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CALCULATING THE INDEXES OF EARNED VALUE FOR ASSESSMENT THE PERFORMANCE OF WASTE WATER TREATMENT PLANT

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ABSTRACT

Earned value system appears to be a compelling technique to use on waste water treatment plant projects to better understand and manage performance. Objectives: The main objective of this study is the practical application of the concept of the earned value management acquired in the Al-Hamza water treatment plant project using Microsoft Project 2016 and finding the performance parameters for the Al-Hamza project, CPI, SPI, and TCPI. Methods: Al-Hamzah waste water treatment plant project was constructed in 2017in Republic of Iraq. The data were collected through the field study of the researcher in the Al-Hamzah project. The project schedule was prepared and then the progress of the work was reviewed periodically and compared to the values planned with the actual values for the cost and duration. Results: it is found that the earned value concept is still not been fully used and recognized within the Iraqi companies, while this research covered the concept of earned value as a trend analysis within the Iraqi construction, the researcher found that the earned value concept is still not been fully used and recognized within the Iraqi companies, reasons for that is not part of this research and can be a subject for further research. While this research covered the concept of earned value as a trend novel analysis within the Iraqi construction, the researcher found that the concept of the earned value management is not fully accepted and acknowledged within other industries; where earned value could be used for help. The engineering industry also fails to fully utilize the concept of earned value. The researcher agrees that further research into the concept of earned value within other industry is worth researching as well as benefits of earned value as a performance measuring tool.

Keywords: earned value management, performance measurement, Al-Hamzah waste water treatment plant project.

INTRODUCTION

Wastewater is a liquid waste from very various human operations, whether domestic, commercial, institutional or industrial, that is collected through a network of pipes and canals to reach a specific assembly point to begin the process of treatment. The point at the water treatment plant. (Mackenzie and Daved, 2000)

Wastewater treatment was a process in which sewage is purified of impurities, contaminants, contaminants and organic matter, so that it is then usable for non-human use, or can be disposed of in sewage or water bodies without being contaminated, And the treatment of wastewater in several stages, as follows (Vicent *et al,* 2018):

a) First stage, the water is treated in an initial manner, so that the water is collected from all places to facilitate its treatment. The impurities, fats, oils, grease, sand, rocks and large pieces suspended in the water are removed, cut off and separated from the water by the barrier Located in the treatment plant.
b) Liquidation phase: Sewage water is then passed to filters designed to filter water from suspended solid pieces such as iron, wood, glass or large pieces such as cloth or paper so as not to disrupt or damage the equipment during the treatment process.
c) The phase of sand and rock removal: At this stage, the sewage is passed in sedimentary basins at a slow speed so that its contents are deposited from the suspended materials from sand, dust, and rocks, solid parts and sometimes some chemicals that facilitate sedimentation such assemioriron- Somewhat expensive) so that a greasy substance floats on the surface and is scraped from any time to any time.
d) The deposition phase: This is where the wastewater was placed in the primary sediment tanks, so that the dust, sand and other impurities are deposited with water, and the oil and grease float on the surface to be scrapped. Objectives of these processes are to produce a homogeneous liquid that can be treated biologically to extract the dirt from Disposable or reused.

Wastewater is classified according to its source to (Miquel, 2018):

a) Domestic Wastewater is the wastewater from homes, commercial places such as markets, restaurants, banks, institutional places such as houses, hospitals and schools. The amount of wastewater coming from homes varies according to the hours of the day, weeks, seasons, the new sewage is characterized by the smell of kerosene, and the old sewage is characterized by its smell is very foul, like the smell of rotten eggs similar to the smell of hydrogen sulfide, and owns the modern sewage gray, Old health color black, ranging from the degree of sewage household temperature is between ten to twenty degrees siliceous.
b) Industrial Wastewater is the wastewater from various plants.
c) Infiltration and Inflow Water is the water that infiltrates sewage networks from underground water wells by leaking and leaking through damaged pipes or through pipe connections, as well as rainwater entering through manholes and sinks.

d) Storm Water is rainwater or water from melting snow entering sewerage systems.

Sewage is treated through the following steps: (Mackenzie and Daved, 2000)

a) The examination phase is the first stage of the sewage treatment process, in which large dirt, sanitary ware, impregnated bottles, and other objects may be obstructed or damaged, and special equipment is used to remove small-sized impurities.
b) Primary treatment stage: At this stage solid organic matter and waste water is separated by placing the wastewater in large tanks so that the solids are deposited in the bottom of the tank. These materials are called sludge, the solid materials are removed and the remaining water is removed to the next stage.
c) Secondary treatment stage: At this stage, water is placed in very large rectangular tanks, in the form of corridors called ventilation corridors. The air is pumped into the water to stimulate the bacteria to destroy the very small residues of sludge that may have remained in the water.
d) The final stage of treatment is the final stage in which more sludge is formed at the bottom of the tank after being destroyed by the bacteria. The sludge is then removed from the water. The water is then filtered through a special filter to remove any remaining particles. Or its place wastewater treatment is necessary to maintain the integrity of the ecosystem, in addition to its importance in other matters, including: (Backgrounder, 2018)

a) Improve the environment through proper drainage and disposal of wastewater.
b) Prevent flooding by removing rainwater.
c) Maintaining water quality.
d) Extraction of energy from wastewater and wastewater.

One of the main advantages of project management activities is to provide direction for the project costs management and project time management during the project lifecycle. (Al-Zwainy and Ibraheem, 2017) (Firas and Faiq, 2018)

It is difficult to visualize that there is a construction project is performed without happening a cost deviation and time deviation or without failures during the execution phase that may occur due to poor time management, poor cost management, poor supervision or very poor monitoring. (Al-Zwainy and Reem, 2018)

Cost prediction remains a complex and difficult problem, in spite that, the researchers were still studying and trying different approaches and methodologies to solve it. Preparation of a cost estimate for any construction project is a very complex process. The process of cost estimation contains many variables. All variables have to be correctly estimated based on the proper study, past experience, and research to calculate total cost of construction project. (Al-Zwainy and Hadhal, 2015).

The phrase "Earned Value" is gaining in popularity around construction project management circles as if it is some wonderful new concept embraced. Yet, it has been used since the 1960s when the department of defense adopted it as a standard method of measuring construction project performance. Also, EVM was the used of an integrated management system that coordinates work scope, duration, and cost goals and objectively measures progress toward these aims. (Ibrahim *et al.*, 2014), (Faiq *et al*, 2015)

JUSTIFICATIONS AND HYPOTHESIS OF RESEARCH

Through the field visits of some construction projects in Iraq and the actual coexistence of the Al-Hamzah sewer project (Waste Water Treatment Plant) in Diwaniyah Governorate, a number of points and observations about the earned value management system were identified.

a) Not using modern methods and techniques in earned value management such as Primavera Project Planner, Microsoft Project, Gantt project, Open Workbench,

b) Adopting immediate, urgent and unthoughtful decisions to solve delays in construction projects.

c) Reliance on engineers who are not qualified to use planning techniques and methods.

d) Do not save historical data for previous construction projects and not use them for subsequent construction projects.

e) Relying on the style of Bar-Chart in planning without other methods.

f) Poor attention to earned value management system in the construction projects management

g) Managing of waste water treatment plant project in Iraq needing to modern efficient tools for measuring the performance of project such as (Earned Value Management).

Therefore, research hypothesis can be formulated as "Earned Value System has strong technique and effective recognition indexes for measuring the performance of parking project under different status".

RESEARCH AIMS

The main objective is to apply the value management methodology acquired in the waste water treatment plant projects to measure performance by predicting performance indicators such as CPI, SPI and TCPI.

RESEARCH METHODOLOGY

The research aims were achieved by using research methodology as shown in Figure-1.

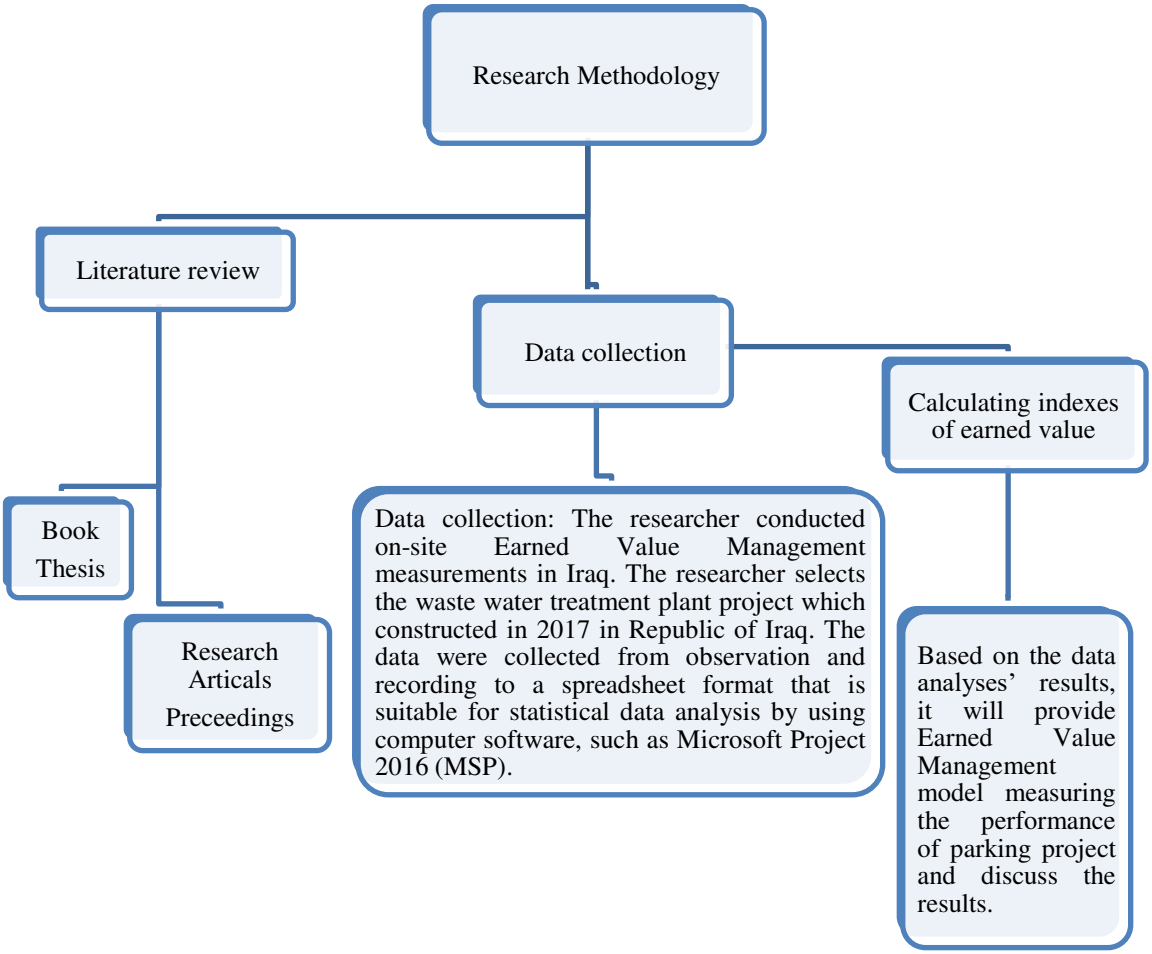


Figure-1. Research methodology.

Waste water treatment plant

The project is one of the most important infrastructure projects in Iraq in terms of design and construction of drainage and drainage water projects. The Ministry of Municipalities and Public Works has set up several projects for the design and construction of sewage and rain networks, lifting stations and treatment plants in several Iraqi cities. One of these projects is the Al-Hamzah sewer project (Waste Water Treatment Plant). The project referred our company the (Iraqi Ghulwa Company) and the Turkish company (Envirotek) to provide the necessary engineering consulting services in the field of designing sewer projects.

The project includes a treatment plant, rain lift stations, sewage lifting stations, rain networks, sewage networks. The pumping station consists of (6) rain stations and (8) sewage stations, and the treatment plant consists of two phases where the capacity of the project is (30 000 m3 / day) for the first phase and (60 000 m3 / day) for the second phase. The project is serve 206,781 people until 2045,

Figure-2. Al-Hamzah sewer project.

is noteworthy that all Iraqi provinces suffer from sewage networks because of the aging of most of these projects, especially the central projects with large capacity, some of which dates back to the 30s and 40s of the last century, while the provinces are growing population up to 3% per year, therefore the biding of the Ministry of Municipalities and Public Works four projects of sewage, including the implementation of the study and design of the project Talafar streams and sewage project in Al-Hamzah in Qadisiyah, in addition to the draft design of the streams of Samarra, as well as the tender operation and maintenance of the streams in Rabia in Mosul, "noting that" 18 billion Iraqi dinars. For collecting information and data on the subject of earned value of Al-Hamzah sewer project, the duration of the field study distribution is three months taken from April. 2017 to March 2019.

The selection of Al-Hamzah sewer project, as an application example for this search, related the following reasons:

a) This project is located in a safe and stable area.
b) This project is considered a vital project that serves the whole community
c) This project includes a large number of complex activities.
d) Facility track progress in this project.

The Work Breakdown Structural (WBS) division of labor could be clarified in the form below:

Table-1. WBS of waste water treatment plant.

WBS	Task name
P	**Al-Hamzah waste water treatment plant**
P01	Mobilization Work
P02	Fence Works
P03	Guard House
P04	Storage Building
P05	Administration Building
P06	Inlet Pumping Station
P07	Screen Plant
P08	Grit Chambers
P09	Electrical Power Building
P10	Venturi Flume
P11	Distribution Boxes
P12	Aeration Tank
P13	Sedimentation Tank
P14	Sludge Pump Station
P15	Sludge Pump Unit 1
P16	Sludge Pump Unit 2
P17	Sludge Holding Tank
P18	Sludge Drainage Bed
P19	Chlorinator Pumping Station
P20	Wash Water Recovery Tank
P21	Water Supply Station
P22	Electrical Supply Station
P23	Control Room
P24	Nitrogen and Phosphors Removement System
P25	Site Works
P26	Demobilization Works

Technical characteristics of the waste water treatment plant project

The researcher has been identifying a set of technical characteristics in order to facilitate the schedule of the project, and in order to easily follow the progress of the work, as follows:

Information project

Figure-3 shows the information project as title (name of project), subject (type of construction), author (planner), manager (project manager) and company (implementation company and consultant company).

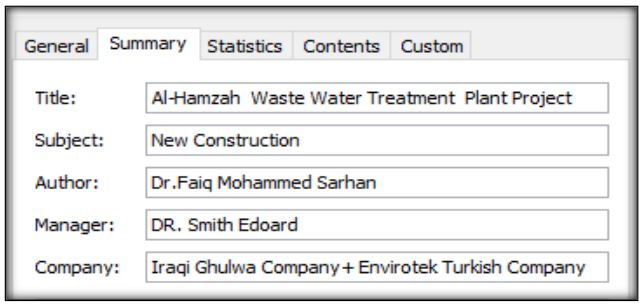


Figure-3. Time work on the waste water treatment plant project.

Time work

Time will be working on the project every day of the week except Friday and Saturday. The action starts at 8 am to 5 pm and interspersed with a one-hour break. The number of working hours per day is eight for five days a week, that's mean the number of hours worked per week is 40 working days, and a number of working days in the month is 26 days, as shown in Figure-4 below.

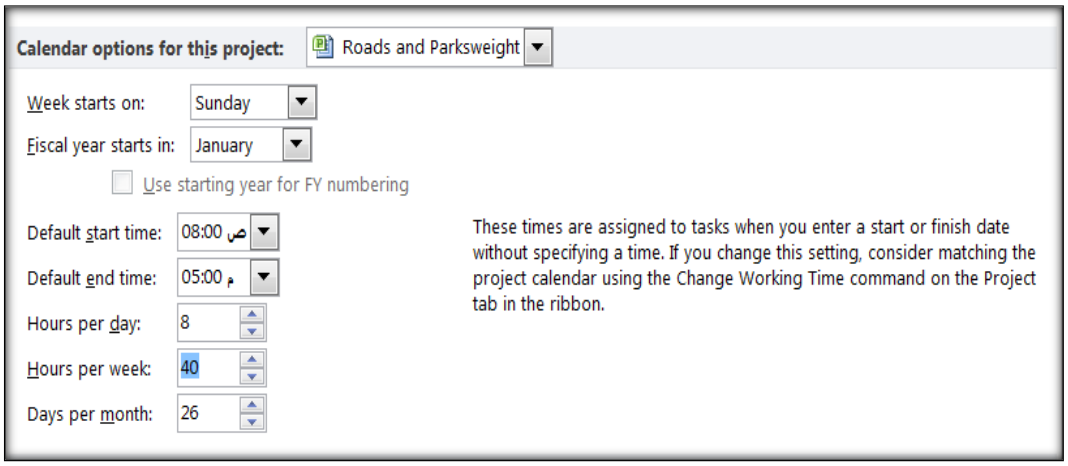


Figure-4. Time work on the waste water treatment plant project.

Time schedule

Figure-5 below shows the Bar - chart for the Al-Hamzah waste water treatment plant project. The start of the project is at 2-April-2017, while the finish of this project is at20-March-2019 and the total duration equal to 22 months.

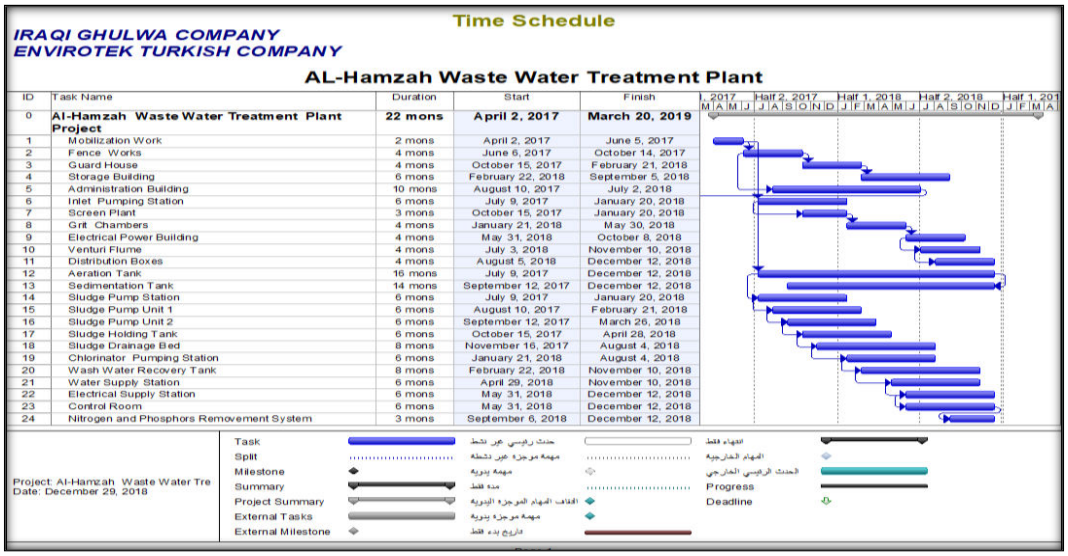


Figure-5. Bar - chart of waste water treatment plant project.

Critical path

The Microsoft-project-2016 program has been activated in order to find the critical path with an indication of the total float, free float, late start, and late finish of all activities of the Al-Hamzah Waste Water Treatment Plant project as shown in Figure-6.

Critical Path

IRAQI GHULWA COMPANY
ENVIROTEK TURKISH COMPANY

AL-Hamzah Waste Water Treatment Plant

ID	Task Mode	اسم المهمة	Late Start	Late Finish	Free Slack	Total Slack
0		**Al-Hamzah Waste Water Treatment Plant Project**	**April 2, 2017**	**March 20, 2019**	**0 mons**	**0 mons**
1		Mobilization Work	April 2, 2017	June 5, 2017	0 mons	0 mons
2		Fence Works	June 6, 2017	October 14, 2017	0 mons	0 mons
3		Guard House	April 29, 2018	September 5, 2018	0 mons	6 mons
4		Storage Building	September 6, 2018	March 20, 2019	6 mons	6 mons
5		Administration Building	August 10, 2017	July 2, 2018	0 mons	0 mons
6		Inlet Pumping Station	October 15, 2017	April 28, 2018	0 mons	3 mons
7		Screen Plant	January 21, 2018	April 28, 2018	0 mons	3 mons
8		Grit Chambers	April 29, 2018	September 5, 2018	0 mons	3 mons
9		Electrical Power Building	September 6, 2018	January 14, 2019	0 mons	3 mons
10		Venturi Flume	October 9, 2018	February 16, 2019	0 mons	3 mons
11		Distribution Boxes	November 11, 2018	March 20, 2019	3 mons	3 mons
12		Aeration Tank	October 15, 2017	March 20, 2019	0 mons	3 mons
13		Sedimentation Tank	December 19, 2017	March 20, 2019	3 mons	3 mons
14		Sludge Pump Station	October 15, 2017	April 28, 2018	0 mons	3 mons
15		Sludge Pump Unit 1	November 16, 2017	May 30, 2018	0 mons	3 mons
16		Sludge Pump Unit 2	December 19, 2017	July 2, 2018	0 mons	3 mons
17		Sludge Holding Tank	January 21, 2018	August 4, 2018	0 mons	3 mons
18		Sludge Drainage Bed	February 22, 2018	November 10, 2018	0 mons	3 mons
19		Chlorinator Pumping Station	April 29, 2018	November 10, 2018	0 mons	3 mons
20		Wash Water Recovery Tank	May 31, 2018	February 16, 2019	0 mons	3 mons
21		Water Supply Station	August 5, 2018	February 16, 2019	0 mons	3 mons
22		Electrical Supply Station	September 6, 2018	March 20, 2019	0 mons	3 mons
23		Control Room	September 6, 2018	March 20, 2019	0 mons	3 mons
24		Nitrogen and Phosphors Removement System	December 13, 2018	March 20, 2019	3 mons	3 mons
25		Site Works	September 6, 2018	February 16, 2019	0 mons	0 mons
26		Demobilization Works	February 17, 2019	March 20, 2019	0 mons	0 mons

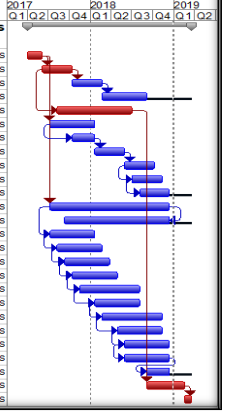


Figure-6. Critical path for waste water treatment plant project.

Total cost

The total cost of the Waste Water Treatment Plant project is equal to 1,777,000$. The researcher has been obtained the total cost of the project from Ministry of Industrial and Mineral in Iraq. The researcher used this data (total cost) in MS-Project as shown in Figure-7, and in the cash flow of Waste Water Treatment Plant as shown in Figure-8.

Total Cost

IRAQI GHULWA COMPANY
ENVIROTEK TURKISH COMPANY

AL-Hamzah Waste Water Treatment Plant

ID	Task Name	Duration	Start	Finish	% Comp.	Cost	Work
0	**Al-Hamzah Waste Water Treatment Plant Project**	**22 mons**	**April 2, 2017**	**March 20, 2019**	**0%**	**$1,777,000.00**	**0 hrs**
1	Mobilization Work	2 mons	April 2, 2017	June 5, 2017	0%	$20,000.00	0 hrs
2	Fence Works	4 mons	June 6, 2017	October 14, 2017	0%	$30,000.00	0 hrs
3	Guard House	4 mons	October 15, 2017	February 21, 201	0%	$20,000.00	0 hrs
4	Storage Building	6 mons	February 22, 201	September 5, 20	0%	$50,000.00	0 hrs
5	Administration Building	10 mons	August 10, 2017	July 2, 2018	0%	$75,000.00	0 hrs
6	Inlet Pumping Station	6 mons	July 9, 2017	January 20, 2018	0%	$70,000.00	0 hrs
7	Screen Plant	3 mons	October 15, 2017	January 20, 2018	0%	$73,000.00	0 hrs
8	Grit Chambers	4 mons	January 21, 2018	May 30, 2018	0%	$90,000.00	0 hrs
9	Electrical Power Building	4 mons	May 31, 2018	October 8, 2018	0%	$60,000.00	0 hrs
10	Venturi Flume	4 mons	July 3, 2018	November 10, 20	0%	$65,000.00	0 hrs
11	Distribution Boxes	4 mons	August 5, 2018	December 12, 20	0%	$64,000.00	0 hrs
12	Aeration Tank	16 mons	July 9, 2017	December 12, 20	0%	$80,000.00	0 hrs
13	Sedimentation Tank	14 mons	September 12, 2	December 12, 20	0%	$85,000.00	0 hrs
14	Sludge Pump Station	6 mons	July 9, 2017	January 20, 2018	0%	$85,000.00	0 hrs
15	Sludge Pump Unit 1	6 mons	August 10, 2017	February 21, 201	0%	$100,000.00	0 hrs
16	Sludge Pump Unit 2	6 mons	September 12, 2	March 26, 2018	0%	$100,000.00	0 hrs
17	Sludge Holding Tank	6 mons	October 15, 2017	April 28, 2018	0%	$90,000.00	0 hrs
18	Sludge Drainage Bed	8 mons	November 16, 20	August 4, 2018	0%	$85,000.00	0 hrs
19	Chlorinator Pumping Station	6 mons	January 21, 2018	August 4, 2018	0%	$75,000.00	0 hrs
20	Wash Water Recovery Tank	8 mons	February 22, 201	November 10, 20	0%	$70,000.00	0 hrs
21	Water Supply Station	6 mons	April 29, 2018	November 10, 20	0%	$75,000.00	0 hrs
22	Electrical Supply Station	6 mons	May 31, 2018	December 12, 20	0%	$60,000.00	0 hrs
23	Control Room	6 mons	May 31, 2018	December 12, 20	0%	$60,000.00	0 hrs
24	Nitrogen and Phosphors Removement System	3 mons	September 6, 20	December 12, 20	0%	$55,000.00	0 hrs
25	Site Works	5 mons	September 6, 20	February 16, 201	0%	$100,000.00	0 hrs
26	Demobilization Works	1 mon	February 17, 201	March 20, 2019	0%	$40,000.00	0 hrs

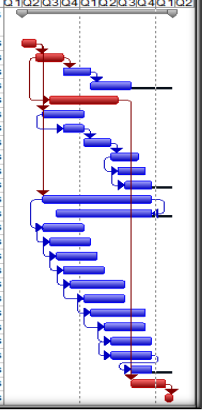


Figure-7. Total cost of waste water treatment plant project.

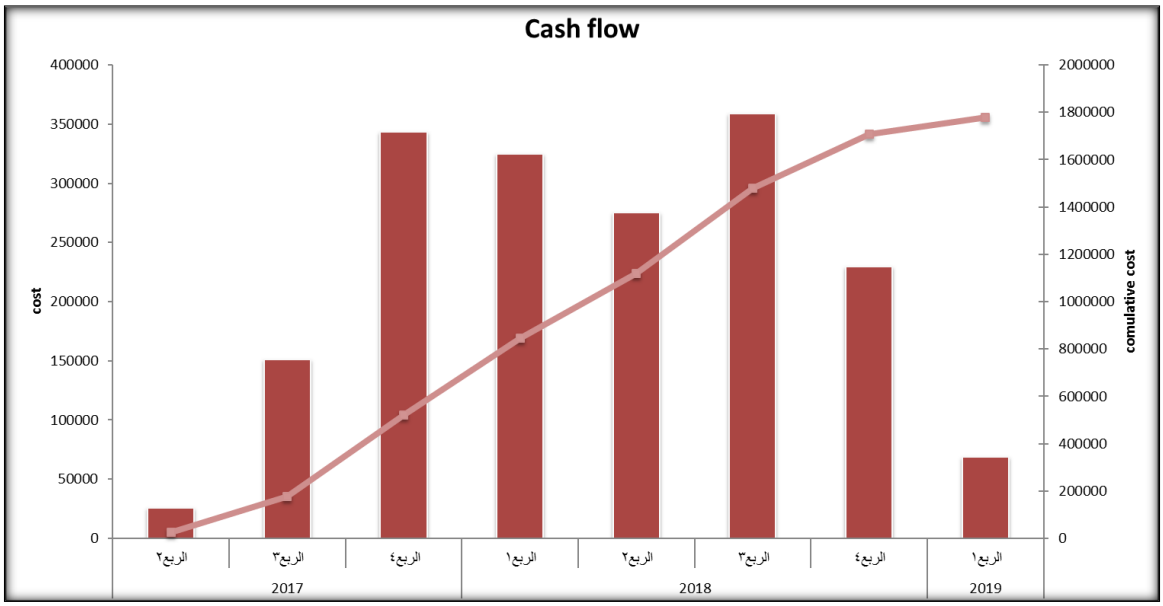
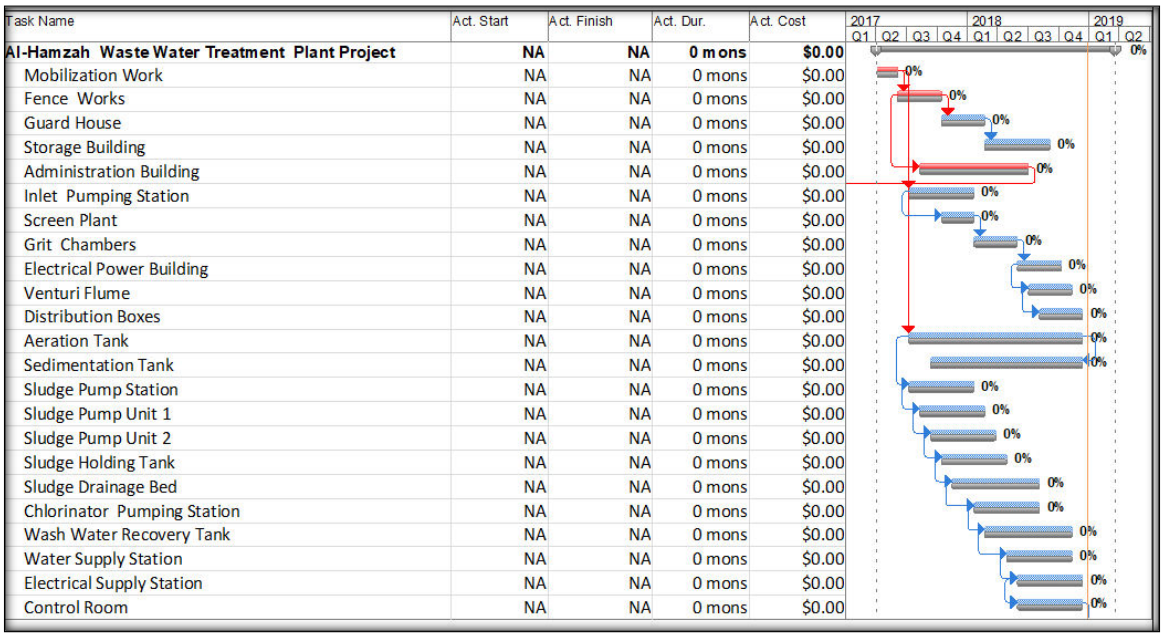


Figure-8. Cash flow for waste water treatment plant project.

Tracking work progress

Progress has been preparing for the Waste Water Treatment Plant Project, as shown in the Figure-9 below. This figure shows the actual start, actual finish dates and the percentage of completion for each activity. While the bar chart shows real deviation between the actual duration for each activity with the planning duration of them.



Task Name	Act. Start	Act. Finish	Act. Dur.	Act. Cost
Al-Hamzah Waste Water Treatment Plant Project	**NA**	**NA**	**0 mons**	**$0.00**
Mobilization Work	NA	NA	0 mons	$0.00
Fence Works	NA	NA	0 mons	$0.00
Guard House	NA	NA	0 mons	$0.00
Storage Building	NA	NA	0 mons	$0.00
Administration Building	NA	NA	0 mons	$0.00
Inlet Pumping Station	NA	NA	0 mons	$0.00
Screen Plant	NA	NA	0 mons	$0.00
Grit Chambers	NA	NA	0 mons	$0.00
Electrical Power Building	NA	NA	0 mons	$0.00
Venturi Flume	NA	NA	0 mons	$0.00
Distribution Boxes	NA	NA	0 mons	$0.00
Aeration Tank	NA	NA	0 mons	$0.00
Sedimentation Tank	NA	NA	0 mons	$0.00
Sludge Pump Station	NA	NA	0 mons	$0.00
Sludge Pump Unit 1	NA	NA	0 mons	$0.00
Sludge Pump Unit 2	NA	NA	0 mons	$0.00
Sludge Holding Tank	NA	NA	0 mons	$0.00
Sludge Drainage Bed	NA	NA	0 mons	$0.00
Chlorinator Pumping Station	NA	NA	0 mons	$0.00
Wash Water Recovery Tank	NA	NA	0 mons	$0.00
Water Supply Station	NA	NA	0 mons	$0.00
Electrical Supply Station	NA	NA	0 mons	$0.00
Control Room	NA	NA	0 mons	$0.00

Figure-9. Work progress of the waste water treatment plant project.

The researcher conducted a follow-up to the progress of work on this project on 2/Jan./2018, and it found that the first and second activity closed completely at a rate of 100% completion and the events of the beginning are identical with her planned events, the completed percentage equal to 20% as shown Figure-10.

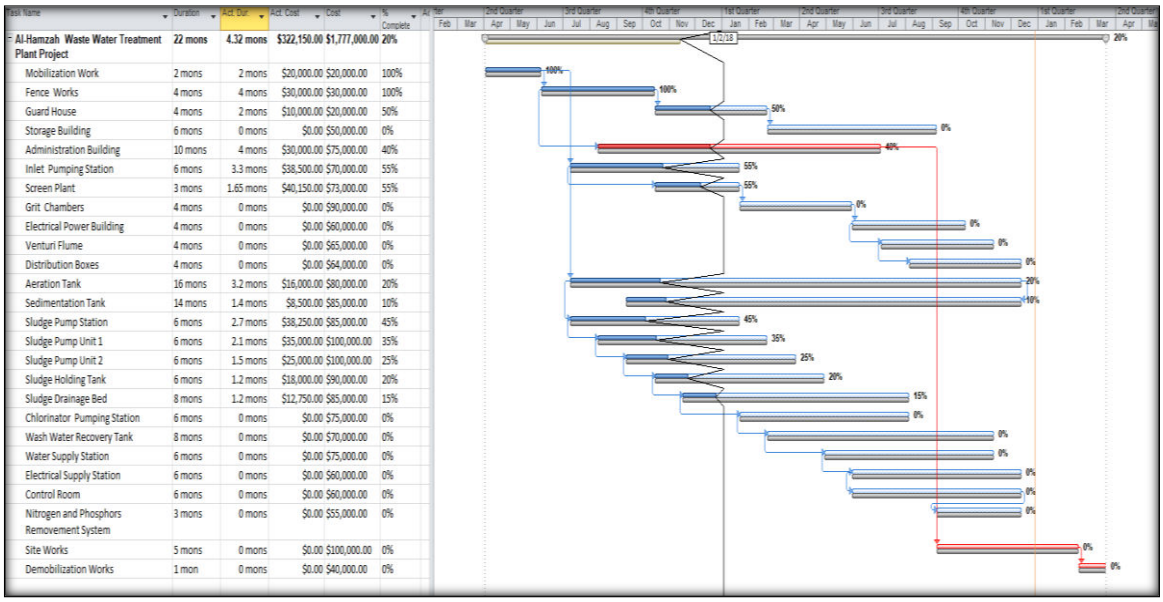


Figure-10. Work progress of the waste water treatment plant at 2/Jan./2018.

In order to find out the earned value of the project at this date, 2/Jan./2018, the researchers using equations of earned value approach, and the results are shown in Table-2, and Table-3 shows the earned value cost indicators of the waste water treatment plant at 8/1/2018, while Table-4 shows earned value schedule of the waste water treatment plant at 8/1/2018.

Table-2. Earned value of the waste water treatment plant at 8/1/2018.

Task Name	Planned Value - PV (BCWS)	Earned Value - EV (BCWP)	AC (ACWP)	SV	CV	EAC	BAC	VAC
Al-Hamzah Waste Water Treatment Plant Project	**$1,706,285.71**	**$322,150.00**	**$322,150.00**	**($1,384,135.71)**	**$0.00**	**777,000.00**	**777,000.00**	**$0.00**
Mobilization Work	$20,000.00	$20,000.00	$20,000.00	$0.00	$0.00	$20,000.00	$20,000.00	$0.00
Fence Works	$30,000.00	$30,000.00	$30,000.00	$0.00	$0.00	$30,000.00	$30,000.00	$0.00
Guard House	$20,000.00	$10,000.00	$10,000.00	($10,000.00)	$0.00	$20,000.00	$20,000.00	$0.00
Storage Building	$50,000.00	$0.00	$0.00	($50,000.00)	$0.00	$50,000.00	$50,000.00	$0.00
Administration Building	$75,000.00	$30,000.00	$30,000.00	($45,000.00)	$0.00	$75,000.00	$75,000.00	$0.00
Inlet Pumping Station	$70,000.00	$38,500.00	$38,500.00	($31,500.00)	$0.00	$70,000.00	$70,000.00	$0.00
Screen Plant	$73,000.00	$40,150.00	$40,150.00	($32,850.00)	$0.00	$73,000.00	$73,000.00	$0.00
Grit Chambers	$90,000.00	$0.00	$0.00	($90,000.00)	$0.00	$90,000.00	$90,000.00	$0.00
Electrical Power Building	$60,000.00	$0.00	$0.00	($60,000.00)	$0.00	$60,000.00	$60,000.00	$0.00
Venturi Flume	$65,000.00	$0.00	$0.00	($65,000.00)	$0.00	$65,000.00	$65,000.00	$0.00
Distribution Boxes	$64,000.00	$0.00	$0.00	($64,000.00)	$0.00	$64,000.00	$64,000.00	$0.00
Aeration Tank	$80,000.00	$16,000.00	$16,000.00	($64,000.00)	$0.00	$80,000.00	$80,000.00	$0.00
Sedimentation Tank	$85,000.00	$8,500.00	$8,500.00	($76,500.00)	$0.00	$85,000.00	$85,000.00	$0.00
Sludge Pump Station	$85,000.00	$38,250.00	$38,250.00	($46,750.00)	$0.00	$85,000.00	$85,000.00	$0.00
Sludge Pump Unit 1	$100,000.00	$35,000.00	$35,000.00	($65,000.00)	$0.00	100,000.00	100,000.00	$0.00
Sludge Pump Unit 2	$100,000.00	$25,000.00	$25,000.00	($75,000.00)	$0.00	100,000.00	100,000.00	$0.00
Sludge Holding Tank	$90,000.00	$18,000.00	$18,000.00	($72,000.00)	$0.00	$90,000.00	$90,000.00	$0.00
Sludge Drainage Bed	$85,000.00	$12,750.00	$12,750.00	($72,250.00)	$0.00	$85,000.00	$85,000.00	$0.00
Chlorinator Pumping Station	$75,000.00	$0.00	$0.00	($75,000.00)	$0.00	$75,000.00	$75,000.00	$0.00
Wash Water Recovery Tank	$70,000.00	$0.00	$0.00	($70,000.00)	$0.00	$70,000.00	$70,000.00	$0.00
Water Supply Station	$75,000.00	$0.00	$0.00	($75,000.00)	$0.00	$75,000.00	$75,000.00	$0.00
Electrical Supply Station	$60,000.00	$0.00	$0.00	($60,000.00)	$0.00	$60,000.00	$60,000.00	$0.00
Control Room	$60,000.00	$0.00	$0.00	($60,000.00)	$0.00	$60,000.00	$60,000.00	$0.00
Nitrogen and Phosphors Removement System	$55,000.00	$0.00	$0.00	($55,000.00)	$0.00	$55,000.00	$55,000.00	$0.00
Site Works	$69,285.71	$0.00	$0.00	($69,285.71)	$0.00	100,000.00	100,000.00	$0.00
Demobilization Works	$0.00	$0.00	$0.00	$0.00	$0.00	$40,000.00	$40,000.00	$0.00

Table-3. Earned value cost indicators of the waste water treatment plant at 8/1/2018.

Task Name	Planned Value - PV (BCWS)	Earned Value - EV (BCWP)	CV	CV%	CPI	BAC	EAC	VAC	TCPI
Al-Hamzah Waste Water Treatment Plant Project	**$1,706,285.71**	**$322,150.00**	**$0.00**	**0%**	**1**	**777,000.00**	**777,000.00**	**$0.00**	**1**
Mobilization Work	$20,000.00	$20,000.00	$0.00	0%	1	$20,000.00	$20,000.00	$0.00	1
Fence Works	$30,000.00	$30,000.00	$0.00	0%	1	$30,000.00	$30,000.00	$0.00	1
Guard House	$20,000.00	$10,000.00	$0.00	0%	1	$20,000.00	$20,000.00	$0.00	1
Storage Building	$50,000.00	$0.00	$0.00	0%	0	$50,000.00	$50,000.00	$0.00	1
Administration Building	$75,000.00	$30,000.00	$0.00	0%	1	$75,000.00	$75,000.00	$0.00	1
Inlet Pumping Station	$70,000.00	$38,500.00	$0.00	0%	1	$70,000.00	$70,000.00	$0.00	1
Screen Plant	$73,000.00	$40,150.00	$0.00	0%	1	$73,000.00	$73,000.00	$0.00	1
Grit Chambers	$90,000.00	$0.00	$0.00	0%	0	$90,000.00	$90,000.00	$0.00	1
Electrical Power Building	$60,000.00	$0.00	$0.00	0%	0	$60,000.00	$60,000.00	$0.00	1
Venturi Flume	$65,000.00	$0.00	$0.00	0%	0	$65,000.00	$65,000.00	$0.00	1
Distribution Boxes	$64,000.00	$0.00	$0.00	0%	0	$64,000.00	$64,000.00	$0.00	1
Aeration Tank	$80,000.00	$16,000.00	$0.00	0%	1	$80,000.00	$80,000.00	$0.00	1
Sedimentation Tank	$85,000.00	$8,500.00	$0.00	0%	1	$85,000.00	$85,000.00	$0.00	1
Sludge Pump Station	$85,000.00	$38,250.00	$0.00	0%	1	$85,000.00	$85,000.00	$0.00	1
Sludge Pump Unit 1	$100,000.00	$35,000.00	$0.00	0%	1	100,000.00	100,000.00	$0.00	1
Sludge Pump Unit 2	$100,000.00	$25,000.00	$0.00	0%	1	100,000.00	100,000.00	$0.00	1
Sludge Holding Tank	$90,000.00	$18,000.00	$0.00	0%	1	$90,000.00	$90,000.00	$0.00	1
Sludge Drainage Bed	$85,000.00	$12,750.00	$0.00	0%	1	$85,000.00	$85,000.00	$0.00	1
Chlorinator Pumping Station	$75,000.00	$0.00	$0.00	0%	0	$75,000.00	$75,000.00	$0.00	1
Wash Water Recovery Tank	$70,000.00	$0.00	$0.00	0%	0	$70,000.00	$70,000.00	$0.00	1
Water Supply Station	$75,000.00	$0.00	$0.00	0%	0	$75,000.00	$75,000.00	$0.00	1
Electrical Supply Station	$60,000.00	$0.00	$0.00	0%	0	$60,000.00	$60,000.00	$0.00	1
Control Room	$60,000.00	$0.00	$0.00	0%	0	$60,000.00	$60,000.00	$0.00	1
Nitrogen and Phosphors Removement System	$55,000.00	$0.00	$0.00	0%	0	$55,000.00	$55,000.00	$0.00	1
Site Works	$69,285.71	$0.00	$0.00	0%	0	100,000.00	100,000.00	$0.00	1
Demobilization Works	$0.00	$0.00	$0.00	0%	0	$40,000.00	$40,000.00	$0.00	1

Table-4. Earned value schedule of the waste water treatment plant at 8/1/2018.

Task Name	Planned Value - PV (BCWS)	Earned Value - EV (BCWP)	SV	SV%	SPI
Al-Hamzah Waste Water Treatment Plant Project	**$1,706,285.71**	**$322,150.00**	**($1,384,135.71)**	**-81%**	**0.19**
Mobilization Work	$20,000.00	$20,000.00	$0.00	0%	1
Fence Works	$30,000.00	$30,000.00	$0.00	0%	1
Guard House	$20,000.00	$10,000.00	($10,000.00)	-50%	0.5
Storage Building	$50,000.00	$0.00	($50,000.00)	-100%	0
Administration Building	$75,000.00	$30,000.00	($45,000.00)	-60%	0.4
Inlet Pumping Station	$70,000.00	$38,500.00	($31,500.00)	-45%	0.55
Screen Plant	$73,000.00	$40,150.00	($32,850.00)	-45%	0.55
Grit Chambers	$90,000.00	$0.00	($90,000.00)	-100%	0
Electrical Power Building	$60,000.00	$0.00	($60,000.00)	-100%	0
Venturi Flume	$65,000.00	$0.00	($65,000.00)	-100%	0
Distribution Boxes	$64,000.00	$0.00	($64,000.00)	-100%	0
Aeration Tank	$80,000.00	$16,000.00	($64,000.00)	-80%	0.2
Sedimentation Tank	$85,000.00	$8,500.00	($76,500.00)	-90%	0.1
Sludge Pump Station	$85,000.00	$38,250.00	($46,750.00)	-55%	0.45
Sludge Pump Unit 1	$100,000.00	$35,000.00	($65,000.00)	-65%	0.35
Sludge Pump Unit 2	$100,000.00	$25,000.00	($75,000.00)	-75%	0.25
Sludge Holding Tank	$90,000.00	$18,000.00	($72,000.00)	-80%	0.2
Sludge Drainage Bed	$85,000.00	$12,750.00	($72,250.00)	-85%	0.15
Chlorinator Pumping Station	$75,000.00	$0.00	($75,000.00)	-100%	0
Wash Water Recovery Tank	$70,000.00	$0.00	($70,000.00)	-100%	0
Water Supply Station	$75,000.00	$0.00	($75,000.00)	-100%	0
Electrical Supply Station	$60,000.00	$0.00	($60,000.00)	-100%	0
Control Room	$60,000.00	$0.00	($60,000.00)	-100%	0
Nitrogen and Phosphors Removement System	$55,000.00	$0.00	($55,000.00)	-100%	0
Site Works	$69,285.71	$0.00	($69,285.71)	-100%	0
Demobilization Works	$0.00	$0.00	$0.00	0%	0

By studying Figure-10 and Tables (2), (3) and (4) above, it is found that the actual cost is equal to the planned cost project and cost variance equal to zero, therefore CV% equal to 0%, but actual completion percentage is less than planning completion percentage because the project is late in time, because the actual completion percentage is less than to the planning completion percentage, therefore the values of earned value and results as follows:

1) ACWP=$322,150.00
2) BCWP= $322,150.00
3) BCWS= $1,706,285.71
4) EAC=$1,777,000.00
5) SV%= -81%
6) SV= $1,384,135.71
7) CV%= 0%
8) CV= $0
9) VAC= $0
10) CPI=1

11) SPI=0.19
12) TCPI= 1
13) Completion= 20%

Through the above results, it finds that the project is progressing well in cost but the bad in time. This indicates the presence of good planning and good follow-up work. Because of the short duration of the preparation of research and an interruption in work due to administrative measures, the researcher was unable to prepare another report for the remainder of the life of the project. However, this research is a good start in the field of application of earned value in construction projects in Iraq.

CONCLUSIONS AND RECOMMENDATIONS

This study reached an important group of conclusions:

a) In view of the complex nature of the projects of wastewater treatment plants, and the large amounts required in terms of operation and maintenance, the researcher found the role of planning and follow-up of this project using the Microsoft-project-2016 especially follow-up performance and analysis of the earned value to control this important project.

b) Based on the experience of the researcher in the management of sewage projects, as well as to the expert opinions of consultants and the performance of projects, the study found that there is a strong belief in the importance of the method of management of acquired value, but there is weakness in the application of this method because most of the construction projects in Iraq suffer from a lack To take care of the application of modern technology in following up the progress of work.

c) During the researcher's study, it was found that the earned value concept is still not been fully used and recognized within the Iraqi companies, reasons for that is not part of this research and can be a subject for further research.While this research covered the concept of earned value as a trend analysis within the Iraqi construction, the researcher found that the concept of earned value is not fully accepted and acknowledged within other industries; where earned value could be used for help. The engineering industry also fails to fully utilize the concept of earned value. The researcher agrees that further research into the concept of earned value within other industry is worth researching as well as benefits of earned value as a performance measuring tool.

This study recommends a range of important agency recommendations:

a) All construction companies are required to apply the earned value method of managing the construction project.

b) To require the faculties of engineering to teach the earned value approach at the undergraduate level.

c) The same study is being conducted on other construction projects such as bridges, tunnels and others.

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