AN EARNED VALUE MANAGEMENT (EVM) FRAMEWORK FOR THE PERFORMANCE MEASUREMENT OF PFI CONSTRUCTION PROJECTS IN MALAYSIA

M. WARIS ALI KHAN, MOHD FARIS KHAMIDI, ARAZI IDRUS
Civil Engineering Department, Universiti Teknologi PETRONAS, Malaysia

ABSTRACT

Earned Value Management (EVM) is a project performance measurement method which integrates the cost, schedule and technical performance. It establishes the earn value of a completed work and compares it with the actual cost and planned cost to determine the project performance and to forecast its future trends. This technique encourages public and private organizations to monitor the performance of their mega projects effectively. The present study examines the EVM process in order to derive a framework for monitoring and controlling of PFI construction projects in Malaysia. The proposed framework is comprised of five fundamental elements i.e. organizational policy; planning; implementation; measurement, analysis and reporting; and management performance review. These elements interact with each other to form an integrated EVM performance measurement system. The aim of this framework is to provide the construction organizations an understandable view about the implementation of an EVM System.

Keywords: Earned Value Management (EVM); Private Finance Initiative (PFI); Contract Management

INTRODUCTION

The Private Finance Initiative (PFI) mode of procurement was launched in the United Kingdom in 1992. Since then it has become an increasingly popular mechanism for procuring public infrastructure in various countries. PFI is one of the categories and a subset of Public Private Partnerships (PPP). The aim of PFI is to bring the private sector's finance, management, skills, and expertise into the provision of public sector facilities and services (Akintoye et al., 1998). The United Kingdom has approved a total of 700 PFI projects to date and over the next 5 years approximately 200 projects of worth $400 billion (£200 billion) are planned (Patricia et al., 2008) KPMG International (2007) stated that the experience of U.K, Italy, France, Germany and Australia has shown that well designed PFI can enhance the efficiency and quality of public services by improving procurement and management procedures and efficiently allocating risk between the public and private sector. Many public facilities have traditionally been procured and funded directly by the government. Nevertheless, PFI allows the government to release fiscal funds for use in other areas. Unlike, Sale of Asset / Equity, PFI involves a fixed term contract typically of up to 25 – 30 years, after which the asset often returns to the public ownership.

In 2006, the Malaysian government has also taken a positive view of the potential benefits of PFI and announced its implementation in the Ninth Malaysian Plan (2006-2010) in order to expedite the execution of development projects in the country. Yakcop, N.M. (2006), Minister of Finance II expressed that the PFI approach in Malaysia will be utilized broadly in two circumstances, first to optimize the implementation of government projects and services and second, to enhance the viability of private sector projects in strategic or promoted areas. Based on the literature review (Takim et al., 2009); the structure of PFI in Malaysia starts by establishing PFI project agreement between the Public sector (represented by various Government Ministries) and the Special Purpose Vehicle (SPV) Company (private consortium). In view of the Malaysian Public Private Partnership Guideline (2009), the main parties would include:

- The Special Purpose Vehicle (SPV) created specifically for the project
- Financiers
- Construction contractor

- Facilities management operator
- The Public sector (Procuring Authority)

Figure 1 demonstrates a typical structure of PPP/PFI in Malaysia and indicates a functional relationship between different stakeholders involved in procurement process (PPP Guideline, 2009).

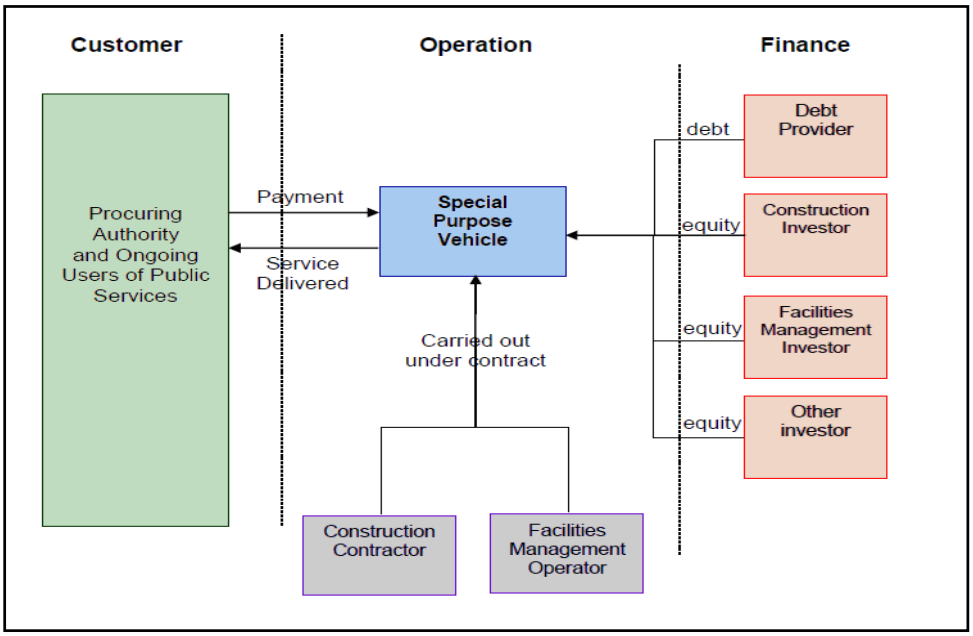


Figure 1. Typical PPP/PFI Structure

During the Ninth Malaysian Plan period (2006 – 2010), the Government has identified a total number of 425 PFI projects under the domain of different Ministries. The Government has also established PFI Sdn Bhd, a specific governing body to administer the PFI projects under the Ninth Malaysian Plan (Takim et al., 2009). In this perspective, the commitment of PFI Sdn Bhd is to govern the designing, construction, operation and maintenance of the facility throughout the concession period. Apart from this, PFI Sdn Bhd will also borrow money from Employee Provident Fund (EPF) for financing PFI projects including schools and government buildings, public transport, health and water infrastructure facilities. Hence, the role of PFI Sdn Bhd as a financier deviates the PFI scheme (under the Ninth Malaysian Plan) from the true spirit of international PFI Framework. In this later type, the private sector consortium is responsible to arrange the finance for the government projects and bear the associated risk.

PFI projects under the Ninth Malaysian Plan require significant capital investment i.e. RM 20 billion from the Government and the most of which are used up during the pre-operational phase i.e. design, construction and commissioning. In this case, PFI Sdn Bhd will bear the project execution risk and may bear the loss, if the contractors could not perform satisfactorily or if the project completion is delayed (Gunasegaram, 2006). Hence, in order to secure the mutual interest of PFI Sdn Bhd and private sector consortiums, a systematic monitoring and controlling of pre-operational phase of a PFI project is a prerequisite.

This situation demands an efficient and proven performance monitoring tool for managing Government sponsored projects. Therefore, this paper attempts to highlight the importance of EVM technique as a valuable tool for the performance measurement of construction projects and proposes a framework for its implementation on PFI projects in Malaysia. This technique has widely been adopted by the developed countries, as it encourages both the Government and private organizations to monitor the performance of their infrastructure/development projects with a stringent control over their cost and schedule performances.

IMPORTANCE OF PERFORMANCE MEASUREMENT

The performance measurement of construction projects is considered to be one of the most important tasks of plan-do-check-act management cycle. All key stakeholders may wish to monitor the project progress in a timely and reliable manner. It plays a vital role in maintaining the equilibrium between the triple constraints of a project i.e. scope, time and cost. It can also help project organizations to improve their performances by identifying good practices and cut down the weaknesses in their process. Performance measurement can also make certain that the organizations are focused on their key priorities and the areas of poor performance are questioned. Figure 2 exhibits how performance measurement can contribute to effective delivery of services (Osborne & Gaebler, 1992).

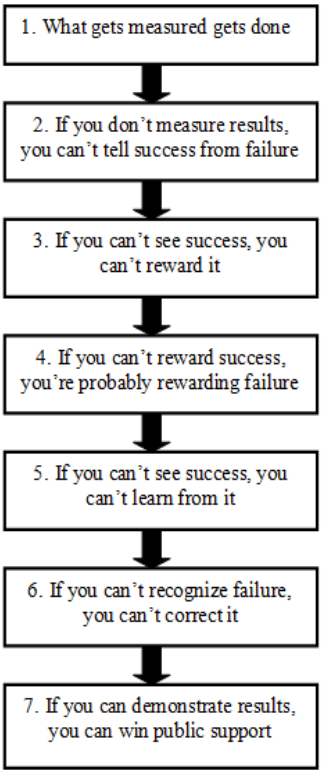


Figure 2. Performance Measurement Supports Effective Delivery of Services

The notion of performance measurement is derived from two basic units, i.e. monitoring and controlling. Monitoring means to aware with the current circumstances of the project. It includes collecting, measuring and distributing performance information, assessing measurements and trends which affect process improvements. It gives project management team a clear insight into the health of the project and identifies any areas that may require special attention. Whereas, control determines corrective or preventive actions and follow up to determine if the actions taken resolved the performance issue (PMBOK®, 2004).

EARNED VALUE (EV) TECHNIQUE FOR PERFORMANCE MEASUREMENT

The Performance measurement of an on going project can be assessed by using different traditional tools like day to day monitoring, monthly or weekly management reports, performance reviews, key performance indicators, , project audit reports etc. In these traditional techniques, usually there are two data sources, the budget (or planned) expenditures and the actual expenditures. The comparison of budget versus actual expenditures merely indicates what was planned to be spent versus what was actually spent at any given time. But how much has been produced? With this approach there in no way to determine the physical amount of work performed. It does not indicate anything about what has actually been produced for the amount

of money spent nor whether it is being produced at the rate, or according to the schedule, originally planned. In other words, it does not relate the true cost performance of the project (Hamilton, B.A. 2006).

Based on these limitations of traditional performance measurement tools, this paper discusses Earned Value Management (EVM) Technique as an effective tool for monitoring and control of construction projects. In EVM, there are three data sources:

– the budget or Planned Value (PV) of work scheduled
– the Actual Value (AC) of work completed
– the Earned Value (EV) of the physical work completed

EVM takes these three data sources and is able to compare the budgeted value of work scheduled (PV) with the Earned Value (EV) of physical work completed and the Actual Value (AV) of work completed (Hamilton, B.A. 2006). Hence, performance data achieved by using EVM is an objective measure of actual work performed and can be used for the future analysis and forecasting. It also supports efficient risk management by providing early identification of possible trouble area. PMI Practice Standard for EVM (2005) stated that EVM can play a crucial role in answering several management questions that are essential to the success of every project, such as;

- Are we ahead of or behind schedule?
- How efficiently are we using our time?
- When is the project likely to be completed?
- Are we currently under or over our budget?
- How efficiently are we using our resources?
- What is the remaining work likely to cost?
- What is the entire project likely to cost?
- How much will be under or over budget at the end?

In addition to this, Earned Value data may be linked to the project "interim payments" i.e. payment by Earned Value to the contractor. It is a mechanism of regular payments to the contractor based on the tangible achievements against the planned work.

EVM is relatively a new project performance measurement technique for the Malaysian construction industries. Currently, it has a limited usage as a project monitoring tool. Therefore, this study examines the available EVM Standards and derived a framework for its implementation during the contract management phase of a PFI project.

APPRAISAL OF THE EVM STANDARDS

This section briefly reviews the EVM Standards which are being used in construction industry from the past one decade. These Standards provide different level of details with expanded approach; however, all of them satisfy the EVM user with their stated objectives (Harris, 2006).

ANSI/Electronic Industries Alliance EVM Standard – 1998
In May 1998, American National Standards Institute (ANSI) set forth 32 steps criteria, named as ANSI/Electronic Industries Alliance 748-A-98 for EVM. According to this Standard:

"Earned Value Management System (EVMS) for program management will effectively integrate the work scope of a program with the schedule and cost elements for optimum program planning and control. The primary purpose of the system is to support program management. The system is owned by the organization and is governed by the organization's policies and procedures."

This Standard describes five processes to implement EVM in managing projects at programme level. These processes are further elaborated by using 32 guiding steps which provides an overall structure for an integrated performance measurement system.

PMI Practice Standard for Earned Value Management – 2005
According to this Standard:

"It has been developed as supplement to A Guide to the Project Management Body of Knowledge (PMBOK® Guide). The Practice Standard for EVM is designed to provide readers who are familiar with the PMBOK® Guide with a fundamental understanding of the principal of EVM and its role in facilitating effective project management."

The standard describes the basic elements of EVM i.e. Planned Value (PV), Earned Value (EV), and Actual Cost (AC) and examines their derivation and relationships in detailed. It discusses the EVM performance analysis and forecasting. This Standard outlines the structure of EVM processes which consists of 10 criteria and organized into two high level categories.

Australian Standards for EVM – 2006
According to this Standard:

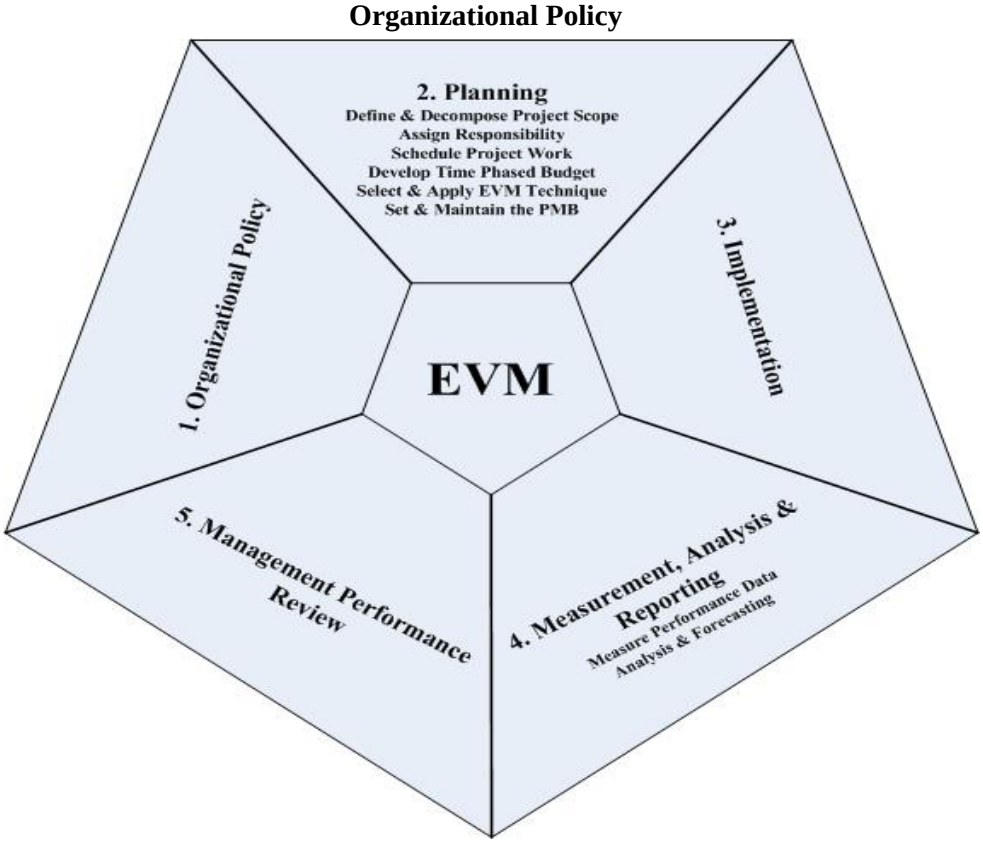
"It establishes requirements and gives guidance for the measurement and reporting of cost and schedule performance of projects and programmes using the EVPM method".

It describes the fundamental notions and actions that are required for the EV performance measurement. It can be applied to any single or multidisciplinary array of projects (i.e. programme). The EVM processes are listed in 11 steps with stipulated requirements for each step.

A PROPOSED FRAMEWORK FOR IMPLEMENTING EVM SYSTEM

A basic framework of Earned Value Management (EVM) System is shown in Figure 3. It comprises of five fundamental elements i.e. organizational policy; planning; implementation; measurement, analysis and reporting; and management performance review. It is derived by understanding the theory of EVM process and by reviewing the EVM Standards as developed by American National Standard Institute (ANSI), Project Management Institute (PMI) and Standards Australia (SA). These elements of the framework interact with each other to form an integrated EVM System for the performance measurement. This framework is not intended to encompassing all, but rather its aim is to provide the organizations with the perceptive view about the implementation of EVM.

Figure 3. Pictorial View of EVM Framework



Top management commitment is indispensable for the adoption and implementation of a well structured EVM System. This will require an organizational policy that set forth the ground rules to support the system. Essentially, without it, the best laid plans are often doomed for failure.

An organizational EVM policy should consider the following requirements, but are not limited to;

- It must set up criteria to prioritize the projects for which EVM System applies.
- It must provide sufficient information regarding organizational process and procedures in order to plan and implement the EVM System.
- It must be consistent with the EVM Standards.
- It must provide guidelines for the training of project team members/staff in order to understand the principles of EVM and its practical usage in project management.
- It must be equipped with an effective and efficient data collection, reporting and analysis system.
- It must be communicated to all stakeholders involved in planning, implementation and use of EVM System.

Planning

Planning of EVM System is the next important step after setting up the organizational policy. It consists of all the processes with specific requirements that are essential for the implementation of an EVM System and are aligned with the EVM Standards. These are as follows;

Define and Decomposing the Project Scope

The planning process starts with the definition of project scope. PMBOK® (2008) defined it as the work that needs to be accomplished to deliver a product, services or results with the specified features and functions. The project scope is then decomposed into discrete elements or work tasks by using work breakdown structure (WBS) tool. WBS helps and organizes the project scope to a lowest level i.e. work package levels where cost and schedule development, estimation and control can be managed. A typical level 4 WBS format is shown in Figure 4.

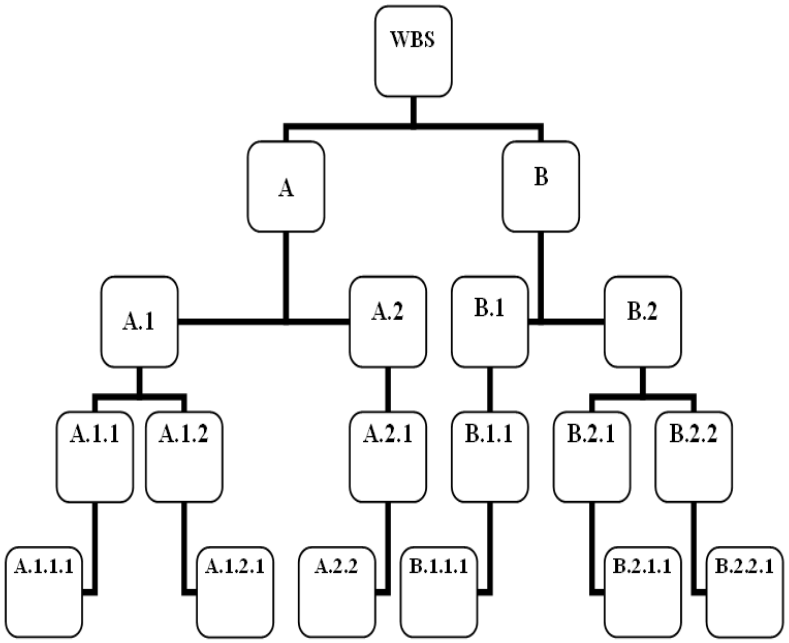


Figure 4. A Level 4 Work Breakdown Structure

Assign Responsibility

Roles and responsibilities for the execution of various work package activities need to be defined and assigned accordingly to the project team. This process can be achieved by the use of Responsibility Assignment Matrix (RAM). It describes the association between the work package activities and the project team. RAM is also known as RACI matrix and it is derived from the four key responsibilities most typically used;

i. R: Responsible
ii. A: Accountable
iii. C: Consulted
iv. I: Informed

Table 1 illustrates an example of RAM matrix. Left hand column shows the work package activities as a deliverable and the top horizontal axis represents the assigned roles and responsibilities to each individual member of the project team.

Table 1. RACI Chart

RACI CHART				
Activity	**Project Team Member**			
	X	***Y***	***Z***	***Z_1***
Design	R	C	A	I
Review	C	R	I	A
Approve	I	A	R	C
Execute	A	I	C	R

Schedule Project Work

A project schedule consists of work package activities with planned start and finish dates. As stated earlier, work package activities are the lowest level activities in a work break down structure, which can not be further subdivided. Each of these activities is then estimated in terms of resource requirement and time. Project schedule describe the sequence of work and identify all interdependencies required to deliver the project scope.

Develop Time-Phased Budget

Project schedule integrates the scope, time and cost for the work package activities and results in a time-phased budget. This is also known as Performance measurement baseline (PMB) as shown in Figure 5. PMBOK® (2008) states that PMB is developed as a summation of the approved budgets by time and is typically displayed in the form of S – curve.

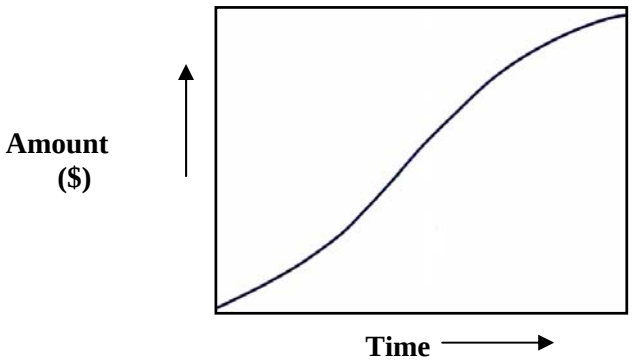


Figure 5. A typical S-Curve (Time Vs $)

Select and Apply the Earned Value (EV) Technique

EV technique is used for the performance measurement of work package activities. It is an objective measure of work performed. PMI-Practice Standard for EVM (2005) provides guidelines for selecting EV measurement technique in detailed manner. Table 2 shows some of the common techniques;

Table 2. Earned Value Measurement Technique

Product of Work	Duration of Work Effort	
	1 – 2 Measurement Periods	> 2 Measurement Periods
Tangible	Fixed Formula	Weighted Milestone Percent Complete
Intangible	Apportioned Effort Level of Effort	

Set and Maintain the Performance Measurement Baseline (PMB)
PMB is considered as a plan against which the project performance is measured and compared with the stipulated performance level. It is therefore necessary that the PMB must be realistic and rational. Its sustainability must be ensured throughout the project life cycle as a standard stable baseline to measure the overall project progress. However, PMI-Practice Standard for EVM (2005) mentions two reasons to change or update the status of PMB;

i. If the work scope is changed, then the estimated cost and possibly the schedule will change, and all of these changes need to be reflected in a revised baseline.

ii. If poor performance in the past is rendering the baseline worthless as a tool for measuring present performance, then a revised baseline must be justified.

Implementation
Implementation of EVM System is the realization of an organizational policy and a matter of doing the planning elements in lined with the project Work Authorization System (WAS).

Measurement, Analysis and Reporting
This is an essential element of the EVM Framework and ensures that the system is implemented as planned. This section comprises of two basic requirements which are discussed below in order to monitor and measure the project progress on a regular basis.

Measuring Performance Data
During the project execution, cost and performance information is measured in order to find out the resource utilization on a regular basis. Planned Value (PV), Actual Cost (AC), and Earned Value (EV) of the work package activities are tracked to ensure the integrity of PMB. PMI - Practice Standard for EVM (2005) strives to objectively measure the physical progress of work. The more this technique achieves this goal, the better it performs its role of performance management and the more it contributes to effective project management. The pre-defined earned value crediting techniques of the planning phase is now used to determine the physical progress in an objective manner.

Analysis and Forecasting
In addition to the PV, AC and EV, there are other indices and forecast elements that require appropriate concern. PMI-Practice Standard (2005) for EVM explains these elements as follows;

- **Variances:** Schedule Variance (SV); Cost Variance (CV); and Variance at- completion (VAC)
- **Indices:** Schedule Performance Index (SPI); Cost Performance Index (CPI); and To Completion Performance Index (TCPI)
- **Forecast:** Time Estimate at Completion (EAC_t); Estimate at Completion (EAC) and Estimate to Complete (ETC)

Table 3 provides a set of basic EVM performance measures to analyze the project performance data. These can be used to measure the current project progress as well as forecast its future trends.

Table 3. Interpretation of Basic EVM Measures

Performance Measures		Schedule		
		SV > 0 & SPI > 1.0	**SV = 0 & SPI = 1.0**	**SV < 0 & SPI < 1.0**
Cost	CV > 0 & CPI > 1.0	Ahead of Schedule Under Budget	On Schedule Under Budget	Behind Schedule Under Budget
	CV = 0 & CPI = 1.0	Ahead of Schedule On Budget	On Schedule On Budget	Behind Schedule On Budget
	CV < 0 & CPI < 1.0	Ahead of Schedule Over Budget	On Schedule Over Budget	Behind Schedule Over Budget

Management Performance Review

Management review is an important and a final element of EVM Framework. It must be done at specified intervals to review the EVM performance measures for answering the management questions.

Management performance review of EVM System may include:

- Objectives and targets
- Timelines for project deliverables
- Schedule analysis
- Cost analysis
- Project performance analysis
- Risk related issues
- Identification and remedial measures for problematic areas
- Corrective/preventive measures

It is anticipated that after the management review, the PMB will be revised or updated to replicate the outcome of the review process. By doing this, the integrity of PMB is maintained as a standard baseline for future performance evaluations.

CONCLUSIONS

This paper presents EVM Framework for the performance measurement of PFI construction projects in Malaysia. The framework is derived by reviewing and synthesizing the EVM Standards as adopted by the construction industries in USA, UK, South Korea and Australia. This framework could also be used for other Government funded projects beside PFI/PPP projects where schedule and cost performance are critical parameters for contractor evaluation. The performance measurement by using EVM System enables the project organizations to

monitor their performance with an open eye. EVM can integrate the cost, schedule and physical progress in an objective, relevant and quantifiable manner.

Descriptive case studies are also planned in order to demonstrate the practical application of EVM Framework on construction projects. This paper is a part of the ongoing research at Civil Engineering Department of University Teknologi PETRONAS (UTP) and it provides the Malaysian construction organizations a good understanding about the implementation of an EVM System in their PFI/Government funded projects.

REFRENCES

ANSI/EIA-748-A for *Earned Value Management Standard, 1998*

AS-4817 for *Project Performance Measurement Using Earned Value, 2006*

Akintoye, A., Taylor, C., and Fitzgerald, E. (1998). *Risk analysis and management of Private Finance Initiative projects*. Eng., Constr., Archit. Manage., 5(1), 9 – 21.

Hamilton, B.A. (2006). *Earned Value Management Tutorial Module1: Introduction to Earned Value Management*, United States of America Department of Energy, http://www.science.doe.gov/opa/pdf/FinalModule1.ppt.

Gunasegaram (2006). *Why PFIs Are Going to Face Problems*. Master Builders, 3rd Quarter 2006, 100.

Harris, P., (2006). *Comparison of Earned Value Standards*. Eastwood Harris Pvt. Ltd. Chapter 2, 03

KPMG International (2007). *Building for prosperity: Exploring the prospects of Public Private Partnership in Asia Pacific*, Chapter 1, 02

http://www.kpmg.com/CN/en/IssuesAndInsights/ArticlesPublications/Documents/ppp_aspac_O_0703.pdf

Osborne, D., Gaebler, T. (1992). *Reinventing Government, How the Entrepreneurial Spirit is Transforming the Public Sector*.

Patricia, C., Herbert, R., Peter, F., Chimay, A., and Dino, B. (2008). *Participation, Barriers, and Opportunities in PFI: the United Kingdom Experience*. Journal of Management in Engineering, Vol. 24, No. 3, July 1, 2008

PMI *Project Management Body of Knowledge (2004)*. Chapter 12, 291.

PMI *Practice Standard for Earned Value Management (2005)*. Chapter 1 – 4,

PMI *Project Management Body of Knowledge (2008)*. Chapter 4, 89.

Public-Private Partnership Unit. *Public Private Partnership (PPP) Guideline (2009).* Prim Minister Department, Putrajaya, Chapter 3, 09

Syuhaida I. and Aminah Md. Y. (2008). *Understanding of the Conceptual and Philosophical of Malaysia's Version of Private Finance Initiative (PFI) in the Provision of Public Infrastructure*. Proceedings of MICRA 2008 7th Conference and Annual Meeting, International Islamic University of Malaysia (IUUM), Gombak, 18th – 19th June, 2008.

Takim, R., Ismail, K., Nawawi, A.H., Jaafar, A., (2009). *The Malaysian Private Initiative and Value for Money*, Vol.5, No. 3, 103 – 111.

Yakcop, N.M. (2006). *Minister of Finance II, Key note address in Private Finance Initiative (PFI) Seminar*, Impiana Hotel, Kuala Lumpur.