AN INVESTIGATION ON THE APPLICATION OF EARNED VALUE MANAGEMENT (EVM) IN MANAGING COST PERFORMANCE

BY

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DECLARATION BY THE CANDIDATE

I, Lum Seon Cin (Student I.D. I12000021) confirm that the work in this report is my own work and the appropriate credit has been given where reference have been made to the work of other researchers

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ABSTRACT

Although majority understands the significant of triple constraints of time, cost and quality in succeeding a project; however, the cost and time overruns are still the most critical problems encountered in construction project. Gantt chart S – curve is a common traditional tool that is used in the construction industry to monitor project performance. A good project schedule certainly assist better project plan in detail, however project implementation is the key success of any project. Earned Value Management (EVM) is one of the fundamental approaches acting as a sound management tools towards the improvement upon the standard comparison of budget and actual cost which lacks an adequate indicator of progress. To address this, this research was conducted quantitatively to identify the percentage usage of EVM in Kuala Lumpur and Selangor construction industry, to examine the extent of EVM contribution compared to Gantt chart S - curve and to identify the challenges faced by using EVM. 100 questionnaires are distributed to focal groups from contractor firm, consultant firm and project management firms. Feedbacks from 33 respondents revealed that majority agreed that EVM contributes to project cost monitoring and it provides an overall cost effective cost management tools. Besides, the three major challenges encountered using EVM is due to the lack of EVM knowledge, expertise and experience in the industry, lack of motivation and top management support and tedious data collection required when implementing EVM.

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CHAPTER 1

INTRODUCTION

1.1 Background and Purpose of Study

Cost and schedule overruns is common yet critical problem in the construction industry. Moment (cited by Zayyana Shehu et al. 2013) states that about half of the Malaysian construction industry encountered approximately 72.88% cost overruns issue. On the other hand, Ismail Abdul Rahman et al. 2012 had also conducted a study on time and cost performance in Malaysia and founded out that 89% respondents agreed that project was facing average 5% - 10% cost overruns from contract; while, only 11% respondents completed their job within contract period.

It was thought that the development of EVM is to overcome the scarcity of the traditional project monitoring tool such as Gantt chart S – curve. Gantt chart itself is a schedule management tool. Although Gantt chart was one of the most popular and effective management tools used in the industry (Mark Gershon (2013)); however, it does not deals wisely with the project management triple constraint which is essential for project succession (Michele McDonough (2013)).

Triple constraint in the context of project management consists of time, cost and scope. Single change in an element from the triple constraint influences the other elements. For example, an increased in scope of work increases the cost incurred. This may also prolonged project duration in the preparation of an alternative work. Gantt chart notifies delay in terms of time, but it does not shows actual cost incurred during project progression and this may result in cost overruns and reduced value of work. Thus, in order to monitor project cost, S – curve was introduced and management tool was improved by superimposing S – curve on Gantt chart.

Numbers of literature reviews supported the positive contribution of EVM. Dayal (2008) stated that coupling with the use of EVM enable the elimination of project cost and schedule overruns issues. In addition, Naderpour (2011) constructed a case study to determine the effectiveness of EVM by applying it in a real project. Results derived a report showing exact project information allowing him to make wise decision in mitigating the risks. Furthermore, Howard Hunter et al. 2014 concluded that EVM provides clear understanding on project issues and allow stakeholders to make management decision effectively.

Apart from that, Robert A. Marshall (2007) suggested that the implementation of EVM results in a greater project success on contracted efforts whereby the types of contracts were moderately affected. Additionally, Young Hoon Kwak and Frank T.Anbari (2010) listed several benefits of EVM. For example, EVM status project life cycle; EVM provides effective projects management, project programmes and portfolios; and, EVM allows managers to make wise decisions on the scope of project, resources allocations, risks mitigation plan.

In addition, Quentin W. Fleming and Joel M. Koppelman (1998) also listed advantages of EVM applying on all projects. For instance, EVM defines scope of work; EVM creates an integrated bottom-up plan via control account plans (CAPs); EVM measures project cost efficiency against cost incurred; EVM provides final cost forecasting based on project performance; EVM manages baseline changes and etc. Apart from that, based on the basis concept of EVM discussed by Ms. Radhika et al. (2015), EVM allows both schedules – cost analysis against physical work performed which is different from traditional management approach. The measurement metrics of EVM provide advance warning. It allows project managers and stakeholders to visualize project life cycle and manage project effectively.

Although most findings show positive comments in EVM, there are also arguments towards the implementation of EVM. Lius et al. (2014), Ms. Radhika et al. (2015) and José Ignacio Muñoz Hernández (2013) revealed that EVM is insufficient as process indicators as it does not take quality into consideration. Besides, Narbaev and Demarco (2013) (cited by Luis Felipe Candido et al. 2014)

viewed that the forecasting of work progress was incompatible at early stage. In addition, White and Fortune (2002) (cited by Luis Felipe Candido et al. 2014) analyzed challenges implementing EVM. It was concluded that EVM is inadequate for complex projects; EVM incurred large time consumptions and bureaucratic for documentations; EVM showed failure in long term predictions; EVM was highly dependent on standardized procedure; EVM was lacking of comprehensive view; EVM was difficult to implement and EVM was difficult to after implementation.

Furthermore, José Ignacio Muñoz Hernández (2013) argued that standard EVM guidelines has significant shortfalls where it addresses only project scope of work which neglected scope requirements and EVM was not designed to manage risks which had been perceived to be a risk management tool. Hall 2012 (cited by Oncu Hazir 2014) also listed down EVM limitations where EVM assumed activities to be independent where it does not differentiate critical and noncritical activities. Furthermore, EVM does not take behavioral management aspects into consideration. In order to implement EVM, large data are required. Ms Radhika (2015) stated that the cost of EVM implementation hurdled project manager from implementing it as software and coordination between various departments are required. Moreover, Oncu Hazir (2014) suggested that it is necessary to develop more accurate forecast project performance analytic model and flexible general practice approach.

According to a mixed method research done by Khan (2011), 80% of respondents do not implement EVM in organization and one of the most significant reasons was that Malaysia construction industry are lacking of EVM knowledge and expertise.

1.2 Problem Statement

Cost and schedule overruns is common yet critical problem in the construction industry. Moment (cited by Zayyana Shehu et al. 2013) states that about half of the Malaysia construction industry encountered approximately 72.88% cost overruns. It was claimed that project managers unable to identify the factors affecting cost overruns until project completed in which damages had already imposed. (Jerald G.Kerby and Stacy M.Counts, '*The benefits of Earned Value Management from Project Manager's Perspective*). As being the lack of analytic approach of Gantt chart S – curve, it was thought that Earned Value Management (EVM) is one of the sound management approach to monitor overall project performance in terms of schedule and cost performance. Hence, the ideology of the study is to investigate the contribution of EVM in project cost monitoring.

1.3 Aim and Objectives of Study

Aim:

To investigate the contributions of EVM towards construction project cost management in Kuala Lumpur and Selangor.

Objectives:

a. To identify the percentage usage of EVM in Kuala Lumpur and Selangor area
b. To examine the extent of EVM contribution compared to Gantt chart S – curve
c. To identify what are the challenges faced by using EVM

1.4 Research Questions

a. Statistically, what is the percentage usage of EVM in Kuala Lumpur and Selangor construction industry?
b. As compared to Gantt chart S – curve and EVM, which tool do construction industry players prefer in monitoring project cost?
c. How much do construction industry players agree towards the benefits of EVM in successfully monitoring project cost performance?
d. It was thought that EVM is ~~does~~ not commonly used in Malaysia construction industry. So, what are the challenges faced when implementing it?

1.5 Scope/ Limitation of Study

The major focuses of this research are to identify the application of EVM contributes to construction industry being a cost control tool by means of taking Gantt chart S – curve as comparison; to identify statistically percentage use of EVM and obtain opinions towards benefits and challenges of implementing EVM. This research was conducted in construction industry within Kuala Lumpur and Selangor. The research focused of three different types of firms who provide services for project management separately the Quantity Surveying Consultancy, Contractor firm and Project Management firms.

1.6 Research Methodology

Primary and secondary data were used throughout the whole project process. Initially, literature review was done through research articles, journals, newspapers, books and any other inter-based article to identify the contributions of EVM, the applications of EVM and Gantt chart S - curve, difficulties in implementing EVM, and etc.

The research was conducted in quantitative research method by distributing survey via online Google doc. The survey questions were designed based on literature review and to allow justification on literature review. In addition, questions also include obtaining opinion from respondents towards objectives of research in such a way to determine respondent's viewpoints on the contributions and benefits of EVM, tools preferred comparing between Gantt chart S – curve and EVM and identifying the major barriers faced by respondents in the implementations of EVM. A hundred (100) survey forms were distributed to focal group of Quantity Surveying Consultancy, contractor firms and project management firms who does construction project management in Kuala Lumpur and Selangor. 33 feedbacks data are collected and were analyzed using Microsoft Excel based on frequency distribution method in terms of percentage and measurement of central tendency for questions with ranking scale (4=Strongly Agree, 3=Agree, 2=Disagree, 1=Strongly Disagree) and sliding scale (4=Very Important, 3=Important, 2=Less Important, 1=Not important).

1.7 Organization of Chapters

Chapter 1: Introduction

This chapter described background of research, problem statement, aim and objectives, scope of studies, research methodology and the designed expected outcomes

Chapter 2: Literature Review

This chapter provided a theoretical review on the research information providing significant terminology, concepts and principles to the research study. Data and information of literature review were collected through research articles, journals, newspapers, books and any other inter-based article relating to the research topic

Chapter 3: Research Methodology

This chapter explained the methods gathering information from quantitative research method.

Chapter 4: Results, Analysis and Findings

This chapter produced a detail analysis and results from all collected data from quantitative research method to derive objectives of the research.

Chapter 5: Discussion, Conclusion and Recommendation

This chapter provided discussions on the results findings, conclusions and recommendations for further research.

1.8 Project Expected Outcomes

a. To derive that majority agree towards the contribution of EVM in managing project cost.
b. To derive that EVM is better usage than Gantt chart S – curve.
c. To derive the statistical analysis on EVM implementation by construction industry players in Kuala Lumpur and Selangor.
d. To determine the major challenges encountered by organization when implementing EVM.

CHAPTER 2

LITERATURE REVIEW

2.1 Importance of Cost Control

Unlike many manufacturing situations, more concern pasted within the construction industry was on the one-off projects. This generally creates difficulties for an effective management tool to monitor project performance as each new contract is unique. Construction industry often involves circumstances such as involvement of fresh management team, ad hoc labour recruitments, site dispersed throughout the country which tends to cause effective communications problems among parties, the frequent use of subcontractors and 'lump sum' labour items and the ever-changing weather conditions. Nonetheless irrespective to the scale of operation, costs of production are necessary to be monitored and controlled if the anticipated level of profits is to be realized. (Frank Harris et al., 2013)

On top of that, cost control system became an essential tool to all managers and team members in the cost control procedures and keeping every data of a project in record. The two major objectives of a cost monitoring system are to serve the purpose of financial transactions recording and also provide indication of the work progress and problems associated in a project. Essentially, a cost control system should enable the project manager to observe the current cost levels and compare it with the standard baseline. In addition, cost control system shall identify problems encountered and indicate remedial actions that shall be implemented keeping costs within acceptable bounds.

Although parties in the project know the significant of project cost control; however, cost overruns faced by construction industry players is still a critical problem.

One of the hot issues found recently in Malaysia was the construction of Kuala Lumpur International Airport 2 (KLIA 2) which was built to replace the Low-Cost Carrier Terminal (LCCT). This project faced a significant cost and schedule overruns problems. The completion date was originally set on September 2011 with initial estimated budget of RM 1.7 billion. However as project starts, delays occur and this subsequently affected the overall actual cost in used. In July 2012, a shocking news tweeted by Chief Executive Office of Air Asia Group, Tan Sri Tony that the current cost of construction had ballooned to RM 5 billion; but it was denied immediately by the authorities.

On 16th April 2014, Azman Ujang (2014) reported the cost of KLIA 2 had already doubled to RM 4 billion from its original plan. Besides, there is a high LAD imposed by the contractor reaching approximate sum of RM60 million (Eva Yeong 2014).

Blames such as poor soil condition leading to requirements of expensive earthworks, poor building designing and poor management had results delay in schedule and hike on cost. Tan Sri Johan Jaaffar suggested that solutions shall sought from financial and cost management system and identify negligence in by verifying design variation, cost variations, construction management, poor design and planning. (*the Sun* 2014). Although major cost and schedule overruns factors were not clearly identified, however, it was believe that poor cost and schedule performance management were one of the major causes.

Therefore from the above example, it can be observed that cost control system significantly provide client value-for money and achieving balanced design expenditure between various building elements.

2.2 GANTT CHART

Bar chart is a means of a chart or graph integrating project activities into overall project plan. It shows the estimated start and completion time for each activity of a project. Besides, bar chart allow the project manager to measure the time of resources that are required for the project plan, and also allow contractors to record the actual work progress of each of the project activities. This eased the project manager to determine the progress of project schedule which is plotted on a horizontal time scale for each of the task. In addition, the term Gantt chat is also be used, which is introduced by Henry Gantt who began to use bar chart as production control tool in the year of 1861 to 1919. (Wan Maimun Wan Abdullah, Ahmad Tamly 2006)

Gantt chart is a traditional project management tool as one of the basic schedule management technique and widely used for project scheduling and controlling due to its simplicity, graphical method and also ease of preparation. Activity in this context refers to a task or closely related group of tasks whose performance contributes to the overall project completion. Each of the activity is shown in the schedule position for efficiently allocate resources, presenting logic and floats and marks clearly the important constraints or key dates (Ismaaini ismail et al. 2013). Figure 2.1 shows a typical Gantt chart (*Gantt Charts, Evolution of the Gantt Chart).*

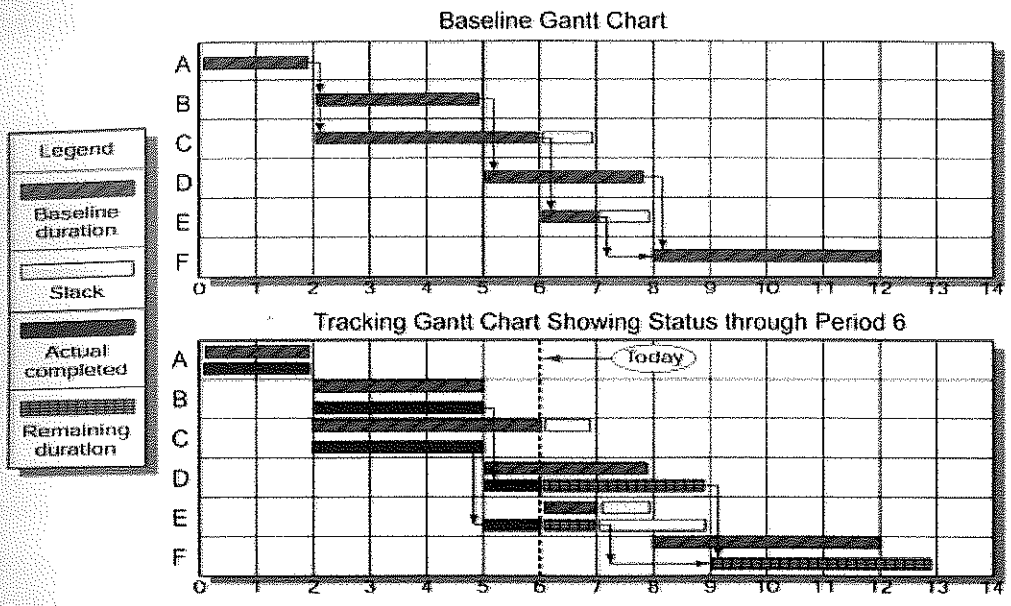

Figure 2.1: Typical Gantt chart

According to Figure 2.1, Gantt chart is organized in such a way that all activities or tasks are listed in the column at the left side column of the diagram. While, a horizontal time scale was extended to the right of the lists runs depending on the total. If the project period was short, dates will normally runs in the increments on days; and if the project duration was moderate, date may runs in terms of weeks and etc.

Furthermore, the project activity planned time is shown in a horizontal bar aligned with each activity. This horizontal bar is drawn from an estimated starting date and ends at the estimated finish date of that particular activity. Basically, the project progress is tracked where additional bars at the bottom of planned bars was filled to a fraction of accomplished work indicating the percentage completions of the tasks as shown in Figure 2.1. In addition, resources such as man power were inserted to each activity identifying persons responsible for the task (W.Durfee 2008).

2.2.1 ADVANTAGES AND DISADVANTAGES OF GANTT CHART

The Gantt chart helps contractor in many different ways to plan and control the building of the construction project. Below shows the benefits of Gantt chart:

(a) Simple to construct and it is easy to comprehend

The graphical form of Gantt chart eased visualization of the project management timeline by creating horizontal bar charts from a list of tasks including information such as tasks names, start and end dates and duration of the activity. In addition, no complicated calculations or theories required to establish a Gantt chart. Thus, reduces preparation time of work programme required under the contract to be submitted prior to the commencement of works.

(b) Applicable to all stages in planning process

Gantt chart can be used in all stages in planning process such as the project planning stage, pre-tendering stage, post-tendering stage and contract planning stage. It can be used to develop programme from tender stage to master programme; likewise developing programme from tender stage to the short term-planning throughout the contract period.

(c) Readily update with information

Gantt chart is readily updated with information at weekly or monthly intervals and updates of programme even can be done readily on site with the aid of computers. The examples of information are the key site deliveries, progress to date and delays, simple to produce 'as built' to the programme which may prove an asset to the contractor in forming contractual claims. The effect of late information received on programmed operations can also be monitored and reported. Furthermore, copies of the contract position at the date of a specific occurrence may provide evidence of any resulting delay.

(d) Gantt chart summaries at any desired Work breakdown structure (WBS) level

In the development of Gantt chart, works are identified and planned in detailed by breaking down project into various activities. These activities are arranged according to own desired work packages arrangement in the form of WBS. Therefore, it draws out the overall planning details for a particular WBS in bar chart format that is easy to comprehend.

(e) Time Management

Gantt chart enables parties under the contract to understand well project programme and have a clear picture on the overall impact of project delays and therefore encourage in better task organization.

Although Gantt chart is widely used, there are limitations as well. Below show the disadvantages of Gantt chart acting a project management tool.

(a) Too many dependencies

Although Gantt chart is simple to use and ease in visualization; but large amount of dependencies especially in large and complex project, may leads to the lost of overall project progress impression. The purpose of a Gantt chart is to provide clear and simple plan showing the summary of work packages rather than a plan overloads with project activity details. Therefore, it is impractical for complex projects with many tasks.

(b) Does not reveal relative priorities of individual tasks and resources expended on a task.

Tasks within Gantt chart are prioritized based on the amount of float and neglected the significant of tasks to the project. For instance, Gantt chart shows the elapsed time of tasks; however, it does not indicate what are the resources required to complete the tasks. Therefore, backup data is necessary which otherwise may leads to misleading impression to stakeholders.

(c) Gantt chart does not reveal the problems encountered due to expected delays

Gantt chart only shows the planned and actual start and end dates for each task. Although it enables quick review on the overall project status; however it does not show how delaying a single task affects the rest of the project activity or the overall project.

(d) Gantt chart does not show the degree of completion for each task

In general, Gantt chart is not designed for detailed tracking where the main intention of the development of Gantt chart is to provide an overview of the entire project. Once errors discovered, it was timely to investigate and identify the cause of the errors and mitigations plan. As a result, damages may already impose on the project.

(e) Inflexibility

Although Gantt chart is readily to be updated in terms of programme; however, it does not accommodate to the changes in projects. Projects are not static as it is affected by many factors such as weather conditions and soil conditions. Besides, a complete estimate is required before the development of Gantt chart because chart must be redrawn with a change on estimates. Therefore, constant update is required and this may consume large amount of time for the reconstruction of Gantt chart.

no referencing?

2.3 S – Curve Cash Flow

Cash flow refers to the money transferred in and out from a company. Large sum of money required to enter into construction project. Thus, client needs to be informed on the financial demands during all stages of development; likewise, contractor also needs to be informed on their predicted cash flow for him to cover any funding deficient. It is significant to forecast cash flow to the feasibility of contractor and, as many other businesses in the current economic climate, it affects in financial products that underwrite profit flows in corporate transactions to give them the same force as cash flows. (Frank Harris et al. 2013).

Cash flow forecasting is normally done in two levels by the contractor. First, it is at estimating and tendering stage where forecast is just for single project estimation. While another cash flow forecasting is to the calculation of cash flow forecast for company, division or area. This calculation involved every active project's cash flow and it is normally done monthly or quarterly.

In terms of forecasting on estimating single project, it is normally calculated by allocation bill items to the activities on pretender bar chart or network. This therefore directly link Bills of Quantities build-ups and pretender work programme. By looking into both of these elements, it creates the value versus time and cost versus time S – curves.

An S – curve is defined as the graphical display of cumulative progress in terms of costs, labour hours or other quantities plotted against time. A typical S-curve in most of the project flatters at the beginning and end, and steeper in the middle. Slow progress at the beginning results in gradual curve. As project commenced, accelerating starts results in a steeper curve; while as work runs out, graph is leveled off at the end of project. In a perfect project, the initial mobilization and start-up encompasses the first 25% of the time and accomplishes 15% of the work. By the 75% time mark, 85% of the work is performed and remaining 15% of work is accomplished during the last 25% of the time (Theodore 1993).

S – Curve is best applied to projects where provisional sums are evenly spread though the contract, as this technique does not allow for high expenditure provisional items at early stage of project. The basis for forecasting using this method is the presumption that the cumulative expenditure on any construction project is similar to an S – shaped curve. As a consequence, sum of monthly payment with and including the total previous payments of a project describes a cumulative S-curve (Brian Cooke & Peter Williams 2004).

A value versus time S – curve derives the income of contractor. It can be obtained by producing project plan summing all assigned dollar or hour values to each activity in the established Gantt chart directly link Bills of Quantities build-ups and pretender work programme either by weeks of months. This is usually measured in cumulative basis and so, the graph represents the cumulative value versus time produced by running total over each time period.

While, cost versus time S – curve forecasts the estimated expenses over the life of the project. In other words, it is the graph to derive money spent by the contractor in a project. The difference between value and cost is that, margin profit and head-office overheads that are added into the estimated cost in each bill items and spread uniformly throughout the project where each bill items carries the same percentage for profit and overhead.

Alternatively, the cost versus time graph may be in the same way with value versus time where the contribution margin may not be uniformly distributed due to either rate loading had occurred and early activities carries great margin than later activities or several setting up costs reduced the margin on the early work. Figure 2.2 shows a simple S curve graph.

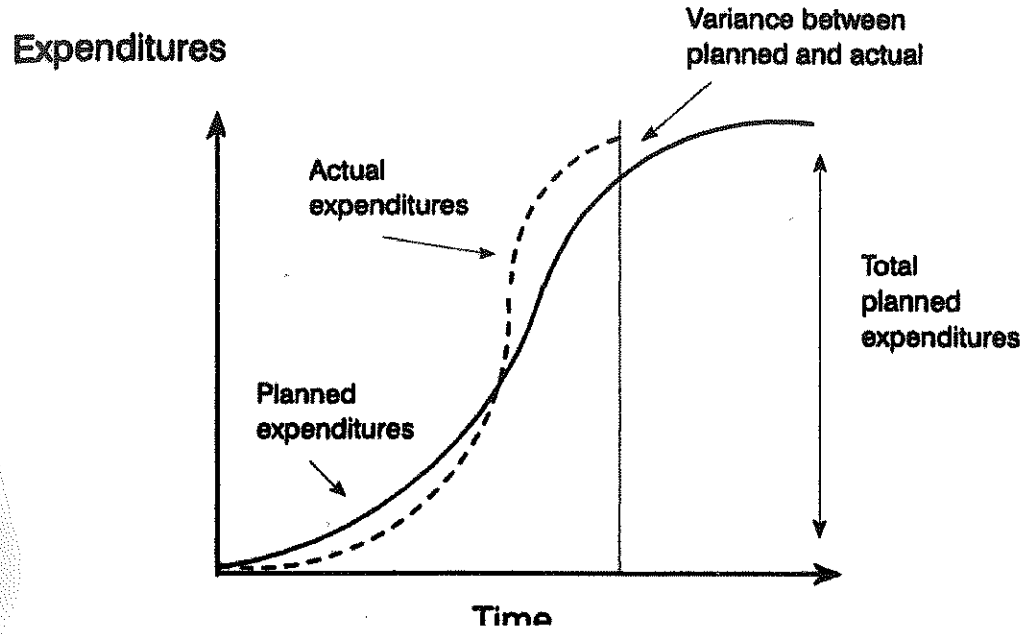

Figure 2.2: S – curve

By simply monitoring the actual performance with the scheduled budget in cost versus time S - curve graph as shown in Figure 2.2, if the actual performance graph lies below the budget graph, it may be concluded that cost performance is under control or better than expected. However, this cannot draw a conclusion unless it relates the information with time performance. This is because, although cost performance shows an efficient cost expenditure; but delays may have caused smaller-than-planned progress and the work actually accomplished may have cost more than planned.

Besides, this curve was also developed by presuming that cost and time are in direct relationship additionally further assumed that the costs assigned to activities are correct. Most of the time, S – curve show project is in good performance at the initial stage; however, the actual cost expended was more than what had planned.

Furthermore, S – curve as well established on the assumption that all activities planned starts and ends at their early time. In non-critical activities, it consists of slacks that allow them to delay without affecting the project progress. Such delays can result in actual total cost to date that are lower than those shown on curve, with no unfavorable consequences, provided that critical activities are on schedule.

2.4 GANTT CHART S – CURVE

The main idea of Gantt chart is a basic schedule management tool used for project scheduling and controlling. The biggest advantage of Gantt chart was assisting in visualization that breakdown tasks based on own preferred WBS level. However as discussed under section 2.2.1, Gantt chart does not reveal the expended resources in terms of cost on tasks. Thus, the interpretation of project performance may be misleading as if the project was on schedule; the maintenance of schedule based on the horizontal bar chart may be achieved under great cost overruns. Therefore, in order to monitor cost, bar chart was loaded with resources or budget into each task and thereafter producing an S – curve. Figure 2.3 shows superimpose of S – curve on Gantt chart.

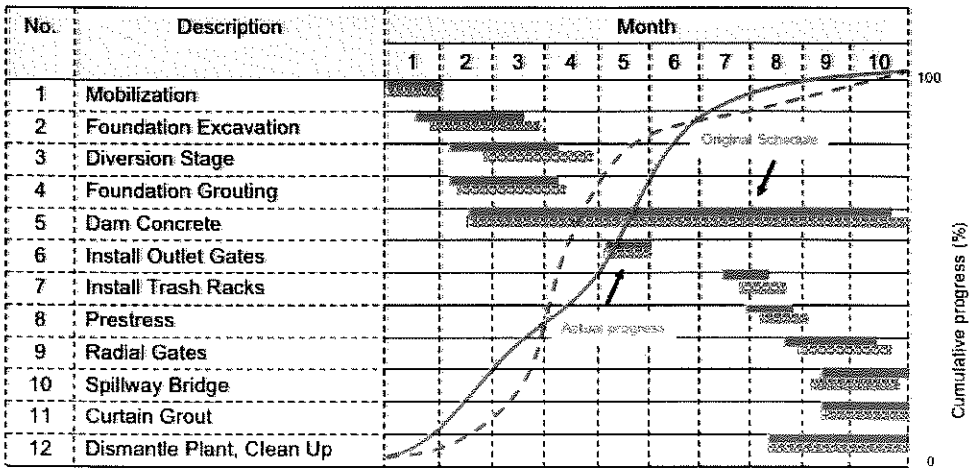

Figure 2.3: Superimpose S – curve on Gantt chart

From Figure 2.3, superimposing S – curve on Gantt chart may look good as it ties cost from S – curve and schedule performance from Gantt chart together. However, the physical percentage complete field to a task view and enter values when the calculated percent completion of works would not be an accurate measure of real work performed or measured. Unlike the percentage complete field, the physical percentage completion field is independent of the total duration or actual duration values used to calculate the percentage complete field under Earned Value (EV) in EVM.

For example, the construction of stone wall for a building project consists of 100 stones stacked in five high. It takes approximately 20 minutes to lay the first row of 20 stones. However, as efforts required lifting the stones up on single row higher, the laying of stones on second row take approximately 25 minutes. Following which, laying third row of stones takes 30 minutes, fourth row consumed 35 minutes and laying the last row of stones takes 40 minutes. Hence, in total, 150 minutes consumed stacking 100 stones in five high.

From the example above, after laying the first three rows of stones may be concluded that 60% of physical works had However in actual facts, the physical work complete is only 50% because in total, only 75 out of 150 minutes of work completed.

On the other hand, in terms of financial S – curve in Figure 2.3, updating the actual cost in cost versus time curve was depending on the build – ups on Bills of Quantities with additional marginal profits and head – office overhead that it does not reviewed the actual cost spent in the completion of project tasks. Besides, cost comparison for Gantt chart S – curve was based on the cost planned by loading budget into each task. Unlike the cumulative percentage actual cost in Gantt chart S – curve, Actual Costs (AC) in EVM measures the budget spent in view of the amount of work done so far and with the baseline cost for task, assignment or resources allocated. It compares the actual to budgeted cost assigned additionally display the resulting task expenses along with any cost incurred up to status date.