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EVM WITHOUT QUALITY IS UNSUITABLE FOR SOFTWARE PROJECT & PROGRAM MANAGEMENT

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Abstract: ***Earned Value Analysis/Management*** *is an industry standard method of measuring project's progress at any given point in time; forecasting its completion date and final cost, and analyzing variances in the schedule and budget as the project proceeds. It compares the planned amount of work with what has actually been completed, to determine if the cost, schedule, and work accomplished are progressing in accordance with the plan. As work is completed, it is considered "earned".*

EVM /EVA missed to consider a significant and important aspect of Project Management - Quality which is completely missing from its landscape. This paper aims to highlights, how not including quality in traditional EVM is detrimental/counterproductive in reporting project progress of software projects.

Keywords: *Program Management, Project Management, EVM, Earned Value Management, Cost of Quality*

1. INTRODUCTION

IT entities are remarkably complex compared to any other construct since there are no two parts alike in general. IT cannot ignore or simplify details of the real world. Complexity grows exponentially as the size of the system increases. Since there is no physical reality, it cannot be accurately modeled as in the case of, for example, construction. The projects are continuously subject to change even after being completed. In contrast, manufactured things, such as buildings, cars, and computers are rarely changed after manufacturing. They are simply outdated by later models. For example, callbacks of automobiles occur reasonably infrequent.

In particular, because of the changeability, IT projects are subject to continuous changes which makes planning and controlling very hard. Additionally, complexity and invisibility bring other challenges into management. In the light of these essential difficulties, the new concept that does not exist in traditional projects comes out as an inevitable part of IT project: **reworking**. It represents all the changes to the existing system as well as corrective actions of defective, failed or non-conforming items. Reworking itself introduces further complexity in terms of planning, estimating, monitoring and controlling. It could also cause further rework in a recursive cycle that can affect the project timeline. In various studies performed it has been reported that approximately 40% of the total IT project budget was spent for reworking. The studies also show that the cost of rework can approach 50% of the project budget for the large IT projects. Reworking impacts the entire development process from definition to implementation and testing.

IT projects are suffering a lot from reworking. Based on the essential characteristics of the IT developments projects especially and the quality related issues, reworking is accepted as a natural consequence and an indispensable part of the projects. For the projects of the other industries like construction projects, reworking is not very common or acceptable particularly after some milestones. As a result, the consequences of reworking are not so visible for those projects in most cases.

IT projects especially development projects have significant rework effort directly influenced by quality factors. The quality of the work matters and affects the quantity as well in terms of reworking. A research shows that IT development specialists spend about 40 to 50 percent of their time on avoidable rework rather than on work that's done right in the first time. Another study states that software vendors typically spend 30% to 50% of their development budget on detecting and fixing errors.

EVM in a traditional form focuses on the three main elements of software project success: scope, schedule and cost. It essentially emphases the quantity of the work performed. It does not deal with the quality explicitly. EVM assumes quality to be part of scope element. It means when the task is completed, it is supposed to be completed without

any quality deficiency. Therefore, the quality shortages or issues are not considered explicitly in EVM. In traditional project management, those three elements would be enough by considering quality dimension already in the scope since there are no significant changeability as in case of IT development projects. Even though this approach might work for many project management disciplines, IT projects could not utilize EVM properly because reworking is an inevitable part of its projects.

The main issue of EVM is the volatility of the value earned. Any kind of reworking i.e. unpredictable changes, requirement and design errors, software bugs affect the EV. If we would do it 100% correct in every aspect for the first time, we would not have such an issue and we would have exactly the same EV in every calculation. As an example, the following is a very ordinary scenario in a development project: At a given time in the project, the task is completed and the scope is achieved, but after some time, it is changed due to defects, and more effort is spent. The scope is still the same but cost spent is more, it is not the cost of scope, it is the cost of quality for scope was not complete before.

EV is particularly significant and key data of EVM in order to reveal the current status as well as predicting the future of the project. It is vital to have EV as accurate as possible, it is difficult to get the same EV at any time of project progress because of the rework or the changes that are inherent of any IT project. For that reason, we need an improved EVM approach for IT projects to calculate more accurate EV, to provide enhanced current and future estimates of the projects and to have an idea about the project quality status.

EVM does not represent the quality status of a project in any way. Since EVM does not consider the quality dimension explicitly, it does not measure anything related to quality and therefore does not give any clues to the project managers regarding the quality perspective while understanding the progress of the project. Quality is a vital success factor and the fourth dimension of a project and also affects the other dimensions, scope, schedule and cost in due course.

Applying traditional EVM could give IT project manager's incorrect information. Even at a specific time the project is supposed to be on track, the additional cost/effort would still be needed for the features that are already completed. Since these later costs may approach 50% of the total IT project cost, this fact should not be ignored and needs to be carefully considered.

2. COMPARISION OF EVM/EVA WITH AND WITHOUT INCLUDING QUALITY FACTOR IN EV MEASUREMENT

2.1 Calculation using Traditional EVM

The project in analysis, is a simple software development project with multiple phases and was executed using the waterfall methodology for software development. It follows incremental development approach where in there were some major releases along with minor releases planned and executed.

The project executing team consisted of 5 main people; with clear responsibility ranging from project management, software coding, design analyst, testing and providing post implementation support. Entire team was located in the same premise. Along with the main team, there were 2 business experts who were involved during the requirement phase of the project and during acceptance testing. Project plan at high level is shown below:

PROJECT START DATE	**01-May-2016**
PROJECT END DATE	**31-Jan-2017**
AGGREGATE	**MONTHLY**
PLANNING UNIT	**HOURS**
COST ENTRY	**ACTUAL COST**

The EVM application data as given in the tables above results in following calculations:

SNAPSHOT DATE	31-Jan-2017
PROJECT START DATE	01-May-2016
PROJECT END DATE	31-Jan-2017
PLANNED VALUE (PV)	309610
EARNED VALUE (EV)	305386
ACTUAL COST (AC)	337660
BUDGET AT COMPLETION (BAC)	309610

VARIANCES

SCHEDULE VARIANCE (SV)	-4224	BEHIND SCHEDULE
COST VARIANCE (CV)	-32274	OVER PLANNED COST

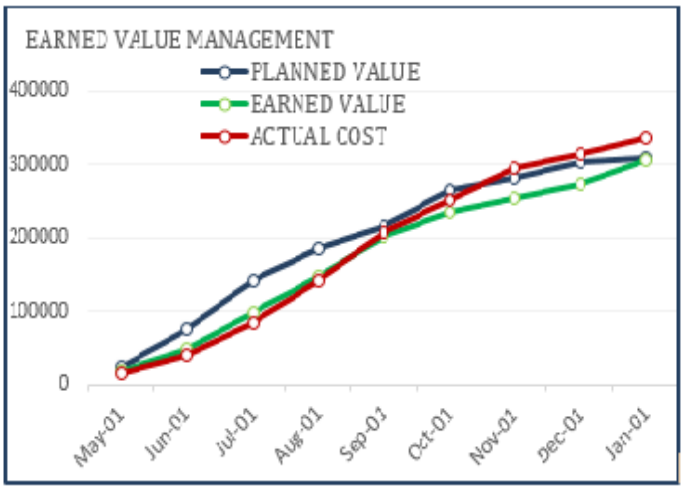
INDICES

SCHEDULE PERFORMANCE INDEX (SPI)	0.99
COST PERFORMANCE INDEX (CPI)	0.90

TO-COMPLETE PERFORMANCE INDEX (TCPI)

Option 1: To Complete On Planned Budget	-0.15
Option 2: To Complete on new EAC Budget	0.90

FORECASTING METHOD	SPI & CPI
ESTIMATE TO COMPLETE (ETC)	4735
ESTIMATE AT COMPLETION (EAC)	342395
VARIANCE AT COMPLETION (VAC)	-32785
ESTIMATED COMPLETION DATE	03-Feb-2017



From the EVM implementation, the picture for task looks OK. Most of the tasks planned were executed on time, though there are a few tasks that have been delayed but the overall project has been completed on-time. Though the cost that was budget for the project has gone up. The total cost of the project has gone up by 32,785. Also in case if no new additional resources were provided that project would have completed on 03-Feb-2017 rather that the scheduled date of 31-Jan-2017.

Now from the look of EVM, though there is some delay during the later phases of the project, it does not look too bad. Cost in the project has over shooted by around 10%.

2.2 Calculation using EVM with Quality / Rework factor included (iEVM)

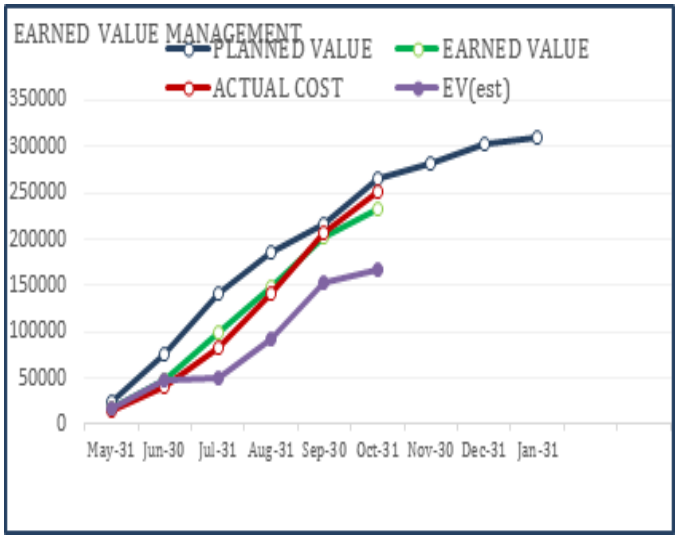
SNAPSHOT DATE	31-Oct-2016	
PROJECT START DATE	01-May-2016	
PROJECT END DATE	31-Jan-2017	
PLANNED VALUE (PV)	265760	
EARNED VALUE (EV)	233816	
ACTUAL COST (AC)	252300	
BUDGET AT COMPLETION (BAC)	309610	
EARNED VALUE (EVest) per iEVM Methodology	-142724	
VARIANCES		
SCHEDULE VARIANCE (SV)	-4224	BEHIND SCHEDULE
SCHEDULE VARIANCE (SVest) per iEVM Methodology	-142724	BEHIND SCHEDULE
COST VARIANCE (CV)	53086	UNDER PLANNED COST
COST VARIANCE (CVest) per iEVM Methodology	-85414	OVER PLANNED COST

INDICES

SCHEDULE PERFORMANCE INDEX (SPI)	0.88
SCHEDULE PERFORMANCE INDEX (SPI_{est}) per iEVM Methodology	0.66

COST PERFORMANCE INDEX (CPI)	0.93	
TO-COMPLETE PERFORMANCE INDEX (TCPI)		
Option 1: To Complete On Planned Budget	1.32	HARDER TO COMPLETE
Option 2: To Complete on new EAC Budget	0.82	EASIER TO COMPLETE

FORECASTING METHOD	SPI & CPI
ESTIMATE TO COMPLETE (ETC)	92959
ESTIMATE TO COMPLETE (ETC_{est}) per iEVM Methodology	
ESTIMATE AT COMPLETION (EAC)	345259
ESTIMATE AT COMPLETION (EAC_{est}) per iEVM Methodology	
VARIANCE AT COMPLETION (VAC)	-35649
VARIANCE AT COMPLETION (VAC_{est}) per iEVM Methodology	
ESTIMATED COMPLETION DATE	09-Mar-2017



In the above project case study context, the aim was to explore the applicability of new EVM model that we introduced in chapter 3, iEVM and too validate the applicability of the model. Case study explores whether iEVM can be applied properly to software development projects by integrating quality aspects and overcoming the problems associated with EVM.

2.3 Results

As can be seen above from through EVM the results as on 31-Oct-2016 EV = 233,816 (EVM method) whereas EV 166,886 (through iEVM method). iEVM method takes into consideration the rework that was done on the task before 31-Oct-2017 and thus shows that the actual amount of value earned is significantly low.

The value also shows that project is significantly delayed and if it goes in the same and with the same set of resources the estimated project completion will be 09-March-2017.

The iEVM methodology also shows a vast difference in Cost Variance thorough EMV and iEMV method. In case of EVM it shows that CV is under planned cost where as if we take rework in consideration per iEVM the CV is way above the planned cost.

3. CONCLUSION

iEVM, which is the extension of traditional EVM and incorporates quality cost metrics into the model. iEVM provides the usable and valuable model for software projects since it takes the significant quality costs into consideration. Even though the software projects suffer from a lot of reworking, those costs are not incorporated into traditional EVM. iEVM provides the quality related metrics to the project manager in order to not only track the quality status but also integrate the cost of quality with the project cost status.

iEVM will deliver more visibility to effort and costs, more accurate forecasts and better predictions of future.

Including FCs into total costs will increase the visibility of the project aspect, quality status and effort should become visible. The revealed FCs will result in more accurate total cost, schedule and cost indices and so improves the accuracy of the project. Accuracy in current progress information will enable more accurate estimations of future values of project.

The accurate progress information and forecasts are the main targets of project management since they allow the project manager to understand the present clearly getting him necessary actions. Depending on the status of the project, the project manager could get different actions like informing the stakeholders about these trends and forecasts or calibrating the project budget and schedule, or investigating the reasons behind and so taking the necessary actions to make the project on track.

The literature also shows, that even EVM is a powerful method to reflect project progress in terms of scope, time

and cost, especially for the first time implementation of the tasks, it could not represent the later reworking and could not incorporate the reworking costs and its effects into the method. Although the project manager observes that the project is on track by EVM at a given time during project execution, there could be some cost and schedule problems due to the quality issues and subsequent reworking efforts.

By providing accurate project progress, iEVM (which includes quality) removes this complication. Two main objectives of traditional EVM is to measure the progress clearly and to estimate future correctly. iEVM improves both for the software projects with high FCs. If there were no reworking for the software projects, iEVM would be same as the traditional EVM and such improvement may not be needed.

Main benefits that iEVM would provide to software projects are summarized in the followings:

- Providing CC indices and benchmarking opportunity at the beginning of the project
- Revealing hidden FCs and integrating them into project management and performance management - more visibility
- Measuring the quality status of a project at a given time in addition to schedule and cost – more visibility
- Estimating the project progress more accurately at any given time using past quality cost data –more accuracy
- Estimating project future more realistically – more predictability

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