

# Complex Project Management: An Appropriate Monitoring / Evaluation / Course Correction Methodology

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*Avoid persecution of the responsible parties if there are overruns, otherwise in future the managers will be reluctant to give any information for fear that it will be held against them. Project control should be seen as a tool to assist managers reach their objectives, not as a weapon of attack.*

Project performance monitoring and control are areas on which one should spend a significant amount of time. To monitor a project, you need to measure its success against established performance benchmarks or parameters. Measuring the success of an advanced project can be difficult. Advanced projects tend to be unique projects and little in the way of previous performance exists. Despite the difficulties associated with performance measurement, it is nevertheless a goal worth pursuing. The key to measuring and reporting success is to focus on the main foundations of any project. These are – timescale, resource, quality and scope. Once you have understood these, and put in place measures to enable their management, you need to look at the fifth aspect; performance analysis.

Let us approach the subject of monitoring, evaluating and controlling projects through a few fundamental questions.

*What kind of projects should be monitored?* If the project is of short duration, if the information collected by monitoring is not going to be used for control and feedback actions, and if the experience of the project is not going to be of any use for future projects, there is no point in applying time, money and effort to monitor and evaluate its status. It stands to reason that larger, more complex projects as in the construction and defence industry have to be monitored to ensure that milestones are achieved and information gathered in the process of monitoring provides positive feedback loops for rescheduling or re-allocation of resources.

In traditional project management approaches, it is assumed that project

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contexts are unchanging and key factors, though complicated, are reducible to unambiguous elements for management and control. But if projects are complex by size, technical difficulty, conflicting environmental and political constraints or poorly understood or shared goals, then existing project management methodologies and structures may have to be adapted, and managers would need to look at things in a pluralistic perspective, drawing upon a much wider range of models to help them cope with the complexities.

*What is to be monitored?* The progress of the project should be evaluated against original assumptions about time, cost, resource requirements, scope and objectives.

The project manager must have the ability and the willingness to cope with continuous complex changes without getting frustrated by them.

An important lesson for the project manager is that no project plan is cast in stone. New knowledge derived from project monitoring and project environment changes will drive changes in the project plan. This is called a project update. The project manager must have the ability and the willingness to cope with continuous complex changes without getting frustrated by them. Change commences as soon as the project is taken up and comes to an end when the project is completed. The monitoring process creates snapshots at proper intervals which help the management to deal with change.

Reporting requirements of a project may vary depending on duration, size, complexity, risk, visibility and other factors. Most reports would cover the following aspects: scope, time, cost, quality and risk.

**Scope:** Progress reports, accomplishment reports or production reports bring out in quantitative terms the physical achievements of the project, e.g. the number of units completed, percentage of work completed or milestones achieved. If scope changes have been approved by the competent authority, this can also be reflected. Reporting on scope changes highlights the changes in the project requirements and processes.

**Time:** Reports on the project progress with reference to the laid down schedule compare actual achievements against planned achievements, or actual percent complete to planned percent complete. Gantt charts or milestone charts are examples of graphical reports for progress tracking, understanding of variances and schedule control.

**Cost, Resource Requirements and Utilisation:** Cost has to be tracked with

reference to approved cost baselines in the project plan as well as the physical progress. Reports on resource requirements can specify the types of skill required and the amount of time needed from each skill grade during different time periods. Against this, the actual availability and any resource surplus or resource shortage can be indicated.

**Quality:** Quality is a key factor that can affect project deliverables as well as project schedule and cost. If quality of requisite levels is not reached, it results in rework and modifications, production of scrap, repairs and such other non-value adding efforts. It is therefore important to identify and keep a close watch on factors that impinge on project quality. Information on quality parameters can be gathered from design reviews, software testing and simulation, facility inspection, customer feedback, and comparison with historical benchmarks /averages. Through a control chart, one can analyze normal (tolerable) and abnormal (exceptional) variances of project output against a mean. The upper and the lower control limits can be placed three standard deviations (3  $\sigma$ ) above and below the mean, respectively. If 99.7 % of the time, product quality is within these limits, the system is said to be stable or in control. Special customer requirements may require specific upper and lower limits for quality.

**Risk:** Projects are undoubtedly risky endeavours. If the project plan is evaluated periodically and especially at major milestones, a risk information and management report can be prepared listing the types of risk, the probability of each one arising, its impact on the project and the response of the project management to the risk, along with current status.

The project plan when drawn up, represents reality as it was at that particular point of time.

*When to monitor?* The project plans being in a continual state of change, it would of course be ideal to monitor the project continuously. However, monitoring involves expenditure of time and resources and so this decision has to be balanced against the availability of resources. The following criteria would have an important impact on the frequency of project status evaluation:

**Management information needs:** The project owners need to have a clear idea of the projects for which they are ultimately responsible. They would like to be informed on whether their commitments to stakeholders, investors, partners and customers will be delivered as promised, on time and within the stated cost. They are not terribly concerned about the day to day details of the working of the project team except to the extent that these details are likely to have an impact on the reliability and quality of project execution.

Key events are milestones and these should be captured in a project

evaluation as they are of interest to a number of management levels. Achievement of a milestone should be taken as an opportunity to collect data on the project and evaluate its status.

**New activity information:** The project plan when drawn up, represents reality as it was at that particular point of time. Thereafter, the project team has to keep responding to changes in the environment. When new information is available that can add value to the project, the project plan must be updated.

It may also be a good idea to review project progress periodically on the basis of passage of time even if little activity or new developments have taken place.

*Who should monitor?* Overall responsibility for ensuring satisfactory progress of a project is generally given to a project steering committee or a project board. Day to day responsibility rests with the project manager. In small projects, individual team members usually report directly to the project manager; in larger projects, there can be a number of teams, each team having a team leader. The team leaders report to the project manager. Team leaders collate reports on their section's progress and forward summaries to the project manager. These in turn are collated into project level reports for the steering committee and via them or directly progress reports for the client.

Sometimes, third party teams are set up to monitor progress of a project. The members, being experts in their own field are expected to be able to collect and analyze a lot of data, make cross project comparisons and prepare reports. Also, it is argued that as they maintain an arms-length relationship with the project, their analysis is more objective. However, unlike the members of the project team, they are not stakeholders in the project. Without a stake in the project, it is rather difficult to make a realistic assessment of data or react appropriately to changes as they occur. Third party monitoring may lead to unrealistic evaluations, inappropriate recommendations and expensive changes to project plans. The members of the project team are in the best position to monitor project activities, evaluate collected information, and take necessary action.

*How should we monitor?* We now come to the fifth aspect of project management namely, performance analysis and how it should be done.

**Conceptual Techniques:**

There are several techniques for looking at the various aspects of a project:

**Comparison** – it simply means comparing the actual result achieved against

the baseline plan. This technique enables the project manager to quickly identify where problems areas are.

**Ratio Analysis** –For comparing tasks of dissimilar size, different types of ratios can be used.

**Benchmarking analysis** – Benchmarking analysis compares an actual result against something similar. In analogy analysis, the best practice carried out for a similar activity in industry is compared to the project task. Benchmarking can be difficult, especially in advanced projects as they tend to be new and untried, and there is little data to create a benchmark from. To overcome this difficulty one can set performance guesses. This is done by gathering as much evidence as possible from similar tasks and then guessing what value to use.

**Historical Analysis** – Historical analysis examines previous work of a similar nature. It focuses specifically on organisational data relating to culture, people and operating methods from the sponsoring organisation. Understanding what is different about the historical project and the one being undertaken and what changes have taken place in the organisation since the historical project are the basic points in examining historical data.

#### Collection of Data:

For an effective performance analysis, a basic requirement is data collection or data capture. Data capture is a part of the progress reporting cycle where information is regularly reported back to the project manager on the project's progress and status. Some important issues are:

- The structure of the data capture feedback proforma should be in line with the original estimate. This will make the data capture less subjective. A common integration problem arises when tracking categories are set within one structure, but data is collected through a different structure. For example, the planning department may be structured by work packages or activities, whereas the procurement department collects data supplier wise. In this case, there will be no basis for comparison.
- The persons responsible for the quality of the data capture and regular data updates should be clearly identified by the project manager.
- The design of the reports should be worked out in consultation with the people who will use them.
- Information should be easily available and accessible to all team members.

- The accuracy of reports generated will reflect the accuracy of data capture. As a guide, the accuracy of the reports should be within the profit margins of the project and in line with the level of risk and the level of control required.
- At the same time, measurement systems need to be only as accurate as the end use requires; for example, if you calculate percentage completion to 3 decimal figures 56.317% for example, that is only as meaningful as 56%! The additional effort at attaining precision may not be worth it.
- A higher level of accuracy is required for the critical activities, because here delays will extend the project duration.
- Data has to be timely; late data is as bad as inaccurate data. If you find out that the budget was overspent 3 months ago that is not of much use.
- Only data relevant and pertinent to project performance should be collected. Managers' time should not be wasted in collecting data that will not be analysed or used. Only such data should be collected that can be measured in a consistent matter.
- Duplication in collecting data should be avoided.

### Reporting:

A properly structured reporting system will ensure there is good quality data and information available to aid monitoring, control and information flows within the project. Reporting enables those outside the project to determine what is happening and whether everything is going according to plan.

There are many types of report required during the lifetime of a project ranging from standard weekly reports to more specialized single-topic reports.

Weekly or monthly reports present the progress of the project. They gather together the information about the various project work packages. The progress report should show the actual plan against the baseline plan and should highlight and explain any differences.

Periodic reports could be:

In-depth reports which are normally produced in response to a requirement to

investigate an area of the project in detail; these reports are designed to enable senior managers or stakeholders to gain a detailed insight into areas that may cause significant problems within a project.

General reports which provide high-level summary information to a variety of people; they supply basic information about progress and deliveries.

Overview reports to educate senior managers who are not directly involved in the project.

If project managers lead reporting effectively they will provide confidence to the people involved in the project. Regular communication that is timely, clear and targeted will enable the project to progress smoothly with the support of its stakeholders. Project managers can drive this communication through the effective use of the following report types:

**Risk reports:** An integral part of progress reporting is risk reporting. Risks come in all shapes and sizes and it is difficult to know what risks to report. However, as with many areas of advanced project management, there are tools that can help.

**Budget reporting:** A simple but effective report is simply to profile the resources against time. Tolerance zones can be indicated in the reporting in order to give report's readers reassurance that the cost risk is actively being managed.

The project manager has to beware of the dangers of over-optimistic reporting. Stakeholders in the project may sometimes be tempted to make claims for greater progress than has actually been achieved.

**Management Summary:**This covers the top-level activity in the work breakdown structure. It is a summary of all the project reports. This report should concentrate on the fundamentals of the project: timescale, scope, resources and quality.

**Project Team information:**An important area is reporting the progress to the project team. Ensuring that the project team know what's going on in the project is essential for building clarity, purpose and motivation.

As projects increase in size and complexity, so progress reporting needs to move from subjective assessment of progress to a more structured approach. For effective project control, performance has to be measured while there is still

time to take corrective action. As the project nears completion, it will be more and more difficult for the project manager to take corrective steps. The project manager has to be aware of the dangers of over-optimistic reporting. Stakeholders in the project may sometimes be tempted to make claims for greater progress than has actually been achieved. For example, contractors may be tempted to over claim to improve their cash-flow in the short term. If there is consistent over reporting in the early stages of a project, the lack of progress will become evident at the final stages when the over optimistic reporting catches up with itself and the project appears not to move forward for a long period of time. For example, when a frigate for the US Navy was being built, the project was reported to be 99% complete for nearly one year!

### Visualizing Progress:

Once the conceptual techniques and the data collection and reporting systems are in place, it has to be presented or viewed in an effective manner. To do so, the following tools can be used:

Gantt Chart is an activity bar chart indicating scheduled activity dates and durations frequently augmented with activity floats. Reported progress is reported on the chart by shading activity bars and a today cursor provides an immediate visual indication of which activities are ahead of, or behind schedule. A slip chart is a Gantt chart with the today cursor a bent line, an inward bend indicates that the activity is behind schedule and an outward bend indicates that the activity is ahead of schedule. Another variant is the ball chart, in which circles containing the scheduled date of start and completion of the activity, represent the starting and finishing points of different activities. The actual dates of start and completion as and when these events occur, are entered into the respective circles just below the scheduled dates. An appropriate shading scheme for the circles indicates whether the activity is ahead of, or behind schedule.

The above charts do not show the slippage of the project completion date through the life of the project. Knowing the current state of a project helps to revise plans to bring it back on target, but analyzing and understanding trends provides valuable lessons for future projects. The timeline chart is a method of recording and displaying the way in which targets have changed through the duration of the project.

### Earned Value Analysis (EVA) / Earned Value Measurement (EVM) System

EVA as a combined means of cost and time schedule monitoring has gained popularity in recent times. Like so many other project management tools, Earned Value Project Management originated in the US Department of Defense for management of its one-time-only projects. It was first used to monitor the

Minuteman missile development project in the sixties.

Under the EVA/EVM system, each element in the Work Breakdown Structure of the project is assigned a certain value. While employing earned value, the management would focus attention on the completed work, which is also called the earned value. Earned value is simply the authorized work when it has been completed, and the original authorized budget. Project performance is related to the earned value achieved. Both the actual schedules as well as the actual cost achieved are tracked against the original project baseline, and variances detected. The project manager has to examine where and why variances are occurring, what costs require baseline changes, and which expenditures are wasteful/ unnecessary and can be eliminated.

Important concepts/ parameters in this analysis are:

Budget at completion (BAC) is the original cost estimate or budget for the project.

Time-now is the data date or the progress date and it is used to indicate up to what date the progress has been recorded

Percentage complete (PC) is the measure of activities performance and progress up to time now and is required for the earned value calculation.

BCWS (Budgeted Cost of Work Scheduled) is the original budgeted cost or the baseline plan.

BCWP (Budgeted Cost of Work Performed) or the earned value, is a measure of the value of the work done up to time now and is calculated as  $PC \times BAC$ .

ACWP (Actual Cost of Work Performed) is the amount payable for the work done up to time now i.e. the real cost incurred in achieving the progress reported.

Accounting variance =  $BCWS$  minus  $ACWP$  (This indicates the difference between budgeted & actual expenditure).

Schedule variance =  $BCWP$  minus  $BCWS$  (This indicates the budgetary value of the work completed as against the budgetary value of work planned or scheduled. A positive figure means the work is running ahead of schedule, a negative figure means work is lagging).

Cost variance =  $BCWP$  minus  $ACWP$  (This indicates the difference between the budgetary cost of the work actually performed, as against its actual cost. It is a

measure of pure cost variance.)

These parameters can also be worked into indices:

Schedule performance index (SPI) = BCWP/BCWS (SPI greater than 1 shows work is ahead of schedule and vice versa)

Cost performance index (CPI) = BCWP/ACWP (CPI greater than 1 shows that cost is under budget and vice versa. The cumulative CPI is a reflector of true cost efficiency from as early as 15-20% completion point of a project and can be used to accurately predict the final cost requirements for any project, even those spanning multiple years.)

The method can also be used for forecasting:

Estimate at completion (EAC): This is the revised budget for an activity, work package of project, based on current productivity. The EAC is calculated by extrapolating the performance trend from time now to the end of the project. It assumes that the productivity to date will continue at the same rate to the end of the project. The productivity is defined as costs (ACWP) / earned value (BCWP). If the costs are less than the earned value, the EAC will be lower than the BAC and vice versa.

The budget variance is BAC minus EAC.

The estimate to complete (ETC) is defined as EAC minus ACWP. This is a useful figure for the project manager to compare funds available with the cost to complete. A significant difference should trigger a review and build methods for a corrective solution.

The earned value figures can now be projected to give an overall status in tabular (or graphical) format which can be easily visualized. e.g.

(Rs)

WBS	BAC	BCWS	PC	BCWP	Status	ACWP	SV	CV	EAC
1.1	2000	1000	40%	800	Behind	1200	(200)	(400)	3000
1.2									
Total									

The concepts used in earned value project management are simple, but it takes a lot of discipline to employ these practices in any organization. The fundamental requirements to successfully implement earned value project management are summed up in the following steps:

1. You need to define the project, quantify and decompose the work, so that the effort can be planned, scheduled and estimated with a fair degree of certainty. A useful tool is the Work Breakdown Structure which decomposes work into measurable work packages.
2. You need to define who will perform which work. Work that is outsourced under formal contracts must be specially monitored. Vendors who do outsourced work would like to have changes in the scope of work, as it helps them to get out of commitments made under a tightly competitive bid. The project must compile a tight procurement and outsourcing package that can be legally enforced later, if required. All work done, whether in house or outsourced, must be measured.
3. Each piece of work must be formally scheduled and plotted into a specific time frame for performance. In complex projects, a full hierarchy of project schedules may be required. Every sub-ordinate schedule will reflect the same requirements as the project's master schedule. The inter-relationships between tasks also become important in a complex project. Critical paths must be aggressively managed using earned value schedule variances. Schedule variances  $< 1$  for tasks on the critical path indicate that the project is falling behind its baseline schedule.
4. The required resources for each task must be assessed and budgets formally authorized. Authorized budgets are key requirements for implementation of an earned value project management system.
5. The metrics required for measuring the completion of planned work and its conversion to earned value in the project must be determined. One way is to identify *milestones* in the project schedule. Each milestone has a weighted value and a specific budget. As you work towards the milestone, no earned value is credited. That will happen only when the milestone has been achieved and the total budget is earned. Another technique is the *fixed formula* method, where each individual task has a fixed budget. As a work is started a fixed percentage of the total budget is earned, and when the task is completed, another pre-defined percentage is earned, the two totalling 100% of the budget. Before the work starts the percentage values for starting and finishing each task are set. Earned value is credited only at the start or finish of the task. Hence the tasks should be small and cover only one or two reporting

periods. You could also have *percentage completion estimates*. If there is a long task over several reporting periods, the manager in charge may make his own assessment of the percentage of work completed in each reporting period. However, it may lead to excessive estimates of performance, with managers taking credit for work not yet performed. The percentage completion estimates can be combined therefore with milestones, implying deliverables, which serve as gates or check points.

6. The points of management focus, or the control account plans (CAPs) must then be formally laid down. CAPs are placed at selected WBS elements, and can be thought of as sub divisions of the total project. EVM measurement will take place within the specified CAPs. Total project performance would be a summation of the detailed CAPs.
7. Project managers have to be told what they have spent on their projects. Some organizations, if they are functionally oriented, find this very difficult to do. They cannot see the projects from the functions. However, this is very important if EVM is to be employed.
8. You must continuously monitor the schedule and cost results and the schedule and cost variances against the authorized baseline. Management will focus attention on the exceptions to the baseline plan. Negative schedule variances mean that the task is falling behind the work plan; if the late tasks are on the critical path the whole project is affected, and resources have to be applied to bring back the late tasks on schedule. Negative cost variances represent cost over-runs.
9. Using earned value metrics, the final required costs should be continuously forecast so that management is apprised and can take necessary corrective action wherever required. One method used is to assume that the project will continue at its established cost efficiency rate. For example, if the project budget is Rs 1 crore, and the cumulative cost efficiency factor achieved at 20% completion stage is 0.75, the final projected costs would be Rs 1.3 crore ( i.e. Rs 1 crore divided by 0.75.) thus there will be 30% overrun, which needs management attention.
10. Change requests in the project must be carefully managed and any change incorporated into the project baseline so that it remains valid. Maintaining an approved baseline can be a major challenge.

#### Lessons in Project Management Information Systems (PMIS):

- Because a PMIS works well in one organization, it need not necessarily suit another. It depends on the operating environment. A method of analysis cannot be forced on to a project. For example, there may be a

project that does not require critical path analysis and for which a different time planning technique may have to be applied.

- Project management is about managing projects and not about sophisticated systems. What are needed are not state of the art systems but systems that provided appropriate and adequate management information.
- The best PMISs are those, that project manager's trust and feel comfortable about using. PMISs are not about producing complex voluminous reports but rather, about generating the proper information to enable the project manager and major stakeholders to manage the relevant areas of their project.

#### Some Practical Aspects of Project Control:

**Prioritizing monitoring:** So far we have assumed that all aspects of a project will receive equal treatment in terms of the degree of monitoring applied. But monitoring also takes time and resources that can be put to better use. Certain priorities can be applied in deciding the focus points of monitoring:

- **Critical path activities:** Critical path activities are likely to have high priority, as any delay in these activities will delay the whole project.
- **Activities with no free float:** A delay in an activity with no free float will delay some of the subsequent activities, although, if the delay is less than the total float, it may not delay the project completion date. But the delay could have serious implications for resource scheduling, as a delay in a subsequent activity will mean that the resources for that activity will remain locked up until the activity is completed.
- **Activities with less than specified float:** If an activity has very little float, it might use up this float before regular project monitoring brings the problem to the notice of the project manager.
- **High risk activities:** A set of high risk activities should be identified as part of the initial risk profiling exercise. These could be defined as those that have a high estimated duration variance. These activities should be given close attention as they would have likelihood of overrunning or overspending.
- **Activities using critical resources:** Activities can be critical because they are very expensive. Staff or other resources may be available only for a limited period, especially if they are controlled outside the project team. Any activity that requires a critical resource requires a higher level of

monitoring.

Ultimately, it is the project manager's responsibility to establish priorities. Allowing the workforces to have their own priorities could adversely affect the scheduling of the project.

Getting a project back on target: Almost any project will be subject to delays and unexpected events. The project manager has to recognize when this is happening and with minimum delay or disruption, attempt to mitigate the effects of the problem. The first attempt would be to ensure that the project end date remains unaltered. This can be done by shortening remaining activity durations or shortening the overall duration of the remaining project in various ways including rearranging workload or applying more resources/efforts. This may however not always be the most appropriate response to disruptions in a plan. There are obviously trade-offs involved. For example, applying more resources will remedy a time delay, but will increase costs and perhaps make quality management a little less effective. The decision that is to be taken depends upon the goals of the project and whether time, cost or quality is the main consideration.

It all depends on what is important for the client. For example, there is no point in speeding up activities by making huge overtime payments in a project when the client is not overly concerned about the delivery date and is more sensitive to cost. In such a situation, the project manager may have to consider moving milestone dates or lowering the level of quality/expectation. These can be resorted to only after consultation with the client/ higher management.

Dealing with change: Changes can have an adverse effect on project performance and should be kept to a minimum. Change for change's sake causes confusion and disruption and places the project at risk. Change has to be properly planned and executed. It may be a good idea to discuss changes to the plan with actual executors first:

To see if the changes are possible  
To get their input for the planning  
To gain their commitment.

A formal review and control mechanism must be introduced. The change control process would incorporate the following elements:

- Continually identify changes as they occur;
- Reveal their consequences in terms of impact on project cost, project duration and other tasks;
- Permit managerial analysis, investigation of alternative courses of action;

- Communicate changes to all parties concerned;
- Specify a policy for minimizing conflict and resolving disputes;
- Ensure that required changes are implemented;
- Report periodically on all changes to date and their impact on the project.

#### Some Other Practical Aspects:

- Failure to coordinate and communicate information between department lead to a dissipation of company resources and duplication of effort. It will limit the amount of cross checking, which is a useful method for identifying discrepancies and future problems.
- An effective way to achieve commitment is to make the person aware of the cost of any delay to the project.
- An excuse often used for not feeding progress back to the planner is “we don't have the time” or “we are too busy doing the work”. The project manager must ensure that all the project members appreciate that data capture is an important aspect of their management function.
- Short training programmes can ensure that all managers appreciate and understand how information is flowing in the project.
- The process of project tracking and analysis should be seen as a tool for the project manager and not as a means of removing responsibility.
- Avoid persecution of the responsible parties if there are overruns, otherwise in future the managers will be reluctant to give any information for fear that it will be held against them. Project control should be seen as a tool to assist managers reach their objectives, not as a weapon of attack.
- As the schedule is only an estimate, you must expect activities not to be as per the schedule – introduce a degree of flexibility.
- Encourage the team members to inform you of deviations.
- Although plans should be revised to reflect current progress, it is important not to forget the original baseline plan to guide the project to completion.
- Respond early to any variation, before small problems become disaster.

- If the project is in serious jeopardy, the client and stakeholders should be informed.



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Notes:

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