

Investigation of the Function of the Mahshahr's Petrochemical Projects with the Use of Earned Value system

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ABSTRACT

The present study was conducted with the aim of using the earned value management system as a project control approach in Mahshahr petrochemical projects. This project was performance-oriented and applied in terms of purpose and descriptive-survey in terms of method. The statistical population of the present study consists of the main employer and subcontractors, experts and professional specialists in Mahshahr petrochemical projects, totaling 100 people, and the consensus counting method was used, while the sample size was equal to the entire research objective. A population of over 100 people to whom the questionnaire was distributed. The collected data was analyzed using descriptive statistics (mean, standard deviation, etc.) and inferential statistics. With the results obtained from the variables of the earned value management system, it was determined how this new system can be used as a suitable tool in evaluating the performance of projects, especially construction projects. Also, by identifying the effective dimensions in indicators such as time and cost and their relationship with project performance, we were able to achieve a proper evaluation of project performance. Because, in this evaluation, the progress of projects is accurately reflected and it is evaluated whether the project progress is acceptable. What was resolved in this research was the necessity of using this system in project management with the aim of achieving maximum performance in terms of time and cost. What was identified in this research was the necessity of using and applying the earned value management system in all stages of work, and especially such applications were definitively demonstrated in Mahshahr petrochemical projects. In addition, Potential future applications of these findings were also explored. All in all, this efficient and reliable method can address the identified gaps and challenges faced by project managers in the sector.

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1. Introduction

1.1. Indicators of the topic of the article

A project can be considered totally successful if it achieves its professional performance specifications and purposes. This successful completion of cost, time, and quality objectives is due to the project management success [1]. Because, one of the most important objectives of the project management teams is that they should be able to finish a project in accordance with the budget, time-table, and by the key coverage of the work limits. As a result, it is felt that these factors are required to be under constant control [2]. In this regards, measuring the performance of a project, a comparison between the real performance and the baseline plan, during the execution of projects is crucial. The output of this process is project status indication which is used for prediction of future performance. In fact, the study of schedule and cost performance of projects is summarized under two categories: control of the organization's projects and replanning system.

Adequate control and appropriate monitoring of project status is one of the crucial success factors for projects. Thus, project managers always quest for possible approaches to monitor project progress closely to avoid potential problems and manage delays and budget overruns [3] [4] [5]. Project monitoring consists of collecting progress data which supports managers in identifying and reporting the status of the project. Control decisions are based on monitoring the schedule and cost realizations/variances of a specific project and analyzing the data collected during project execution [6]. During implementation of the projects, deviations from plans are quite common. To ensure achieving project goals, it is critical to establish effective monitoring and control of the progress, assess the performance by analyzing data, mainly identifying time and cost deviations, and take effective control decisions, which involve the initiation of timely corrective actions such as rescheduling and reallocation of resources to get the project back on track [3] [4].

Execution of petrochemical projects is usually unique, complex, has a high risk so that many factors can result in increased costs. The larger the project, the more complex the mechanism means the more problems that must be faced. If not handled properly, these problems can result in increased costs, quality deviations, waste of resources, and failure to achieve desired goals and objectives [7] [8]. This situation causes the fact that control of costs and compliance with the schedule is a difficult management task [9]. On the other hand, budget and time related processes cannot be regarded independent from each other and the impact that each bears on the other one cannot be neglected. This is a topic disregarded in the traditional methods of project control [10] [11]. This interdependence makes it possible to assess either of the two parameters in project controlling. This results in desirable consequences such as fast and more accurate analysis of information, quick decision-making process, straightforward analysis of the impact of changes on the design, and ease of developing recommendations and countermeasures to improve project cost, schedule, and quality.

A considerable number of techniques have been proposed in project controlling context such as earned schedule, Monte Carlo simulation [12], and earned duration management (EDM) [13], yet the most well-known among these still is the earned value management (EVM). Earned value management is a technical tool introduced for the first time by the American Academy of Project Management (AAPM) can be of great assistance to the managers. It has many of the characteristics of an efficient system and is implementable to a wide range of projects. It is a systematic method for incorporating and estimating the costs, time, and scope of any given project or activity [14] [15].

The management of the earned value, conducted with the aim of controlling and planning costs in their various forms, is a common method in application for assessing the performance of the projects and it does bring unity to time and cost by integrating time and cost management, and limits assessment and thus assists the project management team for evaluating and assessing the project's performance. In this method, the existing temporal indexes are articulated on the basis of the cost unit, and with the aim of planning and a more effective control over the projects, applying these indexes, by the side of the traditional indexes (like the project's physical fulfillment percentage, the percentage of budget absorption and the like) can be rendered highly effective. In a project-based organization, such indexes can be turned into consistent outputs of the planning system and control of the organization's projects and thus create viable feedback for the other parts.

The method of earned value management is quite significant in change management too. One of the determined factors in this method, with regard to the fact that it fully encircles the project, is determination of change within the limits of the project and taking necessary corrective measures. Project managers can use this technique before the project reaching 15% of progress in its performance by studying the procedure of the project performance in order to come to an exact and reliable prediction of the final status of the project with regard to the time and costs required for completing the project. In fact, the trends of EVM in reckoning the project's cost

performance is stable, within the acceptable range, and in accordance with the physical progress at site [16]. This is why the earned value management is called a light at the end of the tunnel of management.

EVM can be effectively employed to assess the current cost performance and progress of a construction project with easiness. Petrochemical projects have been criticized to have many participants, long project cycle, high risk and uncertainty, lack of coordination among work players, and lack of data sharing and resource integration. Thus, simplicity of the project management methods seems inevitable in the world of such projects. In the earned value management method, based on several parameters (PV, EV, AC), one can quickly assess the actual project status and predict the future. The process of the production of the aforementioned indexes, which must be conducted in the Projects Management Office (PMO), can in practice result in the creation of information-based surplus value over the data pool [17]. These values lie at the core of project management, but unfortunately project managers in developing countries are lagging in embracing these concepts in managing projects.

The information circulation in most organization regarding the financial processes, especially the financial affairs of the projects, is usually not in real time, meaning that the executed financial transactions are informed to the control units of the projects with a considerable temporal delay. As a result, gathering information in this area is one of the complications of project planning and control in companies. Assessing the liable individuals' performance in projects and even the units of one single organization is one of the most important control processes in management and also one of the outputs of the process of the improvement of the organization in the area of human resource management. The documents attained through this assessment can be put to use for improving the work process of the organization and its selected criteria for executing future activities. The first and most important stage of the process of performance assessment is to determine useful and effective indexes for doing this activity [6].

1.2. Advantages and Disadvantages of the EVM

Project management is one of the most essential and highly interdisciplinary branches of management sciences due to complications that may occur during project implementation. Project managers continuously look for incurring useful tools and techniques to manage ongoing projects efficiently [18]. An enduring theme in project management is the poor management of project schedule and cost performance [19]. It is expected that the control of time and cost would result in getting excellent outcomes by applying the use of modern computer technologies which can be explained in more detail to the investors or the stockholders to make the central plan more clear [11]. But these technologies suffer from low simplicity, especially, in developing countries where the dearth of financial incentives and obstructive policies are among the challenges inherent when it comes to precise monitoring. The accurate measurement of project progress is extremely difficult, if not impossible [5]. A method is needed which requires simple calculations, fewer data and does not need typical distributions [5]. EVM can fulfil these requirements and plays a crucial role in enabling and smoothing the process of integrating controlling and estimation into project management practices. This method enjoys a high level of simplicity, is applied at the lowest possible cost (this is the most important reasons for using it) and has high executive functionality.

The methodology of the calculation of the percentage of the project fulfillment in the management of the earned value is the most central concept to guarantee the accuracy of the results of such analyses [5]. It provides a better view for project manager in terms of scope and procurement management and works as an early warning system and will prevent problems before they occur in the project [5]. In other words, the laws of Earned Value Management (EVM) are established on the basis of performance assessment. EVM is one of the techniques used in unifying various processes and also assessing the performance of the project, from A to Z. This technique is used as a methodology in the management of the unification of the project and, in other project management areas, is used as a tool for assessing the performance against the project planning [20]. This performance of the EVM encourages people to implement the process of project control to handle projects more successfully. In fact, The EVM is a crucial tool that can help project manager in making decisions. Except for the very early and extreme final stage of the project, the output values for schedule indication in EVM are in close agreement with the actual progress of the projects [21] [22]. Thus, the use of EVM is valid for quantifying the schedule performance. Contrarily, the trends of other techniques values for the purpose of schedule indication are as odd as observed for cost performance and, at most, show strange and inconsistent outputs [2]. Its incorporation in the progress reporting regime for projects can offer a great potential.

EVM not only is capable of determining the right state of the project under different conditions, but also developed a reliable forecasting method for the final duration and cost of the projects in order to enhance the capability of project managers to make informed decisions. Many studies verified the EVM's soundness in forecasting the cost and schedule, required for project's completion. This method can predict the trend of delay in the projects and estimate future project costs even with little project progress [23]. A simple analysis of the CPI and SPI indicators facilitates estimation. It is safe to say that EVM's incorporation in progress reporting regime can

revolutionize the assessment procedures by rightly indicating the project's current status as well as visualizing the future performance. Because, one of the important concerns of the project managers and involved individuals is to be able to finalize the project in accordance with the predetermined and scheduled plan. This is particularly significant with regards to the complications and added sensitivities in projects especially in the project-based organizations. One can daresay that a manager can become aware of the ways in which the objectives can be met and operations are pursued with the help of the control process and thus the manager become enabled to assess and correct them [23].

As well as direct positive outcomes of EVM, indirect positive results of this methodology which are critical factors for this management methodology are also prominent. Some of these factors are utilizing on-the-job training, sufficient knowledge of project managers in terms of management and technical issues, employing computer software, providing adequate resources for all processes for the EVM implementations, the highest level of communication in the organization and the necessity of colleague based work environment [24]. Therefore, the superiority of EVM over conventional project control and forecast assessment methods has been authenticated by diverse case studies and problems from engineering and project management. In these studies, researcher(s) focused on specific sector projects due to heterogeneity problems across sectors, and even though different projects may require different monitoring frequencies, within a single industry, such as petrochemical projects, variations were not observed. However, it is best suited for projects that last more than a year, and for projects lasting less than a year, more frequent project auditing and regular determination of earned value (EV) are recommended [23]. Adoption of EVM on projects of different scales and from multiple sectors validates its authenticity.

Despite the above-stated advantages, this method suffers from some limitations and drawbacks due to its assumptions. Not addressing some attributes such as time value of money, delay in the employer's payment, quality, uncertainty, risk, opportunity, and skill status is an example [25] [26]. In addition, exclusion of some small but important details may affect gained results to some extent. For instance, in this approach, for easy modelling, tracking and analysis, project activities are simplified. Furthermore, there are other reasons for which this method not immune to any criticism. For instance, Henderson [27] questioned the reliability of the cost performance index metric of EVM, and others focus on the fact that it does not distinguish between critical and noncritical activities. Thus, there are possibilities of distortion of the EVM indicators (e.g., performing non-critical tasks) [28]. Vandevoorde and Vanhoucke [29] claimed that well-performing activities can neutralize the delay of nonperforming activities, arguing that focusing on the project level instead of activities is acceptable.

Two other significant shortcomings of this method are: 1. The loss of controllability when the project is close to its end: As all the planned activities will be nearly finished, the EV will tend to the PV, and, as a consequence, the SV will converge to zero and the SPI will conclude at one. This gives project managers the illusive impression that the project is a little bit late even if the project actually suffers a serious delay [30]. 2. Ignorance of project delivery system: In the traditional and common methods used for assessing the physical progress of the activities of a project the contractual payments are of no use and thus for using the method of the earned value for projects in an organization, one must renew the control and calculating methods of the projects on the basis of the engineering methods [31].

1.3. Literature Review and introduction of index works

The significance of project control is a reason for developing appropriate methods to enhance this process. In this domain, Jeffrey Boon Hui Yap and Martin Skitmore investigated the nature of project communication and learning and their role on project time and cost control [10]. In other study, the authors determine how BIM (building information modelling) can be integrated with VE (value engineering) and illustrate the benefits of this integration. The study proposed a framework based on the analytic hierarchy process (AHP) and the entropy method to calculate the weight and coefficient [20]. Another article analyzed the relationship between project cost and time performance indicators and monitoring activities, namely, tracking frequency and regularity with real project data. Earned value management technique with performance indicators is adopted to assess the project performance [6]. Another the research aim was to develop and apply the general planning mechanisms of the project to get the development of projects detailed plans to control the factors time, cost and quality of the executed works [11].

Profits of EVM encouraged many researchers to substantiate usefulness of this methodology against other approaches. For instance, The resulting analysis of Matthew Evans Jones provides quantifiable metrics that confirm the benefits of Earned Value Management (EVM) across industries, while also highlighting differences that are likely driven by the varying levels of scope risk [32]. In other study, Michael Raby showed that the concept of earned value can be very useful in controlling large, expensive projects, and it offers a consistent view across time and across a number of projects and sophisticated progress monitoring [33]. Also, John M. Nevison and Karim J. Chichakly in other paper presented a project model that weaves together ideas from earned value project

management and systems dynamics. It is able to adjust to increasingly unhealthy actual project behaviors in ways that preserve the signature pattern of the staffing histograms observed in the real world and provide a tool for managers to correct projects that are not meeting the plan [34]. Iman Attarzadeh and Ow Siew Hock presented an implementation and evaluation of Earned Value (EV) method of projects to improve earned value management system (EVMS) and forecasting time and cost for projects. The model has been validated by a simulation study using a progress generator a new software [35]. A research in Pakistan implemented EVM on under-construction building projects in Pakistan, and compares its upshots with the projects' actual records and with the outcomes of conventional progress reporting methodology [2].

Other authors addressed the weaknesses and limitations of the traditional EVM. For example, Miguel et. al proposed a new project management model in which earned schedule, quality management, and risk management were integrated into earned value management [36]. Furthermore, integration of fuzzy theory and grey theory simultaneously with EVA was performed by Endale Mamuye Desse, Wubishet Jekale Mengesh. Thus, simple and valid project cost controlling Grey-Fuzzy EVA algorithms were developed to ensure continuous project cost performance improvement in the presence of imprecise data [37]. YONG-WOO KIM and GLENN BALLARD claimed that EVM does not differentiate between value generating work and non-value-generating work and suggested a new cost measure, Customer Earned Value (CEV), which can differentiate between value and non-value-generating work. With the use of CEV, managers can get information on work-in-process inventory levels and co-ordination between trades [38]. Araszkievicz and Bochenek Used sensitivity analysis in relation to the results of the CPI and SPI calculations which afforded combining control of costs and time with risk monitoring in the project. The findings revealed significant benefits in using EVM to implement construction projects but also highlight some important limitations [23]. Another paper concluded with the observation that earned value metrics for assessing a project's schedule performance all suffer from the same confounding impact of parallel activities, as well as other issues [39].

The use of earned value management in special situation is also the topic of some research. For example, presents a new fuzzy-based earned value model with the advantage of developing and analyzing the earned value indices, and the time and the cost estimates at completion under uncertainty. As the uncertainty is inherent in real-life activities, the developed model is very useful in evaluating the progress of a project where uncertainty arises [40]. For taking uncertainties into account, Mahmoudi et. al dealt with the EVM method in grey systems paradigm. The results demonstrated that the proposed approach has a unique performance in highly uncertain environments when experts have become unavailable. Comparisons between grey earned value management and the fuzzy earned value management approaches revealed the superior performance of grey earned value management [5]. Song et. Al extended project control approaches for resource-constrained projects to measure and evaluate whether the project progress is acceptable. Moreover, they designed three scenarios considering possible resource conflicts to take corrective actions when needed [41].

Concepts of Earned Value Management were used by some researchers to develop new tools. Anthony Cabri and Mike Griffiths are an example. They determined whether and how these concepts can be applied to software development projects following an Agile methodology [42]. In addition, a student in a thesis presented an improved EVM method, which is named the Earned Value Construction Management (EVCM) method. EVCM integrates quality and safety as scheduled activities to capture costs as they occur. EVCM incorporates a new index-linked to quality control activities and improves the accuracy of reporting on the project in normal or pandemic construction environments [43]. Based on the Earned Value Management/Earned Schedule (EVM/ES) schedule performance metrics, Chen et. al proposed a new method to set the tolerance limits. These tolerance limits can help a project manager to identify whether the schedule deviations from the baseline schedule are within the possible deviations derived from the expected variability of the project [30].

Now, the current study falls approximately in the second group of studies, and with the use of the system of earned value management, authors are in pursuit of addressing the performance of this managerial system in the petrochemical projects of Mahshahr. Presenting the mentioned effort in this paper is as follows: Section 2 describes the methodology of the research. Research findings which include the descriptive findings and the deductive analysis of the research variables are presented in the section 3. Finally, section 5 concludes this paper in four subsections: Implications of key findings, Practical relevance of the study in terms of identified gaps and challenges, Potential future research directions, The study's limitations.

2. The Methodology of the Research

With regard to the points mentioned above, the project's method is descriptive and in kind it is a survey method. In addition, in terms of its objective the present research is practical and in terms of its status is a field study. It is practical given the fact that one of the issues or problems existing in the organizations and economic sectors of country and the conclusions drawn on the basis of its findings can be helpful for the managers in providing answers to their questions. And, with regard to the method, it is descriptive-correlation. Its statistical

society consists in individuals or units with at least one share attribute. The statistical society of the present research consists of the main employer and the minor contractors, experts and professional specialists in the petrochemical projects of Mahshahr as a testbed of this industry in this region. They amounted to 100 individuals involved as staff. The population size is almost limited and the sample size was selected 100 respondents to ensure enough responses even if some respondents doing the survey do not answer some of the questions. Fortunately, 100 participants completed the questionnaire and provided useful comments. Based on the feedback of the respondents, changes were made to the questionnaire to improve its readability and ensure accuracy and appropriateness. In addition, the validity and reliability of the scales and factor analysis were performed and the results showed that the tests were adequate.

In this research and due to the limited volume of the statistical society, there is no sampling done and instead a consensus-survey is applied and thus the sample volume equals the entire society under research equal to 100 individuals. In other words, the entire population is the sample and all people in a population are available. The main strength of this kind of studies named register-based studies is that data already exist and valuable time is not wasted. In addition, this complete study of populations minimizes selection bias and independently collects data. However, main limitations are that necessary information may be unavailable, data collection is not done by the researcher, confounder information is lacking, missing information on data quality, truncation at start of follow-up making it difficult to differentiate between prevalent and incident cases and the risk of data dredging. We concluded that project management studies with inclusion of all persons in a population followed for decades available relatively fast are important data sources for modern project management, but it is important to acknowledge the data limitations [44].

In this research, two methods of statistical analysis will be used: 1) descriptive analysis. 2) The application of the methods of time-related and cost-related information-analysis, and the performance of the projects will be conducted through Gantt chart, CPM, PERT, and its comparison with EMV, project management software, in addition to the use of deductive analysis and for processing and analyzing the normal data and investigating research assumptions in which structural equations modelling (SEM), software PLS and SPSS software, 22nd version, will be used. In fact, to analyze the processes and results, the PLS-SEM method was used. This method is a general statistical modeling method, which has been widely used in many sciences in recent years. SEM provides a simplified framework for statistical analysis, which encompasses various traditional multivariate procedures such as discriminant analysis, regression analysis, and factor analysis [45]. There are several limitations in preliminary statistical methods, which do not allow the consideration of multiple variables simultaneously and are therefore not capable of taking into account more complex concepts. SEM techniques can be used to confirm or reject theories quantitatively [46].

Besides, SEM is a powerful method for combining complex path models with cryptic factors [47]. PLS-SEM is particularly useful for studying new concepts where the theoretical foundation is not well-established. Another important reason to use the variance-based structural equation modeling rather than the covariance-based one is its less significant dependence to sample size. In addition, the normal distribution of data does not pose any constraint for the PLS as the approach supports non-normal data [48]. Furthermore, an important aspect of measurement tools is their validity and reliability (e.g. measurement error). The good performance of SEM caused the growth and development of it in recent years, especially the analysis of advanced structural theoretical models [49]. This motivated the authors to develop a comprehensive conceptual model in which structural equation modeling (SEM) and causal relationships are considered.

Research Questions:

- What is the relationship between project management techniques in surplus value management which consists of resource planning and technical costs, and also the requirements of such planning?
- What is the relationship between earned value management system and its indexes in the improvement of the projects' performance?
- What is the relationship between the earned value management system and its indexes in the improvement of the projects' performance and time?
- What is the relationship between the earned value management system and its indexes in the improvement of the projects' performance and cost?

3. Research Findings:

Table 1: The data's normalcy through Kolmogorov-Smirnov (S-S) test

The result of the distribution's (lack of) normalcy	Significance level	k-s amount	Number	Variables
Normal	0.563	0.86	100	Project performance
Normal	0.512	0.88	100	Costs
Normal	0.529	0.76	100	Time

According to the table1, it can be observed that all scales of a significance level over 0/50; thus, they have a normal distribution. For gaining the normalcy of the data through Kolmogorov-Smirnov, if the sig of the variables is over 0/05, the data would be normal and if it be under 0/05, then the data would be non-normal. As a result, for studying the relationship between research variables, one can use correlation parametric test with regard to the distribution of the scores in both scales. In other words, with regard to the distribution of the scores, in both scales and their relevant micro-scales are normal. Here, we use parametric statistics methods in which Pierson test is applied as a parametric test for investigating the extent of the correlation of the variables.

3-1 Descriptive Findings

Before conducting the principal analyses, a number of preliminary analyses were done with the aim of coming to the primary insights in relation with the data. In this research, in total, the relationships among 3 variables have been studied within the suggested model. The descriptive findings pertinent to the average, standard deviation, and the highest and lowest variable scores on research variables are demonstrated in table2 and the correlation matrix of the model's variables are demonstrated in table3.

Table 2: The descriptive findings pertinent to the research variables for the entire variables

The highest	The lowest	Standard deviation	Average	Variables
31	5	8.28	26.14	Projects' performance
20	3	5.92	15.86	Costs
15	2	4.96	11.03	Time

N= 100

As it can be discerned by the content of the table2, the average (and standard aviation) of the entire sample (that is, 100 individuals) in the projects' performance is 26/14 (8/28), costs 15/86 (5/92), time 11/03 (4/96).

Table 3: the matrix of the correlation of the model's variables

3	2	1		
		1	Projects' performance	1
	1	0.86**	Costs	2
1	0.74**	0.84**	Time	3

0.01<P**

The content of the table3 demonstrates that the assumed notion of the relationship among variables is in accordance with the expected paths. This means that the entire relations on significance levels have had a significance of 0/01. These correlation analyses provide an insight into the relations between dual variables existing in the variables of the study. For the simultaneous of the notion of the assumed relations in the present research, the path-alteration method has been exerted.

3-2. The deductive analysis of the research variables

The method of earned value management (EVM) is one of the very important techniques which, in the last three decades, has been used for calculating the actual progress of the project and/or, in other words, for the comprehensive and unified management of the project [39].

Using (EVM) method, in technical projects, with the intention of assessing the performance of the projects and the results in progress and it impact on budget-planning of the projects, is completely observable. This requires assessing some of the main bases such as the costs of project completion and its termination date which, in this method, one first addressed the identification and approximation of the time and costs required for fulfilling the project. In this method, after having fulfilled the assessments mentioned above, one follows with the analysis of each of the indexes pertinent to the project’s performance [41]. Here, the time and costs assessed are analyzed and determined via particular parameters, tables, and formulas.

The first question of the research

What is the relationship between project management techniques in the surplus value management which consists of the source planning and technical costs in addition to the planning requirements?

In this research, the quotes or questions in the questionnaire, consisting of 21 questions, are considered as the observed variables, where these 21 questions for the indexes of costs (8 questions), time (9 questions), and performance (4 questions) as the lurking or latent variables.

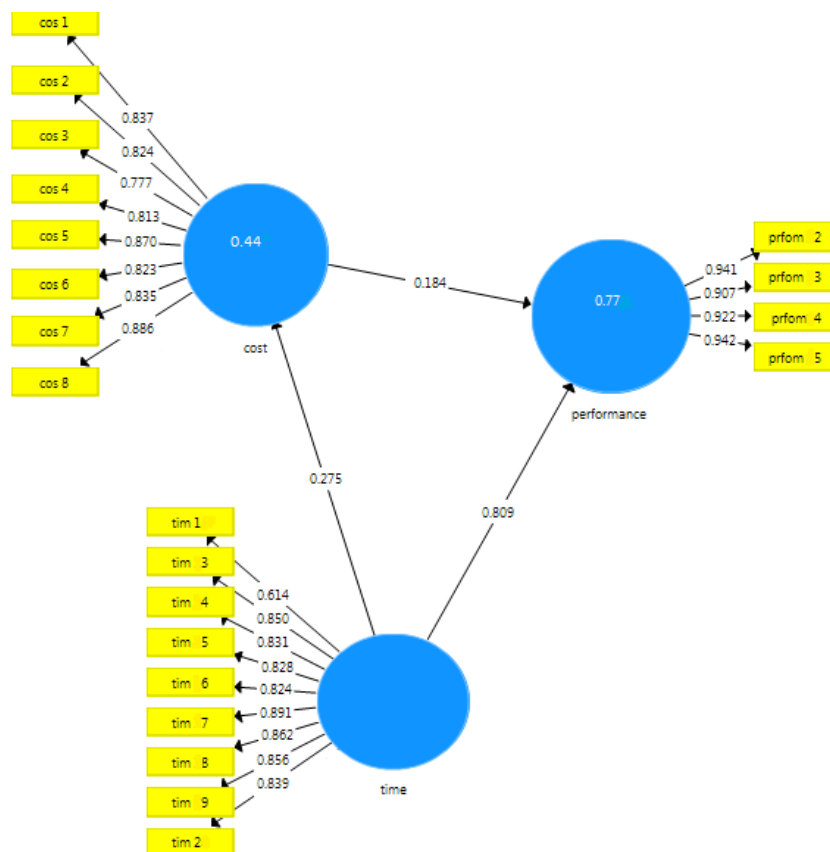


Figure 1- The output of pls software

The first question of the research was investigated on the model of structural equations. Considering the results of the study of relation between the independent and dependent constructs, by the use of the relevant co-efficient, one can address the significance of the impacts between the constructs of the first research question. In the present research, smart pls software is used. This software is compatible with the existence of certain conditions such as collinearity of the independent variables related to the lack of normalcy in the data, and the smallness of the volume of the sample.

In pls models, two models are put to test. The exterior model is equivalent to the measuring model and the interior model similar to the structural model in the models of structural equations. The interior model represents the load factors of the observed variables and the relationship between the latent or lurking variables of the research. The conceptual model put to test is presented in the figure1 and the numbers on the lines are the beta coefficient resulted from the regression equation between the variables which is the path coefficient and expresses the load factors are demonstrated the numbers within circles represent the amount of R2 of a mode whose predictive variables have entered that circle via an arrow.

For studying the amount of the significance of the path coefficient, it is required to demonstrate the amount of t in each path in which all paths have become significant at the level of 0/95.

Table 4-results of t-test for research's variables

Significance level	T	Standard deviation	Average sample	Main sample	Variables
0.023	8.236	0.092	0.226	-0.219	time ← cost
0.018	6.237	0.072	0.208	-0.189	time ← performance
0.001	12.298	0.083	0.520	0.452	cost ← performance

As demonstrated in table4, the amount of t of each path under study in the model is above the standard amount of the absolute value, that is, 92/5 and an evidence for the significant relationship between the research dimensions and the first question of it which is thus rendered valid.

The second research question

- What is the relationship between the earned value management system and its indexes in the improvement of the projects' performance?

The stages of the analysis of the second question consists of the following:

- Time-tabling the project's activities and resources allocation and leveling
- Drawing the project's baseline
- Updating (report collecting) for the project

Time-tabling the project's activities and resources allocation and leveling

In this process, the sequential order of the commencement of the project activities and also the amount of the resources required for fulfilling the project are determined. Scheduling or time-tabling, along with the time lengths assessed for the activities, enables us to draw the Gantt graph of the activities. With the use of the Microsoft software, it is possible to draw, as done in the figure2, one can insert the project's list of activities and their relevant account in addition to Gantt graph of them.

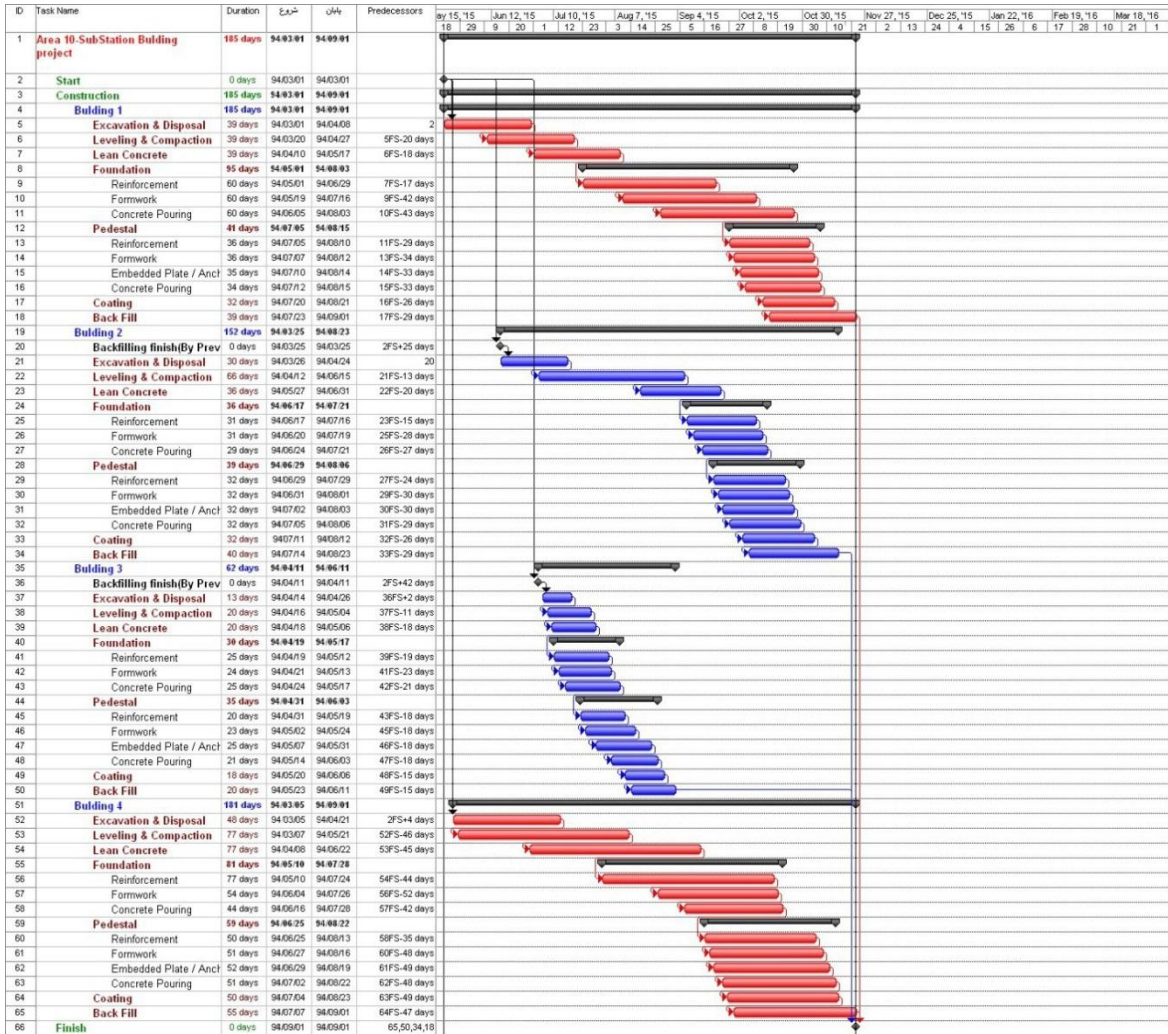


Figure 2- Gantt graph

With access to the limits of the project, scheduling or time-tabling, and the costs assessed for each activity, one can draw the baseline of the project. The date of the initiation of the project is 23rd of December, 2009, and, after the preliminary scheduling or time-tabling of the project, a baseline (figure 3) representing the primary plan is saved in the software so that after the updates and inserting the actual percentages be of use for making comparisons (the horizontal axis: the number of the activity/vertical axis: the time of the activity).

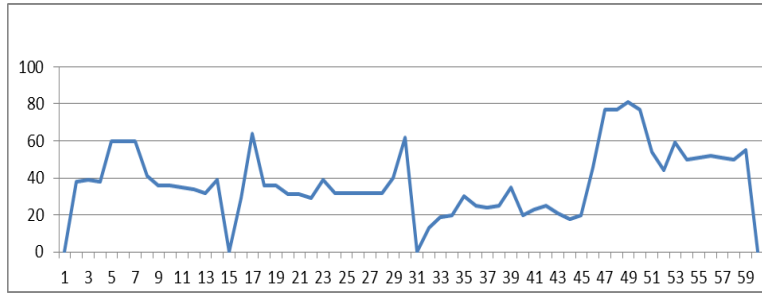


Figure 3- Project baseline

ID	Task Name	BCWS	BCWP	ACWP	CV%	SV%	EAC	VAC
1	Area 10-SubStation Building project	1,263,255,705.10	1,127,472,423.60	1,225,744,212.86	-9%	-11%	10,877,816,123.01	(872,108,913.41)
2	Start	0.00	0.00	0.00	0%	0%	0.00	0.00
3	Construction	1,263,255,705.10	1,127,472,423.60	1,225,744,212.86	-9%	-11%	10,877,816,123.01	(872,108,913.41)
4	Building 1	142,513,394.74	101,480,744.36	161,403,379.30	-59%	-29%	2,904,530,631.17	#####
5	Excavation & Disposal	76,954,020.97	76,954,020.97	136,254,020.97	-77%	0%	136,254,020.97	(59,300,000.00)
6	Leveling & Compaction	19,962,599.85	3,768,001.00	3,972,519.97	-81%	-5%	20,936,253.89	(1,073,654.05)
7	Lean Concrete	38,901,918.08	12,484,095.38	13,158,911.35	-68%	-5%	69,351,019.28	(3,558,462.53)
8	Foundation	6,894,855.84	8,273,827.01	8,017,827.01	3%	20%	815,464,670.31	26,036,849.56
9	Reinforcement	6,894,855.84	8,273,827.01	8,017,827.01	3%	20%	400,891,350.00	12,800,000.00
10	Formwork	0.00	0.00	0.00	0%	0%	70,684,328.89	0.00
11	Concrete Pouring	0.00	0.00	0.00	0%	0%	357,145,840.61	0.00
12	Pedestal	0.00	0.00	0.00	0%	0%	617,587,086.31	0.00
13	Reinforcement	0.00	0.00	0.00	0%	0%	223,472,680.21	0.00
14	Formwork	0.00	0.00	0.00	0%	0%	91,874,180.21	0.00
15	Embedded Plate / Anchor Bolt	0.00	0.00	0.00	0%	0%	116,945,558.63	0.00
16	Concrete Pouring	0.00	0.00	0.00	0%	0%	185,494,667.25	0.00
17	Coating	0.00	0.00	0.00	0%	0%	76,732,540.86	0.00
18	Back Fill	0.00	0.00	0.00	0%	0%	127,649,928.74	0.00
19	Building 2	108,525,200.77	35,703,744.43	35,234,021.45	1%	-67%	2,867,551,947.82	38,228,818.81
20	Backfilling finish(By Previous Subcontractor)	0.00	0.00	0.00	0%	0%	0.00	0.00
21	Excavation & Disposal	97,803,263.38	24,450,815.84	24,450,815.84	0%	-75%	97,803,263.38	0.00
22	Leveling & Compaction	10,721,897.40	11,262,928.58	10,763,205.61	4%	5%	32,280,908.08	1,406,611.44
23	Lean Concrete	0.00	0.00	0.00	0%	0%	107,307,678.58	0.00
24	Foundation	0.00	0.00	0.00	0%	0%	1,347,313,786.86	0.00
25	Reinforcement	0.00	0.00	0.00	0%	0%	585,292,356.77	0.00
26	Formwork	0.00	0.00	0.00	0%	0%	112,376,266.79	0.00
27	Concrete Pouring	0.00	0.00	0.00	0%	0%	649,646,143.29	0.00
28	Pedestal	0.00	0.00	0.00	0%	0%	989,141,509.17	0.00
29	Reinforcement	0.00	0.00	0.00	0%	0%	326,828,043.28	0.00
30	Formwork	0.00	0.00	0.00	0%	0%	128,163,543.28	0.00
31	Embedded Plate / Anchor Bolt	0.00	0.00	0.00	0%	0%	232,822,997.37	0.00
32	Concrete Pouring	0.00	0.00	0.00	0%	0%	294,526,924.27	0.00
33	Coating	0.00	0.00	0.00	0%	0%	131,515,581.52	0.00
34	Back Fill	0.00	0.00	0.00	0%	0%	206,001,430.21	0.00
35	Building 3	868,106,546.75	847,170,807.01	811,543,636.55	4%	-2%	2,879,052,146.13	126,391,825.31
36	Backfilling finish(By Previous Subcontractor)	0.00	0.00	0.00	0%	0%	0.00	0.00
37	Excavation & Disposal	80,848,879.71	56,594,215.88	56,594,215.88	0%	-30%	80,848,879.71	0.00
38	Leveling & Compaction	30,838,880.25	22,348,369.71	21,627,444.88	3%	-27%	34,882,975.62	1,162,765.88
39	Lean Concrete	67,363,040.95	68,143,171.94	64,066,230.03	6%	-22%	109,514,923.13	6,969,131.47
40	Foundation	637,295,436.31	668,124,444.83	637,295,436.31	5%	1%	1,331,043,835.12	64,426,793.68
41	Reinforcement	331,490,331.97	331,490,331.97	331,490,331.97	0%	0%	59,447,021.97	0.00
42	Formwork	58,069,241.65	58,069,241.65	58,069,241.65	0%	0%	116,138,483.31	0.00
43	Concrete Pouring	247,735,596.69	278,564,870.41	247,735,596.69	11%	12%	611,994,952.29	76,159,371.84
44	Pedestal	31,960,615.53	31,960,615.53	31,960,615.53	0%	0%	1,019,771,144.59	0.00
45	Reinforcement	31,960,615.53	31,960,615.53	31,960,615.53	0%	0%	319,606,155.29	0.00
46	Formwork	0.00	0.00	0.00	0%	0%	140,232,155.29	0.00
47	Embedded Plate / Anchor Bolt	0.00	0.00	0.00	0%	0%	244,461,741.47	0.00
48	Concrete Pouring	0.00	0.00	0.00	0%	0%	315,871,952.54	0.00
49	Coating	0.00	0.00	0.00	0%	0%	140,169,674.35	0.00
50	Back Fill	0.00	0.00	0.00	0%	0%	215,884,646.90	0.00
51	Building 4	144,110,662.83	143,117,327.80	217,563,276.55	-52%	-1%	3,448,368,406.82	#####
52	Excavation & Disposal	97,350,971.14	97,350,971.14	171,210,971.14	-76%	3%	171,210,971.14	(73,860,000.00)
53	Leveling & Compaction	18,935,163.53	18,499,896.47	18,928,548.01	3%	3%	24,829,611.50	749,469.02
54	Lean Concrete	27,824,428.17	26,266,260.19	27,423,756.41	-4%	-6%	89,475,815.39	(3,776,576.62)
55	Foundation	0.00	0.00	0.00	0%	0%	1,052,297,489.69	0.00
56	Reinforcement	0.00	0.00	0.00	0%	0%	499,115,510.68	0.00
57	Formwork	0.00	0.00	0.00	0%	0%	87,741,079.04	0.00
58	Concrete Pouring	0.00	0.00	0.00	0%	0%	465,440,819.99	0.00
59	Pedestal	0.00	0.00	0.00	0%	0%	743,163,992.27	0.00
60	Reinforcement	0.00	0.00	0.00	0%	0%	274,373,191.63	0.00
61	Formwork	0.00	0.00	0.00	0%	0%	105,139,981.63	0.00
62	Embedded Plate / Anchor Bolt	0.00	0.00	0.00	0%	0%	151,860,003.74	0.00
63	Concrete Pouring	0.00	0.00	0.00	0%	0%	211,890,735.71	0.00
64	Coating	0.00	0.00	0.00	0%	0%	99,346,613.26	0.00
65	Back Fill	0.00	0.00	0.00	0%	0%	164,963,003.27	0.00
66	Finish	0.00	0.00	0.00	0%	0%	0.00	0.00

Figure 4- Updating the project

With regard to the updating date 22nd of October, 2016, it can be observed that 6 years after its commencement, the project has been completed at about 75% in which there are deviations in comparison with the extent of progress expected to make; this is addressed further in what follows:

The extent of the actual progress made is 25% while it is expected to be 90%. The amount of the actual cost is equal to ACWP = (3.524.958.752) while it was expected to be BCWP = (4.968.42.631).

On the basis of the cost performance index, one can deduce that out of each 100 hours of the consumed labor in the project, only 72 hours of it have been effective. On the basis of the timing performance index, too, one can deduce that in order to meet the objectives of the project, for each 72 hours of the consumed labor, one has to plan for 100 hours. In the

figure4, the information relevant to the BCWS, BCWP, ACWP of the progress made in the project at the date of its updating are demonstrated. Since the index has attributed to itself a critical proportion, a number been 0/5 and 0/9.

The third research question

What is the relationship between the earned value management system and its indexes in the improvement of the performance and time of the projects?

The stages involved in the analysis of the second question of the research:

- Time-tabling the project's activities and resources allocation and leveling
- Drawing the project's baseline
- Updating (report collecting) for the project
- Analyzing the project's status up to its updating date (the primary report collection)
- Corrective measures and the second updating of the project

Time-tabling the project's activities and resources allocation and leveling

In this process, the sequential order of the commencement of the project activities and also the amount of the resources required for fulfilling the project are determined. Scheduling or time-tabling, along with the time lengths assessed for the activities, enables us to draw the Gantt graph of the activities. With the use of the Microsoft software, it is possible to draw, as done in the figure5, one can insert the project's list of activities and their relevant account in addition to Gantt graph of them.

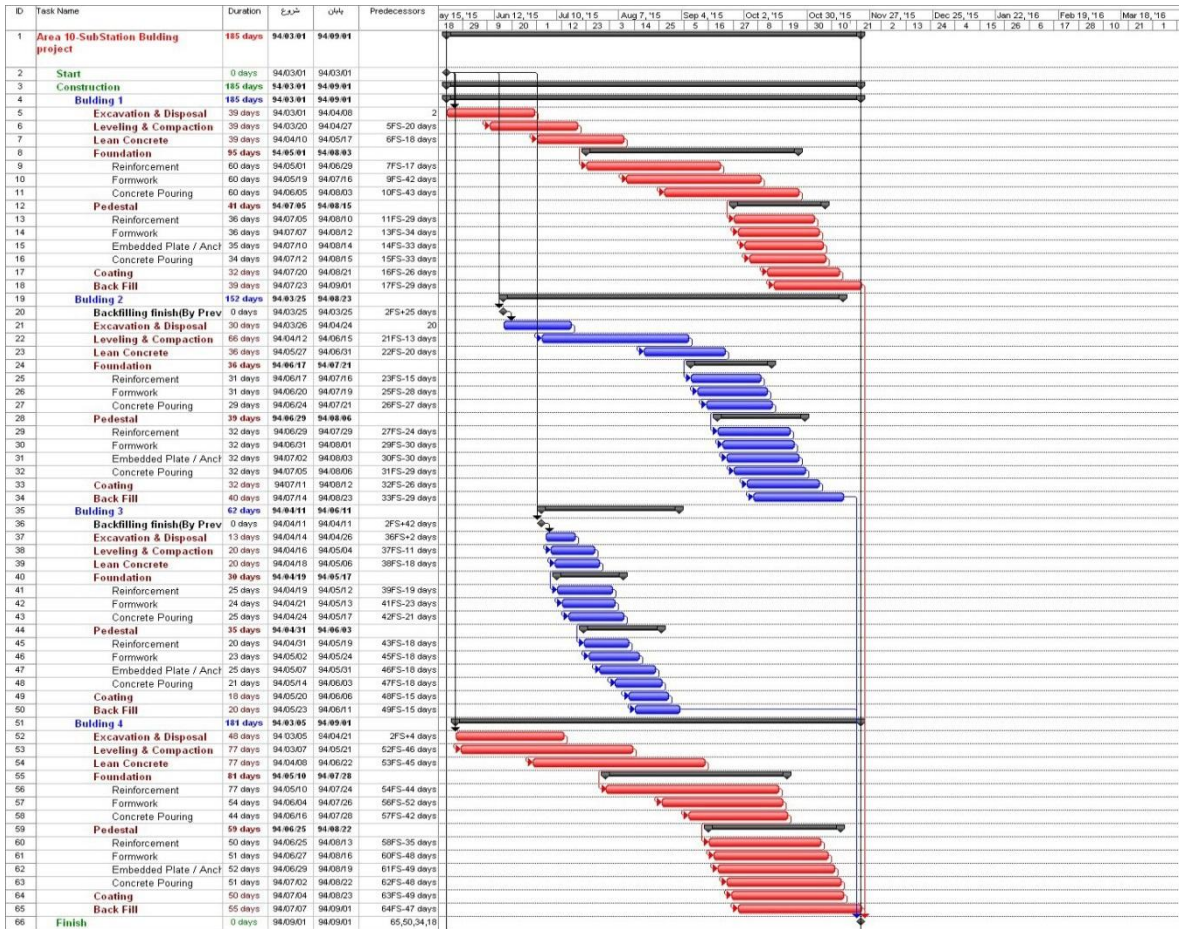


Figure 5- Gantt graph for project costs

With access to the limits of the project, scheduling or time-tabling, and the costs assessed for each activity, one can draw the baseline of the project. The date of the initiation of the project is 23rd of December, 2009, and, after the preliminary scheduling or time-tabling of the project, a baseline (figure 6) representing the primary plan is saved in the software so that after the updates and inserting the actual percentages be of use for making comparisons (the horizontal axis: the number of the activity/vertical axis: the time of the activity).

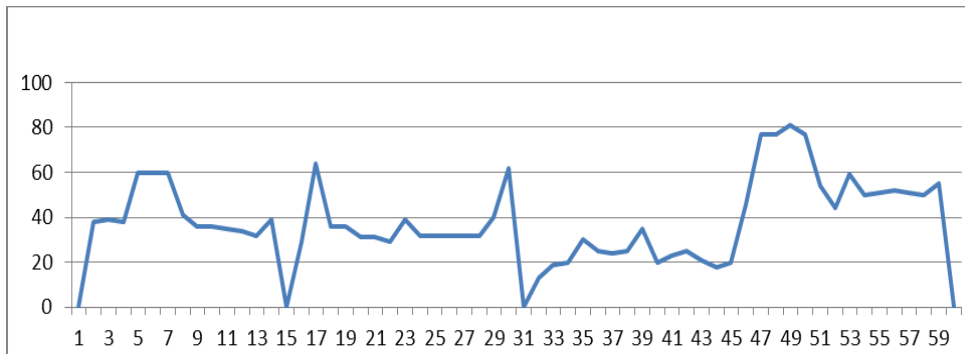


Figure 6- project baseline

ID	Task Name	BCWS	BCWP	ACWP	CV%	SV%	EAC	VAC
1	Area 10-SubStation Building project	1,263,255,705.10	1,127,472,423.60	1,225,744,212.86	-9%	-11%	10,877,816,123.01	(872,108,913.41)
2	Start	0.00	0.00	0.00	0%	0%	0.00	0.00
3	Construction	1,263,255,705.10	1,127,472,423.60	1,225,744,212.86	-9%	-11%	10,877,816,123.01	(872,108,913.41)
4	Building 1	142,513,394.74	101,480,744.36	161,403,279.30	-59%	-29%	2,904,350,631.11	(1,007,364,050.00)
5	Excavation & Disposal	76,954,020.97	76,954,020.97	136,254,020.97	-77%	0%	136,254,020.97	(59,300,000.00)
6	Leveling & Compaction	19,862,599.85	3,768,801.00	3,972,519.97	-81%	-5%	20,536,253.83	(1,073,654.00)
7	Lean Concrete	36,801,916.08	12,484,095.36	13,158,911.35	-66%	-5%	69,351,019.28	(3,556,462.53)
8	Foundation	6,894,855.84	8,273,827.01	8,017,827.01	3%	20%	815,464,670.31	26,036,849.56
9	Reinforcement	6,894,855.84	8,273,827.01	8,017,827.01	3%	20%	400,891,350.40	12,800,000.00
10	Formwork	0.00	0.00	0.00	0%	0%	70,664,328.86	0.00
11	Concrete Pouring	0.00	0.00	0.00	0%	0%	357,145,840.61	0.00
12	Pedestal	0.00	0.00	0.00	0%	0%	617,587,086.31	0.00
13	Reinforcement	0.00	0.00	0.00	0%	0%	223,472,680.21	0.00
14	Formwork	0.00	0.00	0.00	0%	0%	91,674,180.21	0.00
15	Embedded Plate / Anchor Bolt	0.00	0.00	0.00	0%	0%	116,945,558.63	0.00
16	Concrete Pouring	0.00	0.00	0.00	0%	0%	185,494,867.26	0.00
17	Coating	0.00	0.00	0.00	0%	0%	76,732,540.66	0.00
18	Back Fill	0.00	0.00	0.00	0%	0%	127,849,928.76	0.00
19	Building 2	108,525,200.77	35,703,744.43	35,234,021.45	1%	-67%	2,867,551,947.82	38,228,818.81
20	Backfilling finish(By Previous Subcontractor)	0.00	0.00	0.00	0%	0%	0.00	0.00
21	Excavation & Disposal	97,803,263.38	24,450,815.84	24,450,815.84	0%	-75%	97,803,263.38	0.00
22	Leveling & Compaction	10,721,937.40	11,252,928.58	10,763,205.61	4%	5%	32,290,906.09	1,406,611.44
23	Lean Concrete	0.00	0.00	0.00	0%	0%	107,307,678.58	0.00
24	Foundation	0.00	0.00	0.00	0%	0%	1,347,313,786.85	0.00
25	Reinforcement	0.00	0.00	0.00	0%	0%	585,292,356.77	0.00
26	Formwork	0.00	0.00	0.00	0%	0%	112,375,286.79	0.00
27	Concrete Pouring	0.00	0.00	0.00	0%	0%	649,846,143.29	0.00
28	Pedestal	0.00	0.00	0.00	0%	0%	982,141,598.17	0.00
29	Reinforcement	0.00	0.00	0.00	0%	0%	326,626,043.26	0.00
30	Formwork	0.00	0.00	0.00	0%	0%	128,163,543.26	0.00
31	Embedded Plate / Anchor Bolt	0.00	0.00	0.00	0%	0%	232,822,997.37	0.00
32	Concrete Pouring	0.00	0.00	0.00	0%	0%	294,626,924.27	0.00
33	Coating	0.00	0.00	0.00	0%	0%	131,515,581.52	0.00
34	Back Fill	0.00	0.00	0.00	0%	0%	206,001,430.21	0.00
35	Building 3	868,106,546.75	847,170,807.01	811,543,636.55	4%	-2%	2,879,052,145.11	126,391,825.31
36	Backfilling finish(By Previous Subcontractor)	0.00	0.00	0.00	0%	0%	0.00	0.00
37	Excavation & Disposal	80,846,874.71	56,594,215.80	56,594,215.80	0%	-30%	80,846,874.71	0.00
38	Leveling & Compaction	30,636,880.25	22,348,359.71	21,627,444.88	3%	-27%	34,882,975.62	1,162,765.85
39	Lean Concrete	87,363,040.95	68,143,171.94	84,086,230.03	6%	-22%	108,514,323.11	6,989,131.47
40	Foundation	637,495,136.31	668,124,444.83	637,495,136.31	5%	5%	1,331,813,835.18	64,426,733.69
41	Reinforcement	331,490,331.97	331,490,331.97	331,490,331.97	0%	0%	591,947,021.37	0.00
42	Formwork	58,069,241.65	58,069,241.65	58,069,241.65	0%	0%	116,138,483.31	0.00
43	Concrete Pouring	247,735,556.69	278,564,870.41	247,735,556.69	11%	12%	811,994,952.29	76,159,371.84
44	Pedestal	31,960,615.53	31,960,615.53	31,960,615.53	0%	0%	1,019,771,144.59	0.00
45	Reinforcement	31,960,615.53	31,960,615.53	31,960,615.53	0%	0%	319,606,155.23	0.00
46	Formwork	0.00	0.00	0.00	0%	0%	140,232,155.29	0.00
47	Embedded Plate / Anchor Bolt	0.00	0.00	0.00	0%	0%	244,461,741.47	0.00
48	Concrete Pouring	0.00	0.00	0.00	0%	0%	315,471,092.02	0.00
49	Coating	0.00	0.00	0.00	0%	0%	140,169,674.35	0.00
50	Back Fill	0.00	0.00	0.00	0%	0%	215,884,646.90	0.00
51	Building 4	144,110,562.83	143,117,127.80	217,563,275.55	-52%	-1%	3,448,368,406.82	(73,860,000.00)
52	Excavation & Disposal	97,350,971.14	97,350,971.14	171,210,971.14	-76%	0%	171,210,971.14	(73,860,000.00)
53	Leveling & Compaction	16,935,153.53	19,499,896.47	18,828,548.01	3%	3%	24,829,611.53	749,469.02
54	Lean Concrete	27,824,428.17	26,266,260.19	27,423,756.41	-4%	-6%	89,475,815.39	(3,776,576.62)
55	Foundation	0.00	0.00	0.00	0%	0%	1,652,297,409.69	0.00
56	Reinforcement	0.00	0.00	0.00	0%	0%	499,115,510.63	0.00
57	Formwork	0.00	0.00	0.00	0%	0%	87,741,079.04	0.00
58	Concrete Pouring	0.00	0.00	0.00	0%	0%	465,440,819.99	0.00
59	Pedestal	0.00	0.00	0.00	0%	0%	743,163,902.72	0.00
60	Reinforcement	0.00	0.00	0.00	0%	0%	274,373,161.63	0.00
61	Formwork	0.00	0.00	0.00	0%	0%	105,139,981.63	0.00
62	Embedded Plate / Anchor Bolt	0.00	0.00	0.00	0%	0%	151,660,003.74	0.00
63	Concrete Pouring	0.00	0.00	0.00	0%	0%	211,990,735.71	0.00
64	Coating	0.00	0.00	0.00	0%	0%	93,946,613.23	0.00
65	Back Fill	0.00	0.00	0.00	0%	0%	164,963,003.27	0.00
66	Finish	0.00	0.00	0.00	0%	0%	0.00	0.00

Figure 7- updating the costs

With regard to the updating date (22nd of October, 2016), it can be observed that 6 years after its commencement, the project has been completed at about 75% in which there are deviations in comparison with the extent of progress expected to make; this is addressed further in what follows:

The extent of the actual progress made is 25% while it is expected to be 90%. The amount of the actual cost is equal to ACWP = (3.524.958.752) while it was expected to be BCWP = (4.968.42.631).

On the basis of the cost performance index, one can deduce that out of each 100 hours of the consumed labor in the project, only 72 hours of it have been effective. On the basis of the timing performance index, too, one can deduce that in order to meet the objectives of the project, for each 72 hours of the consumed labor, one has to plan for 100 hours. In the figure7, the information relevant to the BCWS, BCWP, ACWP of the progress made in the project at the date of its updating are demonstrated. Since the index has attributed to itself a critical proportion, a number been 0/5 and 0/9.

Updating (report collecting) the project

The date of the project’s update was 22nd of July, 2016 whose results are presented in figure 8 and figure 9. (horizontal axis: the number of the activity/the vertical axis: costs)

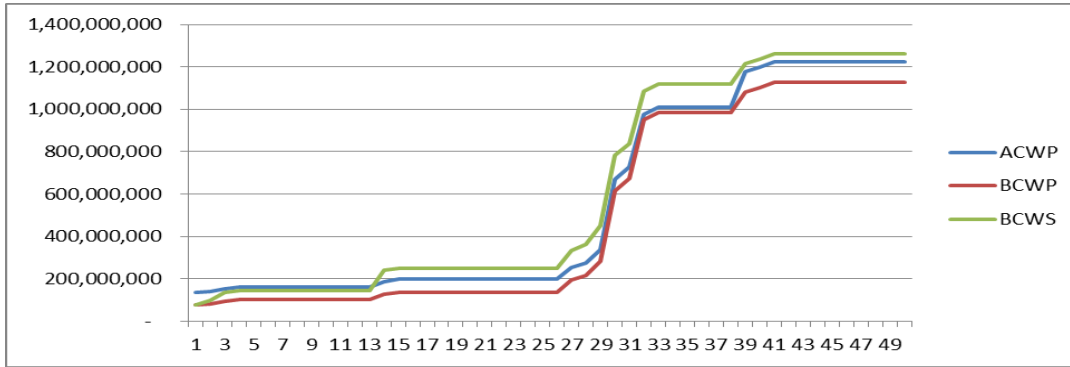


Figure 8- Updating (report collecting) the project

ID	Task Name	BCWS	BCWP	ACWP	CV%	SV%	EAC	VAC
1	Area 10-SubStation Building project	1,263,255,705.10 تومان	1,127,472,423.60 تومان	1,225,744,212.86 تومان	-9%	-11%	10,877,816,123.01 تومان	(872,108,913.41 تومان)
2	Start	0.00 تومان	0.00 تومان	0.00 تومان	0%	0%	0.00 تومان	0.00 تومان
3	Construction	1,263,255,705.10 تومان	1,127,472,423.60 تومان	1,225,744,212.86 تومان	-9%	-11%	10,877,816,123.01 تومان	(872,108,913.41 تومان)
4	Building 1	142,513,394.74 تومان	101,486,744.36 تومان	161,483,275.36 تومان	-59%	-29%	2,304,350,631.11 تومان	(59,300,000.00 تومان)
5	Excavation & Disposal	76,954,029.97 تومان	76,954,029.97 تومان	136,254,020.97 تومان	-77%	0%	136,254,020.97 تومان	(59,300,000.00 تومان)
6	Leveling & Compaction	19,862,599.85 تومان	3,768,801.00 تومان	3,972,519.97 تومان	-5%	-81%	20,336,263.89 تومان	(1,073,654.05 تومان)
7	Lean Concrete	38,801,918.08 تومان	12,484,095.38 تومان	13,158,911.35 تومان	-5%	-68%	69,351,019.28 تومان	(3,556,462.53 تومان)
8	Foundation	6,894,855.84 تومان	8,273,827.01 تومان	8,017,827.01 تومان	3%	20%	815,464,670.31 تومان	26,036,849.56 تومان
9	Reinforcement	6,894,855.84 تومان	8,273,827.01 تومان	8,017,827.01 تومان	3%	20%	400,891,350.40 تومان	12,800,000.00 تومان
10	Formwork	0.00 تومان	0.00 تومان	0.00 تومان	0%	0%	70,864,328.96 تومان	0.00 تومان
11	Concrete Pouring	0.00 تومان	0.00 تومان	0.00 تومان	0%	0%	357,145,840.51 تومان	0.00 تومان
12	Pedestal	0.00 تومان	0.00 تومان	0.00 تومان	0%	0%	617,587,096.31 تومان	0.00 تومان
13	Reinforcement	0.00 تومان	0.00 تومان	0.00 تومان	0%	0%	223,472,680.21 تومان	0.00 تومان
14	Formwork	0.00 تومان	0.00 تومان	0.00 تومان	0%	0%	91,674,180.21 تومان	0.00 تومان
15	Embedded Plate / Anchor Bolt	0.00 تومان	0.00 تومان	0.00 تومان	0%	0%	116,945,558.83 تومان	0.00 تومان
16	Concrete Pouring	0.00 تومان	0.00 تومان	0.00 تومان	0%	0%	185,494,687.25 تومان	0.00 تومان
17	Coating	0.00 تومان	0.00 تومان	0.00 تومان	0%	0%	76,322,540.86 تومان	0.00 تومان
18	Back Fill	0.00 تومان	0.00 تومان	0.00 تومان	0%	0%	127,649,928.74 تومان	0.00 تومان
19	Building 2	108,525,200.77 تومان	35,703,744.43 تومان	35,234,021.45 تومان	1%	-67%	2,867,551,947.82 تومان	38,228,818.81 تومان
20	Backfilling finish(By Previous Subcontractor)	0.00 تومان	0.00 تومان	0.00 تومان	0%	0%	0.00 تومان	0.00 تومان
21	Excavation & Disposal	97,803,263.38 تومان	24,450,815.84 تومان	24,450,815.84 تومان	0%	-75%	97,803,263.38 تومان	0.00 تومان
22	Leveling & Compaction	10,721,937.40 تومان	11,252,928.58 تومان	10,783,205.61 تومان	4%	5%	32,290,906.09 تومان	1,406,611.44 تومان
23	Lean Concrete	0.00 تومان	0.00 تومان	0.00 تومان	0%	0%	107,307,678.58 تومان	0.00 تومان
24	Foundation	0.00 تومان	0.00 تومان	0.00 تومان	0%	0%	1,347,313,786.85 تومان	0.00 تومان
25	Reinforcement	0.00 تومان	0.00 تومان	0.00 تومان	0%	0%	585,292,356.77 تومان	0.00 تومان
26	Formwork	0.00 تومان	0.00 تومان	0.00 تومان	0%	0%	112,375,286.79 تومان	0.00 تومان
27	Concrete Pouring	0.00 تومان	0.00 تومان	0.00 تومان	0%	0%	649,646,143.29 تومان	0.00 تومان
28	Pedestal	0.00 تومان	0.00 تومان	0.00 تومان	0%	0%	982,141,508.17 تومان	0.00 تومان
29	Reinforcement	0.00 تومان	0.00 تومان	0.00 تومان	0%	0%	326,620,943.26 تومان	0.00 تومان
30	Formwork	0.00 تومان	0.00 تومان	0.00 تومان	0%	0%	128,163,543.26 تومان	0.00 تومان
31	Embedded Plate / Anchor Bolt	0.00 تومان	0.00 تومان	0.00 تومان	0%	0%	232,822,997.37 تومان	0.00 تومان
32	Concrete Pouring	0.00 تومان	0.00 تومان	0.00 تومان	0%	0%	294,526,824.27 تومان	0.00 تومان
33	Coating	0.00 تومان	0.00 تومان	0.00 تومان	0%	0%	131,515,581.92 تومان	0.00 تومان
34	Back Fill	0.00 تومان	0.00 تومان	0.00 تومان	0%	0%	206,001,430.21 تومان	0.00 تومان
35	Building 3	868,166,546.75 تومان	847,170,007.48 تومان	815,543,636.55 تومان	4%	-2%	2,879,052,446.13 تومان	126,391,825.31 تومان
36	Backfilling finish(By Previous Subcontractor)	0.00 تومان	0.00 تومان	0.00 تومان	0%	0%	0.00 تومان	0.00 تومان
37	Excavation & Disposal	80,848,679.71 تومان	56,594,215.80 تومان	56,594,215.80 تومان	0%	-30%	80,848,679.71 تومان	0.00 تومان
38	Leveling & Compaction	30,638,880.25 تومان	22,348,359.71 تومان	21,827,444.88 تومان	3%	-27%	34,882,675.62 تومان	1,162,765.85 تومان
39	Lean Concrete	67,363,040.95 تومان	68,143,171.94 تومان	64,066,230.03 تومان	6%	-22%	109,514,923.13 تومان	6,968,131.47 تومان
40	Foundation	637,295,136.31 تومان	668,124,444.03 تومان	637,295,136.31 تومان	5%	5%	1,331,813,035.12 تومان	64,426,793.69 تومان
41	Reinforcement	331,490,331.97 تومان	331,490,331.97 تومان	331,490,331.97 تومان	0%	0%	581,947,021.37 تومان	0.00 تومان
42	Formwork	59,069,241.85 تومان	59,069,241.85 تومان	59,069,241.85 تومان	0%	0%	116,130,483.31 تومان	0.00 تومان
43	Concrete Pouring	247,735,556.69 تومان	278,564,870.41 تومان	247,735,556.69 تومان	11%	12%	611,594,852.29 تومان	76,159,371.84 تومان
44	Pedestal	31,960,615.53 تومان	31,960,615.53 تومان	31,960,615.53 تومان	0%	0%	1,019,771,144.59 تومان	0.00 تومان
45	Reinforcement	31,960,615.53 تومان	31,960,615.53 تومان	31,960,615.53 تومان	0%	0%	319,606,155.29 تومان	0.00 تومان
46	Formwork	0.00 تومان	0.00 تومان	0.00 تومان	0%	0%	140,232,155.29 تومان	0.00 تومان
47	Embedded Plate / Anchor Bolt	0.00 تومان	0.00 تومان	0.00 تومان	0%	0%	244,461,741.47 تومان	0.00 تومان
48	Concrete Pouring	0.00 تومان	0.00 تومان	0.00 تومان	0%	0%	315,471,092.54 تومان	0.00 تومان
49	Coating	0.00 تومان	0.00 تومان	0.00 تومان	0%	0%	140,169,674.35 تومان	0.00 تومان
50	Back Fill	0.00 تومان	0.00 تومان	0.00 تومان	0%	0%	215,984,646.90 تومان	0.00 تومان
51	Building 4	144,110,562.83 تومان	143,117,127.80 تومان	217,563,275.55 تومان	-52%	-1%	3,448,368,406.82 تومان	(73,860,000.00 تومان)
52	Excavation & Disposal	97,350,971.14 تومان	97,350,971.14 تومان	171,210,971.14 تومان	-76%	0%	171,210,971.14 تومان	(73,860,000.00 تومان)
53	Leveling & Compaction	18,935,163.53 تومان	19,499,896.47 تومان	18,928,548.01 تومان	3%	3%	24,829,611.53 تومان	749,469.02 تومان
54	Lean Concrete	27,824,420.17 تومان	26,268,280.19 تومان	27,423,756.41 تومان	-4%	-6%	69,475,815.39 تومان	(3,776,576.62 تومان)
55	Foundation	0.00 تومان	0.00 تومان	0.00 تومان	0%	0%	1,052,297,409.69 تومان	0.00 تومان
56	Reinforcement	0.00 تومان	0.00 تومان	0.00 تومان	0%	0%	499,115,510.66 تومان	0.00 تومان
57	Formwork	0.00 تومان	0.00 تومان	0.00 تومان	0%	0%	87,741,079.04 تومان	0.00 تومان
58	Concrete Pouring	0.00 تومان	0.00 تومان	0.00 تومان	0%	0%	465,440,819.99 تومان	0.00 تومان
59	Pedestal	0.00 تومان	0.00 تومان	0.00 تومان	0%	0%	743,163,902.72 تومان	0.00 تومان
60	Reinforcement	0.00 تومان	0.00 تومان	0.00 تومان	0%	0%	274,373,181.83 تومان	0.00 تومان
61	Formwork	0.00 تومان	0.00 تومان	0.00 تومان	0%	0%	105,139,981.83 تومان	0.00 تومان
62	Embedded Plate / Anchor Bolt	0.00 تومان	0.00 تومان	0.00 تومان	0%	0%	151,560,003.74 تومان	0.00 تومان
63	Concrete Pouring	0.00 تومان	0.00 تومان	0.00 تومان	0%	0%	211,990,735.71 تومان	0.00 تومان
64	Coating	0.00 تومان	0.00 تومان	0.00 تومان	0%	0%	99,346,613.25 تومان	0.00 تومان
65	Back Fill	0.00 تومان	0.00 تومان	0.00 تومان	0%	0%	164,963,003.27 تومان	0.00 تومان
66	Finish	0.00 تومان	0.00 تومان	0.00 تومان	0%	0%	0.00 تومان	0.00 تومان

Figure 9- Temporal update

Project managers are responsible for managing the costs of a project. If the project management plan says that the organized analysis of the deviation and prediction are needed; they necessitate the use of earned value management for covering the aforesaid issue.

4. Discussion and Conclusion

4.1. Implications of key findings

At the end of this paper it is essential to briefly state the logic of the present work which needs firstly the clarification of its purpose and how authors can support the main purpose. In addition, the findings of the present research and how they can be effectively captured for the benefit of future projects should be outlined. In the petrochemical industry, project stakeholders always investigate possible approaches to monitor project progress closely and further, taking necessary actions during the whole phases of the project in order to manage time and cost. On the other hand, they have come to conclusion that the use of specific approaches may threaten future trend of projects. In searching for a reliable approach, the study was expected to ascertain the applicability breadth of earned value management system with its potential for strategic reuse to add value to future projects, conclusively increasing the likelihood of projects' success.

For assessing the system of earned value management, firstly, certain questions were designed on the basis of the indexes of time and cost in the system of earned value management and then, by an estimation gained through the relationship between the aforesaid system and performance, we were able to come to a clear and convincing answer. Thus, the questions were arranged and ordered on the basis of Likert scale, and distributed among 100 individuals of the high-ranking managers involved in the project. What was resulted as the output of that questionnaire demonstrated the meaningful relationship between the constructs of question one (cost, time, and performance). Six years since its beginning, about 75% of it was completed which suggests the advancement of it from the plan) which equals 90% at the end of the sixth year). The index of the cost performance has increased from 50% to 70% and also the index of time performance (planning) has attributed to itself the approximated number of 0/26 which is undesirable and caused the dissatisfaction of the project managers. What became clear by the results gained from the mentioned questions was the necessity of using this system in projects' management with the aim of attaining the maximum degree of performance in time and cost dimensions. However, practitioners should delimit the generalizability of the findings.

There are many typical examples addressing change management and the use or lack of use of the earned value management. These changes are based on project control. Project's cost and time control is a crucial subject in change management, and based on which project managers determine if they are in their own comfort zone and no problem leads them towards change. Therefore, they, like others, find a proper excuse for running things exactly the way they already are. No business manager would refrain from controlling project's costs; since they are the main beneficiaries of the project and the project managers are liable and it would be their problem. The examples suggest that when an employer asks the project managers to control the costs and times of their project, they usually do not ask how, yet there is a standard called the earned value management. But, these managers are in need of controlling the costs and times in their projects. A project control process (earned value management) is applied to a large set of projects with different characteristics and further validated on real-life project data. It proved that project managers need using earned value management and there is no excuse in tools cannot be rendered acceptably. Such tools as OpenPPM, MSP, and the like are available.

Findings also revealed novel insights related to time management. Customers of any given project desire to see the project finished in the shortest time. Yet, it cannot be the justification to using the fast tracking method by itself. This is a common solution for delay management in the studied projects. But, depending of the type of the

project and the experiences of the project team and the expected results this technique may not amount to a good choice. When implementation of earned value management system take place in a project-based environment, there would be many incentives stimulating learning through experience and knowledge creation from past project experiences to improve project and managers' performance. Then, projects' stakeholders would be informed that in a project that should go through a temporal line that cannot be shortened, using this technique would only end in disruption and, consequently, failure. This is while if this technique is applied effectively by means of a thorough study of the project can become a helpful tool in reaction to the changes of conditions and market demands. In addition, the uni-factorial system is considered as the best method for performing a fast tracking project.

With the results gained from delving into data from some projects and the variables of the earned value management system, it became clear how one can exploit this new system as a convenient tool for assessing projects' performance especially with regard to the construction projects. In addition, with the identification of the effective dimension on the indexes of time and cost and their relationship with project performance, we managed to come to a proper assessment of the project's performance. What was certified in the present research was the necessity of applying the earned value management system at all work stages especially in petrochemical projects where its application necessity became evident and specified. The results of this research were in line with that of [13] [14] [15] [16] [40]. The earned value technique is an important technique for analysing project performance which enables one to do a more precise measuring of both performance and progress of a project and findings of this study causes a high level of trust to be built-up with regards to the use of this system among project-based companies.

4.2. Practical relevance of the study in terms of identified gaps and challenges

The methodology for the best methodical choice is to estimate the cost and time of the project being completed. In this method, the best way for estimating the costs of the completion of the project is attained and its performative index was used for estimating the time of the project's completion. With the use of the scientific example, various existing methods in the area of time and cost estimation of the project were compared with one another and the best method with the lowest deviation from the actually observed amounts were selected. The method was earned value management which could provide the involved people in petrochemical projects with long-term and short-term perspective.

Prevalence of earned value management system in petrochemical projects would enlighten the stakeholders that they fail to attain their time and cost objectives due to ineffective coordination and sufficient communication and working experience cause enough essential learning from projects. They would beware that they should be aware of what knowledge needs to be retained and focus on the nature of project communication and learning and their role on project time and cost control. Because, they would know that allowing errors can lead to missing project milestones and business objectives and, eventually, project failures. Hence, they need to keep track of their projects systematically to detect and diagnose problems swiftly and make decisions to correct them as soon as they occur.

Another outcome of this study is that it provide policy makers and companies' directors with guidelines and views which uncover the most important areas to be considered to focus their efforts and allocate resources

efficiently. In fact, the model intends to rectify the common problem of project teams and organizations failing to balance between the three elements (time, cost and quality). Usually, due to the focus on the time factor in projects the quality level is influenced by poor implementation because of speed, the percentage of wastage in construction materials will increase and workers' energy will be overspent by employing them for overtime, which negatively affects the quality of workers' productivity and production. Simultaneous control of both time and cost in earned value management system avoid the mentioned negatives to appear and this in turn results in a high level of stakeholder's satisfaction for the project outcomes among the company, project team and service recipients.

Despite the importance of the earned value management system as a valuable methodology in analyzing and controlling the project performance of petrochemical projects, research conducted with the aim of developing and designing a unified approach for controlling project's performance through this methodology have been very limited. In the projects CPI and SPI were used. For gaining reassurance of the main conditions for using these graphs being met, the relevant tests were run. One must keep in mind that regardless of the statistical distribution of the data, the presented methodology in this research can be applied in general for bringing the project performance under control via the indexes of the earned value. However, some researchers have extended some indices to enhance cost and time performance measures. These indices are very helpful in developing countries where a wide range of challenges such as unstable economy, lack of data and transparency and corruption affect projects.

4.3. Potential future research directions

With each research the path to other research is paved and the necessity of further research felt. The model presented here is completely practical and can be used whenever time and cost of the project have been defined in an indeterminate and fuzzy environment from the very beginning. In other words, the present research can prepare the ground for the expansion of the fuzzy model of earned value in a way that other parameters of this technique would be put to study and, if possible, turned into fuzzy numbers; as an example, one can calculate the actual progress percentage of the activities through other methods and then study the feasibility of them becoming fuzzy.

In addition to controlling projects' costs and time in an uncertain environment, three further research was felt: Studying the applications of the system of the earned value management in each of the contractual systems of the country and studying the feasibility of the application of the earned value as a criterion for the financial statement being paid to the contractor in each of the conventional payment methods in the country. Lastly, the combination of risk analysis during the implementation of the project with EVM analysis is an interesting direction for further research, which may be an extension of the issue addressed in this article.

4.4. The study's limitations

It is worth mentioning that the study findings should be considered with caution due to a number of limitations. In other words, although the objectives of this study have been achieved, some limitations still exist. That is, the findings have to be applied to other project types in light of the nature discrepancies between petrochemical and other industries. Moreover, the sample size was relatively small and the respondents mostly came from contractor companies and clients, a small number of which were project manager. As such, the findings might not reflect the perceptions of project managers in large-sized companies, clients and designers.

These limitations warrant further investigation by validating the model in other contexts and using larger samples that cover different sizes and various types of companies. Moreover, exploring project managers which incorporates the viewpoints of a wider range of project stakeholders might add value to the findings presented here as another fertile ground for future research studies.

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