CONTRACTORS' PERSPECTIVE ON APPLICATION OF EARNED VALUE ANALYSIS (EVA) AS COST CONTROLLING TOOLS IN CONSTRUCTION PROJECTS

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Abstract

Poor cost management is a severe problem that occurs in the current construction industry, resulting in big amount of cost overrun which not only in Malaysia but also happens frequently in the global construction industry. Traditional methods such as standard financial s-curve, daily monitoring, weekly or monthly report are less efficient in monitoring and controlling the cost performance of a project. This paper is focusing on the investigation of the effectiveness of Earned Value Analysis (EVA) as cost controlling tools in construction projects in contractor's perspective. EVA is a cost controlling technique that unites the performance of cost and schedule. Descriptive study is carried out in this research and survey form was used to collect the quantitative data from target respondents who are Grade 7 Contractor firms in Petaling District. The findings have shown that the awareness of EVA technique is low among study area as the frequency of usability is low. However, the findings have indicated that EVA is able to improve the cost performance of the construction projects. The contribution of EVA which is remedial actions can be taken earlier to keep the cost within budget is ranked as the 1st place among the listed contributions.

Keywords

Cost overrun, Earned Value Analysis (EVA), Petaling District

1.0 Introduction

Construction industry plays a crucial role in determining the development status of a Nation. Research studies have opined that construction industry has contributed a lot to the economic development of a country (Myers 2013). Takim and Akintoye (2002) indicated that construction project is unique yet complicated as it involved many different parties, complicated procedures and process and it requires special skills and technique for the sake of the project success. The most significant performance indicator used to assess the success of a construction projects is a great performance of cost (Akinsiku et al. 2014). However, according to Malaysians Auditor General 2008 report, the issue of poor cost performance in which eventually causing the cost overrun has brought the delay of the progress of the project and this has caused clients and contractors suffered from financial loss (Khamidi et al. 2011). Bowen et al. (2012) has opined that time, cost and quality are the most significant components in order to plan and manage a successful construction project.

Table 1.1 illustrates that the extent of cost overrun in terms of approximate percentage over budget studied by Memon et al. (2012) which revealed that 96% of the construction projects in Johor, Melaka and Negeri Sembilan had undergone the problem of cost overrun. A clearer figure of the extent of cost overrun is shown in Figure 1.1. In order to avoid the occurrence of the cost overrun issue, the application of proper cost controlling tools should be adapted in the construction projects. Khamidi et al. (2011) has reported that controlling of the cost performance of a project shouldn't be merely rely on the comparison between the actual and planned expenditure but it has to take into accounts the value of work done at the particular milestone. A proper assessment tool of cost performance should also take into considerations of future trends of the project. According to Nguyen (1998), Earned Value Management (EVM) is an effective tools used in cost management which is indispensable in this modern century.

Table 1.1 Extent of cost overrun

Scale	Extent of Cost Overrun	Frequency	Percent (%)
1	0%	4	4.1%
2	1-5%	15	15.5%
3	5-10%	59	60.8%
4	10-15%	8	8.2%
5	> 15%	11	11.3%
Total		**97**	**100.0%**

(*Note*: Adapted from "The Cause Factors of Large Project's Cost Overrun: A Survey in the Southern Part of Peninsular Malaysia", by Memon. Aftab Hameed, Abdul Rahman. Ismail, and Abdul Aziz. Ade Asmi, 2012, *International Journal of Real Estate Studies, Volume 7(2*), page 7. Universiti Tun Hussein Onn Malaysia and Universiti Bakrie, Indonesia (2012).

Earned Value Analysis (EVA) is a cost controlling technique that unites the performance of cost and schedule. It does not only compare the planned expenditure to actual expenditure to determine whether the project is undergoing cost overrun or stay in the budget. However, it takes budgeted value of work schedules (PV) with the earned value (EV) of physical work done and the actual value (AV) of work completed (Hamilton, B.A 2006). Premalal et al. (2017) has reported that the awareness programs should be conducted to raise the importance of using Earned Value Management (EVM) as EVM is one of the most useful technique in controlling the cost performance of the construction project. The result from previous research carried out by Premalal et al. (2017) has also shown that contractors agreed that Earned Value Analysis (EVA) has contributed a lot in project cost monitoring purpose.

2.0 Research methodology

In order to achieve the research goals which are the aim and the objectives of the research, quantitative research will be carried out to collect the data from respondent. The design of the approach to carry out this research is by applying descriptive research. Descriptive research is a type of research which carried out with based on the amount or quantity collected in data collection (Kothari 2004). The quantifiable information will be used for data analysis which collected from target respondents; while online survey will be the method of research used to collect the data from respondents. Questionnaire is the form of survey used to collect the data from respondents. The setting of the questions in questionnaire is based on the literature review. After pilot study is done, the final design of the questionnaire will be divided into six sections and including 15 questions in total.

The target respondents of this research are Grade 7 Contractor Firm in Petaling District. According to Flyvberg et al. (2004), they have described that the larger the size of projects, the higher the chance of cost will be overrun. This is due to the longer duration of project period which may be influenced by the inflation in market or any other possible factors. So, the target respondents will be only focus on Grade 7 Contractor Firms which only focus on large project

which tend to suffer from cost overrun. Sampling size is determined by using the online survey system which the confidence level is assumed to be 95% and the confidence interval is at 5%. From total population of 878 G7 contractor firms, the sampling size needed to ensure the accuracy of this research is 267 firms. Confidence level means the level of certainty of the result. 95% of confidence level in this research means the result is 95% certain; whereas the confidence interval which also known as margin error is a figure which shows the plus-or-minus of the result gained. Higher confidence level and lower confidence interval ensure the higher accuracy of the results.

Finding of mean:

$$= \frac{5A + 4B + 3C + 2D + 1E}{\text{Total number of respondents}}$$

$$= \frac{5( ) + 4( ) + 3( ) + 2( ) + ( )}{\text{Total number of respondents}}$$

The value of is also called as "Important Index" or Ranking Index"

- ✓ A = Number of respondents with "Strongly Agree"
- ✓ B = Number of respondents with "Agree"
- ✓ C = Number of respondents with "Neutral"
- ✓ D = Number of respondents with "Disagree"
- ✓ E = Number of respondents with "Strongly Disagree"

According to the data collected, the average index or mean score were calculated by using Microsoft Excel based on options given in the Likert scale. Rating range is classified to all measures based on their mean score. Based on the questionnaire of level of factors of cost overrun, 3 pro-codes are applied which 1 is representing lowest impact of factor, 3 represents medium impact of factor and 5 represents highest impact of factor. The difference of the range between highest and lowest impact is divided by 3 to represent the three scales which are high, medium and low contribution measure. The factors of cost overrun which lie between the range of 1.00 to 2.33 is under low rating scale, 2.34 to 3.67 is under medium rating scale and 3.68 to 5.00 is considered as high rating scale.

3.0 Results and discussion

3.1 Respondent's Background

Majority of the respondents are from the category of less than 5 years of experience which is 38.3% out of 81 of total respondents. Following which by category of 5 to 10 years in 24.7% and the least category of respondents are from 11 to 15 years of experience. Over the respondents' background in the contractor firms, 27.2% of the respondents are from the category of others (e.g. Construction Manager, Project Executive, Site supervisor, Site manager and etc). The result is following by second majority which is Quantity Surveyor (23.5%) and Contractor (22.2%). The least category which is the project manager has carried 11.1% from total respondents.

3.2 Factors of Poor Cost Performance on Construction Projects

The results reveal 12 factors of cost overrun which were abstracted from previous studies. According to the data collected, the average index or mean score were calculated for every single factor based on options given in the Likert scale. All the factors were ranked based on their mean score, a factor with highest rank means that it has the highest impact to cost overrun.

Table 3.1 Factors of Poor Cost Performance on Construction Projects

Rank	Factors of Poor Cost Performance	Average Index
HIGH	Poor cost control method	4.90
	Lack of planning and coordination	4.44
	Inaccurate quantity estimation	4.43
	Delayed payments to contractors	4.01
	Increase in the cost of construction materials	3.91
	Additional costs due to variation works/change order	3.90
MEDIUM	Fluctuations in the cost of labour and/or material	3.64
	Wrong method of cost estimation	3.62
	Changes in plans and drawings or design changes	3.59
	Inexperienced contractor	3.58
	Changes to specification	3.54
	Inadequate site investigation	2.94

Rating range is classified to all measures based on their mean score. Based on the questionnaire of level of factors of cost overrun, 3 pro-codes are applied which 1 is representing lowest impact of factor, 3 represents medium impact of factor and 5 represents highest impact of factor. The difference of the range between highest and lowest impact is divided by 3 to represent the three scales which are high, medium and low contribution measure. The factors of cost overrun which lie between the range of 1.00 to 2.33 is under low rating scale, 2.34 to 3.67 is under medium rating scale and 3.68 to 5.00 is considered as high rating scale.

The factors which causing project cost overrun are evaluated by the respondents to determine which of the factors are the most commonly happening in the construction project. This question is used to answer the first objective of this research. Ranking of the factors causing cost overrun was assessed by using mean score. Table 4.5 and Figure 4.5 are showing the ranking of each of the factor that contributes in project cost overrun with their corresponding mean scores. The result is revealing that 6 factors are under high rating scale and 6 factors are under medium rating scale. None of the factor is classified under low rating scale. The findings are showing that poor cost control method (High rating scale) is the most significant contributor that causing cost overrun followed by the lack of planning and coordination with mean score of 4.90 and 4.44 respectively. The 3rd rank of factor is inaccurate quantity estimation with mean score of 4.43 while the lowest rank among the factors listed is the inadequate site investigation with the mean score of 2.94.

Cost control during the construction phase plays the most important role in keeping the expenditure within the budget. Respondents have chosen this factor in the first rank is due to the using of traditional method in cost controlling process which is not effective or efficient as using advance technique to control the cost. As the problem exist may not be detected and remedial actions can't be taken immediately before the problem went serious.

This finding is consistent with the finding of earlier literature studies by Abdul Azis et al. (2013) which opined that poor cost management is the main contributors that occurs prevalently in Malaysia construction industry which consequently causing the severe problem of cost overrun in construction projects. While according to Akinsiku et al. (2014), lack of planning and coordination was ranked in the first place by the respondents. The suggestion to redress the problem is by adaptation of advanced technology which allow the proper planning and coordination of the project to be carried out as well as proper cost control system such as using of EVA as cost controlling tool to ensure remedial actions can be taken earlier.

3.3 Contributions of Earned Value Analysis (EVA)

Table 3.2 Contributions of Earned Value Analysis (EVA)

Contributions	Mean	Rank
Remedial actions can be taken earlier to keep the cost within budget	4.94	1
Early risk identification tool	4.75	2
Determination of project status	4.69	3
Prediction of project deviation trends	4.63	4
Scope change management	3.94	5
Clear work breakdown structure (WBS)	3.88	6
Motivation for project manager	3.38	7

From the result shown, EVA has the ability in curing the high rating scale of cost overrun factors such as poor cost control method, lack of planning and coordination, inaccurate quantity estimation, delayed payments to contractors, increase in the cost of construction materials and additional costs due to variation orders.

Poor cost control method is the greatest contribution of factor of cost overrun and this is in accordance with the statement stated in previous study by Abdul Azis et al. (2013) which opined that poor cost management is severe problem which can result in big amount of cost overrun. A better cost controlling method can be carried out by a good cost management system which remedial actions can be taken earlier after the risk is identified. A negative value of cost variance will be produced if Actual Value is higher than Earned Value. This situation implies that the status of the project is having cost overrun and remedial actions need to be taken immediately to keep the cost within the budget. The lack of planning and coordination which is second rank of high rating scale among the factors of cost overrun can be curbed by using EVA as well. This is because an accurate BSWS or Planned Value will be generated during the planning phase of the project. Delayed payments to contractors will not be causing serious schedule delay and eventually with cost overrun as the project deviation trends will be predicted and remedial actions will be taken immediately by contractors so that the project cost can be controlled. Apart from that, inaccurate quantity estimation, inflation of cost of construction material or additional costs due to variation orders will allow scope change management of EVA to keep the final budget of the project within check by providing alternatives to decide in what activities to reduce scope or reduce specifications/ performance to save money in order to fit cost overruns in other activities.

Referring to the finding of previous question that stated 81.3% of total 16 respondents had been involved in the implementing EVA technique in project with contract sum exceeding RM10 million. Usually project with bigger contract sum may have longer period of construction and hence possess a lot of uncertainty and risk. This is the strongest evidence to support the finding from this question which remedial action can be taken earlier (1st rank) after the possible risk is identified; whereas early risk identification is ranked as the 2nd greatest contribution of EVA as EVA is able to provide early warning to the project manager when there is a possible risk which may cause failure of the project. This result has also indicated that cost performance of the projects will not be deteriorated if remedial actions are able to be taken in time after the risk is identified.

The result is supported by Vandevoorde and Vanhoucke (2006) who mentioned that EVA technique also acts as an early reminding tool to raise a better cost-consciousness so that remedial actions can be taken before the cost is overrun.

3.4 Barriers and Challenges of Earned Value Analysis (EVA)

Table 3.3 Barriers and Challenges Faced by Respondents

Barriers and Challenges	Mean	Rank
Requires more information	5.00	1
Time consuming	4.38	2
Insufficient for complex project	4.13	3
Inaccuracy of baseline	4.06	4
Unfamiliar with EVA	3.13	5
Complex equations are used	3.19	6

This finding has revealed that EVA users have the basic knowledge of applying the EVA technique in their project. The jargonized phrases and complicated equations are not the obstacles that hinder the application of EVA. However, the biggest obstacle that faced by the respondents is that EVA technique requires too much information to generate BCWP, BCWS and ACWP to ensure the determination of the project status is accurate. When more information is required, thus more time to be consumed in collecting the information. Even though the finding highlights that 81.3% of 16 respondents who are applying EVA technique in the project with contract sum exceeding RM10 million, however, respondents have opined that EVA is insufficient for complex projects which ranked at 3rd place. Interestingly, the reasons of insufficient of the EVA for complex project are related to complete information needed and time consuming when gathering the data needed. Apart from that, it is tough to gather all the information of complex project in order to generate EVA graph.

The finding of this research is in the line with the statement of Kang et al. (2015) which claimed that most of the company not able the information needed to generate the EVA graph such as date report of the project costs, detailed work breakdown structure from all the parties involved such as the suppliers, main contractor and sub-contractors. Sometimes the up-to-date information is unavailable from one of the parties, then, the procedure may be obstructed. While the statement of Gershon (2013) which opined that long list of equations is one of the barriers that faced by users is not in the line with the finding of this research which most of the users are equipped with the basic knowledge of EVA and they have mentioned that collecting of information is the biggest challenge in the process of implementing EVA technique.

3.5 Effectiveness of Tools In-use

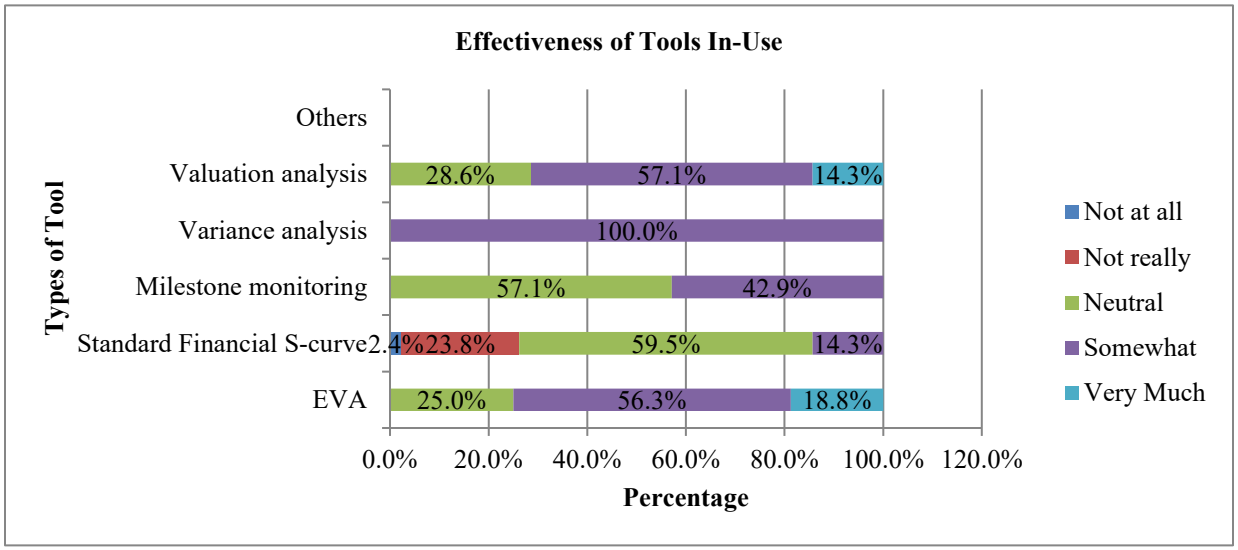

Figure 3.1 Effectiveness of Tools In-Use

This question is used to obtain the perspective of respondents on the effectiveness of the tools in-use. From Figure 4.12, the effectiveness of EVA can be proved by 18.75% of respondents opined that it is a very much effective tools by comparing EVA to another four types of tool in-used. None of the respondents has rated its effectiveness below neutral. Therefore, the aim of the research which is to investigate the effectiveness of EVA as cost controlling tools can be proved.

4.0 Conclusion

The result of the findings has shown EVA technique is able to improve the cost performance of the projects. The following conclusions can be drawn from the present study by according to the most obvious finding to emerge from this study which shows that EVA is effective in controlling the cost of the projects and three of the objectives in this research have been achieved. After the interpretation of the findings, the factor that contributes the most in the cost overrun of the project is evaluated and the result shown is poor cost control method. Besides, the greatest benefit that contributed by EVA in improving the cost performance is remedial action can be taken earlier to keep the cost within the budget; while the biggest challenge that encountered by contractor is complete information of the expenditure of the project is needed in order to generate an accurate EVA graph. In a nutshell, the effectiveness of the application of EVA technique in improving cost performance could be a reference or guidance for those who wish to adopt EVA technique in future. This research will be served as a base to raise a better cost-consciousness in the construction industry. The awareness of adapting advanced technique among all the parties in the construction industry can definitely curb the problem of cost overrun. It is crucial that the decision of cost controlling method or technique used in a construction project will consequently define the success of the project.

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