Master Thesis

‘Why the Earned Value Analysis method fails? Critical Analysis of its implication to the Construction Industry?’

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Abstract

The paper investigates the reasons behind the failure of the Earned Value Analysis (EVA) when applied specifically to projects that are executed within the construction industry. Before addressing the main research question it presents an overview of how the EVA has evolved to becoming an important performance tool for projects, the additional value it contributes to its users in comparison with the traditional cost method and finally presents the EVA calculations, formulas and graphs.

The subject paper uses interviews as a research technique in order to answer its research question. The semi-structured interview technique is used in order to interview six construction specialists of different professional backgrounds. Furthermore the paper investigates the existing literature found as to the reasons EVA fails to provide the desired outcome. From the research of the existing literature it concludes that the current information found is 1) Generic and lacks precision 2) Lacks proposal of corrective actions for the obstacles encountered during the implementation of EVA 3) A lack of prioritization of the deficiencies is noted. Although several papers deal with the deficiencies of the EVA tool, none of the papers deal with the level of importance of each obstacle.

Through the responses obtained from the interviews the paper attempts initially to identify the most important obstacles and on a second stage to sequence them, enabling its users in applying it to their project and understanding which of the problems have to be solved and at which stage of the project execution phases can they be identified. In order to facilitate the reader, the obstacles and corrective actions identified from the interview responses, are grouped into three categories depending on the status at which the organizations are with the EVA implementation. The three categories are 1) EVA has been implemented 2) EVA has been partially implemented 3) EVA has not been implemented.

From the results of the research and the analysis done the reader should be able to assess at which stage of the EVA implementation his organizations stands.
Furthermore the reader should be able to identify applicable and potential obstacles to his projects and apply the corrective actions as proposed. In the end he can prioritize the obstacles in terms of level of importance and time sequence that is linked with phases of a project.
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<tbody>
<tr>
<td>$SV$ (Schedule Variance) = $BCWP - BCWS$</td>
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<td>$CV$ (Cost Variance) = $BCWP - ACWP$</td>
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<td>$SPI$ (Schedule Performance Index) = $BCWP/BCWS$</td>
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<td>$CPI$ (Cost Performance Index) = $BCWP/ACWP$</td>
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<td>$EAC1$ (Estimated-at-Completion) = $ACWP + (BAC - BCWP)$</td>
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<td>$EAC2$ (Estimated-at-Completion) = $BAC/CPI$</td>
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<td>$EAC3$ (Estimated-at-Completion) = $BAC/(CPI \times SPI)$</td>
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<td>$ETC$ (Estimated-to-Completion) = $EAC - ACWP$</td>
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List of Abbreviations

<table>
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<tr>
<th>ABBREVIATION</th>
<th>DESCRIPTION</th>
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<tr>
<td>EVA</td>
<td>Earned Value Analysis</td>
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<tr>
<td>IMS</td>
<td>Integrated Management System</td>
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<tr>
<td>EPC</td>
<td>Engineering, Procurement and Contracting</td>
</tr>
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<td>AC</td>
<td>Actual Cost</td>
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<td>PV</td>
<td>Planned Value</td>
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<td>EV</td>
<td>Earned Value</td>
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<td>WBS</td>
<td>Work Breakdown-Structure</td>
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<td>BCWS</td>
<td>Budgeted Cost Work Scheduled</td>
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<tr>
<td>ACWP</td>
<td>Actual Cost Work Performed</td>
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<tr>
<td>BCWP</td>
<td>Budgeted Cost Work Performed</td>
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<td>SV</td>
<td>Schedule Variance</td>
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<td>CV</td>
<td>Cost Variance</td>
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<td>SPI</td>
<td>Schedule Performance Index</td>
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<td>Cost Performance Index</td>
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<td>CSI</td>
<td>Cost Schedule Index</td>
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<td>ETC</td>
<td>Estimated - To - Complete</td>
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<td>EAC</td>
<td>Estimated – At - Completion</td>
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<td>Acronym</td>
<td>Description</td>
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<tr>
<td>BAC</td>
<td>Budget - At - Completion</td>
</tr>
<tr>
<td>CSCSCS</td>
<td>Cost/Schedule Control Systems Criteria</td>
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<tr>
<td>DOD</td>
<td>Department of Defense</td>
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<tr>
<td>WPM</td>
<td>Working Package Method</td>
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<td>TCM</td>
<td>Traditional Cost Method</td>
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<td>IFRS</td>
<td>International Financial Reporting Standards</td>
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1. Introduction

1.1. The Problem

The purpose of this paper is to investigate and find the main reasons behind the failure of the Earned Value Analysis (EVA) when applied specifically to projects that are executed within the Construction Industry. Construction companies utilize the earned value analysis (EVA) method in order to improve the monitoring of the performance of their projects and to get a better insight of the details of the projects. It is very common for construction organizations to create procedures and policies that define how the Earned Value Analysis tool should be used as part of an Integrated Management System (IMS). However, when project managers, project schedulers and project controllers are called upon to implement the EVA tool, multiple complex, complicated and problematic issues are encountered in the implementation of the EVA tool. This results in no improvements as to the control of the project and on the contrary may result in increased costs due to the effort put in to having the EVA tool implemented. Contractors are then faced with the difficult decision on whether to try to solve the problems that they have encountered and take corrective actions, which means they have to spend even more resources, or layoff the EVA tool.

1.2. The Target

This paper tries to go one step further into finding the reasons behind the unsuccessful application of the EVA tool within the construction industry; the errors noted during its implementation and suggest corrective actions in order to tackle these problems. In the end, the paper will try to present the key drivers as well as the main conclusion of achieving an effective and efficient earned value analysis tool.

1.3. The Methodology
The subject paper uses interviews as a research technique and along with the existing scattered information found in the existing literature until today; it will try to answer the basic question of this paper. The semi-structured interview technique shall be used when interviewing the six construction specialists. Therefore the questions to be used during the interview process will be structured and the same questions shall be repeated to all six interviewees, however some degree of flexibility shall be given as to the nature of questions asked since the six interviewees vary coming from different professional backgrounds (Kajomboon, p. 5). The following job positions from an Engineering-Procurement-Construction (EPC) Contractor shall be interviewed as previously discussed:

1. Project Control Manager  
2. Commercial Manager/Accounting & Finance Manager  
3. Project Manager  
4. Construction Manager  
5. Construction Section Head  
6. System Analyst

Useful information related to the non-use or misapplication of the EVA tool will be investigated through the interviews. The results will be presented and compared with the existing findings. Furthermore areas of special attention shall be addressed and corrective actions shall be proposed based on the input from the interviewees.

2. The EVA in the Construction Industry

2.1. The Evolution of EVA

The execution of construction projects involves following a standard set of steps. Initially a great amount of preliminary work is put into estimating the time and cost of constructing a project. After having the cost and time factors identified and calculated then a bid is prepared and submitted to the client. The client will select the most appropriate contractor based on their bids taking into consideration
factors such as cost, time and quality of the works to be executed. Upon selection of the appropriate contractor, the client along with contractor shall sign a contract that will authorize the contractor to initiate the process of constructing the project within the agreed time frame.

During the execution phase of the project, contractors are called upon to execute the project within the strict time limit that has been agreed to. Often contractors are faced with the problem of delaying the project, due to various external or internal reasons that may sometimes be controlled and other times are beyond their control. Therefore it is crucial for contractors to be able to monitor potential cost overruns (more expenses than budgeted) and delays in project execution (Khamidi, Khan, & Idrus, 2011, p. 1). Therefore the earned value analysis (EVA) tool was developed, to be able to monitor the performance of a project, created from the needs of its own project members and more specifically of the members of the project management and its stakeholders.

An additional reason that led to the development of the earned value analysis tool was due to reasons of payment. Contractors faced difficulties in financing the projects that were to be executed and requested partial payments for partial works that were executed. Therefore the need for the creation of a tool that would quantify the works that have been executed was important, in order to secure the financing of the next phases of the project. This tool was initially introduced in contracts with clients that involved the government and evolved when introduced and applied to private sector projects (Kopelman, Fleming, & Joel, 1998, p. 19).

Irrespective of whether the project belongs to the government or the private sector, project control can be obtained when actual amounts are compared to budgeted amounts as per the initial Master Budget. Therefore, it is of vital importance that variances are sufficiently analyzed enabling project managers and controllers to take necessary corrective actions punctually.

As part of using the EVA tool during the construction of a project, its users on a regular basis raise questions at which stage of the project they are, the reasons
behind the variances occurred and corrective actions to be taken. This is the logical and typical order process of thinking that is followed when applying the EVA tool.

Despite its benefit, the earned value analysis tool is still an under-used instrument (Fleming & Koppelman, 1994, pp. 13.2 - 13.8). It is believed this is caused due to the lack of understanding of the earned value basics and its potential benefits (Chen, The ABCs of Earned Value Application, 2008, pp. 3.1 - 3.2). Moreover this paper will go one step further into finding the reasons behind the unsuccessful application of the EVA tool within the construction industry; the errors noted during its implementation and suggest corrective actions in order to tackle these problems. In the end, the paper will try to present the key drivers as well as the main conclusion of achieving an effective and efficient earned value analysis tool.

2.2. The Difference

Traditional cost management utilizes a basic approach in which it compares budgeted cost to actual cost (Chen, The ABCs of Earned Value Application, 2008, p. 3.1). However the difference between the estimated and the actual result does not provide users with all the information as to the reasons behind these variances. In other words, the actual cost incurred does not reflect truly the actual works accomplished. For example, after having spent half of the project budgeted cost, can we say that the project has reached half of its completion? The answer is clearly no. Therefore, apart from the planned values and the actual costs, a third variable is introduced; the earned value.

This third variable is utilized in order to evaluate the accomplished works of the project and provides an objective performance measurement. For example, two-hundred and thirty (230) concrete blocks have been casted out of the 320 required (Output Method). Figure 1 depicts the comparison among the traditional cost method and the earned value method by presenting the introduction of the third Earned Value (EV) variable. This can be seen clearly in the table of (Chen, The ABCs of Earned Value Application, 2008, p. 3.2).
The traditional cost management method of project cost controlling is based on a simplified two factor approach. These data sources compare the budgeted spending and the actual spending. The comparison of budgeted versus actual spending merely tells what was planned to be spent versus what was actually spent at any given time. Furthermore, it does not relate any current performance trend to be able to forecast any future performance (Khamidi, Khan, & Idrus, 2011, p. 1).

The traditional cost management approach of monitoring project performance measurement separates time and cost factors. On the other hand, the EVA tool accomplishes to integrate scope, time and cost functions and allows project managers and controllers to get a clear insight of project performance (Khamidi, Khan, & Idrus, 2011, p. 1).

### 2.3. The Benefits of EVA

The advantages of having an earned value analysis tool implemented, while constructing a project, is multiple and its benefits crucial for the successful completion and handing over of a project. As discussed earlier the most important advantage of EVA is the introduction of a tool that integrates scope, cost and time management (Valle & Soares, p. 1).

<table>
<thead>
<tr>
<th>TCM - Traditional Cost Management Variables</th>
<th>EVA - Earned Value Analysis Variables</th>
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<tbody>
<tr>
<td>AC: Actual Cost</td>
<td>AC: - Actual Cost</td>
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<tr>
<td>PV: Planned Value</td>
<td>PV: Planned Value</td>
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<td>-</td>
<td>EV: Earned Value</td>
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Table 1. Comparison of TCM and EVA Variables (Chen, 2008).
Furthermore EVA provides an early warning system of potential cost overruns or delays that may be encountered during the execution of a project. Management therefore can take timely corrective actions to compensate for the problems encountered.

Management is also able to forecast cost and time trends based on the existing performance of the project and obtain crucial information of future costs and time shifts due to delays.

After having an EVA tool implemented for several years, management can utilize all the important information gathered in the database of the organization from the execution of the previous projects, to prepare accurate and correct bids for new projects during the tendering process. Therefore departments external to the project such as the tendering department can benefit from all the information that can be extracted from the database and reports the EVA inputs accumulates its information.

In addition, the EVA tool simplifies project management since all parties involved use a single performance measurement tool, avoiding the need of consolidating and reconciling various performance measurement tools.

The EVA tool enforces the project management to plan early prior to initiation of any works, since they are required to construct a Work Break-Down Structure (WBS) of all the activities to be executed. Additionally it provides a high level of objectivity through its calculations and removes human subjectivity, emotion and perception. In the end the EVA tool, when properly and sufficiently implemented, provides motivations to project members, since good work by high achievers can be identified and acknowledged.

3. The EVA Method
A presentation of the definitions, calculations and analysis of the EVA tool explain the main concepts of the earned value analysis tool as described in the project management PMBOK Guide (2013, pp. 217-224).

3.1. The EVA Definitions

**Earned Value Analysis** is the:

- Planned compared to completed work (earned)
- Progress of cost, schedule and work accomplished
- Forecast project completion

Elements of the EVA are:

- **BCWS**: “Budgeted Cost of Work Scheduled” is the planned cost of planned work to be done to date.
- **ACWP**: “Actual Cost of Work Performed” is the actual cost of actual work done to date.
- **BCWP**: “Budgeted Cost of Work Performed” is the planned cost for the work that has been done.

3.2. The EVA formulas

- **SV**: Schedule Variance (BCWP – BCWS)
  - Comparison of work performed during a given time to what was scheduled to be performed
  - **SV< 0**: Project is behind schedule in terms of cost

- **CV**: Cost Variance (BCWP – ACWP)
  - Comparison of budgeted cost of work performed with actual cost of work performed
  - **CV< 0**: Project is over budget in terms of cost

Earned Value Analysis indexes:
• SPI: Schedule Performance Index
  ➢ SPI = BCWP/BCWS
  ➢ SPI<1: project is behind schedule

• CPI: Cost Performance Index
  ➢ CPI = BCWP/ACWP
  ➢ CPI<1: project is over budget

• CSI: Cost Performance Index
  ➢ The further CSI is from 1.0, the less likely the project recovery becomes feasible

3.3. The EVA Analysis

After calculating all the performance indices as part of the earned value analysis, project managers and controllers should fully utilize the subject indices to forecast final project cost such as estimate to completion (ETC) costs for the remaining work as well as estimate at completion (EAC) costs. Furthermore, the EAC can be compared with budget at completion (BAC), in order to assess the areas associated with project risks and eventually help develop a risk mitigation plan. The following definitions and formulas explain how forecasts can be derived from the performance indices as given by (Lukas, 2008, pp. 4-6):

• **Estimate to Complete (ETC)** - the expected additional cost needed to complete the project.

• **Estimate at Completion (EAC)** - The expected total cost of the project when the defined scope of work is completed.

• **Budget at Completion (BAC)** - The total approved budget when the scope of the project is completed. Most techniques for forecasting EAC include some adjustment of the original cost estimate based on project performance to date. The three formulas are:

1.  \( \text{EAC}_1 = \text{ACWP} + (\text{BAC} - \text{BCWP}) \). This formula is called the ‘mathematical’ or ‘overrun to date’ formula in some textbooks.
However, using the term ‘overrun to date’ is incorrect because the project could be under on costs and ahead of schedule. This formula assumes the plan will be met for the remaining work (CPI = 1.0), and yields the most optimistic EAC when a project is not doing well.

2. **EAC2 = BAC/CPI.** This formula is called the ‘cumulative CPI’ in some textbooks, and assumes the entire project will be done at the same cost performance.

3. **EAC3 = BAC/(CPI x SPI).** This formula considers both cost and schedule impact on the EAC, and usually yields the most pessimistic EAC for a project not doing well.

4. **ETC = EAC - ACWP**

The crucial point when calculating the BCWP or EV is being able to identify the most appropriate method of measuring progress. This depends on the nature of construction works and should be determined in the initial phase of the project or even better during the bidding stages. The various methods of measuring progress are identified as the following (Orczyk, 2003, pp. 14.1-14.2):

- Unit completed
- Incremental milestone
- Start/finish
- Supervisor opinion
- Cost ratio
- Weighted or equivalent units

After having completed the earned value analysis during the construction of a project, it is of vital importance that the results obtained are analyzed and interpreted. Special attention is given to the variances noted, that should be substantiated thoroughly from the project manager and controller. However there are four standard outcomes that an EVA tool can generate and these are depicted through the following graphs (Project controlling using EVA, 2006):
Figure 1. Project is behind schedule and is overspent

Figure 2. Project is ahead of schedule and it is spending correctly
Figure 3. Project is behind schedule but spending correctly

Figure 4. Project is ahead of schedule and under spent
After having analyzed the results, usually project managers along with stakeholders are called upon to take a specific decision or even a combination of decisions. These decisions could fall under the following four general categories (Project Control Using Earned Value Analysis, 2006):

1. Ignore variances due to non-significant cost and risk.
2. Make corrections to get back on track with the budget.
3. Revise budget to reflect a change that can’t be corrected within the execution of the project.
4. Abort the project due to high cost and risk. Losses occurred from the cancellation of the project are less than cost of having the project executed.

However in order to be able to derive to one of the above mentioned decisions a series of steps has to be taken. Subsequently a thorough analysis of the project should be undergone through the systematic application of the EVA tool.

4. Literature Overview

The idea of being able to control the performance of a project being executed was initiated by the United States American Department of Defense through the introduction of the Cost/Schedule Control Systems Criteria (CSCSC) consisting of the thirty five criteria (Erik & Kirk, 1980, p. 2). The CSCSC was used for the next two decades and evolved to becoming the EVA we know today. In 1989 the United States Undersecretary of Defense for Acquisition made the EVA a mandated method for program management and procurement (Pinnacle Enterprise Management Specialists). Since then, the EVA concept grew in popularity and expanded to other public sectors and furthermore to the private sector like the oil and gas, construction and engineering industry.

The paper of Khamidi, Khan, & Idrus, (2011, p. 1) presents EVA as an effective tool for financially controlling construction projects. They use a case study in order to calculate earned value performance variances and indices and ultimately make it possible to calculate future costs of the project in various ways.
Furthermore their paper suggests that it is possible to forecast cash flows through EVA and provide useful information as to cost overruns during the life of a project. It concludes by informing its readers that EVA establishes an early warning system when cost divergences from the estimated are noted and helps those involved in the implementation of the project to develop contingency strategies that ensure a successful implementation of the project.

Thamhain (1998) makes an attempt to explain some internal and external barriers responsible for the reduced applicability of EVA in the execution of projects. Some of them are associated with:

- High cost of its implementation
- Low familiarity with the technique or even lack of knowledge of how the technique functions
- Implementation of the EVA tool requires a lot of work and time consumption
- EVA tool is not properly integrated in managerial procedures/business processes
- EVA method seen as a threat
- Its purpose and benefit are vague and not fully understood
- Prior unsuccessful implementation of similar techniques

Furthermore, Christensen (1998) stresses the need of cultural change within an organization for a successful implementation of an EVA tool. However at the same moment he acknowledges that cultural change requires time and effort. Therefore it is important that organization acknowledge this factor and invest in training sufficiently those who will responsible for the implementation of EVA.

Another issue that Terrel (1998) was able to bring to the surface was the necessity of having the information of the resources defined clearly. That basically means
that failing to obtain sufficient data in an efficient manner would definitely lead to a failing EVA tool.

In the paper of Fleming & Koppelman (1999) the importance of an adequate and precise work breakdown structure (WBS) is stressed as well as the implications that come along with it. Having a project sub divided into small working packages provides many advantages linked with the control of the project, such as clear works to be performed that help defining a clear strategy, however it may create a high costs of control and extra paperwork. Furthermore the absence of work breakdown structure (WBS) may lead to inaccurate data an inaccuracy of data related to the costs and timeframe of the project as a whole.

A thorough investigation of the main obstacles and benefits of the use of earned value analysis found in projects is discussed in the paper of Viana Vargas (2003, pp. 1-3). He goes one step further by identifying the factors that have to be improved and implemented during the project plan phase and moreover the actions that have to be taken while the project is executed and simultaneously monitored. He uses a real case study applied to the civil construction industry and tries to investigate the applicability of an earned value analysis tool form a theoretical perspective. He concludes that EVA is a powerful tool when applied correctly. He identifies as crucial success factors, having a detailed scope of the works to be done and having experienced staff with the sufficient and appropriate level of knowledge.

Therefore, establishing dedication to the scope improves the outcomes that an earned value analysis can generate. He additionally emphasizes as a risk factor to the EVA implementation, the resistance to changes that can be found. He stresses the negative impact of having a management that is resistant to the implementation of a new model of control and points out the importance of training managers through workshops and seminars from professionals as a way of overcoming managements’ reluctance to change. Managers that are trained to
be flexible to changes and are willing to overcome cultural taboos will get a better understanding of the importance of the EVA tool.

In the end he acknowledges that implementing EVA has a cost which has to be calculated and evaluated without providing further details on the subject topic.

The paper of Chen (2008, pp. 1-7) reconfirms the findings of Vargas as to the usefulness of the EVA tool as a simple and effective tool to detect project risks and warning signs. The subject paper also reconfirms the advantages of providing the project team sufficient orientation and education. As per the authors this strengthens the commitment and supports the implementation of an effective EVA. They conclude the paper by stating that the benefits of applying an earned value outweigh the additional effort put in for its implementation.

The paper of Lukas (2008, pp. 1.6 - 1.10) acknowledges the importance of the EVA tool on the performance of the projects’ progress and health. Furthermore he lists and subsequently describes the top ten reasons responsible for the failure of the earned value analysis. These are as follows:

- No documented requirements;
- Incomplete requirements;
- WBS not used or not accepted;
- WBS incomplete;
- Plan not integrated (WBS-Schedule-Budget);
- Schedule and/or budget incorrect;
- Change management not used or ineffective;
- Cost collection system inadequate;
- Incorrect progress; and
- Management influence and/or control.
The paper concludes by pointing out the significance of having complete requirements, a robust project plan, a clear scope, schedule and cost estimate that is integrated to the WBS.

The paper of Vandervoode & Vanboucke (2005, pp. 1, 14, 15) recognizes the EVA tool as an effective method to calculate the performance of a project, however goes one step further by emphasizing on forecasting the future duration in terms of cost and time. In his paper he provides a state-of-the-art knowledge of the research trend aiming to clarify the generic schedule forecasting formula that is applicable to various project situations and have them compared with three other methods from existing literature to estimate total project duration. In the end, he depicts on a one simple activity example the application of each method based on data from real projects.

The paper of Howes (2000, pp. 408 - 410) focuses on the potential problems caused when forecasting the estimated cost at completion of the project and the full cost of completion of a project, when using EVA indicators for future projections. This is created because works to be executed in the future may differ entirely and be unrelated to what has been executed until that time. Therefore the author concludes that it appears to be invalid to make an assumption that future performance is based automatically in the same manner and behavior as noted in the past. Furthermore he notes that schedule variances are related purely to cost performance only and neither time nor logical sequence of the activities is taken into consideration when forecasting. Howes believes that this constitutes a serious deficiency of the EVA forecasting system and acknowledges the need of great caution when implementing it.

In order to facilitate the forecasting deficiency caused from EVA, Howes attempts to investigate the performance of EVA by developing a cost and scheduling methodology. This methodology will have the ultimate purpose of providing a more reliable approach when predicting cost and duration of a project at
completion. He terms this method as the Work Package Method (WPM) in his paper. This is achieved by splitting the project in a series of work packages at the lowest level that are not related in terms of time and sequence.

The paper of Gershon (2013, pp. 11 - 14) stresses the importance of having a good detailed plan for the successful application of the EVA tool. As per the author a detailed plan ensures that the correct and precise information required for the application of the EVA tool has been collected. He disagrees with the existing perception that EVA requires more information and points out that EVA needs punctual and good information rather than volume of information.

The paper of Valle & Soares (pp. 64 - 68) investigates the EVA tool through its application to a real case study of a construction project. He realizes that the EVA tool is very sensitive to scope changes. However, he mentions that the reports can be corrected easily and fast, allowing the corrections of mistakes. The data base used for the generation of the reporting system provides an effective and efficient analysis of data. Furthermore he notes that the Schedule Performance Index (SPI) is not a in reality a time performance indicator but rather a progress performance indicator linked with the physical execution of the project. For the above mentioned reason the author suggests to have the name of the SPI changed from Schedule Performance Index to a name that better reflects it, Progress Performance Index.

Furthermore the author characterizes the Work Break-Down Structure (WBS) as the soul of the management process and the working packages should have clear responsibilities and criteria facilitating their measurement. Important for the generation of a proper working package system, is to maintain a high level of professional skepticism.

In the end the author embraces the EVA as a tool that is able to inspire project members to pay more attention to costs and progress. Furthermore it gives the
required motivation to the project members to take into consideration cost factors with more devotion leading to cost optimizations of the project.

From the existing literature someone can get an understanding of the status of the EVA today. However, the problems and corrective actions presented from the existing literature are determined rather generic and vague. The papers provide a general overview of the obstacles encountered but lack precision because information is rather based on own personal opinions and research rather than based on real life practical situations during the application of the EVA tool. This paper identifies this need and attempts to fill in the gap found.

5. Methodology – Interviews

5.1. Qualitative Analysis of Existing Findings

From the existing literature and findings, a clear need to separate our existing findings into three broader categories of organizations is generated based on which phase of the EVA the organizations are. It is a factor that has not been taken into consideration from the existing authors and it will facilitate the research of this paper. Therefore construction projects can be categorized included in one of the following categories. Organizations that have:

1. Not Implemented the EVA Tool.
   Organizations use a traditional method of analysis by simply comparing actual cost against forecasted cost. Therefore no indices are utilized and projections do not use current trends of the various executed phases of the project.

2. Partially Implemented the EVA Tool
   Organizations that are defined as having partially implemented the EVA tool have a sufficient database created with all the required information for the calculation of the EVA. However, fail to integrate the time factor of the EVA tool into the determination of the progress of their projects.
3. Implemented the EVA Tool

Organizations understand the EVA tool and its calculation, yet face problems related to the accuracy of the results and search for ways of improving methods of evaluating earned value (BCWP). Furthermore, they address issues related to forecasting project costs based on the EVA metrics.

The segregation into the above groups will contribute in having a more clear classification of the problems and corrective actions that have been noted until today from the existing literature. Furthermore it will assist readers to initially classify their organizations/projects into one of the above groups and it will help them easier identify, which of the problems and corrective actions may be applicable to their situation. In the end the segregation of the application of the EVA tool in the above categories will help in the comparison of the existing results with the results that will be obtained from the interviews to be conducted. The following table depicts the problems encountered and the potential corrective actions as suggested and found in the existing literature.
<table>
<thead>
<tr>
<th>Obstacles</th>
<th>EVA not implemented</th>
<th>EVA partially implemented</th>
<th>EVA implemented</th>
<th>Corrective Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>High implementation cost</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>Training</td>
</tr>
<tr>
<td>Not familiar with EVA</td>
<td>✓</td>
<td></td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>Effort and time</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>-</td>
</tr>
<tr>
<td>Perceived as a threat</td>
<td>✓</td>
<td></td>
<td></td>
<td>Training/Recruit professional</td>
</tr>
<tr>
<td>Cultural change required</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>Training</td>
</tr>
<tr>
<td>Insufficient database</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>Time not integrated</td>
<td></td>
<td>✓</td>
<td></td>
<td>Training</td>
</tr>
<tr>
<td>Obstacles</td>
<td>EVA not implemented</td>
<td>EVA partially implemented</td>
<td>EVA implemented</td>
<td>Corrective Action</td>
</tr>
<tr>
<td>---------------------------------</td>
<td>---------------------</td>
<td>---------------------------</td>
<td>-----------------</td>
<td>-------------------</td>
</tr>
<tr>
<td>Inadequate WBS structure</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>Resistance to change</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>Wrong methods selected</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>Judgment</td>
</tr>
<tr>
<td>Unreliable forecast</td>
<td></td>
<td></td>
<td>✓</td>
<td>Trends</td>
</tr>
<tr>
<td>High maintenance cost</td>
<td></td>
<td></td>
<td>✓</td>
<td>-</td>
</tr>
<tr>
<td>Sensitive to scope changes</td>
<td></td>
<td></td>
<td>✓</td>
<td>-</td>
</tr>
</tbody>
</table>

Table 2. Qualitative Analysis of the Existing Literature
From the analysis of the above table, three main conclusions can be drawn:

1. Although there are a significant number of deficiencies noted in each of the categories of the implementation phases of EVA, they are not sufficiently explained in detail. The deficiencies are rather generic and lack precision. Therefore a need to dig deeper into the problems of each category is required and this is one of the points the paper will deal with through the interviewing process (tool) that has been selected.

2. Another important conclusion obtained from the above analysis, is the lack of discussion and research noted on corrective actions that can be taken against each deficiencies as noted from the existing literature. This paper will try to address this issue, by incorporating these characteristics into questions enabling us to get the appropriate answers that will provide the answers to the respective deficiencies noted above.

3. A lack of prioritization of the deficiencies is noted. Although several papers deal with the deficiencies of the EVA tool, none of the papers deal with the level of importance of each deficiency. This paper will try to investigate the importance of each deficiency as to the application of the EVA tool and will try to provide a grading of the deficiencies noted varying from low to high importance. It is important initially to identify the most important deficiencies and on a second stage to sequence them, enabling its users to understand which of the problems have to be solved and most importantly when.

The paper will not limit itself only in making the existing deficiencies clearer, finding the respective remedy to each deficiency and prioritizing the importance of each of the existing deficiencies. It will try to note down the current situation of the EVA application in the construction industry and will try to get an insight of
the current challenges that construction organizations have been dealing with, in respect to the application of the EVA tool.

5.2. Qualitative Analysis of the Interview Responses

The questions addressed to the interviewees focused on trying to answer the main research question, by following the life cycle of the EVA tool, through the execution phases of a project. All weak points have been noted and discussed with each interviewee and wherever applicable cross checked with each other, in order to better comprehend the root of the problem. Furthermore, the interviewees are asked to express their opinions as to the corrective actions that should be taken in order to tackle the problems encountered with the application of EVA. Interviewees have not been informed about the participation of the other interviewees in order to assure that the information obtained is unbiased.

The results from the interviewees have been noted down in points and the paper attempts to organize the results in tables making it user friendly to the reader and easier to comprehend and categorize for his own personal use. Initially the obstacles will be presented and analyzed. Subsequently the corrective actions for the subject obstacles will be presented in extensive detail.

A. Material received but not incorporated into the project

As noted by the Project Control Manager, it is very common that Construction Managers receive their requested material on site; however the subject material is not used at the same moment. Therefore the material is not incorporated into the progress of the project. However the costs of the material have been recognized from the moment they have been issued to the project but in reality these incurred costs have not generated their respective revenue progress since they have not been yet incorporated into the project. Eventually a difference between the ACWP and the BCWP is generated, that is very difficult to quantify due to the fact that the material is scattered all over the site after its issuance from the warehouse.
B. **Incomplete and inconsistent cost centre directory**

A problem identified from the Construction Manager is the cost centre directory. It is common to have cost centre directories that are not decomposed sufficiently and inconsistent with the activities of the WBS structure. This results in employees registering their actual performed man-hours under wrong cost centers and therefore activities. Eventually control is lost since man-hours are not allocated properly among the activities of the project and cannot be compared against the forecasted hours for each activity.

C. **Project employees do not register and allocate their man hours correctly.**

The Project Control Manager highlights the problem associated with the constructions section heads not monitoring the proper allocation of project employee’s man-hours. This is obvious from the significant variances noted when comparing the actual man-hours to the forecasted figures. Although the end result of the EVA calculations will not be affected on the consolidated level of the project, however when calculating on a working package level, figures are distorted and eventually wrong actions and decisions can be taken affecting the performance of the project.

D. **WBS linked with chart of accounts rather than on an activity basis**

A deficiency highlighted by the Commercial Manager/Accounting & Finance Manager and the Project Control Manager, is the that in many cases in the construction industry the WBS is built upon the costs-expenses to be incurred by the project rather than on an activity basis as defined by the project manager. This is a simplistic way of recording costs and measuring performance, however this benefits the TCM and not EVA. The reason is that the third performance measurement factor required from the EVA tool is removed and therefore the EVA tool cannot be applied.
E. Lack of corporate direction and support as to the implementation of EVA

An issue that was raised from the Project Manager and the Project Control Manager was the fact that the application of EVA method has not always been communicated as a direction and target from the corporate level of management. This means that within the same organization it is up to the Project Manager whether he will select to apply the EVA method instead of the TCM. This requires a great deal of effort and time by the Project Manager when it is not part of the regular procedure of the Organization.

F. Project managers dealing more with technical issues rather than with project management (stakeholder needs) and performance of their projects

Project Managers often commit the mistake of focusing on technical engineering aspects of the project rather than on focusing in communicating with the related stakeholders of the project and monitoring the progress of the project. This is an issue identified by both the project managers and especially from the construction managers who are responsible for the technical details of the project. Project Managers should be accountable but not responsible for these type of technical details. Project Managers focusing on technical details of the project neglect the progress reports and therefore the application of EVA.

G. Methods of forecasting questionable affecting BCWP

As discussed earlier in the paper, there are various ways of measuring progress for each activity – working package as identified by (Orczyk, 2003, pp. 14.1-14.2). These are:

- Unit completed
- Incremental milestone
- Start/finish
• Supervisor opinion
• Cost ratio
• Weighted or equivalent units

As discussed by the Project Control manager and the Project Manager, not always the appropriate method of evaluating progress is selected. This may be done intentionally or without intent, however it is a factor that affects the results of the BCWP element of the EVA.

H. Project manager has power to manipulate cost and man-hours to complete.

The result of EVA analysis can be easily manipulated when there are not sufficient internal controls in place. The Project manager can manipulate the results of the EVA by adjusting the figures related with the ETC and EAC of the project.

I. Tender-Sales department not coordinating with project controls

As discussed previously it is of vital importance that the WBS is created on a sufficient detailed basis (Activity-Working Package basis). Tender-Sales department often refuses to coordinate with the Project Controlling department in building the WBS early on during the bidding phase of projects. Having a WBS built during the tendering phase promotes the achievement of an accurate commercial proposal and improves significantly time management, since no time is wasted on preparing a WBS upon awarding of a project and project can be kicked off immediately without delays. It is of vital importance for the application of the EVA to have a clear and effective WBS early on in the beginning stage of the project. However Tendering-Sale Department often refuse to coordinate with the Project Controlling Department in preparing a WBS on an early stage considering it a waste of time and effort, since awarding of the project is not guaranteed.
J. **Lack of Project Controlling Department.**

There is a false perception that the Project controlling department is often seen as an additional overhead cost to the project that does not contribute any additional value to the project and does not contribute in generating any revenue. One of the basic reasons that the EVA tool has not evolved as expected throughout the years, as per the Project Controller, is the lack of investment in a Project Controlling Department that will define the pre-requisites of the EVA tool. Organizations that have understood the importance of the EVA tool have made steps into investing and building a Project Controlling department that bring with them the require qualifications to successfully implement the EVA tool tailored to the needs of the each organization.

K. **Clients scope of works not defined clearly and in detail**

An obstacle of implementing EVA, as identified by Project Managers during the execution phase of the project, is the lack of a clear scope of works from the client. Often the scope of works lacks precision and incorporates many changes that had not been communicated from the client initially. This affects the calculation and results of EVA, since the WBS has to be modified and adjusted for the subject changes in the scope of works.

L. **Collusion of Project manager with Project Controller to smooth results.**

An area in which the EVA tool fails to reflect the progress of the project is when project managers along with project controllers collude in order to smooth results. This is either done by overestimating works executed or underestimating works executed for future use, resulting in a false representation of the status of works of the project.

M. **Consideration of labor cost manipulates the ACWP component of the EVA.**
A problem identified by the Accounting & Finance Manager is the use of estimated man hour rates per job position that are revised on a yearly basis rather than the use of actual labor cost that is allocated to each project during its execution. As a result of this misapplication, deviations of even up to 10% can be applicable which manipulate the EVA calculation as noted by the Accounting & Finance Manager when comparing to financial accounting results. Even a 5% deviation, can be an important distortion to the EVA calculation, especially when labor costs constitutes 30%-60% of the total project cost.

N. **Pressure on Project Managers to report only good news.**

Objectivity of the EVA tool is severely affected when Project Managers’ performance is highly linked with the performance of their projects. EVA is manipulated to improve performance or smooth variances with the budget.

Businesses that are not applying the EVA tool, have no mechanisms built in their software systems that allow space for the third performance measurement factor that EVA introduces to be taken into consideration. The costs of changing the company’s software are high and the process of implementing such a change is complex and time consuming. The combination of the above creates a serious barrier towards the implementation of the EVA tool.

**5.3. Suggest Corrective Actions**

A. **Material received but not incorporated into the project**

Technology can be used to solve the problem noted with the project material. A solution can be the use of electronic barcodes. Barcodes can be used in order to control when a material has left the store and when the respective material has been incorporated into the project. Also material can be ordered when needed avoiding stock piling. Finally, the example project used state-of-the-art methods for measuring progress.
B. Incomplete and inconsistent cost centre directory

Invest in the beginning of the project in defining an adequate cost centre directory on the basis of the WBS of the project, in order to avoid wrong registration of man-hours. Communicate the cost centre directory to the project team and monitor the allocation of the man-hours throughout the project duration.

C. Project employees do not register and allocate their man hours correctly.

Electronic cards can be used in order to monitor the hours the employees entered into various areas of the project and the hour they left. Information can be collected in order to ensure the correct allocation of man-hours to WBS activities. Furthermore random on site audits can take place in order to monitor that employees’ man-hours are allocated to the activity that they are actually working for. In the end a point system for construction section heads can be introduced for maintaining the timesheets correctly and can be linked with their performance appraisal. The Project Accounting and Finance Manager can monitor the allocations of the man-hours on a weekly or monthly basis and any significant variance from the Master Budget could be discussed with the project manager. Significant and unreasonable variance from the Master Budget or Rolling Forecast is a potential indicator of misallocation of man-hours.

D. WBS linked with chart of accounts rather than on an activity basis

Upon awarding of a project, the Project Manager, the Project Accounting and Finance Manager and the Project Control Manager should invest in building a sufficient WBS based on the activities to be executed on a working package level and not on WBS that is linked with the chart of accounts. To each activity labor and non-labor resources will be allocated. This will ensure the existence of a third performance measurement based upon on an EVA could be achieved. The WBS must be detailed indicating clearly all the activities to be achieved. Furthermore for every activity, a project member should be allocated the responsibility of executing the specific milestone. In addition to the allocation of a person to each
activity, a time and a cost forecast should be clearly depicted. In the end each activity of the project should have a start and finish calendar date. This ensures that project members commit in completing their activities in due time.

E. Lack of corporate direction and support as to the implementation of EVA

It is crucial to be able to ensure top level organization commitment towards the application of the EVA tool. EVA should be communicated and directed from top to down (from corporate level management to operational level). It should be part of the procedures of a construction organization. Project Managers and the project team should put their energy in trying to implement the EVA tool successfully and not waste energy in trying to convince project members of the importance of the EVA tool. Increasing acceptance on the other hand can be achieved by using a top-down approach which states that top management truly believes in the EVM methodology. (Buyse & Vandenbussche, 2010, p. 27)

F. Project managers dealing more with technical issues rather than with project management (stakeholder needs) and performance of their projects

Recruit experienced and qualified Construction Managers. Recruit Project Managers that understand their responsibilities and are qualified (PMP). Furthermore project managers should distribute the workload to the team ensuring that they have sufficient time and energy to deal with the needs of their stakeholders.

G. Questionable methods used to measure progress

It is of vital importance to decide and agree in the beginning of the project the best methods for evaluating progress for each activity of the WBS. Subjectivity
should be removed as much as possible in estimating performance and supervisor’s opinions should be used when all other ways have been exhausted.

H. Project manager has power to manipulate cost and man-hours to complete.

In order to remove subjectivity and avoid unilateral decisions by Project Managers, sufficient internal controls should be set by the responsible finance person of the project ensuring that figures are not manipulated and smoothened. This can be achieved by random cross checks of the EAC and ETC calculations of working packages/ activities directly with the Construction Managers or even with the Construction Section Heads of the project. If significant differences are noted then further investigation is required. Duties should be segregated in order to avoid unilateral decisions by the project managers.

I. Tender-Sales department not coordinating with project manager and project controls

As part of the bidding process, commercial proposals should use the WBS as a backbone. Sales Engineers ignore the WBS structure when preparing commercial proposals. It is usual that project managers and project controls are left out of the bidding phase. The result is the creation of weak WBS structures that are difficult to adjust once the contract has been awarded and a project is initiated. Furthermore corporate management should support the implementation of this process.

J. Lack of Accounting and Finance department.

Corporate management should invest in an accounting and finance department and support its purpose. Cost can be controlled only by professionals of the subject field that will have the knowledge of the EVA method. Furthermore the control of cost should be monitored by an independent person ensuring sufficient segregation of duties.
K. Clients scope of works not defined clearly and in detail

Project Manager should invest some time in the beginning of the project to remove any gray areas in the contract as to the technical specifications of the project and scope of works. Furthermore procedures and processes should be defined and agreed upon prior to the initiation of the works between the contractor and the client, as to the way changes of scope will be addressed, avoiding delays in the re-defining the WBS.

L. Collusion of Project manager with Project Controller to smooth results

Collusion among two parties cannot be detected by internal controls. Therefore it is important when recruiting project controllers, to select qualified employees with high sense of integrity and ethics. Furthermore the Accounting and Finance Manager of the project could also play a role in identify such type of collusions when the explanations for the variances from budgets are not sufficiently substantiated.

M. Consideration of labor cost manipulates the ACWP component of the EVA

Extract actual labor cost from the financial accounting department, in order to get the accurate figure for the EVA calculations and avoid unnecessary manipulations of EVA. Avoid using estimated ma-hour cost rates rather than actual costs generated from the accounting department bookkeeping software.

N. Pressure on Project Managers to report only good news.

Performance appraisals should not be linked with the ‘good news’. They should be rather linked with being able to reflect the reality and actual status of a project, enabling those involved in the project to take appropriate corrective action in improving the project.
O. High cost of changing the software system

Organizations that are willing to invest into implementing the EVA tool should look into the market in order to purchase software tailored to their needs avoiding additional unnecessary costs. Organization should invest in infrastructure enabling project members to access the required data at the right time. Furthermore engaging a qualified team to execute the implementation and transition to the new software is crucial, since experience has shown that there can be cost overruns when the transition phase does not evolve smoothly.
<table>
<thead>
<tr>
<th>Obstacles</th>
<th>EVA not implemented</th>
<th>EVA partially implemented</th>
<th>EVA implemented</th>
<th>Corrective Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Material received and issued from the warehouse but not incorporated into the project</td>
<td>☑️</td>
<td>☑️</td>
<td>✔️</td>
<td>Close monitoring through the use of technology e.g. Barcodes, scanners</td>
</tr>
<tr>
<td>Incomplete and inconsistent cost centre directory</td>
<td>☑️</td>
<td>☑️</td>
<td>✔️</td>
<td>Create clear cost centre directory/ Communicate it to the project team</td>
</tr>
<tr>
<td>Project employees do not register and allocate their man hours correctly.</td>
<td>☑️</td>
<td></td>
<td>✔️</td>
<td>Monitor the allocation of man-hours/ Establish point system for supervisors/ Perform random audits</td>
</tr>
<tr>
<td>The WBS is based on expense accounts from the Chart of Accounts rather than on detailed activities comprising a project</td>
<td>☑️</td>
<td></td>
<td>✔️</td>
<td>Prepare detailed and complete WBS prior to initiation of work/ Ensure WBS is on activity basis/ Coordination among project members required</td>
</tr>
<tr>
<td>Obstacles</td>
<td>EVA not implemented</td>
<td>EVA partially implemented</td>
<td>EVA implemented</td>
<td>Corrective Action</td>
</tr>
<tr>
<td>--------------------------------------------------------------------------</td>
<td>---------------------</td>
<td>---------------------------</td>
<td>-----------------</td>
<td>----------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Lack of corporate direction and support as to the implementation of EVA</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>Corporate level management should set the ‘tone at the top’. They should support the implementation of the EVA</td>
</tr>
<tr>
<td>Project managers dealing more with technical issues rather than with stakeholder needs and performance of projects</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>Recruit qualified Project Managers that understand their responsibilities/ Project managers should distribute workload to the Project Team</td>
</tr>
<tr>
<td>Questionable methods used in order to measure project performance</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>Select appropriate method of progress measurement prior to initiation of the project/ Avoid methods that are based on subjectivity</td>
</tr>
<tr>
<td>Project manager utilizes his power to manipulate cost and man-hours</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>Conduct regular internal audit checks / Ensure segregation of duties</td>
</tr>
<tr>
<td>Obstacles</td>
<td>EVA not implemented</td>
<td>EVA partially implemented</td>
<td>EVA implemented</td>
<td>Corrective Action</td>
</tr>
<tr>
<td>--------------------------------------------------------------------------</td>
<td>---------------------</td>
<td>---------------------------</td>
<td>-----------------</td>
<td>-----------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Tender-Sales department not coordinating with project controlling department</td>
<td></td>
<td>✓</td>
<td></td>
<td>Commercial proposal should use the WBS as a backbone/ Sales engineers should align with Project Manager and Project Controls</td>
</tr>
<tr>
<td>Lack of Project Controlling Department.</td>
<td>✓</td>
<td></td>
<td></td>
<td>Corporate management to support the creation of project controls</td>
</tr>
<tr>
<td>Clients scope of works not defined clearly and in detail</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>Project manager should clarify grey areas of the contract</td>
</tr>
<tr>
<td>Collusion of Project manager with Project Controller to smooth results</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>High sense of ethics and integrity should be promoted</td>
</tr>
<tr>
<td>Consideration of labor cost manipulates the ACWP component of the EVA</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>Actual costs should be extracted by accounting department</td>
</tr>
<tr>
<td>Pressure on Project Managers to report only good news.</td>
<td>✓</td>
<td>✓</td>
<td>Base performance on minimal deviations and not only on profit</td>
<td></td>
</tr>
<tr>
<td>-----------------------------------------------</td>
<td>---</td>
<td>---</td>
<td>-------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>High cost of changing the software system</td>
<td>✓</td>
<td>✓</td>
<td>Use tailored software/ Engage qualified team to execute the transition</td>
<td></td>
</tr>
</tbody>
</table>

Table 3. Qualitative Analysis of the Responses from the Interviewee
5.4. Prioritizing Obstacles Based on Importance

In this last section of the methodology, the paper evaluates the importance of each obstacle as to the application of the EVA tool and attempts to provide a grading for the previously mentioned obstacles varying from low to high importance. It is crucial to determine the level of importance of the obstacles, enabling the readers of the paper to understand which of the problems that are applicable to their situation have to be given more attention and priority. Time and effort are resources that are limited during the project execution phases and therefore it is important to address any obstacles efficiently. Furthermore as extracted from the interview responses, the phase in which the obstacles can be encountered, is presented for each obstacle. This assists the EVA users, since they can have a better indication of the timing that an obstacle may be encountered (Table 4).

<table>
<thead>
<tr>
<th>Obstacles</th>
<th>High</th>
<th>Medium</th>
<th>Low</th>
<th>Phase</th>
</tr>
</thead>
<tbody>
<tr>
<td>High implementation cost</td>
<td></td>
<td></td>
<td>✓</td>
<td>All times</td>
</tr>
<tr>
<td>Not familiar with EVA</td>
<td>✓</td>
<td></td>
<td></td>
<td>All times</td>
</tr>
<tr>
<td>Effort and time</td>
<td></td>
<td></td>
<td>✓</td>
<td>Execution</td>
</tr>
<tr>
<td>Perceived as a threat</td>
<td></td>
<td>✓</td>
<td></td>
<td>Initiation</td>
</tr>
<tr>
<td>Cultural change required</td>
<td>✓</td>
<td></td>
<td></td>
<td>All times</td>
</tr>
<tr>
<td>Insufficient database</td>
<td>✓</td>
<td></td>
<td></td>
<td>Execution</td>
</tr>
<tr>
<td>Time not integrated</td>
<td>✓</td>
<td></td>
<td></td>
<td>Execution</td>
</tr>
<tr>
<td>Inadequate WBS structure</td>
<td></td>
<td></td>
<td>✓</td>
<td>Planning</td>
</tr>
<tr>
<td>Resistance to change</td>
<td>✓</td>
<td></td>
<td></td>
<td>All times</td>
</tr>
<tr>
<td>Obstacles</td>
<td>High</td>
<td>Medium</td>
<td>Low</td>
<td>Phase</td>
</tr>
<tr>
<td>--------------------------------------------------------------------------</td>
<td>------</td>
<td>--------</td>
<td>-----</td>
<td>----------</td>
</tr>
<tr>
<td>Unreliable forecast</td>
<td>✓</td>
<td></td>
<td></td>
<td>Planning</td>
</tr>
<tr>
<td>High maintenance cost</td>
<td></td>
<td>✓</td>
<td></td>
<td>All times</td>
</tr>
<tr>
<td>Sensitive to scope changes during execution</td>
<td></td>
<td></td>
<td>✓</td>
<td>Execution</td>
</tr>
<tr>
<td>Material received and issued from the warehouse but not incorporated into the project as part of works executed</td>
<td></td>
<td></td>
<td>✓</td>
<td>Execution</td>
</tr>
<tr>
<td>Incomplete and inconsistent cost centre directory that is required for man-hour registration</td>
<td>✓</td>
<td></td>
<td></td>
<td>Planning</td>
</tr>
<tr>
<td>Wrong methods of measuring performance selected during the application of EVA</td>
<td></td>
<td>✓</td>
<td></td>
<td>Execution</td>
</tr>
<tr>
<td>The WBS is based on expense accounts from the Chart of Accounts rather than on detailed activities</td>
<td>✓</td>
<td></td>
<td></td>
<td>Planning</td>
</tr>
<tr>
<td>Lack of corporate direction and support as to the implementation of EVA</td>
<td></td>
<td></td>
<td>✓</td>
<td>All times</td>
</tr>
<tr>
<td>Project employees do not register and allocate their man hours correctly</td>
<td>✓</td>
<td></td>
<td></td>
<td>Execution</td>
</tr>
<tr>
<td>Obstacles</td>
<td>High</td>
<td>Medium</td>
<td>Low</td>
<td>Phase</td>
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<tr>
<td>---------------------------------------------------------------------------</td>
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<td>-------------</td>
</tr>
<tr>
<td>Project managers dealing more with technical issues rather than with stakeholder needs and performance of projects</td>
<td></td>
<td>✓</td>
<td></td>
<td>Execution</td>
</tr>
<tr>
<td>Questionable methods used</td>
<td></td>
<td>✓</td>
<td></td>
<td>Execution</td>
</tr>
<tr>
<td>Project manager utilizes his power to manipulate cost and man-hours to complete</td>
<td>✓</td>
<td></td>
<td></td>
<td>Execution</td>
</tr>
<tr>
<td>Tender-Sales department not coordinating with project controlling department</td>
<td></td>
<td></td>
<td>✓</td>
<td>Tendering</td>
</tr>
<tr>
<td>Lack of Project Controlling Dpt.</td>
<td>✓</td>
<td></td>
<td></td>
<td>All times</td>
</tr>
<tr>
<td>Clients scope of works not defined clearly and in detail</td>
<td>✓</td>
<td></td>
<td></td>
<td>Tendering</td>
</tr>
<tr>
<td>Collusion of Project manager with Project Controller</td>
<td></td>
<td></td>
<td>✓</td>
<td>Execution</td>
</tr>
<tr>
<td>Consideration of labor cost manipulates the ACWP component of the EVA</td>
<td></td>
<td></td>
<td>✓</td>
<td>Planning</td>
</tr>
<tr>
<td>Pressure on Project Managers to report only good news.</td>
<td></td>
<td></td>
<td>✓</td>
<td>Execution</td>
</tr>
</tbody>
</table>

Table 4. Prioritization of EVA Obstacles
6. Results of the Research

The main results obtained through the interview conducted with the professionals of the construction industry, indicate that the obstacles in applying EVA are persistent and significant, although the tool has been introduced decades ago. The obstacles however differ from organization to organization. Some organizations have no improvement, other organizations have partially implemented the EVA tool and other organizations have implemented sufficiently the EVA tool. Therefore it is crucial for its users to comprehend where the organization stands as to the application of the EVA enabling them to deal with the related problems efficiently without wasting the scarce resources allocated for a project.

Furthermore the paper goes one step further in introducing corrective actions for each obstacle encountered based on the answers obtained from the experienced professionals that have been interviewed. In the end, due to the scarce resources, a natural need is generated in order to prioritize the obstacles noted down into three categories based on their importance. Therefore those obstacles that are identified by the interviewees as of high and medium importance can be given more attention prior to dealing with the obstacles of less importance.

After reading the subject paper, the reader should have a better and clearer picture of the obstacles that can be encountered in his organization, when applying the EVA tool. In addition he should be able to classify his organization at which stage of the EVA implementation it stands. Knowing at which stage of the EVA implementation phase an organization stands, assists in determining the corrective actions that have to be taken for the respective problems.

7. Conclusion

7.1. Summary of the Paper

To summarize the paper investigates the reasons behind the failure of the Earned Value Analysis (EVA) when applied specifically to projects that are executed
within the Construction Industry. Before addressing the main research question it presents an overview of how the EVA has evolved to becoming an important performance tool for projects, the additional value it contributes to its users in comparison with the traditional cost method and finally presents the EVA calculations, formulas and graphs.

The subject paper uses interviews as a research technique in order to answer its research question. The semi-structured interview technique is used in order to interview six construction specialists of different professional backgrounds. Furthermore the paper investigates the existing literature found as to the reasons EVA fails to provide the desired outcome.

From the research of the existing literature it concludes that the current information found is 1) Generic and lacks precision 2) Lacks proposal of corrective actions for the obstacles encountered during the implementation of EVA 3) A lack of prioritization of the deficiencies is noted.

Through the responses obtained from the interviews the paper attempts initially to identify the most important obstacles and on a second stage to sequence them, enabling its users to understand which of the problems have to be solved and at which stage of the project execution phases can they be identified.

In order to facilitate the reader, the obstacles and corrective actions identified from the interview responses, are grouped into three categories depending on the status at which the organizations are with the EVA implementation. The three categories are 1) EVA has been implemented 2) EVA has been partially implemented 3) EVA has not been implemented.

From the results of the research and the analysis done the reader should be able to assess at which stage of the EVA implementation his organizations stands. Furthermore identify applicable and potential obstacles to his projects and apply the corrective actions as proposed. In the end he can prioritize the obstacles in terms of level of importance and time sequence that is linked with phases of a
project in order to take maximum advantage from the scarce resources that are allocated to a project for its execution.

7.2. Limitations of Study

The subject paper contains some limitations as to the methodology selected to extract information required to analyze the EVA tool. Therefore various assumptions are made, that have to be identified and noted. This is of great importance for the readers, who select to use this paper for further research on the applicability of the EVA tool in the Construction-Engineering industry.

A basic limitation to be taken into consideration of the subject paper is the interview methodology selected, in order to obtain information. Although the selected interviewees are highly qualified professionals with several years of experience in the construction field, however their input remains subjective and limited to the experience that one person can obtain during their career. This does not overrule the results of the paper; however it should be made clear that the results are not absolute.

Another limitation of the subject paper is the fact that the results of the paper do not cover all of the sectors of the construction industry. The construction industry contains streams such as Civil Engineering, Marine Engineering, and Industrial Automation Engineering that differ from each other although the same project management principles apply to all. This occurs because other sectors are more service oriented and others more material based. Other sectors deal with large scale projects and other sectors with smaller projects (Subcontractors to Main Contractors). The above mentioned factors play a significant role to the application of the EVA tool, although the rules of EVA tool are applicable to all projects that have a start and end date.

In the end, many of the EVA obstacles presented in the subject paper have a great deal of materiality and feasibility, such as the obstacle presented earlier in the warehouse with the issuance and incorporation of the material to the project. However it was not possible to physically inspect such obstacles, since the
projects were located in remote locations of countries that cannot be accessed easily.

7.3. Suggestion of Future Literature

Based on the limitations and assumptions mentioned above, further research can be done to:

1. Check the credibility of the results of the subject paper by observing the life cycle of the EVA with physical presence at the project.
2. Run a quantitative application of the EVA tool of three organizations based on the three categories referred in the methodology of the paper (EVA not implemented, partially implemented, and implemented) and compare quantitative results to the qualitative results of the subject paper.
3. Select to apply a qualitative or quantitative research of the EVA tool to specific sectors of the construction-engineering industry and compare them with the results of the subject paper.
4. Investigate the relation of the EVA tool with the new requirement of IFRS (International Financial Reporting Standards) 15 Revenue with Customers requirement. Can EVA become more than just a performance measurement tool? Can it become a prerequisite to comply with the new IFRS 15 five step model?
Reference List


Appendix

Interview Questions

1. Are requirements by the client clearly documented to the contractor?
2. Do the requirements of the client actually meet their expectation?
3. Are the requirements set out by the client complete?
4. Is a Work Breakdown Structure used and if yes, is it accepted by the client?
5. Is the Work Breakdown Structure complete? In terms of Schedule, Cost, Staffing, Procurement, Quality and Risk.
6. Is the Work Breakdown Structure sufficiently integrated?
7. Has the Master Budget been correctly prepared? Is the Master Budget monitored in comparison to actual costs? Are significant variances decoded?
8. Are change orders sufficiently addressed? Is there a built in procedure and process to handle such changes?
9. Is there a sufficient costing system followed? Is it fed properly by the engineers?
10. Is the Work in Progress correctly reported? How can management influence the reported results in order to smooth project performance?
11. How do you control whether the material purchased has been incorporated into your project? At which point of time are the costs realized for the material incorporated into the project? Is there a time lag between recognizing the cost and actual incorporation of the material into the project?
12. What software do you use in order to control your costs? Is it sufficient?
13. What problems do you encounter with the cost centre directory? Is it complete and consistent? If not, what do you believe is the problem?
14. Do project employees register their man-hours accurately and fairly? How do you believe we can get better results?
15. On what basis do you register you actual costs? Are there any side effects based on the method chosen?
16. Does corporate level manage support your efforts in implementing EVA?
17. Do you believe that you have sufficient time in order to apply and monitor the application of the EVA tool? How much of your time does it spend on a monthly basis?
18. What methods do you use in evaluating performance for each activity? How many methods do you use? How many methods do you use and which are those? Could you please explain in detail the methods you have used?
19. Do you believe project managers manipulate the performance of the project? Can you give me an example? What do you believe should be done in order to avoid such practices?
20. To what extent does the profitability of the project affect the performance appraisals of the project members?
21. Does the Sales department coordinate with you when preparing a bid? Do you believe that you should be involved in this process? What do you believe will be the benefits for the application of EVA?
22. Does the client have a clear scope? Do you have problems with the client in respect to the works to be executed?
23. Have you noticed any cases of collusion within the project team, in order to manipulate the performance metrics?
Statutory Declaration

„I herewith formally declare that I myself have written the submitted dissertation independently. I did not use any outside support except for the quoted literature and other sources mentioned at the end of this paper. I clearly marked and separately listed all the literature and all other sources which I employed producing this academic work, either literals or in content. Moreover, I certify that no part of this work has been previously submitted for any other examination. I am aware that the violation of this regulation will be penalized.”

Signature : Samer Ammari

Date : 23.01.2017