APPLICABILITY OF EARNED VALUE MANAGEMENT AS A PERFORMANCE MEASUREMENT TOOL FOR SRI LANKAN CONSTRUCTION INDUSTRY

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ABSTRACT

This study is based on the Earned Value Management (EVM) performance measurement technique and its practice in Sri Lankan construction industry. Since the project success clearly depend on accuracy on evaluated performance measurement, EVM have emerged through various techniques, due to its higher degree of reliability, effectiveness, accuracy, and efficiency.

Data collection was done through the case study research approach and cross case analysis was used for data analysis. Four cases were selected to extract the current practice of EVM and its suitability as a performance measurement for the industry.

In traditional methods, physical progress is not taken into account when analysing cost performance. Instead, actual cost of a project up to date is simply compared to planned costs, often with misleading results. Therefore, as a mitigating measure, EVM can be applied for measuring a project's performance forecasting future trends and analysing variances in the schedule and budget as the project proceeds. EVM as a standard method can be considered more successful with better results in projects simple and direct with a detailed scope. As evidenced in the case study, projects with complex and incomplete final products show higher deviations in the use of the technique. The EVM suggests a cultural change in the process of projects control; therefore people who have experience in dealing with the tool are really necessary in this process. The way an organisation implements the tool, influences directly to the results. If it had an organisational support, provided by specialised resources, will have better results in terms of application.

Keywords: *Construction; Earned Value Management; Performance Measurement; Sri Lanka; Traditional Methods.*

1. INTRODUCTION

Criteria of construction project's success has constantly enriched in project management context. Therefore, a systematic critique of the existing literature is needed to develop framework for measuring construction success both quantitatively and qualitatively (Chan and Chan, 2004). Thus, the performance of a construction project has been judging using different traditional approaches to get a better picture of the project's status (Khamidi *et al.*, 2011a). Therefore, as a new performance measurement technique, EVM has been originally developed by the United States Air Force and it has increasingly being addressed in the literature of project management over the years. Since, there was a lack of literature on EVM in Sri Lankan context this article examined the emphasis of practicing the EVM methodology in Sri Lankan context and its conceptual underpinnings and applicability as a measuring process of a project's performance, based on the particular benefits and drawbacks comparing to traditional approaches.

2. PROJECT PERFORMANCE MEASUREMENT

Before any construction project becomes a project, it begins as a concept which is subjected to evaluation at some high level of management (Nalewaik and Witt, 2010). Further, Bokhary (2010) indicated that to make that concept reality the project must comprise with temporary set of activities which had planned from the beginning to ensure the timely completion with desired quality and budget. Since, construction

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industry is usually famous for its underperformance, due to several uncertainties in the system; project duration is not expected to be exact like any other output of a project (Kagioglou *et al.*, 2001). Therefore, it is necessary to introduce a system for project scheduling and monitoring into the project management. Hence, Project scheduling began in order to mathematically scheduled the planned activities, while act as a predictive model for performance measurement of the project (Vanhoucke, 2012).

Many researchers had introduced several performance measuring techniques, which can be separated according to three levels in project management, i.e. project level, organisational level and stakeholder level. According to Lin and Shen (2007), it is important to carry out performance measurement at organisational level considering not only financial aspects but also on non-financial aspects such as time and quality of work and Wang and Huang (2006), further stated that measuring the owner's, the supervisor's and the contractor's performances are significantly related to the criteria of project success. Mostly there are researches conducted in project level and there are several Changing measures of project performance over the last 10 years. Meantime, a study conducted by Lin and Shen (2007), had found that the 68% of total number of researches in performance measurement had conducted at the project level.

A study by Yang *et al*. (2010) indicated the main purpose of performance measurement is to measure and improve the efficiency and the quality of the performance, and identify opportunities for progressive improvements in performance using both traditional and new philosophies. Kagioglou *et al*. (2001) and Khamidi *et al.* (2011a) had found several traditional approaches such as day to day monitoring, monthly or weekly management reports, performance reviews, key performance indicators, 'S' curves and financial management techniques and new techniques such as EVM and Schedule Risk Analysis to measure the project's performance continuously throughout the project life time.

In performance evaluation, main considerations are time, cost and quality; therefore it is important to use mechanisms which can measure both factors simultaneously. One of those mechanisms that monitor both dimensions is time-cost analysis, which is monitor the project's progress as a function of the cumulative costs and plotted against time for both budgeted and actual amounts (Bokhary, 2010). Other than above mentioned techniques Gantt charts, control charts, and milestones are often used to monitor project performance. However, as mentioned by Bokhary (2010) these tools track progress only in the dimension of time while, other important dimension of project performance, cost, is virtually ignoring. This disadvantage created significant problems for several high profile US aircraft development projects in the early 1960s, and ultimately led to the adoption of the more popular analytical approach of EVM. Next explains the EVM in detail.

3. BACKGROUND OF EVM

Anbari (2003), Fleming and Koppelman (2010) has explained the EVM and its applicability as a performance measurement technique for construction industry. Further, as per a study conducted by Nagrecha (2002), earned value is an enhancement over traditional accounting progress measures and goes one step further and examines actual accomplishment. According to study conducted by Czarnigowska (2008), EVM had proved its usefulness in practice of cost control by establishing the current status of a project while predicting its likely final effect, using its cost and schedule information from project's Work Breakdown Structure (WBS), project network and the schedule. Further, Pajares and Paredes (2011) has illustrated that, EVM use new real data generated during project run time to forecast the trends for the future project total cost and finishing date (based on past performance). Thus, many researchers have recognised the importance of EVM in creating an early and accurate image of the status of a project for performance evaluation and project management.

A study in Korean construction industry conducted by Kwon *et al.* (2008) found out that the application of the EVM can be considered more successful in projects which have clear and tangible objectives, with a detailed scope, simple and direct. Vargas (2003) argued that applicability of EVM analysis will be widely enlarged, if the data collection is made in adequate speed and accuracy and the information is correctly compiled accomplishing the deadlines and if it fails EVM will not add much effect to the process of project control. However, Kwon *et al.* (2008) had argued in a study, that incomplete projects or projects that involve aspects of creativity, which make a precise plan impossible, show high in viability in the use of the technique. Therefore, to minimise the misuse of EVM and maintain its quality, there are several established

standards such as ANSI/EIA standard 748-A guidelines published by National Defence Industrial Association (NDIA) in USA, AS4817 published by Australian standards committee and PMI practice standards by the Project Management Institute (PMI) to establish the requirements and to get a fundamental understanding of the principles of EVM and its role in facilitating effective project management.

4. EVM TERMINOLOGY

Currently practicing standard EVM terminology for the calculations for EVM was first devised by the US Department of Defence in 1996 comprising with dozens of acronyms numbers. However, regardless of the kind of project (construction, production, defence, and space), only three basic data elements, Budgeted Cost of Work Scheduled (BCWS), Budgeted Cost of Work Performed (BCWP), and Actual Cost of Work Performed (ACWP) are central to proper planning, measurement, and analysis of data (Christensen, 1998). Nearly all of the other data items, project status indicators, and earned value "forecasting" parameters have been derived from them. Cost Variance (CV), Schedule Variance (SV), Cost Performance Index (CPI) and Schedule Performance Index (SPI) indicate the current performance of the project. Vanhoucke and Vandevoorde (2006) concluded that CPI and SPI provide valuable information about trends in project performance and Warburton (2011) further stated that, when implementing corrective managerial actions, the changes in the behaviour of the indexes are assumed to reflect the impact of management actions as illustrated in Table 1.

Table 1: Schedule and Cost Performance from CV, SV, SPI and CPI

Project Status Indicators Variances	**Positive**	**Zero Value**	**Negative**
Cost Variance (CV)	Cost overrun	On budget	Cost under run
Schedule Variance (SV)	Behind schedule	On schedule	Ahead of schedule
Indexes	**Greater than 1**	**1**	**Less than 1**
Cost Performance Index (CPI)	Cost overrun	On budget	Cost under run
Schedule Performance Index (SPI)	Behind schedule	On schedule	Ahead of schedule

Source: Adapted from Kim *et al*. (2010) and Pajares and Paredes (2011)

To Complete Performance Index (TCPI) and Estimate at Completion are the forecasting parameters of the project. If the project is delayed or over-budgeted, can use TCPI to determine the project performance required to complete the project as budgeted or estimated. TCPI also leverages the EVM formula (Sharma, 2009).

5. EVM PRACTICE IN SRI LANKA

Traditional methods and EVM have been used in worldwide for performance measurement of construction projects in last three decades. Most of the countries in the world, especially USA had introduced EVM as a standard for the construction projects, and currently investigate for its newest improvements, since EVM had proved its usefulness in practice of cost control by establishing the current status of a project while predicting its likely final effect, using its cost and schedule information from project's WBS, project network and the schedule (Czarnigowska, 2008). While Korean Construction Industry applied it to most large-scale constructions for achieve a successful outcome, in Australia, it has use for add value to the effective commercial project management under Australian EVM standards (Kwon *et al*., 2008). However, unfortunately in Sri Lankan context EVM had not gained any attention or importance. Hence, there is not an established standard for project performance evaluation in Sri Lanka, the success or failure of a project depends on traditional methods which had many disadvantages comparing to EVM. Therefore, it indicated that the necessity of applying EVM in the Sri Lankan construction industry had significantly enlarging its important, using its arrogant advantages and history of success.

6. RESEARCH METHODOLOGY

To study the application of EVM as a performance measurement it is necessary to compare the benefits and the limitations arose during the practice of the technique with other traditional methods of measurements in Sri Lankan Context. Therefore, the study was conducted as a cross case analysis using four number of construction projects from both EVM practice and traditional approaches., interviews were adopted as the data collection technique as the most reachable and reasonable data collection tool when considering circumstances and the nature of the research and the restrictions on accessibility to other sources of data. Since, in semi-structured interview, the interviewers seek for clarification and elaboration on the answers given where the interview is balanced between free-flow and directed conversation, semi-structured interview was selected as the data collection tool. According to Senarathne (2005), code-based content analysis enables to find similar cognitions under a particular concept and consider its significance rather than the actual content of the segment. Therefore, code-based content analysis was used in this study to capture significant findings from the transcripts and for effective interpretation of those.

7. RESEARCH FINDINGS

Cross case analysis has been carried out to identify the similarities and differences between each case, on the way to find out; the current practice of performance measurement techniques, benefits and issues arose in the implementation of the EVM and other traditional methods and applicability of EVM as a suitable measure for project performance measurement and progress monitoring.

Performance measurement techniques in current practice

According to research findings, there are only limited numbers of companies which practice a particular technique for performance measurement such as EVM or cost coding systems in Sri Lanka. Those companies has selected, because it required to compare the project's status with the cost base line and schedule base line and then forecasting the trend of the project in terms of cost and time, which can be only done using EVM. Other than those companies others were using traditional approaches such as, "S" curve, Gantt charts, management reports and the audit reports of the project and performance reviews for the project management.

7.1. BENEFITS AND LIMITATIONS IN PERFORMANCE MEASUREMENT PRACTICE

Table 2: Comparison of the Practice of Measurement Techniques

Requirement of the respondents	Traditional method	EVM
Technique which is simple	Simple	Not simple
Able to maintain with limited staff	Give unbearable working load for the person who give progress reports	With the systematic method require person who has authority to collect required data
Less initial cost	initial cost was less, since only general software were required, and able to manually conduct the process	Initial cost is high since the method requires particular software and hardware to build up the system.
Easy to maintain	Not easy to maintain, had to do calculations repetitively for every report.	Easy to update and maintain since the system is already build up
Limited technical knowledge	Did not require any technical knowledge	Require knowledge to control particular software for updating process

Requirement of the respondents	Traditional method	EVM
Higher accuracy of data	Less accuracy of data since, process was manually conducted	Higher accuracy of data, since systematic approach used
Capable to measure actual progress of the project	Actual progress is unable to measure	Measure Earned value of the project
Measure required performance for timely completion	Cannot measure required performance	Measure To Complete Performance Index (TCPI)
possibility to forecast the time for completion and probable final cost	Use experience to predict the probable situations	Measure Estimate At Completion (EAC) in for both time and cost

As shown in Table 2, as plus points of traditional methods, it was easy to practice those methods, "S" curves, Gantt charts, progress reports and management reports, because they are easy to generate, update and simple to understand and EVM was more complex and require more resource persons and software and hardware to administrate the project. However, traditional methods were easier to evaluate the performance of the projects it cannot estimate the actual performance level and the required performance for timely completion of the project which can be clearly measure with EVM technique by developing the cost loaded base line schedule for the project and updating it constantly.

Projects which had use traditional approaches has faced difficulties when comparing the planned work with actual cost of the project, since actual cost did not specified what had been completed and only mentioned the total expenditure of the project for particular period. Therefore, the readings misconstrued the status of the project which leads for erroneous decisions when administrating the project. While, EVM allocate resources for particular tasks separately and measure the planned work and the actual work done using those data and avoid the errors which may happen in present project status and the future project forecast by using the actual value of the work completed for the calculations.

Moreover, when using traditional approaches, progress monitoring of a project also had to repeat with the time and repeating same format of calculations were difficult to continue throughout the project life, while the calculations for variances and indices and forecasting the trend in EVM technique were not difficult to continue after preparation of the cost loaded base line schedule for the project.

EVM had provide very convenient data using TCPI, which shows the value of cost performance index that is to be maintained from now on if the project is to be completed to budget and SV and CV variances and SPI and CPI indices, which provide valuable information about trends in project performance. While traditional approaches had not provide a clear quantitative picture of the true project status and further it does not provide a means for extrapolating project cost to complete or completion date.

The main issue arose in practicing EVM in Sri Lankan context is the difficulty in reporting earned value due to several reasons. First getting actual costs onto each task is difficult, setting up an automatic interface between departmental databases and project management systems are not trivial and usually projects do not use a standard formats and data bases and using the earned value mechanism in these systems are typically not straightforward and simple. Therefore, when implementing EVM in a project, it required an experienced contractor who has standard formats and databases for data reporting and monitoring to maintain the reliability and accuracy of the data used for the process. Further, Earned Value reporting cannot be handled in an easily implemented manner and required professional service for implementation. However, since limited resources were available, it was difficult to give much time or support for performance measurement process. Therefore, to use EVM method efficiently, it requires a disciplined approach to collection of data on project cost and progress and the findings are to be processed immediately. The purpose is to detect any deviation as soon as possible, so that there is enough time to asses if the deviation is dangerous for the project and, if necessary, to take corrective actions. Therefore, collect data within the time is important or had to invent another solution for the time problem.

Further, findings indicated that in both practices, due to limited financial support for the project monitoring process, lack of staff for progress monitoring and controlling had create conflicts in responsibilities since, there was not any particular person assigned to measure performance and progress monitoring. This situation had lowered their liability of the data and delay the data collection and evaluation process which finally reduced the accuracy of the conclusion.

Minimum awareness of EVM and lack of experts in the industry had had create less interest to use EVM in the industry. Cost for the software and hardware which required for the measuring process of EVM technique are too costly and it required lots of technical knowledge in the beginning to administrated these software and hardware and maintain afterwards. Therefore, it required lot of effort to change the people in to the system and introduce EVM.

8. CONCLUSIONS

When concluding research findings, it can be stated that, in the initial stage traditional performance measurement is simple and easy to apply to a project and easy to understand. However, during the constructions develop the schedules and measure the performance time to time was not an easy task. The findings had described that, the requirement for systematic method for performance measurement had been identified through limitations of traditional methods. Further, it had identify that, most of the people in the industry, without a clear idea about the EVM, think it as a time wasting and costly technique while, using EVM to measure performance during the progress was not difficult and actual limitation is the higher cost and time requirement in initial stage of EVM practice.

As a plus point of traditional methods that, it does not require any special software or hardware which cost more for the process since, it can be manually proceed without usually available software such as Microsoft Excel or word. However, it was also agreed that, it did not calculate the work done in depth and the accuracy of the result was less since it cannot verify the reliability of data. Therefore, according to the cross case analysis and other empirical data, accuracy of the data get the priority and requirement of proper system to update data continuously had been initialised. Other than that, as a limitation of EVM the respondent had identified the additional cost requirement for the software, hard ware and technical knowledge in the beginning to administrate the process which unable to overcome since, accuracy of the data was depending on the reliability of the system.

As other limitations of traditional methods are, they demonstrate that, traditional methods were unable to estimate about what will be the total cost and the duration in the completion other than a prediction according to the experience and practical knowledge. Thus, in EVM it is able to measure the EAC on both cost and time. Since, performance evaluation reports were used for decision making of the project; it will be suitable to use a system which can measure the probable time duration for the project and the probable cost. Other than that, performance measurement had been demonstrated as the heart of the project management, measures and the parameters had achieved a level that get highest priority of the project. Therefore, empirical data had demonstrated several plus and minus points of two types of performance measurement techniques implemented on project management (Refer Table 2). Since traditional methods which practicing currently had several limitations which can be mitigate by using EVM in Sri Lankan Construction Industry, it can be concluded that practicing EVM in Sri Lankan context will improve the accuracy and the reliability of the project performance measurements and it is the most effective technique for the project performance evaluation process.

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