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INVESTIGATING THE INFLUENCE OF ACCRUED EXPENSES ON THE EARNED VALUE ANALYSIS OF A PROJECT

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Project Earned value analysis (PEVA) is a project performance assessment tool considered to be one of the best-known methods to control and monitor project progress. The earned value analysis assesses the three main aspects of any project: cost, schedule, and scope, and can be used to identify early indications of project performance, enabling project managers not only to identify project progress, but also to control it and hence take corrective actions. The earned value concept allows cost managers to manage projects optimizing time and budget goals, and to identify when the project is behind or ahead of schedule, under- or over-budget, using performance indices and variance parameters. However, implementing PEVA is not without limitations, such as not taking late invoices or purchase orders into account, which results in inaccuracy of actual costs which can significantly affect the outcome and consequently provide an incorrect indication of project progress. This paper outlines the basic format of the earned value analysis, concisely explaining how earned value analysis can be implemented. Moreover, it explores challenges associated with PEVA implementation such as inaccuracy of actual costs, and how accrued costs can be used to tackle this challenge. It also aims to raise awareness regarding accrued expenses and how the tool can be used to address the issue of late invoices in order to help practitioners improve reliability when implementing the earned value analysis tool. In this paper, PEVA has been applied to a real construction project at Petroleum Marine Services Company (PMS), and the findings show that accrued costs enhance the reliability of PEVA.

Keywords: earned value management, cost control, project management, accrued expenses

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АНАЛИЗ ВЛИЯНИЯ НАЧИСЛЕННЫХ РАСХОДОВ НА ОЦЕНКУ ЭФФЕКТИВНОСТИ ПРОЕКТА В МЕТОДЕ ОСВОЕННОГО ОБЪЕМА

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Метод управления освоенным объёмом – система методик, объединённых под общим названием, использующихся для измерения и контроля эффективности выполнения проектов. Он широко применяется за рубежом, а в России только набирает популярность в проектном

управлении с учетом обновления Practice Standard for Earned Value Management, PMI. Данный метод применяется в финансовом управлении проектами или в рамках контроллинга крупных проектно-ориентированных организаций. Метод соединяет в себе анализ всего объема работ по проекту с планом выполнения работ и стоимостью его выполнения. Он основан на применении ряда числовых показателей, рассчитываемых по ходу проекта, и может использоваться для ранней диагностики и контроля эффективности выполнения проекта. Концепция освоенного объема позволяет управлять проектом, оптимизируя временные и бюджетные цели, а также идентифицировать опережение или отставание проекта от намеченных этапов и/или от запланированного бюджета на основе индексов результативности и параметров отклонений. Метод управления освоенным объемом имеет ряд ограничений: например, он не учитывает счета к оплате и заказы на приобретение товара, что приводит к неточностям в подсчете реальных затрат. А это, в свою очередь, может сильно повлиять на конечный результат и исказить картину исполнения проекта. Цель исследования – анализ влияния начисленных расходов на оценку эффективности проекта в рассматриваемом методе. Изучены особенности применения метода управления освоенным объемом, проведен анализ его недостатков, например неточности подсчета реальных затрат. Предлагается усовершенствовать метод управления освоенным объемом путем добавления в подсчеты данных о начисленных расходах и «поздних» счетах. Усовершенствованный подход иллюстрируется подсчетами, проведенными на реальных данных строительного проекта Нефтяной морской сервисной компании (Petroleum Marine Services Company, PMS). Показывается, что учет начисленных расходов увеличивает надежность применения метода управления освоенным объемом.

Ключевые слова: метод управления освоенным объемом, контроль издержек, управление проектами, начисленные расходы

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Introduction. The Project earned Value Analysis (PEVA) is a very effective tool that is mainly used to assess ongoing project performance and progress in quantitative measures at any point during the life of the project against a baseline plan or expectations. It involves the integration of schedule, work scope, and cost. PEVA compares original cost estimates to the actual work performed to determine whether the project is on the budget or not. Moreover, it allows project managers to take corrective actions in terms of cost and duration by extrapolating current trends of a project. Understanding and analysis of those trends provide accurate forecasts of project performance [1]. The earned value management analysis is considered one of the most straightforward and most widely used techniques for monitoring and controlling projects [2].

The traditional method to assess the progress of the project is manually done by calculating the difference between planned cost and actual cost incurred in a project which is very difficult in terms of manually tracking and handling the difference between actual costs and planned costs which does not help managers to get the real progress of the project.

The basic concepts of earned value were originally implemented by the US Department of Defense in the early 1960s [3]. Earned value analysis is a technique that can be applied to the management of all capital projects, in any industry, while employing any contracting approach [4]. Earned value analysis provides project assessments, if correctly applied, to maintain control over the budget, schedule, and scope of several types of projects [5].

The most fundamental part of the Earned value analysis is that project progress is measured through the quantity of money instead of engineering quantity, and in this sense, the project progress would be reflected by work progress transformed from monetary units [6].

The structure of the paper is as follows: the introduction provides a short literature review and background for the research; in the part 1 the main

research objective and tasks are defined, the main concepts of PEVA are explained. Further, in the part 2 the research methodology used to address research objectives is described. Part 3 applies and discusses the study findings by using real project cost data. The paper ends up with a conclusion and directions for further research.

1. Formulating the research problem

There are some challenges associated with implementing PEVA technique. Actual costs inaccuracy is one of the main challenges encountered with the PEVA application. Therefore, the main objective of this study is to increase the accuracy of the PEVA by including the accrued expenses when calculating PEVA; consequently, this will lead to an increase in the validity of the method.

In order to achieve the above objective the following tasks should be performed;

- Exploring and illustrating the main concepts of the PEVA;
- Identify main challenges encountered with the accuracy of PEVA;
- Exploring the main concepts of accrued expenses, and how they may affect the project actual cost, and how to come over this problem. Defining to what extent accrued expenses influence the earned value analysis; suggesting an update to the PEVA to make it more reliable.
- Applying the new approach to real data, and proving the new approach is valid.

1.1. The concept of PEVA

In PEVA, there are three data sources, the planned cost (budget), actual expenditure and the earned value which is the actual physical work done at a given time. Therefore, in PEVA the actual value of the work could be compared with the earned value and the estimated cost [4].

The three basic key parameters used in PEVA are as follows:

$$\text{Budgeted Cost of Work Scheduled (BCWS)} = \text{Planned Value (PV)}; \quad (1)$$

$$\text{Budgeted Cost of Work Performed (BCWP)} = \text{Earned Value (EV)}; \quad (2)$$

$$\text{Actual Cost of Work Performed (ACWP)} = \text{Actual Cost (AC)}. \quad (3)$$

Actual Cost: AC or known as actual cost work performed (ACWP). It measures the actual cost that has been incurred while accomplishing the work performed within a given time period.

Planned Value: PV or budgeted cost of work scheduled (BCWS) it measures the budgeted cost of all individual tasks/activities scheduled to be accomplished within a given time period.

Earned Value: EV or known as the budgeted cost of work performed (BCWP) indicates the sum of budgets for the work that has been accomplished already.

PV, EV, and AC are the basic metrics of the earned value analysis that generates performance indices and variances for project progress [7, 8].

1.2. Variances

The variances are used to check the deviation of a project from the path of the original plan. The variances are as follows;

Cost Variance: It measures the difference between the proposed planned project and the current status on a specific date. It shows the variation of a project in form of cost. The formula used for calculating cost variance is,

$$\text{Cost Variance (CV)} = \text{EV} - \text{AC} = (2) - (3). \quad (4)$$

A negative (–) cost variance means the project is over budget which means that the cost of performed work is higher than the planned cost. While a positive (+) cost variance means that the project is under budget which means that the performed work costs less than the planned budget for it. It is considered a good sign as it shows that the project cost is under control.

Schedule Variance: It is used to check the deviation of the current progress of the project from what was planned for the project [19]. In other words, It is used to compare the quantity of work performed to what has been scheduled to be performed within a given period of time. The formula for calculating the schedule variance is,

$$\text{Schedule Variance (SV)} = \text{EV} - \text{PV} = (2) - (1). \quad (5)$$

A negative (–) SV indicates that the project is behind schedule which means that the project took more time than what was planned to be done within a given period of time. While a positive (+) SV means that the project is ahead of schedule which means that it took less time than what was planned.

1.3. Performance Indices

Cost Performance Index (CPI): The ratio of the cost of work performed (EV) to actual cost (AC). It compares the planned and actual value of works done. The formula for calculating the CPI is,

$$CPI = EV / AC = (2) / (3); \quad (6)$$

• If CPI higher than 1, it indicates that the project is under budget (CPI > 1)

• If CPI less than 1, it indicates that the project is over budget (CPI < 1)

Schedule Performance Index (SPI): The ratio of the work performed (EV) to the planned progress (PV). It compares the cost of work done and planned cost of work. The formula for calculating the SPI is given by;

$$SPI = EV / PV = (2) / (1); \quad (7)$$

• If SPI higher than 1, it indicates that the project is ahead schedule;

• If SPI less than 1, it indicates that the project is behind schedule.

1.4. Forecasting Indicators

Earned value analysis (PEVA) can also be used to forecast project spending. Project forecasting is determined by three indicators, as follows [9];

Budget at Completion (BAC):
the total budget of the whole project. (8)

Estimation at Completion (EAC): is calculated at the date of reporting to serve as a forecast of total project costs. It shows the deviations effect on the total project cost. The formula for calculating the EAC is given by;

$$EAC = AC + ETC = (3) + (10). \quad (9)$$

Estimation to Complete (ETC): This is the estimated remaining cost to complete the project from any given time. It is the difference between the Estimate at Completion (EAC) (8) and the Actual cost (AC) (3).

$$ETC = EAC - AC = (9) - (3). \quad (10)$$

Variance at Completion (VAC): It is an indication to know if the project in under budget or over budget, by calculating the difference between Budget at completion (BAC) (8) and Estimate at Completion (EAC) (9). If the result is positive it means that the project is under budget, and if the result is negative it means that the project is over budget.

$$VAC = BAC - EAC = (8) - (9). \quad (11)$$

The following figure is a graphical representation of earned value parameters;

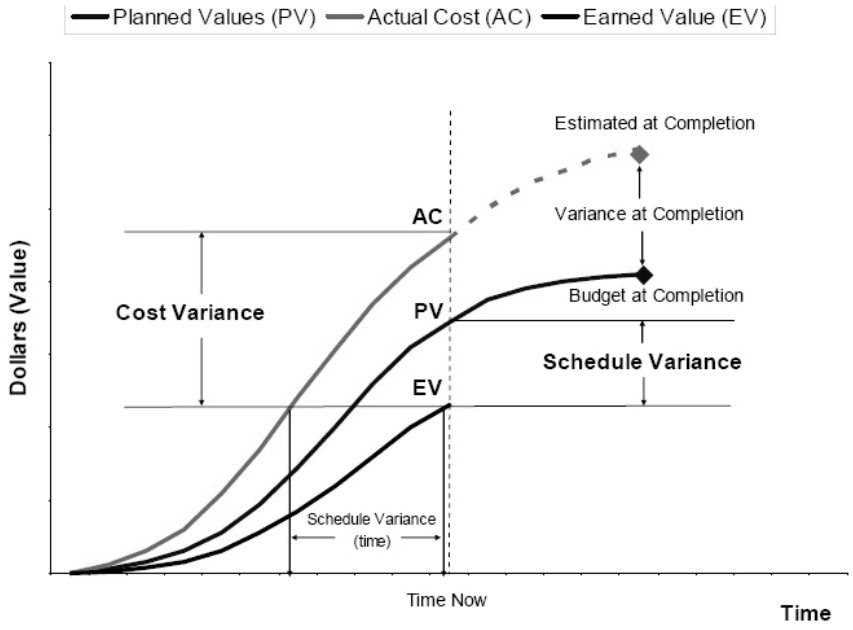

Fig. 1. Key Measures and Metrics from an Earned Value Management System [10]

The above figure illustrates the main concept of the earned value analysis as follows [1];

- Planned Value (PV): the baseline for the analysis, cumulated planned costs at the time of their incurrence;
- Earned Value (EV): the measure of physical progress expressed by the cumulated planned cost of works actually done related to time;
- Actual Value (AC): the cumulated paid amount for work done related to time;
- Budget at Completion (BAC): the total approved budget of the whole project;
- Schedule Variance (SV): the planned duration of the project, it is an estimate of duration variance.

1.5. Forecasting Scenarios

The Estimate at Completion can be calculated based on three scenarios depending on the performance.

Scenario 1: The project will continue to perform to the end the same as it was performing during the first stage. In this scenario, the Estimate at Completion (EAC) can be calculated as follows;

$$EAC = BAC / CPI. \quad (12)$$

Scenario 2: The project will continue to perform as planned before commencing into the project. The Estimate at Completion in Scenario 2 is calculated as follows**:**

$$EAC = AC + (BAC - EV). \quad (13)$$

Scenario 3: Project will continue to perform based on the current CPI and SPI. Let us assume that the project is over budget and behind the schedule and the project should be finished on time. In this case, CPI and SPI should be taken into consideration when calculating the Estimate at Completion (EAC) using the following formula;

$$EAC = AC + (BAC - EV) / (CPI * SPI). \quad (14)$$

1.6. Problem Statement

Project earned value analysis (PEVA) technique is an effective analytical tool when used properly, as implementing the PEVA technique helps monitor project performance and progress at any time during the life cycle of executing the project. However, implementing PEVA is not without limitations, such as not taking late invoices or purchase orders into account, as which results in inaccuracy of actual costs. Therefore, the accuracy of the actual costs plays a vital role in the earned value analysis. One of the major earned value management challenges is in most of the cost systems the expenditure is recognized when it is incurred specifically when invoices received and/or paid. Sometimes there is a considerable time lag between completion of work packages and receiving the invoices .This time lag depends on different credit periods and can vary from a month in most cases to three months in some cases after the work was actually done. Therefore, using information from an organization's Management Information System (MIS), such as the Enterprise Resources Planning (ERP) system for PEVA calculations can be very misleading [11].

1.7. Research Methodology

As discussed in the previous section that earned value analysis will not work efficiently unless accurate actual costs are obtained. In order to tackle this problem, the actual costs should be adjusted and this can be done by adding the actual cost from the organization's ERP system, plus the estimate for pending invoices for work finished, and this concept is named Accrued Expenses or Estimated Actual Costs. Estimated Actual Costs is an adjusted value of the actual costs that represents the costs which have been incurred for material and subcontracted items for which earned value has been earned but invoices have not been shown in the cost system [11].

In most cases, the estimated actual cost is typically required for material costs, subcontracts, labour subcontracts and other direct costs such as salaries, purchased labour and travel expenses [12]. The estimated actual cost information is collected from various sources such as invoices, purchase orders, time-card registration, or contract change orders. The Control Account Manager is responsible to monitor if the earned value is claimed and the invoices have not been paid, estimated actual cost should be incorporated into actual costs [13, 14].

1.8. Estimated Actual Cost Implementation

Once the item or the material is received and the earned value is claimed while actual costs do not appear, then the estimated AC should be collected and calculated from various credible sources such as

invoices [15–17]. The Estimated AC then should be integrated with the earned value management software. Before the transaction is due, the Estimated AC adjustments should be reversed [18, 19]. Otherwise, when for example the invoice is paid the actual cost data from the accounting system is transferred automatically to the earned value software, consequently, the Estimated AC will be counted once more [20].

3. Results and Discussion

3.1. Illustrative Application of PEVA

The following example is real project progress after six months. This is a construction project of a barge vessel accommodation at Petroleum Marine Services Company. PMS is one of the major Construction & Marine Services Contractor in Egypt and the Middle East. It shows project progress without taking accrued expenses into consideration.

Table 1

Earned Value Analysis Calculations

Work Package	BCWS	ACWP	%Progress	BCWP
	Planned Value	Actual Cost		Earned Value
1	$100,000	$98,570	100%	$100,000
2	$88,000	$90,233	100%	$88,000
3	$52,000	$40,019	90%	$46,800
4	$121,000	$75,300	80%	$96,800
5	$300,000	$198,530	85%	$255,000
6	$55,000	$32,350	90%	$49,500
7	$23,000	$0.00	0%	$0.00
8	$17,000	$0.00	0%	$0.00
9	$50,000	$0.00	0%	$0.00
10	$255,000	$0.00	0%	$0.00
BAC	$1,061,000	$535,002		$636,100

Cost Variance (CV = EV – AC)	$101,098.00
Cost Performance Index (CPI = EV/AC)	1.19
Schedule Variance (SV = EV – PV)	$136,100.00
Schedule Performance Index (SPI = EV/PV)	1.27

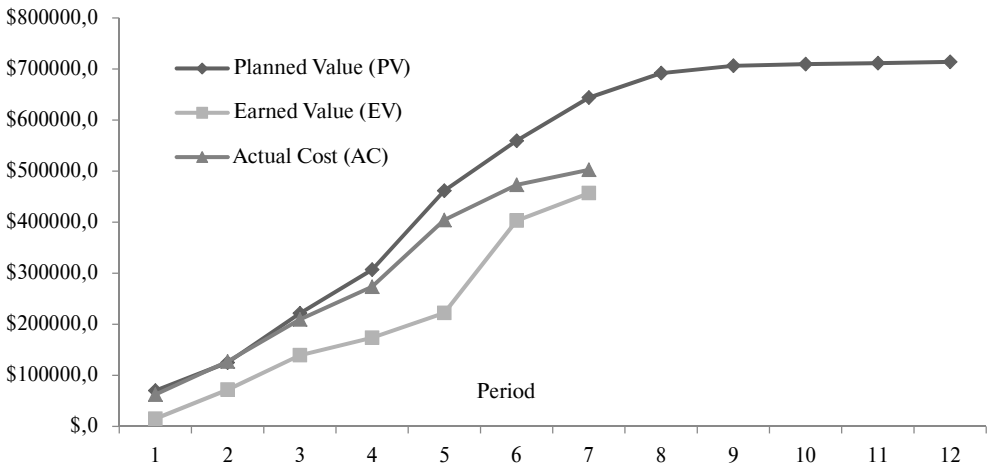

Fig. 2. S-Curve, Project's Progress before Adding Accruals

Table 2

Earned Value Calculations After Adding Accrued Expenses

WP	BCWS	ACWP	Estimated ACWP	Adjusted	Progress%	BCWP
	Planned Value	Actual Cost	Accruals	Actual Cost		Earned Value
1	$100,000	$98,570	$23,500	$122,070	100%	$100,000
2	$88,000	$90,233	$15,740	$105,973	100%	$88,000
3	$52,000	$40,019	$4,950	$44,969	90%	$46,800
4	$121,000	$75,300	$15,320	$90,620	80%	$96,800
5	$300,000	$198,530	$33,715	$232,245	85%	$255,000
6	$55,000	$32,350	$7,850	$40,200	90%	$49,500
7	$23,000	$0.00	$0.00	$0.00	0%	$0.00
8	$17,000	$0.00	$0.00	$0.00	0%	$0.00
9	$50,000	$0.00	$0.00	$0.00	0%	$0.00
10	$255,000	$0.00	$0.00	$0.00	0%	$0.00
BAC	$1,061,000			$636,077		$636,100

Cost Variance (CV = EV – AC)	$-325,525.00
Cost Performance Index (CPI = EV/AC)	0.73
Schedule Variance (SV = EV – PV)	$136,100.00
Schedule Performance Index (SPI = EV/PV)	1.27

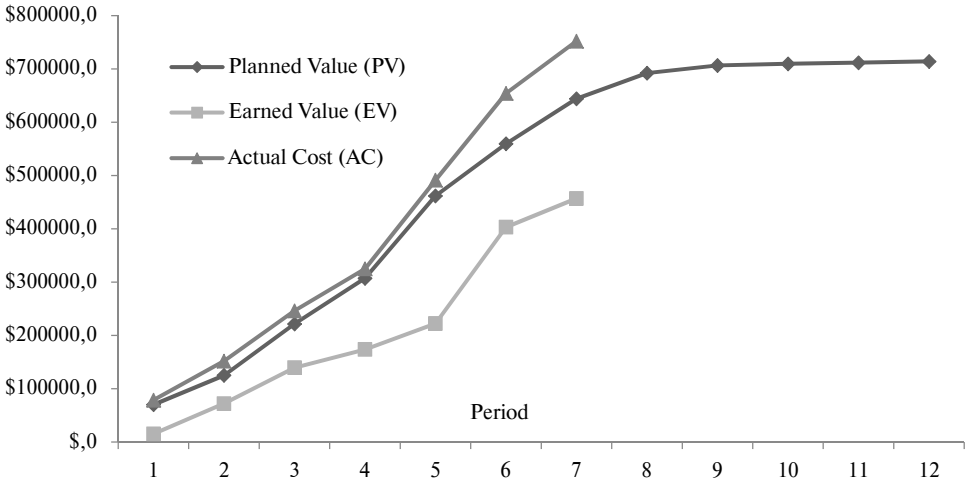

Fig. 3. S-Curve, Project's Progress after Taking Accrued Expenses into Consideration

One can interpret from the above figure that the project is ahead schedule and under budget, which gives positive sign about the project progress. In the following example, the estimated actual cost concept was applied to the same project and the results were as follows;

The Fig. 3 shows how adding accrued expenses to the Actual Costs (AC) can give a more reliable outcome of the project progress which means that neglecting the accrued expenses can give a false indication of project progress.

Conclusion. Earned Value Analysis is one of the most effective techniques of a project cost control if only applied properly. Effective use of earned value analysis should be supported by good cost and schedule control systems.

The paper presented the following;

• an overview of the main concepts of earned value analysis;

• challenges associated with its implementation with a focus on the inaccurate actual costs and how to overcome this problem;

• accrued cost expenses main concept and how it can be used in PEVA in order to obtain reliable results;

• an application of accrued expenses concept on a vessel construction project at PMS company and the results have proved that this adjustment gives a more reliable application of the PEVA.

By using accrued expenses, the inaccuracy of the project can be evaluated. Therefore, the project managers and practitioners may get to know the real status of the project, as it allows them to not only to efficiently control the project but also to generate more reliable forecasts.

Future research can be directed towards the integration and the application of the accrued expenses concepts and the application of the earned value analysis on Management Information Systems (MIS).

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