Barriers to Implement Earned Value Management (EVM) at Construction Companies in China

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Abstract - Earned Value Management (EVM) has been recognized as a powerful project management tool to forecast and track time and cost. However the practical application of EVM with project management software in the China construction industry does not seem popular. This paper aims to investigate into practice of EVM for construction projects in Jiangsu province, China. Intensive and extensive literature review has been conducted. The obstacles to implement EVM for construction projects have been identified through the literature. A questionnaire was designed based on these obstacles and possible issues in relation to EVM in the Jiangsu construction industry. 10-construciton companies were visited and investigated and a total of 74 replies were received from the survey. The outcomes show that EVM practice is not positive and active compared to traditional cost/time management practice. Further the results show that various material price, usage of new materials and usage of construction equipment are top three barriers to conduct efficient and effective cost management and EVM. Further research can be conducted in different areas of China particularly Shanghai and Beijing to generalize the trend of EVM application and concurrent cost management for construction projects in China.

Keywords— EVM, barriers, construction, project

I. INTRODUCTION

The advance and importance of Earned Value Management (EVM) in cost and schedule management of construction projects has been well understood in the academia and industry. The current work performance and forecasting assessment of project are allowed to be expressed in form of graphs or tables based on EVM. The first case of EVM is attempted by U.S. Air Force, Department of Defense (DOD) and this new control method is introduced as Cost/Schedule Control System Criteria (C/SCSC) in the 1960s [1, 2]. The first implementation guidance of C/SCSC is issued amount the military departments in 1972. The early version of C/SCSC is so complex that this system is resisted by many project managers. It has been frequently practiced into control of governmental organizations and was improved during 1990s. The idea of Earned Value Management System (EVM) was set up to replace

C/SCSC in the end of 1990s and practiced in the construction industry.

In 2000, the terminology and formulas of EVM was simplified by Project Management Institute's "A Guide to the Project Management Body of Knowledge" (PMBOK Guide). The method was further developed in detail in later PMBOK Guide. The first practice guidance "Practice Standard for Earned Value Management" was published in 2005. The publisher, PMI, published the second edition in 2011. EVM method allows concurrent analysis which consists of schedule, cost and performance. The analysis method of EVM also provides the forecast of project in aspects of budge, progress and cost at any time. [3]

As an advanced tool of project management, EVM is brought to China in 1990s and regarded as an important part in training of project manager. In 1994, Deyin visited the foreigner company and accessed to the C/SCSC [4]. Deyin summarized the knowledge structure and procedure of C/SCSC and spared it with other Chinese construction professional. Three years later, Xinyou X. made a further research on C/SCSC. Xinyou detailed explained the main knowledge and practice standard of this system in the 1997 [5]. After 2000, EVM was published by PMI and introduced in China. EVM is incorporated in most of project management software such as Primavera, Microsoft Project.

Considering the large number of construction projects in China, it is necessary to make an investigation on the practice of EVM in the China construction industry.

The objectives of this research are:

To investigate the current practice of EVM in construction companies in Jiangsu province, China

To find out barriers and obstacles to implement EVM in construction projects in China

II. LITERATURE REVIEW

A. Theory of Earned Value Management (EVM)

NASA defines it as, "An integrated management control system for assessing, understanding and quantifying what a contractor or field activity is achieving with program dollars. EVM provides project management with objective, accurate and timely data for effective decision making." Earned Value differs from the usual budget versus actual costs incurred model, in that it requires the cost of work in progress to be quantified. This

allows the project manager to compare how much work has been completed against how much he expected to be completed at a given point.

EVM is an important control system which integrates the cost control and schedule control. To track the cost and schedule performance of project, three fundamental parameters is defined in EVM [6, 7].

Budgeted cost of work schedule (BCWS) or Planed value (PV)
Budgeted cost of work performance (BCWP) or Earned value (EV)
Actual cost of work performance (ACWP) or Actual cost (AC)

For each parameter, there are two kinds of terminologies. The long term belongs to C/SCSC and the simple one is used in EVM. After terminology of EVM is simplified by PMI, most managers have been used to adopt the short term of EVM.

The Planed Value (PV) is the measurement which represents the planed budgeted cost based on the current performance of project [6]. It is the approved budget for processing the project, activities and work package. The cumulative value of PV is the performance measurement baseline (PMB), which is always referred to as the S-curve. The value at the end of PMB is the summarization of budget, which called Budget at Completion (BAC). The baseline, or PMB, is the total view of schedule and budget for the authorized work. It can show all the authorized work and budget cost allowed for these work. Actually, any project that approaches the earned value management must be referred to this curve.

Through using three basic parameters mentioned above, EVM allows the calculations of performance measurements (show in Figure 1), cost variance (CV) and schedule variance (SV). The cost variance (CV) is the comparison between the budgets that has been earned and actual cost incurred in the project. A negative cost variance (CV<0) will result in permanent lost to budget cost at completion of project. It means the budget cost incurred is larger than value has earned. The formula of CV can be expressed as follows [1, 3]:
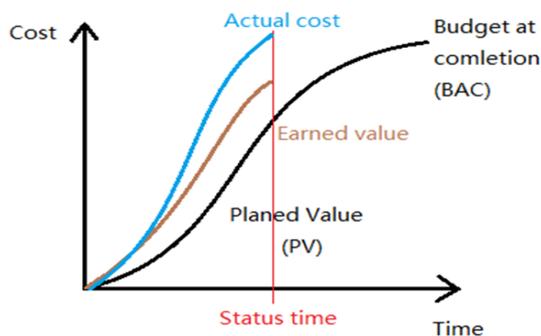
$$CV=EV-AC$$

Figure 1 Performance measurements, SV and CV [3]

Schedule variance (SV) shows the actual progress of project to the schedule. Similarly, the negative schedule variance (SV<0) represents the current progress of project is behind the schedule of plan. SV is defined as the difference between the earned value and planed value. It can be formulated as follows:

$$SV=EV-PV$$

The EVM also allow the indices of cost and schedule to assess the efficiency of project. Both cost and schedule indices can be measured by three basic parameters. The cost performance index (CPI) is a measure of the budgetary conformance of actual cost of work has performed [1]. CPI can be expressed as following formula:

$$CPI=EV/AC$$

The Schedule performance index (SPI) represents the conformance of actual progress to the planed schedule of project [1]. SPI can be formulated as follow:

$$SPI=EV/PV$$

The indices can be considered as the ratios which reflect the efficiency of project in terms of cost and schedule. In EVM, the constant 1 indicates that the project performance efficiently follows the initial plan. If CPI or SPI are larger than unit 1, the work performance can be recognized to be processed under better condition. If they are less than unit 1, which means the cost or schedule of project is below the target [6].

EVM is a powerful management tool that the forecasting of project can be published to server for project managers. The forecasting is set up based on the key points mention from above part. The managers could assess the cost and schedule of project at the completion through calculation at any time during the work.

For a construction project, the cost control is always the most important part. The EVM provide measurements to forecast the estimate budget cost at the end of project based on the current work performance. The cost estimate at completion (EAC) is a measurement of total budget cost from EVM. The estimated cost to complete the test work of project is called the estimate to complete (ETC).

From the components mentioned above, the EVM is so powerful that the project managers can assess the current work performance and future work at any time. The report published by EVM can provide project managers with reliable evidence to control cost and schedule in their work.

B. Practice Standard of EVM

The U.S. department of defense control and track the huge governmental project by using C/SCSC, which include 35 criteria [2]. Although the C/SCSC is so useful for other civil industries, the industrial managers and

executives rejected to attempt C/SCSC due to complex steps. The EVM is developed from C/SCSC, which has simple terminologies and standards. Generally, the EVM integrates the tracking and assessment of cost and schedule of project. The project managers are allowed to check and control their work at any time. Practice guidance is published by PMI in 1998 [8], the key steps of earned value management are:

1. Scope the work and organize the WBS of project

   1.1 Define product and project scope and decompose work to a manageable level.

   1.2 Assign clear management responsibility for discrete work elements.

   1.3 Plan the activities of the project into a logical schedule.

   1.4 Develop a time-phased budget for each element of the WBS.

2. Create the PMB based on WBS

   2.1 Select EV measurement techniques for each work package prior to execution.

   2.2 Establish a performance measurement baseline.

3. Collecting primary information of cost and schedule

   3.1 Develop a structure for collecting costs into the same accounts and time periods where performance is being measured

   3.2 Determine earned value by objectively measuring the physical work progress according to the earned value technique selected for the work.

4. Make assessment and forecasting of project based EVM

   4.1 Analyze cost/schedule performance.

   4.2 Forecast cost /schedule performance.

   4.3 Project the estimates at completion.

   4.4 Report performance problems and take appropriate corrective action.

   4.5 Maintain integrity of the PMB.

According to the Table 1, the procedure of EVM has been much simplified compared with C/SCSC. The guidance includes all work that process EVM from scoping work to publishing EVM report.

C. Problems and Barriers of EVM in Practice

Although EVM has so powerful function that support project managers to track and find early warning of project performance, this useful project management is not perfectly applied to real work. The barriers and problems may occur into aspects of training condition of managers, EVM required data gathering, management level of executives, and so on. The possible problems of EVM applied into project managements have been listed as below [8, 9, 10]: These problems are reflected in the questionnaire design of this research.

- The earned value is rarely mentioned as a top of measurement in training courses of project management. At the same time, EV is not usually applied into project.

- The method or technology selected to measure the actual cost and completing degree based on guidance is much time confusing and expensive.

- Earned value management is always reported in complex format which cannot be understood easily. The confusing report resulted in significant employee and application resistance when EVM is applied in construction industrial tasks.

- The cost estimating system is missing in most work of project managers, which is one of the most important bases of EVM. Normally, the inputs of EVM, planed value, earned value and actual cost are gathering from cost estimating system.

- Even when a good cost tracking system is in place, that system always compares two numbers, a planned cost and an actual cost, for control purposes. Most systems have no mechanism built in to allow the third number (earned value); the company's software systems provide a powerful barrier to using Earned Value. The cost of changing the system and the change management issues as well, hinder adoption of Earned Value.

- Another problem is the long list of equations used in Earned Value Management. Its quantitative nature puts off the typical user. But this is a false barrier, as most courses teach all possible Earned Value statistics, when only the one pair is needed.

- The assumption is that with a good plan, a good project manager can carry out that plan. Very little focus is provided on project execution.

- The poor timeliness of cost system is also a barrier. A good Earned Value system requires up to date reporting on project costs, detailed by project task. Many companies cannot provide this information. Many others do not want to, as it increases transparency of problems.

III.   RESERCH METHODOLOGY

As the investigation was to generalize the trend and issues related to EVM practice, the appropriate method for collecting data was a questionnaire survey. A questionnaire was developed based on the literature review and possible issues in the China construction industry. To represent the whole Jiangsu construction industry and to increase the response rate, the researcher visited 10 construction companies including contractor company, engineering and design company, supervisor company and investor company The questionnaires were handed over to the participants and collected later by the researcher. A total of 74 responses have been received.

IV.   FINDINGS FROM THE SURVEY UNDERTAKEN

The following shows the questions and answers from the survey with the averages of 74-responses in the order. As can be seen from the table, For Q1 to Q5, the Likert scale (1) indicates positive and/or active answers and Likert scale (5) indicates negative and/or passive answers.

Questions 1 to 5 are related to cost/time management and project management. The average response for these questions ranges between 2.0 and 2.9, identifying frequency of training as the most serious issue.

Q1. How often do you receive training on project management including cost and schedule management?
　　Average answer: 2.9
　　1. Once a month
　　2. Once a quarter
　　3. Once a year
　　4. Once in two years
　　5. Not at all

Q2. How do you evaluate your application of schedule and cost management tools into project?
　　Average answer: 2.5
　Q3. How do you evaluate your project execution and performance based on your project plan?
　　Average answer: 2.3
　　Multiple Choice Answers
　　1. Very good
　　2. Good
　　3. Average
　　4. Poor
　　5. Very poor

Q4. How often do you check the schedule and cost of project?
　　Average answer: 2.2
　　Multiple Choice Answers
　　1. Once a week
　　2. Once in two weeks
　　3. Once a month
　　4. Once in two months
　　5. Once a quarter

Q5. How much do you agree that your company is able to provide up to date information of project cost in time?
　　Average answer: 2.0
　Q6. How much do you agree that EVM has too many of equations to understand?
　　Average answer: 3.1
　Q7. How much do you agree that EVM's reports are difficult to understand?
　　Average answer: 3.1
　Q8. How much do you agree that it requires too much time to collect the data of EVM?
　　Average answer: 2.6
　Q9. How much do you agree that EV, as a new estimate value on top of Plan Value and Actual Cost, is necessary in cost estimate systems?
　　Average answer: 2.2
　　Multiple Choice Answers
　　1. Strongly agree
　　2. Agree
　　3. Neutral

　　4. Disagree
　　5. Strongly disagree

Q10. How well are you familiar with "Earned Value Management (EVM)"?
　　Average answer: 3.2
　　Multiple Choice Answers
　　1. Very well
　　2. Well
　　3. Average
　　4. Poorly
　　5. Very poorly
　　6. Didn't know at all

Q11. Which elements do you think are the major barriers of company to practice efficient and effective cost management and Earned Value Management? (Multiple choices)
　　1. Change of construction policy or code
　　2. Current situation of construction process
　　3. Labor rates
　　4. Usage of 6construction equipment
　　5. Usage of new materials
　　6. Various material prices

For EVM related questions (Q6-Q10), it is identified that the construction professionals take a neutral positions with respect to familiarity with EVM, equations in EVM, EVM report and data collection for EVM. Compared to cost/time management questions, the answerers are less positive and/or active. This findings show that EVM is still relatively new area compared to traditional cost/time management. However the respondents agreed that EV can be a new estimate value.

From the responses of the last question, the significance of barriers for cost management and EVM are found out and listed below:

1. Various material prices (49 Responses)
2. Usage of new materials (44 Responses)
3. Labor rates (43 Responses)
4. Usage of construction equipment (36 Responses)
5. Change of construction policy or code (34 Responses)
6. Current situation of construction process (24 Responses)

V. CONCLUSION

A comprehensive survey was conducted to investigate the current practice of Earned Value Management (EVM) in the Jiangsu province construction industry. The findings of the survey shows that EVM is less actively conducted compared to traditional cost/time management. However the participants of the survey agreed that earned value can be a new estimate value on top of planned value and actual cost, leaving the potential to possible advancement of EVM practice in future. Further the

outcomes of survey shows the barriers for cost management and EVM. Top three barriers include various material prices, usage of new materials, labour rates.

The geographical area of this research has been limited to Jiangsu Province in China. Further researches in other areas of China, particularly Shanghai and Beijing, can be conducted to generalize the trend and practice of EVM in the China construction industry.

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