PROJECT ENGINEERING

Chapter 4 - Project Implementation and controlling

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Project Implementation and Controlling

Contents

Monitoring, Evaluation and Controlling

Monitoring

- Monitoring is collecting data, recording and reporting the information concerning all aspects of project managers or others in the organization wish to know.
- It is a management function to guide in the intended direction and to check the performance against the predetermined plans.

Evaluation

- It is the *systematic judgmental process* for determining the relevance, efficiency, effectiveness and impact on the project performance.
- It is done to *improve the project implementation and to improve future project planning*.

Controlling

- It is the management function of comparing the actual achievements with the planned ones at every stage and taking necessary actions, if required to ensure the attainment of the planned goals.
- It includes three step process
- Monitoring+ Evaluating+ Taking necessary actions

Project Control

- The project is controlled by **project control system**.
- The project control system is an arrangement that offers the project manager with details about the deviations of the project from what has planned and also recommend corrective actions needed for rectifying the deviations.
- The control system help in identifying the cost over run situations and deviations from quality parameter.

Types of control

Pre-control

- It is initiated before the start of the activity. It detects the probable problem in advance and takes preventive , corrective actions

Go/No-go control

- It takes the form of testing to make sure that certain preconditions are met before the task is undertaken. This type of control is used for specific part of the project.

Post control

- It is initiated after completion of the activity. It is based on the feedback performance results.

Elements of effective Project Control System

- Correct and timely communication, regular feedback from implementation, and effective management of data are prerequisite for the control to be effective.
- **It includes:**

✓ Conformity to plans and activities
✓ Appropriate to positions and personalities
✓ Simplicity
✓ Accepted by the persons concerned.
✓ Timeliness
✓ Economy
✓ Emphasis on critical factors (T-C-Q)
✓ Corrective plan
✓ Flexibility

Difficulty in implementing the project control system

- Departmental and management gaps
- Uniqueness of the project and its organization
- Human factors (resistance to change, reluctance to display their plans)
- Complex characteristics of project
- Difficulties in keeping track of performance and expenditure of complex project.
- Uncertainty and change
- Poor control and information system.

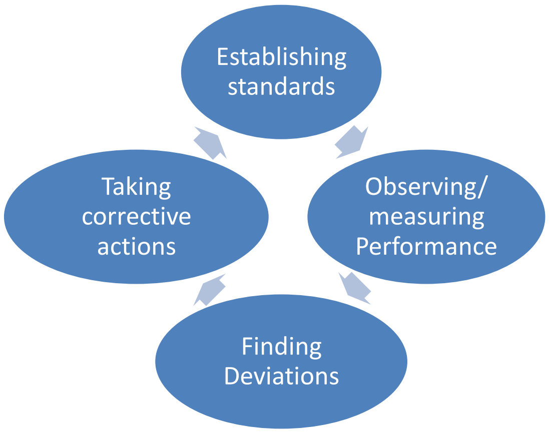
Difficulties in project control in Nepal

- In Nepal cost is given prime importance which results in slippage of time and poor workmanship quality.
- Reluctance to change/ adopt proper control measures by experienced personnel of the project team.
- Inappropriate reporting system or partially reporting.
- Personnel bias of project staff
- Few project managers believe that with time problem will get automatically resolved but in actual it worsen.

Difficulties in project control in Nepal

- Where the project manager looks the several projects, there may be tendency to affect the poor performance in one project against the good performance in the other project.
- Information reporting and accounting mechanisms may be misleading
- Other factors like culture, norms, values of personnel, time period available, geographic location.

Project control cycle



Establishing standards(What to be done)

- Project performance standards are based on project planning. Through the standards project is controlled. They are the standard point of control. They should be reasonable standards and can be in terms of time, quantity, quality cost etc.
- Observing/ measuring performance (What actually was done)
- Actual performance is measured within a given period. It is continuous ongoing process to feedback. Suitable monitoring system is required to get required information.

Finding deviations (extent and cause of deviations)

- In third steps the actual performance is compared with the standards and deviation is identified if any. The sources of the deviation is analysed.
- Taking the corrective actions
- After the identification of deviation, then corrective actions are taken to bring back the project on track. If the performance deviation is within allowable limit, no action will be taken. If not, they can be corrected by improvement of design: changing raw materials etc. or standards can be revised as requirement.

Elements project control

Time control

- The time/schedule control process monitors and controls the changes to the project schedule. **Output includes**
- Updates of the schedule model data and baseline
- Performance measurements
- Requested changes
- Recommend corrective actions
- Updates the project management plan
- Activity list and activity attribute updates

Cost control

- Cost control may be broadly defined as the process of controlling the expenditure in a project at all stages from the inception through its development.
- Cost control means controlling the changes to project budget.
- Cost control is mainly concerned with:
  - Influencing the factors which create changes to the cost baseline to ensure that changes are beneficial.
  - Determining the cost baseline has changed.
  - Managing the actual changes as when they occur.

Elements of cost control

Elements of cost control	Description
Observation	Regular observation should be made on: material consumed, manpower and equipment employed, other direct costs
Comparison	The observed data must be compared with the design standard by calculating variances
Identify the reasons for variance	If the variance is large, it is important to know the reasons for the variance. For this it is important to check the purchase price of materials, quality, wastage, work condition
Corrective action	If the variance cannot be justified then the middle level or higher level management takes the necessary action for bringing the cost of the project in to the track. It should be worked out and implemented which may include re-scheduling of the project

Quality control

- The quality control performances process measures specific project results to determine whether the project is meeting quality standards.
- Under the quality control following things are used:
  - Raw materials and intermediate stage product testing
  - Some self inspection by operator
  - Lagging process performance data
  - Feedback process information to the operators, setters and production supervisors
  - Use of basic statistics
  - Process control

Quality attributes for products and services

- Performance
- Features
- Reliability
- Serviceability
- Durability
- Aesthetic characteristics
- Perceived quality
- Conformance

Project schedule control

- Controlling schedule is the project management activity in which the activities are compared against the schedule baseline to understand whether project is ahead of schedule or behind.
- Based on the deviation you can plan on corrective or preventive actions and manage the baseline.

Schedule control involves

- Determining the current status
- Influencing factors that could cause schedule changes
- Identify if the schedule has changed
- Managing the changes as they occur.

Project quality control

Quality control

- Quality control is the process for monitoring specific project result to determine whether this comply with relevant quality standards and identifying ways to eliminate cause of unsatisfactory performance.
- According to American society for quality (ASQ)" Quality control consist of the observation techniques and activities used to fulfill requirement for quality."

Quality Assurance

- Quality assurance is a broad practice used for assuring the quality of products or service. According to ASQ quality assurance is the planned and systematic activities implemented in a quality system so that quality requirements for the product and service will be fulfilled.

Quality control vs Quality assurance

- Quality control is a product oriented whereas quality assurance is process oriented.
- Quality control makes sure that the end product meets the quality requirement where as quality assurance makes sure that the process of the manufacturing the product does adhere to the standards.
- Quality assurance can be identified as a productive process while quality control can be noted as a reactive process.

Techniques of Quality control

Following techniques shall be applied for the quality control/assurance:

- Preparation of quality control/ assurance plan
- Regular inspection/ supervision
- Testing
  - a. Destructive test or non destructive
  - b. field or lab
- Sampling
- Identifying deviations or discrepancies
- Adopting necessary corrective measures

Cost of quality

Cost of quality is a combination of :

- Cost to control quality (Prevention and appraisal)
- Cost of failure to control quality (Internal and external failures)

- Cost of quality becomes the cost to the company of doing things wrong, of not confirming the specification.
- The cost of quality includes following costs:

Prevention cost

- The cost of preventing defective work is usually extended before the product is made or service rendered. These cost include:

✓ Design reviews and drawing checks
✓ Quality orientation program, education and training
✓ Process control
✓ Process orientations
✓ Suppliers evaluation and presentation
✓ Workers training.

Appraisal cost

- The cost of appraisal is incurred for auditing service procedure to make sure they conform to the prescribed work practices. These include

✓ Process capability managements (e.g. control charts)
✓ Tests, gauges, test equipments
✓ Prototype inspection and tests
✓ In process and final inspection and tests
✓ Checking material furnished by suppliers
✓ Work in process goods testing and inspections

Internal failure costs

- Internal failure costs is applicable when the product is in factory and not been sold. These cost include

➢ Expenses for producing items that are scrapped
➢ Redesign
➢ Reworking and downtime
➢ Retesting defective items
➢ Lost value of items sold as seconds
➢ Cost of delays
➢ Administration time to review non conforming materials for disposition
➢ Scrap

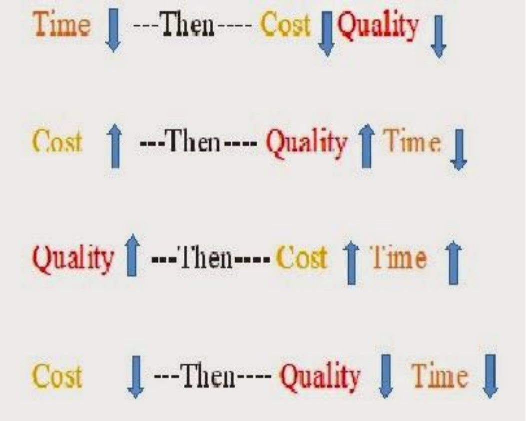
External failure costs

- These cost are applicable to goods when the product has been sold. These cost include:
  - Warranty cost
  - Product liability(insurance and settlements)
  - Consumers affairs (dealing primarily with the customer complaints about quality)
  - Field service (mostly repairs of what should have worked)
  - Product returns, recalls

Tools for quality control

- Well written specification
- National and international standards (codes) NS , ISI
- Other international organization WHO,UNO
- Procedural guidelines
- Training.

Relation between time cost and quality



Earned Value Analysis

- Earned value analysis is an approach for measuring, how much has been completed in a project at given point of time and performance
- This analysis can be done by calculating how much time, the work has taken and the resources it has utilized.
- These value are compared with the planned value of time and resources. If the time taken to do the particular task is greater than what was planned, it means that the project is running behind schedule.
- Similarly, if the resources utilized are more than what were planned, it means the project has not been managed efficiently in terms of resources.

Performance Control Using Earned Value

- The earned value cost analysis relates the budget costs with the time progress.
- Earned value is **the value of work done at a given point of time**.
- Earned value analysis (EVA) is a tool that compares the value of work done with the value of work that should have been done.
- EVA is often presented in the form of progress or S-curve diagrams.
- EVA is a way to measure the amount of work actually performed on a project (i.e. to measure its progress) and to forecast a project's cost and date of completion.

Earned Value Performance Parameters

1. Planned Value (PV) /(Budget Cost of Work Schedule (BCWS).

- It is the cumulative planned value of authorized work scheduled for completion on date at contract rate.
- Planned Value is the value that you should have earned as per the schedule
- Cumulative planned value curve plotted at various periodic interval is called the project cost baseline.
- It represents time-phased cost projections of planned value in the budget for example, if a project has a budget of Rs 10,00,000.00, and five month schedule shows completion of 40 percent of the value of project work, the PV for the fifth month is Rs 400,000.00
- The Planned Value is also called the **Budget Cost of Work Schedule (BCWS).**

2. Actual Cost (AC)/ (Actual Cost of Work Performed (ACWP)):

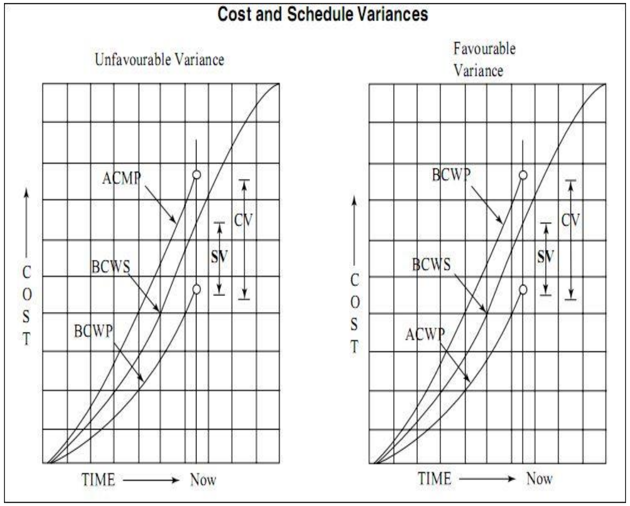
- It is the cumulative actual costs including apportioned management reserve incurred in the project on data date.
- Actual Cost is the amount spent on the project to date
- The actual cumulative cost curve is developed progressively with the completion of activities during the course of project implementation.
- During execution, the actual cost variance with respect to the planned cost, creates favorable or unfavorable project situations. For example, if a project has a budget of Rs. 10,00,000 and Rs. 4,00,000 has been spent on the project to date, the AC of the work done would be Rs. 4,00,000.
- Actual Cost is also known as **Actual Cost of Work Performed (ACWP).**

3. Earned Value (EV) (Budgeted cost of work performed (BCWP))

- It is the cumulative value of the authorized work actually executed on a given date at contract rate.
- Earned Value is the value of the work actually completed to date
- It is obtained by multiplying the cumulative values of the quantum of the work actually executed with the corresponding budgeted unit costs of the respective activities.
- For example, if a project has a budget of Rs. 10,00,000.00 and the work completed to date represents 25 percent of the entire project work, its EV is Rs. 2,50,000.
- This cumulative earned value curve is also called **'budgeted cost of work performed' (BCWP)**.

Earned Value Variances, Performances and Trends Measures

- **Variance Measures:**
- If the project progresses exactly as per cost and time integrated plan, the three parameters will be identical. But this is a rare case.
- PV, EV and AC parameters, when plotted graphically against the time scale, resembles the 'S' curve pattern,
- The difference between **EV-AC** and **EV-PV** during implementation phase, generates variances.
- To quote example, graphical representation of the PV function along with two typical cases of EV and AC, one with favorable and the other with unfavorable variances is given in Figure
- In both cases on reported date (Time Now), there is variance in between EV and AC; and, between EV and PV.



Cost variance.

- Cost variance is computed by comparing actual performance (AC) with the budgeted cost of work performed (EV). Mathematically it is computed as under: *Cost variance = EV – AC*

a. If the cost variance is positive, then the project has a cost under-run, i.e. the cost incurred is less than the planned or budgeted cost.

b. If the cost variance is negative, then there is a cost over-run, i.e. the cost incurred is more than the planned or budgeted cost.

c. If the cost variance is zero, then the project is proceeding according to the budgeted cost.

- Cost overrun and cost underrun are usually expressed in percentages and derived as : *Cost overrun (underrun) % =* $\frac{BCWP - ACWP}{BCWP} * 100$

Schedule variance.

- Schedule variance is computed by comparing planned performance (BCWP) with budged cost of the work schedule (BCWS). Mathematically it is computed as under:

Schedule variance = EV – PV

a. If schedule variance is positive, then the project is ahead of its planned cost, i.e. earned value of the work performed is higher than the planned or scheduled earned value.

b. If scheduled variance is negative, then the project is behind its planned cost, i.e. earned value of work performed is less than the planned or scheduled earned value.

c. If scheduled variance is zero, then the project is proceeding according to the planned schedule.

- When the project is behind the schedule, there is schedule (or time) overrun. Similarly there is time underrun, if the project is ahead of schedule.
- Time overrun (or underrun) is equal to the period that the project is behind or ahead of the schedule.
- Time schedule overrun (or underrun) is expressed in terms of percentage and derived as :

Schedule overrun (or underrun) % = $\frac{BCWP - BCWS}{BCWS} * 100$

Cost trends/forecasts.

- Variance analysis reveals the extent and causes of variances.
- On the other hand, performance efficiency determines how efficiently the task was done and what its implications will be on future trends.
- Future trends in productivity, cost and time performance can be predicted as under:

  Cost Performance Index = EV/AC

  Schedule Performance Index = EV/PV
- An index of 1.0 or greater indicates a favorable performance and less than 1.0 implies an unfavorable trend.

Commonly Used Formulae for Earned Value Analysis

Variances Formulae :

Cost Variance (CV)= EV – AC

Schedule Variance (SV) = EV – PV

Indices Formulae:

Cost Performance Index = CPI = $\frac{EV}{AV}$ (Cost Efficiency)

Schedule Performance Index = SPI = $\frac{EV}{PV}$ (Schedule Efficiency)

Status in Percentage Formulae:

- Schedule variance as a percentage of the PV = SV% = $\frac{EV - PV}{PV} * 100$
- Cost variance as a percentage of the EV = CV% = $\frac{EV - AV}{EV} * 100$
- Percentage completed on data date = $\frac{EV}{BAC} * 100$
- Percentage spent on data date = $\frac{AC}{BAC} * 100$
- Percentage of project scheduled to be achieved on data date = $\frac{PV}{BAC} * 100$

Trends Formulae:

- Estimated Cost At Completion = EAC = AC + $\frac{BAC - PV}{CPI}$, forecasting ETC at budget rate
- Variance at completion = VAC = BAC – EAC

Example: EVA

- A contractor was responsible for 125 m^3 of concreting to be done in 10 days with the expenditure of Rs. 12,50,000. At the end of 3rd day he managed to complete 40 m^3 of concreting work with expense of Rs. 375,000. Perform EVA and comment on this performance.
- **Solution:**

Given:

Total work = 125 m^3 of concreting

Total project cost = Rs. 12,50,000

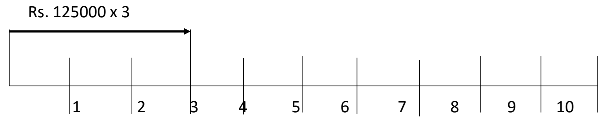
Monitoring date = 3rd day from start

Work Completed at this day = 40 m^3 of concreting

Expenses for completed work so far = Rs. 375,000

Solution:

Budgeted Cost for Work Schedule (BCWS)/ PV:



- Cost of concreting for 10 days = 12,50,000.
- Cost per day as per schedule = 12,50,000/ 10 = Rs. 1,25,000.
- Scheduled Cost for 3 days = 3* 1,25,000. = Rs. 3,75,000.

Budgeted Cost of Work Performed (BCWP)/ EV :

- Cost per m^3 of concreting = Rs. 10,000.
- Performed work upto monitoring = 40 m^3
- So, Scheduled cost or Budgeted cost of work performed = 10,000 * 40 = 400,000.

[This is value earned from the work performed]

Actual Cost of Work Performed (ACWP)/ AC

- Actual expenses of work performed upto monitoring = Rs. 3,75,000

Variances:

- Cost Variance (CV) = BCWP – ACWP = 400000 – 375000 = 25000 (+ve)

This shows the project is under budgeted (less spending than plan)

- Schedule Variance (SV) = BCWP – BCWS = 400000 – 375000 = 25000 (+ve)

[Ahead of Schedule]

Indices

- Cost Performance Index (CPI) = $\frac{BCWP}{ACWP} = \frac{400000}{375000} = 1.06 > 1(\text{under budget})$
- Schedule Performance Index (SPI) = $\frac{BCWP}{ACWP} = \frac{400000}{375000} = 1.06 > 1$ (ahead schedule)

Variances in %

- Cost variance (CV %) = $\frac{CV}{BCWP} = \frac{25000}{400000} = 6.25\%$
- Schedule Variance (SV%) = $\frac{SV}{BCWS} = \frac{25000}{375000} = 6.67\%$
- Here cost is spending less than budgeted by 6.25% and schedule is ahead by 6.67%

Forecast

- Estimate @ completion (EAC) = $\frac{Total\ Project\ Cost}{CPI} = \frac{1250000}{1.06}$ = 11,79245.28
- Schedule @ completion (SAC) = $\frac{Total\ Project\ Duration}{SPI} = \frac{10}{1.06} =$ 9.43 days

Variance @ completion

- VAC cost = Scheduled cost – EAC = 1250000 – 1179245.28 = +70754
- VAC schedule = Scheduled duration – SAC = 10 – 9.43 = +0.57 days

Numerical

- 50 units of plantation have to be done in 4 weeks period. Per unit cost of plantation is estimated as Rs. 200 of which progress monitoring was done 3 weeks after the work was started. Only 60% work was found completed and the account record showed that the actual expenditure for plantation per unit was Rs. 300. Perform EVA and comment on works.

Project management information system (PMIS)

- It is a system of a data base for the project.
- It may be defined as a system of obtaining, abstracting, storing, retrieving and analyzing data produce information for the use by the managers in planning, controlling and decision making. It consists of people, equipment and procedure. It is continuously developing in nature.
- An information system includes
  - Policy flow from the management
  - Information flow to the management

Objectives of PMIS

- To reduce project duration
- To make better use of resources
- To increase resources productivity
- To decrease cost/price
- To bring the new facts to the knowledge
- To reduce the uncertainty in decision making

Advantages of PMIS

- Promote the better understanding in project
- It helps to target control by quantifying the risks and initiating the corrective actions
- It helps to comprehend the change in the project
- It provides basis to monitor, evaluate and show the interrelationship among cost. Schedule and technical performance of entire project.
- It helps to identify project problem before they occur
- It helps to make better decision and execution of those decisions

- It facilitates project planning
- It informs the stakeholders about the progress and status of project.
- PMIS simplifies project control
- It reduces information overload in project
- It facilitates project transaction such as progress payments
- It targets control by quantifying the risks, testing proposed control and initiating corrective actions.

Some PMIS Software

- Microsoft Project
- Clickup
- Nifty
- Wrike
- Teamwork Project
- TeamGantt
- Basecamp
- Monday.com