

Example Application of Cost and Schedule Equilibrium Control Model in Communication Base Station Construction Project Based on Earned Value Method

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Abstract. How to improve the efficiency and quality of network mobile construction has become the focus of operators' mobile communication construction project management. The completion time of the construction of the base station will be subject to a number of uncertain factors. The project management theory and mobile communication base station network construction grafting is conducive to the construction of all aspects of the project and all resources are effectively integrated and use. Based on the complexity and system of the construction of the mobile base station, through the use of project planning management theory and practical experience, this paper can obtain the project's periodic bidding through the earnest value method, and can make the project plan unreasonable and unfavorable implementation, In order to make timely adjustments, so that the base station construction projects can be completed on time and quality.

Introduction

At present, the development of economic and social development of China's mobile communications industry must be high-speed development, there will be a lot of communication network construction project quality problems. For the operators, good and fast mobile communication network construction quality is the key to market opportunities, therefore, how to improve the network mobile construction efficiency and quality has become the operator of mobile communication construction project management focus. The core of mobile communication construction project management is the management of mobile base station project with the characteristics of project management and the characteristics of communication construction project.

EVM(Earned Value Management)[1] is a technology which is widely used to measure project cost and schedule performance. But there are some problems when applying EVM to software projects. The primary one is that it is too sensitive to detect abnormal signals. Each variance between earned value and planned value (or actual value) is considered as an abnormal signal. We all know that the software project is different from the traditional project by nature. Therefore, the difference between earned value and planned value is common in software projects. Most of these differences do not affect the success of the project, but they still report vitamins and abnormal signals, and managers must spend a lot of unnecessary effort to deal with these distorted abnormal

signals. In order to solve this problem, we must establish a reasonable boundary to determine the impact of these differences on the success of the measures.

Brief literature review on EVM

The EVM literature is largely anecdotal. The very few empirical studies on EVM implementation were found in the literature review[2]. The National Security Industrial Association (NSIA) estimated that about 32.8 million pages of papers were required annually for industry to achieve C/SCSC compliance. A subsequent study by Arthur D. Little also noted serious problems with implementation such as too costly, too complex, and too much paper work, but identified EVM users' general agreement with C/SCSC principles. Also, a DOD/ NSIA study found that the majority of the cost driver procedures were not required by C/SCSC. A recent study by the GAO (Government Accounting Office) noted that significant changes underway in DOD's EVM implementation could have a potential positive impact on streamlining EVM processes. Some of these changes included reducing reporting requirements by replacing the C/SCSC with commercial industry criteria and using information technologies to enhance timely data transfer between government agencies and contractors. While these empirical studies mainly identified EVM problems such as high-cost and suggested streamlining EVM processes, other literature—mainly practitioners' essays—have discussed diverse factors on why EVM was not widely accepted. Some of these factors include project managers' lack of understanding of EVM, government-led centralized EVM implementation and the resulting lack of user participation, political conflict between project managers and project consulting groups (i.e. groups that initiate the adoption of EVM), distrust between government and contractors, and pressures to report only good news. As pointed out in the EVM literature cited earlier, there are quite diverse factors that can impact EVM processes and successful implementation. Thus, it can be argued that, as a multidimensional issue in practice, achieving successful EVM implementation requires deeper and more systematic research and analysis. However, the EVM literature review did not reveal any comprehensive research studies on an integration or synthesis of the many EVM factors that have been identified. Even in implementation studies in other fields (e.g. total quality management, information technology, and production manufacturing technology), no consensus has been achieved even on what leads to implementation success and how to measure it.

EVM framework and system flow

EVM metrics for the construction phase. This section describes a fundamental framework for visualizing the EV analysis process and applying it as a PPMB tool. Since a construction project integrates numerous activities that ultimately result in project delivery, each activity has its own schedule and cost, and each is closely linked to other activities (a situation normally identified as a lead - lag relationship). Consequently, scope, time, cost, and quality are most significant components during construction. Distinctively, scope indicates the work required for successful project completion, time is the period required for project completion, cost denotes the capitals required to complete the work, and quality is measured based on owner (or their representative) acceptance of work performed. EVM integrates these components to measure project outcomes. The x-axis of the EVM diagram (Fig. 1) represents time. The y-axis could represent planned cost, actual cost of work performed (ACWP), and work items that have been inspected and paid for (or earned) possessing the required quality. The primary curves on the EVM diagram (Fig. 2) include planned value (PV), actual cost (AC), and EV. The PV curve, also known as the budgeted cost of

work scheduled (BCWS) curve, represents planned work. The initially submitted and accepted contractor bid contains the PV information. Meanwhile, the AC curve represents the total construction cost incurred, and the EV curve, also known as the budgeted cost of work performed (BCWP), represents the actual payments received for completed work. The AC and EV curves are dynamic during construction. Moreover, project performance can be measured using project Cost Variance (CV, EV minus AC), Schedule Variance (SV, EV minus PV), Cost Performance Index (CPI, EV/AC), Schedule Performance Index (SPI, EV/PV), and combined cost – schedule index (CPI×SPI)[3].

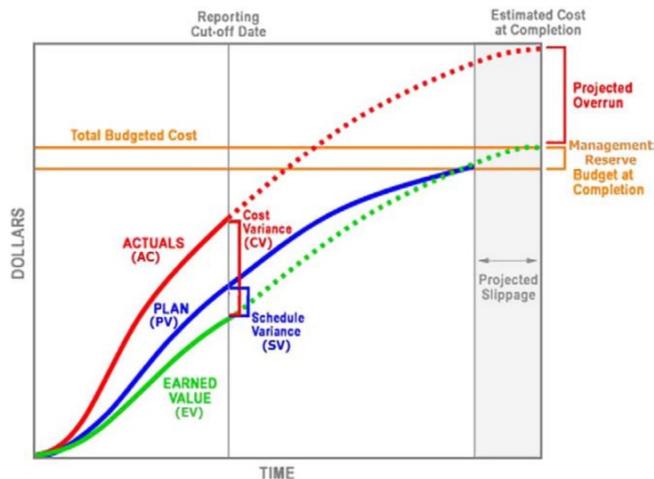


Fig. 1. Cost and Schedule Equilibrium Control Model

Simplified EVM process components. Constructing the EVM curves requires dividing the contractor bid into time values (e.g., monthly or weekly), and presenting the payment dates as points on the time-axis. This schedule can then be used to determine the actual work values to be completed in each time slot. The earned value is the total payment from the client to the contractor. Although valuing work on a construction site is challenging[4, 5], accurate status appraisal by the experienced engineers or responsible managers of ongoing activities under conditions of mutual trust between the client and the contractor ensures the effectiveness of EVM. Fig. 2 illustrates the project data components and processes represented in the graph.

Data preparation for visual presentation. Project managers must regularly gather and update baseline project data. Real-time measurement of project performance using the proposed system requires further analysis and presentation of the following data:

- Work scope data, including
 - Detailed activities or work packages in the WBS with required quality.
- Project time data, including
 - Actual task start and finish dates.
 - Expected task start and finish dates.
 - Estimated task completion ratio.
- Project cost data, including
 - Actual costs incurred in task completion.
 - Expected costs of task completion.
 - Actual payments received for completed work.

Project control and operations flow. EVMS can facilitate project control during construction by providing a platform for users to continuously analyze project information within an IT architecture. The proposed system also provides a document trail that project stakeholders can

follow from project initiation through to closeout. Consequently, the EVMS can be transformed into a data warehouse as project completion, which has a potential to become a valuable explicit corporate knowledge asset.

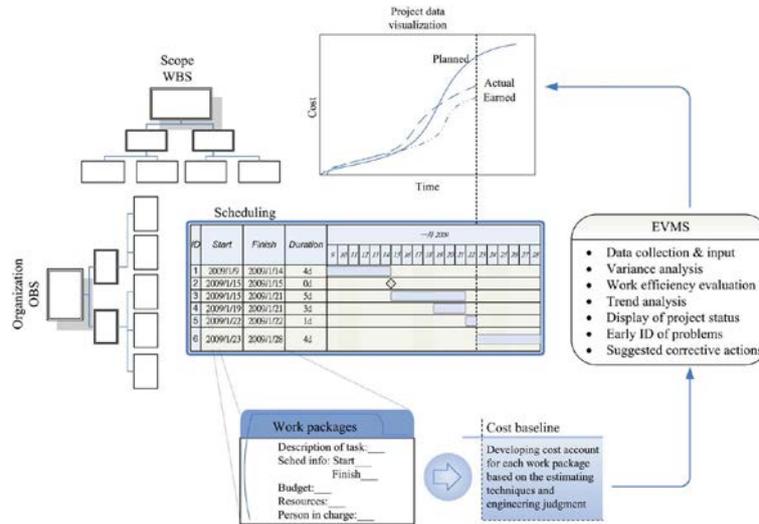


Fig. 2. Project data components and processes

Application examples

A total base project budget is 1535000, the demand analysis sub-task is 750000, the base station construction design sub-task is 350,000, the coding sub-task is 290000, the test sub-program is divided into four sub-tasks: demand analysis, project design, construction, test and test. The task is 145000, as of September 5, 2016, the demand analysis sub-task has been completed, the project design sub-task more than half, the construction sub-task has just begun, the test sub-task has not yet begun, Table 1 is the day plan costs and actual costs as of September 5, 2016. If the 50/50 rule is used, the progress and cost of the base station construction project as of September 5, 2016 will be analyzed. To analyze the progress and cost of the base station construction project as of September 5, 2016, the key to calculate CV, SV, CPI, SPI and other parameters. The key to calculating these parameters is to correctly calculate BCWP. As a result of the 50/50 rule, the requirements analysis sub-task has been completed, so its BCWP is 750,000. Base station construction design sub-task more than half, the construction sub-task has just begun, but did not complete, we believe that the realization of the 50% of the budget value, so the base station construction design sub-task more than half BCWP = 175000, construction sub-task BCWP = 145000. The test sub-task has not yet begun, so the test sub-task BCWP = 0, see Table 1.

Table 1. Calculate BCWS, ACWP, BCWP

Task	BCWS	ACWP	BCWP
Demand analysis	750000	730000	750000
Project design	262500	154000	175000
Construction	144000	125000	145000
Test	0	0	0
Total	1156500	1009000	1070000

Therefore, as of September 5, 2016, the base station construction project CV, SV, CPI, SPI calculation results are as follows:

BCWS=1156500, ACWP=1009000, BCWP=1070000,

$$CV = BCWP - ACWP = 1070000 - 1009000 = 61000,$$

$$SV = BCWP - BCWS = 1070000 - 1156500 = -86500,$$

$$CPI = BCWP / ACWP = 1070000 / 1009000 = 106\%,$$

$$SPI = BCWP / BCWS = 1070000 / 1156500 = 92.5\%。$$

SPI is less than 1 indicates that the work is not completed on September 5, 2016, that is, the progress is somewhat behind; but the CPI is greater than 1, indicating that the cost of completing the workload as of September 5, 2016 is greater than the value of the actual cost.

Conclusion

Considering that the construction of the mobile communication base station needs to go through a long period of time, the implementers and supervisors of the project need to decompose the implementation steps. The completion time of the construction of the base station will be subject to a number of uncertain factors. Based on the complexity and system of the construction of mobile base stations, this paper is based on the EVM method to study the application of the base station construction project scope, schedule and cost planning management in the mobile base station project. By using the project planning management theory and practical experience, More accurate and reasonable reflection of the progress of infrastructure projects and the actual situation of the cost. Through the earnest value of the project regularly to obtain the stage of the tender, the project can be timely and unreasonable implementation of the project and other issues in order to timely adjustments to the base station construction projects can be completed on time and quality.

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