PROJECT MANAGEMENT: USING EARNED VALUE ANALYSIS (EVA) TO MONITOR A PROJECT'S PROGRESS

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CASE DESCRIPTION

This case illustrates one of several important project monitoring and controlling techniques available for project manager use in construction and other related fields. The case highlights that the lack of proper project monitoring could lead to cost and schedule run-ups that eventually could result in complete failure of a project and financial loss. The case illustrates how a project manager could use variance analysis as an effective tool for project monitoring and controlling. The problem presented originated from a real-life situation of an actual federal building contractor. In this particular scenario, the contractor had incurred losses as a result of project delays due to multiple business factors. The issue became problematic since the responsible project manager lacked knowledge of sophisticated project control and monitoring tools, and relied primarily on his memory and intuition-based physical assessments of activities. The case is an attempt to show that if an appropriate project monitoring technique, earned value analysis (EVA), had been used, this contractor potentially could have avoided losses or even made some profit. This case is appropriate for senior or graduate level courses in project management or operations management. The case will require an estimated 2-3 hours of classroom lecture time. Students might have to spend 4-6 hours of time depending upon their prior experience and knowledge of the project management environment.

CASE SYNOPSIS

A small federal government contractor, Environmental Services, is located in the Virginia Beach area of Virginia. It has incurred losses on some of its projects due to poor cost controls and schedule overruns. The company executes 10 to 30 small to medium-size projects at any given point of time. The company is growing and wishes to find a way to cut its losses due to cost and/or schedule overruns. These overruns occur due to several internal and external factors. The internal factors include the loss of key personnel, improper supervision, the lack of technical skills, poor understanding of the scope of projects, etc. External factors such as vendor delays, quality of supplies, unclear designs, weather and similar factors may also cause a project activity to miss an

established deadline or to cost more than the estimated budget. The company largely relies on the experience of the project managers to make a decision based on their assessment whenever a problem arises. Currently, there is no system in the company to keep track of the impact of cost and schedule overruns on a given project. The company recognizes profit or loss once projects are completed and final performance analysis is performed.

The company gave the task of establishing procedures and developing an ongoing monitor/control system to an outside consultant. The consultant reviewed several old projects and presented an analysis to the company. It was suggested that the company establish a proper mechanism for recording cost and budget details during the life of each project. Furthermore, it was suggested that the company use an Earned Value Analysis (EVA) tool to monitor the cost and schedule overruns and adjust project tasks, schedules and resources accordingly.

BACKGROUND INFORMATION

Environmental Services is a general contracting company based in Virginia Beach, Virginia. The company performs general contracting work mainly in the area of construction and facility maintenance. The company executes approximately 10-30 projects at any given time and each project is managed by a project manager (PM). Most federal government contracts are awarded to the company on a fixed cost basis. Also, most Environmental Services' projects are awarded on a "design-bid-build" basis. That is, the company bids on the projects after the design has been completed by the federal government or other governmental agency. Environmental Services is not involved either directly or indirectly in any design aspects of the project.

The general contracting organizations like Environmental Services that work on fixed cost "design-bid-build" projects can only be profitable by completing projects on time and within budget. However, in construction projects, cost and/or schedule overruns could occur due to a variety of internal and/or external factors. These overruns can quickly wipe out profit margins and may result in a loss. Project losses generally are the result of problems of a few activities in a project which may impact other activities and hence, the entire project may be impacted negatively. It is not possible to avoid all schedule or cost overruns (such as those due to inclement weather), but proper project monitoring can reduce the impact of these overruns.

ANALYSIS OF PROJECT MANAGEMENT PROBLEMS

There are two main categories of factors that can create risk in a construction project during its monitoring and controlling phase. These categories are internal and external factors. Internal factors include scheduling conflicts, lack of subcontractor supervision, insufficient labor and/or supervisor training, improper match between labor skills and the tasks assigned, and changes in key personnel. It is important that the project management recognizes a problem and takes corrective

action in a timely manner. For example, scheduling conflicts could be resolved by rescheduling (if time permits), supporting an activity with additional labor, or resource leveling. The lack of subcontractor supervision or improper supervision could be resolved with the proper training of management or by providing support to the subcontractor as needed. Similarly, when there is a change in the key personnel, management needs to find an effective replacement quickly. Tools like EVA provide necessary information to management regarding the project status while requiring proper documentation of project parameters at select time intervals or other milestones. These tools and techniques (like EVA) are used at the monitoring and controlling stage of a project life cycle, hence, should not to be confused with project scheduling techniques like PERT, CPM, etc. which are used at the planning stages of a project life cycle.

External factors could be more serious since contractors have little or no control over these factors. Problems may arise due to delay by an external organization or due to natural causes like rain, snow, wind, etc. External organizations may include subcontractors, suppliers, and project owners. Subcontractors' internal problems can have a direct impact on a project. For example, labor disputes at a subcontractor's business may force a company to miss completion dates, potentially delaying a project. Suppliers could have similar problems as subcontractors. Delays in material supply can also cause significant cost and schedule overruns. Project managers should have the ability to spot these problems early and to take corrective action. Providing extra labor or financing to fix the subcontractor problem could avoid bigger delays and losses to the entire project. Furthermore, project owners can also increase general risk by changing task requirements (scope creep). The change in one task could result in a much larger cumulative impact of the project cost and time. These changes should be carefully evaluated and budgeted. A proper application of EVA could also be very helpful in determining the expected variances caused by additional requirements, the correction of design flaws, or misinterpretation of the requirements; thus the contractor can have better estimates for negotiating additional terms and budgets.

Natural causes like excessive rain, snow, extreme temperatures, severe storms, etc. can also cause large delays in projects, as well as increase project costs. These are uncontrollable events; nevertheless these events require a contractor's response. Again, EVA can help management in determining the cost and schedule variances as the result of natural events. Consequently, management can take proper remedial action to reduce the impact of the delay caused by natural events.

FACTORS TO CONSIDER IN EVA

An application of EVA assumes that a detailed project plan has been created. In fact, most project grantors will require some kind of project plan to be submitted as a part of the bid approval process. Additionally, EVA will also require detailed cost estimates, methods of assessment of

completion of a part or full activity, and time interval for assessment of activities. The following table (Table 1) shows a list of necessary items and processes for the proper application of EVA.

Table 1: Necessary Steps in EVA Application

Step #	Description
1.	Develop a Work Breakdown Structure (WBS) where major tasks are broken down into their detailed tasks levels. For most government agencies, a federal contractor must submit a WBS to bid for a job.
2.	Estimate the cost of each task involved, including direct cost; indirect cost that includes general and administrative overhead and marketing; contingency cost; and residuals like profit.
3.	Create a schedule of implementation with the critical path clearly identified. For a larger project there might be more than one schedule, one for each major task in the WBS.
4.	Determine how often monitoring information should be compiled and/or milestones for monitoring the project. Short time period estimates of work completed (cost and time) may waste managerial time and allow little time to assess the effectiveness of a corrective action. Very long time between estimations may not allow enough time to take corrective action.
5.	Calculate the variances for EVA to obtain measures like the Cost Schedule Index (CSI), the Schedule Performance Index (SPI), and the Cost Performance Index (CPI), etc. These measures allow you to tell how well the project is progressing and how close it is following schedule and budgeted costs. These indexes would also help to prioritize where corrective action is critical.
6.	Take corrective action wherever management thinks it is necessary.

TECHNIQUES FOR PERFORMANCE ESTIMATION

It is not difficult to estimate the cost or time associated with a task during construction operations but the process of estimating cost and time continuously can be time consuming. However, there are several methods that allow quick practical estimations, such as the milestone method, percent complete, 50/50%, or 0/100%, etc. This company uses the percentage of completion method as it is required by some of the government agencies for which Environmental Services has the construction contacts. In the percentage of completion method, at a given interval the project manager estimates each ongoing task and estimates how much or what percentage of the work has been completed. The project manager will record the percentage of work completed as well as dollar amount spent on any ongoing activity. A few tasks may require additional management time to determine what percentage of the task is completed. Cost and time variances are calculated based on actual percentage completed.

APPLYING EVA TO MONITORING A PROJECT

The project in this case involved a federal government contract to build a special ceremony center on a military base. This was one of many independent projects Environmental Services was handling at that time. The project manager for this project was Mr. Krish Patel. This project exceeded time budgeted, and the company ended up incurring substantial losses on the project. The estimated losses were approximately 5% of overall budget. The losses were higher due to the time sensitive nature of the project. The consultants analyzed the project and showed that if EVA had been used the company could have cut its losses substantially or remained profitable on the project. The specifications of the project's ceremony center were prepared by the design team that was independently hired by the military. The total project time was seven months (November 1 to May 31). However, to facilitate an on-time start of the contract, the award was made two months in advance to account for the lead time of delivery of construction supplies. Any delay to the project would be subject to penalty due to a pre-specified contract clause. Therefore, careful planning by the management was important for the on-time delivery of this project. Tables 2 and 3 provide the estimated timeline and budget for six major construction tasks. For simplicity, other project activity constraints are ignored, including any activity-dependent requirements.

Table 2: Percentage of Tasks to be Completed Each Month

Task	Months	Percentage Completion by Month						
		Nov	Dec	Jan	Feb	Mar	Apr	May
Business Overheads (A)	7	14.3%	14.3%	14.3%	14.3%	14.3%	14.3%	14.3%
Site Development (B)	3.5	40%	30%	20%	10%	-	-	-
Concrete Work (C)	2.6	10%	40%	50%	-	-	-	-
Framing/Steel Work (D)	2.75	30%	-	50%	20%	-	-	-
Wood/Roof (E)	3.5	20%	20%		45%	15%	-	-
Interior/Elec/Plumb (F)	5.5	-	10%	15%	20%	20%	25%	10%

Table 3: Budgeted Cost								
Tasks	Budgeted Cost Of Work Scheduled	Months						
		Nov	Dec	Jan	Feb	Mar	Apr	May
A	$250,000	$35,714	$35,714	$35,714	$35,714	$35,714	$35,714	$35,714
B	$450,000	$180,000	$135,000	$90,000	$45,000	$0	$0	$0
C	$155,000	$15,500	$62,000	$77,500	$0	$0	$0	$0
D	$95,000	$28,500	$0	$47,500	$19,000	$0	$0	$0
E	$175,000	$35,000	$35,000	$0	$78,750	$26,250	$0	$0
F	$300,000	$0	$30,000	$45,000	$60,000	$60,000	$75,000	$30,000
Totals	$1,425,000	$294,714	$297,714	$295,714	$238,464	$121,964	$110,714	$65,714

PROBLEMS

At the end of September, prior to starting the project, a severe thunderstorm disrupted the construction site. More than two weeks of work time was lost due to the flooding of the site. This loss of time could not be made up by an extension of the project time. The building had a major event scheduled at the end of construction.

By the end of December, another problem surfaced related to the quality of work performed by a subcontractor. The wood/roof subcontractor failed to meet the standards set in the military contract. About 50% of the work completed in December by this subcontractor had to be redone.

In January, Mr. Patel realized that the subcontractor for interior work was having problems in procuring cabinets and other specialty items. A meeting with the subcontractor revealed that the company was having problems with labor and finances. Mr. Patel did not take action in December, as this was an outside contractor and Krish Patel was not yet sure of the problem. Furthermore, the subcontractor indicated that the problem would be resolved in the near future. At this time, hiring a new contractor was not an option.

CASE DISCUSSION QUESTIONS

If you were an assistant to project manager, Mr. Krish Patel, how would you help Mr. Patel in monitoring the project using EVA? Data regarding the variance for November, December, and January are provided below in Tables 4-9.

Table 4: Task Variance Analysis Progress Report (November)								
Task		Months						
		Nov	Dec	Jan	Feb	Mar	Apr	May
A	Planned	14.3%	14.3%	14.3%	14.3%	14.3%	14.3%	14.3%
	Actual	*14.3%*						
B	Planned	40%	30%	20%	20%	10%	-	-
	Actual	*20%*						
C	Planned	10%	40%	50%	-	-	-	-
	Actual	*10%*						
D	Planned	30%	-	50%	20%	-	-	-
	Actual	*30%*						
E	Planned	20%	20%		45%	15%	-	-
	Actual	*20%*						
F	Planned	-	10%	15%	20%	20%	25%	10%
	Actual	-						

Table 5: Cost Variance Analysis Progress Report (November)									
Tasks		Months							LRE
		Nov	Dec	Jan	Feb	Mar	Apr	May	
A	BCWS	$35,714	$35,714	$35,714	$35,714	$35,714	$35,714	$35,714	$250,000
	ACWP	$35,714							
B	BCWS	$180,000	$135,000	$90,000	$90,000	$45,000	$ -	$ -	$460,000
	ACWP	$100,000							
C	BCWS	$15,500	$62,000	$77,500	$ -	$ -	$ -	$ -	$157,000
	ACWP	$17,500							
D	BCWS	$28,500	$ -	$47,500	$19,000	$ -	$ -	$ -	$95,000
	ACWP	$28,500							
E	BCWS	$35,000	$35,000	$17,500	$78,750	$26,250	$ -	$ -	$192,500
	ACWP	$35,000							
F	BCWS	$ -	$30,000	$45,000	$60,000	$60,000	$75,000	$30,000	$300,000
	ACWP	$ -							
	Total								$1,454,500

BCWS: Budgeted cost for work scheduled, or scheduled work (SW); ACWP: Actual cost of work performed LRE:Latest revised-budget estimates

Table 6: Task Variance Analysis Progress Report (December)								
Task		Months						
		Nov	Dec	Jan	Feb	Mar	Apr	May
A	Planned	14.3%	14.3%	14.3%	14.3%	14.3%	14.3%	14.3%
	Actual	*14.3%*	*14.3%*					
B	Planned	40%	30%	20%	*20%*	*10%*	-	-
	Actual	*20%*	*30%*					
C	Planned	10%	40%	50%	-	-	-	-
	Actual	*10%*	*40%*					
D	Planned	30%	-	50%	20%	-	-	-
	Actual	*30%*	-					
E	Planned	20%	20%	*10%*	45%	15%	-	-
	Actual	*20%*	*10%*					
F	Planned	-	10%	*20%*	20%	20%	25%	10%
	Actual	-	*5%*					

Table 7: Cost Variance Analysis Progress Report (December)									
Tasks		Months							LRE
		Nov	Dec	Jan	Feb	Mar	Apr	May	
A	BCWS	$35,714	$35,714	$35,714	$35,714	$35,714	$35,714	$35,714	$250,000
	ACWP	$35,714	$35,714						
B	BCWS	$180,000	$135,000	$90,000	$90,000	$45,000	$ -	$ -	$460,000
	ACWP	$100,000	$135,000						
C	BCWS	$15,500	$62,000	$77,500	$ -	$ -	$ -	$ -	$157,000
	ACWP	$17,500	$62,000						
D	BCWS	$28,500	$ -	$47,500	$19,000	$ -	$ -	$ -	$95,000
	ACWP	$28,500	$ -						
E	BCWS	$35,000	$35,000	$17,500	$78,750	$26,250	$ -	$ -	$192,500
	ACWP	$35,000	$35,000						
F	BCWS	$ -	$30,000	$60,000	$60,000	$60,000	$75,000	$30,000	$300,000
	ACWP	$ -	$15,000						
Total									$1,454,500

Table 8: Task Variance Analysis Progress Report (January)								
Task		Months						
		Nov	Dec	Jan	Feb	Mar	Apr	May
A	Planned	14.3%	14.3%	14.3%	14.3%	14.3%	14.3%	14.3%
	Actual	14.3%	14.3%	14.3%				
B	Planned	40%	30%	20%	20%	10%	-	-
	Actual	*20%*	*30%*	*20%*				
C	Planned	10%	40%	50%	-	-	-	-
	Actual	*10%*	*40%*	*50%*				
D	Planned	30%	-	50%	20%	-	-	-
	Actual	*30%*	-	*50%*				
E	Planned	20%	20%	10%	45%	15%	-	-
	Actual	20%	10%	10%				
F	Planned	-	10%	20%	20%	20%	30%	15%
	Actual	-	*5%*	*10%*				

Table 9: Cost Variance Analysis Progress Report (January)									
Tasks		Months							LRE
		Nov	Dec	Jan	Feb	Mar	Apr	May	
A	BCWS	$35,714	$35,714	$35,714	$35,714	$35,714	$35,714	$35,714	$250,000
	ACWP	*$35,714*	*$35,714*						
B	BCWS	$180,000	$135,000	$90,000	$90,000	$45,000	$ -	$ -	$460,000
	ACWP	*$100,000*	*$135,000*						
C	BCWS	$15,500	$62,000	$77,500	$ -	$ -	$ -	$ -	$157,000
	ACWP	*$17,500*	*$62,000*						
D	BCWS	$28,500	$ -	$47,500	$19,000	$ -	$ -	$ -	$95,000
	ACWP	*$28,500*	*$ -*						
E	BCWS	$35,000	$35,000	$17,500	$78,750	$26,250	$ -	$ -	$192,500
	ACWP	*$35,000*	*$35,000*						
F	BCWS	$ -	$30,000	$60,000	$60,000	$60,000	$75,000	$30,000	$300,000
	ACWP	*$ -*	*$15,000*						
Total									$1,454,500

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