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Impact of Integrating Earned Value Management and Risk Management on the Success in Oil, Gas and Petrochemicals Engineering Procurement and Construction EPC Projects

M. Hamdy Elwany[1] and Amr Elsharkawy[2*]

[1] Professor of Industrial Engineering, faculty of Engineering
Alexandria University, EGYPT

[2] Senior Project Manager in Oil and Gas Industry
Jacobs Engineering, AL Khobar, KSA

Abstract

Engineering, Procurement, and Construction (EPC) specially in oil, gas and petrochemicals projects eventually has execution complexity as it also links with internal and external risk environment that causes frequent changes. Earned Value Management (EVM) and Risk Management (RM) are very powerful project management tools that help in better project implementation. Many projects fail despite the use of Earned Value Management and Risk Management

Normally, EVM & RM being used separately do not add enough project value in forecasting a current project's performance in the future.

This paper focuses on a technique to improve the present project management knowledge by identifying the effect(s) of integrating EVM with RM and its impact in accurately forecasting the future performance of projects and leads to project success compared to using EVM and RM on their own or even when RM and EVM are used separately with no integration.

The paper is supported by questionnaire survey that was conducted by interviewing (110) project leaders in the field of oil, gas and petrochemicals EPC contractor who supply good experience in EVM and RM with project management. The paper provides project managers with several recommendations potentially benefit their projects success and improve project performance by providing evidence for use of an integrated EVM and RM.

Keywords: *EVM; RM; EPC; Project success; Integration; oil and gas; petrochemical*

1. Introduction

Project Management Techniques (PMT) seek enabling of efficient project implementation, and also providing a complete model of project execution over project life cycle. Various project management techniques can be utilized efficiently to achieve project's objectives such as: Critical Path Method CPM and analysis, Gantt Charts, S-Curves, earned value EV, contingency plan, Monte Carlo, project scope rating and index, PERT, schedule crashing, milestone charts, Risk matrix, decision tree analysis, check list, SWOT analysis and Delphi method.

Recent studies support the argument that PMT are very strong tools in the hand of a project manager which enable efficient project implementation. These studies have started to be investigated by researchers in order to confirm the impact of the technique of this research study on project performance. This technique is based on the integration of EVM (Earned value management) and RM (Risk management). The National Defense Industrial

Association's (cited as NDIA, 2003) was the first to attempt implementing this technique on a number of NASA projects and programs (Infanti, 2003).

The concept of Earned Value Management (EVM) has been extensively studied by scholars (Besner & Hobbs, 2006; Bower & Finnegan, 2009; Butler & Richardson, 2011; Fleming & Koppelmann, 2008; Garrett & Roberts, 2008; Hillson, 2004, 2011; Leu & Lin, 2008; Liu &Tu, 2010; Shepherd, 2010; Song, 2010). These scholars tried to highlight the value of EVM in estimating the costs of projects at completion, based on various measurable and estimable costs and the schedule of a project. As an example, David Hillson (2004) and Gay Infanti (2003) introduced EVM as a widely recognized and accepted technique for managing programs, and an effective discipline for measuring the cost and schedule variances of project execution.

Despite the extensive studies, project management practitioners find continuous problems and challenges facing EVM. A key drawback of EVM is found to be its inability to predict the volume of cost and schedule changes until their occurrence, and also its failure define a corrective action. EVM only identifies the cause of the problem. While, on the other hand, Risk Management (RM) is the most operative discipline that identifies, assesses and deals with risk.

Definitions

Earned Value Management

A project management planning and controlling method that estimates project results according to cost and schedule, based on the past performance of work, along with the cost and time that it has taken to complete work tasks and provide deliverables up to the point of assessment (PMI, 2011a). It can be used as an assessment technique to determine whether a project is performing according to budget and on schedule, as well as a management technique, in which managers can derive strategies to improve performance from results (Marshall, Ruiz & Bredillet, 2008).

Risk Management

A project management technique that is used to identify potential risks that could arise in the future, as a project is completed, as well as anticipating the consequences of these risks. It can be used to determine the course of action a project manager should take with regard to certain risks (PMI, 2009; Stuban, 2011). Risk Management method scan include probabilistic assessment (Butler & Richardson, 2011), interdepartmental discussions forrisk detection (Liu & Tu, 2008), trade off analyses of processes in the WBS (Harbour, 2009), and others.

Integration of EVM with RM

A project management technique that uses the output of the risk register resulted from the risk management process with EVM in the EVM calculation and to show accurate predictions of the future state of a current project. This technique combines the use of both EVM and RM approaches for project management (PMI, 2011a).

Engineering Procurement Construction EPC

Engineering, Procurement, and Construction (EPC) is "an advanced contracting method in which a single party is responsible to complete all the components of the project and further commission it and handover to the client within a predefined cost and agreed timeline. Failure to which, EPC contractor has to pay heavy penalties. There are many risks for both the parties in this arrangement. Proper risk analysis and management is very important for this type of contract which dominates a project's success or failure." (Sajjad & Abdul Mannan, 2013).

2. Objective of this Paper

The need for realistic forecasting of future performance of current projects is accepted by scholars and project leaders. For example, Bower and Finnegan (2009), as well as Harbour (2009) recommended that EVM should be integrated with other techniques, like RM to compensate for this weakness of the EVM method. Even with all the researches done in the field of EVM and RM, the extent to which they add project value in predicting future performance of current projects, is still not enough.

The problem is that EVM & RM (when used separately on their own), do not add adequate project value accurately in forecasting a current project's performance in the future. Thus, EVM and RM can be viewed as complementary project management

techniques (Bower & Finnegan, 2009). Risk Management identifies risks and the effects, (if any), on future performance. Integration of the EVM with the RM method can be a valuable way to provide more accurate measurements of project states at completion, thereby maximizing the value of applied EVM (PMI, 2011a). The main objective of this paper is to improve the current knowledge of project management by studying the effect(s) of integrating EVM with RM on project success investigating whether or not the integration of EVM with RM adds project value in accurately forecasting the future performance of current projects and leads to project success compared to using EVM and RM with no integration and also when each of RM and EVM is used on its own. In addition to the above objectives, this paper describes the difficulties which appear to project managers along project execution and may limit the implementation of the integration of EVM and RM.

Significance of the Integration of EVM&RM

The oil, gas and petrochemicals sector is one of the world's most capital-intensive industries that invests billions every year in launching new refineries, upgrading existing plants, expanding capacity, maintaining operated facilities, and rehabilitating of existing terminals. The industry has been using risk management techniques for several years but there has not been any systematic measure on how effective these techniques have been in improving project success or plant turnaround performance, and still there is significance increase of projects' failure. Ernst & Young (2012) conducted a comprehensive research into the success of 365 EPC projects, in term of investment received high risk's register along the different oil, gas and petrochemicals segments among all regions. Findings show that 58% proportion of North America projects

facing cost overruns and 55% proportion of projects facing schedule delays, 67% proportion of projects in Africa facing cost overruns and 82% proportion of projects facing schedule delays; 89% proportion of Middle east projects facing cost overruns and 87% proportion of projects facing schedule delays. Outlooks suggest that project delivery success is actually decreasing where complexity is considerably higher .From a project delivery perspective and top management standpoint as well, the new combined technique would be much more useful than current EVM and RM strategies, as it would not only identify sources of risk, but would also show their projected range of effects on the project's completion, in terms of time, cost, and quality, similar to the results that were found by Fleming and Koppelman (2008).

"The importance of integrating EVM and RM is that it processes delivers significant benefits to project success along different project phases starting pre-contract award through project close out proposing: Identifying and assessing the key project's risks and allowing for the cost and time to carry out mitigating actions that ensures that a more realistic baseline is established pre-contract. Taking a view of the project's post-mitigation (residual) risk exposure informs the decisions and negotiations surrounding the provision of management reserve; Identifying and assessing the risks to a program, and proactively managing the risks, opportunities and mitigating actions that increases the chances of meeting the baseline time, cost and performance targets." (PM KNOWLEDGE: Interfacing Risk and Earned Value Management, Boden, 2008, p.40).

Authors of the existing studies have generally focused on either EVM or RM or EVM and RM separately as two different project management techniques to improve project performance. Other authors have studied the integration of the EVM and RM in a theoretical format that presents the benefits and weaknesses of each technique separately and then have presented the benefits of the integration (Shepherd, 2010). In best cases, authors have studied the integration of the EVM and RM in a format that uses EVM calculations which then serve as the basis for later RM methods, which is a pattern followed in Y.Kim and Ballard (2010), the Project Management Institute (2011a), and in Shepherd (2010).By providing evidence for use of an integrated EVM and RM method that yields more precise and useful results, this paper would be able to provide project managers with a method that could potentially benefit their projects success factors. The results of this paper could serve as a launch point for future studies which would likely study the best RM methods that could be integrated into EVM, determine threshold points for which levels of risk should be integrated into WBS, develop best practices for integrated EVM and RM and its use in the EPC oil, gas and petrochemicals industry, and provide good experiences for researchers so they can test on other industries and different sectors. In addition, the paper addresses applicable difficulties which face project managers to apply this technique. Knowing these difficulties and problems should

provide a starting point for future studies to enhance the implementation of the integration.

3 Brief Literature

The first evidence that links EVM and RM techniques is the one that was recognized by NDIA Program Management Systems Committee (PMSC) which started through a survey to include EVM in an integrated program management with several management mechanisms such as RM, that if correctly applied, could confirm that projects and programs are managed more effectively and that they would eventually achieve project success criteria in terms of cost, schedule, and quality. The conducted survey by NDIA has given preliminary conclusions to a strong value of integrating EVM and RM and to a better project performance from which projects would benefit through experiencing enhanced project's delivery, (Infanti, 2003).

Research in the last ten years about the integration of EVM and RM has involved using EVM methods, which then can be used with subsequent RM strategies to find out how these calculations would be influenced by various risks (PMI, 2011a; Shepherd, 2010). This application of EVM results into RM strategies is just one potential way in which EVM and RM could be integrated (Fleming & Koppelmann, 2008); PMI, 2011a; Shepherd, 2010). For example, Liu and Tu (2010) noted that calculating the risk for different project areas, assessing external threats and opportunities, and consulting interdepartmental sources for information on risk can provide information that fits well with the Project Management Institute's (2011a) approach to EVM. In addition, Butler and Richardson (2011) suggested using risks to find out probabilistic estimates of completion time for different project technique and stages to yield more accurate EVM results.

Literature presents EVM as weakened by its assumption that the project future performance can be predicted based on the past performance. While, the main drawback of RM lies in that it always seeks future conditions with no consideration or analysis of past performance. A useful integration might be achieved if a combined approach of integrating both EVM-RM techniques together. Hillson (2011) stated that "risk should be included in estimate at completion (EAC) and then EVM calculation should be made, unexecuted project activities should be reviewed, re-estimated and modified. Based on the results of EVM, risks identification and risk response should be updated and Monte Carlo should be re-run for new risks" (Hillson 2011). Hillson (2011) and Sheives (2011) further explained that the results of the updated Risk Management process should be loaded again in PMB with the new updated data so EVM can then be recalculated (Hinson, 2011; Sheives 2011), reflecting this to project execution, project managers need to revalidate the risk management process on a regular basis at agreed milestones based on project complexity, the outcome should then be incorporated to the calculation of the EVM.

According to Mojabi, Radfar, and Nazemi (2013), "The NDIA PMSC's Risk Management Working Group reached three major conclusions based on the results of its survey, first, programs will benefit from the integration of RM with EVM. 70% of respondents agreed or strongly agreed that there is value in integrating RM with EVM; only 10% of respondents disagreed and the rest remained neutral indicating that they had no opinion. Second, while some PMs are already integrating these two processes, there are opportunities to improve the integration of RM and EVM because only 34% of respondents indicated that process integration is effective while43% indicated it is poor or very poor. Third, there are many barriers to the effective integration of RM with EVM, which must be overcome to improve process integration" (Mojabi, Radfar, and Nazemi, 2013).

Figure 1 presents the main studies addressing the integration of both EVM and RM as a new technique to improve project control process and ensure better project performance.

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Year	Researchers	Field Studies
2001	Teixeria	This paper is about how the RM and EVM processes are naturally interrelated, it is important to assess both methodologies independently and then identify the natural overlap between the two in measuring project performance
2002 , 2003, 2006	NDIA	These papers summarized a study of the current status of the integration of risk management with earned value management and recommendations for further actions. Three studies were conducted by the National Defense Industrial Association Program Management Systems Committee's Risk Management Working Group for NASA projects .
2004 , 2011	Hillson	RM&EVM two approaches that are not in conflict or mutually exclusive. Their commonalities imply a powerful synergy, which is available through combining the complementary strengths of each technique and using insights from one to inform the application of the other
2006	Seider and Aramvareekul	The Cost–Time–Risk diagram (CTR) was presented in this paper and that is a new project planning and management technique that helps project managers consider project risk issues while monitoring and controlling their project schedule and cost performance in one diagram
2007	Graham	This paper study has offered a new cost management process that involves the identification, assessment and quantification of risky WBS elements in the cost estimating process for reporting feedback using Earned Value Management (EVM).
2008	Nobuhiro and Akihiro	In this paper, the researchers analyzed real cases of projects that adopted risk management but failed, and identified the root causes. Next, they proposed a permanent monitoring agency that predicts future risks generation using quantitative data captured by Earned Value Management technique.
2010	Hong and Xiaozhong	This paper proposes a new analysis method to project duration risk based on earned value measurement, discusses the different possible risk types under different earned value indexes, then divides the severity of duration risk into five different levels which will be convenient for project managers to take measures and corrective actions
2011	Pajares and Lopes-Paredes	How CPI , SPI and other EVM measurments work when Intergrate with risk management

Fig 1 : (Summary of Key Studies of Integrated EVM and RM
By: Mojabi, Radfar, and Nazemi, 2013)

4.Integrating EVM and RM

A number of possible overlapping areas exist between the EVM and RM. The steps required to implement these synergies are: Creating the baseline spend plan, predicting future outcomes, evaluating risk process effectiveness and continuous monitoring of risk severity. Earned Value Management System (EVMS) utilizes Planned Values (PV), planned value was earlier presented as BCWS Budgeted Cost of Work Scheduled; Actual Cost (AC), actual cost was earlier presented as the Actual Cost of Work Performed (ACWP); the main calculate Earned Value (EV) that also was earlier presented as the Budgeted Cost of Work Performed (BCWP). Percent Complete (PC), is the level of scope completion at the moment of progress check; Budget at Completion (BAC); Estimate at completion (EAC). The basic performance measurements of the EVM:

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Cost Variance CV = EV – AC
Cost Performance Index CPI = EV / AC
Schedule Variance SV = EV – PV
Schedule Performance Index SPI = EV / PV
PC =EV/BAC
EAC =BAC/CPI.

Creating the baseline spend plan (BCWS/PV):

At the project start-up phase, the project management team needs to develop a comprehensive cost and resource plan based on detailed WBS to explain contract scope of work with no contingency cost. This includes any uncertainty associated with initial time/cost estimates. Moreover, the whole project team needs to conduct a risk session in which risk identification, risk assessment and risk response plan are developed. This risk register needs to quantify time and cost of each risk item. Create integrated time/cost S-Curve as a project baseline spending profile (BCWS/PV); it is most common for the EPC contractors to use the "expected values" model from project schedule.

Predicting future outcomes (EAC):

Along project execution, project team takes records of project performance and all actual expenditures spent to date (ACWP). Then, the project team needs to calculate earned value
(BCWP) and also review the initial time/cost estimates for all activities not yet completed at the moment of this calculation. Based on risk importance criteria, project team needs to update the risk register for the ongoing risk items and also to address new risks and then to revaluate the existing risks.

Evaluating risk management process effectiveness

Project team determines the threshold values for CPI and SPI to generate corrective
actions in the risk process. This is based on the project scope complexity and also the importance of each project. Either to exploit opportunities, address threats or apply contingency factors to recover the time. Figure 2, Figure 3 present the synergy of Risk Management and Earned Value Management.

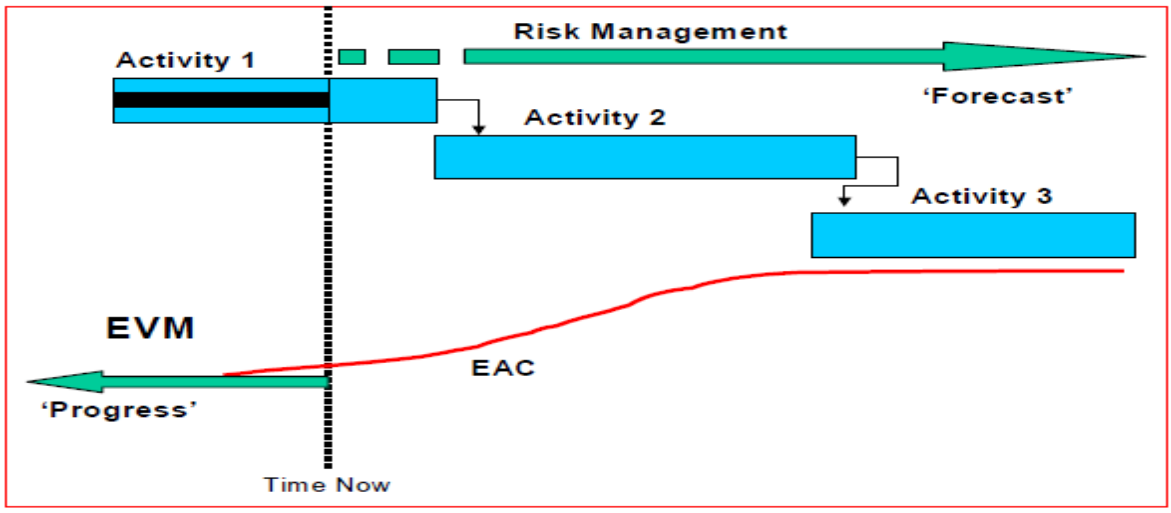

Fig 2 : (Synergy of Risk Management and Earned Value Management By: Risk Decisions Ltd, 2003, p4)

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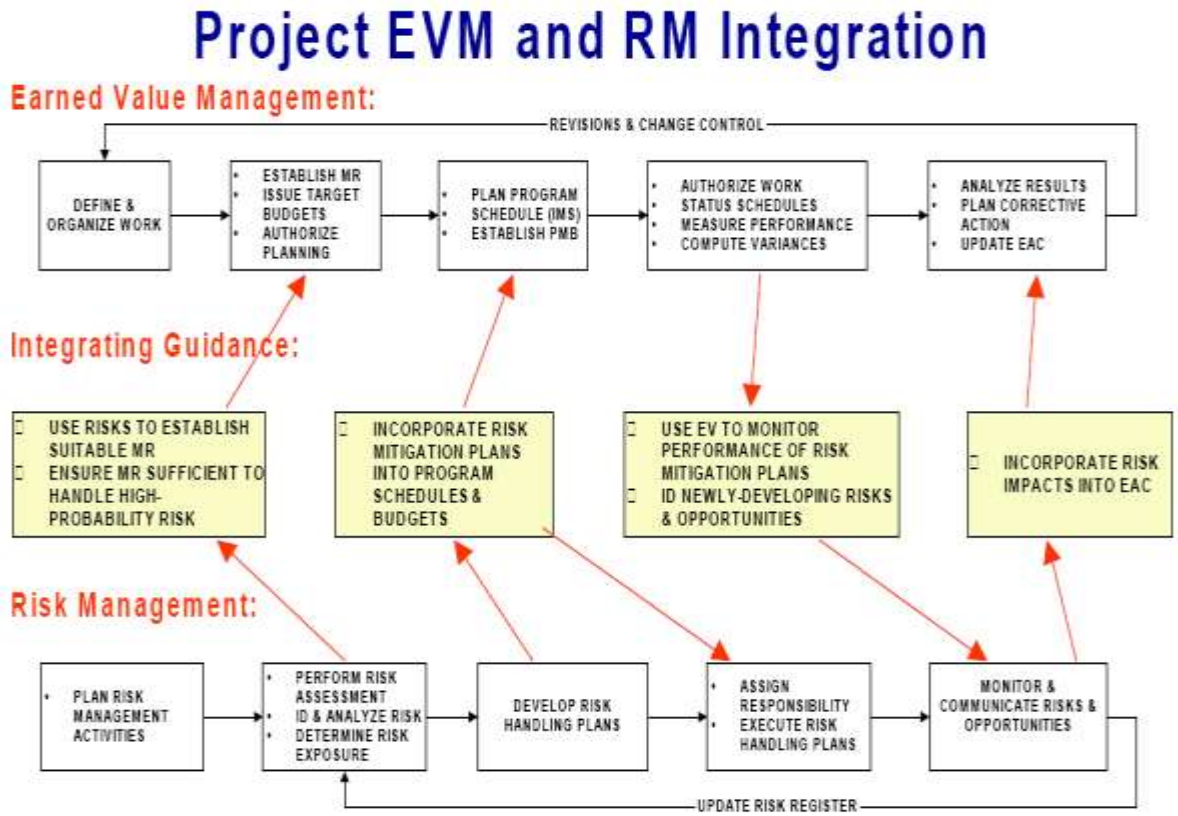

Fig 3 : (Integration process of Earned Value and Risk Management By: National Defense Industrial Association, 2007).

5. Proposed Model and Design

Though an aged model developed by Pinto and Slevin (1987), this model is still practiced by scholars studying different correlations that include the relation between projects' independent and dependent variables ; relation between moderator variables and dependent variables .Some modifications to Pinto and Slevin model are added so the proposed conceptual framework of project success fulfills the research requirements and can test the influence of the integration of EVM and RM on project success for different scenarios: RM alone or EVM alone; RM and EVM are both applied separately; integration of RM and EVM is applied .Figure 4 presents the proposed conceptual design model.

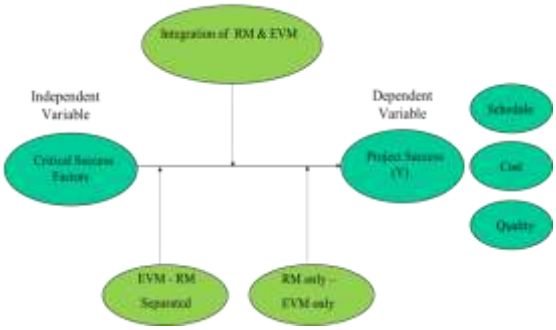

Fig 4 : (Project Success Conceptual Framework)

Research Questions and Hypotheses

This paper is supported with a research questions and hypotheses that are examined whether the integration of EVM with RM adds project value compared to no integration, and that it is positively influence project success in terms of schedule, cost, and quality during project execution. The questions are:

Ql: Does the integration of Earned Value Management (EVM) with Risk Management (RM) add project value to project success and does it provide better project performance forecast compared to using EVM and RM separately or compared to EVM alone and RM alone?

Q2: What are the technical difficulties, execution obstacles and other complications that hinder the project manager from applying the integration of EVM and RM?

Hypotheses:

Hlo: There is no improvement in project success in terms of base line schedule when applying the integration of EVM and RM compared to when applying both EVM and RM with no integration.
Hla: There is a significant improvement in project success in terms of base line schedule when applying the integration of EVM and RM compared to when applying both EVM and RM with no integration.
H2o: There is no improvement in project success in terms of base line schedule when applying the integration of EVM and RM compared to when applying EVM or RM only.
H2a: There is a significant improvement in project success in terms of base line schedule when applying the integration of EVM and RM compared to when applying EVM or RM only.
H3o: There is no improvement in project success in terms of base line budget when
applying the integration of EVM and RM compared to when applying both EVM and RM with no integration.
H3a: There is a significant improvement in project success in terms of base line budget when applying the integration of EVM and RM compared to when applying both EVM and RM with no integration. Impact of Integrating EVM and RM to the Success in Oil, Gas and Petrochemicals EPC Projects
H4o: There is no improvement in project success in terms of base line budget when applying the integration of EVM and RM compared to when applying EVM or RM only.
H4a: There is a significant improvement in project success in terms of base line budget when applying the integration of EVM and RM compared to when applying EVM or RM only.
H5o: There is no improvement in project success in terms of quality when applying the integration of EVM and RM compared to when applying both EVM and RM with no integration.
H5a: There is a significant improvement in project success in terms of quality when
applying the integration of EVM and RM compared to when applying both EVM and RM with no integration.
H6o: There is no improvement in project success in terms of quality when applying the integration of EVM and RM compared to when applying EVM or RM only.
H6a: There is a significant improvement in project success in terms of quality when applying the integration of EVM and RM compared to when applying EVM or RM only.

Sample and Population

A sample of 100 experts in the oil, gas and petrochemicals and sector represents EPC
contractors who are implementing EVM and RM techniques and the integration of EVM and RM. The experts are expected to be project managers, project engineering managers, cost control managers, planning and scheduling managers, and risk management specialist. The experts should have wide practical experiences ranged between 15-30 years working for International EPC organizations in the oil, gas and petrochemicals industry. The population represents different regions such as North America, Europe, and Middle East and North Africa MENA (this includes gulf area and Egypt). The studied projects are categorized as small , medium , to large size with a total of 10,000 — 200,000 man-hours with a value ranging between $15 - 100 million

Data Collection

The primary and secondary data are collected. With regards to primary data, survey questionnaire is constructed to include four sections (refer to Appendix A). With regard to secondary data, personal interviews are conducted with selective number from the survey's participants to triangulate the questionnaire's findings and make sure data is unbiased.

6. Results and Conclusion

Findings and Results

The main finding in this paper is supported by the survey questionnaire which strongly supports the use of the integration of EVM and RM holding benefits for project managers and ensuring better project execution with enhanced performance. Table 1 summarizes project and respondent's characteristics. It shows that project complexity in terms of project budgeted man-hours, project schedule, participant's experiences using EVM, and participant's experiences using RM are all highly significant with respect to the usage of EVM and RM.

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Table 1: Summary Bivariate Analyses: Project and Respondent Characteristics by Type of EVM & RM usage

	EVM and RM Usage, n (row %)			
Project & Respondent Characteristic	EVM or RM only (N=12)	EVM and RM separated (N=60)	EVM & RM Integrated (N=20)	p-value[a]
Organization Classification				0.078
Engineering related	12 (14.0)	57 (66.3)	17 (19.8)	
Client and/or Owner	0 (0.0)	3 (100.0)	0 (0.0)	
Operation	0 (0.0)	0 (0.0)	2 (100.0)	
Planning and Contracting	0 (0.0)	0 (0.0)	1 (100.0)	
Department				0.50
Project Management	6 (10.0)	40 (66.7)	14 (23.3)	
Operation	0 (0.0)	1 (100.0)	0 (0.0)	
Project Engineering Management	4 (21.1)	12 (63.2)	3 (15.8)	
Project Control & Planning	1 (9.1)	7 (63.6)	3 (27.3)	
Construction	1 (100.0)	0 (0.0)	0 (0.0)	
Job Role				0.228
Team Lead	3 (9.4)	24 (75.0)	5 (15.6)	
Manager	5 (16.1)	17 (54.8)	9 (29.0)	
Senior Manager	1 (5.3)	15 (78.9)	3 (15.8)	

Director	3 (30.0)	4 (40.0)	3 (30.0)	
Scope Type				0.217
Eng. Include (Study, Feed, Detailed)	7 (25.9)	16 (59.3)	4 (14.8)	
Construction	1 (16.7)	3 (50.0)	2 (33.3)	
EPC	4 (7.0)	39 (68.4)	14 (26.4)	
EPCm	0 (0.0)	2 (100.0)	0 (0.0)	
Man hours				**0.012**
m Less Than 10,000 Man-hours	2 (66.7)	1 (33.3)	0 (0.0)	
10,001 - 50,000 Man-hours	3 (17.6)	6 (35.3)	8 (47.1)	
50,001 - 80,000 Man-hours	3 (15.8)	13 (68.4)	3 (15.8)	
80,001 - 150,000 Man-hours	1 (3.3)	22 (73.3)	7 (23.3)	
> 150,000 Man-hours	3 (13.3)	18 (78.3)	2 (8.7)	
Baseline Schedule				**0.028**
Less than 12 weeks	1 (33.3)	2 (66.7)	0 (0.0)	
12 - 24 Weeks	4 (57.1)	2 (28.6)	1 (14.3)	
25 - 52 Weeks	4 (10.8)	21 (56.8)	12 (32.4)	
1 Year - 2 Years	2 (7.7)	19 (73.1)	5 (19.2)	
> 2 Years	1 (5.3)	16 (84.2)	2 (10.5)	
Project Management Experience				0.455

None	1 (33.3)	2 (66.7)	0 (0.0)	
Less than 5 Years	1 (33.3)	1 (33.3)	1 (33.3)	
5 to 15 Years	5 (12.8)	24 (61.5)	10 (25.6)	
More than 15 Years	5 (10.6)	33 (70.2)	9 (19.1)	
EVM Experience				**0.000**
None	4 (66.7)	2 (33.3)	0 (0.0)	
Less than 5 Years	5 (21.7)	11 (47.8)	7 (30.4)	
5 to 15 Years	3 (5.8)	43 (82.7)	6 (11.5)	
More than 15 Years	0 (0.0)	4 (40.0)	6 (60.0)	
RM Experience				**0.019**
None	1 (33.3)	2 (66.7)	0 (0.0)	
Less than 5 Years	5 (21.7)	11 (47.8)	7 (30.4)	
5 to 15 Years	6 (12.0)	38 (76.0)	6 (12.0)	
More than 15 Years	0 (0.0)	9 (56.3)	7 (43.8)	

a Chi-square's p-values are presented. For those cases in which there are cells with expected counts less than 5 Fisher's exact p-value is reported instead

Second major finding in this paper declares 21% of participants apply the integration of EVM and RM on their current projects. The integration of EVM with RM compared to EVM and RM separated with no integration, RM alone, and EVM alone receive Mean ranking scores of4.29, 3.37, 3.70, and 3.37 respectively. These scores indicate that participants perceive the integration of RM and EVM very positively.

With relation to project baseline schedule as one of project success criteria, relationships demonstrate only 5% of participants who use the integration of EVM and RM are behind of project schedule compared with 51.7% use EVM and RM separately with no integration. With regard to project budget, relations are significantly reported as well, only 10% of participants who use the integration of EVM and RM report cost overrun on their current projects vs. 41.7% of participants who use RM and EVM separated vs. 50% of participants who use RM alone and EVM alone. Also, 40% of participants who apply the integration of EVM and RM are cost underrun vs. 15% of participants use EVM and RM separated. Summary of the project success with relation to different EVM and RM usage is presented through Table 2.

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Table 2 :Summary: Bivariate Analyses: Relationship between Type of EVM & RM usage and Success Measures

EVM and RM Usage, n (col. %)				
Success Measure	EVM or RM only (N=12)	EVM and RM separated (N=60)	EVM & RM Integrated (N=20)	p-value[a]
Status Baseline				**0.001**
Behind (Fail)	6 (50.0)	31 (51.7)	1 (5.0)	
Within	6 (50.0)	26 (43.3)	18 (90.0)	
Ahead (Success)	0 (0.0)	0 (5.0)	1 (5.0)	
Cost				**0.025**
Overrun (Fail)	6 (50.0)	25 (41.7)	14 (23.3)	
Within	0 (41.7)	26 (43.3)	0 (0.0)	
Underrun (Success)	1 (8.3)	9 (15.0)	8 (40.0)	
Quality (NCR)				0.082
> 2 (Fail)	2 (16.7)	3 (5.1)	0 (0.0)	
2 (Accepted)	2 (16.7)	5 (8.5)	0 (0.0)	
1 or Less (Success)	8 (66.7)	51 (86.4)	20 (100.0)	
Overall Performance				0.217
Poor (Fail)	6 (50.0)	28 (46.7)	4 (14.8)	

Accepted	6 (50.0)	32 (53.3)	14 (70.0)	
Good (Success)	0 (0.0)	0 (0.0)	2 (10.0)	
Success Score, , Mean ± SD	5.58 ± 1.24	6.10 ± 1.20	7.30 ± .73	**0.000**[b]

a. Chi-square's p-values are presented. For those cases in which there are cells with expected counts less than 5 Fisher 's exact p-value is reported instead.
b. p-value corresponding to the Kruskal Wallis Test

The p-value for the Kruskal Wallis test indicates that there are significant differences in the success score between different techniques (p=.000). Looking at the Mean value for each technique, we conclude that integration of EVM and RM is associated with the highest average success score 7.30 compared to 6.10 for EVM and RM with no integration, and 5.58 for EVM alone and RM alone

Conclusion

Testing hypothesis conclude the positive impact of the integration of EVM and RM on project success, and also confirm with evidence the added value to project performance in addition to the integration's ability to accurately indicate the future performance of current projects. The analysis allows the null associated with it to be rejected, due to the fact that there are significant positive results larger than the alpha < .05 which would be required for rejecting Null.

Hl: There is a significant improvement in project success in terms of base line schedule when applying the integration of EVM and RM compared to when applying both EVM and RM with no integration

H2: There is a significant improvement in project success in terms of base line schedule when applying the integration of EVM and RM compared to when applying EVM or RM only

H3: There is a significant improvement in project success in terms of base line budget when applying the integration of EVM and RM compared to when applying both EVM and RM with no integration

H4: There is a significant improvement in project success in terms of base line budget when applying the integration of EVM and RM compared to when applying EVM or RM only.

H5: There is improvement in project success in terms of quality when applying the integration of EVM and RM compared to when applying both EVM and RM with no integration

H6: There is improvement in project success in terms of quality when applying the integration of EVM and RM compared to when applying EVM or RM only

Secondary conclusion in this study provides good insights for the different difficulties while applying the integration. 45% of the participants agree that the process of integrating RM and EVM is the most difficult part that consumes time in order to maintain the S-Curve updated with fresh risk items and cost elements, while 23% of the participants believe that the difficulty comes from the lack of project control skills and that this integration process requires special skills by project planner and scheduler. Complete participants' feedback is presented in Table 3below.

Table 3:Summary: Bivariate Analyses: Relationship between Type of EVM & RM usage and Success Measures

Integration issues		Responses		Percent of Cases
		N	%	
Difficulties[a]	Client doesn't support the integration due to time consuming	53	17.7	57.60%
	Required high skilled project control team	70	23.4	76.10%
	Integration process to update baseline	135	45.2	78.30%
	Regular update of Risk register	17	5.7	18.50%
	Management support	24	8	26.10%
Total		299	100	325.00%

a. Dichotomy group tabulated at value 1.

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