PM World Journal
Vol. VII, Issue IX – September 2018
www.pmworldjournal.net
Second Edition

Critical Success Factors for Earned Value Analysis
in Manaaging Construction Project
by Mohamed Morad and
Sameh El-Sayegh

Critical Success Factors for Earned Value Analysis in Managing Construction Projects [1, 2]

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Abstract

Completing construction projects on time and within budget is important to achieve project objectives. Project Managers use Earned Value Analysis (EVA) in order to evaluate project performance at certain points in time to ensure successful project completion. The use of EVA, in construction projects, is on the rise due to its importance. Several barriers make it difficult to implement EVA in construction projects. This paper evaluates the main barriers and critical success factors for implementing Earned Value Analysis in construction projects in the United Arab Emirates (UAE). The main barriers and success factors were identified through literature review. A survey was then developed and distributed to construction professionals in the UAE. Thirty-Five surveys were analysed since their companies are implementing EVA. The results indicate that the main benefits of using earned value analysis include providing a database of completed projects that can be used for comparative analysis, achieving project cost objectives and providing early warning signals for performance problems. The main limitations of EVA include dependency on past performance for forecasting, independency of activities and difficulty in incorporating scope changes. The results also indicate that the main barriers to EVA implementation include cultural resistance, ill scope definition and lack of expertise. The Critical Success Factors (CSFs) include top management support, high level of acceptance among project managers and strong administrative and technical ability of project managers. The paper also presents recommendations for the successful implementation of Earned Value Analysis (EVA) in construction projects.

Key words: *Earned Value Management, project management, construction projects*, *United Arab* Emirates (UAE)

JEL code: L74: Construction; O22: Project Analysis

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[2] How to cite this paper: Morad, M. and El-Sayegh, S. (2018). Critical Success Factors for Earned Value Analysis in Managing Construction Projects; Proceedings of the 7th Scientific Conference on Project Management in the Baltic States, University of Latvia, Riga, Latvia, April 2018; republished in the *PM World Journal,* Vol. VII, Issue IX – September.

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Introduction

The early phase of Earned Value Management (EVM) goes back to the 1960s. It became a standard in 1998. In May 1998, an earned value management commercial standard was approved and it was adopted in 1999 as the official US Department of Defence (DOD) approach (Webb, 2003). EVM consists of a framework which integrates project's scope, cost, and schedule together. Earned Value Analysis (EVA) is a quantitative technique that is used in project management to evaluate performance and predicate final project outcomes, by comparing executed work and their cost against planned work and their cost (Lukas, 2008). Earned Value management is a management methodology of integrating scope, schedule and resources, for objectively measuring project performance and progress (Storm, 2008). The method depends on quantitative approach to measure preformed work. Managing using Earned Value Method considered as "managing with open eyes" because project manager and site team can obviously see the difference among what have been accomplished, what was planned and actual cost (Snog and Shalini, 2009). EVM is a powerful tool that assists the decision process by providing indicators (indexes) which act as alarms to keep the project on time and budget (Kerzner, 2006). Studies showed that the application of Earned Value Management is successful in projects that have clear and tangible objectives; these projects indicate better results in the use of EVM (Vargas, 2003). EVM is considered as a crucial method for project management that can facilitates project control and forecasts the expected final project cost and duration (Lipke, 2009). EVM works as supportive tool for forecasting future cost depending on schedule and budget although many authors has critiqued the assumptions of forecasting in EVM.

The UAE experienced a period of construction boom. Many construction companies had participated in breaking the ground for new buildings and facilities. Dubai has built outstanding projects that no any city can do such as Burj Khalifa, Palm Jemeriah, and world's islands. Our concern is what kind of system did construction companies used to control the project budget and duration. The objective is to determine the status of Earned Value Management in UAE and especially in Dubai, including its barriers, limitations and success factors. EVM has been widely used in construction companies. Construction companies in Dubai have been controlling their projects through control systems. Although it has been developed long time ago, the method has some imperfections and weaknesses. This paper focuses on the barriers that prevent the proper implementation of earned value management. These barriers considered as obstacles such as company's qualification, people culture, staff responsibility, project conditions, processes and procedures, and measuring methods. Furthermore, the paper addresses the several limitations in earned value management concept. The paper also presents recommendations for the successful implementation of Earned Value Analysis (EVA) in construction projects.

Research Methodology

The research method included four phases. Phase 1 is the literature review. The literature review covered the benefits of EVM, the barriers preventing EV implementation, the limitations faced while implementing EVM, and the critical success factors to maintain EVM across the organization. Phase 2 is the survey development. The survey is developed to analyse the most common barriers and limitations preventing proper implementation of EV in real life project.

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Phase 3 is data collection. One hundred and fifty surveys were distributed to several construction companies in the UAE. The survey targeted only engineers who worked with EVM method such as project managers, quantity surveyors and cost engineers. Phase 4 is data analysis. Respondents were asked to indicate their level of agreement with the question. Likert scale of 5 to 1 was used to indicate strongly agree, agree, neither agree nor disagree, disagree, and strongly disagree. The weighted average of responses is then calculated from completed surveys. Out of 150 distributed surveys 53 surveys were collected from 29 construction companies. This research considers only 35 surveys, which are EVM implementers. Table 1 summarizes the respondents' profile.

Table 1

Respondents' Profile

Parameter	Number	%
Years of Experience		
>20 years	11	31%
10–20 years	12	34%
5–10 years	9	26%
<5 years	3	9%
Project Size		
less than 10 M (Dirhams)	0	0
10-50 M (Dirhams)	1	3
50-100 M (Dirhams)	4	11
above 100 M (Dirhams)	30	86
Project Type		
Housing	2	6
Building	24	69
Industrial	4	11
Infrastructure/ Heavy	5	14

1 US$ is equivalent to 3.67 UAE Dirhams (2018 Rates).

Research results and discussion

Benefits of EVM

There are several benefits from using EVM in construction projects. Table 2 shows the ranked benefits based on the weighted average.

Table 2

Benefits of EVM

Benefit	Rank	Average
EVM provides a database of completed projects useful for comparative analysis	1	4.32
EVM contributes to achieving project cost objectives	2	4.29
EVM provides early warning signals of performance problems	3	4.29
EVM establishes a single management control system	4	4.26
EVM enables the integration of work, schedule, and cost	5	4.24
The Cost Performance Index (CPI) can be used as a predictor for the	6	4.15

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final cost of the project		
The periodic Cost Performance Index is used as a benchmark	7	4.15
Allows better communication among the project team	8	4.12
Provides one database of information (Multi-disciplinary capability)	9	4.00
EVM contributes to achieving project time objectives	10	3.94
Helps identifying and documenting project risk	11	3.88
The management by exception principle can reduce information overload	12	3.50
EVM contributes to improving project scope definition	13	3.35

Barriers

Several barriers could prevent the proper implementation of Earned Value Management. In this project, various barriers were identified that could lead to a failure in the concept of EV. Before implementing any new method in an organization or project, one should ensure the existence of right supportive requirements. Table 3 express barriers prevent EVM application.

Table 3

Barriers to EVM Implementation

S/N	Barrier	Reference
1	Lack of organization's resources to implement EVM	Webb, 2003; Lukas, 2008
2	Cultural resistance (people resistance) to implement control tool	Storm, 2008; Webb, 2003; Janagan, 2009; Vargas, 2003; Thamhain, 1998
3	Lack of EVM expertise	Janagan, 2009; Storm, 2008; Vargas, 2003; Thamhain, 1998
4	Ill definition of project scope	Fleming and Kopperlman, 2005; Webb, 2003; Lukas, 2008; Janagan, 2009; Vargas, 2003
5	Complicated procedures to conduct EVM	Webb, 2003; Lukas, 2008; Janagan, 2009; Vargas, 2003; Thamhain, 1998
6	Intensive paper work and reporting	Lukas, 2008; Snog and Shalini, 2009, Vargas, 2003; Fleming and Kopperlman, 2005
7	Difficulty in calculating progress	Webb, 2003; Lukas, 2008; Janagan, 2009; Orczyk et al., 2004
8	High time and effort commitment	Janagan, 2009; Vargas, 2003; Thamhain, 1998
9	High implementation cost	Webb, 2003; Janagan, 2009; Snog and Shalini, 2009; Vargas, 2003; Thamhain, 1998
10	Lack of top management support	Webb, 2003; Lukas, 2008; Janagan, 2009; Snog and Shalini, 2009

Table 4 shows the ranked barriers of EVM. Results indicate that people resistance to implement control tool is still ranked the first barrier according to implementers' view. While interviewing participants who obtained the initiation phase of EVM as cost control tool in their organization, they stated, many engineers were rejecting this system saying that we are already making profits without control tool, why now! The next highest barrier is ill definition project scope of work.

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Many experts face difficulties implementing EVM without frozen scope of work. The last ranked barrier is high implementation cost, which participants pointed out that it is their least concern.

Table 4

Ranked Barriers to EVM Implementation

Rank	Barrier	Weighted Average
1	Cultural resistance (people resistance) to implement control tool	4.03
2	Ill definition of project scope of work	3.97
3	Lack of EVM expertise	3.91
4	Lack of organization's resources to implement EVM	3.85
5	Lack of top management support	3.85
6	High time and effort commitment	3.24
7	Complicated procedures to conduct EVM	3.21
8	Intensive paper work and reporting	3.15
9	Difficulty in calculating progress	3.15
10	High implementation cost	3.06

Limitations of EVM

There are several limitations of Earned Value Management that project managers should be aware of while implementing EVM. There is no perfect method that suits the need for controlling and tracking in the construction world. EVM is the most suitable method currently; however, it is not the perfect one since it has many limitations. Table 5 defines number of these limitations.

Table 5

Limitations of EVM

S/N	Limitation	Reference
1	EVM determines project performance based on budget thus ignoring risk, quality, safety	Storm, 2008
2	EVM encourages completing high progress non-critical activities to guarantee higher SPI	Czarnigowska et al., 2011; Lukas, 2008; Janagan, 2009; Moselhi, 2011; Russel, 2009
3	EVM encourages completing lower cost / high value activities to guarantee higher CPI	Kim and Ballard, 2002;
4	EVM represents schedule variance in terms of cost not time	Czarnigowska et al., 2011; Howes, 2009; Kerzner, 2006
5	EVM considers all activities as independent	Czarnigowska et al., 2011
6	Improper application of EVM by project managers (data manipulation)	Webb, 2003; Kim and Ballard, 2002
7	Difficulty in incorporating scope changes	Howes, 2009
8	Dependency on past performance in terms of forecasting	Czarnigowska et al., 2011; Howes, 2009; Moselhi, 2011; Russel, 2009
9	EVM is applicable only on certain types of contracts	Webb, 2003; Floyd, 2004; Snog and Shalini, 2009
10	EVM does not consider the time value of money	Meyer, 2008

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| 11 | Lack of suitable standards | Russel, 2009 |

The ranked limitations are stated in Table 6. Dependency on past performance for forecasting is the first limitation, followed by independency of activities, then incorporating scope changes. Out of technical point of view, implementers noticed that it is not allows accurate to depend on past performance based on their experience. Furthermore, they may face difficulties accommodating defects of predecessor on successor activities in term of cost and time. Integrating variations due to scope changes into the EVM is intricate and complex procedure. Implementers positioned EVM applicability on contractual agreement as last rank (similar to all responses' ranking) since they consider contracts do not touch EVM reliability.

Table 6

Ranked Limitations of EVM

Rank	Limitation	Weighted Average
1	Dependency on past performance in terms of forecasting	3.71
2	EVM considers all activities as independent	3.68
3	Difficulty in incorporating scope changes (variations)	3.62
4	EVM encourages completing lower cost / high value activities to guarantee higher CPI	3.53
5	EVM determines project performance based on activities' budget and cost only thus ignoring risk, quality, safety	3.47
6	Improper application of EVM by project managers (data manipulation)	3.47
7	EVM does not consider the time value of money	3.24
8	Lack of suitable standards	3.24
9	EVM encourages completing high progress non-critical activities to guarantee higher SPI	3.18
10	EVM represents schedule variance in terms of cost not time	3.18
11	EVM is applicable only on certain types of contracts	3.06

Critical Success Factors of EVM

There are several factors to ensure proper implementation of EVM in any organization. Some of these factors are presented in this Table 7. The senior management support and project managers' acceptance are the most critical issues to ensure successful implementation of EVM. These two factors as stated in upper section plays big role in changing employees' perceptions and make them think positively toward EVM. As a conclusion, the UAE construction industry includes companies which perform EVM in their cost control system. These companies hired engineers that are specialized in cost control and commercial issues, these engineers have good knowledge about cost management including Earned Value Management.

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Table 7

Critical Success Factors of EVM

Rank	Success Factor	Weighted Average
1	Strong support from top management	4.32
2	High level of acceptance among project managers	4.29
3	Strong administrative and technical capabilities of project managers	4.24
4	Open communications among project team members	4.18
5	Sufficient organization's resources for EVM implementation	4.18
6	Efficient procedures & processes for EVM implementation	4.18
7	Motivation of team members to use EVM	4.15
8	Adequate computer & software infrastructure	4.12
9	Extensive training on EVM implementation	4.09
10	The use of electronic data interchange	3.85

Conclusions, proposals, recommendations

The results indicate that the main benefits of using earned value analysis include providing a database of completed projects that can be used for comparative analysis, achieving project cost objectives and providing early warning signals for performance problems. The main limitations of EVA include dependency on past performance for forecasting, independency of activities and difficulty in incorporating scope changes. The results also indicate that the main barriers to EVA implementation include cultural resistance, ill scope definition and lack of expertise. The Critical Success Factors (CSFs) include top management support, high level of acceptance among project managers and strong administrative and technical ability of project managers. To address the limitations of EVM, future research needs to focus on:

- Developing forecasting models that are not solely dependent on past performance
- Integrate risk in the EVM methodology

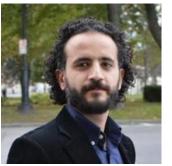Based on the research results, the following recommendations are made:

- Top management support is key to the successful implementation of EVM. Top management need to ensure high level of acceptance amongst project managers and provide training.

- Organizations need to develop efficient procedures and processes for EVM implementation and provide the required resources to support that effort.

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