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Monitoring project performance through earned value analysis

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Abstract

Planning, monitoring and controlling are important aspects to ensure project success in project management. Although planning is the first step to follow in order to commence certain projects or programs, quite often than not, many projects are still bound to failures. Such scenarios occur because there exist poor monitoring of project progress by project managers. Hence, project may delay or non-accomplish at all given a targeted schedule. This paper attempts to evaluate and analyze project performance through earned value analysis. The methodological approach is based on the calculation of cost performance indices (CPI) as well as schedule performance indices (SPI). From here, critical ratios could be determined. In this exercise, we used the development of one of the UiTM campuses where four project sites implemented between 2009 and 2011, were used. The analysis showed that there are variances between 4% and 12% between the budgeted costs and the actual costs in most of the projects. However, due to careful monitoring, eventually all the four projects were successfully accomplished. In retrospect, the analysis suggests that careful monitoring enhances the right control in project management which would give beneficial impact to both project teams as well as organizations.

Keywords: monitoring; controlling; earned value analysis; cost performance indices; schedule performances indices.

1. Introduction

For the past several decades, there has been a rapid growth in the use of project management as a means by which organizations achieved their objectives. Project management has been seen to provide the organization the powerful tools to improve its ability to plan, implement and control the activities as well as the ways to handle the utilization of people and resources. There are a lots of construction based projects managed by various project organizations in Malaysia today, in tandem with the growth of the construction industry as well as the overall economy. However, the past decade saw quite a number of medium to large size projects which were stalled or restored due to poor performance. In 2008, for instance, there were 115 construction projects were stalled [1]. Fortunately, with the help of SPNB (Suruhanjaya Perumahan Negara Berhad), 73 projects were restored and completed that year [2].

Scenarios of non-accomplishments or indefinite delays of projects were normally related to poor morale, bad human relations in project supervisions, labour productivity as well as redirection of efforts towards the original objectives [3]. In such situations, frustration occurred to the project team members, even though initial planning before project implementation was carried out smoothly. In retrospect, just planning alone is

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insufficient to render project success. In other words, careful monitoring and control are essential ingredients for the successful completion of projects.

2. Performance of Construction Sector

The construction sector plays an important role in the economic development of Malaysia. Although its contribution towards the GDP (gross domestic product) was only 3.2% for the years 2009 and 2010 [4,5], nonetheless, if real estate sector is categorically included, the percentage contribution for both years exceeded 8.3% and 8.6% respectively. It is sanguine to place this sector for development purposes of the future. On the other hand, if we consider the number of construction projects as well as the total value of the projects, we notice that there was slight increase in number of projects, while quite a significant increase in value terms of projects from 2008 to 2012. Table 1 below shows the number of projects and the values in millions ringgits from 2008 to 2012.

Table 1. Number of Construction projects and values in Malaysia 2008-2012

Years	Number of Projects	Percentage change	Values (in RM millions)	Percentage change
2008	5693	-	74,164	-
2009	6898	21.1	74,058	0.02
2010	7196	4.3	87,914	18.7
2011	7461	3.7	98,947	12.5
2012	6770	-9.2	112,513	13.7

*Source: CIDB Bulletin 2010 and 2013.

As depicted from Table 1, the total number of projects increased steadily from 2008 to 2011 but decreased in 2012. The average growth from 2009 to 2012 was about 5%. However, in terms of values, there was a significant increase from RM 74,614 millions in 2008 to RM 112,513 millions in 2012 and the average growth for the periods of 2009 to 2012 was about 11.2%. It is also envisaged that the building and construction sectors will benefit indirectly from the inception of the 131 large scale projects initiated from the ETP (Economic Transformation Programme) [6]. This shows the significant role of the construction sector in enhancing the overall economic growth in Malaysia.

However, if we consider the un-accomplishments of some of the construction projects, we have to investigate the contractors' obligations in carrying out their duties in order to deliver their final projects deliverables to the customers or clients. In this respect, most delayed projects are directly caused by incompetent project-teams which were normally hired as "sub-contractors." In many circumstances, the main project contractors did not practice proper monitoring system in handling projects done by the sub-contractors. They normally resort to traditional view of accepting agreement through face-value and following the normal simple Gantt chart for monitoring.

3. Objectives

As many organizations did not practice good monitoring systems due to "sub-contractual practices", our study is to investigate proper analysis of monitoring for projects done during the 9th Malaysia Plan. It is only a case study of 4 medium-size construction projects, situated in Malacca.

4. Methodological Approach

The methodological approach for the purpose of this monitoring system is through the utilization of earned value analysis. Earned value analysis relies on the concept of variances from actual to planned budgets or schedules. Thus the two types of variances are:

(i) Cost variance (CV) = Budgeted cost for work performed (BCWP) – Actual cost for work performed (ACWP) (1)

(ii) Schedule variance (SV) = Budgeted cost for work performed (BCWP) – Budgeted cost for work schedule (BCWS) (2)

Or in terms of performance *(SV) = Planned time schedule (PS) – Actual time schedule (AT)* (2a)

From these variances concepts, the Cost Performance Index (CPI) and the Schedule Performance Index (SPI) can be calculated as follows:

(i) CPI = BCWP/ ACWP (3)

(ii) SPI = BCWP/BCWS
= PS/AT (4)

For the purpose of good monitoring system, normally each activity or WBS (work breakdown structure) of the projects is monitored individually (see Khedi, Z and Hongping, Y. (2010) [7]. However, for reporting purposes, most project managers prefer the aggregation of the WBS up to a given time-periods which normally takes the quarterly basis (once in 3 months). Finally, critical ratios could be determined, which normally be used as a yardstick of overall performance. Critical ratio is actually the Cost Schedule Index (CSI) (see Meredith, J R and Mantel, S.J (202010) [8] and defined as:

SCI = (CPI) x (SPI) (5)

In retrospect, for values of SCI >1 it normally shows that the project is showing good or exceptionally good performance, while SCI<1 denotes poor performance.

4.1. Data Sources

For the purpose of this study data is collected from the engineers and planner of building the UiTM complex of a new branch campus of UiTM in Malacca. We discussed with the planner and engineers about the construction of 4 sites (we called them as projects) in order to find out some of the rollout and issues to share with them on the development path. After that, we resort to the secondary data taken from the data base of Time-Scaled Data Report for activities done from late 2009 and end of 2011 from the main developer of the 4 projects.

5. Results and Interpretations

The results of the exercise can be viewed using the general principle of whether there exist elements of below or above budgets. In other words, the first step is to know the general pre-view of the cost variance by estimating the EAC (Estimated Cost at Completion Time). Secondly, the overall cost performance, the schedule performance as well as the cost-schedule indices were obtained, which are actually part of the earned value analysis.

5.1 Cost variance ratio

Table 2 denotes the percentage cost variance of the four projects under the assumption of 100%-completion rule, and using the EAC only.

Table 2. Percentage of cost variance with respect to actual cost

Project/Site	Budgeted Cost (RM values)	EAC (Estimated Cost at Compl. (RM)	Percentage of Cost Variance(CV)
A	278,700.0	258,970.7	0.07
B	149,385.6	144,063.7	0.04
C	266,768.6	287,660.2	(0.08)
D	355,572.0	440,227.1	(0.12)

As depicted from table 2, that the four projects have percentage variances of between 4% and 12%. In normal circumstances, project managers were not worried about the variances if they fall below 10% level. However, negative variances are signs of cost overrun. It should be thoroughly investigated, especially if it falls below negative 10% as for example shown by project D (-12%). Project C should also be investigated further, even though the cost variance is only about (-8%).

5.2 Earned Value Analysis

Using equations (3), (4) and (5) from previous section, the CPI, SPI and the CSI indices could be obtained. However, in this case, the data used were taken from the data base of the developer's office, known as the Time-Scaled Site Report. It should be noted that the starting time as well as the ending time of each project differs and the overall calculation was based on the aggregated or cumulative sums of quarterly budgeted cost and budgeted progress versus actual cost and actual progress. The same assumption was used as before, i.e the 100% completion rule but the time of monitoring was about 90% completion time. The summary of the results is depicted in Table 3 below.

Table 3. Cost Performance, Schedule Performance and Cost-Schedule Indices of the 4 projects.

Variance/index	Project A	Project B	Project C	Project D
Cost Variance	23,700	2371.2	-26,245.5	-7,688.9
Schedule Variance	-900	-1185.6	-19,013.8	-3,704.9
CPI	1.09	1.02	0.90	0.98
SPI	0.99	0.99	0.93	0.99
CSI	1.01	1.03	0.968	0.989

From Table 3, it revealed that Project A and B showed good performances in terms of CPIs as the values are greater than 1. However, in terms of schedule or time they showed slightly poor performances as the SPIs are equivalent to 0.99. Generally, the overall performances of these two projects are good as the values of the CSIs are 1.01 and 1.03 respectively. Hence, the existing monitoring and controlling systems are adequate for smooth running of the projects. In contrast, Project C and D showed poor performances by looking at both the CPIs and the SPIs, (all have values of less than unity). Even the CSIs values were not encouraging as well. It is therefore appropriate to take serious effort to realign these two projects with the original goals as well as the existing problems in order to avoid un-accomplishments. Such efforts are indispensible as it would help in recovering the overruns of both the costs and schedule till the completion dates.

6. Conclusion

The exercise reveals that it is beneficial to use monitoring system that could avoid delays as well as cost overrun. The system which was utilized using the CPIs, SPIs and the SCIs are in fact the analysis using earned value approach. It is an effective tool because we could realign the undesirable increase in cost of raw materials and labor as well as the unprecedented delay due to small scope changes or weather conditions. The exercise on the four projects above is a case in point, where the two projects C and D were seen to have poor performance, but finally they were completed even though they experienced un-favorable variances. However, one thing that we should bear in mind is that the two projects had CSIs of more than 0.95. Hence, further monitoring and controlling is easier as compared to projects which had CSIs of only around 70%. It makes sense that in addition to normal usage of Gantt chart, earned value analysis is a reliable tool to monitor and control construction projects which are done by "sub-contractors."

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