Practical application of Earned Value Method to evaluation of progress status of medium size construction projects

A. Czemplik
Wrocław University of Science and Technology
Wybrzeże Wyspiańskiego 27, 50-370 Wrocław, Poland.

E-mail: andrzej.czemplik@pwr.edu.pl

Abstract. Earned Value Method (EVM) became in recent years the global standard for describing of the current time/budget status of engineering projects. It is the most preferred tool by international construction arbitrage bodies, in case the advancement of the construction project for a given date must be defined in a commonly recognizable way. Application of the method in every day site practice needs 2-3 people team dedicated just for that task, so the EVM is used rather for large projects. However, using of the method in its reduced scale, as presented in the paper, can be fully economic also for medium size construction projects and provides set of information that can be very helpful for site managers in decision making processes. The numerical example of EVM used for medium size apartment construction project has been presented in the paper to illustrate the proposed concept of using EVM to the reduced extend.

1. Introduction
According to [1], the Earned Value Method is recommended as the global standard for project performance measurement. The method really integrates scope, cost and schedule measures, and could give good picture of current project status at the date of control. Concept of implementation the EVM into the cost control and even to overall performance measurement of construction projects have been presented by many authors [3, 4, 5, 7]. Application of EVM in the construction site management practice requires systematic register of time and cost data in order to get the two following values: ACWP which is Actual Cost of Work Performed and BCWP – Budgeted Cost of Work Performed. The third required value, namely BCWS – Budgeted Cost of Work Scheduled can be defined before start of works, based on the time schedule of all works and on the respective cost plan (Figure 1). Thanks to use of the EVM we can always have the reliable prognosis of final cost and the completion date of a construction project, calculated on the base of earlier performance of site works and with contractual cost plan taken into account. Moreover, we can anytime calculate the Cost Performance Index CPI and the Schedule Performance Index SPI, which are commonly recognized numerical measures expressing the status of the project, considering both, time and costs. Collecting all data needed for a single EVM analysis at a certain date is complex and time consuming exercise, so for large projects usually 2-3 people do that job. From managerial perspective it may sense to calculate CPI, SPI and prognosis outcome like Estimate At Completion EAC, twice a month for large projects. The budget of medium size construction projects is usually too small for such a frequency of EVM analysis, and more often the project overall duration period is divided into 3-4 equal phases, defining in this way 2-3 intermediate dates for EVM analysis. The method is suitable for all types of
construction contracts for works, including the most complex one, namely the Engineering-Procurement-Construction (EPC contract) [9]. However, expenditure of time needed for the single exercise of EVM analysis is considerably different, if to consider various contract models, i.e. various organization schemes of the project.

The earned value concept was developed about 60 years ago, but its use in construction sector is still limited by many construction companies. The method has been mostly implemented in large and big budget construction projects, so far, as power plants, etc. [6]. It is worth to notice that 47% of construction companies in United Arab Emirates, which is the country with spectacular construction sector, use that method in their daily practice [8].

![Figure 1. Three basic curves as used in the EVM.](image1)

Effective managing the construction site with supporting decisions by EVM needs use of some other managerial instruments like the cost plan and the breakdown of lump-sum price which enable for quick and efficient cost/time data identification needed for each date of control. As an effect of EVM activated for a given status date (date of control), the site manager can get the up-dated prognosis on cost variance at completion and schedule delay at completion (Figure 2).

![Figure 2. Forecast values provided by EVM.](image2)
But, EVM can be also successfully used for medium and small construction projects [2]. The main difference between its application for large and for medium size projects is just a frequency of analysis. And, having the analysis outcome as EAC, is rather easy – in case of small or medium size projects - to implement the successful project improvement program, if needed. Such a program is always needed in case EAC is beyond the Budget At Completion (BAC) point.

2. Case study

The EV Method has been implemented for three intermediate status dates of the medium size apartment building construction project, located in Poland. The building total budget was 6,000,000.00 EUR. Total useable area of 120 apartments was about 7000 sq. m. The building except of 5 above ground floors, had one underground garage floor with spaces for 120 cars. The contractual duration of the project was scheduled for 20 months. Three EVM analysis exercises were performed, as follow:

- after 5th month of the project duration – analysis no. I,
- after 10th month of the project duration – analysis no. II,
- after 15th month of the project duration – analysis no. III.

The objective of three analysis actions performed was mainly to minimize risk of any delays and to keep all costs within the planned budget bounds. It is important to add here, that the design documentation as used for the tender, was not detailed to adequate extend, so there was a big risk of considerable overcrossing the project budget. The cumulated project budget (PV curve) as long as the three values of EAC for respective actions I, II and III, are presented on Figure 3.

![Figure 3. EAC values resulted from three EVM analysis actions.](image)

The dominant improvement action undertaken after the analysis no. I, was relocation of several workers from non-critical works to some works which were critical in the Critical Path Method meaning. Five months later, the resulted value of EAC(II) showed reduce of the delay, however, no reduce of the exceeded costs. So, in order to reduce actual costs, some design changes have been introduced. The changes were focused mainly on modifying the façade, reducing glazed part area of external walls. All in all, the final real cost and the final completion date, were not as far from the
originally planned values as in case no information about the Estimate At Completion available during the project course. Finally, the budget was exceeded of 5% and the final delay was 2 weeks.

3. Conclusions
There are practical and economy reasons for which use of the Earned Value Method should be considered not only for large projects but also for medium and small size construction projects. Amount of data needed for EVM analysis of medium project is rather small, so even one person can perform the job if the number of analysis exercises is not bigger than 5-6 during the whole project duration. Results of each subsequent analysis performed do allow the project manager to undertake accurate repair decisions, if such are needed. Other words, it is very difficult to find alternative managerial instrument which would provide such concrete directives for construction project management decision making process.

References
[1] A Guide to the Project Management Body of Knowledge, Fourth edition, PMI 2013
[2] Avlijaš R, Avlijaš G, Heleta M, Application of earned value based metrics on small-scale construction projects European Journal of Applied Economics 12 (2) 2015 pp 1-8
[3] Burtonshaw-Gunn S A, Risk Financial Management in Construction, Gower, 2009
[4] Code of Practice for Project Management for Construction and Development. Fourth edition, Blackwell Publishing 2009
[5] Fewings P, Construction Project Management. An integrated approach. Taylor & Francis 2005
[6] Jung Y, Moon B S, Kim J Y, EVMS for Nuclear Power Plant Construction: Variables for Theory and Implementation Computing in Civil Engineering 2011 pp 728-735
[7] Levy S M, Project Management in Construction, McGraw Hill, 2012
[8] Morad M, El-Sayegh S M, Use of Earned Value Management in the UAE Construction Industry. Industrial Engineering, Management Science and Application (ICIMSA), International Conference 1-5 May 2016
[9] Yonezawa T, Practical EVMS for an EPC Project AACE International Transactions 2005 pp 18.1-18.7