

**EARN VALUE MANAGEMENT FOR PERFORMANCE  
MEASUREMENT IN PUBLIC HOUSING  
CONSTRUCTION PROJECTS IN SRI LANKA**

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Degree of Master of Science

Department of Building Economics

University Of Moratuwa

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This dissertation was submitted in partial fulfillment of the requirements  
for the Degree Master of Science in Project Management

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Sri Lanka

June 2016

## **DECLARATION**

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I declare that this is my own work and this dissertation does not incorporate without acknowledgement any material previously submitted for a Degree or Diploma in any other University or Institute of higher learning and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text.

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Department of Building Economics  
University of Moratuwa

.....

Date

The above candidate has carried out research for the Masters Dissertation under my supervision.

.....

Signature of the supervisor

.....

Date

## **DEDICATION**

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*To my family and to those who gave me  
the support that needed*

## **ACKNOWLEDGEMENT**

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This study is an outcome of much remarkable assistance received from many personnel and organizations, who contributed in ample ways to complete successfully. I wish to take this first instance to acknowledge my gratefulness to the persons who were helping me to complete this research well, without whom, I would not be able to complete a productive project.

First and foremost, I pay gratitude to my dynamic and inspirational supervisor, Dr. K.A.K. Devapriya, for all the guidance, assistance and continuous encouragement provided to me. I am also indebted to him for the constructive criticisms and most importantly for his astonishing patience.

I also convey my earnest thanks to Dr. Y.G. Sandanayake to the support given as the Head of the Department of Building Economics as well as key contributor to the knowledge on research methodologies.

It is my duty to highly appreciate the initial assistance provided to me by Dr. Joachim, the former Chairman of State Engineering Corporation of Sri Lanka, for his encouragement, contribution, values and ideas, valuable assistance and especially his commitment towards this research.

Also, I convey my earnest thanks to my loving husband who always encouraged me to do the best for this research. Without the active support I obtained from the participants of the data collection process, this research would not be successful. Therefore, I wish to express my greatest appreciation to all the practitioners in the industry who contributed to this study.

W.D.C. Harshani

## **ABSTRACT**

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Most of construction organizations use project budget when commencing the project. but most of organizations don't properly monitor and use it as a performance measurement tool from the beginning to end of every project. There is no proper basis or standard practice in construction projects for preparing a project budget where Budgeted cost for work performed (BCWP) can be accurately calculated for performance measurement. If there is a proper framework to evaluate the budget, mainly, project team can understand the financial and physical progress of the project rather than other benefits of having a project budget.

Earned Value Management (EVM) has been used in other industries such as software and product development businesses. Its applicability within the construction industry as risk-free performance measurement tool is still been overlooked in the industry. EVM supports effective management of projects and work packages collectively and enhances management of the enterprises' project portfolio. Forecasting using these techniques provides a uniform approach to project reviews, building confidence in the project outcome as time progresses.

The concept of EVM, process of EVM, benefits & potential drawbacks have been discussed at literature synthesis. Case study approach was selected for research methodology and Semi-structured interviews, for data collection with the professionals in construction projects to investigate the basic elements which may have in a costing framework and as well as conduct a case study for evaluating the feasibility of the proposed costing framework for evaluating the project budget.

Therefore, this research intends to identify a framework to prepare a proper cost budget for public housing construction projects using which, BCWP can be accurately calculated. Usability of EVM in practice is reflected with the measurement of physical progress with the budgeted and actual cost of the housing project.

**Key words:** *Performance Measurement, Earn Value Management, Project Budget, Public housing*

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## **LIST OF ABBREVIATIONS**

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AC	–	Actual Cost
ACWP	-	Actual cost for the work performed
BCWP	-	Budgeted cost for work performed
BCWS	-	Budget cost of work scheduled
BOM	–	Bill of Materials
CV	-	Cost Variance
EAC	-	Estimate At Completion
EV	-	Earned Value
EVA	-	Earn Value Analysis
EVM	-	Earn Value Management
EVMS	-	Earn Value Management System
G & A	-	General & Administrative
MHBP	-	Mass House Building Projects
OBS	-	Organizational Breakdown Structure
PC	–	Percentage Complete
PM	-	Project Manager
PMB	-	Performance Measurement Baseline
PMI	-	Project Management Institute
PMP	-	Project Management Professional
PV	-	Planned Value
QS	-	Quantity Surveyor
SEC	–	State Engineering Corporation
SPM	-	Senior Project Manager
SV	-	Schedule Variance
WBS	-	Work Breakdown Structure



## **CHAPTER 01**

### **1.0 INTRODUCTION TO THE RESEARCH**

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#### **1.1 BACKGROUND**

The technology, being used in today's projects is increasing in complexity as the state of the art of technology is being pushed to it's all the heights. The level of suitably skilled human resources is often limited and in a great cost, and the scope of work and contract costs are continually growing resulting in the need of having efficient monitoring and controlling tools to measure project performance (Naeini, 2013). Project controlling tools are commonly used in the construction industry as thus, most of the construction projects still suffer from the cost and time overruns due to a multiplicity of the factors (Bhosekar & Vyas, 2012). Performance measurement of a construction project as a project planning and control system that goes beyond the traditional concept of comparing the amount of project time elapsed against the amount of actual cost spent to give a comparison of actual value of work accomplished against the planned value of work scheduled (Naeini, 2013).

Schedule execution and management refers to schedule controlling techniques such as methods for measuring work progress, analyzing data, reporting results and taking corrective actions (Gurmu et al., 2016). Some of techniques include units completed, incremental milestone, start/finish, supervisor judgment, S-curve, time variance and forecast, analysis tree, percent complete report, activity crashing and activity overlapping (Attalla, 1997). Delay in the progress of a particular sub contractor could affect the progress of others and lead to overall project delay. Thus, implementation of the schedule controlling techniques might be an important practice in construction organizations (Gurmu et al., 2016).

Earn Value Management (EVM) is a methodology used to measure and communicate the real physical progress of a project and show its true cost situation. In accordance with the definition given by Project Management Institute (2005), EVM is a methodology used to evaluate and to communicate the actual progress of a project taking into account other work complete, the time taken and the costs incurred to complete that work. Further, it can be described as Earned Value (EV) is a program management technique that uses "work in progress" to indicate what will

happen to work in the future. EVM uses cost as the common measure of project cost and schedule performance. It is vital for the contractors to operate an effective performance control procedure during the post contract stage of project to keep the cost of the scheme within the budget (Sanni & Durodola, 2012).

EVM is not a specific system or a tool but rather, a set of guidelines that guide a company's management control system. Furthermore, EVM is a development over traditional accounting progress measures. Traditional methods only focus on planned cost or income and actual costs or incomes. However, EVM goes one step further and examines actual accomplishment (Bhosekar & Vyas, 2012).

According to Naeini (2013), it is necessary to have reliable forecasts at the beginning of a project or when a percentage of the project has been performed due to existence of risk factors of cost and time overrun even when there have been detailed plots. Two of the most important documents prepare for any project are the project schedule and the project budget (PMP study guide, 2013). Project schedule and project budget documents throughout the executing, monitoring and controlling processes to measure progress and determine if the project is on track. To prepare the budget it should understand that, the activities have been defined and the resource estimates calculated. According to PMP study guide, there are three processes will perform that lead to the cost baseline output. The cost baseline is the authorized budget. The processes are plan cost management, estimate costs and determine budget (PMP study guide, 2013).

It is advisable to ask team leaders and functional managers to review cost and schedule mathematical forecasts and to provide their own objective forecasts for their own work areas in advance of issuing project performance reports and conducting project review meetings. Forecasting in project management may well be a self-defeating prophecy, and that may be good for the organization. Large deviations usually attract management's attention and result in corrective action. Small deviations are usually left alone (Anbari, 2003). EVM helps to focus management's interest on projects or work packages that need the most attention. As a result, EVM supports effective management of projects and work packages collectively and enhances management of the enterprises' project portfolio. Forecasting using these techniques provides a uniform approach to project reviews, building confidence in the project outcome as time progresses (Anbari, 2003).

By reviewing these details, it can argue that forecasting of project budget is very essential to project performance monitoring and controlling. Every project has a budget, and part of completing a project successfully is completing it within the approved budget. The need of change, for implementation of much better and latest project budgeting system, should flow through the ownership of the organization to its grass-roots at the site level (Khan, 2003).

## **1.2 PROBLEM STATEMENT**

BCWP is one of the main parameters used in the application of EVM. However, there is no proper basis or standard practice in construction projects for preparing a project budget where BCWP can be accurately a framework to performance measurement. Therefore this research intends to identify a framework to prepare a proper cost budget for housing construction projects using which, BCWP can be accurately calculated.

## **1.3 AIM**

This research is aimed to identify a framework to prepare a proper cost budget for Public housing construction projects using which, BCWP can be accurately calculated.

## **1.4 OBJECTIVES**

1. To identify EVM as a project performance measurement tool.
2. To analyze performance measurement with the construction cost budgeting in Public housing construction.
3. To propose cost controlling techniques with a budget framework for project management practices in Public housing projects.



## **1.5 RESEARCH METHODOLOGY**

### **Literature Survey**

An introduction to the research including findings of previous studies was given in literature synthesis. It has elaborated the concept of EVM and construction cost budgeting. It was carried out through previous research papers, journals and articles in order to elaborate the key words of the research as well as to prepare the framework.

### **Data Collection**

Case study approach was selected for research methodology and semi-structured interviews, for data collection with the professionals in construction projects to investigate the basic elements which may have in a costing framework and as well as conducted three case studies for evaluating the feasibility of the proposed costing framework for evaluating the project budget.

### **Data Analysis**

Qualitative and quantitative data analysis methods are used to analyze the collected data. Based on that, it analyzed the professional views of project budget and its applications in public sector construction organization.

## **1.6 SCOPE AND LIMITATIONS**

This research is mainly focused on preparation of budget framework for construction projects under taken by public sector construction organizations. The ageing and increasing of population demographics allied with a sustained under build of new housing provision is pressing need for a marked increase in the levels of housing provision in the private and public sector. Hence the engagement of public sector construction organizations in Sri Lanka for constructing housing complexes are increasing rapidly same as private sector, the researcher has narrowed down the scope of research to housing construction in Sri Lanka.

## 1.7 STRATEGY OF ACHIEVING RESEARCH OBJECTIVES

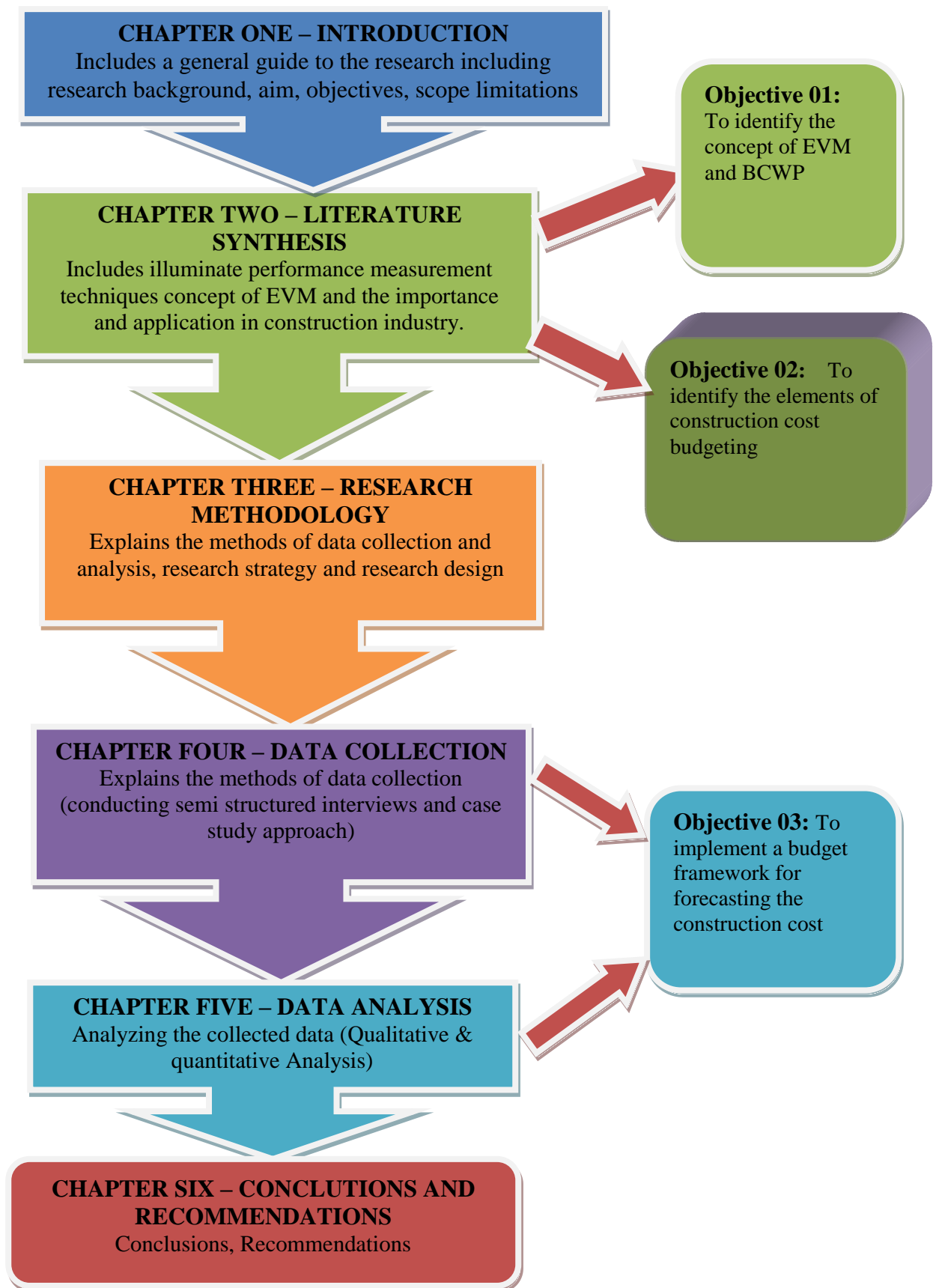


Figure 01- strategy of achieving the research objectives

Source : Author

## CHAPTER 02

### 2.0 LITERATURE SYNTHESIS

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#### 2.1 INTRODUCTION.

The introduction chapter described the background for the study and the aim and objective of the research. Therefore, to investigate the appropriate literature on the research area, "literature synthesis" had conducted. It has conducted through the literature findings regarding the project performance measurement techniques which are used in Construction Industry, the concept of Earned Value Management (EVM), and basic elements of a costing framework of a forecasting budget for a construction project.

#### 2.2 PROJECT MANAGEMENT

Project management approach is relatively modern. Like most organisational efforts, the major goal of a project is to satisfy a customer's needs. Beyond this fundamental similarity, the characteristics of a project help differentiate it from endowers of the organisation. Project should not be confused with everyday work. A project is not routine, repetitive work. A project is usually a one-time activity with a well-defined set of desired end results. It can be divided into sub-tasks that must be accomplished in order to achieve the project goals. The project is complex enough that the sub tasks require careful coordination and control in terms of timing, precedence, cost and performance. Often the project itself must be coordinated with other projects being carried out by the same parent organisation (Jack et al., 2010).

The project life cycle typically passes sequentially through four stages: defining, planning, executing and delivering. The starting point begins the moment the project is given the go-ahead. Project effort starts slowly, builds to a peak and then ebbs to delivery of the project to the customer.

1. **Defining stage:** specifications of the project are defined; project objectives are established; teams are formed; major responsibilities are assigned. The project is given the go-ahead to become initiated.

2. **Planning stage:** the level of effort increases and plans are developed to determine what the project will entail, when it will be scheduled, whom it will benefit, what quality level should be maintained and what the budget will be.
3. **Executing stage:** a major portion of the project work takes place both physical & mental. The physical product is produced time, cost and specification measures are used for control.
4. **Closing stage:** closing includes three activities; delivering the project to the customer; redeploying project resources; and post-project review. Delivery of the project might include change management, customer training and transferring documents. Redeployment usually involves releasing project equipment/materials to other projects and finding new assignments for team members. Post project reviews include not only assessing performance but also capturing lessons learned (Larson et al., 2014).

Project management is no longer a special – need management. It is rapidly becoming a standard way of doing business. The generation of project cash flows is crucial for both project managers and project owners. During project implementation, the cash flow is crucial for the assessment of working capital requirements.

### **2.3 PROJECT PLANNING AND CONTROLLING TECHNIQUES**

Planning is an important component of the planning and control cycle, because the planning process not only establishes what is to be done, but also smooth the way to ‘make it happen’. The challenge is to select and apply the available planning tools and techniques effectively (Alexander, 1998). Planning asks questions, encourages participation, creates awareness, prompts action, solves problems and formalises decisions based on consensus. Although the planning steps are outlined as a sequence of discrete operations, in practice other factors may influence the sequence and there almost certainly be a number of iterations, compromises and trade-offs before achieving an optimum plan (figure 2.1 – planning and control cycle) Project control cycle is presented as a sequence of steps to guide the project to a successful completion. The baseline plan outlines the course to steer, but once the project starts

it can be sure things will deviate; be it late deliveries, sickness, absentees or scope creep (Burke, 2003).

The components which make up the total project cost may vary from project to project. The building contract cost and resource cost are the two components which the client is most likely to require the PM to manage, but there are others which the client may, or may not, delegate to the PM (David, 1994). Some of resource costs, have an element of confidentiality, and it is possible for consultants to object to details of their fees being disclosed, particularly in times when competition is fierce. In these circumstances, total cost management and reporting must be undertaken by the PM, while the cost consultant is given the responsibility for the building contract cost advice only.

## **2.4 PROJECT PERFORMANCE MEASUREMENT**

The success of a construction project depends on a number of factors, such as project participants, the competency of project managers, and the abilities of key project members (Cheung et al., 2004).

Successful project delivery requires the concerted effort of the project team to carry out the various project activities, but it is the project manager who, at the center of the project network, is responsible for orchestrating the whole construction process. The project manager has to maintain the project network and monitor against slippages in cost, time and quality for the duration of the project.

In achieving this, the project manager relies heavily on a reliable monitoring system that can provide timely signaling of project problems, whether they are real or potential (Cheung et al., 2004). Performance Measurement has increased (Yu, Kim, Jung, & Chin, 2007). Never before have the pressure on project managers been as great as it is at the present to successfully satisfy the criteria of time, cost and quality in the completion of the projects for which they are responsible. The level of suitably skilled human resources is often limited and in a great cost, and the scope of work and contract costs are continually growing resulting in the need of having efficient monitoring and controlling tools to measure project performance (Naeini, 2013). Figure 2.1 shows the how performance measurement affects to project success.

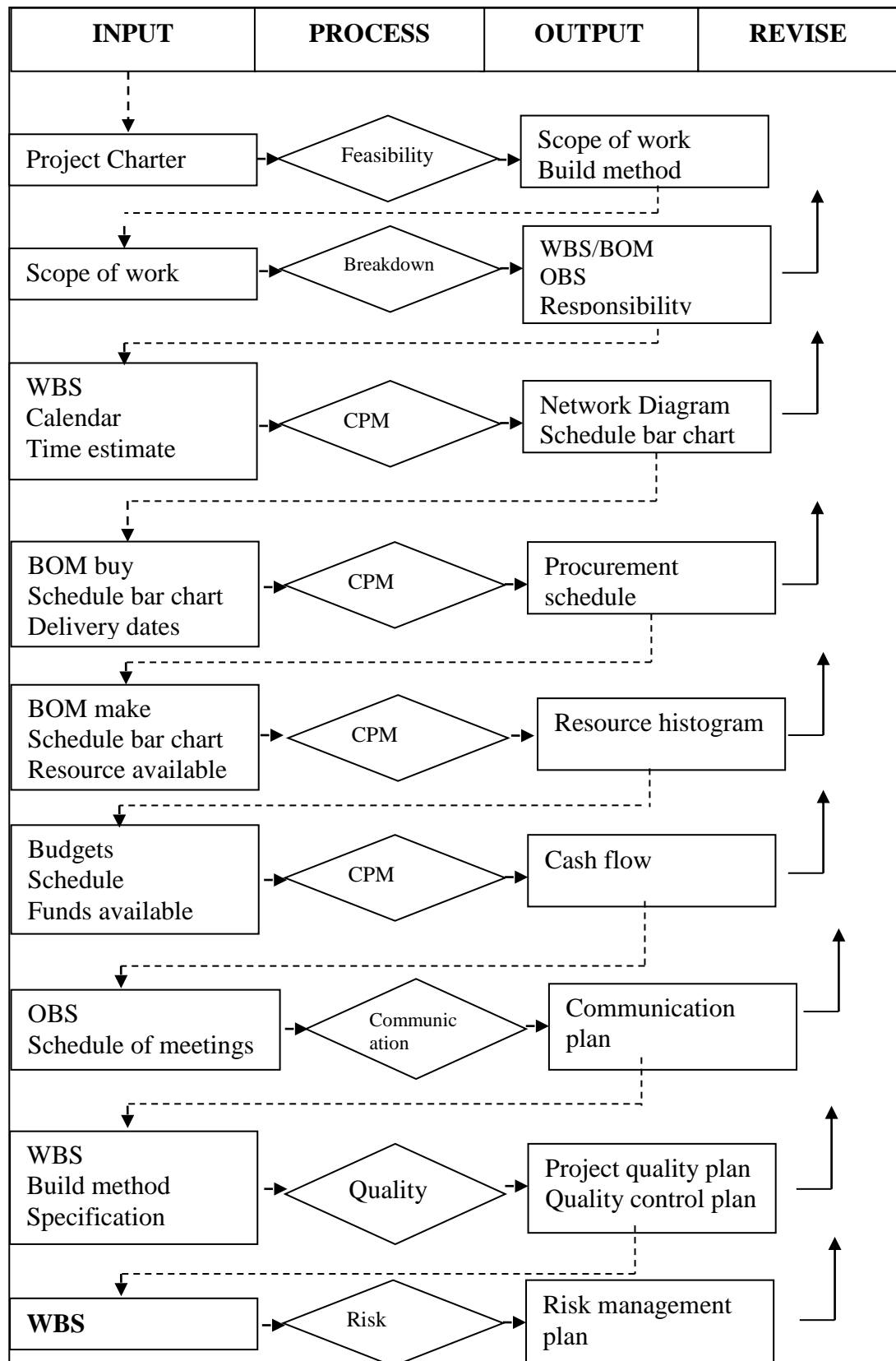
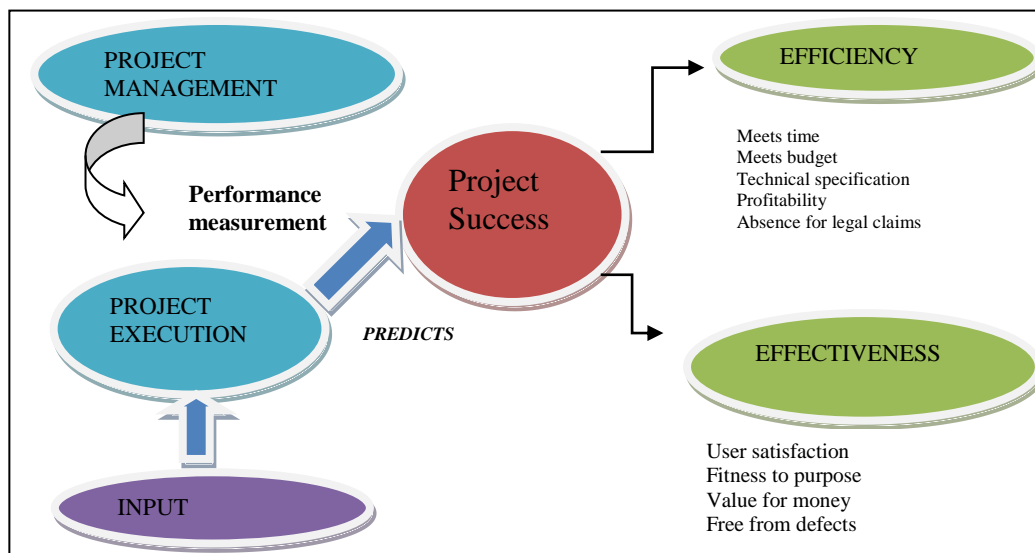


Figure 2.1- Planning and control cycle

Source : (Meredith & Samuel , 2010)

Furthermore, the author defined the performance measurement of a construction project as a project planning and control system that goes beyond the traditional concept of comparing the amount of project time elapsed against the amount of actual cost spent to give a comparison of actual value of work accomplished against the planned value of work scheduled. It is essential for effective project control that performance is measured while there is still time to take corrective action (Burke, 2003).

EVM is a project performance evaluation technique that has originated in industrial engineering, but which has been adapted for application in project management. Although the earned value technique was initially set up to track the progress of cost and time, in practice it is often more appropriate to track progress measured as earned man-hours and time (Burke, 2003). EV is also a measure of progress. As we shall see later, there is a direct relationship between EV and percent complete. The attributes of EV are threefold. First, it is a uniform unit of measure for total project progress or for any sub-element of the project. Second, it is a consistent method for analysis of project progress and performance. Third, it is a basis for cost performance analysis of a project (Takim et al., 2002).



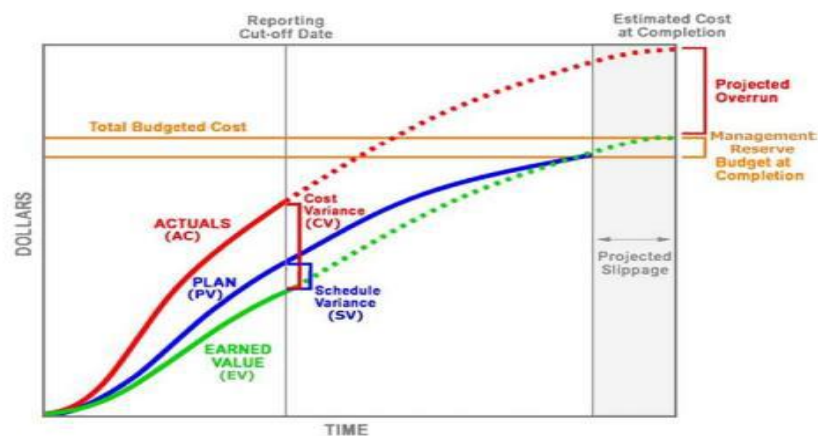
**Figure 2.2: Performance Measurement for Project Management**  
Source: (Takim & Akintoye, 2002)

## **2.5 EARNED VALUE MANAGEMENT**

EVM establishes a work package EV baseline by integrating project scope, time schedule and cost objectives. This baseline, called control account, is used for performance evaluation on a given date. Analysis of variances from the baseline provides cost- related information for problem identification, trend analysis and corrective action including re-planning and revision the budget (Daniel, 1984).

EV provides a uniform unit of measure for reporting progress of a project. The traditional units that are used include working hours and dollars. For labor intensive efforts, working hours are often considered adequate in such instances; the financial details of the remaining project cost are controlled by the accounting system. These costs include subcontractors, overheads and other direct costs.

When the entire project cost is to be controlled from the project control system, then it is more effective to use dollars as the unit of measure for EV (Raby, 2000). Since each labor hour has a price, dollars can be used to control labor as well. However, when using dollars, additional factors enter into the performance evaluation. This includes salary rate differences, overhead adjustments and differences.



**Figure 2.3: Graphical Presentation of Earned Value Analysis**  
Source (Pajares & López-Paredes, 2011)

EV also is a consistent method for analysis of project performance. Suppose that someone asks the bricklayers and the carpenters how they're doing. You are likely to get different answers, influenced not only by how they are actually doing, but also by how they calculate their plan and their progress. As we shall see below in the



discussion of “How,” using EV establishes a particular method for determining what the plan to date is and what the progress actually achieved is (Alexander, 1998).

There is a difference between EV and Earn Value Management System (EVMS) criteria. EV is a special metric that can be used to manage any project. The criteria are standards for management control systems that use EV (David, 1998). According to David (1998), further that researcher has described, EV is a metric devised to achieve meaningful comparisons between planned and completed work. It is similar to what accountants call a “flexible budget,” where the original budget for work is adjusted for the actual level of output. Cost variances result when the actual cost of the work and its flexible budget differ. A major difference between a flexible budget and EV is the time dimension associated with EV. Initially, the work on a project is divided into pieces, assigned a budget, and assigned a schedule.

### **2.5.1. Earned value parameters and variance measures**

According to Daniel (1984), commonly used budget monitoring parameters are:

1. Budget cost of work scheduled (BCWS). This represents time-phased cost projections planned in the budget. It shows the cumulative planned value (PV) scheduled to be achieved on the data date
2. Budgeted cost for work performed (BCWP). This shows the cumulative cost planned for the work performed on data date. It is the earned value (EV)
3. Actual cost for the work performed (ACWP). This is the total actual cost incurred to date in progress the works.

### **2.5.2 Earned value forecast**

When the integration of cost and time are combined with forecasting the project manager has the best of both situations (Burke, 2003).

#### **2.5.2.1. Estimate At Completion (EAC)**

According to Burke (2003), the EAC is a revised budget for the activity, work package or project, based on current productivity. The EAC is calculated by extrapolating the performance trend from time now to the end of the project. This value assumes that the productivity to date will continue at the same rate to the end of the project.

### **2.5.3 Process of Earned Value Management**

At this point we come to the practical part of actually seeing how EV is applied on any project (Takim et al., 2002). There are 5 steps in setting up the Earned Value system on a project, and 4 steps in using it. These steps are described generically but they are the same for all projects.

#### **2.5.3.1: Establish the Work Breakdown Structure (WBS)**

The WBS is the roadmap for analyzing the project progress and performance. It provides a multi-level structure for analyzing the project at varying degrees of detail. A properly defined WBS also provides that each element of the structure at each level is the responsibility of an individual who has management authority over that element and all the elements that roll up into that element. Furthermore, the WBS must contain the full scope of the project. Otherwise, the information generated will not represent the total project.

The WBS is generally a hierarchical structure in which each lower level element rolls into one and only element at the level above it. The bottom level of the WBS should be the activities of the project. The key here is that each element has a responsible individual identified with it and each element represents a part of the project that someone or more people are interested in monitoring. While this personal responsibility might bring to mind an Organizational Breakdown Structure (OBS), the WBS should not be confused with an OBS. either structure can function as the framework for analyzing the project performance.

#### **2.5.3.2. Identify the Activities**

The second step is to identify the activities of the project. The WBS provides the framework for identifying the project components. Each activity should be assigned to one element in the WBS. The completion of this step will produce the project schedule of activities in a network system.

#### **2.5.3.3. Allocate the Costs**

The third step is to identify and allocate the costs to be expended for each activity. Since an activity represents a finite effort within the project, it has duration of time and it requires the expenditure of some resources. The practitioner needs to decide whether to use labor resources only, such as work hours, or to use dollars and load all

project costs into the schedule. The allocation of resources (costs) requires a choice of the degree of detail with which one will allocate the resources. These options include linear spread across the duration of the activity or use of a curve to approximate the expected expenditure during the activity's execution.

#### **2.5.3.4: Schedule the Activities**

The fourth step is to calculate the schedule of the activities. This step generally provides the spread of the resources over the entire time duration of the project.

#### **2.5.3.5: Tabulate, Plot and Analyze**

The final step is to tabulate and plot the information that was loaded and then to analyze this information. The purpose is to assure that the allocation of resources is properly planned. This includes analysis of individual resources to see if the maximum requirement during any time period is available. It also includes review of cash flows, if cash are entered, to see if the financing plan for the project supports the schedule. Third, it provides a review to see that all project resources and costs that are budgeted are entered into the program. Once these five steps are completed, the project team will have the basis for conducting periodic analysis of the project progress and performance. That process is explained in the next four steps

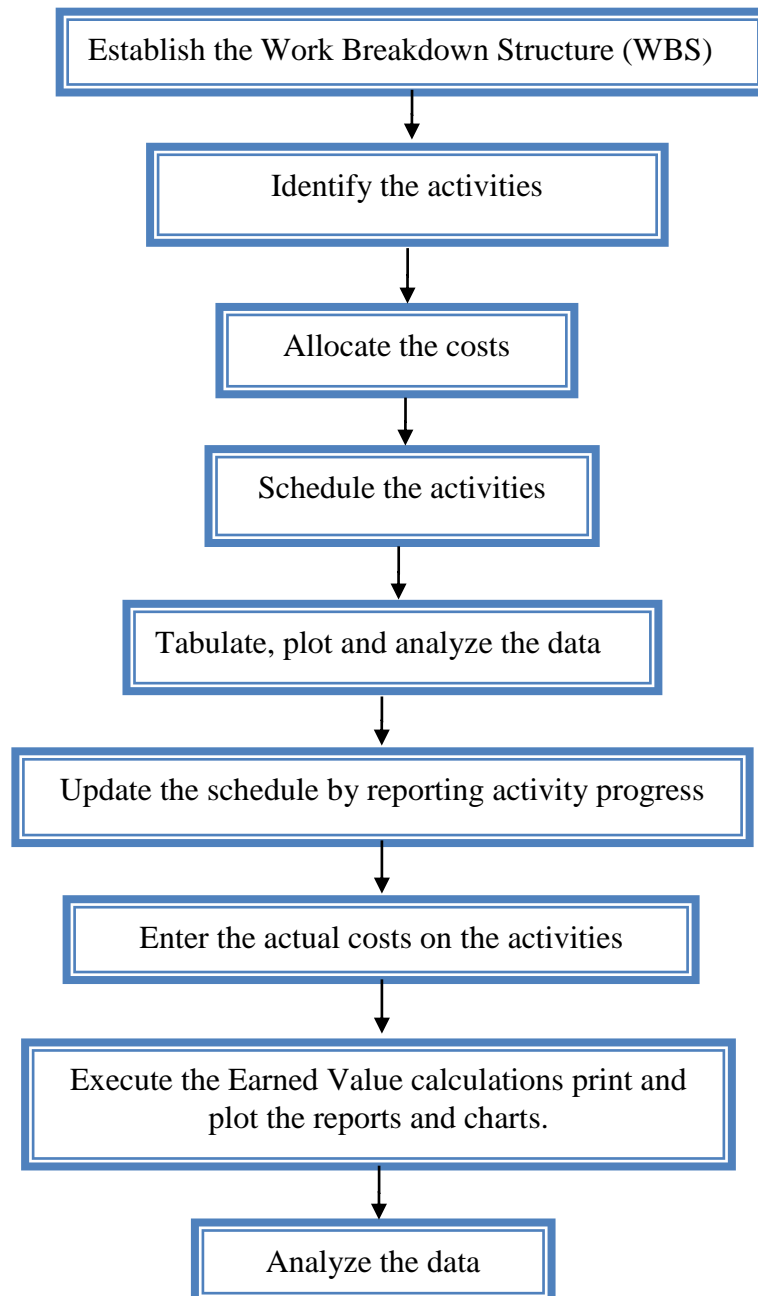
#### **2.5.3.6: Update the Schedule**

The first step in the periodic process is to update the schedule with the period progress. This is generally done whether Earned Value is used or not. The project schedule activities are reported as started, completed or with a remaining duration, as appropriate. The percent complete of unfinished activities should also be reported. Here is where the practitioner should avoid subjectivity. For physical work it may be easy to determine the percent complete. For efforts that are not so easily measured, special earning rules might have to be employed.

#### **2.5.3.7: Enter the Actual Costs**

The second step in the periodic process is to enter the actual costs into the schedule. This information comes from the time sheets and invoices to the project. Whether the data is entered manually or electronically is a matter of choice, depending on the degree of integration between the company's financial accounting system and the project control systems. In any case, it is necessary to determine which costs are to

be allocated to which activity. By proper integration of the financial and project accounting systems, this process is facilitated to the point of total automation. However, human analysis of the actual data is recommended to assure that improper data doesn't inadvertently enter the system.



**Figure 2.4 - Process of EVM**

**Source: (Shtub et al., 1994)**

### **2.5.3.8: Calculate, Print and Plot**

The next step in the periodic process is to calculate the EV and to print reports and plot charts for analysis. The EV is simply the per cent complete of an activity times its budget. This provides the key value in the EV process. Other calculations include the schedule and cost variances, performance indices, estimates at completion and percent complete of the upper elements of the WBS.

### **2.5.4 Earned value variances**

A variance is simply the difference between planned and actual values. According to Burke (2003), in the Earned value context there are a number of important flags to attract the project manager's attention, consider the following:

- Schedule Variance (SV)
- Cost Variance (CV)
- Threshold variance

#### **2.5.4.1. Schedule Variance (SV)**

The schedule variance calculation is a measure of the time deviation between the planned progress (BCWS) and the earned progress (BCWP).

$$\mathbf{SV = BCWP - BCWS}$$

The sign of the variance will indicate if the project is ahead or behind the planned progress:

**Negative Variance:** the project is behind the planned progress.

**Positive variance:** the project is ahead of planned progress

#### **2.5.4.2 Cost variance (CV):**

The cost variance is a measure of the deviation between the earned value (BCWP) and the actual cost of doing the work (ACWP)

$$\mathbf{CV = BCWP - ACWP}$$

The sign of the variance will indicate if the costs are under or over the estimate.

**Negative variance:** the cost is higher than the original estimate (BAC)

**Positive variance:** the cost is lower than the original estimate (BAC)

#### **2.5.4.3 Threshold variance:**

The threshold variances can be used to flag problem areas and attract the project manager's attention. The threshold limits may be set as a percentage to give an early indication of an undesirable trend. Tight variance thresholds allow true management-by-exception, as negative variances should trigger an immediate response helping supervisors to assign priorities and additional resources. Positive variances identify praiseworthy employee productivity which could have an input into productivity bonuses.

#### **2.5.5 Earned value reporting**

According to Burke (2003), the earned value output lends itself to effective reporting for the following reasons.

1. The overall status of the project can be seen at a glance on a graph and the tabular reports present more detailed information at the work package and activity levels.
2. When reporting to functional management the report should clearly indicate the activities that fall under their responsibility. This information can be separately reported if a responsibility field has been included in the data base.
3. The sign of the variance should influence the management response.

**SV (+)** the project is ahead of schedule, move labour off the project if they can be used more effectively elsewhere.

**SV (-)** the project is behind schedule, move resources on to the project to increase production.

**CV (+)** the project costs are less than budget, if significant, amend estimating data base for future projects.

**CV (-)** the project costs are greater than budget, try to increase productivity through efficiency and effectiveness.

#### **Determining percentage complete:**

The weakest link in the earned value calculation is determining percentage complete (PC). If the activity has not started it is zero and if it is complete it is 100%, but all points in between are somewhat of a guess even if you use a structure. A quick way to estimate PC is to use the 50/50 rule, if the job has started give is 50% and when it

is finished give it 100%. This rule can be distorted to 40/60,30/70,20/80 and 10/90. If the work packages or activities are kept small, then this method will work well (Burke, 2003).

- The earned value analysis should not be used in isolation. An activity with a large schedule variance may have plenty of float and not be a problem, while an activity with a small schedule variance may be on the critical path and need prompt action to prevent the project overrunning.
- Estimate at completion (EAC) – is based on the ratio of past performance, but if the original estimate is fundamentally flawed, or performance is significantly different to planned, then the rest of the project should be re-estimated.
- EAC includes the actual costs to date plus the forecast cost-to-complete.
- Cost reserves are budgeted amounts not assigned to any specific work package.

### **2.5.6 Project cash flow cost controlling techniques**

The generation of project cash flows is crucial for both project managers and project owners. During project implementation, the cash flow is crucial for the assessment of working capital requirements since the difference between project expenditures and income determines the necessary capital reserves. Furthermore, an accurate cash flow is required in conducting project cost-benefit analysis, the determination of project financing requirements and in performing EVA (Maravas et al., 2011).

## **2.6 CONSTRUCTION COST BUDGETING**

The budget of any specific project is tied to the organizational budget. In some organizations, a project budget includes only expenditures. In other organizations the project budget includes both income and expenditures. When an organization is involved in several projects, the budgets of these projects are coordinated centrally. It is important to combine the budget of each project to avoid the risk of steering the organization into financial difficulties. This issue should be considered when selecting new projects because it provides a hard constraint in the decision making process (Al-Jibouri, 2003).

Accurate, early cost estimates for engineering and construction projects are extremely important to the sponsoring organization and the project team. For the sponsoring organization, early cost estimates are vital for business unit decisions that include strategies for asset development, potential project screening, and resource commitment for further project development. Inaccurate early estimates can lead to lost opportunities, wasted development effort, and lower than expected returns. Future estimates are often expected to agree with the initial estimates. However, final cost often exceeds the initial estimate (Garold, 2001). The sponsor plans funding based on cash outflow forecast and controls his budgeted amount using techniques like EV control system.

A well-designed budget is an efficient communication channel for management. Through the budget, managers are advised of their organizational goals and the resources allocated to their units. A detailed budget defines expected costs and expenditures, thus setting the framework of constraints within which each manager is expected to operate. These constraints represent organizational policy and goals (Jack et al., 2010). The well-structured budget is a yardstick that can be used to measure the performance of organizational units and their managers (Erik et al., 2014). Managers who participate in the budget development process commit themselves, their subordinates and their unit's resources to the goals specified in the budget as well as the constraints implied by the negotiated funding levels. A successful manager is one who can achieve the budget goals with resources allocated to his or her project, that is, one who can successfully execute the organization's policy. The well-structured budget is also a useful tool for identifying deviations from plans, the magnitude of these deviations, and their source (Avraham et al., 1994).

According to Garold (2001), for the project team, performance and overall project success are often measured by how well the actual cost compares to the early cost estimate. Initial cost estimates are the basis on which all future estimates are compared. In a project, the sponsor/owner and developer have the same objective of completing the project within the specified time and agreed cost, but their goals and approached differ (Erik et al., 2014).



According to Avraham et al., (1994), such organizations develop its own budgeting procedures; several points can help make the budget an efficient vehicle for planning, as well as a standard channel of communication:

1. The budget should present management's objectives stated in terms of measurable outputs.
2. The budget should be presented quantitatively as a function of time. The presentation can be based on a functional structure, a project's organizational structure, or a combination of the two if a matrix structure is assumed.
3. The budget should be divided into long range, mid range and short range levels. Each level should contain a detailed breakdown of the budget at the preceding level for the planning horizon.

### **2.6.1. Project budget & organizational goals**

The budget of an organization reflects management's goals. These goals and organizational constraints determine decisions on project selection, resource allocation, and the desired rate of progress for each project. The budget depends on the perceived organizational mission and the sector to which the organization belongs. It also depends on internal and external environment factors such as competition, profit, cash flow, risk, technological ability, resources and perceived needs (Avraham et al., 1994).

Some of budget analysis techniques can be named as Breakeven Analysis, Cash Flow analysis and EV calculations. A cash flow statement is one of the most important financial statements for a project or business. The statement can be as simple as a one page analysis or may involve several schedules that feed information into a central statement. The management of cash flow is one part of a larger management responsibility known as the management working capital, which refers to the operating liquidity available to an organization. Breakeven point analysis is a measurement system that calculates the margin of safety by comparing the amount of revenues or units that must be sold to cover fixed and variable costs associated with making the sales. In other words, it's a way to calculate when a project will be profitable by equating its total revenues with its total expenses.

EVM integrates project scope, time & cost through periodic measurements of actual cost and work completion. It views project progress in terms of cost as a function of

time against a firm baseline setup at the start of the project. When the project is originally planned, it is divided into WBS. These work packages are assessed for cost estimates and scheduled in a time sequence. By measuring periodic intervals, EVM focuses on the flow rates of actual cost and completion against the planned cost and completion. PV, EV & AC make it possible to compute cost and time variances, as well as extrapolate how much cost and time would be required for project completion.

### **2.6.2. Creating the Project Budget**

In order to develop a project budget, it should forecast what resources the project will require, the required quantity of each, when they will be needed, and how much they will cost- including the effects of potential price inflation. Uncertainty is involved in any forecast, though some forecasts have less uncertainty than others (Meredith et al., 2008). The Project budget, which is the final result of the planning cycle of the Management cost & control system, must be reasonable. Project cost management function is primarily concerned with the planning, budgeting and monitoring of project costs and presenting the monitored information to project management for making decisions. The pre requesting for managing project cost are that a project must have clearly defined objectives, time plans, organization structure and cost estimates (Erik,et.al, 2014). Although upper management sets the long-range objectives, lower level management is responsible for establishing the detailed plans and must clearly articulate and understand the short range objectives before executing the budget (Avraham et al., 1994). The building blocks of the project's budget are the work packages in which tasks performed on the lowest- level WBS elements are assigned to organizational units at the lowest level of the OBS.

By adjusting for anticipated demand, the expected inflation rate, and the effect of learning, the financial planners can develop the new budget based on past information (Jack & Samuel, 2010). Thus the process of integrating single project budgets and the budgets of ongoing activities into an acceptable organizational budget requires planning and coordination. The final budget should embody sound, workable programs for each functional area, and coordinate the efforts of functional units and project managers to achieve their goals (Erik et al., 2014).

To create a project budget, it should have an exhaustive breakdown of project activities, and it should have some pretty good duration estimates. Sometimes project

managers are not responsible for the budget portion of the project. Instead, this function is assigned to a functional manager who is responsible for tracking and reporting all the project costs. Before diving into the estimates costs and determine costs and determine budget process particulars, you should know that these processes are governed by a cost management plan that is created when you perform the plan cost management process.

### **2.6.3. Managing the budget**

The budget of a project represents scheduled expenditures and scheduled revenue as a function of time. The simplest approach to budgeting is to estimate the expected costs and income associated with each activity, task and milestone. Based on the project schedule, these costs are assigned specific dates and a budget is generated; however, it may be only a partial budget because some of the indirect costs are usually not included at the preliminary stage. Typical indirect costs are those for management, facilities & quality control and are not always related to specific activities. The product of this effort can serve as the basis for the decision – making process needed to develop a detailed, comprehensive budget.

### **2.6.4. Determine The Budget Inputs**

Outputs from other planning processes, including the create WBS, develop schedule, and estimate costs processes, must be completed prior to working on determine budget because some of their outputs become the inputs to this process. The inputs for determine budget is as follows:

- **Cost management plan:**

The cost management plan documents how the project costs will be developed managed and controlled throughout the project.

- **Scope baseline:**

Scope baseline includes the project scope statement, WBS and WBS dictionary. The scope statement describes the constraints of the project. It should consider when developing the budget. The WBS shows how the project deliverables are related to their components, and the work package level typically contains control account information.

- **Activity cost estimates.**

These are an output of the estimate costs process. Activity cost estimates are determined for each activity within a work package and then summed to determine the total estimates for work package.

- **Basis of estimates**

This is also an output of the estimate cost process and contains all the supporting detail regarding the estimates. It should consider assumptions regarding indirect costs and whether they will be included in the project budget. Indirect costs cannot be directly linked to any one project. They are allocated among several projects, usually within the department or division in which the project is being performed. Indirect costs can include items like building leases, management and administrative salaries and soon.

- **Project schedule**

The schedule contains information that is helpful in developing the budget, such as start and end dates for activities, milestones and so on. Based on the information in the schedule, it can determine the budget expenditures for calendar periods.

- **Resource calendars**

Resource calendars help you determine costs in calendar periods and over the length of the project because they describe what resources are needed when on the project.

- **Risk register**

The risk register contains a list of risks that could occur on the project. Risks with a high impact and /or high probability of occurring will likely have response plans that could add costs to the project, so, it should review them before preparing the budget.

- **Organizational process assets**

The organizational process assets that will, assist you with the work of this process include budgeting tools, the policies and procedures of the organization may have regarding budgeting exercises and reporting methods.

## **2.6.5. Determine budget tools and techniques**

According to PMBOK guide, the determinations of budget process can be described as follows::

### **Cost aggregation**

Cost aggregation is the process of tallying the schedule activity cost estimates at the work package level and then totaling the work package levels to higher level WBS component levels. Then all of the costs can be aggregated to obtain a total project cost.

### **Reserve analysis**

Reserve analysis works the same for the determine budget process. Contingency costs are considered and included in the aggregation of control accounts for both activity cost estimates and work package estimates. Management reserves are also not considered when calculating earned value measurements.

### **Historical relationships**

Analogues estimates and parametric estimates can be used to help determine total project costs.

## **2.6.6. Types of cost in project budget**

### **1. Direct costs**

These costs are clearly chargeable to a specific work package. Direct costs can be influenced by the project manager, project team and individuals implementing the work package. These costs represent real cash outflows and must be paid as the project progresses; therefore direct costs are usually separated from overhead costs. Lower-level project rollups frequently include only direct costs.

### **2. Direct overhead costs**

Direct overhead rates more closely pinpoint which resources of the organizations are being used in the project. Direct overhead costs can be tied to project deliverables or work packages. Example includes the salary of the project manager and temporary rental space for the project team. Although overhead is not an immediate out-of-pocket expense. It is real and must be covered in the long run if the firm is to remain viable. These rates are usually a ratio of the dollar value of the resources used – e.g. direct labor, materials, equipment. For example, a direct labor burden rate of 20 percent would add a direct overhead charge of 20 percent to the direct labor cost estimate (Hill. 2003).

### 3. General & Administrative (G & A) overhead costs

These represent organization costs that are not directly linked to a specific project. These costs are carried for the duration of the project. Examples include organization costs across all products and projects such as advertising, accounting and senior management above the project level. The G & A costs are usually allocated as a percent of total direct cost or a percent of the total of a specific direct cost such as labor, Material or equipment.

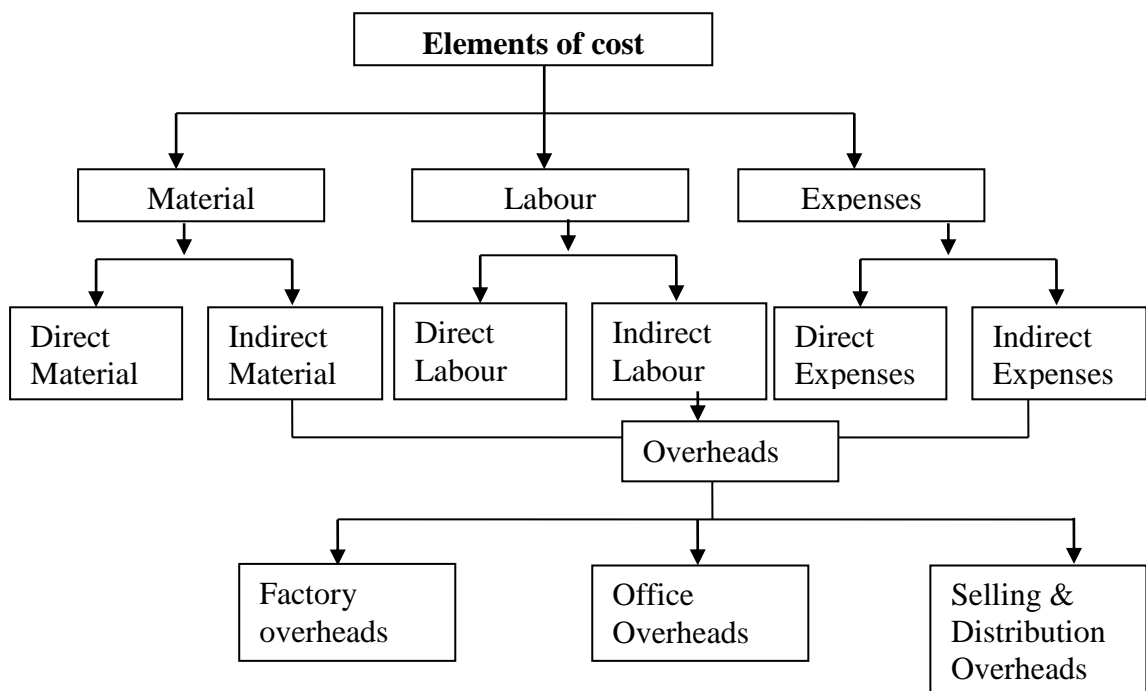


Figure 2.5 – Elements of Cost

Source : Maravas et al., 2011.

## 2.7 ANALYZING THE PROBLEM STATEMENT OF RESEARCH

When start a project, there should be a proper and effective budget in order to proceed the project. Currently, there is not any framework to evaluate or forecast the project budget. If there is a proper framework to evaluate the budget, mainly, project team can understand the financial and physical progress of the project rather than other benefits of having a project budget. Hence, this research aims to implement a costing framework for forecasting the budget for construction projects.

It is very important to know, following concepts to get the clear idea about the problem statement of this research.

### **Planned value or budgeted cost for work scheduled**

A project plan identifies the work to be accomplished. Assessment of this planned work is called **Planned Value (PV)**. The PV is a numeric reflection of the budgeted work that is scheduled to be performed, and it is the established baseline against which the actual progress of the project is measured (also called as performance measurement baseline or PMB). The main factor which is related to project plan is **Budgeted Cost for Work Scheduled (BCWS)** which comprises the total planned costs for all tasks or sub-tasks to be achieved by a given point in time. In fact, the PV is often denoted as the BCWS and in literature findings either the PV or the BCWS is used (Project Management Institute, 2005).

### **Earned value or budgeted cost for work performed**

The metric which quantifies the accomplishment of work is called Earned Value (EV). The EV reflects the amount of work that has actually been accomplished to date, expressed as the planned value for that work (Project Management Institute, 2005). The EV is often used interchangeably with budgeted cost for work performed (BCWP) which interpret the total planned costs associated with completed work on tasks or sub-tasks at a given point in time.

### **Actual Cost or actual cost of work performed**

Critical part of controlling a project's characteristics is controlling the actual costs of the project. Therefore, this amount can be compared with the other above-mentioned amounts in order to apply the EVM method. Actual Cost of Work Performed (ACWP) also known as Actual Cost (AC) is the total expenditure for tasks or sub-tasks at any point in time and as cited by the PMI (Project Management Institute, 2005). It is an indication of the level of the resources that have been expended to achieve the actual work performed to considered date.

Several minor issues encounter throughout literature, as the resistance to change, functional stovepipes and inappropriate success measurement criteria within organizations can generate an incredibly negative effect on the implementation of project budget. With reference to Patton & Sechelt (2007), Gowan, Mathieu, & Hey (2006) and ESI International Inc. (2007) the solutions for above facts must be addressed through embracing EVM basics and increasing collaboration through

knowledge sharing. So, it is very important to have a common format for forecasting project budget which can compare the budgeted cost data vs. actual cost data of projects.

## **2.8 . Housing construction in Sri Lanka**

The aim of this research was to designing a framework for prepare a project budget in order to support for implementing EVM concept in housing projects in Sri Lanka. The term Mass House Building Projects (MHBP) is used in the construction industry to describe mass production techniques of housing development projects. Some characteristics of this kind of housing projects are Project environment, Site conditions including topography; bulky material; design considerations (Ahadzie et al., 2008). Further it has elaborated that the key to achieving project management success on MHBPs is for PMs to have the requisite knowledge and skills that enhances management intuition in repetitive construction planning. That is, the PM must be able to take advantage of the repetitive tasks involved so as to ensure continuity of work and in particular achieve cost and time savings.

According to the information given by Census and Statistics Department, there can be seen a considerable improvement of housing construction and it can be figured as shown in table 3.1. Hence housing construction is upcoming category in construction field in accordance with the information given by Department of Census and Statistics; the research has narrowed down to construction of housing projects in Sri Lanka.

**Table 2.1: some selected indicators of construction**

Type of building	Value of contracts (Rs. Mn)				
	2005	2008	2009	2011	2013
Market complex	2,181	1,019	0.428	2,010	66,797
Office building	2,816	12,642	19,303	17,530	27,260
Hospital building	0.749	11,764	4,341	5,306	15,906
Repair & maintenance	2,715	2,037	2,143	3,768	6,217
School buildings	0.419	4,634	6,099	5,416	5,649
Collective living quarters	0.153	16,009	5,004	2,723	3,091
<b>Housing Units</b>	<b>8,864</b>	<b>9,331</b>	<b>5,564</b>	<b>5,100</b>	<b>1,826</b>
Factories	0.140	1,642	4,003	4,075	1,685
Other Building	14.609	15,888	49,659	49,422	18,780



## **CHAPTER 03**

### **3.0 METHOD OF STUDY**

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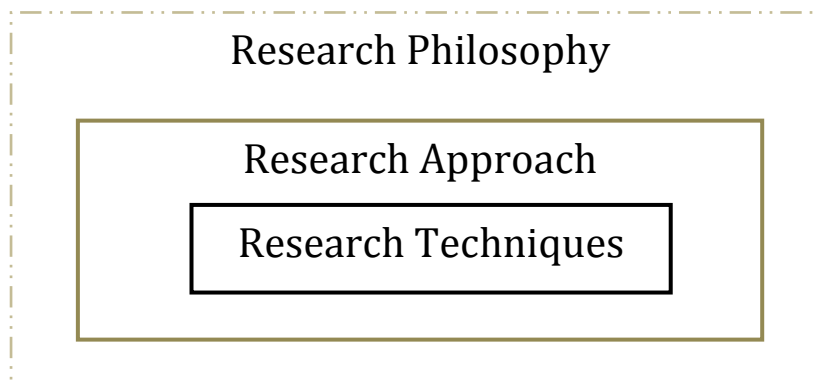
#### **3.1 INTRODUCTION**

Chapter two contained of the literature synthesis and the identification of the research problems, While, the purpose of this chapter is to clarify the methodological framework used to conduct this research.

This chapter is prepared in three main headings. First, the design of this study is described including research philosophy and the research approach. Afterwards, the research process of this study and the measures taken to certify research validity are described in detailed manner.

#### **3.2 RESEARCH DESIGN**

In this research, the “Nested” research model (Kagioglou et al., 2000 cited Senarathne, 2005), (see Figure 3.1) was adapted for the research. The model illustrates the method of study contains of research techniques which are selected based on the research approach and, research approach is selected based on the philosophical stand of the research.



**Figure 3.1 The “Nested” Research Model**

**Source : Kagioglou et al., 2000 cited Senarathne, 2005**

### **3.2.1 Research Philosophy**

Research philosophy is considered as the first issue when designing a research. Smith et al. (2002) emphasized the significance of research philosophy with three reasons. Firstly, the researcher needs to clarify the research design and, research philosophy helps in clarifying it. Secondly, research philosophy helps in identifying the circumstances on which the research design functions. Finally, it helps the researcher to identify and create research designs which may be beyond his past experience.

In order to complete a project successfully, there should have a project budget from commencing of the project. As well as to evaluate the EV & AC of the project, it should have to have a proper budget framework. But most of public organizations in Sri Lanka, do not use a proper framework for evaluate the project budget. most of the time, they have a project budget, but they are not effective budgets. If there is a proper framework to evaluate the budget, project team can understand the financial & physical progress of the project rather than other benefits of having a project budget. so, the research philosophy is to implement a proper costing framework to evaluate the project budget for construction of Public housing projects in Sri Lanka.

### **3.2.2 Research Approach**

After defining the research philosophy, a suitable research approach had to be selected to deal with the research problem. Easter by-Smith et al. (2002) stated that, the research approaches helped to organize research activities, including the collection of data, in ways that are more likely to achieve research aims. According to Yin (1994), five different types of research approaches can be adapted to a research; namely, experiment, survey, archival analysis, case study and history.

Considering the above, this study was conducted under a qualitative research approach and quantitative approach also used for measuring the feasibility of the framework. In order to conduct this research, it has selected a pilot study and secondly conducting three numbers of case studies. The objective of conducting a pilot survey was to investigate the awareness for industry people regarding EVM concept and get the views from industry experts regarding the use of EVM for Public

housing construction in Sri Lanka. The objective of doing a case study was to evaluate the feasibility of proposed framework.

### **3.3 Research Process**

This research falls into qualitative as well as quantitative research category. Senarathne (2005) illustrated that the research process of a qualitative research. The stages of that process are followed in this research. These stages include initial impetus, literature synthesis, problem statement, case study design, data collection, data analysis and write-up in sequential manner. These stages are described in next sections.

#### **3.3.1 Initial Impetus**

The initial impetus to carry out this study was generated when the researcher was working for a semi government organization in Sri Lanka. The organization was undertaken lots of minor and major projects all over the country. Specially, it has undertaken housing schemes for low income people in Colombo city area. When the begging of the project, they had a project budget and annual allocation for the project by the government entities because for most of the projects, the client was a separate ministry. When the project was proceeding, it was noted that there was not a proper mechanism or a framework to monitor the target and actual cost incurred to the project effectively and efficiently. They monitored the data but it was not in an effective and efficient way of doing it. So, the researcher was tried to find out solutions for that problem by doing this research.

#### **3.3.2. Pilot study**

The purpose of the pilot study was to investigate the views from industry experts regarding EVM concept and its usage. Once a comprehensive understanding was attained through the literature review, expert opinion surveys using semi structured interviews were carried out in gathering details for preparing the project budget framework. On account of that, during the pilot study the concept of EVM and its benefits by usage of it was communicated. So, it was conducted semi structured interviews in order to get views from the professionals in construction industry. Researcher has selected five construction organizations and from those five, it has

interviewed one Senior Project manager & one Quantity Surveyor to collect the views regarding project budget from each organization.

### ***3.3.2.1. Interview structure***

The interview type in pilot survey was face to face semi structured interviews. According to the Naoum (2007), Semi structured interviews are more formal than the unstructured interviews. Semi structured interviews by using an interview questionnaire followed to make the study more effective. Liamputtong (2009) stated that interview is the most commonly used data collection technique for qualitative research approach. The interview structure was developed by using the interview guidelines and these guidelines were formed to capture data around the research problem. The information incorporated from literature and expert opinion surveys were analyzed next in developing the framework.

### ***3.3.2.2 Interview Process***

For achieving the objectives of doing pilot survey, researcher has interviewed ten industry peoples such as Senior Project Managers & Quantity Surveyors. Ten interviews were conducted and each was normally lasted for 45 minutes to one hour. In order to maintain confidentiality, the actual names of the projects and the interviewees were not revealed in this report or any other document relating to this study.

### **3.3.3. Case Study Design**

Ragin and Beker (as cited in Patton and Appelbaum, 2003) stated that case studies are based on analytic generalization rather than statistical generalization. According to Yin (1994, p.36), in analytic generalization, “the investigator is striving to generalize a particular set of results to a broader theory.” He further stated that, generalization of the study can be increased through the design of the case study and thus, special care should be taken in the case study design. The case study designing procedure which is emphasized next, including the identification of unit of analysis, defining the number of cases and selection of cases.

According to Yin (1994), within the single case may still be incorporated subunits of analyses, so that a more complex or embedded design is developed. The subunits can often add significant opportunities for extensive analysis, enhancing the insights into

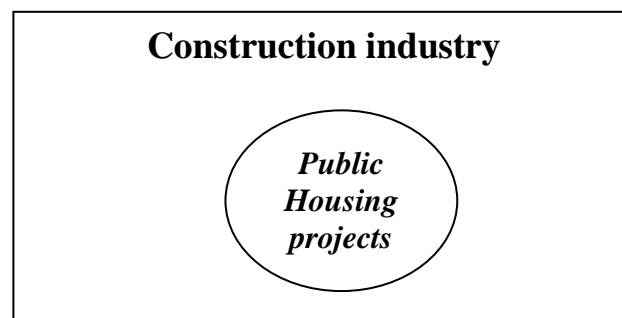
the single case. If too much attention is given to these subunits, and if the larger, holistic aspects of the case begin to be ignored, the case study itself will have shifted its orientation and changed its nature. If the shift is justifiable, the writer needs to address it explicitly and indicate its relationship to the original inquiry.

Multiple case designs have distinct advantages and disadvantages in comparison to single case designs (Yin, 1994). The evidence from multiple cases is often considered more compelling and the overall study is therefore regarded as being more robust. Each case must be carefully selected so that it either predicts similar results or predicts contrasting results but for predictable reasons. Some of the replications might have attempted to duplicate the exact conditions of the finding could still be duplicated. Only with such replications would the original finding be considered robust and worthy of continued investigation or interpretation (Yin, 1994). So, the researcher has selected three cases from the selected organization in order to analyze the proposed framework.

#### ***3.3.4.1 Identification of Unit of Analysis***

Identification of ‘unit of analysis’ or the ‘case’ is of foremost importance to any research design and it is linked with the way the research problem is created (Yin, 1994). This research is aimed to designing a framework for prepare a project budget in order to support for implementing EVM concept in housing projects undertaken by Public sector organization in Sri Lanka. Therefore, the unit of analysis or the case in this research was housing projects in Colombo city area which were using project budget before commencing the construction works but it was not properly monitor as an effective and efficient manner.

***Figure 3.2 unit of analysis***



**Source : Author**

#### **3.3.4.2 Defining Number of Cases**

After identifying the unit of analysis or the case, the defining of number of cases is important. According to Yin (1994), the number of cases in case study could vary from one to eight as per the nature of the research. Perry (1998) stated that, when the study area is too broad in a qualitative research, it is advisable to use only one or two and utmost four. Romano (1989 cited Perry, 1998, p.36) stressed that; “the literature recommending the use of case studies rarely specifies how many cases should be developed. This decision is left to the researcher.” Hence, there is no precise guide to the number of cases to be included. Similarly Patton (1990 cited Perry, 1998, p. 185) stated that, “the validity, meaningfulness and insights generated from qualitative inquiry have more to do with the information-richness of the cases selected and the observational/analytical capabilities of the researcher than with sample size.

Accordingly, information richness in selected cases and analyzing those in depth are the important features than number of cases in a case study research. Further he mentioned that “there is no rule” for sample size in a qualitative research and the selection process is affected by real constrains like time and funding. By considering above and due to the time constrains associated with the study, the researcher decided to limit the number of cases which was investigated in this case study to three. The selection criterion of this case is graphically illustrated in next section.

#### **3.3.4.3 Selecting the Cases**

Yin (1994) stressed that the criteria for selecting cases is a matter of discretion and judgment, convenience, access and to be those which are subjective for the purpose of the research. When selecting the cases, above issues of Yin (1994) were considered in this research.

Currently, most of construction organizations have not used a budget framework for forecasting the project cost or expenditure. They usually forecast the cost for a particular product by considering the percentage from the Bill Of Quantity (BOQ) amount. That means, reducing the profit margin from BOQ amount and get the final figure as cost of the project. If people encourage preparing the project budget, before commencing the project works, it will be very useful and accurate for future decision making. Then People can measure the financial and physical progress of the project

by using the concept of EVM because they use project budget as preliminary support for implementing EVM concept.

Hence the output of this research is a designing a framework for preparing a project budget in order to support for implementing EVM concept, the researcher tried to evaluate the feasibility of that framework by using three case studies and finally it has tested through a quantitative analysis. So, the other consideration of selection of appropriate case for this research was three housing projects which are undertaken by semi government organization and the same time, the projects were forecasted budget for that project but they were not giving a support to take decision in efficient and effective manner. After explaining about the case study designing stage, the data collection stage is illustrated in the next section.

#### **3.3.4. Data Collection**

Patton and Appelbaum (2003) emphasized that intensive use of empirical evidence can yield theory that is overly complex. Therefore, discipline and focus are certainly required in data collection and further, the sources used to collect data are important. According to Patton and Appelbaum (2003), case studies utilize an excess of data collection methods including observation, interviews, histories and quantitative measures. Yin (1994) has illustrated six sources of data collection under case study approaches, namely; documents, archival records, interviews, direct observation, participant observation and physical artefacts. Among these techniques, interviews were selected as the most reachable and reasonable data collection tool when considering circumstances and the nature of the research. Because as the researcher has investigated through literature review, semi structured interviews are more formal than the unstructured interviews and by using an interview questionnaire followed to make the study more effective.

Sekaran (2003) stated that, when interviews are conducted in semi-structured manner, it enables to adapt the questions necessary, clarify doubts and ensure that the response is properly understood by repeating and rephrasing the questions. He further emphasized that, if the interviews are carried out face-to-face manner, researcher can pick up the nonverbal cues from the respondent and it is beneficial to understand the response effectively and evaluate whether the respondent's mental condition is suitable to answer the question clearly. Therefore, the interviews were

carried out face-to-face in semi structured manner. The structure of the interview and the interview process are explained in next section.

#### ***3.3.5.1 Interview Structure***

The main facts and information regarding EVM concept, project budgeting and costing frameworks has been collected from the pilot survey. Hence the objective of doing the case study was evaluating the feasibility of the proposed costing framework; the interview guideline of case study was different from interview guideline of pilot survey. The interview guideline of case study was included the facts and information which are used for evaluating the costing framework.

#### ***3.3.5.2 Interview Process***

The interviews were conducted with two key professionals from each selected project such as Senior Project Manager & Project Quantity Surveyor of the project. Interview type was face to face semi structured interviews. As same as pilot survey, two numbers of interviews were conducted and each was normally lasted for two hours to two and half hours. Hence the selected case has covered from the pilot survey, no needed to give a theoretical explanation about the research before starting the interview.

However, to maintain confidentiality, the actual names of the projects and the interviewees were not revealed in this report or any other document relating to this study. The next section describes the data analyzing process of collected data.

### **3.3.5. Data Analysis**

When consider the method of evaluating of framework, the researcher has estimated the cost of the project and the base for forecasting cost was, items illustrated in the BOQ. The researcher has figured all forecasted cost data related to the housing project in accordance with the proposed framework as support to implementing the EVM concept. So, the final objective of the research was achieved by doing this case study.

In this cascading, data analysis techniques in similar research on housing construction like Mass housing (Bon et al., 2013) was considered for EV analysis in the selected housing project sample.



### **3.3.6. Conclusion Drawing**

Conclusion drawing is the final stage of data analysis. Patton and Appelbaum (2003) state that, “the ultimate goal of the case study is to uncover patterns, determine meanings, construct conclusions and build theory.” Thus, constructing conclusions is one of the ultimate goals in the study. The findings from the empirical study; their interrelationship with existing literature; and, the propositions from this study to both the theory and to the practice were emphasized under conclusions. Further, new research directions that appeared from this research were also illustrated in the conclusions.

### **3.3.7. Write-Up**

Even though the write up is given as the final stage of the dissertation, this is being gradually done throughout the research process in sequential manner. The write-up was started in an explanatory manner in the early stages (For example Chapter two and Chapter three), narrowed down towards the latter stages (For example Chapter five). Throughout the write-up process, visual aids such as Tables and Figures were being presented for the ease of the use.

## **CHAPTER 04**

### **4.0 RESEARCH FINDINGS**

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#### **4.1 INTRODUCTION**

Chapter three was focused on the method of study adapted in the research whereas; this chapter has divided into two sub chapters as findings in pilot study and empirical study. The purpose of this chapter is to explain the findings through the pilot study and empirical study in a detail manner. First, a brief description about the selected five cases in pilot survey is given. Then it has moved to discuss the process of empirical study as well.

#### **4.2 FINDINGS IN PILOT SURVEY**

##### **4.2.1 The Objective of Pilot Survey**

Hence this concept is being in construction industry in Sri Lanka but it is not using in a proper way for preparing the project budgets, it was very essential to aware about these concepts among professionals in construction industry in Sri Lanka. So, it was conducted a pilot study with industry experts in order to get views. Researcher has selected five construction organizations and from those five, it has interviewed one Senior Project manager & one Quantity Surveyor to collect the views regarding project budget from each organization. The use of semi structured interviews provided a rich source of information on the experience of practitioners regarding the subject in greater depth. The same questions were asked in all interviews for objectively and ease of analysis.

The questions in the interview guideline were constructed under two sections. The first section was set to capture the general information of the respondents. Second was including two sub headings. First was regarding EVM concept and its applicability. Second was forecast the budget for a particular project.

##### **4.2.2 Selection of professionals for the Pilot Survey**

The researcher has conducted a pilot study with ten industry experts by using face to face semi structured interviews. To maintain confidentiality, the actual names of the interviewees were not revealed in this report or any other document relating to this study.

Researcher has selected five construction organizations and from those five, it has interviewed one Senior Project manager & one Quantity Surveyor to collect the views regarding project budget from each organization.

**Table 4.1: Details of Interviewee**

Organization	Designation	Years of experience in PM field
A	Senior Project Manager	10
	Quantity Surveyor	4
B	Senior Project Manager	8
	Quantity Surveyor	6
C	Senior Project Manager	14
	Quantity Surveyor	5
D	Senior Project Manager	11
	Quantity Surveyor	4
E	Senior Project Manager	15
	Quantity Surveyor	5

Source : Author

#### 4.2.3 Summary of views given by the Respondents

**Table 4.2 – Summary of views given by the respondents**

Respondent	Views of EVM		Views of forecasting the project budget		
	Knowledge on EVM	Applicability of EVM in the Industry	Necessity of budget forecasting	Elements of project budget	Strategies to monitor the budget
A - SPM	Well aware	It is a good concept	It is important to have a budget	Direct cost data and indirect cost data	The strategy should comes from site level to managerial level.

A - QS	Aware	Good as a performance measurement tool	It is important to have a budget and monitoring of the budget	Labour, material & overhead expenses	The strategy should come from site level to managerial level and currently we don't have a system to practicing it properly.
B - SPM	Well aware	A better concept as a performance measurement tool	It is important to have a budget and we are practicing it.	Labour, material & overhead and those should be categorize under direct & indirect	The strategy should come from site level to managerial level and currently we have a system to practicing it properly.
B - QS	Well Aware	Good concept	It is important to have a budget and we are practicing it.	Direct labour, material & overhead and all should also come under indirect cost	The strategy should come from site level to managerial level and currently we use EVM concept to practicing it properly.

C - SPM	Well aware	Good concept	It is important to have a budget before commencing the project.	Direct cost & indirect cost	There should be an effective system to monitor and control the performance.
C - QS	Aware	Good as a performance measurement tool	Budget should be aligning with the allocation of the project and there should be proper monitoring system to budgeted vs actual cost data.	Direct cost & indirect cost	It is important to have a proper system to monitor the performance of project in financial as well, as physical.
D - SPM	Well aware	Good concept	It is important to have a budget and we are practicing it.	Direct cost & indirect cost	The strategy should comes from site level to managerial level.
D - QS	Well Aware	Good as a performance measurement tool	It is important to have a budget and we are practicing it.	Direct cost & indirect cost	There should be an effective system to monitor the performance and currently we are

					practicing it.
E - SPM	Well aware	Good concept	It is important to have project budget before commencing the project	Direct cost & indirect cost	The strategy should comes from site level to managerial level and currently we are using EVM as a performance measurement tool.
E - QS	Well Aware	Good concept	It is important to have project budget before commencing the project	Direct cost & indirect cost	The strategy should comes from site level to managerial level and currently we use EVM concept to practicing it properly.

**Source : Author**

### **4.3 FINDINGS OF CASE STUDY**

#### **4.3.1. Objectives of conducting a case study**

The objective of conducting a case study was to measure the feasibility of the proposed framework for estimating the project budget. So firstly, researcher has selected newly commenced housing projects because the project scope was narrowed down to public housing projects. Then research has drawn up the project plan by

using Microsoft project software. Then it has forecasted the project by using EVM concept in order to measure the feasibility of the framework.

In order to effectively analyze the proposed framework, it has selected three housing projects which are currently consider as ongoing projects in selected public housing construction projects.

#### **4.3.2. Proposed framework for forecasting the project budget**

As shown in the following figure 4.2, the process of data collection to decision making was displayed as the main fundamental element to achieve a final result using EVM. In accordance with the data findings, it has implemented following framework for forecasting the project budget and use as a comparison tool for target & actual cost data and progress as well.

In accordance with the proposed costing framework, there are Direct & Indirect cost incurs should be included separately. All the cost data should be include as monthly and cumulative figures. The budgeted cost figures can be fill before commencing the project. when the project is processing, The actual cost data can fill in three stages as 25% completion, 50% completion and the 100% completion of the sub task. The PM can monitor the cost of relevant sub task when it is in processing and if there is cost overrun, PM can get immediate action to overcome it by monitoring each completion stage.

Most PMs have limited to view of both annual & Capital budgeting. In addition, they trend to feel that their responsibility is primarily to get as many resources as possible and then to stay within that budget. While those budget functions are important, PM feels it is also important that PMs take a major role in budget development, in managing the budget during execution, and in conducting a budget post mortem (an evaluation) at the end of each budget year

**Table 4.3: Proposed budget frame work**

S/N o	Descrip tion	Unit	Actua l rate	Actua l QTY	Details of actual cost in different stages			Cons umpti on Up to date	Budg eted Rate	Budg eted Qty	Details of budgeted cost in different stages			Variance/Mn		
					25% Comp letion	50% Comp letion	100% Comp letion				25% Comp letion	50% Comp letion	100% Comp letion	25% Comp letion	50% Comp letion	100% Comp letion
	<b>Direct Material</b>															
	<b>Direct Labour</b>															
	<b>Direct Overhead Cost</b>															
	<b>Indirect Material</b>															
	<b>Indirect Labour</b>															
	<b>Indirect Overhead cost</b>															
	<b>Sub Total for Month of February 2013</b>															



### **4.3.3. Practical example**

#### **Introduction to the selected cases**

##### **Case 01**

Name of the project : Construction of three numbers five storied housing blocks at Colombo suburban area

Scope of project : Construction of three numbers five storied housing blocks consisting of 60 housing units with RCC strip foundations, concrete frame structure and asbestos roof covering lay on timber framework.

Project Cost: : Rs. 170.00Mn

##### **Case 02**

Name of the Project : Construction of housing scheme at Colombo Metropolitan area

Scope of project : Construction of three numbers twelve storied housing blocks consisting of 256 housing units with RCC strip foundations, concrete frame structure and block work wall.

Project Cost: : Rs. 1,102.00 Mn (Without VAT)

##### **Case 03**

Name of the Project : Construction of five storied housing scheme at Colombo suburban area

Scope of project : Construction of two numbers five storied housing blocks consisting of 20 housing units with RCC strip foundations, concrete frame structure and asbestos roof covering lay on timber framework.

Project Cost: : Rs. 44.94 Mn (Without VAT)

In the selected cases, the researcher has illustrated only a selected item & a sub item under the selected main item. The researcher has selected concrete works, as the main item and under that it has illustrated a sub task of in-situ concrete works for giving some awareness about the proposed framework for the reader. It has mentioned the forecasted cost as well as actual cost for concrete works in the proposed framework and finally it has done a quantitative analysis in order to measure the feasibility of the proposed framework.

**Case 01**

**Name of the project** Construction of three numbers five storied housing blocks at Colombo suburban area  
**Main Item:** Concrete Work  
**Sub Item under main item** 50mm Thk screed poured into ground under the foundation base.(Floor area - 129 m<sup>2</sup>) - Grade 15

S/no.	Description	Unit	Actual Rate	Actual Qty	Details of actual cost in different stages			Consumption Up to date	Budgeted Rate	Budgeted Qty	Details of budgeted cost in different stages			Variance/Mn		
					25% completion	50% completion	100% completion				25% completion	50% completion	100% completion	25% completion	50% completion	100% completion
<b>Direct Material</b>																
01	Cement	cwt	950.00	31.00	7,362.50	14,725.00	29,450.00		705.50	34.00	5,996.75	11,993.50	23,987.00	(1,365.75)	(2,731.50)	(5,463.00)
02	Sand	Cube	12,000.00	1.50	4,500.00	9,000.00	18,000.00		12,000.00	1.40	4,200.00	8,400.00	16,800.00	(300.00)	(600.00)	(1,200.00)
03	Metal (1 1/2")	Cube	5,500.00	2.00	2,750.00	5,500.00	11,000.00		5,150.00	2.40	3,090.00	6,180.00	12,360.00	340.00	680.00	1,360.00
04	Water	gals	1.50	262.00	98.25	196.50	393.00		1.00	281.00	70.25	140.50	281.00	(28.00)	(56.00)	(112.00)
	<b>TOTAL</b>						<b>58,843.00</b>						<b>53,428.00</b>	<b>(1,353.75)</b>	<b>(2,707.50)</b>	<b>(5,415.00)</b>
<b>Direct Labour</b>																
01	Skilled Labour	day	1,050.00	3.50	918.75	1,837.50	3,675.00		950.00	2.60	617.5	1,235.00	2,470.00	(301.25)	(602.50)	(1,205.00)
02	Unskilled Labour	day	850.00	14.00	2,975.00	5,950.00	11,900.00		750.00	15.30	2868.75	5,737.50	11,475.00	(106.25)	(212.50)	(425.00)
	<b>TOTAL</b>						<b>15,575.00</b>						<b>13,945.00</b>	<b>(407.50)</b>	<b>(815.00)</b>	<b>(1,630.00)</b>
<b>Direct Overhead Cost</b>																
01	Hire of mixer	day	6,250.00	1.50	2,343.75	4,687.50	9,375.00		5,500.00	0.85	1168.75	2,337.50	4,675.00	(1,175.00)	(2,350.00)	(4,700.00)
	<b>TOTAL</b>						<b>9,375.00</b>						<b>4,675.00</b>	<b>(1,175.00)</b>	<b>(2,350.00)</b>	<b>(4,700.00)</b>
<b>Indirect Material</b>																
<b>Indirect Labour</b>																
<b>Indirect Overhead</b>																
<b>Sub Total for Month of February 2013</b>																

**Case 02**

**Name of the project** Construction of housing scheme at Colombo Metropolitan area  
**Main Item:** Concrete Work  
**Sub Item under main item** Grade 25 reinforced concrete in strip foundation (5m<sup>3</sup>)

S/no.	Description	Unit	Actual Rate	Actual Qty	Details of actual cost in different stages			Consumption Up to date	Budgeted Rate	Budgeted Qty	Details of budgeted cost in different stages			Variance/Mn		
					25% completion	50% completion	100% completion				25% completion	50% completion	100% completion	25% completion	50% completion	100% completion
<b>Direct Material</b>																
01	Cement	cwt	950.00	42.50	10,093.75	20,187.50	40,375.00		705.50	40.65	7,169.64	14,339.29	28,678.58	(2,924.11)	(5,848.21)	(11,696.43)
02	Sand	cube	12,000.00	0.75	2,250.00	4,500.00	9,000.00		12,000.00	0.75	2,250.00	4,500.00	9,000.00	-	-	-
03	3/4" Metal	cube	5,500.00	2.80	3,850.00	7,700.00	15,400.00		5,275.00	1.45	1,912.19	3,824.38	7,648.75	(1,937.81)	(3,875.63)	(7,751.25)
04	Water	gals	1.50	950.00	356.25	712.50	1,425.00		1.00	932.45	233.11	466.23	932.45	(123.14)	(246.28)	(492.55)
05	Jute Hessian	Sq.ft	8.00	42.50	85.00	170.00	340.00		30.00	39.25	294.38	588.75	1,177.50	209.38	418.75	837.50
	<b>TOTAL</b>						<b>66,540.00</b>						<b>47,437.28</b>			<b>(19,102.73)</b>
<b>Direct Labour</b>																
01	Skilled Labour	day	1,050.00	4.00	1,050.00	2,100.00	4,200.00		950.00	6.00	1,425.00	2,850.00	5,700.00	375.00	750.00	1,500.00
02	Unskilled Labour	day	850.00	6.00	1,275.00	2,550.00	5,100.00		750.00	8.00	1,500.00	3,000.00	6,000.00	225.00	450.00	900.00
	<b>TOTAL</b>						<b>9,300.00</b>						<b>11,700.00</b>			<b>2,400.00</b>
<b>Direct Overhead Cost</b>																
01	Hire of Vibrator	day	2,500.00	3.50	2,187.50	4,375.00	8,750.00		1,300.00	3.95	1,283.75	2,567.50	5,135.00	(903.75)	(1,807.50)	(3,615.00)
02	Hire of Mixer	day	6,000.00	2.50	3,750.00	7,500.00	15,000.00		5,500.00	0.60	825.00	1,650.00	3,300.00	(2,925.00)	(5,850.00)	(11,700.00)
	<b>TOTAL</b>						<b>23,750.00</b>						<b>8,435.00</b>			<b>(15,315.00)</b>
<b>Indirect Material</b>																
<b>Indirect Labour</b>																
<b>Indirect Overhead</b>																
<b>Sub Total for Month of February 2013</b>																

**Case 03**

**Name of the project** Construction of housing scheme at Colombo Metropolitan area  
**Main Item:** Concrete Work  
**Sub Item under main item** Rubble stone work (random rubble masonry work bedded and jointed in cement and sand (1:5) in foundation (15m<sup>3</sup>)

S/no.	Description	Unit	Actual Rate	Actual Qty	Details of actual cost in different stages			Consumption Up to date	Budgeted Rate	Budgeted Qty	Details of budgeted cost in different stages			Variance/Mn		
					25% completion	50% completion	100% completion				25% completion	50% completion	100% completion	25% completion	50% completion	100% completion
<b>Direct Material</b>																
01	6" - 9" Rubble	Cube	5,750.00	7.25	10,421.88	20,843.75	41,687.50	-	5,400.00	6.90	9,315.00	18,630.00	37,260.00	(1,106.88)	(2,213.75)	(4,427.50)
02	Cement	Bags	950.00	26.00	6,175.00	12,350.00	24,700.00		705.50	26.55	4,682.76	9,365.51	18,731.03	(1,492.24)	(2,984.49)	(5,968.98)
03	Sand	Cube	12,000.00	1.50	4,500.00	9,000.00	18,000.00		12,000.00	1.65	4,950.00	9,900.00	19,800.00	450.00	900.00	1,800.00
04	Water	gal	1.50	550.00	206.25	412.50	825.00		1.00	530.10	132.53	265.05	530.10	(73.73)	(147.45)	(294.90)
	<b>TOTAL</b>						<b>85,212.50</b>						<b>76,321.13</b>			<b>(8,891.38)</b>
<b>Direct Labour</b>																
01	Mason	Day	1,050.00	20.00	5,250.00	10,500.00	21,000.00		950.00	21.15	5,023.13	10,046.25	20,092.50	(226.88)	(453.75)	(907.50)
02	Unskilled Labour	Day	850.00	33.00	7,012.50	14,025.00	28,050.00		750.00	31.80	5,962.50	11,925.00	23,850.00	(1,050.00)	(2,100.00)	(4,200.00)
	<b>TOTAL</b>						<b>49,050.00</b>						<b>43,942.50</b>			<b>(5,107.50)</b>
<b>Indirect Material</b>																
<b>Indirect Labour</b>																
<b>Indirect Overhead</b>																
<b>Sub Total for Month of February 2013</b>																

### **Testing the feasibility of proposed framework**

**Table 4.4 – variation analysis of planned vs. actual cost**

<b>Case</b>	<b>Type of Cost</b>	<b>Planned cost</b>	<b>Actual cost</b>	<b>Amount of variation</b>
<b>Case 01</b>	Direct Material	53,428.00	58,843.00	(5,415.00)
	Direct Labour	13,945.00	15,575.00	(1,630.00)
	Direct Overhead cost	4,675.00	9,375.00	(4,700.00)
<b>Case 02</b>	Direct Material	47,437.28	66,540.00	(19,102.73)
	Direct Labour	11,700.00	9,300.00	2,400.00
	Direct Overhead cost	8,435.00	23,750.00	(15,315.00)
<b>Case 03</b>	Direct Material	76,321.13	85,212.50	(8,891.38)
	Direct Labour	43,942.50	49,050.00	(5,107.50)

**Source: Author**

According to the above table, it has shown the variations between budgeted and actual cost of each item in each case. One perception that reduced difficulties was that the reports allow easy and fast debugging of mistakes. The data base and reporting system provide easy consistency analysis of data. Wrong data is easily detected and corrected. Error detection allow improve the practices and provide support for decision making processes, as well as negotiations with suppliers.

The main benefits can obtain by using the above cost budget framework are integrated cost, progress and time management, better vision of the project in terms of scope and procurement, early alert to problems, feasibility of project deviation trends, reduced time to perceive and understand problems and solutions, support for negotiations and the decision making process, and the motivation of people to implement the project control process.

The framework introduced by Cioffi F D (2006) described the mere contemplation of the budgeted cost of work performed cries out for an immediate comparison to the schedule into this common comparison basis by asking how much spending should have occurred, i.e. according to a project's schedule, at the specific time of any comparison. Further he has explained that, the EV system incorporates scope and integrates it with cost and schedule. first, the manager determines the value of a project's fully completed or partially completed efforts in the context of the cost that was budgeted and agreed upon in the project plans. only when a specified amount of task work is accomplished does a project EV, and the amount of that value is determined by the cost that was budgeted.

## **CHAPTER 06**

# **CONCLUSION & RECOMMENDATIONS**

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### **6.1 INTRODUCTION**

Project monitoring and decision making are well proven to be challenging tasks. EVM method has sized to be an aid by presenting an accurate and early feedback technique if mastered properly. It is vital to acknowledge what a conceptual framework can perform and support all the responsible entities to ease the introduction of the Earned Value Management (EVM) method in addition to existing performance measurement techniques. This research is aimed for designing a framework for project budget in order to support for implementing EVM concept in housing projects in Sri Lanka. This chapter presents a summary of accomplishment of ultimate overall objectives stated at Chapter one. The recommendations and further research pathways are presented within the chapter.

### **6.2 SUMMARY OF CONCLUSIONS**

**The first objective** of this research was to understand the concept of EVM and the BCWP. This objective had been accomplished through the literature synthesis. In order to achieve the first objective, the research has firstly understood the concepts of performance measurement tool as well as project budget. According to Sinclair & Zairi (1995), performance measurement is a systematic way of evaluating the inputs and outputs in manufacturing operations or construction activity and acts as a tool for continuous improvements. The construction industry has mainly relied on financially focused performance measurements, and studies on Performance Measurement Systems (PMSs) have been carried out at the project level. Never before have the pressure on project managers been as great as it is at the present to successfully satisfy the criteria of time, cost and quality in the completion of the projects for which they are responsible.

Furthermore, the author defined the performance measurement of a construction project as a project planning and control system that goes beyond the traditional concept of comparing the amount of project time elapsed against the amount of actual cost spent to give a comparison of actual value of work accomplished against

the planned value of work scheduled. The main and prompt purpose of PMS is to maintain the project's cost, schedule, and forecast status including their correlation with technical achievement (Daniel, 1984).

### **Earn value management concept**

EVM is a project performance evaluation technique that has originated in industrial engineering, but which has been adapted for application in project management. EVM has been practiced in different countries for different types of projects. The importance and effectiveness of this method in controlling projects in different industries is undeniable. Earned Value is a program management technique that uses "work in progress" to indicate what will happen to work in the future. EVA uses cost as the common measure of project cost and schedule performance. It allows the measurement of cost in currency, hours, worker-days, or any other similar quantity that can be used as a common measurement of the values associated with project work. Project management team may execute a value engineering program in the case of cost overrun and for cost reduction either reducing scope and quality in some sections of project or providing additional budget to cover overrun cost. Similarly, for time overrun case, project manager may plan some program such as fast tracking or time crashing for time reduction. The requirement for using EVM on any kind of a project is to plan all activities prior to start date and project progress is measured against the performance management baseline (Alexander, 1998).

In order to achieve **the second objective** of the research, it has identify the elements of a project budget by going through a literature review. Budgeting is the process of forecasting the cost of completing project deliverables. All project stakeholders prefer accurate cost, but they also understand the inherent uncertainty in all projects. Inaccurate estimates lead to false expectations and consumer dissatisfaction. Accuracy is improved with greater effort. Project cost forecasting becomes a trade-off, balancing the benefits of better accuracy against the costs for securing increased accuracy. Depending on the project, it might need resources other than people. The project might require equipment, additional facilities etc. in order to accomplish the objectives of the project. In addition to estimating the number of human resources, it also has to estimate the quantity and cost of the materials, equipment and facilities the project requires.

The **third objective** of this research was implementing a framework for preparation project budget by considering the EVM concept. So, the researcher has implemented the framework after investigating, observing current practices of EVM in construction industry in Sri Lanka. Also, it has applicable to three of a housing project conducted by State Engineering Corporation of Sri Lanka.

Project Management methods are defined as a system of practices, techniques, procedures and rules used by those who work in the discipline. In construction projects, the techniques of integration of different schedules; schedule controlling methods; mechanisms used in the preparation of site layout, project start-up and completion procedures; and investigation of suitable technologies are some of the methods considered as best practices.

### **6.3 RECOMMENDATIONS**

By using EVM as a performance measurement tool it can reduce the uncertainty of the project deliverables and performance of the future project decisions, specially the cash flow and project budget. Cost management on construction projects includes the planning of budgeted costs and their control. The actual costs are related with the work performed but the work performed is not often exactly equal to the work scheduled. The solution is the control, measurement and determination of the budgeted cost of the work performed and then compare this is to actual costs.

The main contribution of the Earn Value analysis (EVA) process was the motivation of the project manager and his team concerning the cost management and the goal to finish the project on budget. The EVA process provided more perception about the costs and their related elements of scope, contracts, procurement, communications, quality, people and negotiations. The EVM process provides clearer information about scope issues because the scope was better modelled through the WBS and appropriate account packages.

The following recommendations are made while considering the both literature review and data findings. The recommendations aim to give perception on modern project monitoring mechanisms

- Especially in government construction organization, they do not like to forecast the project budget in initial stage of the project. So, it is



recommended that, by introducing awareness programmes people who are engaged in construction industry should improve their knowledge of EVM concept as well as forecasting the project cost and its benefits.

- It is recommended to get top management support and active involvement more than present towards the implementation of EVM. The management will usually become the future company oath. Therefore, the management should have a proper preliminary education.
- EVM concept should be introduced to syllabus in higher educational institutions

#### **6.4 Further Research Directions**

- A research project to measure the feasibility of use the proposed budget framework for forecasting the project budget in construction industry.
- A research can be conducted to measure the feasibility of this framework in all types of construction projects.

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**APPENDIX 01 – INTERVIEW GUIDELINE**