
35	27 Apr - 31 May 2018	100.00%	1,797,500,000	23.56%	423,491,000	374,780,955	1,797,500,000	48,710,045	- 1,374,009,000
36	1 June - 28 June 2018	100.00%	1,797,500,000	24.19%	434,815,250	387,053,895	1,797,500,000	47,761,355	- 1,362,684,750
37	29 Jun - 26 July 2018	100.00%	1,797,500,000	25.02%	449,734,500	399,326,835	1,797,500,000	50,407,665	- 1,347,765,500
38	27 July - 30 Aug 2018	100.00%	1,797,500,000	26.66%	479,213,500	411,599,775	1,797,500,000	67,613,725	- 1,318,286,500
39	31 Aug - 27 Sep 2018	100.00%	1,797,500,000	28.24%	507,614,000	423,872,715	1,797,500,000	83,741,285	- 1,289,886,000
40	28 Sep - 25 Oct 2018	100.00%	1,797,500,000	30.25%	543,743,750	448,796,070	1,797,500,000	94,947,680	- 1,253,756,250
41	26 Oct - 29 Nov 2018	100.00%	1,797,500,000	32.96%	592,456,000	473,341,950	1,797,500,000	119,114,050	- 1,205,044,000
42	30 Nov - 27 Dec 2018	64.80%	1,797,500,000	35.88%	644,943,000	497,887,830	1,797,500,000	147,055,170	- 519,837,000

43	28 Dec - 31 Jan 2019	100.00%	1,797,500,000	36.67%	659,143,250	534,706,650	1,797,500,000	124,436,600	- 1,138,356,750
44	1 Feb - 28 Feb 2019	100.00%	1,797,500,000	42.92%	771,487,000	583,798,410	1,797,500,000	187,688,590	- 1,026,013,000
45	1 Mar 28 Mar 2019	100.00%	1,797,500,000	46.20%	830,445,000	620,617,230	1,797,500,000	209,827,770	-967,055,000
46	29 Mar - 25 Apr 2019	100.00%	1,797,500,000	49.31%	886,347,250	669,708,990	1,797,500,000	216,638,260	- 911,152,750
47	26 Apr - 30 May 2019	100.00%	1,797,500,000	52.90%	950,877,500	706,527,810	1,797,500,000	244,349,690	- 846,622,500
48	31 May - 27 Jun 2019	100.00%	1,797,500,000	55.57%	998,870,750	743,346,630	1,797,500,000	255,524,120	- 798,629,250
49	28 Jun - 25 July 2019	54.80%	1,797,500,000	58.78%	1,056,570,500	780,165,450	1,797,500,000	276,405,050	71.540.500
50	26 Jul -29 Aug 2019	100.00%	1,797,500,000	62.27%	1,119,303,250	825,073,020	1,797,500,000	294,230,230	- 678,196,750
51	30 Aug - 26 Sep 2019	100.00%	1,797,500,000	65.27%	1,173,228,250	879,557,280	1,797,500,000	293,670,970	- 624,271,750
52	27 Sep - 31 Oct 2019	100.00%	1,797,500,000	68.91%	1,238,657,250	935,249,850	1,797,500,000	303,407,400	- 558,842,750
53	1 Nov - 28 Nov 2019	100.00%	1,797,500,000	72.04%	1,294,919,000	972,068,670	1,797,500,000	322,850,330	- 502,581,000
54	29 Nov - 19 Dec 2019	100.00%	1,797,500,000	74.15%	1,332,846,250	1,104,744,180	1,797,500,000	228,102,070	- 464,653.750
55	20 Dec - 09 Jan 2020	72.62%	1,305,344,500	76.19%	1,369,515,250	1,104,744,180	1,797,500,000	264,771,070	64,170,750
56	10 Jan - 30 Jan 2020	75.13%	1,350,461,750	78.22%	1,406,004,500	1,283,255,940	1,797,500,000	122,748,560	55.542.750
57	31 Jan - 20 Feb 2020	77.56%	1,394,141,000	80.40%	1,445,190,000	1,283,255,940	1,797,500,000	161,934,060	51,049,000
58	21 Feb - 5 Mar 2020	79.08%	1,421,463,000	81.73%	1,469,096,750	1,356,613,950	1,797,500,000	112,482,800	47,633.750
59	06 Mar - 19 Mar 2020	80.58%	1,448,425,500	83.07%	1,493,183,250	1,371,583,140	1,797,500,000	121,600,110	44,757.750
60	20 Mar - 02 Apr 2020	81.95%	1,473,051,250	84.15%	1,512,596,250	1,371,583,140	1,797,500,000	141,013,110	39.545.000
61	03 Apr - 30 Apr 2020	84.63%	1,521,224,250	86.06%	1,546,928,500	1,419,186,960	1,797,500,000	127,741,540	25,704,250
62	01 May - 28 May 2020	86.29%	1,551,062,750	87.36%	1,570,296,000	1,455,756,080	1,797,500,000	114,539,920	19,233.250
63	29 May - 25 June 2020	100.00%	1,797,500,000	88.98%	1,599,415,500	1,468,648,140	1,797,500,000	130,767,360	- 198,084,500
64	26 June - 26 Nov 2020	100.00%	1,797,500,000	89.77%	1,613,615,750	1,490,248,070	1,797,500,000	123,367,680	- 183,884,250
65	27 Nov - 31 Dec 2020	100.00%	1,797,500,000	90.71%	1,630,512,250	1,502,521,010	1,797,500,000	127,991,240	- 166,987,750
66	1 Jan 25 Feb 2021	100.00%	1,797,500,000	91.14%	1,638,241,500	1,515,103,510	1,797,500,000	123,137,990	- 159,258,500
67	26 Feb - 11 May 2021	100.00%	1,797,500,000	92.01%	1,653,879,750	1,554,648,510	1,797,500,000	99,231,240	- 143,620,250
68	12 May - 10 June 2021	100.00%	1,797,500,000	92.60%	1,664,485,000	1,572,164,130	1,797,500,000	92,320,870	- 133,015,000
69	11 June - 29 July 2021	100.00%	1,797,500,000	93.27%	1,676,528,250	1,591,657,000	1,797,500,000	84,871,250	- 120,971,750
70	30 July - 23 Sep 2021	100.00%	1,797,500,000	94.06%	1,690,728,500	1,607,554,870	1,797,500,000	83,173,630	- 106,771,500
71	24 Sep - 28 Oct 2021	100.00%	1,797,500,000	94.72%	1,702,592,000	1,620,446,930	1,797,500,000	82,145,070	- 94,908,000
72	29 Oct - 25 Nov 2021	100.00%	1,797,500,000	95.12%	1,709,782,000	1,625,839,430	1,797,500,000	83,942,570	- 87,718,000
73	26 Nov - 21 Dec 2021	100.00%	1,797,500,000	96.16%	1,728,476,000	1,638,731,490	1,797,500,000	89,744,510	- 69,024,000
74	22 Dec -27 Jan 2022	100.00%	1,797,500,000	96.16%	1,728,476,000	1,646,820,240	1,797,500,000	81,655,760	- 69,024,000
75	28 Jan - 17 Feb 2022	100.00%	1,797,500,000	96.54%	1,735,306,500	1,661,250,180	1,797,500,000	74,056,320	- 62,193,500
76	18 Feb - 24 Feb 2022	100.00%	1,797,500,000	96.63%	1,736,924,250	1,661,250,180	1,797,500,000	75,674,070	- 60,575,750
77	25 Feb - 17 Mar 2022	100.00%	1,797,500,000	97.01%	1,743,754,750	1,661,559,740	1,797,500,000	82,195,010	- 53,745,250
78	18 Mar - 28 Apr 2022	100.00%	1,797,500,000	97.75%	1,757,056,250	1,681,921,430	1,797,500,000	75,134,820	- 40,443,750
79	29 Apr - 19 May 2022	100.00%	1,797,500,000	98.05%	1,762,448,750	1,687,403,720	1,797,500,000	75,045,030	- 35,051,250
80	20 May - 16 June 2022	100.00%	1,797,500,000	98.49%	1,770,357,750	1,700,295,780	1,797,500,000	70,061,970	- 27,142,250
81	17 June - 28 July 2022	100.00%	1,797,500,000	99.05%	1,780,423,750	1,701,534,020	1,797,500,000	78,889,730	- 17,076,250
82	29 July - 04 Aug 2022	100.00%	1,797,500,000	99.12%	1,781,682,000	1,716,892,640	1,797,500,000	64,789,360	- 15,818,000
83	5 Aug - 9 Aug 2022	100.00%	1,797,500,000	99.12%	1,781,682,000	1,722,594,700	1,797,500,000	59,087,300	- 15,818,000
84	5 Aug - 25 Aug 2022	100.00%	1,797,500,000	99.12%	1,781,682,000	1,730,683,450	1,797,500,000	50,998,550	- 15,818,000

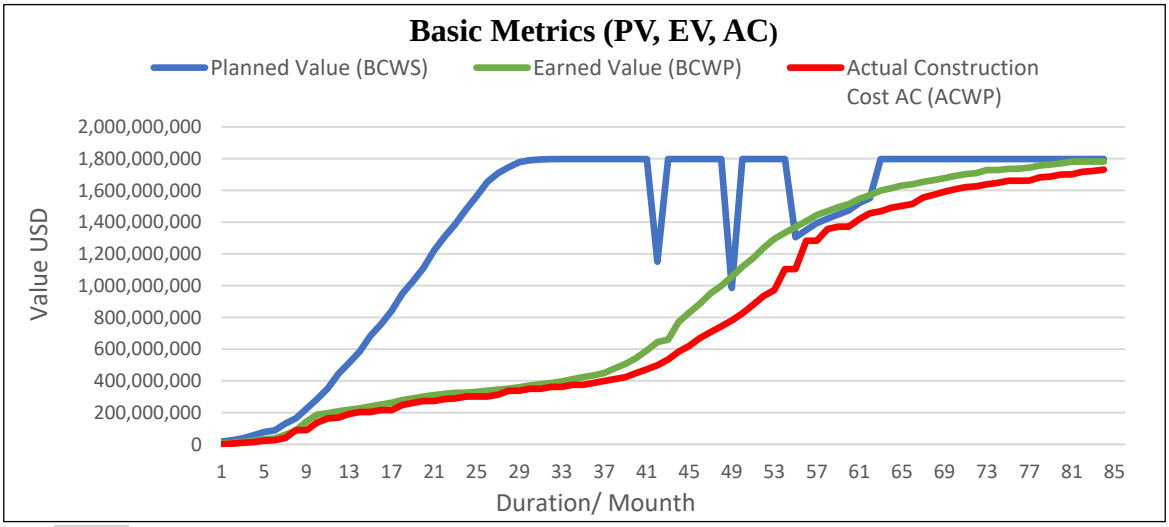

Fig. 5 Cumulative Value (PV, EV, and AC) for the Karbala Refinery up to August 25, 2022.

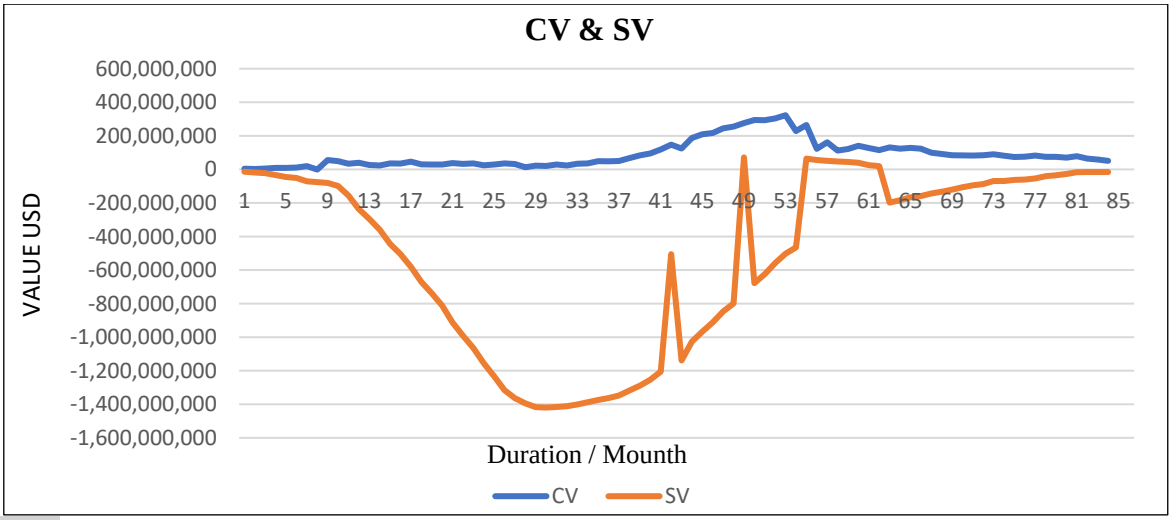

Fig. 6 Cost Variance (CV) and Schedule Variance (SV) for the Karbala Refinery up to August 25, 2022.

6.CALCULATE EARNED VALUE INDEXES

As shown in Table 7, the earned value indexes for the Karbala Refinery up to August 25, 2022, can be computed using Eq. (5) to Eq. (10), as follows [1,16]:

1) **Cost Performance Index (CPI) = Earned Value (EV) / Actual Cost (AC)** **(5)**
CPI =USD 1,781,682,000 / USD 1,730,683,450 = 1.029

2) **Schedule Performance Index (SPI) = Earned Value (EV)/Planned Value (PV)** **(6)**
SPI = USD 1,781,682,000 / USD 1,797,500,000 = 0.991

3) **To Complete Cost Performance Indicator (TCPI)based on BAC = (BAC – EV)/ (BAC – AC)** **(7)**
TCPI = (USD 1,797,500,000 - USD 1,781,682,000) / (USD 1,797,500,000 - USD 1,730,683,450) = 0.237

Since the CPI index equals (1.029) and the SPI index equals (0,991), i.e., less than 1. Therefore, the Karbala Refinery project is behind schedule, yet it remains on budget. Fig. 7 shows the value of the performance index for the Karbala Refinery up to (August 25, 2022). When calculating the predicted indexes, the EAC, ETC, and VAC values for the Karbala Refinery up to August 25, 2022, were obtained, as shown below:

1) **Estimate at Completion (EAC)= BAC / CPI** **(8)**
EAC= USD 1,797,500,000 / 1.029 = USD 1,746,048,678
Figure 8 shows a comparison between BAC and EAC for the Karbala Refinery up to August 25, 2022.

2) **Estimate to Complete (ETC) = EAC – AC** **(9)**
ETC = USD 1,746,048,678 - USD 1,730,683,450 = USD 15,365,228

3) **Variance at Completion (VAC) = BAC – EAC** **(10)**
VAC = USD 1,797,500,000 - USD 1,746,048,678 = USD 51,451,322

Table 7 Earned Value Indexes for the Karbala Refinery up to August 25, 2022.

Report No.	Date	CPI	SPI	TCPI	ETC	EAC	VAC
1	26 Jun -30 July 2015	-----	0.238	----	------	-------	------
2	31 July - 27 Aug 2015	1.500	0.302	0.998	USD 1,192,940,833	USD 1,198,333,333	USD 599,166,667
3	28 Aug - 24 Sep 2015	1.487	0.404	0.997	USD 621,642,384	USD 627,034,884	USD 1,170,465,116
4	25 Sep - 29 Oct 2015	1.599	0.401	0.995	USD 415,896,563	USD 421,289,063	USD 1,376,210,938
5	30 Oct - 26 Nov 2015	1.391	0.418	0.995	USD 292,535,677	USD 297,928,177	USD 1,499,571,823
6	27 Nov - 10 Dec 2015	1.395	0.422	0.994	USD 977,939,861	USD 998,611,111	USD 798,888,889
7	11 Dec - 28 Jan 2016	1.496	0.460	0.989	USD 959,395,504	USD 992,649,254	USD 804,850,746
8	29 Jan - 25 Feb 2016	0.990	0.539	1.001	USD 1,726,600,595	USD 1,816,136,105	(USD 18,636,105)
9	26 Feb - 31 Mar 2016	1.626	0.644	0.967	USD 1,015,841,157	USD 1,105,376,667	USD 692,123,333
10	01 Apr - 28 Apr 2016	1.351	0.654	0.971	USD 1,191,768,795	USD 1,330,396,065	USD 467,103,935
11	29 Apr - 26 May 2016	1.207	0.558	0.979	USD 1,325,632,963	USD 1,488,806,113	USD 308,693,887
12	27 May - 30 Jan 2016	1.237	0.468	0.975	USD 1,284,586,505	USD 1,453,152,155	USD 344,347,845
13	01 Jul - 28 Jul 2016	1.139	0.425	0.983	USD 1,386,824,433	USD 1,578,448,023	USD 219,051,977
14	29 Jul - 25 Aug 2016	1.113	0.387	0.985	USD 1,410,486,130	USD 1,614,382,660	USD 183,117,340
15	25 Aug - 29 Sep 2016	1.174	0.350	0.978	USD 1,326,858,200	USD 1,530,754,730	USD 266,745,270
16	30 Sep - 27 Oct 2016	1.161	0.332	0.978	USD 1,332,322,435	USD 1,548,491,905	USD 249,008,095
17	28 Oct - 24 Nov 2016	1.213	0.311	0.971	USD 1,265,458,152	USD 1,481,627,622	USD 315,872,378
18	25 Nov - 29 Dec 2016	1.123	0.294	0.980	USD 1,352,673,456	USD 1,601,175,966	USD 196,324,034
19	30 Dec - 26 Jan 2017	1.112	0.282	0.981	USD 1,355,935,337	USD 1,616,710,787	USD 180,789,213
20	27 Jan - 23 Feb 2017	1.105	0.271	0.981	USD 1,353,207,655	USD 1,626,256,045	USD 171,243,955
21	24 Feb - 30 Mar 2017	1.140	0.254	0.975	USD 1,304,354,210	USD 1,577,402,600	USD 220,097,400
22	31 Mar - 27 Apr 2017	1.116	0.243	0.978	USD 1,324,844,189	USD 1,610,165,519	USD 187,334,481
23	28 Apr - 25 May 2017	1.122	0.234	0.977	USD 1,312,727,528	USD 1,602,255,008	USD 195,244,992
24	26 May - 29 Jun 2017	1.080	0.220	0.984	USD 1,362,846,133	USD 1,664,646,553	USD 132,853,447
25	30 Jun - 27 July 2017	1.096	0.212	0.981	USD 1,337,528,314	USD 1,639,328,734	USD 158,171,266
26	28 July - 31 Aug 2017	1.119	0.204	0.976	USD 1,305,230,570	USD 1,607,030,990	USD 190,469,010
27	1 Sep - 28 Sep 2017	1.102	0.202	0.978	USD 1,318,011,450	USD 1,630,596,870	USD 166,903,130
28	29 Sep - 26 Oct 2017	1.039	0.201	0.991	USD 1,391,629,139	USD 1,729,591,274	USD 67,908,726
29	27 Oct - 30 Nov 2017	1.067	0.203	0.985	USD 1,346,794,271	USD 1,684,756,406	USD 112,743,594
30	1 Dec - 28 Dec 2017	1.059	0.207	0.986	USD 1,347,462,816	USD 1,697,697,891	USD 99,802,109
31	28 Dec - 25 Jan 2018	1.082	0.211	0.980	USD 1,310,433,844	USD 1,660,668,919	USD 136,831,081
32	26 Jan - 22 Feb 2018	1.065	0.215	0.984	USD 1,325,145,686	USD 1,687,653,701	USD 109,846,299
33	23 Feb - 29 Mar 2018	1.093	0.221	0.976	USD 1,281,519,264	USD 1,644,027,279	USD 153,472,721
34	30 Mar - 26 Apr 2018	1.094	0.228	0.975	USD 1,267,554,518	USD 1,642,335,473	USD 155,164,527
35	27 Apr - 31 May 2018	1.130	0.236	0.966	USD 1,215,970,127	USD 1,590,751,082	USD 206,748,918
36	1 June - 28 June 2018	1.123	0.242	0.966	USD 1,213,003,546	USD 1,600,057,441	USD 197,442,559
37	29 Jun - 26 July 2018	1.126	0.250	0.964	USD 1,196,703,681	USD 1,596,030,516	USD 201,469,484
38	27 July - 30 Aug 2018	1.164	0.267	0.951	USD 1,132,285,353	USD 1,543,885,128	USD 253,614,872
39	31 Aug - 27 Sep 2018	1.198	0.282	0.939	USD 1,077,092,990	USD 1,500,965,705	USD 296,534,295
40	28 Sep - 25 Oct 2018	1.212	0.303	0.930	USD 1,034,827,302	USD 1,483,623,372	USD 313,876,628
41	26 Oct - 29 Nov 2018	1.252	0.330	0.910	USD 962,768,335	USD 1,436,110,285	USD 361,389,715
42	30 Nov - 27 Dec 2018	1.295	0.554	0.887	USD 889,759,411	USD 1,387,647,241	USD 409,852,759
43	28 Dec - 31 Jan 2019	1.233	0.367	0.901	USD 923,451,654	USD 1,458,158,304	USD 339,341,696
44	1 Feb - 28 Feb 2019	1.321	0.429	0.845	USD 776,402,918	USD 1,360,201,328	USD 437,298,672
45	1 Mar 28 Mar 2019	1.338	0.462	0.822	USD 722,710,108	USD 1,343,327,338	USD 454,172,662
46	29 Mar - 25 Apr 2019	1.323	0.493	0.808	USD 688,451,606	USD 1,358,160,596	USD 439,339,404
47	26 Apr - 30 May 2019	1.346	0.529	0.776	USD 629,063,513	USD 1,335,591,323	USD 461,908,677
48	31 May - 27 Jun 2019	1.344	0.556	0.758	USD 594,329,508	USD 1,337,676,138	USD 459,823,862
49	28 Jun - 25 July 2019	1.354	1.073	0.728	USD 547,097,990	USD 1,327,263,440	USD 470,236,560
50	26 Jul -29 Aug 2019	1.357	0.623	0.697	USD 499,919,786	USD 1,324,992,806	USD 472,507,194
51	30 Aug - 26 Sep 2019	1.334	0.653	0.680	USD 468,010,178	USD 1,347,567,458	USD 449,932,542
52	27 Sep - 31 Oct 2019	1.324	0.689	0.648	USD 421,954,982	USD 1,357,204,832	USD 440,295,168
53	1 Nov - 28 Nov 2019	1.332	0.720	0.609	USD 377,277,068	USD 1,349,345,738	USD 448,154,262
54	29 Nov - 19 Dec 2019	1.206	0.742	0.671	USD 385,133,339	USD 1,489,877,519	USD 307,622,481
55	20 Dec - 09 Jan 2020	1.240	1.049	0.618	USD 345,241,619	USD 1,449,985,799	USD 347,514,201
56	10 Jan - 30 Jan 2020	1.096	1.041	0.761	USD 357,316,727	USD 1,640,572,667	USD 156,927,333
57	31 Jan - 20 Feb 2020	1.126	1.037	0.685	USD 312,833,538	USD 1,596,089,478	USD 201,410,522
58	21 Feb - 5 Mar 2020	1.083	1.034	0.745	USD 303,258,741	USD 1,659,872,691	USD 137,627,309
59	06 Mar - 19 Mar 2020	1.089	1.031	0.714	USD 279,534,159	USD 1,651,117,299	USD 146,382,701

60	20 Mar - 02 Apr 2020	1.103	1.027	0.669	USD 258,343,348	USD 1,629,926,488	USD 167,573,512
61	03 Apr - 30 Apr 2020	1.090	1.017	0.662	USD 229,879,924	USD 1,649,066,884	USD 148,433,116
62	01 May - 28 May 2020	1.079	1.012	0.665	USD 210,631,374	USD 1,666,387,454	USD 131,112,546
63	29 May - 25 June 2020	1.089	0.890	0.602	USD 181,889,217	USD 1,650,537,357	USD 146,962,643
64	26 June - 26 Nov 2020	1.083	0.898	0.598	USD 169,825,529	USD 1,660,073,599	USD 137,426,401
65	27 Nov - 31 Dec 2020	1.085	0.907	0.566	USD 153,879,618	USD 1,656,400,628	USD 141,099,372
66	1 Jan 25 Feb 2021	1.081	0.911	0.564	USD 147,287,877	USD 1,662,391,387	USD 135,108,613
67	26 Feb - 11 May 2021	1.064	0.920	0.591	USD 135,003,169	USD 1,689,651,679	USD 107,848,321
68	12 May - 10 June 2021	1.059	0.926	0.590	USD 125,637,306	USD 1,697,801,436	USD 99,698,564
69	11 June - 29 July 2021	1.053	0.933	0.588	USD 114,847,771	USD 1,706,504,771	USD 90,995,229
70	30 July - 23 Sep 2021	1.052	0.941	0.562	USD 101,518,987	USD 1,709,073,857	USD 88,426,143
71	24 Sep - 28 Oct 2021	1.051	0.947	0.536	USD 90,328,967	USD 1,710,775,897	USD 86,724,103
72	29 Oct - 25 Nov 2021	1.052	0.951	0.511	USD 83,411,443	USD 1,709,250,873	USD 88,249,127
73	26 Nov - 21 Dec 2021	1.055	0.962	0.435	USD 65,440,193	USD 1,704,171,683	USD 93,328,317
74	22 Dec -27 Jan 2022	1.050	0.962	0.458	USD 65,763,204	USD 1,712,583,444	USD 84,916,556
75	28 Jan - 17 Feb 2022	1.045	0.965	0.456	USD 59,539,317	USD 1,720,789,497	USD 76,710,503
76	18 Feb - 24 Feb 2022	1.046	0.966	0.445	USD 57,936,594	USD 1,719,186,774	USD 78,313,226
77	25 Feb - 17 Mar 2022	1.049	0.970	0.395	USD 51,211,871	USD 1,712,771,611	USD 84,728,389
78	18 Mar - 28 Apr 2022	1.045	0.978	0.350	USD 38,714,304	USD 1,720,635,734	USD 76,864,266
79	29 Apr - 19 May 2022	1.044	0.981	0.318	USD 33,558,769	USD 1,720,962,489	USD 76,537,511
80	20 May - 16 June 2022	1.041	0.985	0.279	USD 26,068,095	USD 1,726,363,875	USD 71,136,125
81	17 June - 28 July 2022	1.046	0.991	0.178	USD 16,319,609	USD 1,717,853,629	USD 79,646,371
82	29 July - 04 Aug 2022	1.038	0.991	0.196	USD 15,242,792	USD 1,732,135,432	USD 65,364,568
83	5 Aug - 9 Aug 2022	1.034	0.991	0.211	USD 15,293,415	USD 1,737,888,115	USD 59,611,885
84	5 Aug - 25 Aug 2022	1.029	0.991	0.237	USD 15,365,228	USD 1,746,048,678	USD 51,451,322

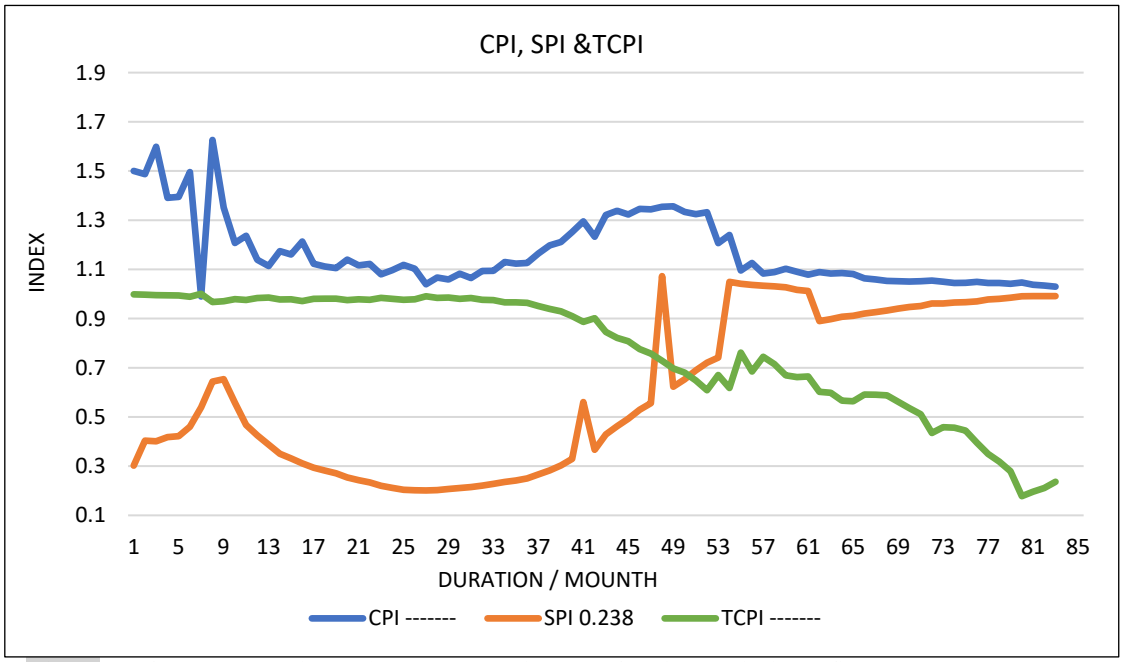

Fig. 7 Performance Indexes (CPI, SPI, and TCPI) for the Karbala Refinery up to August 25, 2022.

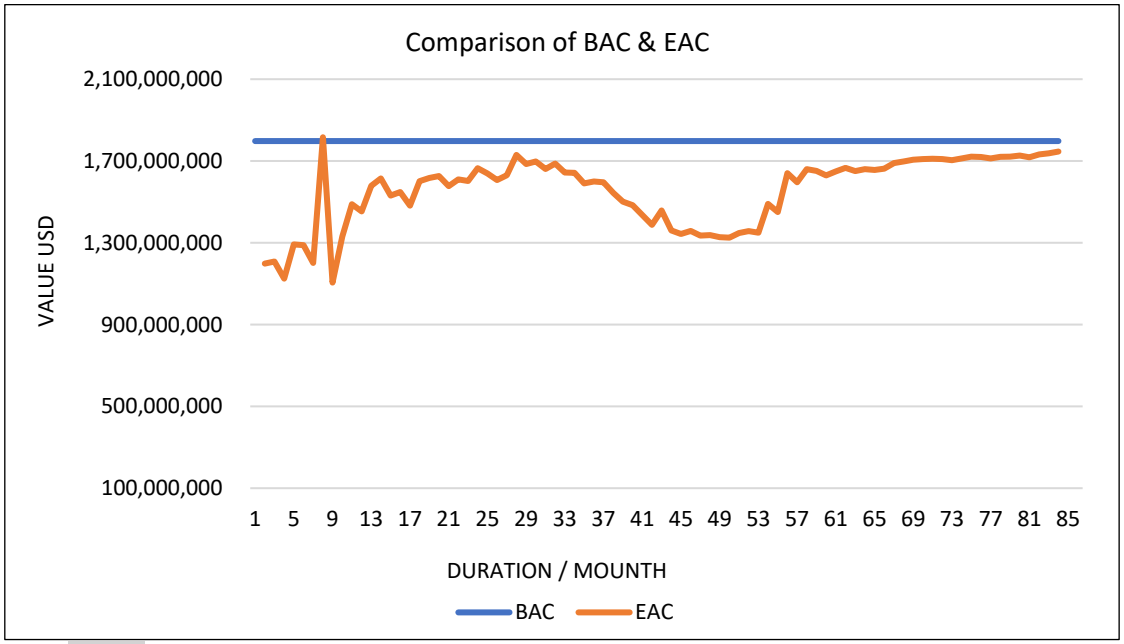

Fig. 8 Comparison of BAC and EAC for the Karbala Refinery up to August 25, 2022.

7.CONCLUSIONS

The present paper shows that the earned value method (EVM) is one of the effective methods used in cost control. This method tracks the progress of work in various activities. Also, it records deviations from the work schedule or budget planned for the project by calculating the time deviation and the deviation of costs. It can be applied at any time in the life of the project. The benefit of calculating these deviations lies in understanding the course of the project to take precautions to correct the method and control these deviations in the future. The earned value indicators CPI, SPI, and TCPI achieved for the task of building the Karbala refinery project were 1.029, 0.991, and 0.237, respectively, which means that the construction work for the Karbala refinery project is late and still within the budget. The scope of work includes all project tasks, i.e., management, engineering, procurement, and commissioning; the Karbala refinery project is behind schedule and over budget. The reasons for extending the time and increasing the cost of the Karbala refinery project can be summarized in the following points:

- As a result of the war on the criminal gangs of ISIS, as well as the global financial crisis, there was a delay in paying the dues of the Korean consortium, which negatively affected the safety of work and decreased the completion rates (Slow down), which led to the inability to complete the project according to the planned contractual date, so the Korean consortium requested that it be granted an additional period to complete the project under contractual terms.
- Delayed procedures for issuing entry visas for foreign experts and workers.
- Delayed customs clearance procedures for project materials and equipment.
- Adding change orders because of the necessary need, such as adding a fourth electric power generation unit.
- Delayed appropriation of agricultural lands for pipeline routes by the concerned authorities.
- The outbreak of the COVID-19 pandemic worldwide caused:
  1- Cessation of site works for a temporary period.
  2- Slowing the safety of work because of the conditions for distancing between workers.
  3- Restricting travel made it difficult to recruit foreign cadres.

REFERENCES

[1] Ziyash A. **Earned Value Management and its Applications: A Case of an Oil & Gas Project in Kazakhstan**. *PM World Journal* 2018; **7**: 1-23.

[2] Jasim NA, Ibrahim AA, Hatem WA. **Artificial Neural Networks Models for Predicting Performance Measurement of Oil Projects**. *Asian Journal of Civil Engineering* 2023; **24**(8): 3597-3612.

[3] Antony PM, Thirumalai R. **Project Performance Evaluation by Earned Value Method**. *International Journal of Innovative Research in Science, Engineering & Technology* 2014; **3**(1): 73-81.

[4] Jasim NA, Ibrahim AA, Hatem WA. **Forecasting the Performance Measurement for Iraqi Oil Projects Using Multiple Linear Regression**. *Tikrit Journal of Engineering Sciences* 2023; **30**(2): 94-102.

[5] Jaber FK, Jasim NA, Al-Zwainy FM. **Forecasting Techniques in Construction Industry: Earned Value Indicators and Performance Models**. *Scientific Review – Engineering and Environmental Sciences* (2020); **29**(2): 234–243.

[6] Al-Fadhli SKI, Al-Bazaz SH. **Applying Earned Value to Construction Projects**. *4th International Conference on Buildings, Construction and Environmental Engineering 7-9 October 2019*; Istanbul, Turkey. IOP Publishing: p. 1-6.

[7] Jaber FK, Hachem SW, Al-Zwainy FM. **Calculating the Indexes of Earned Value for Assessment the Performance of Waste Water Treatment Plant**. *ARPN Journal of Engineering and Applied Sciences* 2019; **14**(4): 792-802.

[8] Araszkiewicz K, Bochenek M. **Control of Construction Projects Using the Earned Value Method-Case Study**. *Open Engineering* 2019; **9**(1): 186-195.

[9] Susilowati F, Kurniaji WM. **Effective Performance Evaluation to Estimate Cost and Time Using Earned Value**. *2nd International Conference on Engineering and Applied Sciences (2nd InCEAS) 16 November 2019;* Yogyakarta, Indonesia. IOP Publishing: p. 1-8.

[10] Hussien EAM, Jasim NA. **BIM-Based Tool for Analysis Earned Value Indicators: Iraq Construction Projects as a Case Study**. *Design Engineering* 2021; **3**: 130-146.

[11] Ugural MN, Burgan HI. **Project Performance Evaluation Using EVA Technique: Kotay Bridge Construction Project on Kayto River in Afghanistan**. *Tehnički vjesnik* 2021; **28**(1): 340-345.

[12] Bonny A, Oetomo W, Marleno R. **Analysis of Time and Cost Control Using the Earned Value Method in**

Well Pad Hilling and Compacting Work in the PT. Pertamina Hulu Rokan Riau Province. *Devotion: Journal of Research and Community Service* 2022; **3**(14): 2802-2814..

[13] Mohammed IA, Sarhan FM, Sameer D. **Evaluation the Performance of the Infrastructure Project Using Earned Value Management**. *International Journal of Civil Engineering and Technology* 2014; **5**(9): 145-155.

[14] Hassan B, Makkieh S, Titizian N. **Forecasting the Final Cost of Infrastructure Projects in Syria Using Earned Value Management and Artificial Intelligence**. *Tishreen University Journal-Engineering Sciences Series* 2020; **42**(1): 197-218.

[15] Czarnigowska A. **Earned Value Method as a Tool for Project Control**. *Budownictwo i Architektura* 2008; **3**(2): 15-32.

[16] Zhong S, Wang X. **Improvement and Application of Earned Value Analysis in Coal Project Management**. *Procedia Engineering* 2011; **26**: 1983-1989.