Block-III

Project & Operations Management

Project Implementation and Closing

Block

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PROJECT IMPLEMENTATION AND CLOSING

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BLOCK III: PROJECT IMPLEMENTATION AND CLOSING

The third block of the course on Project & Operations Management deals with project implementation and project closing. This block contains five units. The first unit in this block explains project cost management. The second unit focuses on project risk management. The third unit examines project quality management. The fourth and fifth units of the block discuss project auditing and project closing, respectively.

The first unit, *Project Cost Management*, discusses the process of managing costs, and planning the resources. The unit also deals with the concepts of cost estimating, cost budgeting, and cost control. Finally, the unit discusses cost overruns and their implications.

The second unit, *Project Risk Management*, deals with the definition of risk, and examines the concept of tolerance for risk. The unit also defines risk management, and explains decision making under the conditions of certainty, risk, and uncertainty. The unit provides an idea about the risk management methodology, and the concept of insurance for projects.

The third unit, *Project Quality Management*, defines quality and discusses the international quality standards. The unit deals with the cost of quality, and explains the various project quality management concepts. It also explains the different project quality control tools. The unit examines the concepts of process capability, acceptance sampling, quality circles, and just-in-time management, and total quality management.

The fourth unit, *Project Auditing*, explains project evaluation and its purpose. The unit discusses project auditing, and the construction and use of audit report. The unit also provides an idea about the responsibilities of the auditor, and discusses the project audit life cycle. It also deals with the essentials of an audit, and the concept of performance measurement.

The fifth unit, *Project Closing*, provides an idea about closing a project. The unit explains the various ways in which a project can be closed. The unit also deals with the reasons for terminating an unsuccessful project. It discusses the process of closing a project.

Unit 11

Project Cost Management

Structure

11.1 Introduction

In the last unit we have discussed about project control. In this unit, we will discuss project cost management. Project cost management includes all the processes that are required to ensure that the project is completed within the approved budget. After each phase of the project is completed, cost management estimates the resources (people, equipment and materials) that were already spent and the budget needed for all subsequent project phases.

Cost is a major element used to measure the performance of a project. As the project progresses, the project manager notes the differences between the planned and the actual costs. He then measures the impact of these differences on the overall project budget is measured. Changes are made to the budget, if necessary, using cost control procedures, with the permission of the client and other stakeholders.

Estimating the cost of a project is difficult as it is affected by different factors like inflation, the exchange rate, demand and supply conditions, seasonal effects, etc. Other than these external factors, internal factors like mismanagement of various resources, failure to complete activities within the specified time, mishandling of equipment and employee absenteeism increase project costs.

Cost management is an important concern for the project manager, as costs directly affect the profits of the firm. However, merely reducing costs should not be the objective of the project manager. If costs are minimized by reducing the number of reviews and inspections, the project output is likely to be of poor quality.

If a project incurs higher costs than originally envisaged, the project client loses confidence in the firm and the firm earns a bad reputation. Thus, the process of cost management requires proper planning and implementation at every stage of the project, if the project is to be a success.

This unit will discuss the process of managing costs, and resource planning. We will discuss the concepts of cost estimating, cost budgeting, and cost control. Finally, we would be discussing cost overruns and their implications.

11.2 Objectives

By the end of this unit, students should be able to:

- Explain the process of cost management.
- Define resource planning.
- Discuss the concepts of cost estimating, cost budgeting, and cost control.
- Define cost overruns, and identify their implications.

11.3 Process of Cost Management

The process of cost management involves four steps – resource planning, cost estimating, cost budgeting and cost control. Resource planning identifies the resources required and the quantities required of each of these, for the completion of the project. Cost estimating is calculating the approximate costs of all project activities, while cost budgeting is the assigning of costs to each project activity. Cost control involves taking necessary steps to keep project costs within permissible limits.

11.4 Resource Planning

Resource planning is the process of identifying what project resources are required and in what quantities for an organization or a scope of work. Resources normally include money, manpower, machinery and materials. For instance, the construction of a cement plant requires skilled workmen, some initial investment, machines like concrete mixers and various construction materials. The project manager should have a thorough knowledge of all the project activities in order to allocate the resources properly. Resource planning involves the evaluation and planning of the use of the physical, human, financial and informational resources required to complete work activities and their tasks. Most activities involve usage of people to perform work, some activities involve materials and consumables. Some tasks like engineering and software design involve creating an asset with the help of information inputs.

Resource planning is done after considering the Project Scope Statement, the Work Breakdown Structure of the Project (WBS), Historical Information, Description of the Resource Pool, and Organizational Policies.

Project Scope Statement: The scope statement allows all project stakeholders to gain an understanding of the project. It explains why the project has been taken up and what the main objectives of the project are. Both these aspects have to be considered during resource planning.

Work Breakdown Structure (WBS): The WBS is a deliverable-oriented grouping of project elements. Each descending level of WBS represents an increasingly detailed description of a project component (the component may be a product or service). The bottom levels of WBS of a project give a clear picture of work packages to be handled and thereby the type of resources required and also their quantities. As it describes all the project activities, it gives the project manager an idea of the resources that will be required.

Historical Information: The project manager studies similar projects that were successfully implemented earlier. This gives him an idea of the resources the project manager will require to execute the current project.

Description of Resource Pool: Here, the project manager specifies what project resources are required and in what quantities. For example, the skill levels of the workmen, and the kind of machinery and materials to be used, are listed. The resource pool description is specific to each project.

It also varies from one phase of the project to another. For example, in the planning phase of an engineering design project, only senior engineers are required. While the project is being executed, junior engineers can also be used for activities like inspection, quality testing, etc.

Organizational Policies: The project manager has to abide by the organizational policies while developing resources plans. Policies regarding the purchase of supplies and staffing should be considered. For instance, if a firm has a long-term contract with a specific supplier for the procurement of raw materials, the project manager must go to the same supplier.

While allocating resources for various project activities, the project manager identifies the alternative ways of completing each activity and makes use of the opinions of experts in various fields.

11.4.1 Identification of Alternatives

There may be several ways of completing a particular project activity. The resources required vary with each method. The project manager uses techniques like brainstorming and focused group interviews to identify different methods of completing different activities. For example, the project manager may hold

discussions the fellow team members to identify the suppliers in the market from whom they can procure the required raw materials.

11.4.2 Expert Opinions

The project manager consults experts like consultants and researchers, to determine what inputs are required will require to implement the project. The ideas given by these experts help the project manager to come up with better resource plans. Sometimes, the project manager may get contradictory views about resource allocation. When this happens, the project manager should choose a suitable approach after a careful analysis of his own constraints.

The 'Resource Planning' process thus specifies the project resources required to execute a project. The resource plan shows the type of resources required and the quantities in which these are required. These resources are obtained either through staff acquisition or by procurement.

Check Your Progress - 1

1. Which of the following options depicts the correct sequence of steps in the process of cost management?
   i. Cost budgeting
   ii. Cost estimating
   iii. Cost control
   iv. Resource planning
   a. Option i followed by ii followed by iii and iv
   b. Option iv followed by ii followed by i and iii
   c. Option iii followed by ii followed by i and iv
   d. Option ii followed by iii followed by i and iv
2. _____ includes all the processes that are essential to ensure that the project is completed within the approved budgets.
   a. Resource planning
   b. Project cost management
   c. Cost budgeting
   d. Cost control
3. Which of the following options provides an understanding of the project and is part of the resource planning of a project?
   a. Project scope statement
   b. Work breakdown structure
   c. Organizational policies
   d. None of the above

4. _____ is considered as the deliverable-oriented grouping of project elements.
   a. Project scope statement
   b. Organizational policies
   c. Work breakdown structure
   d. None of the above
5. Which of the following steps in the process of cost management involves taking necessary steps to keep the project costs within the permissible limits?
   a. Cost budgeting
   b. Cost estimating
   c. Cost control
   d. Resource planning
6. The step in cost management that involves identifying the project resources required and in specific quantities is _____.
   a. cost estimating
   b. cost budgeting
   c. resource planning
   d. cost control

11.5 Cost Estimating

The project costs are of different kinds – direct costs, project overhead costs and general and administrative (G&A) overhead costs. The total project cost estimate is broken down in this manner to sharpen the control process and improve decision making. Direct costs are related to the costs of labor, materials, equipment, etc. These costs are clearly chargeable to a specific work package. Direct costs represent real cost outflows and must be paid as the project progresses. Direct overhead cost can be linked to project deliverables or work packages. Examples include the salary of the project manager and temporary rental space for the project work. General and administrative (G&A) overhead costs are the organization costs that are not directly linked to a specific project. They are carried for the duration of the project. Examples include costs of advertising, accounting and senior management above the project level .Cost estimates, budgets, WBSs and project schedules are interrelated. After the resource requirements are identified, the project manager develops an estimate of the costs of the resources required to execute the project. This includes identifying and evaluating various cost alternatives. Cost estimates, ideally, base upon the WBS elements and are prepared at the bottom levels of WBS consisting of identified and clear work packages. But such estimates are only preliminary estimates because they reflect not only uncertainty varying with type of projects,

but also schedule difficulties. The project manager considers the WBS, resource rates, activity duration estimates, historical information and the chart of accounts in estimating the costs. Project schedules help in understanding the need for resources and rate of expenditures.

The WBS is used to ensure that cost estimates are made for all the identified activities. The resource rates show the cost of each unit of resource such as labor cost per hour, the cost of one litre of lubricant oil, etc. The project manager considers the activity duration estimates for all the project activities to know by what time the resources should be made ready.

The project manager also considers historical information in estimating the cost of the project. Project manager studies project files, and commercial cost estimating databases of past projects. A good overall understanding of similar projects undertaken in the past proves helpful. The chart of accounts is a numbering system used to monitor project costs by category (labor, supplies, materials, etc.) It is a coding structure that the firm uses to report financial information in its ledger. Some of the techniques used by the project manager to estimate costs are -- analogous estimating, bottom-up estimating, parametric modeling, and computerized tools.

11.5.1 Analogous Estimating

In analogous estimating, the project manager considers similar projects (analogous projects) or work packages (analogous work packages) to estimate the costs of the current project. Based on the actual costs incurred in that project, the project manager prepares the cost estimates by considering the parameters like time value of money, inflation rate, etc. The cost for a similar project as a whole or a similar work package is analyzed and adjusted for differences between it and the proposed project or work package, by considering the differences in project scale, locations, dates, complexity, exchange rates, etc. Though this type of estimating is easy and economical, but it is less accurate than the other methods.

Normally, this technique can be used only in consultation with an expert. The difficulty in using this approach lies in finding a similar project and determining its actual costs. This technique is also called the *top-down estimating*.

11.5.2 Top-down and Bottom-up Estimating

Cost estimating can be done in two ways: top-down and bottom-up. In top-down estimating, the project cost is estimated by looking at the project as a whole. This type of cost estimating is typically based upon an expert opinion or analogy to other similar projects. In bottom-up estimating, the cost of each end-item element or work package of the project is calculated separately and all these costs are added up to estimate the total project cost. The smaller the work elements of the project, the greater will be the accuracy of the estimate.

These two approaches can be used in combination: portions of a project that are well defined can be estimated using bottom-up approach, whereas other less-defined portions of the project can be estimated by the top-down approach. Similarly, the cost of each work package can be estimated either way. The work package is broken down into small elements and cost estimation of each element can be done by using bottom-up approach. Or a gross estimate can be made from analogy or expert opinion under top-down approach. The bottom-up method provides better estimates than the top-down estimation, but it is a more time-consuming method requiring more data.

11.5.3 Parametric Modeling

In parametric modeling, cost estimates are made using empirical or mathematical models, which use relevant project "parameters". This method can be used with an analogy project to sale costs up or down, or it can be used directly without an analogous project when costs are a function of system or project "parameters". The parameters can be physical features like area, length, weight, volume and capacity, or performance features like speed, power and strength. For instance, if, according to the estimates of the project manager, the cost of constructing a building is ₹. 20,000 per square yard, a sum of ₹. 20 million is required for constructing a 1000 square yard building. Even if the estimates made with these models are not exact, they give the project manager a rough idea about the costs that are likely to be incurred.

Parametric modeling provides reliable estimates when – the model is developed on the basis of accurate historical information; all project parameters are quantifiable; and the model is scalable (can be applied to all projects irrespective of their size).

11.5.4 Computerized Tools

The project manager can use computerized project management software packages like Project 2000 to estimate the project costs. These software packages compute various costs once the relevant data is provided. The project manager prepares the cost estimates, supporting details and the cost management plan of the project on the basis of techniques discussed above. The cost estimates for all the project resources are expressed in terms of rupees dollors, etc.

The project manager provides supporting details for the project cost estimates. He describes the work estimated (based on the WBS), the basis of estimation, specifies the assumptions made in the estimation and calculates the range of possible estimates. The project manager also prepares a cost management plan that describes how cost variances can be managed. This plan is highly detailed and prepared in such a way as to meet the requirements of the project stakeholders. A good cost management plan lets the stakeholders know how the project manager is going to estimate project costs.

Activity: Today, leading English daily in northern India has 16 editions to cater to readers all over North India. Recently, the management of the Today Group decided to start a new edition in South India to increase its circulation and sales. The chairman of the Today Group, Babu Ramji appointed Subhash Chakravarthy as the project manager and asked him to estimate the costs of the project. What are the alternative techniques available to Chakravarthy to estimate the costs of the project? What are the requirements that Chakravarthy needed for cost estimating?

Answer:

Check Your Progress - 2

7. In which method of cost estimating, the cost of each element of the project calculated separately and then added up to estimate the total project cost?
   a. Analogous estimating
   b. Bottom-up estimating
   c. Parametric modeling
   d. None of the above
8. Under which of the following methods does the project manager estimate the costs by considering similar projects?
   a. Analogous estimating
   b. Bottom-up estimating
   c. Parametric modeling
   d. None of the above
9. In parametric modeling, which of the following conditions need to be fulfilled in order to give reliable estimates?
   a. The project parameters should be quantifiable
   b. The model should be developed on the basis of accurate historical information
   c. The model should be scalable
   d. All of the above
10. Which of the following techniques for estimating costs is also called the 'top-down estimating' technique?
    a. Parametric estimating
    b. Bottom-up estimating
    c. Analogous estimating
    d. None of the above

11.6 Cost Budgeting

Cost estimating serves as a base for the cost budgeting. A cost estimate may undergo several refinements, but once approved, it becomes the budget. In the process of cost budgeting, the project manager allocates the costs to individual work items, based on the cost estimates made. The cost allocated for each individual work becomes the cost baseline for that work. These cost baselines are used to measure the cost performance of the project. The Work Breakdown Structure and the cost estimates made (in the 'cost estimating' process) help the project manager to determine the amount of resources to be allocated for each project work element.

The project schedule helps the project manager to assign costs to the time period during which the costs will be incurred. The project manager can also use techniques like Analogous Estimating, Bottom-up Estimating, Parametric Modeling, and Computerized Tools (discussed earlier) in cost budgeting.

11.6.1 Preparation of Cost Baseline

The 'cost baseline', an output of cost budgeting, is a time-phased budget that periodically measures and monitors the cost performance of the project. It also describes how costs are going to be incurred over a period of time. It is usually displayed in the form of an S-curve. For large and complex projects, multiple cost baselines are prepared for various aspects of the project. The project manager should ensure that costs are being incurred as per the cost baseline.

11.7 Cost Control

The project manager uses cost control to manage the factors that bring about changes in the cost baseline in such a way as to make sure that the changes are beneficial. Cost control also helps the project manager to determine whether the cost baseline has changed and to manage the changes whenever they occur. Therefore, the objective of project cost control is to track variances in expenditures versus budgets that is from the cost baseline, in order to eliminate unauthorized or inappropriate project expenditures and also to minimize or contain cost changes. It helps in identifying the sources and reasons of cost variances that have occurred, and the time to necessitate changes to the cost baselines. Cost control happens at both the work package level and project level. It helps in taking effective corrective action to achieve minimum costs.

The project manager tries to determine how cost variances are likely to occur. Some of the steps that the project manager can take to control project costs are:

- Defining the project scope precisely and clearly
- Using a relevant and reliable database
- Designing an organization structure that is appropriate for the current project

- Monitoring and controlling deviations from the project plan
- Periodically evaluating and monitoring cost performances
- Checking whether the changes are recorded in the cost baseline
- Selecting vendors and project consultants carefully

11.7.1 Cost Change Control System

To control project costs and ensure completion of project as per budget, one of the tools used is cost change control system. It summaries the procedure to be followed in making changes to the cost baseline. It is a collection of processes that allow project cost changes to be analyzed, approved, declined and then managed, in the perceptive of costs. Generally, change requests may be made by the customers or senior management or other project stakeholders to modify the features of the project, when the project is in progress. The project manager has to look at the analysis of these change requests, their effect on project costs and also look at their approval or denial. The cost change control system describes the procedures that bring about changes in the cost baseline. The system includes the paper work, the tracking systems, and the approval levels necessary for authorizing changes. The system must be integrated with the overall change control system, if it is to be effective.

11.7.2 Performance Measurement

Techniques like variance analysis, trend analysis, and earned value analysis help the project manager to understand the cost performance. Variance analysis compares the actual project results to the planned results. The cost variations are measured at every stage of the project and the causes of these variances are determined. Trend analysis examines the project results over a period of time to find out if the cost performance is improving or not.

Earned value analysis is a technique that measures the project performance by integrating the scope, cost and schedule measures of the project. According to this analysis, three values are important. These are: Budgeted Cost Work Schedule, Actual Cost Work Performed (ACWP) and Earned Value (also called Budgeted Cost of Work Performed, (BCWP)).

The Budgeted Cost Work Schedule is the approved cost estimate planned for a project activity for a given period. The Actual Cost Work Performed is the total costs (both direct and indirect) incurred while implementing an activity in a given period. The Earned Value is a percentage of the total budget equal to the percentage of work completed.

These three values along with certain measures like Cost Variance (BCWP-ACWP), the Schedule Variance (BCWP-BCWS) and the Cost Performance Index (BCWP/ACWP) help the project manager to determine whether the work is progressing according to the schedule and whether it is within the budget. The

cumulative Cost Performance Index for the entire project (total of BCWPs of all project activities divided by total of all ACWPs) forecasts the project cost at completion.

The project manager prepares revised cost estimates, budget updates, and Estimates At Completion (EAC) and decides what corrective actions should be taken. The project manager prepares revised cost estimates by making modifications to the current cost information. These revised cost estimates should be communicated to all project stakeholders.

In budget updates, changes are made to the approved cost baseline. The EAC is a forecast of the total project costs on the basis of the project performance. Here, the completion times are estimated as actual work completed plus a new estimate for remaining work. The project manager also documents all the lessons he has learnt in controlling project costs.

Check Your Progress - 3

11. _____ is the process by which the project manager allocates costs to individual work items, based on the cost estimates made.
    a. Cost budgeting
    b. Cost baseline
    c. Parametric modeling
    d. Analogous estimating
12. The analysis which determines whether the cost performance is improving or not by examining the project results over a period of time is called _____.
    a. variance analysis
    b. trend analysis
    c. earned value analysis
    d. None of the above
13. The full form of ACWP is _____.
    a. Actual Cost Work Performed
    b. Actual Cost Work Paid
    c. Actual Cost Week Paid
    d. None of the above
14. Procedures that bring about changes in the cost baseline are called _____.
    a. cost control
    b. cost change control system
    c. cost budgeting
    d. All of the above

15. The full form of EAC is _____.
    a. Estimates At Confirmation
    b. Estimates At Completion
    c. Estimates At Control
    d. Estimates At Costs
16. What is the time-phased budget that periodically measures and monitors the cost performance of the project?
    a. Cost baseline
    b. Cost budgeting
    c. Parametric modeling
    d. Analogous estimating
17. The full form of BCWP is
    a. Budgeted Cost Work Paid
    b. Budgeted Cost Work Performed
    c. Budgeted Cost Week Paid
    d. None of the above
18. Cost performance index is represented by _____.
    a. $\frac{\text{BCWP}}{\text{ACWP}}$
    b. $\frac{\text{BCWP}}{\text{BCWS}}$
    c. $\frac{\text{ACWP}}{\text{BCWS}}$
    d. BCWP – ACWP
19. The project manager decides the corrective actions to be taken after the preparation of which of the following?
    a. Revised cost estimates
    b. Budget updates
    c. Estimates at completion
    d. All of the above
20. What is the technique that measures project performance by integrating the scope, cost, and schedule of the project?
    a. Variance analysis
    b. Earned value analysis
    c. Trend analysis
    d. None of the above

21. Cost variance is represented by _____

    a. BCWP – BCWS

    b. BCWP – ACWP

    c. BCWS – ACWP

    d. ACWP – BCWS

11.8 Cost Overruns and their Implications

Since cost estimation activity begins during the project conception stage and not much is known about the project, accurate cost estimating can be difficult. The less well the project is defined, the greater the chances that estimated costs will differ from the actual costs substantially. In view of this, cost estimate will be too low and the project will suffer from a cost overrun. The extra costs incurred over the estimated costs are called cost overruns. If the actual costs incurred are less than the estimated costs, they are called cost underruns. In practice, this does not happen often as the human tendency is to plan the costs at minimum level and they continue to be raised as the project progresses. For any project, under-estimation or over-estimation of cost is not desirable. There may be ranges of variance that can be meaningful, reasonable and acceptable by the project stakeholders. By offering underestimation of project cost and bagging the work order may benefit the developer initially, but once the project work is started and costs start overrunning, everything will be out of control, conflicts shoot up and sometimes, legal issues may arise. Over estimating the project costs may lead to losing project works and business.

The larger and more complex projects generally experience potential cost escalations. The cost of cutting-edge technology and research projects frequently escalate much more.

11.8.1 Factors that Cause Cost Overruns

The important factors that cause cost overruns are described below.

Cost Escalations

Cost escalation is the amount by which the actual project costs grow to exceed the initial cost estimates. The cost of a project usually increases due to the time gap between the planning and implementation of the project. The estimates that were made initially during conception stage may undergo changes over a course of time as the actual project work is taken up and is progressing. The project manager prepares a ‘cost overruns analysis sheet’ to determine the reasons for cost overruns.

Cost escalations occur for many reasons. Some of these are:

- An increase in the unit price of materials, machinery, labor costs and overheads
- Change in scope of the project
- Increase in statutory taxes and duties like sales tax, customs tax, and excise duty
- The impact of the adverse exchange rate variations on import of machinery and equipment
- An increase in the cost of capital when the project is not completed in the estimated time

The project manager must arrange for forward contracts with importers of machinery and equipment to take care of cost overruns due to unfavorable foreign exchange fluctuations. The project manager should prepare contingency plans to effectively deal with when the cost overruns occur.

Time Overruns

Poor planning and failure to meet time schedules result in time overruns. The project manager prepares a 'time overruns analysis sheet' to understand where delays have occurred and the reasons for delays. Time overruns occur due to:

- A change in the scope of the project
- Ineffective project time management (which itself is the result of improper planning and scheduling)
- Delays in starting and executing some of the project activities
- Delays in subsequent projects as a result of a delay in one project
- Use of outdated technology
- Bureaucratic/ political interference, and poor administration

To complete the project on schedule, the project manager must prepare realistic time schedules, select capable vendors, carryout periodical monitoring of project activities, and take quick decisions.

Scope Changes

Scope changes during the implementation of the project, that were not envisaged during the planning stage increase project costs. Inadequate attention to detail at the time of project formulation is the main cause of these scope changes.

Scope changes include the introduction of new features to the project product, design modifications, increased plant capacity and extra construction works, updated technical versions, and newly framed statutory requirements of the government may necessitate changes in scope.

Proper assessment of the project requirements and understanding the statutory conditions help the project manager to avoid changes in the scope of the project.

Budget under Estimation/Omission

If the budget prepared is not exact, extra costs are incurred when the project is actually implemented. This happens when the costs are estimated on the basis of an incorrect project scope statement, or when adequate technical information is not available. Sometimes certain project elements might be ignored while the budget is being prepared. All these factors finally result in an increase in the project costs. By preparing a detailed, exhaustive checklist of all project activities, the project manager can reduce overruns.

Rectifications and Replacements

The project manager's lack of experience, wrong choice of technology, defective designs and flaws in the equipment purchased result in project cost overruns, as drawings have to be revised, or the machinery has to be repaired. By undertaking frequent inspections, setting up equipment carefully, ensuring that the equipment is not damaged during transportation, and standardizing some of the processes, the project manager can reduce these cost overruns.

Unforeseen Contingencies

Unexpected factors like natural calamities, lockouts, labor unrest, fires or accidents cause project cost overruns. The costs arising out of these contingencies cannot be controlled. However, the project manager can take some preventive measures to reduce their impact.

Other Related Factors

An ineffective organization structure, outdated systems, poor decision making, and the interference of stakeholders are other factors that push up the costs. The project manager should be aware of all these aspects in order to be able to minimize the cost overruns that are likely to occur in the execution of a project. An evaluation of all the project activities, consultation with outside experts, and a critical view of all related factors can minimize cost overruns.

There are widely used project management software products, addressing various elements of project cost management with overall approach to project costing and allied activities. Exhibit 11.1 gives the best of 2021.

Exhibit 11.1: Best Project Cost Management Software Options for Small Business in 2021

Hubstaff: Hubstaff is a highly used cost management software for most businesses. It has useful budget limits and productivity tools. It provides plethora of project cost management solutions and as well complete profile of employees' online activity to managers.

Contd….

Set budget limits based on time or cost. Get notified to make adjustments, if a project's budget is nearing its limit. Set weekly limits to prevent members of the team driving up project costs. Hubstaff's data will give a glimpse of how most productive employees spend their time. It also offers payroll, invoicing, and scheduling features, with customer reviews and competitive pricing.

DeskTime: DeskTime understands that saving money is a key factor of project management and focuses there. Get time tracking (for workers and projects) as well as productivity tracking. Add invoicing and scheduling if needed. It offers valued for money through solid cost management features.

Time Camp: Stands out on cost monitoring, time tracking functions, knowledge base and helpful customer service. TimeCamp has all the tools to manage costs. You can use historic data to predict futures costs, track time, monitor productivity, create invoices, and more. It has a 24/7 customer chat line, and vast knowledge base

Harvest: Harvest integrates features with other apps, like accounting software and project management software, for synchronous planning. Helps organization tuned to multiple different software and wants it all to work together. It offers time tracking, reporting, invoicing, and allows budget alerts to keep costs under control. Create integrations with either a simple widget or its API.

actiTIME: actiTIME offers customizability for organization needs. Customize your project cost management software, as per need. Use actiTIME Online, or have more control and a one-time purchase. Define a standard schedule for easier overtime calculations. Create custom statuses for the projects. Additional advantage - turn off features not on use.

https://www.business.org/finance/cost-management/best-cost-management-software-solutions/

Activity: The Govardhan Group of Industries located near Ahmedabad, Gujarat wanted to lay a railway line inside the company premises (500 acres) to speed up the movement of materials and machinery among the various departments. The management estimated that the project required a capital of Rs. 85 lakh. But the firm did not take up the project due to lack of funds. After two years, the management took up the project. But the firm failed to complete the project within the budget. Discuss why the company failed. Also, list some of the factors that lead to cost overruns.

Answer:

Check Your Progress - 4

22. Which of the following options are the reasons for the escalation of costs that cannot be controlled but whose impact can be reduced by taking some preventive measures?
    a. Scope changes
    b. Unforeseen contingencies
    c. Budget underestimation/omission
    d. Use of outdated technology
23. What among the following options are the reasons for time overruns?
    i. Change in the scope of the project
    ii. Use of outdated technology
    iii. Political interference
    iv. Delay in starting and executing some of the project activities
    a. Only i and ii
    b. Only ii and iii
    c. Only ii, iii, and iv
    d. i, ii, iii, and iv
24. Budget underestimation and budget omission are the causes of _____.
    a. Time overruns
    b. Rectification costs
    c. Estimation errors
    d. Cost escalations
25. The extra costs incurred over the estimated costs are called _____.
    a. Cost escalations
    b. Rectification costs
    c. Cost overruns
    d. Estimation errors
26. From the following options, identify which is/are responsible for project cost overruns?
    a. Cost escalations
    b. Scope changes
    c. Rectification costs
    d. All of the above

27. Which of the following options is the reason for scope changes in the project that occur at the time of implementation of the project?

    a. Use of outdated technology

    b. Bureaucratic and political interference

    c. Updated technical versions

    d. Poor administration

11.9 Summary

- Project cost management includes all the processes that are required to ensure that the project is completed within the approved budget. After each phase of the project is completed, cost management estimates the resources (people, equipment and materials) that were already spent and the budget needed for all subsequent project phases.
- The process of cost management involves four steps -- resource planning, cost estimating, cost budgeting, and cost control.
- Resource planning is the process of identifying what project resources are required and in what quantities. Resources normally include money, manpower, machinery and materials.
- After the resource requirements are identified, the project manager develops an estimate of the costs of the resources required to execute the project. This includes identifying and evaluating various cost alternatives.
- In the process of cost budgeting, the project manager allocates the costs to individual work items, based on the cost estimates made. The cost allocated for each individual work becomes the cost baseline for that work.
- The project manager uses cost control to manage the factors that bring about changes in the cost baseline in such a way as to make sure that the changes are beneficial. Cost control also helps him/her to determine whether the cost baseline has changed and to manage the changes whenever they occur.
- The extra costs incurred over the estimated costs are called cost overruns. If the actual costs incurred are less than the estimated costs, they are called cost underruns.
- The important factors that cause cost overruns are cost escalations, time overruns, scope changes, budget under estimation/omission, rectifications and replacements, unforeseen contingencies, and other related factors.

11.10 Glossary

Actual Cost of Work Performance (ACWP): Total costs incurred (direct and indirect) in accomplishing work during a given time period.

Bottom-up Estimating: In this technique, the cost of each element of the project is calculated separately and all these costs are added up to estimate the total project cost.

Budget Cost of Work Scheduled (BCWS): The sum of the approved cost estimates (including any overhead allocation) for activities scheduled to be performed during a given period.

Budgeted Cost of Work Performance (BCWP): The sum of the approved cost estimates (including any overhead allocation) for activities completed during a given period.

Cost Budgeting: A process of allocating the costs to individual work items, based on the cost estimates made.

Cost Estimating: Identifying and evaluating various cost alternatives.

Cost Overruns: Extra costs incurred over the estimated costs.

Cost Underruns: Actual costs incurred are less than the estimated costs.

Resource Planning: The process of identifying the nature and quantity of physical resources required to perform the project activities.

11.11 Self-Assessment Exercises

1. The process of cost management requires proper planning and implementation at every stage of the project, if the project is to be a success. What are the steps involved in the process of cost management?
2. The first step in the process of cost management involves identification of the resources and their quantities. Explain the process of resource planning in cost management. What the various aspects, which need to be considered while planning for resources?
3. After the resource requirements are identified, the project manager develops an estimate of the costs of the resources. Describe the process of cost estimating.
4. Based on the cost estimates made, the project manager allocates the costs to individual work items. Explain the process of cost budgeting. How can the project manager control the costs?
5. Sometimes, the actual costs incurred may be more or less than the estimated costs. What factors lead to such variations? Explain the implications of such variations.

11.12 Suggested Readings/Reference Material

1. The Project Management Institute (PMI), A Guide to the Project Management Body of Knowledge (6th edition), Published Date: 2017 (6th edition)
2. K R Sharma, Project Management: Text and Practice Paperback – 1, Atlantic Publishers and Distributors (P) Ltd , January 2021
3. Anna Brzozowska, Arnold Pabian, Barbara Pabian, Sustainability in Project Management; A Functional Approach, CRC Press, 2021

4. Peter J. Edwards, Paulo Vaz Serra, Michael Edwards, Managing Project Risks, Wiley-Blackwell, 2019
5. Ronald Blank, The Basics of Quality Auditing, Productivity Press, 2017

11.13 Answers to Check Your Progress Questions

Following are the answers to the Check Your Progress questions given in the Unit.

1. (b) Option iv followed by ii followed by i and iii

The four steps involved in the process of cost management are in sequence, resource planning, cost estimating, cost budgeting, and cost control.

2. (b) Project cost management

Project cost management includes all the processes that are required to complete the project within the approved budget. The other options given in the question – resource planning, cost budgeting, cost control — are the steps involved in the process of cost management.

3. (a) Project scope statement

The project scope statement allows all project stakeholders to gain an understanding of the project. The work breakdown structure is the deliverable-oriented grouping of the project elements. Organizational policies refer to the definite course of action taken by the organization. The project manager has to abide by these organizational policies while developing resource plans. The policies regarding purchase of supplies and staffing should be considered properly.

4. (c) Work breakdown structure

The work breakdown structure refers to the deliverable-oriented grouping of the project elements. Each descending level of WBS represents an increasingly detailed description of the project component. The project scope statement allows all project stakeholders to gain an understanding of the project. Organizational policies refer to the definite course of action taken by the organization. The project manager has to abide by these organizational policies while developing resource plans. The policies regarding purchase of supplies and staffing should be considered.

5. (c) Cost control

Cost control refers to taking the necessary steps to keep the project costs within the permissible limits. Cost budgeting involves assigning costs to each project activity. Cost estimating refers to calculating the approximate costs of all project activities and resource planning means planning for and gathering resources to complete the project.

6. (c) Resource planning

Resource planning is the primary step in the process of cost management and involves identifying what project resources are required and in what quantities. Cost estimating is the estimation of costs of the resources required to execute the project. Cost budgeting is the process of allocating costs to individual work items. Cost control is the process of controlling the costs of the project.

7. (b) Bottom-up estimating

In bottom-up estimating, the cost of each element of the project is calculated and then added up to estimate the total cost of the project. In the case of analogous estimating, the project manager considers similar projects to estimate the cost of the project. In parametric modeling, cost estimates are made using mathematical models.

8. (a) Analogous estimating

In the case of analogous estimating, the project manager estimates the cost of the project by considering similar projects. He/she prepares the cost estimates by considering parameters like time value of money, inflation, etc.

9. (d) All of the above

The following conditions need to be fulfilled if parametric modeling is to give reliable estimates: The model should be developed on the basis of accurate historical information, all the project parameters should be quantifiable, and the model should be scalable.

10. (c) Analogous estimating

The analogous estimating technique refers to estimating the cost of the project by comparing the costs of other similar projects. As this involves arriving at the costs of the project from the top, it is also called top-down estimating. Parametric modeling involves estimating the cost of the project using mathematical models. In bottom-up estimating, the cost of each element of the project is calculated separately and then added to arrive at the project cost.

11. (a) Cost budgeting

Cost budgeting is the process by which the project manager allocates costs to individual work items based on the cost estimates made.

12. (b) Trend analysis

Trend analysis examines the project results over a period of time to know whether the cost performance is improving or not. Variance analysis compares the actual project results with the planned results. Earned value analysis measures the project performance by integrating the scope, cost, and schedule measures of the project.

13. (a) Actual Cost Work Performed

Actual cost work performed is one of the important values in earned value analysis. Earned value analysis is the technique that measures project performance by integrating the scope, cost, and schedule measures of the project.

14. (b) Cost change control system

The cost change control system describes the procedures that bring about changes in the cost baseline. The cost change control system includes the paper work, tracking systems, and approval levels necessary for authorizing changes. Cost budgeting refers to the allocation of costs to individual work items. Cost control refers to the overall necessary steps to keep the project costs within the permissible limits.

15. (b) Estimates At Completion

Before deciding what corrective action is to be taken, the project manager prepares revised cost estimates, budget updates, and estimates at completion (EAC).

16. (a) Cost baseline

Cost baseline is a time-phased budget that periodically measures and monitors the cost performance of the project. It refers to the allocation of costs to individual work items. Parametric modeling involves estimating the cost of the project using mathematical models. In the case of analogous estimating, the project manager considers similar projects to estimate the costs of the project.

17. (b) Budgeted Cost Work Performed

Budgeted cost work performed is an important part of earned value analysis. Earned value analysis is the technique that measures project performance by integrating the scope, cost, and schedule measures of the project.

18. (a) $\frac{\text{BCWP}}{\text{ACWP}}$

Cost performance index is one of the measures of performance measurement. It is represented by budgeted cost of work performed divided by actual cost of work performed.

19. (d) All of the above

The project manager prepares the revised cost estimates, budget updates and estimates at completion and then decides on the corrective actions that need to be taken.

20. (b) Earned value analysis

Earned value analysis is a technique that measures the performance of the project by integrating the scope, cost, and schedule measures of the project. The three values that are important for the measurement of project performance are: budgeted cost work schedule, actual cost work performed, and earned value.

21. (b) BCWP-ACWP

The three values in the performance measurement are: cost variance, schedule variance, and cost performance index. Cost variance is represented by BCWP-ACWP, which means budgeted cost of work performed less actual cost work performed.

22. (b) Unforeseen contingencies

Factors like natural calamities, lockouts, labor unrest, and fire accidents are examples of unforeseen contingencies. The costs arising out of these contingencies cannot be controlled. However, the project manager can take some preventive measures to reduce their impact.

23. (d) i, ii, iii and iv

The main reasons for the occurrence of time overruns are: A change in the scope of the project, ineffective project time management, delays in starting and executing some of the project activities, delays in subsequent projects as a result of a delay in one project, use of outdated technology, bureaucratic/political interference, and poor administration.

24. (c) Estimation errors

Estimation errors are one of the reasons for project cost overruns. Budget underestimation and budget omission are the causes of estimation errors. Time overruns are the results of unrealistic time scheduling and unforeseen contingencies. Rectification costs are the result of flaws in the equipment used and of the wrong choice of technology. Cost escalations are the result of increases in the prices, taxes and duties, and exchange rate fluctuations.

25. (c) Cost overruns

The extra costs that are incurred over the estimated costs are called cost overruns. If the actual costs incurred are less than the estimated costs they are called cost underruns. Cost escalations are the reasons for the increase in costs that, in turn, cause cost overruns. Rectification costs are the costs that are incurred to rectify the errors made by making wrong choices. Estimation errors are the errors that result from underestimation of the budget.

26. (d) All of the above

The following are the reasons for project overruns: cost escalations, time overruns, scope overruns, estimation errors, rectification costs, unforeseen contingencies, and some other miscellaneous reasons like ineffective organization structure and political interference.

27. (c) Updated technical versions

The main reasons for the changes in the scope of the project are: introduction of new features to the project product, design modifications, increased plant capacity and extra construction, updated technical versions, and newly framed statutory requirements of the government. The other options given in the question are the reasons for time overruns in the project.

Unit 12

Project Risk Management

Structure

12.1 Introduction

In the previous unit, we have discussed project cost management. In this unit, we will discuss project risk management. The element of risk is inherent in every activity of a project. The project manager should carefully handle the risks that the project is likely to be exposed to. For projects whose duration is less than one year, we can assume that the operating environment is known and stable. But in the case of big projects of longer duration, it is necessary to conduct a 'risk analysis.' Projects are exposed to various types of risks like technical risks, economic risks, social risks, production risks, financial risks and human risks.

A highly efficient and responsive management of any project is the need of the hour in today's highly competitive, complex and globalized business environment. Hence, managing the risks involved in the project has become one of the vital activities for the project manager. The risks involved at the individual activity of any project contribute to the complete failure of any project. Project risk management has become an integral part of the project management process; because of uncertainty involved which leads susceptibility into the risks than before.

Since all risks cannot be eliminated or avoided, it is the job of the project manager to ensure that risks do not have adverse consequences. Every project manager follows a specialized risk management methodology that normally consists of

four processes: risk identification, risk quantification, risk response and risk control. To relieve themselves of risk, individuals and firms insure the projects they undertake. While insurance cannot prevent risk, it can mitigate the risk by providing financial compensation.

This unit will discuss the definition of risk and examines the concept of tolerance for risk. We will discuss risk management, and decision making under the conditions of certainty, risk, and uncertainty. Finally, we would be discussing the risk management methodology, and the concept of insurance for projects.

12.2 Objectives

By the end of this unit, students should be able to:

- Define risk and risk management.
- Explain the concept of tolerance for risk.
- Explain decision making under the conditions of certainty, risk, and uncertainty.
- Discuss the risk management methodology.

12.3 Definition of Risk

Risk is defined as the possibility of an outcome being different from the expected outcome. It refers to the possibility of adverse results flowing from the uncertainty involved in carrying out the activities. Similarly, "Risk is defined as an uncertain event or set of circumstances which, should it occur, will have an effect on achievement of one or more objectives" (Tuncel and Alpan 2010).When a project or a project activity is expected to be possible, the chance of its occurrence varies from zero and one. Every activity of the project is always exposed to a certain degree of risk. Damage to machinery, dramatic changes in technology, loss of human life and stagnation of financial flows are some of the areas of risk that a project manager should pay attention to.

Conceptually, project risk is a function of uncertainty and damage.

Therefore, Risk = f (uncertainty, damage)

Both uncertainty and the potential for damage for every project activity should be carefully examined when conducting a risk analysis. Sometimes, risk also refers to the cumulative effect of all the adverse, unfavorable action.

Risk also arises because of hazards, which can be defined as a source of danger. The project manager must provide some safeguards to reduce or eliminate hazards. So risk can also be referred to as a function of hazard and safeguard.

Therefore, Risk = f (hazard, safeguard)

12.3.1 Types of Risks

Risks are of several types. Broadly, they can be categorized into technical risks, social risks, economic risks, political risks, production risks, marketing risks, financial risks and human risks.

Technical Risks

Technical risks refer to the failure to meet a particular performance requirement. Failure of the feasibility of a design and changes in technology are some of the sources of technical risk. For example, some software modules run well when tested individually on a limited scale, but they fail when they are integrated and tested on a large scale. The project is also under technical risk if the technology being used becomes outdated by the time the project delivers the final product or service. So it is the responsibility of the project manager to continuously update the technical aspects of the project.

Social Risks

Social risks refer to risks arising from changes in the needs and changing preferences of target customers. Lack of necessary natural resources, labor unrest, agitations and social movements against the project also constitute social risks.

Economic Risks

Economic risks refer to an increase in the rate of inflation, changes in the economic policies of governments, and distribution of income. Since the project manager does not have any control over these risks, he should carefully assess such risks and should ensure that the project is not going to suffer because of these risks.

Political Risks

Nationalization or privatization of a particular industry, political instability, trade restriction are some examples of political risks. The project manager should ensure that the project does not go against the political interests of the country.

Production Risks

Production risks refer to the shortage of necessary raw materials, sudden breakdown of key machinery, and exponential rise in installation and maintenance costs. As these risks can be controlled to some extent, the project manager should try to reduce the effect of these risks on the project.

Marketing Risks

Marketing risks refer to failure of the developed product or service in the market due to changes in market demand, errors in forecasting of demand, or difficulties in distribution. The project manager should change the market strategy to deal with these risks and generate more revenues.

Financial Risks

Financial risks refer to bad debts, change in the interest rates, wrong choice of investments and mistakes in the accounting procedures. Consistent financial performance assessment of the project will give the project manager a clear picture of financial condition of the project.

Human Risks

Human risks refer to the sudden demise of a key employee, limited availability of competent employees, inter-group politics etc. A clear, and result encouraging HR policy coupled with employee group insurance schemes generally solves most problems caused by such risks.

Check Your Progress - 1

1. What is the possibility of an outcome being different from the expected outcome called?
   a. Uncertainty
   b. Risk
   c. Technical risks
   d. Political risks
2. _____ refer to the possibility of failure of the product or service in the market due to factors like change in demand, errors in forecasting of demand, and difficulties in distribution.
   a. Financial risks
   b. Marketing risks
   c. Political risks
   d. Economic risks
3. Identify the risks that arise from the needs and changing preferences of target customers.
   a. Technical risks
   b. Economic risks
   c. Social risks
   d. Human risks
4. Identify the type of the risk that arises due to raw material shortage, breakdown of important machinery, and a steep rise in the installation and maintenance costs.
   a. Marketing risks
   b. Political risks
   c. Social risks
   d. Production risks

5. Risk = f (_____, _____)
   i. Uncertainty, damage
   ii. Certainty, safeguard
   iii. Hazard, safeguard
   iv. Damage, certainty
   a. Only i
   b. Only i and iii
   c. Only ii and iii
   d. i, ii, iii, and iv

12.4 Tolerance for Risk

There are no tools or techniques for avoiding risk completely. The project manager must use his judgment to identify an appropriate tool for dealing with a risk. Even though no tool can nullify a risk completely, it can lessen the adverse impact of the risk. Project managers deal with risks in different ways, depending on their level of tolerance for risks.

Project managers can be classified as risk averters, risk neutrals and risk seekers on the basis of their attitude toward risk. The tolerance curve for each type of manager is derived by comparing his risk preference with the utility (the amount of satisfaction the project manager derives from a payoff). The utility can also be referred as the tolerance for risk.

A risk averter is a person who always wishes to avoid risk. When more money is at stake, the risk averter's utility increases, but at a decreasing rate. A risk seeker is a person who wishes to accept more and more risks. For such a person, the utility increases at an increasing rate as the amount of money at stake increases. A risk neutral person's attitude falls midway between the risk averter's and the risk seeker's attitude. His utility increases in proportion to an increase in the amount of money at stake.

12.5 Definition of Risk Management

The PMBOK defines risk management as "the formal process by which risk factors are systematically identified, assessed, and provided for." Risk management is not a separate project activity, rather, it is an aspect of project implementation. A project manager must use several tools to manage risks in technical areas, to understand the causes of risks, and to identify the corrective actions. It is very important for the project managers to select a best suited risk mitigation strategy by taking several aspects into account especially where uncertainty and risks are involved in the project.

A project manager should take a proactive rather than reactive approach to project management. Take the case of a project for developing new technology for a particular activity. According to the schedule, the project must be completed in six months. But the technical team feels that the development of new technology requires eight months. If the project manager is proactive, he might develop a contingency plan for completing the activity within six months, either by increasing the size of the team or by outsourcing some aspects of the development of technology. If the project manager is reactive, he will not take any action until the problem actually occurs. Proper risk management clearly reduces the likelihood of a risk occurring.

Check Your Progress - 2

6. The formal process by which risk factors are systematically identified, assessed, and tackled is known as _____.
   a. Political risks
   b. Risk management
   c. Financial risks
   d. Economic risks
7. In the case of which of the following types of project manager does the utility increase in proportion to an increase in the amount at stake?
   i. Risk neutral
   ii. Risk averter
   iii. Risk seeker
   a. i, ii and iii
   b. Only i and iii
   c. Only i
   d. Only ii
8. A person who wishes to avoid risks completely is called a _____.
   a. Risk neutral
   b. Risk seeker
   c. Risk averter
   d. NONE of the above

12.6 Certainty, Risk, and Uncertainty

To sustain and compete with the growing complexity in the project have led project managers to pay more attention not only on effective completion of the project but also in efficient risk management in their project management process.

In addition, when some factors are not properly understood it leads to different types of risk exposure to the project manager. This has brought, a strategic risk response planning and management into limelight for the managers to help in an effective decision-making process.

To execute a project successfully, a project manager must be capable of taking good decisions. Project managers take decisions under three conditions: certainty, risk and uncertainty. Decision-making is easy under conditions of certainty, but it is extremely difficult under conditions of uncertainty. As the situation progresses from certainty to risk to uncertainty, the expected potential damage to the project increases.

12.6.1 Decision Making Under Certainty

Decision making under certainty implies that the project manager is fully aware of all the states of nature available and the expected payoffs for each state of nature. The term 'state of nature' refer to a future event that is not under the control of the decision maker. By constructing a payoff matrix for all the states of nature, the project manager can select the best possible strategy.

There are some popular techniques used for decision making under uncertainty such as: system of equations, linear programming problem (LPP), game theory approach, Integer programming problem (IPP), Break even analysis (BEA), Dynamic programming, Queuing models (waiting line model), Inventory models, Capital budgeting analysis.

To construct a payoff matrix, the project manager identifies all the states of nature and formulates the strategies to be taken for each state of nature. All the possible outcomes for each action, under each state of nature, are recorded to complete the payoff matrix. Under conditions of certainty, the project manager exactly knows which state of nature is going to occur. The project manager selects the best course of action on the basis of the state of nature that will exist.

The following example explains the decision-making process under conditions of certainty. For example, Midwest Laboratories wants to develop a new drug with an investment of Rs. 5 lakh. The existing states of nature of market demand are;

N1: strong market demand

N2: average market demand, and

N3: weak market demand

The company has three strategies for developing the drug, S1, S2, and S3. Table 12.1 shows the payoff matrix for the given states of nature and the three strategies formulated.

Table 12.1: Payoff Matrix (Profit in Lakhs of Rupees)

Strategy	States of Nature		
	N1	N2	N3
S1	2	1.5	0.5
S2	3	1.6	0.8
S3	2.5	1.4	0.8

If the project manager knows that a particular state of nature is going to exist, he can choose the appropriate strategy. For example, if the project manager knows N2 is the expected state of nature, he can adopt strategy S2 as it provides higher returns than other strategies.

12.6.2 Decision Making under Risk

The PMBOK defines risk as "the totality effect of outcomes (i.e. states of nature) that can be described within established confidence limits (i.e. probability distributions). Under conditions of risk, the project manager is able to assign some probability of occurrence to each state of nature. Based on this information, the project manager calculates the 'expected value' for each strategy and selects the strategy that earns higher returns.

The expected value of a strategy is calculated as the sum of the product of the probability of a state of nature and the respective payoff value of a strategy. Assume the probabilities of a particular state of nature are 0.25, 0.25 and 0.5. Table 12.2 represents the payoff matrix under conditions of risk.

Table 12.2: Payoff Matrix (Profit in Lakhs of Rupees)

Strategy	States of Nature			Exp. Value
	N1	N2	N3	
S1	2	1.5	0.5	1.125
S2	3	1.6	0.8	1.35
S3	4	3	0.1	1.8

P (N1)=0.25, P(N2)=0.25 and P(N3)=0.5

Considering the above payoff matrix, the project manager chooses strategy S3 as it has high expected value.

12.6.3 Decision Making under Uncertainty

One of the main issues for the project managers in decision making is insufficient information, but at the same time awareness about the various possibilities of occurrence of an event is known as the uncertainty in decision making. Under conditions of uncertainty, the project manager does not know the probability of occurrence of each state of nature. So the project manager uses four types of

criteria to select a strategy. They are: maximax criterion (Hurwicz criterion), maximin criterion (Wald criterion), minimax regret criterion, and criterion of realism.

Maximax Criterion

This criterion is also called 'Hurwicz' criterion. Under this criterion, the project manager chooses the strategy that is likely to earn him the highest returns. From Table 12.2, the project manager would choose strategy S3, as it gives higher returns than other strategies.

Maximin Criterion

This criterion is also called 'Wald' criterion. Under this criterion, the project manager identifies the minimum payoff values for each strategy and adopts the strategy that has the highest payoff value. In Table 12.2, the minimum payoffs are 0.5, 0.8 and 0.1. Using the maximin criterion, the project manager selects strategy S_2.

Minimax regret criterion

In this criterion, the project manager attempts to minimize the maximum regret value (maximum opportunity loss). The regret value is obtained by subtracting all the payoff values in each state of nature from the largest payoff value of that state of nature. Table 12.3 is the regret table for the values given in Table 12.2. The maximum regrets for each strategy are 2, 1.4 and 0.7. So, the project manager chooses strategy S3 as it minimizes the maximum opportunity loss.

Table 12.3: Regret Table

Strategy	Status of Nature			Max. Regret
	N1	N2	N3	
S1	2	1.5	0.3	2
S2	1	1.4	0	1.4
S3	0	0	0.7	0.7

Criterion of realism

This criterion is also called the 'Laplace criterion'. According to this criterion, each state of nature has the same probability of occurrence. So, the project manager considers the average value of all the payoffs for each strategy and selects the strategy that has the highest average payoff value. For Table 12.3, the average payoffs are 1.33, 1.8 and 2.36. So, the project manager chooses strategy S3.

Decision tree analysis

Project decisions can vary with situations, where manager requires to conduct some kind of brainstorming to ensure that all the factors have been given proper consideration. The decision tree analysis is a technique in which managers take

decisions in the presence of uncertainty. It helps the managers in making decisions, with the help of decision tree which is a diagram with the under considerations decision and their branches which represents the potential choice for the managers. The project manager can use 'decision tree analysis' when a decision involves a series of several interrelated decisions. The project manager computes the 'Expected Monetary Value' (EMV) of all strategies and chooses the strategy with highest EMV. EMV decision tree is a one of the popular tools for quantitative risk analysis.

Assume that the project manager has four alternative strategies, S1, S2, S3 and S4. The resultant values for each strategy at different probability levels are R1, R2, and R3. Assume that the probability of occurrence of these results is 0.5, 0.2 and 0.3. The payoff matrix for this problem is given in Table 12.4.

Table 12.4: Payoff Matrix

	R1	**R2**	**R3**
S1	14	9	10
S2	11	10	8
S3	9	10	10
S4	8	10	11

The project manager finally selects strategy S1 as it has the highest expected value.

Activity: The management of Asian Abrasives plans to launch a new product. The project manager in charge of launching the new product, identified three states of nature for the product: a low demand, a moderate demand, and a high demand. The project manager prepared three types of strategies, S1, S2, and S3, to improve the product's sales. A payoff matrix prepared by him is given below. The matrix provides payoff values for each of these three states of nature against each strategy. To choose a strategy for implementation, he wanted to use the minimax regret criterion. What is the minimax criterion? Explain which type of strategy is preferred using this criterion?

Strategy	***States of Nature***		
	N1	**N2**	**N3**
S1	50	30	80
S2	40	35	85
S3	60	40	65

Answer:

Check Your Progress - 3

9. Which of the following criteria is also called the Wald criterion under conditions of uncertainty?
   a. Criterion of realism
   b. Minimax regret criterion
   c. Maximin criterion
   d. Maximax criterion
10. From the given payoff matrix, which strategy should the project manager choose under conditions of certainty?

Payoff matrix (Profit in millions of rupees)

Strategy	States of nature		
	N1	**N2**	**N3**
S1	2	1	0.8
S2	3.5	2.5	1.5
S3	4.5	3	1

N1: Strong market demand

N2: Average market demand, and

N3: Weak market demand

   a. S1
   b. S2
   c. S3
   d. Data insufficient
11. Which of the following criteria is also called the Hurwicz criterion under conditions of uncertainty?
   a. Criterion of realism
   b. Minimax regret criterion
   c. Maximin criterion
   d. Maximax criterion
12. Under conditions of uncertainty, the project manager uses various types of criteria to select a strategy. Which of the following is/are the criteria to select the strategy?
   i. Minimax regret criterion
   ii. Maximin criterion
   iii. Maximax criterion
   iv. Criterion of unrealism
   a. Only i and ii
   b. i, ii, iii and iv
   c. Only iv
   d. i, ii, and iii

13. Which of the following types of analysis is used when a decision involves a series of several interrelated decisions?
    a. Criterion of realism
    b. Decision tree analysis
    c. Maximax criteria
    d. Minimax regret criterion
14. Which of the following criteria is also called the Laplace criterion under conditions of uncertainty?
    a. Minimax regret criterion
    b. Criterion of realism
    c. Maximin criterion
    d. Maximax criterion
15. In the case of decision-making under _____ conditions, the project manager is fully aware of all the states of nature available and the expected payoffs for each state of nature.
    a. RISK
    b. Certainty
    c. Uncertainty
    d. None of the above

Exercises

a. From the given payoff matrix, which strategy should be chosen by the project manager under conditions of risk, assuming the probabilities of a particular state of nature are: 0.2, 0.2, and 0.4?

Payoff Matrix

(Profit in millions of rupees)

Strategy	States of nature		
	N1	**N2**	**N3**
S1	3	2.5	1
S2	4	2	1
S3	5	4	0.5

b. Using the decision tree analysis, select the best strategy with the highest expected monetary value. The project manager has four alternatives strategies to choose from — S1, S2, S3, and S4. The resultant values for each strategy at different probability levels are 0.4, 0.25, and 0.36.

	R1	**R2**	**R3**
S1	13	7	8
S2	10	9	7
S3	8	7	8
S4	7	8	9

12.7 Risk Management Methodology

The successful completion of a project depends on the ability of the project manager to deal with different types of risks. It is important for a project manager to develop a risk management strategy at the beginning of the project. The risk management strategy should be incorporated into the process of project implementation. The steps involved in the process of risk management are – risk identification, risk quantification, risk response, and risk control. Each of these steps is discussed below.

12.7.1 Risk Identification

Risk identification involves the scanning of project activities, the identification of potential risks and documentation of risk. The task of the project manager is to perceive that there is a possibility of risk exposure and identifying the causes of the risks. The project manager should carefully discover all the risks that the project is likely to be exposed to. The project manager should study the nature of all the project activities, the manner in which they are carried out, and where they are carried out. Once all the risks have been identified, the project manager should carefully document all the characteristics of each risk associated with the project. Even though some risks may have meager impact on the project, the project manager should study the cumulative effect of these small risks. The process of risk identification is a continuous process and should be carried out at regular intervals.

The project manager should address both the internal and external risks of the project. Since internal risks normally arise because of negligence or mismanagement, the project manager should deal with such risks in a proactive manner. Certain internal risks are part of the activity of a project. For example, poor quality raw material is regarded as an internal risk. The project manager can take some preventive steps or controlling techniques to deal with such risks. External risks are beyond the control of the project manager. The project manager should ensure that the project will not be seriously affected by the external risks. If necessary, he should find some alternative ways of completing the project.

Risk identification can be done either through a cause-and-effect analysis or an effect-and-cause analysis. In a cause-and-effect analysis, the project manager lists all the causes of risk and compares each risk with its possible effect. Measures are then taken to reduce the effect of each risk. In effect-and-cause analysis, the project manager identifies the outcomes to be avoided and initiates action to remove the causes of those risks.

To identify the potential risks, a project manager should -- analyze the project outcome; critically view all the processes involved in a project; estimate the costs and schedules for various activities of a project; identify the required human resources; understand the market conditions; and study the records and databases of old and successfully implemented projects.

The project manager should use tools and techniques like checklists and flowcharts and conduct interviews to identify the risks involved in the project. Checklists provide the technology required and necessary human resources to conduct a project. A flowchart depicts how the various elements of a system are related to one another. Interviews with various promoters and stakeholders will also help the project manager identify the risks that are likely to arise during the life of the project. The project manager should ensure that the process of risk identification uncovers the sources of risk, potential risk events, and risk symptoms.

Sources of Risk

A project manager must plan for the unseen risks associated with the project. The first step for planning risk management is to identify the risks involved and sources of those risks in their project. Sources of risk are the areas of possible risk events, which are likely to affect the outcome of the project. Team turnover, unreliable investment, new technologies and stockholder actions are some of the sources of risks. The project manager should broadly categorize all the sources of risks, describe all the sources of risk with the probability of a risk to occur, range of possible outcomes, and frequency of occurrence of risk.

Potential Risk Events

Such events occur unexpectedly, but the amount of loss they are likely to cause for the project is very high. The departure of a key project team member, natural disasters, government's ban on a particular product or service that is related to the ongoing project are some examples for potential risk events. A potential risk cannot adversely affect all types of the projects. For example, a storm is a potential risk event for a construction project, but not for a biological lab project. Since the potential risk events are specific to the application area, project managers should carefully assess the sources of potential risks for specific projects.

Risk Symptoms

These are also called 'triggers'. These events are not actual risk events, but they reveal the increasing chances of risk. For example, unusual sound from some equipment is an indication of the possible breakdown of that equipment. Similarly, the employee's personal problems can indicate a likely delay in the schedule. The project manager should carefully handle the risks once he has identified the risk symptoms.

After the risks have been identified, the project manager should initiate activities that will reduce the adverse effects of the risk. Sometimes the process of identification of risk also identifies the need to do another activity in other areas. For example, the process of identification of risk can reveal that the work breakdown structure may not be sufficient to identify all the possible risks.

12.7.2 Risk Quantification

The quantification of risks involves an assessment of the range of risks associated with a possible project outcome. Sometimes, a single risk event can cause multiple effects. For example, delay in obtaining a critical component leads to cost overruns, schedule delays, and low quality outcome.

A small problem in a rocket may lead to the failure to launch a satellite on a specific path. As some of the risks cannot be quantified, reliability of a product or service should also be studied by the project manager. For example, a small defect in an airplane might result in the death of several people.

The changing business environment and the schedule delays that have already occurred create risks and force the project manager to consider an alternative risk strategy. The quantification of risk also changes from one firm to other firm based on their past experiences, nature of project and assumptions made. One firm perceives incurring of 20 percent more overheads than expected as high risk while another firm perceives it as low risk. So financial soundness of an organization should also be considered before taking any decision.

Decision trees and calculation of EMV (Expected Monetary Value) are useful for quantifying risk. Project managers also use some Operations Research techniques like simulation, PERT and CPM, and probability distributions to quantify risk. These techniques help project managers determine whether risk requires attention or can be ignored.

12.7.3 Risk Response

This refers to the steps to be taken by the project manager to respond to the risks identified and quantified. Quick response to a particular risk is likely to reduce its impact on a project. The following data must be gathered before developing a risk response policy:

- List of identified risks
- Probability of occurrence of each risk
- Review of the potential responses that have been identified during risk identification stage
- List of project stakeholders who play a role in developing proper risk response
- Definition of the 'acceptable' level of risk.

If any of this information is missing, the response will not be developed effectively.

Activity: Ruvila Lubricants produces and distributes various industrial lubricants. The management of the company wanted to launch a new industrial lubricant 'Lupil.' Bipin Chandra, the company CEO, asked Andrew Stephen, the project manager, to identify the risks involved in the project.

What is risk identification? What are the things to be uncovered in the process of 'risk identification'? What kind of data should Stephen collect to determine the risk response used for the risks?

Answer:

Criteria for Selection of an Effective Response

The criteria for selection of an appropriate response is very important. Generally, the success of any project depends upon the effective and timely response by the project managers. Therefore, the managers must consider certain criteria in the selection of response. The project manager should ensure that the selected risk response has the following characteristics:

Appropriate: The response should be appropriate for the risk, given the size and criticality of the risk. The project manager should not spend lot of time and effort in developing inappropriate responses to minor risks.

Affordable: The cost of responses must be estimated; responses should be cost-effective. The amount of time, effort and money spent on addressing the risk should not exceed the agreed budget.

Actionable: An 'Action Window' that defines the time within which responses need to be completed should be developed. While some of the risks require immediate action, others can be addressed later.

Achievable: The project manager should ensure that the developed responses are technically feasible, and can be achieved by the project team.

Agreed: The consensus and commitment of the project's stakeholders is essential before developing the responses.

Accepted: Each response should be preliminarily tested before accepting it.

It is important to determine the appropriate response before implementing it. The project manager should select an appropriate model to implement the strategy; otherwise the implementation of one response may nullify the effect of another response. For example, the project has removed some unproductive team members to avoid production risks. Since the response developed by the project manager may affect morale of the other employees, he has to face human risks.

Types of Risk Responses

A project manager can consider four types of responses to risks -- risk avoidance, risk transfer, risk mitigation, and risk acceptance.

Risk Avoidance

The project manager considers this technique as a first option as this attempts to avoid the risk by eliminating the cause of the risk. For example, the project manager might feel that the use of low quality cement caused the failure of the prototype models developed. In this situation, the project manager can replace cement with Plaster of Paris. Of course, it is not possible to eliminate or avoid most types of risks and their causes, and so this kind of response is not often used.

The risk avoidance technique can be implemented in two ways; directly or indirectly. The direct approach is used when the risk arises from lack of knowledge; and the indirect approach is used when the risk arises from a particular source. In the direct approach, uncertainty is eliminated by obtaining more information, improving communication, and undertaking research or prototype development. In the indirect approach, the source or cause of the risk is removed.

Risk Transfer

This risk response method attempts to transfer the liability for risk to a third party. But the scope of this technique is limited as only financial risk can be transferred. The project manager makes use of the insurance mechanism, to transfer the risk to the insurer. But this mechanism only protects against the financial risks of the project. It is also important to remember that risk transfer not only shifts the liability, but also changes ownership of the risk. This means risk transfer does not remove the risk, but simply makes another party responsible.

Some other financial instruments used for risk transferring are performance bonds, warranties and guarantees. The project manager should realize that transfer of risk is limited to recovery of financial losses and does not in any way help put the project back on schedule. The project manager also considers techniques like self-insurance or captive insurance as an alternative mechanism for insurance. These techniques are discussed later.

Risk Mitigation

Very few risks can be effectively addressed by avoidance or transfer responses. The project manager can also take preventive measures to reduce the loss caused by the risk. This is called risk mitigation. The purpose of risk mitigation is to reduce the intensity of the risk to a point where it can be accepted.

Risk mitigation techniques can be implemented in two ways: by eliminating the causes of the risk, or reducing the impact of the risk. By eliminating the causes of the risk, this approach reduces the probability of the occurrence of the risk. If the probability of the risk cannot be reduced, the technique aims at reducing the impact of the risk.

To reduce the likelihood of losses, the project manager can use best quality equipment, maintain the equipment and use sophisticated production processes. As the treatment of risk differs for each risk, the risk mitigation methodology also varies with the nature of the risk. This is the most widely used method as the majority of the risks can be targeted through this technique.

Risk Acceptance

Sometimes the project manager is forced to accept the consequences of certain risks. This is because the risks are the residual risks and cannot be eliminated by using avoidance, transfer or mitigation techniques. In such a situation, the project manager prepares a contingency plan to face the risks. Different types of risks in a project can be interconnected and therefore, at the same time implementation of risk mitigation strategy to control risks has become very important.

In the case of relatively low level risks, the project manager accepts them. For example, the manager of a showroom accepts the risk of his showroom glass windows being broken. Similarly, risks that reduce profits but do not produce any adverse effects are also accepted. The project manager creates a separate reserve to face these risks.

12.7.4 Risk Control

Risk control during project accomplishment is a critical phase to ensure that all risks were considered properly in risk management process. When changes in the course of the project are observed, the project manager repeats the cycle of identifying, quantifying and responding to risks. The process of risk control includes identifying the additional risks and their sources, management by wandering around and developing more risk response developments. The process of risk control results in corrective action and revision of the risk management plan.

Corrective Actions

Corrective action is the action taken to reduce or control negative events, which lead to the deviation of the project from its schedule, such as insufficient information, misallocation of budget etc. To take corrective action, the project manager prepares contingency plans and does workarounds. Contingency plans are the alternative ways of doing the work when the risk is faced. Workarounds are the informal checking up of the project activities. These corrective actions help in reducing the severity of the risk.

Updates to Risk Management Plan

Evaluation of the risk event and identification of the causes for failing to respond to a particular risk are aspects to be considered by the project manager when revising or updating the earlier risk management plan.

Learning organizations build their knowledge bases after each project, covering various aspects of project life cycle, where risk also is a prime parameter. Thus, as time progresses, the risk methodology will definitely change and new mitigation approaches adopted will guide future project managers to handle risk more better way. Exhibit 12.1 presents the risk management strategies suitable for 2021

Exhibit 12.1: What are the 10 Types of Risk Management Strategies to Follow in 2021?

Here are ten types recommended for 2021.

Business Experiments: This risk management strategy is useful in running 'what-if' scenarios to gauge different outcomes to potential threats.

Theory Validation: Theory validation strategies can be conducted using questionnaires and surveys of groups. Direct, timely, and relevant feedback on managing potential challenges and design flaws help better management of risks.

Minimum Viable Product Development: A good risk management strategy needs to consider: Minimum Viable Product (MVP) – means building software using core modules and features which are relevant and useful for the bulk of their customers.

Isolating Identified Risks: Information technology teams need to engage with internal or external help to isolate security gaps or flawed processes leaving room for vulnerabilities.

Building in Buffers: Buffers reduce risks by ensuring activities stay within the intended scope. Buffers may be financial, resource or time-based.

Data Analysis: Qualitative risk analysis can help identify potential project risks. Conducting a thorough qualitative risk analysis helps to isolate and prioritize risks, and to develop strategies to address, monitor, and re-evaluate them.

Risk-Reward Analysis: An analysis of risks versus rewards is a risk strategy. This helps companies to unearth the benefits and drawbacks of initiatives before investing resources, time, or money.

Lessons Learned: Completed projects leave lessons for future project managers. These can significantly reduce risks in future projects or undertakings.

Contingency Planning: Contingency planning is all about anticipating that things will go wrong and defined as the planning necessary alternate solutions for the type of risks that may surface and topple the original plan.

Leveraging Best Practices: Best practices are those tried and tested ways of doing things. These will ultimately reduce risks.

https://www.auditboard.com/blog/10-risk-management-strategies-2021/

Activity: Build India Ltd. manufactures industrial inverters and generators. The company got several orders to manufacture industrial inverters and generators from various companies. The company incurred huge losses due to its poor risk management record. Therefore, the company management asked Ravi Prabhakar, the project manager, to prepare effective risk responses to deal with the risks that may arise. What are the various types of risk responses? Discuss the criteria for selecting an appropriate risk response.

Answer:

Check Your Progress - 4

16. Which of the following options involves the assessment of the range of risks associated with a possible project outcome?
    a. Risk response
    b. Risk quantification
    c. Risk transfer
    d. Risk mitigation
17. Which of the following responses to risks involves taking preventive measures to reduce the loss caused by the risk?
    a. Risk avoidance
    b. Risk transfer
    c. Risk acceptance
    d. Risk mitigation
18. Which of the data need **not** be collected by the project manager before developing a risk response policy?
    a. List of identified risks
    b. Probability of occurrence of each risk
    c. Analysis of the project outcome
    d. Review of the potential responses that have been identified during the risk identification stage

19. The successful implementation of a project depends on the ability of the project manager to deal with different types of risks. Which of the following is/are the steps in risk management?
    i. Risk identification
    ii. Risk quantification
    iii. Risk response
    iv. Risk control
    a. Only i
    b. Only ii and iv
    c. i, ii, iii, and iv
    d. Only iii and iv
20. Which of the following are the events which reveal the increasing chances of risk?
    a. Sources of risk
    b. Risk symptoms
    c. Potential risk events
    d. Risk quantification
21. From the options given, identify the ways by which the risk mitigation techniques can be implemented.
    i. By accepting the consequences of risk
    ii. By eliminating the causes of risk
    iii. By transferring the liability of risk to a third party
    iv. By reducing the impact of risk
    a. i and iv
    b. ii and iv
    c. iii and iv
    d. ii and iii
22. For identifying the potential risks, the project manager need **not** perform which of the following activities?
    a. Analyzing the project outcome
    b. Understanding the market conditions
    c. Estimating the probability of occurrence of each risk
    d. Identifying the required human resources
23. The concept of insurance is a kind of _____ response.
    a. risk avoidance
    b. risk mitigation
    c. risk transfer
    d. risk control

24. _____ refer to the informal checking up of project activities.
    a. Contingency plans
    b. Corrective actions
    c. Workarounds
    d. None of the above
25. Which of the following types of responses to risk involves shifting the risk to a third party?
    a. Risk avoidance
    b. Risk acceptance
    c. Risk transfer
    d. Risk mitigation

12.8 Insurance for Projects

The concept of insurance is a kind of risk transfer response. Diversification of risk is an important aspect of insurance that spreads the risks over a large group of projects. The project manager enters into an insurance or risk pool to transfer the risk over a wide area and over a period of time.

Basically, risks are of two types: speculative risks and pure risks. The mechanism of insurance is applicable only for pure risks. The term 'pure risk' refers to those situations that involve the likelihood of incurring losses. Speculative risk describes a situation where there is the possibility of making profits. Risks caused by changes in technology, political upheaval etc. are speculative risks; and damage caused by fire, earthquake or human risks such as burglary, theft negligence etc are pure risks.

The purpose of insurance is to safeguard the business against a set of pure risks that affect the solvency of the project. The project manager should acquaint himself with all the aspects of insurance coverage and he should identify all the risks that can be covered and the risks that cannot be covered by insurance coverage. At the same time, the project manager is responsible for reducing the severity of the risks. Some of the techniques followed by project managers to secure the project against certain types of risks are discussed below.

12.8.1 Self Insurance

Assuming a financial risk oneself instead of paying the premium to another company is called self- insurance. Organizations that are financially very strong usually opt for self-insurance. Such organizations are aware of the occurrence of risks, instead of transferring these risks to other parties, they create separate reserves to deal with such risks.

Self insurance is normally done when an organization feels that the risks are not very severe and in the case where insurance is not applicable. By making self-insurance, a firm can save costs like agent commission, and administration costs of the insurance company.

12.8.2 Captive Company

Big organizations create a separate entity to provide insurance to its corporate firm and to its affiliates. The created entity works like an insurance company and is called a captive company. There are two types of captives: pure captives and group captives. In a pure captive, a single company provides insurance coverage to its affiliates; and in group captives, a group of companies come together to provide insurance coverage to their corporate offices and affiliates against certain specified risks. But the risk diversification is not spread more in these companies.

In the above cases, the transfer of risk is partial and limited. In order to ensure a greater spreading of risks, the project manager has only a single option, insurance. The project manager considers several policies to cover several project risks. Some of the policies and the risks they cover are discussed below.

12.8.3 Fire and Natural Calamities Insurance

The policy covers all machinery and equipment (movable, immovable) against the risks of fire, lightning, explosion of boiler and explosion of gas. Fire policies 'A', 'B', and 'C' are issued to cover the equipment from several risks. Fire policy 'A' and Fire policy 'B' cover simple risks to dwellings offices, hotels, shops and educational institutions. Fire policy A covers the following perils: (i) fire, (ii) lightning (iii) impact damage (iv) aircraft damage, (v) riot, strike and terrorist damage, (vi) earthquake, (vii) explosion / implosion (viii) storm, flood and inundation (ix) landslide. Only policy A is issued to cover artisans workshops, bio-gas plants, village and cotton industries, tiny sector or small scale industries.

Fire policy B covers the following perils (i) fire (ii) lightning (iii) explosion/implosion (iv) impact damage (v) aircraft damage (vi) riot, strike and terrorist damage. The riot, strike and terrorist damage perils can be excluded with specified reduction in the premium rate. Fire policy 'C' is issued to cover industrial/manufacturing risks and storage risk from perils like fire, lightning, explosion/implosion, impact damage, aircraft damage, riot, strike, malicious and terrorist damage. The riot, strike, malicious and terrorist damage perils can be excluded on specific request with a reduction in the premium rate.

The consequential loss fire insurance policy protects the loss of gross profit from interruption of the commissioned project as a result of fire damage to the machinery and equipment. In the case reduction in output, the financial loss is compensated for by the insurance company.

12.8.4 Industrial All Risks (IAR) Insurance

This is a comprehensive policy that covers perils like fire, burglary, and machinery breakdown/boiler explosion. Various risks are covered in a single policy, thus reducing the premium costs. This policy covers both manufacturing and storage facilities of all industrial units anywhere in India. The policy holder should bear 5% of the claim amount in case of material damage, three days of gross profit in the case of business interruption, subject to a minimum of Rs. 5 lakhs and a maximum of Rs. 50 lakhs.

12.8.5 Projects and Advance Loss of Profits Insurance

This policy is especially designed for large power and construction projects, and industrial plants. It is a comprehensive policy, provides coverage for various perils. Under this policy, and material damage is covered until the project is completed and tested. In addition, if there is any delay in completion of the project because of material damage, the policy offers partial compensation for the loss of profits. But the other policies cover the loss of profit from the day the insured peril occurred. But this policy covers the profit risk from the date the insurance was taken. These policies are framed to meet the insurance needs of major global project financiers and joint venture partners who are making large investments in India.

12.8.6 Erection All Risks (EAR) Insurance

This policy protects the property against accidents that result in damage to the equipment and machinery while constructing or installing. These days, this policy has become a prerequisite for receiving loans from financial institutions. The sum insured for a project under this policy represents the value of the project. Big projects like global infrastructural projects, power generation plants, drugs and fertilizer plants, cement factories and oil refineries purchase this policy to protect buildings and equipment.

12.8.7 Workmen's Compensation Insurance

The Workmen's Compensation Act, provides compensation to workmen for any injury, accident, or disease arising out of and in course of the work. The project manager purchases a policy to cover employees against specified risks. Because of the increased use and growing complexity of machinery in today's projects, all firms are protecting their workmen against several risks. This also improves the morale of the workers of the project.

The other important policies that project managers need to consider are Contractors All Risk (CAR) policy that protects the civil contractors against damage, Machinery Breakdown (MB) policy that provides insurance coverage for any sudden breakdown of expensive plant machinery and equipment, Boiler Explosion Policy indemnifies the insured against damage to the boiler or any

specified apparatus, and Electronic Equipment insurance covers the electronic equipment such as computers, micro processors, telecommunications equipment.

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26. In which of the following ways of providing insurance does a group of companies come together to provide insurance to their corporate offices and affiliates?
    a. Pure captives
    b. Group captivesH
    c. Self insurance
    d. None of the above
27. Which of the following options refer to those situations that involve the likelihood of incurring losses?
    a. Risk avoidance
    b. Pure risks
    c. Risk control
    d. Risk transfer
28. _____ protects a company against loss of profit caused by the commissioned project being interrupted as a result of damage to machinery and equipment due to fire.
    a. Fire policy A
    b. Fire policy B
    c. Consequential loss fire insurance policy
    d. None of the above
29. In insuring the risks of a project, which of the following types refer to a company undertaking the risk on its own without paying a premium to another company?
    a. Captive company
    b. Risk mitigation
    c. Self insurance
    d. None of the above
30. Identify the policy that provides for compensation to workmen for any injury, accident, or disease arising in the course of work.
    a. Erection all risks policy
    b. Workmen’s compensation insurance policy
    c. Industrial all risks insurance policy
    d. None of the above

31. Identify the policy that protects the property against accidents that result in damage to the machinery and equipment during construction and installation.
    a. Industrial all risks
    b. Consequential loss fire insurance policy
    c. Erection all risks
    d. Fire policy
32. Which of the following risks describe the possibility of making profits?
    a. Pure risks
    b. Speculative risks
    c. Risk control
    d. Risk mitigation
33. Which of the following types of insurance policy covers all the perils like fire, burglary, and machinery breakdown/boiler explosion?
    a. Consequential loss fire insurance policy
    b. Fire policy A
    c. Industrial all risks insurance
    d. None of the above

12.9 Summary

- Risk is defined as the possibility of an outcome being different from the expected outcome. It refers to the possibility of adverse results flowing from the uncertainty involved in carrying out the activities.
- Broadly, risks can be categorized into technical risks, economic risks, political risks, production risks, marketing risks, financial risks, and human risks.
- Project managers deal with risks in different ways, depending on their level of tolerance for risks. They can be classified as risk averters, risk neutrals, and risk seekers on the basis of their attitude toward risk.
- The tolerance curve for each type of manager is derived by comparing his/her risk preference with the utility (the amount of satisfaction the project manager derives from a payoff). The utility can also be referred as the tolerance for risk.
- Risk management can be defined as the formal process by which risk factors are systematically identified, assessed, and provided for. Risk management is an aspect of project implementation.
- The successful completion of a project depends on the ability of the project manager to deal with different types of risks. The steps involved in the process of risk management are – risk identification, risk quantification, risk response, and risk control.

- Project managers must be capable of taking good decisions to execute a project successfully. They take decisions under three conditions: certainty, risk and uncertainty. Decision-making is easy under conditions of certainty, but it is extremely difficult under conditions of uncertainty.
- The concept of insurance is a kind of risk transfer response. The project manager enters into an insurance or risk pool to transfer the risk over a wide area and over a period of time.
- Risks are basically of two types: speculative risks (situation where there is the possibility of making profits) and pure risks (situations where there is the likelihood of incurring losses). The mechanism of insurance is applicable only for pure risks.

12.10 Glossary

Decision Tree Analysis: It is used in complex situations when sequential decisions are involved and when these decisions can be taken only after the happening of an uncertain event in future.

Economic Risks: An increase in the rate of inflation, changes in the economic policies of governments, and distribution of income. Production risks

Financial Risk: Variations in the after tax earnings or the earnings per share of the firm caused by the capital structure.

Production Risks: The shortage of necessary raw materials, sudden breakdown of key machinery, and exponential rise in installation and maintenance costs.

Risk Averter: A person who always wishes to avoid risk.

Risk Avoidance: A risk management response technique aimed at eliminating the cause of a risk to avoid the risk.

Risk Identification: It is the process of determining which risk events are likely to affect the project.

Risk Management: A process by which risk factors are systematically identified, assessed, and provided for.

Risk Mitigation: A risk management technique aimed at reducing the loss in the case of a risk by taking the preventive measures.

Risk Quantification: It involves assessment of the range of risks associated with a possible project outcome.

Risk Response: The steps by which the project manager responds to the risks identified and quantified.

Risk Seeker: He/she is a person who wishes to accept the risks.

Risk Symptoms: These are also called triggers. These events are not the actual risk events, but they reveal the increasing chances of risk.

Risk Transfer: The risk response method aimed at transferring the liability for risk to a third party. But the scope for this model is often limited as the financial risk only can be transferred.

Risk: The possibility of an outcome being different from the expected. It is a situation where the possible events are known but which of those will actually happen is not known.

Social risks: Social risks refer to risks arising from changes in the needs and changing preferences of target customers. Economic risks

Technical risk: Risk of failing to meet technical specifications.

12.11 Self-Assessment Exercises

1. Every activity of a project involves the risk element. Define risk. What are the different types of risks to which projects are exposed to?
2. The tolerance curve for each type of manager is derived by comparing his/her risk preference with the utility. Explain how project managers can be classified according to their tolerance to risks.
3. The successful completion of a project depends on the ability of the project manager to deal with different types of risks. Define risk management in projects. What are the steps involved in the process of risk management?
4. Project managers take decisions to execute a project successfully under three conditions of certainty, risk, and uncertainty. Explain decision making under these three conditions.
5. The project manager enters into an insurance to transfer the risk over a wide area and over a period of time. Describe the techniques followed by project managers to secure the project against the various types of risks.

12.12 Suggested Readings/Reference Material

1. The Project Management Institute (PMI), A Guide to the Project Management Body of Knowledge (6th edition), Published Date: 2017 (6th edition)
2. K R Sharma, Project Management: Text and Practice Paperback – 1, Atlantic Publishers and Distributors (P) Ltd , January 2021
3. Anna Brzozowska, Arnold Pabian , Barbara Pabian, Sustainability in Project Management; A Functional Approach, CRC Press, 2021
4. Peter J. Edwards, Paulo Vaz Serra, Michael Edwards, Managing Project Risks, Wiley-Blackwell, 2019
5. Ronald Blank, The Basics of Quality Auditing, Productivity Press, 2017

12.13 Answers to Check Your Progress Questions

Following are the answers to the Check Your Progress questions given in the Unit.

1. (b) Risk

Risk is the function of uncertainty. It involves the possibility of an outcome being different from the expected outcome. Technical risks involve the failure to meet a particular performance requirement. Political risks involve the risk of nationalization, political instability, trade restriction, etc. Both technical risks and political risks are part of business risks.

2. (b) Marketing risks

Marketing risks refer to the failure of the product or service in the market due to factors like change in demand, errors in forecasting of demand, and difficulties in distribution. Financial risks are risks due to financial factors like choice of investments and mistakes in accounting procedures. Political risks refer to the risks due to factors like nationalization, political instability, trade restrictions, etc. Economic risks refer to risks due to changes in inflation, changes in the economic policies of the government, and distribution of income.

3. (c) Social risks

Social risks arise from changes in the needs and preferences of target customers, unavailability of natural resources, and labor unrest. Agitations and social movements against the projects also constitute social risks. Technical risks refer to the failure to meet a particular performance requirement. Economic risks refer to risks of an increase in inflation, changes in economic policy, distribution of income, etc. Human risks refer to the risk of sudden demise of the employee, lack of availability of competent employees, inter-group politics, etc.

4. (d) Production risks

Production risks refer to the risks which cannot be controlled by the project manager like shortage of raw materials, sudden breakdown of machinery, and risk in installation and maintenance costs. Marketing risks refer to the risks arising due to demand factors and difficulties in distribution. Political risks refer to the risks due to political factors like nationalization, political instability, trade restrictions, etc. Economic risks refer to risks due to changes in inflation, changes in the economic policies of the government, and distribution of income. Social risks arise from the possibility of changes in the needs and preferences of target customers, unavailability of natural resources, labor unrest, and agitations and social movements against the projects.

5. (b) Only i and iii

Risk is the possibility of an outcome being different from the expected outcome. Project risk is considered as the function of uncertainty and damage. But uncertainty and damage are considered while conducting a risk analysis of the project. Risk may also arise due to hazards. Hazards can be defined as a source of danger. So risk is also a function of hazard and safeguard.

6. (b) risk management

Risk management is defined as the formal process by which risk factors are defined, assessed, and tackled. Political risks, financial risks, and economic risks are different types of risks. Political risks refer to the risks arising out of political factors like nationalization of a particular industry, political instability, trade restrictions, etc. Financial risks are the risks arising due to financial factors like an increase in bad debts, change in interest rates, wrong choice of investments, and mistakes in accounting procedures. Economic risks refer to the fluctuations in economic factors like inflation, change in the government's economic policy, and distribution of income.

7. (c) Only i

When more money is at stake, the risk averter's utility increases but at a decreasing rate. For a risk seeker, the utility increases at an increasing rate as the amount of money at stake increases. In the case of a risk neutral, the utility increases in proportion to an increase in the amount of money at stake.

8. (c) risk averter

Project managers are classified into risk averters, risk seekers, and risk neutrals. A risk seeker is a person who wishes to accept more and more risks, a risk averter is a person who always wishes to avoid risks, and a risk neutral is a person who falls between a risk seeker and a risk averter.

9. (c) Maximin criterion

The Maximin criterion is also called the Wald criterion. Under this criterion, the project manager identifies the minimum payoff values for each strategy and adopts the strategy that has the highest payoff value. The Maximin criterion finds the alternative that maximizes the minimum outcome or consequence for every alternative. In this case, the minimum outcome is located within every alternative and the alternative with the maximum value is chosen.

10. (d) Data insufficient

Under conditions of certainty, the project manager can choose the strategy if he/she knows which state of nature is going to exist. If the project manager knows that N1 is the expected state of nature, he/she can adopt the strategy

S1 as it will provide higher returns than other strategies. However, in the given question, the expected state of nature is not given. Hence, the data given is not sufficient to answer the question.

11. (d) Maximax criterion

The Maximax criterion is also called the Hurwicz criterion. Under this criterion, the project manager chooses the strategy that is likely to earn him/her the highest returns. The Maximax criterion finds the alternative that maximizes the outcome or consequence for every alternative. The Maximax approach is used in cases where the project manager cannot assess the outcome probabilities with confidence.

12. (d) i, ii, and iii

The project manager uses four types of criteria to select a strategy – Maximax criterion, Maximin criterion, Minimax regret criterion, and criterion of realism. Under the Maximax criterion, the project manager chooses the strategy that is likely to earn him/her the highest returns. Under the Maximin criterion, the project manager identifies the minimum payoff values for each strategy and adopts the strategy that has the highest payoff value. Under the Minimax regret criterion, the project manager attempts to minimize the maximum regret value. The regret value is obtained by subtracting the payoff value in each state of nature from the largest payoff value of that state of nature. Under the criterion of realism, each state of nature has the same probability of occurrence. The project manager considers the average value of all the payoffs for each strategy and selects the strategy that has the highest average payoff value.

13. (b) Decision tree analysis

The decision tree analysis is used by the project manager when a decision involves a series of several interrelated decisions. The project manager chooses the strategy with the highest 'Expected monetary value' (EMV).

14. (b) Criterion of realism

The criterion of realism is called the Laplace criterion. As per this criterion, all the states of nature have the same probability of occurrence. So the project manager considers the average value of all the payoffs for each strategy and selects the strategy that has the highest average payoff value.

15. (b) certainty

The project manager takes a decision under three types of conditions – Certainty, uncertainty, and risk. If the project manager takes the decisions under certainty, he/she is fully aware of all the states of nature available and the expected payoffs for each state of nature. Under uncertainty and risk, the project manager is not fully aware of the states of nature available.

16. (b) Risk quantification

Risk quantification is one of the important steps in risk management. It involves the assessment of the range of risks associated with a possible project outcome. Risk response refers to the steps taken by the project manager in response to the risks identified and quantified. Risk transfer and risk mitigation are the different types of responses to risks.

17. (d) Risk mitigation

Risk mitigation involves taking preventive measures to reduce the loss caused by the risk. Risk avoidance is the first step in risk response. It involves avoiding the risk by avoiding the causes of risk. Risk transfer involves the transfer of the liability to a third party. Risk acceptance involves the project manager accepting the consequences of risk.

18. (c) Analysis of the project outcome

Following is the data that must be gathered before developing a risk response policy: List of identified risks, probability of occurrence of each risk, review of the potential responses that have been identified during the risk identification stage, list of project stakeholders who play a role in developing a proper risk response, and defining the acceptable level of risk. Analysis of the project outcome is one of the steps to identify the potential risks in risk identification.

19. (c) i, ii, iii, and iv

The four steps involved in the risk management strategy are risk identification, risk quantification, risk response, and risk control. Risk identification is the first step in the process of risk management. It involves scanning the project activities, identifying potential risks, and documenting the risks. Risk quantification involves an assessment of the range of risks associated with a possible project outcome. Risk response follows risk quantification and refers to the steps taken by the project manager to respond to the risks identified and quantified. The last step in the risk management process is risk control. This involves identifying additional risks and their sources, management by wandering around, and developing more risk response tools.

20. (b) Risk symptoms

Risk symptoms are the events which reveal the increasing chances of risk. Risk symptoms are also called ‘triggers.’ Sources of risk are the possible risk events which may affect the outcome of the project. Risk quantification involves an assessment of the range of risks associated with the project outcome.

21. (b) ii and iv

The two ways by which risk can be mitigated are by eliminating the causes of risk and by reducing the impact of risk.

22. (c) Estimating the probability of occurrence of each risk

The project manager should carry out the following activities to identify the potential risks in risk identification: analyzing the project outcomes, critically viewing all the processes involved in the project, estimating the costs and schedules of various activities of the project, identifying the required human resources, and studying the records and databases of old and successfully implemented projects. Estimating the probability of occurrence of each risk is the data to be gathered before developing the risk response policy.

23. (c) risk transfer

The concept of insurance is a kind of risk transfer response among the various risk responses. This involves transferring the financial risk to a third partner. Risk avoidance is avoiding the risk by making efforts to eliminate it. Under risk mitigation, the project manager can take preventive measures to reduce the loss caused by the risk. Risk control refers to the control of the risk by identifying, quantifying, and responding to the risks.

24. (c) Workarounds

Workarounds refer to the informal checking up of project activities. Contingency plans are the alternative ways of doing work when a risk is faced. Contingency plans and workarounds fall under the head of corrective actions in risk control.

25. (c) Risk transfer

Risk transfer involves shifting the risk to a third party. Only financial risks are transferred to a third party. Risk avoidance is the first step in risk response. It involves avoiding the risk by avoiding the causes of risk. Risk acceptance involves the project manager accepting the consequences of the risk. Risk mitigation involves undertaking preventive measures to reduce the loss caused by the risk.

26. (b) Group captives

Captive insurance companies are divided into two types: Pure captives and group captives. Group captives refer to the coming together of a group of companies to provide insurance to their corporate office and affiliates. In the case of a pure captive, a single company provides insurance coverage to its affiliates. Self insurance refers to a company assuming the financial risk on its own instead of paying the premium to another company.

27. (b) Pure risks

Risks are divided into pure risks and speculative risks. Pure risks are the risks that involve the likelihood of incurring losses. Risk avoidance, risk control, and risk transfer are the various types of responses to risk.

28. (c) Consequential loss fire insurance policy.

Fire policies A, B, and C are issued to cover the equipment against several risks. Consequential loss fire insurance policy protects a company against the loss of gross profit caused by an interruption of the project as a result of fire damage to the machinery and equipment.

29. (c) Self insurance

Self insurance refers to a company assuming the financial risk on its own instead of paying a premium to another company. A captive company refers to a separate entity created to provide insurance to its corporate firm and affiliates. Risk mitigation is one of the responses to risk.

30. (b) Workmen's compensation insurance policy

The Workmen's Compensation Act provides compensation to workmen for any injury, accident, or disease arising in the course of work. The erection all risks policy protects the property against accidents that result in the damage to the equipment and machinery during construction and installation. Industrial all risks is a comprehensive policy that covers perils like fire, burglary, and machinery breakdown/boiler explosion.

31. (c) Erection all risks

The erection all risks policy protects the property against accidents that result in damage to the equipment and machinery during construction and installation. The industrial all risks policy covers perils like fire, burglary, and machinery breakdown/boiler explosion. Fire policies A, B, and C are issued to cover the equipment against several risks. Fire policy A covers fire, lighting, impact damage, aircraft damage, riot, strike, and terrorist damage, earthquake, explosion/implosion, storm, flood and inundation, and landslide. Some of the risks to artisans workshops, bio-gas plants, village and cotton industries, and small scale industries are covered by only policy A. Fire policy B covers fire, lighting, explosion/implosion, impact damage, aircraft damage, riot, strike, and terrorist damage. But the riot, strike, and terrorist damage perils can be excluded with specific reduction in the premium rate. Fire policy C covers industrial/manufacturing risks and storage risks from perils like fire, lighting, explosion/implosion, impact damage, aircraft damage, riot, strike, malicious and terrorist damage. The riot, strike, malicious and terrorist damage perils can be excluded on specific request with a reduction in the premium rate.

32. (b) Speculative risks

Risks are divided into pure risks and speculative risks. Speculative risks are the risks that describe the possibility of making profits. Risk mitigation and risk control are the various types of response to risk.

33. (c) Industrial all risks insurance

Industrial all risks is a comprehensive insurance policy that covers perils like fire, burglary, and machinery breakdown/boiler explosion. Fire policies A, B, and C are issued to cover the equipment against several risks. Consequential loss fire insurance policy protects a company against loss of gross profit caused by an interruption to the project as a result of fire damage to the machinery and equipment.

Unit 13

Project Quality Management

Structure

13.1 Introduction

In the previous unit, we have discussed project risk management. In this unit, we will discuss project quality management. Earlier, project firms believed that higher quality increased project costs. But now they realize that improved quality increases business volumes. The growing size and complexity of projects have forced firms to concentrate more on quality at every stage. Otherwise, the cumulative effect of each defect in the various stages will lead to a considerable reduction in the quality of project end product.

'Quality' is relative and different people have different definitions of quality. The project manager however, has to be very specific regarding the quality of a project. He can use several techniques to meet the quality requirements. Project quality management includes all the processes required to ensure that the project meets the specific requirements of its stakeholders. The project manager should prepare a quality plan and communicate it to team members and ensure that the plan is being implemented properly.

This unit will discuss quality and the international quality standards. We will discuss the cost of quality, and explain the various project quality management concepts. We shall then move on to discuss the different project quality control tools. Finally, we would be discussing the concepts of process capability, acceptance sampling, quality circles, just-in-time management, and total quality management.

13.2 Objectives

By the end of this unit, the students should be able to:

- Define quality, and explain the international quality standards.
- Discuss the concept of cost of quality.
- Reproduce the project quality management concepts.
- Identify the various project quality control tools.
- Explain process capability and acceptance sampling.
- Discuss the concepts of quality circles, just-in-time management, and total quality management.

13.3 Definition of Quality

The ISO 9000 defines 'quality' as 'the totality of features and characteristics of a product or service that bears on its ability to satisfy stated or implied needs.'

The client looks at quality as:

Conformance to specifications: The project manager mentions the project end product and its clear specifications in the POS. The client expects the product or service to match the specifications provided in the POS. To him, quality is the conformance of the end product's specifications as mentioned in the POS.

Value for money: Clients may define quality as a value or how well the product or service fulfills the intended purpose for the price they are willing to pay. If they feel that the price of the product or service is higher than the utility they derive, then they may conclude that the project is of less quality.

Fitness for use: The client considers the features of a product or the convenience of a service to decide the project quality. The aspects include appearance, style, durability, reliability, and serviceability, etc.

Support: Often the support a company provides to its product or service is considered as the quality. For instance, if the project manager provides servicing facility at a low price or free of cost, the client feels that quality of the product (project) is high.

Psychological impression: Clients evaluate the quality of a product or service based on some psychological impressions: physical ambience, the firm's image,

etc. For instance, well-dressed, courteous, and friendly project team members make a positive impact on clients who associate these attributes with quality.

13.4 International Quality Standards

ISO 9000 Standards are a set of international quality management system standards and guidelines. ISO stands for International Organization for Standardization. It is located in Geneva, Switzerland and was established in 1947. The standards are applicable to all kinds of organizations in areas such as manufacturing, processing, servicing, electronics, computing, financial services, accounting, banking, retailing, aerospace, construction, exploration, pharmaceuticals, petrochemicals, shipping, telecommunications, research and development, health care, agriculture, software development, instrumentation, biotechnology, insurance etc. ISO published its first quality standards in 1987 and revised them in 1994. These standards are referred to as the ISO 9000 Standards:

ISO 9000: This provides a roadmap for the other standards within the series and defines key terms.

ISO 9001: This defines the model for a quality system for companies that design, produce, install, and service products.

ISO 9002: This is a quality system model for quality assurance in production and installation.

ISO 9003: This is a quality system model for quality assurance in final inspection and testing.

ISO 9004: This quality system provides quality management guidelines for firms that wish to develop and implement a quality system, to determine the extent to which each quality model is applicable.

ISO 14000: This provides standards for managing environmental impacts, including management system, environmental performance evaluation, environmental labeling, and life cycle assessment.

The ISO protocol requires that all standards to be reviewed at least every five years to check whether they should be retained, revised or withdrawn. The 1994 version of ISO standards were revised by ISO Technical Committee, TC 176 in year 2000.

In order to reflect the modern management approaches and also to improve organizational practices, the Committee felt the need for some structural changes, while maintaining the essential requirements of past standards. One of the primary objectives of the ‘Year 2000’ revisions to the ISO 9000 standards is to simplify the structure and reduce the number of standards. This was done by the

replacement of ISO 9001:1994, ISO 9002:1994, ISO 9003:1994 standards by a single quality management system (QMS) requirement standard, ISO 9001: 2000.

Example: The Revised ISO Standards	
Standards and guidelines	**Purpose**
ISO 9000:2000, *Quality management systems - Fundamentals and vocabulary*	Establishes a starting point for understanding the standards and defines the fundamental terms and definitions used in the ISO 9000 family to avoid misunderstandings in their use.
ISO 9001:2000, *Quality management systems - Requirements*	This is the requirement standard to assess the firm's ability to meet customer and applicable regulatory requirements and thereby address customer satisfaction. It is now the only standard in the ISO 9000 family against which third-party certification can be carried.
ISO 9004:2000, *Quality management systems - Guidelines for performance improvements*	This standard provides guidance for the continual improvement of quality management system to benefit all parties through sustained customer satisfaction.
ISO 19011, *Guidelines on Quality and/or Environmental Management Systems Auditing* (currently under development)	Provides guidelines for verifying the system's ability to achieve the defined quality objectives. You can use this standard internally or for auditing your suppliers.
ISO 10005:1995, *Quality management - Guidelines for quality plans*	Provides guidelines to assist in the preparation, review, acceptance and revision of quality plans.
ISO 10006:1997, *Quality management - Guidelines to quality in project management*	Ensures the quality of both project processes and project products.
ISO 10007:1995, *Quality management - Guidelines for configuration management*	Ensures that a complex product continues to function when components are changed individually.
ISO/DIS 10012, *Quality assurance requirements for measuring equipment* - Part 1: *Metrological confirmation system for measuring equipment*	Provides guidelines on the main features of a calibration system to ensure that measurements are made with the intended accuracy.
ISO 10012-2:1997, *Quality assurance for measuring equipment* - Part 2: *Guidelines for control of measurement of processes*	Provides supplementary guidance on the application of statistical process control when this is appropriate for achieving the objectives of Part 1.

Standards and guidelines	Purpose
ISO 10013:1995, *Guidelines for developing quality manuals*	Provides guidelines for the development, and maintenance of quality manuals, tailored to your specific needs.
ISO/TR 10014:1998, *Guidelines for managing the economics of quality*	Provides guidance on how to achieve economic benefits from the application of quality management.
ISO 10015:1999, *Quality management - Guidelines for training*	Provides guidance on the development, implementation, maintenance and improvement of strategies and systems for training that affects the quality of products.
ISO/TS 16949:1999, Quality systems - Automotive suppliers - Particular requirements for the application of ISO 9001:1994	Sector specific guidance to the application of ISO 9001 in the automotive industry.

Adapted from www.iso.ch.

Check Your Progress - 1

1. The totality of features and characteristics of a product or service that has a bearing on its ability to satisfy stated or implied needs is referred to as ____.
   a. Standards
   b. Quality
   c. Prevention
   d. NONE of the above
2. Which of the following quality standards provides for managing environmental impacts, environmental performance evaluation, environmental labelling, and life cycle assessment?
   a. ISO 14000
   b. ISO 9000
   c. ISO 9001
   d. ISO 9002
3. The client looks for various aspect of quality such as physical ambience, the firm's image, and friendliness of the project team members. These aspects are collectively known as _____.
   a. Value for money
   b. Psychological impression
   c. Fitness for use
   d. Support

4. The full form of ISO is _____.
   a. International Standardization Organization
   b. International Organization for Standardization
   c. International Services Organization
   d. International Secret Organization
5. The client judges product quality by looking at the features of the product or the convenience of a service. This angle from which the client looks at quality is called _____.
   a. Conformance to specifications
   b. Value for money
   c. Fitness for use
   d. Support
6. The ISO protocol requires all the standards to be reviewed every _____ years to determine whether they should be retained, revised, or withdrawn.
   a. Three years
   b. Two years
   c. Five years
   d. Six years
7. Identify the standard for quality system for organizations that design, produce, install, and service products.
   a. ISO 9000
   b. ISO 9001
   c. ISO 9002
   d. ISO 9003

13.5 The Cost of Quality

Every firm incurs costs when it attempts to improve quality. This is referred to as 'cost of quality'. Costs are of two types: 'cost of conformance' and 'cost of non-conformance'. Conformance costs are the costs that firms incur for the means employed to achieve quality. These costs include costs of training, inspection, testing and auditing. Non-conformance costs are those costs that are incurred for improving the quality of a product that has fallen below the desired quality level. These costs include repairs, reworks, complaint handling, etc. Alternatively, the costs of quality can be classified as follows -- costs of prevention, costs of appraisal or detection, and costs of failure.

13.5.1 Costs of Prevention

Prevention costs are the costs incurred by a company to prevent defective goods and services from being produced and delivered to the customer. These costs

include costs of redesigning the process to remove the causes of poor quality, training project team members, identifying right suppliers, process studies, etc.

13.5.2 Costs of Appraisal

Appraisal costs are incurred while assessing the level of quality attained by the operating procedures of the firm. These costs are associated with the evaluation of the product's performance to see if it meets the client requirements or not. These costs include materials inspection, in-process testing, maintenance of test equipment, etc.

13.5.3 Costs of Failures

Costs of failure are two types: internal failures and external failures. Internal failure costs result from defects that are discovered during the production of a product or service and when the product is under the control of the firm. They include costs of rework, repair, corrective actions, etc. External failure costs arise when a defect is discovered after the customer has received the product or service. Costs in this category include costs of returned material, warranty charges, legal expenses from law suits and costs of concessions made to customers.

To arrive at the optimal cost of quality, the project manager calculates the total cost of quality at various defect rates. The project manager aims at that defect rate where the total cost of quality is minimum.

13.6 Project Quality Management Concepts

It is the project manager's responsibility to ensure that the project attains the desired level of quality. Quality cannot be ensured through continuous inspection alone; it can be only achieved with the help of proper planning. Quality planning process is a part of 'planning phase' of the project and it is done on the basis of cost, time and scope of the project. The project manager studies the following six quality management concepts -- quality policy, quality objectives, quality assurance, quality control, quality audit, and quality program plan.

13.6.1 Quality Policy

The quality policy is a document created by quality experts and backed by the top management. It states the quality objectives of the firm, the acceptable levels of quality, the responsibilities of the project team, etc. It also provides guidelines for important quality matters and promotes consistency throughout the organization.

If the project firm does not have quality policy or if the project involves multiple firms, the project manager and his team develop a quality policy (in consultation with quality experts) for the project. The project manager should formally disclose the quality policy of the project to all stakeholders.

Implementing the quality policy is very important. The top management should periodically review the performance of middle and lower level management to ensure that the activities are in line with the overall quality objective of the firm.

A good quality policy provides guidelines to improve the quality of the project; promotes consistency across all projects of the firm; explains to outsiders how the firm views quality; and provides for changes and updates in the policy.

13.6.2 Quality Objectives

Quality objectives are a part of the firm's quality policy. The quality policy consists of the firm's quality objectives, and the time required meeting those objectives. The project manager should set the quality objectives so as to meet the expectations of project stakeholders. The quality objectives of a project should be understandable, achievable, measurable and time-bound. These objectives should be conveyed to the project team in order to motivate them to meet the quality requirements.

Some examples of the quality objectives of a firm are: training the project team on the quality policy and quality objectives before the end of the current fiscal year, and setting up baseline measurements for all processes in the current quarter.

13.6.3 Quality Planning

The concept of quality planning is fairly simple: identify the relevant quality standards and decide how to implement them in the product or service. This needs to be done early in the product life cycle and reviewed often. The level of quality that the organization desires to have will have a significant impact on the planning process as well as WBS, schedule and budget. One needs to make sure that the product and project meet the expectations of the company's quality policy. Once this is established, the policy, and the standards it references, will guide the rest of the decisions. The future decisions will use a variety of techniques such as benefit/cost analysis, flow charts and cause-and-effect diagrams and other tools. Once this is done, a quality management plan is produced that will define the methods to be used to guarantee the agreed-upon level of quality to be met. Metrics also need to be developed to keep track of the process.

13.6.4 Quality Assurance

Quality assurance means evaluating the quality performance of the project periodically to ensure that the project meets the relevant quality standards. Quality assurance attempts to ensure that the scope, cost, and time of the project match the client's requirement.

The project manager establishes the administrative procedures and identifies quality standards to ensure that the scope statement is in line with the client's requirements. The project manager together with his team prepares the quality processes (procedures) and determines whether they really ensure the required level of project quality.

A quality assurance system should – list the quality objectives of the project and identify the required quality standards; collect data continuously for improvement of quality; establish performance measures; include all project functional areas; and conduct quality audits at regular intervals.

Quality planning and quality assurance are often used interchangeably in the industry. Project Management Institute (PMI) recognizes them as separate entities.

Quality planning is deciding what level of quality and standards that will be used to develop the product.

Quality assurance is monitoring the quality related activities being performed in managing the project/product to ensure that they are being done as outlined in the quality management plan. Actual testing and monitoring of the production process is quality control.

The primary tool to manage quality assurance is the quality audit. Quality control activities are continuous, whereas audits are periodic and often random. The purpose of an audit is to ascertain whether or not the methods and standards agreed upon are being followed, and whether those methods are successful in controlling quality at the desired level.

If you find that you are doing everything you said you would, and doing them correctly, but the quality is not what was agreed to, then you would need to develop a quality improvement plan to bring quality to the desired level, or else redefine the level of quality that is acceptable. It maybe that your company has overstated the level of quality that they are willing to pay for. Perhaps the cost of labour skilled enough to produce a high-quality finish on a piece of furniture cannot be justified based on the projected profit. In either case, a change control system should be in place to allow you to make these corrections.

13.6.5 Quality Control

Quality control is the process of monitoring specific project results and identifying ways to eliminate the causes of unsatisfactory results. It is a collection of activities and techniques used to create specific quality characteristics in the project's end product.

Quality control is a technical aspect of the quality management process and it includes setting up quality processes and procedures. These procedures ensure that the project delivers quality output at every stage of the project. It compares the actual results with the standard results at the end of every phase and measures are then taken up to rectify the problems. The project manager can employ techniques like inspection, control charts, and pareto charts in quality control.

A quality control system should -- select the activities to control; set standards to provide basis for corrective actions; establish procedures to measure quality; and compare actual results with standard results at every stage of the project.

Some of the concepts involved in quality control include:

Prevention: This means using the techniques to keep the process in control so that errors or defects do not occur.

Inspection: This means using sampling and measuring methods to ensure that a defective finished product does not reach the customer.

Attribute sampling: This is a binary test. Either the product complies or it does not. It is also known as a GO-NO-GO test.

Variable sampling: This is where a test is done and the results are compared to a continuous scale.

Cause: This is usually broken down into two categories:

- Special or specific causes: A clearly identifiable event that has created a problem (may also be called an assignable cause). A power failure may prevent you from meeting a schedule update deadline, thereby impacting your compliance goal
- Random causes: These are normal variations in the process. As long as the process is within acceptable range, you should not react to these.
- Ranges: There are two types of ranges you should be familiar with:
- Tolerances: These are the acceptable limits of the product variable being measured. If an activity would take 14 days +/- 2 days, and you did it in 13 days, you are within tolerance.
- Control limits: These are internal constraints that you place on the variable to ensure that you will catch any variation before it exceeds the tolerance.

13.6.6 Quality Audit

Quality audit is an organized, independent evaluation procedure to ensure that the project standards match the quality requirements. The audits may be random or periodic and may be conducted by a qualified in-house auditor or an independent authority. A good quality audit ensures that -- a project activity meets the desired quality; rules and regulations pertaining to quality management are followed; quality improvement opportunities are identified; and corrective actions are taken to meet desired quality.

13.6.7 Quality Program Plan

The quality program plan is a plan of action prepared by the project manager and his team by breaking down project objectives into a work breakdown structure.

Project activities are broken down into lower level activities until specific quality actions can be identified.

A quality program plan enables the project manager to assure the client that he has a roadmap for delivering a quality product or service. Such a plan will make the client feel confident about the project's ability to deliver a product/service that will satisfy his needs.

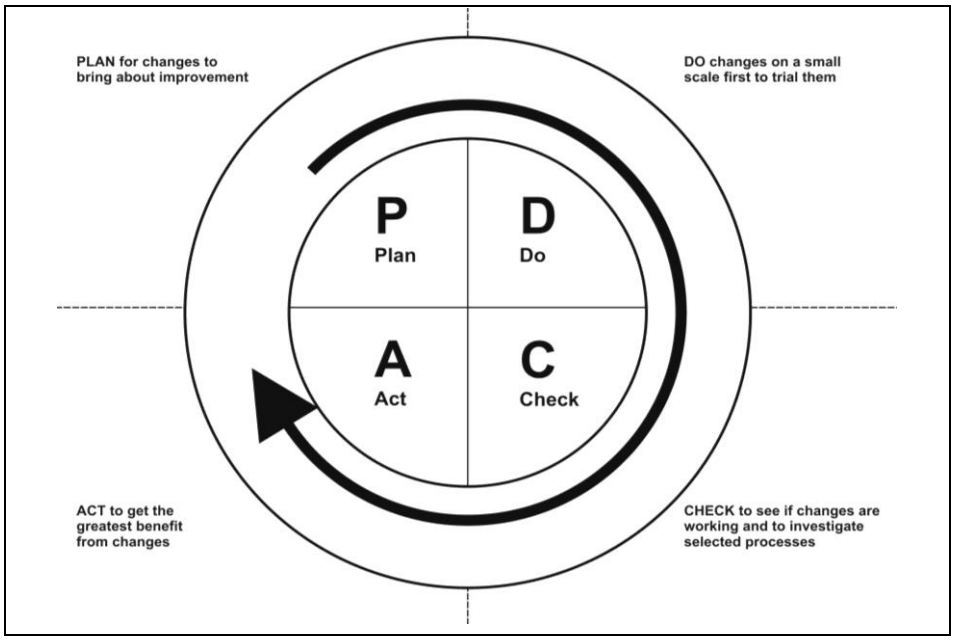
A good quality plan should -- list the features desired by the customer; respond to changing customer needs; and ensure that the quality procedures are enough to meet quality objectives.

13.6.8 Quality Control in Outsourcing

Outsourcing has become a widely practiced strategy in operations management to gain competitive advantage through speed, agility, flexibility and expertise. While it is a standard practice in software industry in the form of off-shoring, it is also very high in the automobile industry. The mass manufacturing strategy of the industry and the deployment of such techniques like Lean and JIT call for planned outsourcing. Of late, recalls have become a regular activity in the automobile industry. A detailed root cause analysis of the reasons for recalls established that most of the problems are quality related, impacting not only customer confidence and satisfaction, but have a serious bearing on safety. Some of the manufacturers indicated that anxiety to reduce costs and delivery on time and the pressure to localize sources generally leads to trade-offs with quality.

In Indian industry, that too in the manufacturing sector, outsourcing is done to the small and medium enterprises, which do not have adequate infrastructure and skilled manpower to ensure efficient process management and quality assurance. Therefore it is the responsibility of the organization to take necessary initiatives to bring in quality culture in these outsourced locations. The requirements include quality planning in outsourcing, vendor management covering identification, evaluation, qualification, and rating and disqualification criteria. Another important responsibility is training the workforce of the vendor in quality tools and techniques and process control techniques.

The advent of ISO 9000 standards and the availability of a structured approach to quality management provided necessary guidelines to all types of organizations. Implementation, certification and maintenance of the quality management system (QMS) thus became an essential road map for ensuring the quality of goods and services. The process approach adopted by these standards facilitates implementation of the Plan-Do-Check-Act methodology for continuous improvement.



Enhanced quality is reduced cost, as we understand this principle from cost fo quality. Thus, establishing quality management systems with in organizations is crucial either it be manufacturing or services sector. Exhibit 13.1 depicts some popular QMS tools in 2021.

Best Quality Management (QMS) Software tools

Product	Features
Dot Compliance	Dot Compliance, is a leader in electronic Quality Management Solution Software. It covers Document management, automations, workflows, assignments, e-signatures, SOPs, Compliance Dashboards, and a Salesforce integration in one platform customized to user needs
Intellect	Intellect's QMS software has proven to enhance quality and reduce overall quality costs by 40%. The apps, which include Document Control, Employee Training, Audit Management, CAPA, Nonconformance are designed by certified quality experts
Benchmark ESG | Gensuite	It has tools necessary to meet and deliver expectations and quality products, solutions to customers expectation. It records non-conformities/defects, helps in follow-up; reports; root cause analyses for continuous improvement, etc
QmsWrapper	qmsWrapper is interconnected and more suited to startups and small businesses as Quality Management Software. It helps ISO 9001:2015 and MedDev creators to achieve and manage ISO 13485:2016 and 21 CFR 820

Compliance Quest	ComplianceQuest is a next generation, flexible Quality Management System (QMS), built around Salesforce focusing on life sciences and manufacturing firms to speed up product and process innovation, minimize risk and drive continuous improvement.
Qualcy QMS	Qualcy Bio-Med QMS designed for Bio-Medical companies (including Biotech, Pharma and Medical Device) to manage QMS records for ISO13485 and FDA requirements. It helps manage the records for Doc. change control, complaints, audits, CAPA, NC Records, Training Records and more
Qualityze Suite	Qualityze next-generation eQMS is an intuitive, easy to use, user interface that is cloud proven and global capable. Its best in class industry closed-loop workflow processes, are aligned with current ISO and FDA/EU standards to enable compliance with stringent regulatory standards.
1factory Manufacturing Quality	1factory provides easy-to-use, powerful Manufacturing and Supply Chain Quality Control software. Benefit of 1factory is that, using this manufacturers can control product quality at their factories, as well all their supply chains.

https://www.capterra.com/quality-management-software/

Check Your Progress - 2

8. Which of the following options consist of the firm's quality objectives, and the time required to meet those objectives?
   a. Quality policy
   b. Quality objectives
   c. Quality assurance
   d. Quality audit
9. The organized, independent evaluation procedure to ensure that the project standards meet quality requirements is called _____.
   a. Quality control
   b. Quality program plan
   c. Quality assurance
   d. Quality audit

10. _____ attempts to ensure that the scope, cost, and time of the project match the client's requirements.

    a. Quality assurance

    b. Quality policy

    c. Quality audit

    d. Quality control

11. The costs incurred by a firm to improve quality are called costs of quality. The costs incurred on the means to achieve quality are called _____.

    a. Conformance costs

    b. Non-conformance costs

    c. Costs of prevention

    d. Costs of failure

12. Which of the following are the features of a good quality policy?

    i. Providing guidelines to improve the quality of the project

    ii. Promoting consistency across all projects of the firm

    iii. Explaining to outsiders how the firm views quality

    iv. Providing for changes and updates in the policy

    a. Only i and ii

    b. Only ii and iii

    c. i, ii, iii, and iv

    d. Only i and iv

13. What are the costs that are incurred on assessing the level of quality attained by the operating procedures of the firm?

    a. Conformance costs

    b. Costs of appraisal

    c. Costs of prevention

    d. Non-conformance costs

14. The costs of returned material, warranty charges, legal expenses on lawsuits, and costs of concessions made to customers are examples of _____.

    a. Costs of appraisal

    b. External failure costs

    c. Internal failure costs

    d. Costs of prevention

15. Which of the following features should a good quality plan have?

    i. It should be responsive to customer needs

    ii. It should list the features desired by the customer

    iii. It should ensure that the quality procedures are stringent enough to meet quality objectives

    iv. It should include all project functional areas

    a. i, ii, iii, and iv

    b. Only ii and iii

    c. i, ii, and iii

    d. Only iv

13.7 Project Quality Control Tools

Statistical methods play a key role in identifying, analyzing, and controlling the quality of different project activities. These tools help the firm in gathering data, identifying patterns of data and measuring variation.

Data tables, and Pareto charts are some useful tools for identifying patterns in data; histograms, scatter diagrams, and control charts are tools used in data analysis; and 'cause and effect analysis', and 'trend analysis' are used both in data identification and data analysis.

13.7.1 Data Tables

Data tables are statistical tools used to collect and present data in a systematic way. Generally, data tables are designed for collecting situation/product specific data. These are effective when data has to be organized and presented for the first round reviews.

A checklist is a form of data table that is used to record the frequency of occurrence of a certain product's quality characteristic. Suppose a textile firm wants to record the defects in different aspects like tears in fabric, discolored fabric, broken fiber board and ragged edges.

13.7.2 Cause and Effect Diagrams

After identifying a problem, the project manager determines the cause of the problem. Cause-and-effect diagrams help identify the relationship between a key quality problem and its potential causes. These diagrams are also called fishbone diagrams or Ishiwaka diagrams. There are six steps in the construction of a cause-and-effect diagram:

Identifying the quality problem: The project manager uses statistical process control tools like pareto chart, histograms (discussed later) and brainstorming etc, to identify the quality problem.

Forming inter-disciplinary team: The project manager forms an inter-disciplinary team from technical and management areas and encourages discussions to determine the causes of the problem.

Drawing problem box and prime arrow: The quality problem is labeled in the problem box (as fish's head) and a prime arrow is drawn to represent major categories of quality problems. Delivery delay is the fish head.

Specifying major categories: The project manager identifies the major categories for the given quality problem (shown in the problem box). Usually, the major categories include materials, production methods, business environment, machinery, human resources, etc. which are represented as the structural 'bones' of the fish in the diagram.

Identifying causes of defects: The project manager identifies the causes that contribute to defects in each of the major categories and lists them down. The causes are shown as the 'ribs' of the fish. The project manager follows three types of approaches in listing the causes of defects. They are: random method, systematic method and process analysis method.

In random method, all major causes in each category are listed at random. In systematic method, the causes are listed in descending order of their importance. In process analysis method, the causes are listed on the basis of the sequence of the process.

Identifying corrective actions: By determining the causes contributing to defects, the project manager prepares a corrective action analysis. The problem box then becomes the corrective action box and corrective actions are shown in the place of defects.

13.7.3 Histograms

Histograms are graphical representations of data as a frequency distribution. When there are a large number of variable data, the histogram summarizes the data into a number of groups.

13.7.4 Pareto Chart

When the project manager identifies several quality problems that need to be addressed, then he has to decide which quality problems should be targeted first. The project manager constructs a Pareto chart to prioritize the quality problems. In this chart, all the quality problems (defect types) are plotted along the horizontal axis in descending order.

The chart has two vertical axes - the one on the left side shows number of defectives (frequency) and the axis on the right side show the cumulative percentage of frequency. The cumulative frequency curve identifies the factors that the management has to address immediately.

13.7.5 Scatter Diagrams

A scatter diagram is a plot of two variables showing how they are related. Data is represented on XY plane and the relationship between the two variables is understood on the basis of how they are distributed.

The relationship between these variables can be of several types:

- No correlation between the variables when the data points are scattered,
- Curvilinear relationship when the data points are in a U-shaped pattern,
- Positive and negative correlation if the patterns of data points have positive and negative slopes respectively.

13.7.6 Trend Analysis

This is a statistical tool that uses mathematical techniques to forecast future outcomes on the basis of historical data. It quantifies the relationships between the data, and establishes an equation that best describes the distribution of data points. The trend line provides a clear, consistent relationship between the dependent (output) and the independent (input) variables.

13.7.7 Control Charts

A control chart is a graphical representation of the results of a process over a period of time. Control charts are used to monitor the production process continuously to see whether the quality of the output is within the acceptable limits.

A typical control chart consists of three horizontal lines:

- A central line which indicates the desired standard or control level of the process.
- An upper control limit that indicates the upper limit of tolerance.
- A lower control limit indicating the lower limit of tolerance.

The central line as well as the upper and lower limits are established by computations based on the past records for a specific production process. The control charts are two types.

- Control charts for variables
- Control charts for attributes

Control Charts for Variables

These are aimed at achieving and maintaining satisfactory quality levels for a given process whose product is amenable to quantitative measurements like thickness, length, diameter, etc. The control charts used for variables are: Control charts for mean (X) and Control charts for range (R).

X – bar Chart: This is the control chart to determine mean variations. Samples are taken and 'mean average' is considered to draw the charts. The central line shows the average quality of the process. The upper and lower control limits are arrived at by adding and subtracting 3 standard deviations to the average. The upper and lower limits are shown as dotted lines and the central line is shown as a dark line.

R- Chart: An R- chart is a plot of the range (dispersion) with in each sample. The range of a sample is the difference between the highest and lowest values. For example, the range of a sample: 12.0, 12.4, 12.5 and 12.6 is (12.6 – 12.0), i.e. 0.6. The range is calculated for all the samples, and the average range of all samples gives the central value of R-chart. The upper and lower control limits are obtained by adding and subtracting 3 standard deviations to the central value. The range values of all samples are marked in the chart to observe, whether the process is in control or not.

Control Charts for Attributes

Control charts for attributes are used to measure quality characteristics for classifying an item as defective or non-defective. The most commonly used control charts for attributes are:

- Control chart for the number of defectives per unit, i.e. c-chart. This chart is used when products have more than one defect per unit. For example, a television picture tube may have more than one defect. When the management wants to analyze the number of defects per unit, this chart is used.
- Control chart for fraction defective, i.e. p-chart. Fraction defective is the number of defective units divided by the sample size. Here, the quality characteristic is counted rather than measured. Then the entire item or service is declared good or bad. For example, in the banking industry, the number of non-endorsed deposits or the number of incorrect financial statements sent are counted. The method involves selecting a random sample, inspecting each item and calculating the fraction defective.
- Control chart for number of defectives, i.e., np-chart. This chart shows the actual number of defectives found in each sample. This is commonly used when the sample size for all samples is constant.

Activity: The management of Sahara International Airlines noticed an increase in the number of delayed flight departures. It called the heads of all departments and brainstormed to list all possible causes for the problem. The group categorized the problem into areas such as materials, procedures, personnel and equipment. The causes for problems in each major category were presented in a cause-and-effect diagram (fishbone diagram). Describe the

procedure for constructing a cause-and-effect diagram and represent various causes for the given problem.

Answer:

13.8 Process Capability

Process capability is the ability of an existing manufacturing process to produce a product that conforms to the design specifications. Since there can be variations during manufacturing, the process capability can help specify product uniformity. It is calculated on the basis of various quality characteristics of the product of the process, and it is given by the mean value plus or minus three standard deviations. i.e,

$$C_p = \frac{(USL - LSL)}{6\sigma}$$

Where, USL is Upper Specification Limit

LSL is Lower Specification Limit

USL and LSL are the specifications given by the client.

The project manager can use Cp while selecting production process for his project. He can compare Cp values of various production processes and select the one that suits the client's quality specifications.

Some of the generally accepted rules for Cp are:

If $C_p > 1.33$, the production process is within customer specifications;

If $1.33 \Sigma C_p > 1.0$, then the production process can be marginally acceptable. But there is likelihood of the client rejecting products from this process.

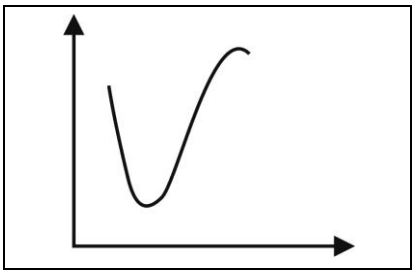
If C_p P 1.0, the production process must be rejected.

Let us now look at how a project manager can use the above formula to select a production process. Suppose a client orders for steel bars of length 10 inches and he accepts .05 inches variation in length. If the existing process has standard deviation of 0.009, then the C_p value of the process is $= \frac{\{0.05 - (-0.05)\}}{6(0.009)} = 1.851$.

Since the C_p value is more than 1.33, the project manager is confident that the selected process would produce the product within the customer specifications.

Check Your Progress - 3

16. The control chart that is used when the products have more than one defect per unit is known as the _____.
    a. np-chart
    b. C-chart
    c. X-chart
    d. R-chart
17. There are six steps in the construction of a cause-and-effect diagram. What is the last of these steps?
    a. Identifying the causes of defects
    b. Specifying major categories
    c. Identifying corrective actions
    d. Identifying the quality problem
18. Which type of relation does the following scatter diagram represent?



    a. Negative correlation
    b. Curvilinear correlation
    c. Positive correlation
    d. No correlation
19. Which of the following statistical methods help in summarizing the data into groups when the data is variable and large in number?
    a. Data tables
    b. Histograms
    c. Pareto chart
    d. None of the above
20. _____ are the statistical tools used to collect and present data in a systematic way.
    a. Data tables
    b. Histograms
    c. Pareto chart
    d. None of the above

21. The control chart used for fraction defective is known as _____.
    a. np-chart
    b. P-chart
    c. X-chart
    d. R-chart
22. Which of the following options show the relationship between two variables on the basis of how they are distributed by plotting the data on a XY plane?
    a. Histograms
    b. Pareto charts
    c. Scatter diagrams
    d. None of the above
23. Which type of control chart shows the number of defects in each sample?
    a. np-chart
    b. X-bar chart
    c. R-chart
    d. None of the above
24. What is the statistical tool that uses mathematical techniques to forecast future outcomes on the basis of historical data?
    a. Trend analysis
    b. Control charts
    c. Scatter diagram
    d. Pareto chart
25. The control chart that determines the mean variations of samples is known as _____
    a. The X-bar chart
    b. The R-chart
    c. Control charts
    d. Trend analysis

Exercise

A. XYZ is glass manufacturing company. A client orders a steel bar of length 15 feet and the acceptable level of variation is 0.06 feet. The existing process has a standard deviation of 0.07. What is the value of process capability (Cp)?

13.9 Acceptance Sampling

Acceptance sampling is a product quality control technique that monitors the quality of a product after it has been produced. This technique is also employed to decide whether to accept or reject a lot on the basis of random samples drawn from a lot. The project manager can either go in for 100% inspection (by incurring huge costs on inspection) or 0% inspection (by allowing defects). Neither of these options is very sound. Therefore, the project manager opts for "acceptance sampling" as a compromise between the two options. A sample of the shipment is inspected and if the number of defective items is more than a stated number, known as acceptance number, the shipment is not accepted.

There are three types of sampling plans. They are: single sampling, double sampling and multiple sampling. In single sampling, the project manager either accepts or rejects a lot after inspecting a single sample chosen from the lot. In double sampling, a single sample is tested. If results are not favorable, then a second sample is tested. In multiple sampling, several samples are tested.

13.9.1 Outcome of Acceptance Plan

Whatever be the sample size, sampling errors are likely to occur. A good lot might be rejected when the sample selected contains a large number of defectives. Similarly, a bad lot might be selected if the sample selected contains less number of defectives. Producer's risk and consumer's risk are the two outcomes of acceptance plan.

Producer's Risk

This is the risk to the producer (any firm or department that produces goods for another firm or another department) that arises because of rejection of a good lot. If the project manager chose a sample of 5 from a lot of 100 and all chosen items are defective then the lot will be rejected even if the remaining items are good. It is also known as risk. The error made by the producer in this context is called Type I error.

Consumer's Risk

This is the risk to the consumer (any firm or department that receives an item from the producer) that arises because of the selection of a bad lot. It is also known as β risk. The error made by the consumer here is called Type II error.

To derive a sampling plan, the producer and consumer should specify the level of the α and β risk, and the lot quality level to which these risks pertain. Therefore, there is a need to define "good lot" and "bad lot" in terms of the percent defective in the population. The usual values of producer's risk and consumer's risk are 5 percent and 10 percent respectively.

13.9.2 Operating Characteristic (OC) Curve

Operating characteristic curve is a probability distribution that is a function of sample size 'n' and the acceptance number 'c' expressed as a percentage of items in a lot of incoming goods. The curve explains how well a sampling plan discriminates the good lots from bad lots. If the project manager uses the Total Quality Control (TQC) principle of 100 percent inspection, then all the incoming goods should be checked. However, in case of large shipments, 100 per cent inspection is not possible. So, the project manager chooses a sample size, 'n' and an acceptance number 'c' to determine whether to accept or reject the lot.

The project manager determines the values of 'n' and 'c' on the basis of four performance requirements: Acceptable Quality Level (AQL), Lot Tolerance Percent Defective (LTPD), consumer's risk (□) and producer's risk (□). □□□AQL is the quality level desired by the consumer. LTPD is the quality level at which one considers that a lot is bad and if exceeded will be rejected. If the producer and the consumer accept a lot even with 1 defective item of 100 items, then AQL is 0.01. If they agree to reject a lot in which there are more than 5 defective items out of 100 items, then LTPD is 0.05.

13.10 Quality Circles

A quality circle is a group of employees, normally from a single department who voluntarily meet periodically to discuss the quality issues in their department. Quality circles effectively address two issues: the well-being of the employee at personal level and the well-being of the company. The activities of quality circles include identifying problems related to quality, analyzing data, recommending solutions, and carrying out changes approved by the management. This helps the management to understand the reasons behind the employees' failure to meet the required quality levels.

The advantages of quality circles are – improved quality of project products and services; better understanding among employees; better employee performance; and improved morale of employees. Each department of the project will maintain its own quality circle to meet the output specifications. Quality circles have proved very successful in Japan. However, their efficiency depends on how they are handled.

Activity: Indhra Machine Works undertakes projects for manufacturing machine tools. For many years the company used ordinary lathe and milling machines for manufacturing tools. To survive in the current competitive environment, the management of the firm has modernized the company's manufacturing process. It has replaced its machines with modern equipment, e.g., Computer Numerically Controlled (CNC) machines, robots, etc. This change has led to an increase in production, however, the firm is having

problems maintaining the required quality levels. Several lots of products have been rejected by its customers. The management of the firm has realized that even though the workmen in the production department were trained to use the new equipment, they have not yet become fully accustomed to the new production system. So the management has started encouraging each department to form quality circles to reduce quality problems. Do you think quality circles can improve the situation? How?

Answer:

Check Your Progress - 4

26. The risk that arises because of the rejection of a good lot is called _____.
    a. Consumer's risk
    b. Producer's risk
    c. Acceptance sampling
    d. NONE of the above
27. The product quality control technique that monitors the quality of a product after it has been produced is called _____.
    a. P-chart
    b. acceptance sampling
    c. R-chart
    d. None of the above
28. The probability distribution that is a function of sample size 'n' and the acceptance number 'c' expressed as a percentage of items in a lot of incoming goods is called _____.
    a. Quality circles
    b. Operating characteristic curve
    c. Just-in-time management
    d. NONE of the above
29. In which type of sampling does the project manager either accept or reject a lot after inspecting a sample chosen from the lot?
    a. Single sampling
    b. Double sampling
    c. Multiple sampling
    d. None of the above

30. Groups of employees from normally a single department who meet periodically to discuss the quality issues in their department are called _____.

    a. Quality circles
    b. Total quality management
    c. Re-engineering
    d. None of the above

13.11 Just-In-Time Management

Just-in-time (JIT) is an operations philosophy based on continuous improvement of organizational processes by reducing wastage from all project operations. It is an integrated set of activities designed to achieve high- quality production using minimal inventories. The principle here is not to produce anything until it is required. This result in eliminating costs associated with maintenance, storage, etc. Under JIT purchasing, firms reduce their procurement costs by developing long-term relationships with a few supplies.

Shiego Shingo of Toyota Motor Company identified seven wastes that the manager should watch out for to ensure continuous improvement of quality. They are – waste of overproduction; waste of waiting of machinery (idle time); waste of transportation; waste of processing itself; waste of stocks; waste of motion/movement; and waste of making defective products.

There are two important concepts in JIT manufacturing: value-added manufacturing, and stockless production. In value-added manufacturing the project manager aims at eliminating any step in the manufacturing process that does not add value to the end product. For example, processes like process delays, work-in-progress inventories, excessive paper work, etc., are eliminated. In stockless production, the project manager maintains less inventories and reduces waste considerably.

Various purchasing characteristics under the procedures of JIT management are discussed below --:

Purchase lot size: JIT purchasing practices involve procuring of products in small lots with frequent deliveries. This practice ensures lower storage and maintenance costs, which are normally high in a traditional purchasing system.

Rejections from suppliers: In traditional purchasing systems, firms rely on multiple sources of supply for each part or item, on short-term contracts. But in JIT system, suppliers who are located close by are selected. In these systems, firms rely on a single source of supply and make long term contracts.

Conditions with suppliers: Both traditional and JIT purchasing systems emphasize product quality, delivery performance, and price. But the conditions with suppliers about the rejection of incoming parts and materials are different in JIT systems. Any product without an acceptable quality level or which arrives late is rejected.

Mode of transportation: In JIT systems, determining the mode of transportation is based on both inbound and outbound freight, and on time delivery. But the delivery schedule is given by the buyer.

Product specification: In JIT systems, the buyer relies more on performance specifications than on product design, and the supplier is encouraged to be more innovative. But in traditional systems, product specifications are very rigid.

Several organizations prefer JIT manufacturing systems because of the following advantages:

- Cost of materials is reduced in JIT systems as this system involves lower inventory carrying costs, lower storage and maintenance costs and lower scrap and waste.
- Since the contract between supplier and buyer is long term, the supplier provides quality materials.
- JIT purchasing systems also provide increased responsiveness from the suppliers as they are geographically close. Flexibility is also ensured as materials are purchased only when there is a need.
- Administrative efficiency is also possible in JIT systems as the delivery schedules are more flexible and there is less paper work.
- Production is improved because of fewer inspections, easier receiving, and better plant layout.
- As the required materials are not purchased all at once, the capital requirements of the firm are reduced considerably.

Activity: Indus Projects Ltd. is involved in projects like constructing National Highways. The firm has a traditional purchasing system. On several occasions, the firm's suppliers failed to send the required materials on time. The firm is also incurring heavy storage and maintenance costs because it purchases in bulk to get quantity discounts. The company recruited Ram Sinha as the project manager. Sinha decided to replace the current purchasing system by a JIT purchasing system. Discuss how a JIT purchasing system can help project firms handle inventory problems.

Answer:

13.12 Total Quality Management

Total Quality Management (TQM) is a philosophy that seeks organization-wide improvement of quality by involving every individual in the firm to improve the quality at every stage of the production process. The concept focuses on ensuring that the products meet the set of specifications required by the customers.

The concept divides customers into two categories: external customers and internal customers. External customers are those who consume final goods and services offered by the company. Each department considers employees in other departments who continue the product processing as internal customers.

To improve the quality of the product, firms:

- Build teams and empower employees
- Solicit ideas to improve organizational activities
- Adopt practices like benchmarking, and bench trending to improve quality of the products to meet future market trends.
- Increase employee participation through initiatives like quality circles, self-managed groups etc.
- Use process management techniques to improve customer service and reduce cycle time.
- Develop and train staff to improve customer service
- Adhere to widely accepted international standards.
- Apart from these activities, firms can take up the following activities to improve quality in long-run:
- Interact constantly with end customers to understand their latent needs and demands
- Maintain closer relationships with suppliers to improve product/service quality.
- Update information and communication technologies to improve customer service.
- Organize training, education programs, and knowledge development workshops for employees.
- Focus on productivity, timeliness, flexibility and profitability.

The benefits of TQM are improved quality, employee participation, teamwork, working relationships, customer satisfaction, employee satisfaction, productivity, communication, profitability and market share.

TQM is a good investment. In 1981, Motorola launched an ambitious drive for a ten-fold improvement in the quality of its products and services. Key initiatives were six-

sigma quality and reducing total cycle time. Six sigma is a statistical measure that translates into a target of no more than 3.4 defects per million products and includes customer service. Motorola's cycle time reduction is even more ambitious; the clock starts ticking the moment the product is conceived. This calls for an examination of the total system, including design, manufacturing, marketing and administration.

TQM encompasses all aspects of business. Its key concepts are emphasis on management commitment, customer focus, involvement of all, continuous improvement, treating suppliers as partners and performance metrics.

The philosophy of TQM has evolved through the contribution of many quality gurus, including Shewhart, Deming, Juran, Feigenbaum, Ishikawa, Crosby and Taguchi. The principles and tools laid down by these experts provide a solid foundation for the TQM framework. The journey to TQM starts when the management realizes the need. The need could be due to some external factors such as loss of market share or some internal factors such as loss of productivity.

There are nine different dimensions to quality. Marketing should identify the relative importance of these in developing new products and improving current products.

There are several obstacles in implementing TQM, the most important being the lack of management commitment.

Sustained implementation of TQM can result in benefits such as improvement in quality, productivity, reliability, market share, revenue, profits and growth. In spite of this, the proportion of companies implementing TQM is low.

Check Your Progress - 5

31. The philosophy that seeks improvement in quality throughout the organization by involving every individual at every stage of production process is called _____.
    a. Business process re-engineering
    b. Total quality management
    c. Just-in-time management
    d. None of the above
32. Under which concepts of manufacturing under JIT does the manager aim to avoid any step in the manufacturing process that is not useful?
    a. Stockless production
    b. Value added manufacturing
    c. Total quality management
    d. None of the above

13.13 Summary

- Quality has been defined by the ISO (International Organization for Standardization) 9000 as the totality of features and characteristics of a product or service that bears on its ability to satisfy stated or implied needs. The client looks at quality as conformance to specifications, value for money, fitness for use, support, and psychological impression.
- ISO 9000 Standards are a set of international quality management system standards and guidelines.
- Every firm incurs costs when it attempts to improve quality, and these costs are referred to as 'cost of quality'.
- Costs are of two types: 'cost of conformance' and 'cost of non-conformance'. Conformance costs are the costs that firms incur for the means employed to achieve quality like costs of training, inspection, testing, and auditing. Non-conformance costs are those costs that are incurred for improving the quality of a product that has fallen below the desired quality level like repairs, reworks, and complaint handling.
- The costs of quality can also be classified as follows -- costs of prevention, costs of appraisal or detection, and costs of failure.
- The project manager should ensure that the project attains the desired level of quality. Quality can be achieved only through proper planning. The project manager studies the following six quality management concepts -- quality policy, quality objectives, quality assurance, quality control, quality audit, and quality program plan.
- Statistical methods play a key role in identifying, analyzing, and controlling the quality of different project activities. These tools help the firm in gathering data, identifying patterns of data and measuring variation.
- Data tables, and Pareto charts are some useful tools for identifying patterns in data; histograms, scatter diagrams, and control charts are tools used in data analysis; and 'cause and effect analysis', and 'trend analysis' are used both in data identification and data analysis.
- Process capability is the ability of an existing manufacturing process to produce a product that conforms to the design specifications. Since there can be variations during manufacturing, the process capability can help specify product uniformity.
- Acceptance sampling is a product quality control technique that monitors the quality of a product after it has been produced. This technique is also employed to decide whether to accept or reject a lot on the basis of random samples drawn from a lot.

- Sampling plans can be of three types -- single sampling, double sampling and multiple sampling.
- A quality circle is a group of employees, normally from a single department who voluntarily meet periodically to discuss the quality issues in their department. Quality circles help the management to understand the reasons behind the employees' failure to meet the required quality levels.
- Just-in-time is an operations philosophy based on continuous improvement of organizational processes by reducing wastage from all project operations. The principle is not to produce anything until it is required.
- Total quality management is a philosophy that seeks organization-wide improvement of quality by involving every individual in the firm to improve the quality at every stage of the production process. The concept focuses on ensuring that the products meet the set of specifications required by the customers.

13.14 Glossary

Acceptance Sampling: A product quality control technique that monitors the quality of a product after it has been produced.

Appraisal costs: Costs incurred while assessing the level of quality attained by the operating procedures of the firm. These costs are associated with the evaluation of the product's performance to see if it meets the client requirements or not.

Cause and Effect (or fishbone or Ishikawa) Diagrams: After identifying a problem, the project manager determines the cause of the problem. These diagrams help identify the relationship between a key quality problem and its potential causes.

Checklist: A form of data table that is used to record the frequency of occurrence of a certain product's quality characteristic.

Conformance and non-conformance costs: Costs are of two types: conformance and non-conformance. Conformance costs are the costs that firms incur for the means employed to achieve quality. Non-conformance costs are those costs that are incurred for improving the quality of a product that has fallen below the desired quality level.

Consumer's Risk: The risk to the consumer (any firm or department that receives an item from the producer) that arises because of the selection of a bad lot.

Control Chart: A graphical representation of the results of a process over a period of time.

Data Tables: Statistical tools used to collect and present data in a systematic way.

Histograms: Graphical representations of data as a frequency distribution. When there are a large number of variable data, the histogram summarizes the data into a number of groups.

Internal and external costs of failure: Costs of failure are two types: internal failures and external failures. Internal failure costs result from defects that are discovered during the production of a product or service and when the product is under the control of the firm. External failure costs arise when a defect is discovered after the customer has received the product or service.

Just-in-time: An integrated set of activities designed to achieve high-quality production using minimal inventories. The principle here is not to produce anything until it is required.

Operating Characteristic Curve: A probability distribution that is a function of sample size (n) and the acceptance number (c), expressed as a percentage of items in a lot of incoming goods.

Pareto Chart: The project manager constructs a Pareto chart to prioritize the quality problems. In this chart, all the quality problems (defect types) are plotted along the horizontal axis in descending order.

Prevention Costs: Costs incurred by a company to prevent defective goods and services from being produced and delivered to the customer.

Process Capability: The ability of an existing manufacturing process to produce a product that conforms to the design specifications.

Producer's Risk: The risk to the producer (any firm or department that produces goods for another firm or another department) that arises because of rejection of a good lot.

Quality Assurance: The process of evaluating the total performance of the project regularly, in order to ensure that the project conforms to the quality standards.

Quality Audit: An organized, independent evaluation procedure to ensure that the project standards match the quality requirements.

Quality Circle: A group of employees, normally from a single department who voluntarily meet periodically to discuss the quality issues in their department.

Quality Control: The process of scrutinizing specific project results in order to check their compliance with the quality standards.

Quality Policy: It is a document created by quality experts and backed by the top management. It states the quality objectives of the firm, the acceptable levels of quality, the responsibilities of the project team, etc.

Quality Program Plan: A plan of action prepared by the project manager and his/her team by breaking down project objectives into a work breakdown structure.

Quality: It is the totality of features and characteristics of a product or service, which influence its ability to satisfy a stated or implied need.

Scatter Diagrams: A plot of two variables showing how they are related. Data is represented on XY plane and the relationship between the two variables is understood on the basis of how they are distributed.

Total Quality Management: A philosophy that seeks organization-wide improvement of quality by involving every individual in the firm to improve the quality at every stage of the production process.

Trend Analysis: A statistical tool that uses mathematical techniques to forecast future outcomes on the basis of historical data. It quantifies the relationships between the data, and establishes an equation that best describes the distribution of data points.

13.15 Self-Assessment Exercises

1. The growing size and complexity of projects have forced firms to concentrate more on quality at every stage. Define quality. What are the International quality standards?
2. Every firm incurs costs when it attempts to improve quality, and these costs are called as costs of quality. What are the various types of costs? Explain the different types into which the costs of quality are classified.
3. The project manager has to ensure that the project attains the desired level of qauality. Describe the detail the various quality management concepts.
4. The project manager uses project quality control tools and statistical methods to gather data, identify patterns in the data, and measure variation. Discuss these project quality control tools.
5. Describe the following concepts in detail.
    a. Process capability
    b. Acceptance sampling
    c. Quality circles
    d. Just-In-Time management
    e. Total Quality Management

13.16 Suggested Reading/Reference Material

1. The Project Management Institute (PMI), A Guide to the Project Management Body of Knowledge (6th edition), Published Date: 2017 (6th edition)
2. K R Sharma, Project Management: Text and Practice Paperback – 1, Atlantic Publishers and Distributors (P) Ltd , January 2021
3. Anna Brzozowska, Arnold Pabian, Barbara Pabian, Sustainability in Project Management; A Functional Approach, CRC Press, 2021
4. Peter J. Edwards, Paulo Vaz Serra, Michael Edwards, Managing Project Risks, Wiley-Blackwell, 2019
5. Ronald Blank, The Basics of Quality Auditing, Productivity Press, 2017

13.17 Answers to Check Your Progress Questions

Following are the answers to the Check Your Progress questions given in the Unit.

1. (b) quality

According to ISO 9000, quality refers to the totality of features and characteristics of a product or service that has a bearing on its ability to satisfy stated or implied needs. ISO 9000 is a group of standards for quality management systems. It is maintained by the International Organization for Standardization. The standards are applicable to all types of organizations in areas such as manufacturing, processing, servicing, electronics, computing, petrochemicals, shipping, etc.

2. (a) ISO 14000

ISO 14000 is one of the industrial and commercial standards which fall under the ISO 9000 standards. It provides standards for managing environmental impact, environmental performance evaluation, environmental labelling, and lifecycle assessment. These standards help organizations to minimize the negative effects on the environment to comply with the applicable laws and environmentally oriented requirements, etc.

3. (b) Psychological impression

Physical ambience, the firm's image, and the friendliness of project team members are some of the aspects which create a psychological impression on the mind of the client.

4. (b) International Organization for Standardization

ISO stands for the International Organization for Standardization. It is an international standard-setting body comprising representatives from various standards organizations. The purpose of the organization is to propagate standards in businesses worldwide. It was established at Geneva in 1947.

5. (c) fitness for use

Fitness for use is one of the angles from which the client looks at quality. The client considers the features of the product or the convenience of a service to decide project quality. Some of the aspects of fitness for use include appearance, style, durability, reliability, and serviceability. Conformance to specifications refers to the product or service matching the specifications in the project overview statement (POS). Value for money refers to how well the product or service fulfills the purpose for which the project is intended in relation to the price the client is willing to pay. Support refers to the help extended by the project manager to the client with reference to the project.

6. (c) Five years

The ISO protocol requires that all standards should be reviewed at least every five years to check whether they should be retained, revised, or withdrawn. The 1994 version of the ISO standards were revised by the ISO technical committee (TC, 176). ISO TC 176 was the umbrella committee under which the ISO 9000 series of quality management and quality assurance standards were developed. The committee developed standards and guidance documents in the year 2000.

7. (b) ISO 9001

The ISO 9001 standard defines the model for a quality system for companies that design, produce, install, and service products. It lists out a number of requirements regarding products and services, which an organization needs to fulfill to achieve the satisfaction of customers. ISO 9000 is a group of standards for quality management systems. It is maintained by the International Organization for Standardization. The standards are applicable to all types of organizations in areas such as manufacturing, processing, servicing, electronics, computing, petrochemicals, shipping, etc. The ISO 9002 standard defines the model for quality system for production and installation. The ISO 9003 standard defines the model system for quality assurance in final inspection and testing.

8. (a) Quality policy

Quality objectives are a part of the firm's quality policy. It specifies the quality objectives of the firm and the time required to meet those objectives. The quality policy is a document which states the quality objectives of the firm, the acceptable levels of quality, the responsibilities of the project team, etc. Quality assurance means evaluating the quality performance of the project periodically to confirm that the project meets the relevant quality standards. Quality audits are organized, independent evaluation procedures to ensure that the project standards meet the quality requirements.

9. (d) quality audit

Quality audits are organized, independent evaluation procedures to ensure that the project standards meet quality requirements. Quality control refers to the process of the collection of activities and techniques used to create specified quality characteristics in the project's end product. A quality program plan is the breaking down of project objectivities into a work breakdown structure. Quality assurance refers to evaluating the quality performance of the project periodically to ensure that the project meets quality standards.

10. (a) Quality assurance

Quality assurance means evaluating the quality performance of the project periodically to confirm that the project meets the relevant quality standards. Quality assurance confirms that the scope, cost, and time of the project meet the client's requirements. Quality policy is a document which states the quality objectives of the firm, acceptable levels of quality, the responsibilities of the project team, etc. Quality audits are organized, independent evaluation procedures to ensure that the project standards meet the quality requirements. Quality control refers to the activities and techniques used to create specified quality characteristics in the project's end product.

11. (a) Conformance costs

Conformance costs are the costs incurred on the means to achieve quality. Non-conformance costs are called costs that are incurred on improving the quality of a product that has fallen below standards. Costs of prevention are the costs that are incurred on preventing defective goods and services from being produced and delivered to the customer. Failure costs are divided into internal failure costs and external failure costs. These are the costs that are incurred on rework, warranty charges, legal expenses, concessions made to the customers, etc. for defective products.

12. (c) i, ii, iii, and iv

The features of a good quality policy are: Providing guidelines to improve the quality of the project**,** promoting consistency across all projects of the firm**,** explaining to outsiders how the firm views quality**,** and providing for changes and updates in the policy.

13. (b) Costs of appraisal

Costs of appraisal are the costs incurred on assessing the level of quality attained by the operating procedures of the firm. Conformance costs are the costs that are incurred on the means to achieve quality. Costs of prevention are the costs incurred on preventing defective goods and services from being produced and delivered to the customer. Non-conformance costs are the costs incurred on improving the quality of a product that has fallen below standards.

14. (b) External failure costs

External failure costs are the costs that are incurred when a defect is discovered after the customer has received the product or service. Some examples of external costs are: costs of returned material, warranty charges, legal expenses on law suits, and costs of concessions made to customers. Costs of appraisal are the costs that are incurred to assess the level of quality attained by the operating procedures of the firm. Internal failure costs result

from defects discovered during the production of the product or service before the product reaches the customer. Costs of prevention are the costs that are incurred to prevent defective goods and services from being produced and delivered to the customer.

15. (c) i, ii, and iii

The features of a good quality plan are: It should list the features desired by the customer, respond to changing customer needs, and ensure that the quality procedures are stringent enough to meet quality objectives. Including all the project functional areas is one of the features of quality assurance system.

16. (b) C-chart

The C-chart is a type of control chart used to find out the number of defects per unit. This chart is used when there is more than one defect per unit. The np-chart shows the actual number of defects found in each sample. The X-bar chart is the control chart to determine mean variation of samples. The R-chart is the plot of range dispersion within each sample.

17. (c) Identifying corrective actions

The project manager prepares the corrective analysis by determining the causes contributing to defects in the last step of preparing the cause and effect diagrams. This process is also known as identifying corrective actions. Identifying the quality problems using the statistical process control tools like the Pareto chart, histograms, brainstorming, etc,. is the first step. Specifying major categories and identifying the causes of defects are the fourth and fifth stages.

18. (b) Curvilinear correlation

The relation between the data points is said to be curvilinear when the data points of the scatter diagram are in a U-shaped pattern. There is said to be no correlation if the data points are scattered. If the data points have positive and negative slopes then they are said to have positive and negative correlation.

19. (b) Histograms

Histograms are used to graphically represent data in the form of frequency distribution. They help in summarizing the data into groups when the data is variable and large in number. Data tables are statistical tools used for collecting situation/product specific data. Pareto charts are used to prioritize the quality problems.

20. (a) Data tables

Data tables are statistical tools used to collect and present data in a systematic way. Histograms are a graphical representation of data as a frequency distribution. Pareto charts are used to prioritize quality problems.

21. (b) P-chart

The P-chart is the control chart used for fraction defective. Fraction defective is the number of defective units divided by the sample size. The np-chart shows the actual number of defects found in each sample. The X-bar chart is the control chart to determine mean variation of samples. The R-chart is a plot of the range dispersion within each sample.

22. (c) Scatter diagrams

Scatter diagrams show the relationship between two variables on the basis of how they are distributed by plotting the data on a XY plane. Histograms are used in graphically representing the data in the form of frequency distribution. Pareto charts are used to prioritize quality problems.

23. (a) np-chart

The np-chart shows the actual number of defects found in each sample. The X-bar chart is the control chart used to determine mean variation of samples. The R-chart is the plot of the range dispersion within each sample.

24. (a) Trend analysis

Trend analysis is the mathematical technique used to forecast future outcomes on the basis of historical data. The trend line provides a clear and consistent relation between the output and input. Scatter diagrams show the relationship between two variables on the basis of how they are distributed by plotting the data on a XY plane. Control charts are used to monitor the production process to see whether the quality of output is within the permissible limits. Pareto charts are used to prioritize quality problems.

25. (a) The X-bar chart

The X-bar chart is a control chart to determine the mean variation of samples. The R-chart is a plot of the range dispersion within each sample. Trend analysis is a mathematical technique to forecast future outcomes on the basis of historical data.

26. (b) Producer's risk

The two outcomes of the acceptance plan are: producer's risk and consumer's risk. The risk that arises because of the rejection of a good lot is called producer's risk. The risk that arises because of the selection of a bad lot is called consumer's risk. Acceptance sampling is a product quality control technique that monitors the quality of a product after it has been produced.

27. (b) Acceptance sampling

Acceptance sampling is a product quality control technique that monitors the quality of a product after it has been produced. It is also employed to decide

whether to accept or reject a lot on the basis of random samples drawn from the lot. The P-chart is the control chart used for fraction defective. Fraction defective is the number of defective units divided by the sample size. R-chart is a plot of the range dispersion within each sample.

28. (b) Operating characteristic curve

The operating characteristic curve is the probability distribution that is a function of sample size 'n' and the acceptance number 'c' expressed as a percentage of items in a lot of incoming goods. Quality circles are groups of employees usually from a single department who meet periodically to discuss the quality issues in the department. Just in time philosophy seeks to improve the organizational process by reducing wastage in all project operations.

29. (a) Single sampling

In single sampling, the project manager accepts or rejects a lot after inspecting a sample chosen from the lot. Under double sampling, a second sample is tested if the results from testing the first sample are not satisfactory. Under multiple sampling, several samples are tested.

30. (a) Quality circles

Quality circles are groups of employees usually from a single department who meet periodically to discuss the quality issues in the department. Total quality management is a philosophy that seeks organization-wide improvement of quality by involving every individual to improve the quality at every stage of production process. Re-engineering is the radical redesigning of the organization's business processes.

31. (b) Total quality management

Total quality management is a philosophy that seeks organization-wide improvement of quality by involving every individual to improve the quality at every stage of production process. Just in time philosophy seeks improvement in the organizational process by reducing the wastage from all project operations.

32. (b) Value added manufacturing

Value added manufacturing is one of the concepts of just-in-time management. It aims to eliminate any step in the manufacturing process that does not add value to the end product. Stockless production inventory levels can reduce waste considerably.

Unit 14

Project Auditing

Structure

14.1 Introduction

In the previous unit, we have discussed project quality management. In this unit, we will discuss about project auditing. As discussed earlier, project control tries to enhance the firm's chances of meeting future project goals, on the basis of lessons learnt in the present projects. An organization can benefit from its past experience only when it tries to understand them through the process of evaluation. The term "evaluate" means to make a judgment as to the worth or value of a product or an activity. In project management context, project evaluation is the process of appraising the progress and performance of the project in comparison to the planned objectives.

A project can be evaluated by using evaluation tools such as Project Audits and Project Reviews. Although many authors use the terms evaluation and audit synonymously, an audit is a formal inquiry in to various aspects of the project. In this unit, the word "audit" is associated with any formal inquiry into various project aspects that are of interest to the top management.

This unit will discuss project evaluation and its purpose. We will discuss project auditing, and the construction and use of the audit report. We shall then move on to discuss the responsibilities of the auditor, and the project audit life cycle. Finally, we would be discussing the essentials of an audit, and the concept of performance measurement.

14.2 Objectives

By the end of this unit, students should be able to:

- Discuss project evaluation and its purpose.
- Define project auditing.
- Find out how to construct and use an audit report.
- Identify the responsibilities of the auditor.
- Explain the project audit life cycle.
- Discuss the essentials of an audit.
- Recall the concept of performance measurement.

14.3 Project Evaluation and its Purpose

Project evaluation is a process of evaluating a project's progress and performance in comparison with its planned progress and performance or with that of identical projects. Also, project evaluation should be supportive to all the management decisions that the project requires. So the manner in which a project is evaluated should make the management feel that all the relevant data has been considered. Project evaluation is considered to be as important as the project itself.

The primary objective of project evaluation is to measure the degree of a project's success. A survey on industrial projects of different nature and size identified four critical parameters for measuring the success of a project. A survey on industrial projects of different nature and size identified four critical parameters for measuring the success of a project. They are --

- Completion of a project within a given budget and time
- Extent to which the project is able to satisfy the client
- Commercial success of the project and the market share captured by the product delivered by the project
- Ability of the product or service to succeed if it enters a new market or its ability to lead to a new product or technology.

Apart from measuring the success of a project, project evaluation aims at identifying the various strengths and weaknesses of a project (in various phases). This will help the organization manage its future projects better. Project evaluation helps the organization and project team to

- Identify problems during the early stages of the project.
- Ensure clarity in performance, cost and time relationships.
- Enhance the performance of the project.
- Explore opportunities for technology advancements in the future.

- Appraise the quality of project management.
- Minimize costs of the project.
- Accelerate the process of achieving results.
- Find, correct and avoid mistakes in the future.
- Communicate information as desired by the client.
- Check the firm's interest and commitment to the project.

All the above benefits resulting from project evaluation are concerned with the primary goals of the project team. Apart from unearthing information related to a project's team's success in meeting its primary goals, "evaluation" also studies other secondary goals that are crucial for the success of the project and the organization. These secondary goals are not defined at the starting of the project, but they are crucial for the well being of the organization. Secondary goals are concerned with

- Understanding the importance and role of projects in an organization
- Improving the way in which projects are organized and managed
- Attempting to create a healthy working environment and encouraging the creativity of the team members
- Exploring the strengths and weaknesses of the organization concerned with projects' team members, management and decision making processes.
- Trying to identify the risk factors associated with the projects taken up by the organization.
- Attempting to enhance the contribution of projects towards the professional growth of the team members.
- Identifying individuals with excellent managerial and leadership skills.

It is relatively easier to find out primary goals than to identify secondary goals. Primary goals can be identified simply by interpreting of the project proposal or by scrutinizing any document describing the reasons for project selection. Such documents state the primary goals of a project. But the implicit nature of secondary goals makes it difficult for the auditor to identify and evaluate them. For example, the behavioral aspects of the employees working in an organization are generally hidden. Since these secondary goals are not stated in any of the organization's manuals, team members are quite likely to ignore them.

People tend to meet their individual goals along with their organizational goals, but they generally give more attention to the achievement of individual goals. A problem may crop up when the auditor tries to discover the secondary goals of the team members. Moreover, people are generally reluctant to reveal their personal goals, because of the feeling that their goals are not in agreement with

the firm's objectives. For example, people may take part in a project to gain knowledge of new skills that improve their career prospects but they will not reveal this to the auditor.

Lack of trust in the auditor would also create problems in identifying the secondary goals. The presence of an auditor, external or internal, would make team members feel uncomfortable and insecure. As a result, they would not like to reveal their personal or secondary goals to the auditor.

On the whole, exploring secondary goals is a difficult task. Generally, project auditors do not take secondary goals into consideration when conducting an audit, but it is always advantageous to consider them as they provide some qualitative information related to the success or failure of a project.

Check Your Progress - 1

1. Which of the following options are **not** the primary goals of project evaluation?

   i. To identify problems during the early stages of the project

   ii. To identify the risk factors associated with the projects taken up by the organization

   iii. To enhance the performance of the project

   iv. To identify the individuals with excellent managerial and leadership skills

   a. Only i and ii

   b. Only ii, iii, and iv

   c. Only ii and iv

   d. Only iii and iv

2. Identify the statements that are **true** with regard to project evaluation.

   i. Project evaluation is a process of evaluating a project's progress and performance in comparison with that of identical projects.

   ii. The main objective of project evaluation is to measure the degree of the success of a project.

   iii. Project evaluation has to be supportive of all the management decisions that the project requires.

   a. Only i and ii

   b. Only i and iii

   c. Only ii and iii

   d. i, ii, and iii

3. Which of the following options refers to the process of appraising the progress and performance of the project with reference to the planned objectives?
    a. Project auditing
    b. Project evaluation
    c. Project screening
    d. Project control
4. From the following options, identify the secondary goal of project evaluation.
    a. To check the firm's interest and commitment to the project
    b. To explore the strengths and weaknesses of the organization in terms of the project team members, management and decision-making processes
    c. To appraise the quality of project management
    d. To explore opportunities for technology advancements in the future
5. Which of the following options are the parameters on which the success of a project is measured?
    i. Whether the project is completed within a given budget and time
    ii. Whether the project is able to satisfy the client
    iii. Whether the project deliverable has the ability to succeed when it enters a new market
    iv. Whether the project is commercially successful
    a. Only i, ii, and iii
    b. Only i, iii, and iv
    c. Only ii, iii, and iv
    d. i, ii, iii, and iv
6. Identify the primary goal of project evaluation from the following options.
    a. To understand the importance and role of projects in an organization
    b. To ensure clarity in performance, cost, and time relationships
    c. To identify the risk factors associated with the projects taken up by the organization
    d. To improve the way in which projects are organized and managed
7. Which of the following options are the secondary goals of project evaluation?
    i. To attempt to enhance the contribution of projects toward the professional growth of the team members
    ii. To check the firm's interest and commitment to the project
    iii. To find and correct mistakes and avoid them in the future

iv. To attempt to create a healthy work environment and encouraging the creativity of the team members

a. Only i and iv

b. Only ii and iv

c. Only iii and iv

d. Only ii, iii, and iv

14.4 Project Auditing

Project auditing can be defined as the process of detailed inspection of the management of a project, its methodology, its techniques, its procedures, its documents, its properties, its budgets, its expenses and its level of completion. Project auditing can be carried over on the whole project or on a part of the project. Though a formal audit report can be presented in various formats, certain aspects must be contained in report without fail. They are

- *Present status of the project:* Is the work performed ahead or behind the planned schedule?
- *Future status of the project:* Will there be any significant change in the schedule? Indicate the nature of change if there is a possibility of change.
- *Status of crucial tasks:* Measuring the progress of the crucial tasks on which the success of a project depends.
- *Assessing risk:* What are the chances of the project failing or running into losses?
- *Information relating to other projects:* What lessons can be learned from the project audit that can be used in the future to improve the management of other projects of the organization?
- *Audit and its limitations*: What are the limitations, assumptions or constraints that have an impact on the audit data?

Though the inspection methodology for both the financial and project audit is similar, the outcome of both the processes varies widely. The scope of a financial audit is limited, it emphasizes on utilization and preservation of the organizational assets. But the scope of a project audit is very wide and can involve the whole of the project or any of its components. Though project auditing deals with all the aspects of project management, it is not a traditional management audit. Management audits are designed to examine the operation of a firm's management systems. Project auditing goes beyond this to make sure that the project is properly managed. A management audit examines the utility of the managerial systems, while a project audit examines the impact of managerial, financial and technical parameters on a particular organizational climate.

14.4.1 Depth of an Audit

There are many practical constraints that limit the scope of an auditor's evaluation of the project. Time and money are two such constraints; they not only limit the depth of the investigation but also affect the amount of detail presented in the audit report. Costs are incurred as a result of the audit process itself, (i.e., professional and clerical costs for conducting an audit) and for gathering, storing and preserving the data to be audited.

There are two other costs that are important and are usually ignored. The first one is the distraction caused by the auditing process to the people working on the project. The project team members may become distracted or anxious when the project is being audited and as a result, they pay less attention to their work and spend more time and energy on securing themselves from the auditor's criticism. The second cost is the drop in the morale of the individuals working on the project. Even though an audit report is presented in a constructive and positive style it can demoralize team members and affect the project negatively.

The depth to which an audit is conducted varies with the situation and the needs of the project. Although this is purely a top management decision, a project audit generally carries out the following three levels of audit -- the general audit, the detailed audit, and the technical audit.

The general audit is usually a brief review of the project, carried out within a limited time period and with only a few resources. It usually touches on all the six dimensions of the auditing report, i.e., the present status of the project; the future status; the status of the crucial tasks; assessing the risk; information relating to other projects and the limitations of the project.

The detailed audit is usually conducted as a follow-up to the general audit. This detailed audit is conducted when an unacceptable level of risk has been discovered by the general audit. The depth of a detailed audit depends on the seriousness of the issues and their impact on the objectives of the project; the more serious the issue, the greater the depth of the audit.

The technical audit is conducted when a detailed audit fails to evaluate the technical aspects of a project satisfactorily because of the auditor's lack of technical knowledge. The project auditor then employs a technically qualified individual to conduct the audit along certain guidelines. When highly sophisticated and confidential technology is used, it is often difficult to find technical auditors from the organization itself. In such cases, academic consultants are often employed by the organization. To ensure confidentiality, the consultants have to sign the document of nondisclosure. Although it is not a hard and fast rule, a technical audit is generally conducted in a detailed manner.

A software project has many deliverables and in the present day 2021 scenario, especially website is a sure deliverable. Thus, a well guided and effective website audit leads to assured quality of the product/project. Exhibit 14.1 presents a small step wise guide for effective audits in 2021.

Exhibit 14.1: The Ultimate Guide For Effective Website Audit and SEO in 2021

A website audit is not about SEO only, but it improves the user experience by identifying technical and SEO issues of a website during audit. A website audit helps to find and fix issues within the website and to achieve various objectives like SEO goals. A good tool helps on information on page speed, broken links, internal and external links, duplicate content, and back links. Tools available for SEO auditinclude: Google Analytics, Screaming Frog, Google Search Console, and Google Structured Data Testing Tool.

How to Carry Out an Effective SEO Website Audit in 2021

1. Increase page speed and load time
2. Enhance website security and user experience
3. Run a Mobile-friendly test
4. Make sure Google is indexing the website.
5. Track the performance of pages with Google Analytics
6. Is the website optimized for search engines?
7. Optimize website images, and check broken links
8. Create more internal links
9. Consider doing a content audit.
10. Keep check of the technical aspect of your website.
11. Create an XML Sitemap for your website
12. Create robot.txt file.
13. Check duplicate content
14. Is your website easy to navigate?

Source: https://upqode.com/website-audit-guide/

14.4.2 Timing of the Audit

Similar to the depth, the timing of an audit is also project specific. Generally, the first audit is conducted early in the project life cycle, as early problem detection would make the rectification process easier. Usually, early audits concentrate on technical issues and focus on solving key technical problems. Auditing conducted towards the end of the project life cycle becomes a value addition to the parent organization than to the project. As the project progresses, concern for the technical factors takes a back seat. At this stage, adherence to the schedule and budget become important. Also, management concerns like disposing of

equipment and reallocating personnel become key issues when a project is evaluated towards the end of its life cycle. Auditing conducted at different phases of project life cycle gives specific benefits to the project and the organization.

14.4.3 Post Project Evaluation

Post project evaluation could be necessary for the following reasons --

- It is specified by the client in the agreement and is required legally.
- It constitutes a major part of the project report. Also, it's the key source of information for giving feedback to the parent organization.
- It accounts for all the assets and expenses of the project.

Check Your Progress - 2

8. Identify the process that involves a detailed inspection of the management of a project, its methodology, its techniques, its procedures, its documents, its properties, its budgets, its expenses, and its level of completion.
   a. Project control
   b. Project auditing
   c. Project screening
   d. Project evaluation
9. Which of the following options is false with regard to the aspects that should be covered in the formal audit report?
   a. The audit report should properly assess the risk associated with the project.
   b. The audit report should include the limitations, assumptions, and constraints that would have an impact on the audit data.
   c. The audit report should include information about the other projects.
   d. The audit report should include the current status of the project while it need not include the future status of the project.
10. From the following options, identify the costs involved in the audit process.
   i. Professional and clerical costs for conducting an audit
   ii. Costs incurred in gathering, storing, and preserving the data to be audited
   iii. Distraction caused by the auditing process to the people working on the project
   iv. The drop in the morale of the individuals working on the project
   a. Only i, ii, and iii
   b. Only i, iii, and iv
   c. Only ii, iii, and iv
   d. i, ii, iii, and iv

11. Which of the following levels of audit covers dimensions of the auditing report such as the present status, the future status, and the status of the crucial tasks?
    a. General audit
    b. Detailed audit
    c. Technical audit
    d. Both (a) and (b)
12. Identify the reasons that make the post project evaluation audit necessary.
    i. It is specified by the client in the agreement and is required legally
    ii. It constitutes a major part of the project report
    iii. It accounts for all the assets and expenses of the project
    iv. It is the key source of information for giving feedback to the parent organization
    a. Only i, ii, and iii
    b. Only i, iii, and iv
    c. Only ii, iii, and iv
    d. i, ii, iii, and iv
13. Which of the following audits is conducted when a serious issue has been discovered and it is known that it will have a major impact on the project?
    a. General audit
    b. Detailed audit
    c. Technical audit
    d. Both (b) and (c)
14. Which of the following statements is **true** regarding the timing of a project audit?
    a. An early audit in the project life cycle would help in early problem detection and would make the rectification process easier.
    b. As the audit process progresses to an advanced stage, the project auditors concentrate on the technical issues, and therefore, focus on solving key technical problems.
    c. A project audit conducted during the end of the project life cycle checks on whether the project is adhering to the schedule and budget.
    d. All of the above
15. A detailed audit is carried out when
    a. An unacceptable level of risk has been discovered by the general audit.
    b. A technical audit fails to evaluate the technical aspects of a project Satisfactorily due to the auditor's lack of technical knowledge.
    c. The project auditor carries out the general and technical audits in a satisfactory manner.
    d. All of the above

16. _____ is a brief review of the project, carried out within a limited time period and with only a few resources.
    a. General audit
    b. Detailed audit
    c. Technical audit
    d. None of the above

14.5 Construction and Use of the Audit Report

The format of an audit report depends on the nature of the project under evaluation and the purpose of the evaluation. It is always advantageous to use a standard format for presenting audit reports. Such a format makes it easy for the project manager and the top management to understand and comprehend it. If the audit report is to be distributed within the organization, then the management should prepare a distribution list. If the distribution of audit reports is restricted, it can attract the attention of every individual thinking it to be a confidential report, which will finally lead to interpersonal and inter-group conflicts.

Though some project managers prefer complex and custom made formats of audit reports for their projects, it is always better to have a simple and straightforward structure. The information should be arranged in such a manner that it is easy to compare the planned and the actual output. The report should focus on the deviations of the delivered output from the planned output, along with explanations and comments. Such a simple and straight forward structure will make it easy for management to identify problems with the project.

The audit report should not make negative comments about the people involved in the project. The content of the report should be limited to the information and the issues that pertain to the project. The report should be written in a professional style without any scope for emotional overtones. A typical audit report must provide the following basic information:

i. Introduction

This part of the report presents the framework of the project. A clear representation of project objectives is a must in this section. In the case of highly complex objectives, it is advisable to add an appendix to the report, providing additional information on the project objectives.

ii. Present Project Status

The project's current status has to be reported when auditing the project. This section of the report is concerned with the following performance measures:

Cost: This part of the audit report compares the actual costs incurred to the planned costs. The report should also mention the timeframe during which the comparison is made. This section usually concentrates on computing the

direct costs of the project. In case it is necessary to highlight the total costs of the project along with the overheads, a cost data sheet should be provided as a supplementary table.

***Schedule*:** This part of the project audit report gives project performance in terms of the milestones accomplished. The auditor must clearly report which tasks have been completed and which are still incomplete. The percent of work completed must also be stated.

***Progress*:** This part of the audit report compares the tasks that have been completed with the resources that have been spent to achieve this task. There should be enough information in the report, to help the project manager zero in on the activities or group of activities that are the sources of the problem. Also, the information helps project managers estimate the time and expenditure necessary to complete the remainder of the project.

Quality: The degree of importance of quality as a factor of evaluation depends on the nature of the project. Quality can be defined as the totality of features and characteristics of a product or service which bear on its ability to satisfy a stated or implied need. These needs, in terms of projects, are pre-specified characteristics. If detailed quality specifications are attached to a project, this part of the project status report should contain a detailed review of the quality control procedures, along with the latest results of the quality tests conducted.

iii. Future Project Status

This part of the report consists of the project evaluator's conclusions. It indicates the progress of the project and makes suggestions regarding the remaining tasks of the project. The purpose of the audit report is not to rewrite the project proposals of existing projects, but to provide guidance to future projects.

iv. Critical Management Issues

This part of the report should address all the critical issues that top management has to monitor constantly. It should explain the link between the critical issues and the project objectives. In addition, this part of the audit report should describe the time, cost and performance trade-off in a brief manner. Such a description would help top management make decisions in the future projects.

v. Risk Analysis

This part of the audit report describes all the major risks involved in a project. It also discusses the impact of these risks on the time, cost and performance of the project. The report can recommend an alternative course of action for minimizing risks.

vi. Limitations and Assumptions

This part of the report can be included in the introduction or can be placed towards the end of the report. Though accuracy and timeliness of the audit report is the responsibility of the project auditor, the top management is totally responsible for the interpretation and actions taken based on the information given in the report. Therefore, it is important to state the limitations on the validity of the audit report.

Example: Extent of Benefits Derived from Auditing at Different Stages in a Project	
Stage in Project Life Cycle	**Extent of Benefit**
Initial	An audit in the early stages of the project is very valuable, especially if it is conducted before 25% of the project has been completed.
During feasibility study	A technical audit at this stage is highly beneficial.
Preliminary planning	Beneficial for developing measurement standards so as to validate the performance standards set.
Scheduling phase	Less beneficial because the flexibility of the project team at this stage is usually limited.
When project team is analyzing the data	Beneficial to a certain extent only.
Implementation phase	Benefits depend on the significance of the project processes and techniques.
Post-project	Benefits are realized to the extent the results of the audit are utilized in future projects.

Adapted from Jack R. Meredith & Samuel J. Martel, "Project Management – A Managerial Approach", Fourth Edition, p.519.

Activity: Odissy Automobiles WLL is a Japan-based automobile manufacturing company that specializes in producing 4x4 sports utility vehicles (SUV). A month ago, the company produced and launched its new model Odissy Roar during the Dubai shopping festival (DSF). The response to the vehicle was tremendous. So, Odissy's top management asked the project manager of Roar, Shan Wang, to conduct a post project evaluation and submit the report as soon as it is finalized. Why do you think a post project evaluation

report was required after the project had been successfully closed? How does a project manager conduct a post project evaluation? Also, discuss the procedure for preparing an audit report.

Answer:

14.6 Responsibilities of the Auditor

The basic responsibility of any project auditor is to convey the facts. This responsibility is not as simple as it seems to be. It is required to acknowledge the presence of different kinds of biases of the people involved in the project. The auditor should be aware of his limitations and seek external help when he has to audit aspects of the project that are beyond his area of expertise. All the information gathered should be kept confidential until the audit report is released officially. He should not allow any political or technical pressures to influence his audit report.

The seriousness with which the top management and the project team regards the audit report depends on the credibility of the information being presented in the report. The data should be checked and calculated very carefully in order to ensure its accuracy. It is the responsibility of the auditor to explore the ways in which he can enhance the effectiveness, efficiency and value of the auditing process.

The steps to be carried out in a project audit are: gathering a small team of experienced experts; informing the project team about the project requirements; conducting on-site project auditing; briefing the management after completing the audit; preparing and producing an audit report as per the predetermined format; distributing the report to the key stakeholders for their feedback; and ensuring follow-up till the suggestions are implemented.

Check Your Progress - 3

17. Which of the following sections in the audit report would contain a comparison of the actual costs incurred with the planned costs, a comparison of the tasks that have been completed with the resources that have been spent to achieve the task, etc.?
    a. Introduction
    b. Present project status
    c. Future project status
    d. Risk analysis

18. Which of the following statements is **not true** regarding the way the audit report is presented?
    i. The format of the audit report should be custom made by the project managers for their projects.
    ii. The content of the audit report should be limited to the information and the issues pertaining to the project.
    iii. The format of an audit report depends on the nature of the project under evaluation and the purpose of the evaluation.
    iv. The audit report should contain detailed information about the people who were responsible for making the project a success or a failure.
    a. Only i and ii
    b. Only i and iv
    c. Only ii and iii
    d. Only iii and iv
19. Following are the steps in carrying out a project audit. Put them into the proper sequence.
    i. Briefing the management after completing the audit
    ii. Informing the project team about the project requirements
    iii. Gathering a small team of experienced experts
    iv. Ensuring follow-up till the suggestions are implemented
    v. Distributing the report to the key stakeholders for their feedback
    vi. Preparing and producing an audit report as per the predetermined format
    vii. Conducting on-site project auditing
    a. iii-vii-ii-vi-i-iv-v
    b. iii-ii-vii-i-vi-v-iv
    c. iii-ii-i-vi-vii-iv-v
    d. iii-vii-vi-vi-v-iv-i
20. Which of the following sections in the project audit report should describe the trade-off between time, cost, and performance in a brief manner?
    a. Risk analysis
    b. Critical management issues
    c. Limitations and assumptions
    d. Both (a) and (c)
21. The introduction part of the audit report should contain
    i. the framework of the project.
    ii. a clear representation of the project objectives.
    iii. the major risks involved in the project.

iv. an appendix to the report stating the complex project objectives.

a. Only i and ii

b. Only i, ii, and iv

c. Only iii and iv

d. Only ii, iii, and iv

22. The project's current status section of the audit report should contain:

i. The percentage of work completed.

ii. The limitations and assumptions taken into consideration by the project auditor.

iii. Project performance in terms of the milestones accomplished.

iv. Detailed quality specifications along with a detailed review of the quality control procedures and latest results of the quality tests conducted.

a. Only i and ii

b. Only i, iii, and iv

c. Only ii, iii, and iv

d. Only iii and iv

14.7 The Project Audit Life Cycle

Just as the project has a life cycle, a project audit too has a life cycle. A project life cycle involves a systematic advancement of pre-defined events. The following are the six events that constitute a project audit life cycle.

14.7.1 Audit Initiation

This step marks the beginning of the audit process. The purpose and scope of the project audit is defined in this step. In this phase a suitable audit methodology is selected.

14.7.2 Defining the Project Baseline

The objective of this phase is to set performance standards to enable the auditor to measure the project performance and achievements against them. This stage in the life cycle involves identifying the areas of performance that require evaluation, setting standards through benchmarking, getting the performance expectations from top management, designing a program that measures the performance and gathering the information required.

14.7.3 Setting up an Audit Database

The audit process starts only after the baseline standards have been set. The next step in this phase is to develop a database that is to be used by the audit team. The information stored in the database is dependent on the purpose and the scope of

the audit. Usually it contains all the information necessary to assess the project's management and control activities, the past, present and future status of the project, the schedule and cost performance of the project and the quality of the delivered output. The information included in the database can range from a highly technical detailing of performance to details on interaction among the team members of the project.

The project master plan should specify the type of information that must be stored in the database. This will ensure the availability of the information when needed.

14.7.4 Preliminary Analysis of the Project

This phase in the audit life cycle begins only when the baseline standards are set and a database has been developed. In this phase the auditor analyzes the data and reports his findings to the managers in a manner that conveys the precise meaning of the findings of the audit. It is the responsibility of the project auditor to report his findings and judgments to the project manager prior to the formal release of the audit report. The project manager must be informed in advance since the purpose of the audit is to enhance the performance of the current project under evaluation and at the same time to improve the way future projects are managed.

14.7.5 Preparing Audit Report

This phase of the audit life cycle involves presenting an audit report in the format that is chosen at the beginning of the project audit. This section of the audit report gives recommendations along with the implementation plan. If the recommendations move beyond the scope of the organization, then they have to be supported right from the policy-making level of management. This support should be obtained prior to the distribution of the audit report. If the top management does not support the suggestions, they should be modified.

14.7.6 Project Audit Termination

The audit should be terminated after it has achieved its desired task. The audit process should be reviewed after the final audit report and the suggestions have been released. This is done to improve the audit process.

Activity: The top management of a software development firm, while going through an audit report submitted by an auditor from an external auditing firm, found that some of the facts and findings were misreported and miscalculated. What are the responsibilities of an auditor? Describe the method that auditors should follow while auditing a project.

Answer:

14.8 The Essentials of an Audit

To be effective, accurate, credible and acceptable to the top management, project team and the client, an audit has to be carried out by a competent audit team that has access to all the records and files of the project.

14.8.1 Selecting a Proper Audit Team

The success of an audit depends on the selection and the composition of the audit team. Auditors should be selected on the basis of their competence. Generally, the size of the audit team is directly proportional to the complexity and the scale of the project. The main task of an audit team is to examine and evaluate the project completely and thoroughly. The team must decide what issues are to be brought to the management's attention. The members of the audit team should not get involved in conflicts among project team members. Auditing is a strict and highly disciplined function, and all auditors and team members should confirm to this discipline with sincerity and dedication.

14.8.2 Access to Records and Files

Access to all the information and data pertaining to the project determines the effectiveness of an audit team. In situations where the access to information is restricted because of security reasons, forming a sub group of the audit team, composed of the qualified individuals, is an appropriate move.

Most of the information required is sourced either from the records of the project team or from functional departments like accounts, personnel and purchasing. Careful and thorough information gathering would result in an effective and highly credible audit report.

The information that is gathered should be organized and filed in a systematic manner. Appropriate methods have to be designed to classify the information. Safeguards have to be developed to prevent the duplication of efforts. Careful development of procedures will ensure the standardization of processes.

14.8.3 Access to Project Personnel

There should be frequent interaction between the audit team and the members involved in the project. Though interaction between the audit team and the client is necessary, it is always restricted even in the case of client being represented on the audit team. This restriction can be relaxed after obtaining permission from top management.

While conducting the audit, the audit team will have to deal with a considerable amount of political pressure. In situations where the project is under political pressure, the opposing parties may also try to take the advantage of the situation. So the audit team should avoid the involvement of such parties as much as possible. The information conveyed (by the project manager) to the audit team is

highly confidential. Information should be used only after confirming the reliability of the source of information. The confidentiality of such sources should be preserved by the audit team.

14.9 Performance Measurement

Measurement is a vital part of the audit/evaluation process. The success of a project can be judged by measuring the project team's ability to accomplish various milestones. Many project milestones are tangible and hence it is easy to find the completion of activities associated with it. Measuring the expenses incurred against the amount allocated in the budget is slightly complicated, requiring a thorough understanding of the methodology adopted by the accounting department.

Even though an auditor uses the cost data sheet, which is filled with a more accurate and precise data than what is required, there would still be some distinct problems while measuring the time, cost and performance parameters of the project. There would be more persistent problems in measuring, when the project objectives are defined in terms of profits, rates of return or discounted cash flows. Measurement problems increase when multi objective scoring models are used rather than financial models. Also, it is comparatively easier to measure some objective parameters. But for a credible measurement of subjective parameters, standard measurement techniques are required. To measure various aspects of the project, interviews and questionnaires are used for collecting data. The scoring methodology and the criteria to be used for weighing the scores should be determined at the project initiation phase itself.

Example: Auditing a Terminated Project at ABC Chemical Testing Services

ABC Chemical Testing Services has entered into a contract with mould aluminum to test the commercialization of the latter's newly invented compound. The contract did not mention a time limit, but laid more stress on quality and speed of testing. Payment was to be on a monthly basis. The contract also mentioned that the client's project leader will have free access to ABC's total testing procedures. After some time, the client's project leader started probing into the matters of the contractor, to the extent that the contractor's project team was forced to change the way they approached the problem. They were even made to skip the regular verification checks all for the sake of saving time. Even when the contractor came up with feasibility options of commercializing the compound, the procedures were re-tested by mould aluminum just to mention that those procedures will not work. The client had indeed become very hard to please.

Contd….

The contractor was taken by surprise when he received a letter from the client, asking for the termination of the project, although ABC was not evidently at fault. ABC's CEO commissioned an audit to unearth the anomalies. The report mentioned the following:

General outline:

- The original procedure and approach to the problem was changed because of the client's project leader. In spite of this, the project team of ABC made good progress.
- The testing was effective.
- ABC's project team was successful in testing the compound for commercialization many times, but they were not accepted (for no proper reasons).
- Though ABC was not responsible for commercialization, it did suggest a few methods.
- The client's project leader interfered way too much. He misguided the contractor's methodology and ultimately misdirected the project.
- ABC Chemical Testing Services neither documented the ongoing project management decisions nor did it communicate the decisions to the client.

Analysis of the client's feedback

Additional points:

- Based on the evidence that ABC's commercialization feasibility was implemented successfully in similar conditions, the client's criticism is proved to be false.
- ABC's reports which were criticized by the client were actually prepared as per the guidelines of the client's project manager. The reports were not user-friendly; they could only be understood by the technical staff or the project manager.
- The contractor's project manager was not guided properly to interact with the client.

Suggestions:

ABC needs to develop a formal procedure to identify projects involving high risks at the time of entering the contract. ABC should also have provisions for monitoring the deviations in the project from its initial plan. Some of the reasons behind terminating the current project are lack of sufficient funds, lack of time, lower probability of success, unsophisticated client and excess interference from the client in the project activities.

Activity: System Ltd. is a software and hardware research institute based in Hyderabad, India. The company is into developing software for cellular equipment. Currently it is working on developing software for Delhi based Reach Cellular. Since the project is coming to a close, the top management sent a fax to one Sukesh Singh to audit the project. How should Singh conduct the project audit?

Answer:

Check Your Progress - 4

23. In which of the following phases in the audit life cycle are recommendations made regarding the project along with the project implementation plan?
    a. Preparing an audit report
    b. Setting up an audit database
    c. Defining the project baseline
    d. Project audit termination
24. In which of the following phases in the audit life cycle does the auditor analyze the data and reports his/her findings to the managers in a manner that conveys the precise meaning of the findings of the audit?
    a. Audit initiation
    b. Preparing audit report
    c. Setting up an audit database
    d. Preliminary analysis of the project
25. Which of the following statements is **false** about the setting up an audit database phase of the project audit life cycle?
    a. The information stored in the database is dependent on the purpose and scope of the audit.
    b. An audit database contains all the information necessary to assess the project's management and control activities.
    c. The audit database contains only the past and present status of the project, but does not mention the future status of the project.
    d. The audit database contains information about the schedule and cost performance of the project and the quality of the delivered output.
26. The defining of the project baseline stage involves
    i. Identifying the areas of performance that require evaluation.
    ii. Setting standards through benchmarking.

iii. Getting the performance expectations from the top management.

iv. Designing a program that measures the performance and gathering the information required.

a. Only i and ii

b. Only ii and iv

c. Only iii and iv

d. i, ii, iii, and iv

27. Identify the statements that are **not true** with regard to the selection of an audit team.

i. Generally, the size of the audit team is indirectly proportional to the complexity and the scale of the project.

ii. The main aim of the audit team is to examine and evaluate the project completely and thoroughly.

iii. The members of the audit team should try to solve conflicts among the project team members.

a. Only i and ii

b. Only i and iii

c. Only ii and iii

d. i, ii, and iii

28. Following are some of the stages involved in the project audit life cycle. Arrange them in the sequence in which they should be conducted.

i. Preparing an audit report

ii. Setting up an audit database

iii. Defining the project baseline

iv. Preliminary analysis of the project

v. Project audit termination

a. i-ii-iv-v-iii

b. ii-iv-iii-i-v

c. iii-ii-iv-i-v

d. iv-v-iii-i-ii

29. The success of an audit **does not** depend on

a. The selection and composition of the audit team.

b. Access to all the information and data pertaining to the project.

c. The frequency of interaction between the audit team and the project members.

d. The structure of the organization and the constitution of the top management.

14.10 Summary

- Project evaluation is a process of evaluating a project's progress and performance in comparison with its planned progress and performance or with that of identical projects.
- Project auditing can be defined as the process of detailed inspection of the management of a project, its methodology, its techniques, its procedures, its documents, its properties, its budgets, its expenses and its level of completion. It can be carried over on the whole project or on a part of the project.
- Though a formal audit report can be presented in various formats, certain aspects must be contained in report without fail. The format of an audit report depends on the nature of the project under evaluation and the purpose of the evaluation.
- A typical audit report must provide the following basic information: introduction, present project status, future project status, critical management issues, risk analysis, and limitations and assumptions.
- The basic responsibility of any project auditor is to convey the facts. All the information gathered should be kept confidential until the audit report is released officially. The auditor should not allow any political or technical pressures to influence his audit report.
- Just as the project has a life cycle, a project audit too has a life cycle. The various stages of the project audit life cycle are – audit initiation, defining the project baseline, setting up an audit database, preliminary analysis of the project, preparing audit report, and project audit termination.
- To be effective, accurate, credible, and acceptable to the top management, project team, and the client, an audit has to be carried out by a competent audit team that has access to all the records and files of the project. The essentials of an audit are -- selecting a proper audit team, access to records and files, and access to project personnel.
- Measurement is a vital part of the audit/evaluation process. The success of a project can be judged by measuring the project team's ability to accomplish various milestones.

14.11 Glossary

Detailed Audit: It is usually conducted as a follow-up to the general audit, when an unacceptable level of risk has been discovered by the general audit.

General Audit: A brief review of the project, carried out within a limited time period and with only a few resources.

Project Auditing: A process of detailed inspection of the management of a project, its methodology, its techniques, its procedures, its documents, its properties, its budgets, its expenses and its level of completion.

Project Evaluation: A process of evaluating a project's progress and performance in comparison with its planned progress and performance or with that of identical projects.

Technical Audit: It is conducted when a detailed audit fails to evaluate the technical aspects of a project satisfactorily because of the auditor's lack of technical knowledge.

14.12 Self-Assessment Exercises

1. An organization can benefit from its past experience only when it tries to understand them through the process of evaluation, even in case of projects. What is project evaluation? Explain the reasons why projects are evaluated.
2. Though the terms, evaluation and audit are used interchangeably, they are different. What is project auditing? Explain the depth and timing aspects of a project audit.
3. The format of an audit report depends on the nature of the project under evaluation and the purpose of the evaluation. Explain the contents of an audit report. What are the responsibilities of a project auditor?
4. Just as the project has a life cycle, a project audit too has a life cycle. Describe the stages involved in a project audit life cycle. What do you think are the basic requirements of an audit? Explain the role played by performance measurement in the audit/evaluation process.

14.13 Suggested Readings/Reference Material

1. The Project Management Institute (PMI), A Guide to the Project Management Body of Knowledge (6th edition), Published Date: 2017 (6th edition)
2. K R Sharma, Project Management: Text and Practice Paperback – 1, Atlantic Publishers and Distributors (P) Ltd , January 2021
3. Anna Brzozowska, Arnold Pabian, Barbara Pabian, Sustainability in Project Management; A Functional Approach, CRC Press, 2021
4. Peter J. Edwards, Paulo Vaz Serra, Michael Edwards, Managing Project Risks, Wiley-Blackwell, 2019
5. Ronald Blank, The Basics of Quality Auditing, Productivity Press, 2017

14.14 Answers to Check Your Progress Questions

Following are the answers to the Check Your Progress questions given in the Unit.

1. (b) Only ii and iv

Project evaluation aims at identifying the various strengths and weaknesses of the project and helps in measuring the success of the project and managing future projects better. Some of the primary goals of project evaluation are: to ensure clarity in performance, cost, and time relationships, identify problems

during the early stages of the project, enhance the performance of the project, explore opportunities for technology advancements in the future, and minimize the costs of the project. To identify the risk factors associated with the projects taken up by the organization and to enhance the performance of the project are the secondary goals of project evaluation.

2. (d) i, ii, and iii

Project evaluation is an important task. It is a process of evaluating the project's progress and performance with reference to its planned progress and performance or in comparison with that of identical projects. Project evaluation should be supportive of all the management decisions that the project requires. The main objective of project evaluation is to measure the degree of a project's success.

3. (b) Project evaluation

Project evaluation is the process of appraising the progress and performance of the project with reference to the planned objectives. A project can be evaluated using evaluation tools like project audits and project reviews. Project auditing is a process of detailed inspection of the management of a project, its methodology, techniques, procedures, documents, budgets, expenses, and level of completion. Project screening refers to the screening of the project ideas that have been collected. It helps in rejecting ideas that cannot be considered for implementation. Project control is the process of collecting information related to the performance of the project system, comparing it with the desired level of performance, and taking corrective action to decrease the gap between the actual and the desired performance levels.

4. (b) To explore the strengths and weaknesses of the organization in terms of the project team members, management, and decision-making processes

Project evaluation aims at identifying the various strengths and weaknesses of the project and helps in measuring the success of the project and managing future projects better. Some of the secondary goals of project evaluation are to explore the strengths and weaknesses of the organization in terms of the project team members, management, and decision-making processes, understand the importance and role of projects in an organization, improve the way in which projects are organized and managed, and identify individuals with excellent managerial and leadership skills.

5. (d) i, ii, iii, and iv

Four critical parameters have been identified for measuring the success of a project based on a survey conducted on industrial projects of different natures and sizes. These are: completion of the project within a given budget and time; extent to which the project is able to satisfy the client; the commercial success of the project and the market share captured by the product delivered

by the project; and ability of the product or service to succeed if it enters a new market or its ability to lead to a new product or technology.

6. (b) To ensure clarity in performance, cost, and time relationships

Project evaluation aims at identifying the various strengths and weaknesses of the project and helps in measuring the success of the project and managing future projects better. Some of the primary goals of project evaluation are: to ensure clarity in performance, cost, and time relationships; identify problems during the early stages of the project; enhance the performance of the project; explore opportunities for technology advancements in the future; and minimize the costs of the project.

7. (a) Only i and iv

Project evaluation aims at identifying the various strengths and weaknesses of the project and helps in measuring the success of the project and managing future projects better. The secondary goals of project evaluation are to attempt to enhance the contribution of projects toward the professional growth of the team members, to try and create a healthy work environment, and to encourage the creativity of the team members. To check the firm's interest and commitment to the project and to find and correct mistakes and avoid them in the future are primary goals of the project.

8. (b) Project auditing

Project auditing is a process of detailed inspection of the management of the project, its methodology, techniques, procedures, documents, budgets, expenses, and level of completion. It can be done for the whole project or for a part of the project. Project control is the process of collecting information related to the performance of the project system, comparing it with the desired level of performance, and taking corrective action to decrease the gap between the actual and the desired performance levels. Project screening refers to the screening of the project ideas that have been collected. It helps in rejecting the ideas that cannot be considered for implementation. Project evaluation is the process of appraising the progress and performance of the project in comparison with the planned objectives.

9. (d) The audit report should include the current status of the project while it need not include the future status of the project.

Project auditing is the process of detailed inspection of the management of a project, its methodology, its techniques, its procedures, its documents, its properties, its budgets, its expenses, and its level of completion. After a project audit is conducted, it is presented in the form of an audit report. Following are certain aspects that are covered in a project audit report: the present status of the project; the future status of the project; the status of critical tasks; the risk factor involved in the project; the information pertaining to the other projects; and the limitations, assumptions, or constraints that have an impact on the audit data.

10. (d) i, ii, iii, and iv

Time and money are the two constraints that limit the scope of an auditor's evaluation of the project. These two constraints limit the depth of the investigation and also affect the amount of detail presented in the audit report. Various types of costs are incurred in the audit process. Some are professional and clerical costs that are incurred on conducting the audit while others are costs that are incurred in the course of gathering, storing, and preserving the data to be audited. Certain other types of costs are also incurred in the audit process. These are, however, ignored. Such costs rise due to the distraction caused by the auditing process to the people working on the project, and due to a drop in the morale of the individuals working on the project.

11. (a) General audit

A project audit is generally carried out at three levels: general audit, detailed audit, and technical audit. The general audit is usually a brief review of the project, carried out within a limited time period and with only a few resources. It usually touches on all the six dimensions of the auditing report, i.e., the present status of the project, the future status, the status of the crucial tasks, assessing the risk, information relating to other projects, and the limitations of the project. The detailed audit is conducted when an unacceptable level of risk has been discovered by the general audit. The technical audit is conducted when a detailed audit fails to evaluate the technical aspects of a project satisfactorily because of the auditor's lack of technical knowledge.

12. (d) i, ii, iii, and iv

Post project evaluation audit is carried out for the following reasons -- it is specified by the client in the agreement and is required legally, it constitutes a major part of the project report and is also a key source of information for giving feedback to the parent organization, and it accounts for all the assets and expenses of the project.

13. (b) Detailed audit

The detailed audit is usually conducted as a follow-up to the general audit. It is conducted when an unacceptable level of risk has been discovered by the general audit. The depth of a detailed audit depends on the seriousness of the issues and their impact on the objectives of the project — the more serious the issue, the greater the depth of the audit.

14. (a) An early audit in the project life cycle would help in early problem detection and would make the rectification process easier.

Auditing conducted at different phases of the project life cycle gives specific benefits to the project and the organization. The timing of an audit depends on the type of project. The first audit is generally conducted early in the project life cycle. This would help in early problem detection, which would

make the rectification process easier. Early audits concentrate on technical issues and focus on solving key technical problems. Auditing conducted toward the end of the project life cycle becomes more a value addition to the parent organization than to the project. As the project progresses, importance is given to adherence to the schedule and budget. Management concerns like disposing of equipment and reallocating personnel become key issues when a project is evaluated toward the end of its life cycle.

15. (a) an unacceptable level of risk has been discovered by the general audit.

The detailed audit is usually conducted as a follow-up to the general audit. It is conducted when an unacceptable level of risk has been discovered by the general audit. The depth of a detailed audit depends on the seriousness of the issues and their impact on the objectives of the project — the more serious the issue, the greater the depth of the audit.

16. (a) General audit

A project audit is generally carried out at three levels: general audit, detailed audit, and technical audit. The general audit is usually a brief review of the project and is carried out within a limited time period and with only a few resources. It usually touches on all the six dimensions of the auditing report, i.e., the present status of the project, the future status, the status of the crucial tasks, assessing the risk, information relating to other projects, and the limitations of the project. The detailed audit is conducted when an unacceptable level of risk has been discovered by the general audit. The technical audit is conducted when a detailed audit fails to evaluate the technical aspects of a project satisfactorily because of the auditor's lack of technical knowledge.

17. (b) Present project status

The project's current status has to be reported when auditing the project. In the section on the present project status, various aspects like cost, schedule, progress, and quality are covered. The report contains a comparison of the actual costs incurred with the planned costs; the project performance in terms of the milestones accomplished; a comparison of the tasks that have been completed with the resources that have been spent to achieve this task; and the quality aspect of the project.

18. (b) Only i and iv

The format of an audit report depends on the nature of the project under evaluation and the purpose of the evaluation. It is advantageous to use a standard format for presenting audit reports as this makes it easy for the project manager and the top management to understand and comprehend it. Though some project managers prefer complex and custom made formats of audit reports for their projects, it is always better to have a simple and straightforward structure that will make it easy for the management to

identify problems with the project. The audit report should not make negative comments about the people involved in the project. The content of the report should be limited to the information and the issues that pertain to the project.

19. (b) iii-ii-vii-i-vi-v-iv

Project auditing can be defined as the process of detailed inspection of the management of a project, its methodology, its techniques, its procedures, its documents, its properties, its budgets, its expenses, and its level of completion. Following are the various steps involved in the project audit: gathering a small team of experienced experts; informing the project team about the project requirements; conducting on-site project auditing; briefing the management after completing the audit; preparing and producing an audit report as per the predetermined format; distributing the report to the key stakeholders for their feedback; and ensuring follow-up till the suggestions are implemented.

20. (b) Critical management issues

In the section on critical management issues, the audit report should address all the critical issues that the top management has to constantly monitor. It should explain the link between the critical issues and the project objectives. It should also describe the time, cost, and performance trade-off in a brief manner. Such a description would help the top management make decisions in the future projects.

21. (b) Only i, ii, and iv

The introduction part of the audit report presents the framework of the project. A clear representation of project objectives is a must in this section. In the case of highly complex objectives, it is advisable to add an appendix to the report, providing additional information on the project objectives. The major risks involved in the project are described in the section on risk analysis.

22. (b) Only i, iii, and iv

The project's current status has to be reported when auditing the project. In the section on the present project status, various aspects like cost, schedule, progress, and quality are covered. The report contains a comparison of the actual costs incurred with the planned costs; the project performance in terms of the milestones accomplished; a comparison of the tasks that have been completed with the resources that have been spent to achieve this task; and the quality aspect of the project. The limitations and assumptions taken into consideration by the project auditor are not covered in this section of the audit report.

23. (a) Preparing an audit report

In the preparing an audit report phase of the audit life cycle, the audit report is presented in the format that is chosen at the beginning of the project audit.

In this stage, recommendations regarding the project are given along with the implementation plan. If the recommendations move beyond the scope of the organization, then they have to be supported right from the policy-making level of management. This support should be obtained prior to the distribution of the audit report. If the top management does not support the suggestions, they should be modified.

24. (d) Preliminary analysis of the project

In the preliminary analysis of the project phase, the auditor analyzes the data and reports his/her findings to the managers in a manner that conveys the precise meaning of the findings of the audit. This phase is taken up only when the baseline standards are set and a database has been developed.

25. (c) The audit database contains only the past and present status of the project, but does not mention the future status of the project.

An audit database is set up after the baseline standards have been set. The information stored in the database is dependent on the purpose and scope of the audit. The audit database contains all the information necessary to assess the project's management and control activities. It also contains the past, present, and future status of the project; the schedule and cost performance of the project; and the quality of the delivered output. The information included in the database can range from a highly technical detailing of performance to details on interaction among the team members of the project.

26. (d) i, ii, iii, and iv

In the defining of the project baseline stage, performance standards are set to enable the auditor to measure the project performance and achievements against them. This stage in the life cycle involves identifying the areas of performance that require evaluation, setting standards through benchmarking, getting the performance expectations from the top management, designing a program that measures the performance, and gathering the information required.

27. (b) Only i and iii

The success of an audit depends on the selection and composition of the audit team. Auditors should be selected on the basis of their competence. The size of the audit team is directly proportional to the complexity and scale of the project. The main task of an audit team is to examine and evaluate the project completely and thoroughly. The team must decide what issues are to be brought to the management's attention. The members of the audit team should not get involved in conflicts among project team members.

28. (c) iii-ii-iv-i-v

A project audit life cycle involves six events that constitute a project audit life cycle. These are: audit initiation, defining the project baseline, setting up an audit database, preliminary analysis of the project, preparing the audit

report, and project audit termination. In the audit initiation stage, the purpose and scope of the project audit are defined. In defining the project baseline stage, the performance standards are set to enable the auditor to measure the project performance and achievements against them. In the setting up an audit database phase, a database is developed for use by the audit team. In the preliminary analysis of the project stage, the auditor analyzes the data and reports his/her findings to the managers in a manner that conveys the precise meaning of the findings of the audit. In preparing audit report stage, the audit report is presented in the format that is chosen at the beginning of the project audit. Finally, in the project audit termination stage, the audit is terminated after it has achieved its desired task.

29. (d) the structure of the organization and the constitution of the top management.

The success of an audit depends on the audit team, access to all the information and data pertaining to the project, and the frequency of interaction between the audit team and the project members. The success or failure of an audit does not depend on the organizational structure and the constitution of the top management. These are not essentials of an audit.

Unit 15

Project Closing

Structure

15.1 Introduction

In the previous unit, we have discussed project auditing. In this unit, we will discuss the process for closing a project. A project comes to a close after it accomplishes its objectives or when it is terminated due to other reasons. Closing a project not only marks the completion of all administrative activities, but also audits the project performance which is a high-value learning tool for the project manager and others.

The project manager should evaluate specific project records for a historical understanding of the project activities which can be of use in the future. All records without value should be scrapped and the rest should be stored for future reference. The final task is to sell off the physical assets after making sure that they can be of no use in any future activities and placing project team members back in their original positions. Once the members of project team finish their respective tasks in the project, they should be made available for other assignments. The project manager should provide feedback on an individual's performance and contribution to the project to his supervisor.

This unit will discuss the closing of a project. We will discuss the various ways in which a project can be closed. We shall then move on to discuss the reasons for terminating an unsuccessful project. Finally, we would be discussing the process of closing a project.

15.2 Objectives

By the end of this unit, students should be able to:

- Define closing of a project.
- Discuss the various ways of closing a project.

- Identify the reasons for terminating an unsuccessful project.
- Explain the process of closing a project.

15.3 Closing a Project

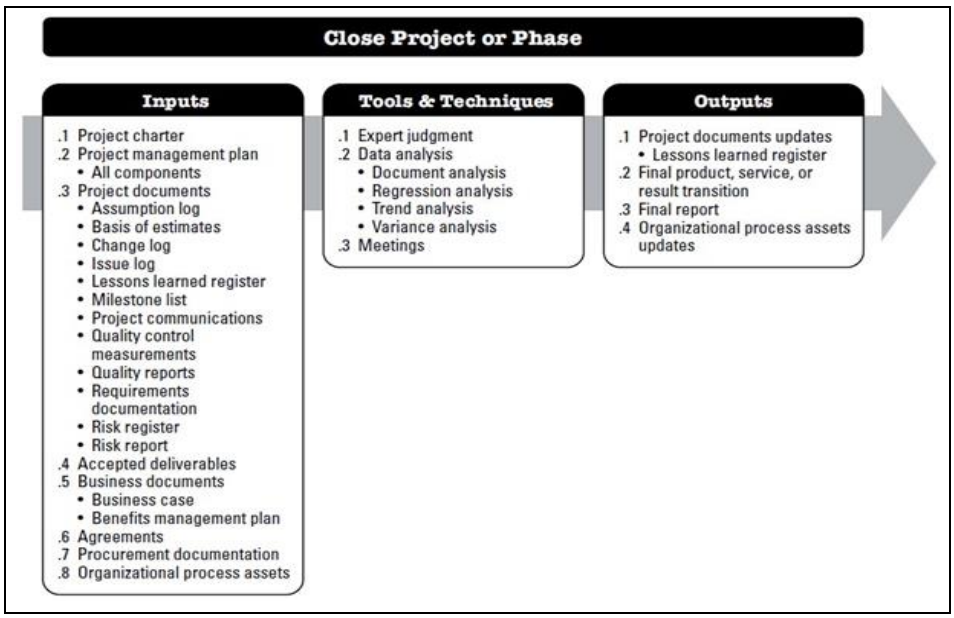
Many practitioners overlook the project closing process group. To them, successful project delivery is defined by the completion of deliverables as per the objectives of time and cost. They consider project closing as overburden, work that is done to satisfy organizational requirements, and in many cases of little significance, if any.

Little do these practitioners know that the Project Closing Process Group is as impactful and significant as the Initiation, Planning, Executing, and Monitoring and Controlling Process Groups. As further explained in this paper, the impact of project closing can be extensive, both to the project and to the organization. Failure to conduct thorough project close out could potentially (a) put the organization at a considerable amount of risk, (b) prevent the organization from realizing the anticipated benefits from the deliverables of the project, (c) result in significant losses to the organization, and (d) undermine the project manager and project management team's credibility.

Closing of a project is the process of finalizing all activities for the project, phase, or contract. The key benefits of this process are the project or phase information is archived, the planned work is completed, and organizational team resources are released to pursue new endeavors. This process is performed once or at predefined points in the project.

The inputs, tools and techniques, and outputs of the process are depicted in Figure below as given in the PMBOK.

Figure 5.1: Chose Project or Phase: Inputs, Tools& Techniques and Outputs



Source: ICFAI Research Center

Closing a project is not like switching a computer off. There is still a lot to be done, and a lot that can go wrong.

The Close Project process is another one where the Project Manager takes center stage and will be checking that that all project work is completed and that the project has met its objectives, including work and objectives that were added along the way as the result of approved change requests.

Just a reminder here that the type of "phase" mentioned here is a mini-project inside the main project.

The activities necessary for the administrative closure of the project or phase include:

- Actions and activities necessary to satisfy completion or exit criteria for the phase or project such as:
- Making certain that all documents and deliverables are up-to-date and that all issues are resolved;
- Confirming the delivery and formal acceptance of deliverables by the customer;
- Ensuring that all costs are charged to the project;
- Closing project accounts;
- Reassigning personnel. Depending upon the organization type (we will be covering organization types later in the course) the project staff will be assigned to another project, or they will return to their usual jobs, or their contracts will be finalized and they will leave the organization to take up the next contract.
- Dealing with excess project material. This can mean dealing with the materials and equipment that is lying around after the project has finished. For example, after completing a building there will be piles of bricks, sands, roof tiles, offcuts of wood, bags of cement, and so on. All this needs to be dealt with. Some can be returned to stock, machines will be returned to the store, or returned to the hire company, and material that can't be reused or recycled but be cleared away.
- Reallocating project facilities, equipment, and other resources; and
- Elaborating the final project reports as required by organizational policies.
- Activities related to the completion of the contractual agreements applicable to the project or project phase.

Some of the examples of project closing oversight are given in Table 5.1

Table 5.1: Some project Closures

Case-based Example	Impact
The IT team has completed the development of an application. The application was fully tested and accepted by the business and users. A few months later, users look for basic "how-to guides" but never find them, because they were seen as a secondary product and of lesser importance than the application itself	Users are dissatisfied with the outcome of the project and view it as a failure. Users are not capable of fully using the application, as they are dissatisfied with the lack of documentation to help them achieve what they need through the application. Responsibility to correct the situation is diluted. Developers engaged in supporting users, as opposed to being in a position to work on new projects.
At the end of the application development project, the project manager is required to close the contract with the vendor who provided him with two HTML developers—but hasn't—on the premise that this is a minor administrative matter and everybody knows that the project is over.	Three months after the project, the finance department receives invoices for work that was completed during the project life cycle, with claims of extra time and effort. Because the work is a distant memory, and the exact proceedings and requests were not documented at the time, the organization and the contractor enter into a dispute. Such a dispute not only harms the relationship between the two parties, but could also make one of them liable for reparations, damages, and legal costs, hence costing the organization far more than necessary.
There is no formal end to the project application development project, and hence developers' time is still allocated to that project, and they are not free to work on other projects or tasks and stakeholders continue to view this as a long-term project.	Project manager, project teams, and other resources are continuously engaged in post-project activities, though unnecessarily. Support staff is incapable of supporting the application due to the lack of a formal hand off. The organization is constrained in initiating new projects due to lack of confidence or lack of resources.

Source: ICFAI Research Center

Just as any of the other project management processes (Initiation, Planning, Execution, Monitoring and Controlling), Project Closing serves an important purpose for the organization and helps it avoid unfavorable and adverse scenarios.

At a high-level, the key elements of project close-out are:

- Verify acceptance of final project deliverables.
- Conduct post-project assessment and lessons learned.
- Conduct post-project review and evaluation.
- Recognize and celebrate outstanding project work.
- Disburse project resources – staff, facilities and automated systems.

The Project Closure Phase is the fourth and last phase in the project life cycle. Project Closure involves handing over the deliverables to your customer, passing the documentation to the business, cancelling supplier contracts, releasing staff and equipment, and informing stakeholders of the closure of the project.

Just as any of the other project management processes (Initiation, Planning, Execution, Monitoring and Controlling), Project Closing serves an important purpose for the organization and helps it avoid unfavorable and adverse scenarios. There are three important elements of closing out a well-managed project: final project housekeeping, project review, and the project close-out report.

A project checklist is used to make sure that none of the items that you have included on the project planning checklist are forgotten or left without action. It

serves as a reminder of what needs to be done and assurance of what has been done once the items are checked off the list.

A Project Close out Report should be developed and signed by both the delivering and accepting parties once the project has been completed. At a minimum it should include: Confirmation of the project's closure. Analysis of the project's performance.

A common reason why projects fail is related to visibility. All three tiers of the project team, executive management, project managers, and team members, need access to the right level of information at the right time. ... The net result that management cares about is the cost of the schedule overruns to the company.

The project closure report should include all important project information that would help stakeholders, auditors, and future project managers to clearly understand what was accomplished during the project and how the work was completed.

The closing phase of a project has very little impact on the success or failure of any project technically, but it certainly has an impact on the attitude of the client, top management and the project team towards the project. It also has a significant impact on learning the reasons behind the success or failure of the project. During this phase, there is no joy when new things are unearthed, because problems have either been solved already or overlooked. A project is terminated when the work on the project has come to a point where there is no further progress is possible. Such a situation is likely when the project is running far behind schedule or when its resources are transfered to other projects. Following are the steps involved in formally closing a project.

- End the external contracts of the company formally with the vendors, clients and other parties who expect early termination of services.
- Suspend the assignments of the team members formally.
- Seek the acceptance of the client formally on the project work and the output.
- Make sure of proper installation and/or implementation of the delivered output on time, with in budget and as per specifications.
- Make sure of the availability of sufficient project documentation that can facilitate any change occuring in the future.
- Submit the final report and get it approved.
- Close the established relationships internally and externally

It is the project manager’s responsibility to set a formal project closing date and get it approved by way of getting it signed by the client. The closing date should match the one mentioned in the master plan. Also the process of closing is to be initiated by the project manager with support from the administrative department of the client’s firm, after getting a green signal from the client.

Check Your Progress - 1

1. Terminating the activities of the project when work on the project has come to a point where further progress is not possible is called _____.
   a. project termination
   b. project ending
   c. project closing
   d. None of the above
2. Which of the following steps should be taken before closing a project?
   i. Suspending the assignments of the team members formally
   ii. Seeking the acceptance of the client formally
   iii. Ending the external contracts of the company formally
   iv. Submitting the final report and getting it approved
   a. Only i and ii
   b. Only ii and iii
   c. Only iii and iv
   d. i, ii, iii, and iv

15.4 Ways of Closing a Project

When a project has achieved all the goals and objectives set under the stipulated cost, time and performance and the delivered output is accepted by the client, then it is said to be a successful project. Since such projects have reached a point from which there is no progress possible even in terms of improving the effectiveness and efficiency of the output, the project has to be closed. The checklist helps the project manager in assessing if the project is ready for closing or not.

Basically there are four ways in which a project can be closed. They are -- closing by extinction, closing by addition, closing by integration and closing by starvation.

15.4.1 Closing by Extinction

Projects are closed by way of extinction either when they are successful in accomplishing the goals or when they fail to deliver within the budgeted time and cost. Some of the examples where in projects can be said to be closed by extinction are:

Successful Projects:

- A new product is produced and is launched successfully in the market.
- L&T has successfully constructed the Cybertowers complex at Hyderabad and handed it over to the government of Andhra Pradesh.
- An ERP solution is suggested and is successfully implemented in a firm.

Unsuccessful Projects:

- Kinetic Motors failed to produce a two seater car that it planned to produce.

In some cases, projects are closed suddenly and using drastic measures. This is called killing a project. The reasons for killing a project may not be related to its effectiveness or ability to deliver the end product.

Some Reasons for Killing a Project Are:

- Political
- Mergers and acquisitions
- Demergers

Project closure by extinction is characterized by the termination of all activities associated with the key project deliverables. But there remain the major activities like putting back project team members to their respective departments and disposing or distributing the assets of the project.

15.4.2 Closing by Addition

This method is adopted when "in-house" projects are to be closed. When a project team undertakes an in-house project for implementing it in its parent organisation and if it is successful in meeting its objectives, then the project can be closed by incorporating it as a functional and formal part of the organisation. When a project is closed or terminated by addition, then it is made a part of the parent firm. But this process of merging it back with the parent firm takes place in a slow and phased manner. The project derives support from all the functional areas of the parent organization and once it attains a stable position economically, then support is slowly withdrawn enabling it to function independently within the firm.

Closing the project both by extinction and by addition share a similarity, i.e, the project is closed when its existence is no more a viable option for the organization.

In the process of closing a project by addition, the project can either be added to the parent organization as a department or as an independent subsidiary depending on the project's ability to be economically independent. Although a project is given financial and tactical support in the initial stages of addition to the parent organization, it is expected to show economical independence with time.

Transfering project resources after closing it by addition is different from that of closing by extinction. In closing a project by addition, the resources of the project are transferred from the account of the successful project to the account of the newly created department or subsidiary. The addition of the project and its subsequent transformation is supported by adequate budgetary allocations as per the rules of the parent organization.

All the assets including the human capital of the closed project are transferred to the new department. During the process of transition from a project to a new department or a subsidiary, the administrative practices and the budgetary style of the parent organization are adopted. There is also the possibility of some individuals in the project requesting for a transfer to the other projects, because of the sharp decline in the freedom during the transformation. It is the responsibility of the project manager to ensure a smooth and free transition of the project into a department. However, it is not an easy process; it is one of the most challenging tasks for the project manager. For successfully transforming a project into a department, the project manager should manage several political issues diplomatically.

15.4.3 Closing by Integration

This type of closing is used for technically complex projects which on completion will form a part of the operating system of the parent organization or the client. It is the responsibility of the project team to integrate the product into the operating system of the parent or client organization. The difficulties in integration can be minor or major. When a new machine center is installed by the project team and they have detailed its operation and maintenance to the customer, minor operational problems can be solved by the operations manager.

However, when a flexible manufacturing system is installed by the project team, then the difficulty of integration is higher. The difficulty in integrating a project is inversely proportional to the expertise and experience level of the parent or client's firm in technology and project integration.

The problems faced while closing a project by integration are similar to the ones that are encountered while closing it by addition. Also the project may not fuction as effectively as it used to function when it was in the project phase. There is a possibility that members of the project team lose interest in the old project as they come back to their respective departments in the organization. Some significant issues related to the functional aspects of closing a project by integration are:

Human capital*:* Where to send the project team? Should it continue as a team? Who will perform the functions of the team if required? What should be the guidelines for the availability of the ex-team members of the closed project for any support required, if they are assigned any new projects?

Production: Is the training fulfilled? Is there a need for replanning the layout of the production system? Are there any bottlenecks because of the change in the layout? Is a new procedure in operations required? Is the new operation integrated with the firm's information systems?

Finance: Are the project accounts terminated and evaluated? Is there a provision for the extra work needed by the project in the budgeting of new departments? Are all the assets distributed as per the contract?

Engineering: Have all the drawings been filed? Is there a proper understanding of the operating manuals and change procedures? Are the training programmes tailored as per the needs of the new employees? Are the maintenance plans modified according to the changes? Are there adequate number of spares in inventory?

Information systems*:* Is the new system tested and evaluated thoroughly? Is the documentation of the software complete? Is there complete integration between the new and the existing systems? Have the end users been trained properly to use the new system?

Marketing*:* Are the marketing and sales departments aware of the changes made? What is the level of comfort for the marketing department in the new line? Is the strategy ready to be implemented by the marketing personnel?

Procurement, logistics and legal*:* Have the changes been communicated to all these and other functional areas?

15.4.4 Closing by Starvation

This method of project closing cannot be considered a closing in the strict sense, because here the project's existence comes to an end as a result of declining budgets. Budget cuts are common during periods of recession and they can also be used as a supporting reason to terminate a project.

There is substantial resistance from the top management in closing a project that is not successful, especially when it is politically risky to acknowledge failure. And under such circumstances, the budget of the project is cut to a level at which progress of any activity of the project is hindered. As a result, the project is shelved, although it may still be shown as an ongoing project.

Activity: Ding Dong Telecommunication Ltd. (DDTL) is a Noida based telecommunication equipment manufacturing company. It is working on a project for manufacturing CDMA (Code Division Multiple Access) technology switches for a cellular company in Bangalore. A month after the submission of the audit report, the top management of DDTL asked the project manager to close the project. Why does the top management of the firm want to close the project? What are the ways in which a project manager can close a project? Specify the situations in which a project manager can close a project?

Answer:

Check Your Progress - 2

3. What type of project closing is used to close a project that has succeeded in accomplishing its goals or has failed to deliver within the budgeted time and cost?
   a. Closing by starvation
   b. Closing by extinction
   c. Closing by integration
   d. None of the above
4. From the following options, identify the reasons for ending the project under closing the project by extinction?
   i. Mergers and acquisitions
   ii. Political Pressure
   iii. Introduction of a new product in the market
   iv. Demergers
   a. Only i and ii
   b. Only i, ii, and iv
   c. Only ii and iii
   d. Only ii, iii, and iv
5. The type of project closing used to close a project when its existence comes to an end as a result of declining budgets is known as _____.
   a. Closing by starvation
   b. Closing by addition
   c. Closing by integration
   d. Closing by extinction
6. _____ is the method adopted when in-house projects are closed.
   a. Closing by addition
   b. Closing by extinction
   c. Closing by integration
   d. Closing by starvation
7. Which of the following options are significant issues related to the functional aspects of closing the project by integration?
   i. Production
   ii. Information systems
   iii. Finance
   iv. Engineering

a. Only i and ii
b. Only ii and iii
c. Only iii and iv
d. i, ii, iii, and iv

15.5 Reasons for Terminating an Unsuccessful Project

A project can be called an unsuccessful one when it fails to meet its established objectives on time, budget and performance. Failure to meet any of these three fundamental parameters can result in project failure and such projects qualify to be closed. Some other key factors that call for project termination are:

- Probability of meeting technical objectives is very low.
- Inability of R&D to resolve the technical problems.
- Return on investment is not significant or is very low.
- High cost involved in running it as an individual project.
- Market potential of the delivered output is very low.
- Constantly changing market needs.
- Requires a very long time to gain profits
- Bears a negative impact on other projects.
- Problems created by intellectual property rights.

Unsuccessful projects need to be terminated at right time for further prevention of losses of cost, image and productivity losses. Exhibit 15.1 identifies some top causes of project failures in 2021.

Exhibit 15.1 Top 10 Main Causes of Project Failure

According to Charles R. Swindoll, Life is 10% what happens to you and 90% how you react to it. Many tips, resources, and guidelines are available project management to lead better, communicate better, and do better

Project Failure Statistics

Failure is natural but one of the least discussed topics. According to a 2019 KPMG, AIPM, and IPMA global survey:

- Only 19% of organizations deliver successful projects, at least most of the time
- Only 30% of organizations deliver on time
- Only 36% deliver projects on budget
- Only 44% deliver projects that meet original goal and business intent
- Only 46% of projects delivered receive stakeholder satisfaction

Contd….

Hence projects need to, examine all road-blocks, hurdles, hills, detours, potholes, manholes. Before starting a project, identifying these exactly, gives the project manager, team, and client the options where they can avoid or mitigate as much risks as possible.

Why Do Projects Fail?

Knowing about these and getting ahead of them will help project managers incoming times

1. Lack of Preparation
2. Inadequate Documentation and Tracking
3. Poor Leadership
4. Failure to Define Parameters and Enforce Them
5. Inexperienced Project Managers
6. Inaccurate Cost Estimates
7. Little Communication at Every Level of Management
8. Culture or Ethical Misalignment
9. Lack of Resource Planning
10. Disregarding Project Warning Signs

https://project-management.com/top-10-main-causes-of-project-failure/ sept 2021

15.6 The Process of Closing a Project

The process of closing a project is equally complex and lengthy as planning the scope of the project. So a project manager is always in need of a systematic methodology that will help him close projects smoothly. There are also situations where "termination managers" are employed to handle the process of closing the project. A termination manager should be a person who is well versed with the administrative parameters of closing and is equally good at analyzing the organizational climate in which the successful project would be put to work. The basic responsibilities of a termination manager are as below:

- To make sure that all tasks are accomplished, even those of external contractors and vendors.
- Inform the client about the completion of the project and deliver the product/project.
- Make sure that project documentation is completed along with a final auditing of the delivered output and submit a final project report.
- Ensure that the final invoices are sent to the client and get them cleared.

- Put all the resources and assets back to their respective positions in the parent or client's organization.
- Get clearance from the legal consultant on the project.
- Find out all the documents that are worth storing
- Check for the proper closing of the project books.

The following are the steps to follow while terminating a project: (i) getting client's acceptance, (ii) installing the project's delivered output, (iii) documenting the project and (iv) signing and submitting the final report.

15.6.1 Getting Client's Acceptance

It is the project manager's responsibility to show to the client that the delivered product or service matches the specifications set by the client. Acceptance can either be informal or formal. Acceptance involves a test on the delivered output to check its performance against the standards established by the client.

Informal or Ceremonial Acceptance

Informal acceptance by the customer involves no signing on the final report to acknowledge the project's success. Ceremonial acceptance is given by the client in two cases. The first is wherein the client accepts the project as closed at a particular time. The second is where there is no need to measure the conformity of the final product.

Formal Acceptance

This is a situation in which the client has a formal acceptance methodology in place while entering into a contract with the project manager. In many projects, both the client and the members of the project team develop the acceptance methodology. This happens at a very early stage in the project life cycle. This methodology involves the project team proving to the client about the delivered output's conformance with the client's specifications. This method involves a detailed step-by-step and feature-by-feature signing off on the performance tests conducted. The performance tests conducted are done in the presence of both the client and the team members. The checklist should be designed in such a manner that it requires no further interpretation to find out whether there is conformance to performance or not.

15.6.2 Installing the Project's Delivered Output

This is the most common step in the closing of an information system project or a manufacturing set-up project. This phase can involve some steps or strategies in itself. However it is considered as a single event or a process that transfers the product into the clients control. This phase initiates several activities of closing pertaining to documentation and preparation of the final report.

15.6.3 Documenting the Project

Documenting is the most difficult task in project closing. The following are the reasons behind documenting a project:

- Documentation acts as a reference for any future changes in the delivered output of the project, even after the completion of the project. Changes that arise out of a strong reason to follow-up, repair or upgrade the project require documents for reference. Utilizing delivered output enables the client to explore the chances of improvement, including new features and functions.
- It provides historical data that help client's to estimate the time and cost of future projects. Past projects can act as an encyclopedia to provide relevant information for all future projects, activities and tasks. But this is possible only when a project is properly documented to be retrieved in the future. The data containing the scheduled and actual duration, planned and actual cost of each task etc. will prove highly valuable in planning these parameters in future projects.
- It acts as a source of training new project managers. It teaches new project managers valuable lessons like determining the work breakdown structure, analyzing and examining the requests for change and taking decisions on the same and exploring problem situations and solving them.
- It becomes an input for further training and development required by the project team members. Project documentation helps project team members to handle any situation. The way in which a similar situation was handled in earlier projects will be a good reference.
- Documentation becomes the basis for evaluating the performance of the project team members. Most of the firms use project documents as a source of evaluating the project manager and the project team members. Functional managers or individuals using this tool for evaluation should be extremely careful because even the best or exceptionally good performance of the team members may result in a failed project, or vice-versa.

15.6.4 Signing and Submitting the Final Report

One of the most significant characteristics of an ideal project management system is its ability to report project history. Project history is best reported in a final project report. It is the content of the report that is of prime concern in a final report than the way it is organized. The topics that need to be covered in a final report are -- the performance of the project; project performance in terms of administration; the organizational structure; project and administrative teams; and techniques of project management.

The Performance of the Project

One of the most important parts of the report is the comparison between the accomplished tasks of the project and the tasks proposed. The comparison should involve description of the reasons behind the variation of the delivered product

from the planned product. It is advisable to have a final end value discussion. Including project performance in the final report can also give the judgement of the project manager elaborating on the reasons for deviation, since it is not a formal evaluation. This section of the report should also include suggestions for future projects that may involve similar situations.

15.6.5 Project performance in terms of administration

This part of the project is often overlooked until problems crop up. Though the administrative department of a project cannot resolve the technical issues of the project, it can provide substantial help in implementing an appropriate technology. After examining the administrative procedure, the practices that worked well or not so well need to be highlighted. It is also advisable to describe the reasons behind the effectiveness or ineffectiveness of an administrative practice. This enables project members to discuss future strategies.

15.6.6 The organizational structure

Every organizational structure used in a project has its own merits and demerits. This section of the report should describe the role of the organizational structure in the success or failure of the project. Suggestions should be made if it is felt that a slight modification or change in the organaizational structure would have been beneficial to the project. The suggestions should be rational and substantiated with examples.

15.6.7 Project and administrative teams

Under some circumstances, even the most competent individuals do not perform as well as expected in a team. In such situations, a report on the performance of the team should be given to the top management of the parent firm. Any recommendations should be made in a confidential manner. Recommendations can also be made by the project manager to the top management recommending those individuals who were very effective in running a team, be retained for future projects.

15.6.8 Techniques of project management

The quality of a project output depends on the efficiency with which it is planned, budgeted, assigned resources and controlled. Since the quality of the output is linked strongly with the efficiency in planning, budgeting and controling, it is very important to check the way in which these tasks were accomplished. The report should contain the ways of increasing efficiency of the forecasts, budgets and schedules, if they were not upto the desired standards. The procedures used in planning, controling and managing risk should also be checked thoroughly.

There is also another format in which a project termination report can be made depending on the nature of the project. All topics covered in a final project report should be listed along with suggestions for altering the existing practices. These

suggestions should also be properly justified. It is important to mention the remarks and suggestions on the issues of the project that performed exceptionally well, but covering this topic in the report is usually overlooked. The final report should also highlight all the informal methods used by the project managers and the team members to speed up the process of preparing the budget, scheduling and improving predictions. Such methods can be tested and if proven successful can be instituitionalised as a part of the project management methodology in the parent organization.

The basic purpose of a final project report is to improve the way in which future projects are to be handled. It highlights the project and the way in which it is executed.

Though data on the project's results are available in reports and audits conducted throughout the project life cycle, the project manager can certainly use his experience to talk about result oriented projects. It is the project manager's job to maintain a diary on all significant issues. This practice will ensure the inclusion of such issues in the final report. Though a project manager's diary is not a formal document, it is an informal collection of thoughts and remarks on the various incidents during the project. On the whole, it prevents the ideas from getting lost.

Activity: Pure Acoustics Inc. is a US-based home theatre system manufacturing company. The company had initiated a project for developing a state-of-the-art digital signal receiver. After the design was approved, the project team was given 18 months to complete the project. Because of high employee turnover, the project took more than double the time, and yet there were some problems with the functioning of the product. Soon, top management decided to terminate the project. What are the reasons behind terminating an unsuccessful project? Also, explain the procedure of closing a successful project (assuming that this project was successful)?

Answer:

Check Your Progress - 3

8. The process of closing the project is a complex and lengthy affair. The person who is specifically appointed to close the project is called the _____.
   a. Closing manager
   b. Termination manager
   c. Project manager
   d. None of the above

9. When there is no need to measure the conformity of the final product to predetermined standards, the kind of acceptance taken from the client for closing the project is called
   a. Informal acceptance.
   b. Ceremonial acceptance.
   c. Formal acceptance.
   d. None of the above
10. From the following options, pick the ones that need to be covered in a final project report.
   i. Performance of the project
   ii. Project performance in terms of administration
   iii. Project and administrative teams
   iv. Techniques of project management
   a. Only ii
   b. Only ii and iii
   c. Only iii and iv
   d. i, ii, iii, and iv
11. Which of the following steps in the closing of the project will help in providing historical data that will help the clients estimate the time and cost of future projects?
   a. Getting the client's acceptance
   b. Documenting the project
   c. Installing the project's delivered output
   d. Signing and submitting the final report
12. Which of the following options do not form the basic responsibilities of the termination manager before he/she closes the project?
   a. Getting clearance from the legal consultation on the project
   b. Finding all the documents that are worth storing
   c. Ensuring that the implementation of the project is profitable to the project organization
   d. Ensuring that the final invoices are sent to the client and getting them cleared
13. There are four steps in terminating a project. Which of the following is the last of these steps?
   a. Getting the client's acceptance
   b. Signing and submitting the final report
   c. Documenting the project
   d. Installing the project's delivered output

14. _____ becomes an input for further training and development required by the project team members.
    a. Documenting the project
    b. Final project report
    c. Installing the project's delivered output
    d. None of the above
15. One of the most significant characteristics of an ideal project management system is its ability to report project history. Project history is best reported in the _____ report.
    a. project termination statement
    b. final project
    c. closing report
    d. None of the above
16. Identify the step in the process of closing a project that involves transfer of the product into the client's control.
    a. Documenting the project
    b. Getting the client's acceptance
    c. Installing the project's delivered output
    d. Signing and submitting the final report
17. _____ involves the project team proving to the client that the delivered output conforms to the client's specifications.
    a. Acceptance methodology
    b. Formal acceptance
    c. Informal acceptance
    d. None of the above

15.7 Summary

- A project comes to a close after it accomplishes its objectives or when it is terminated due to other reasons.
- A project is terminated when the work on the project has come to a point where there is no further progress is possible. This might happen when the project is running far behind schedule or when its resources are transferred to other projects.
- A project can be closed in four ways – closing by extinction, closing by addition, closing by integration, and closing by starvation.
- A project can be called an unsuccessful one when it fails to meet its established objectives on time, budget, and performance. Failure to meet any of these three fundamental parameters can result in project failure and such projects qualify to be closed.

- The process of closing a project is equally complex and lengthy as planning the scope of the project. So a project manager is always in need of a systematic methodology that will help him close projects smoothly.
- Termination managers are employed, in some cases, to handle the process of closing the project. He/she should be a person who is well versed with the administrative parameters of closing and is equally good at analyzing the organizational climate in which the successful project would be put to work.
- Following are the steps to follow while terminating a project: (i) getting client's acceptance, (ii) installing the project's delivered output, (iii) documenting the project, and (iv) signing and submitting the final report.

15.8 Glossary

Project closing by addition: This method is adopted when "in-house" projects are to be closed. When a project team undertakes an in-house project for implementing it in its parent organisation and if it is successful in meeting its objectives, then the project can be closed by incorporating it as a functional and formal part of the organisation.

Project closing by extinction: Projects are closed by way of extinction either when they are successful in accomplishing the goals or when they fail to deliver within the budgeted time and cost.

Project closing by integration: This type of closing is used for technically complex projects which on completion will form a part of the operating system of the parent organization or the client.

Project closing by starvation: This method of project closing cannot be considered a closing, because here the project's existence comes to an end as a result of declining budgets.

15.9 Self-Assessment Exercises

1. A project comes to a close after it accomplishes its objectives or when it is terminated. Under what circumstances can a project be closed? What are the steps involved in the formal closure of a project?
2. A project can be closed when it has reached a point where there is no progress possible even in terms of improving the effectiveness and efficiency of the output. What are the various ways in which a project can be closed?
3. A project is terminated when it is running far behind schedule or when its resources are transferred to other projects. What are the various factors that call for project termination?
4. The process of closing a project is very complex and lengthy. Explain in detail the steps involved in closing a project. Who is a termination manager? What are the basic responsibilities of a termination manager?

15.10 Suggested Readings/REFERENCE Material

1. The Project Management Institute (PMI), A Guide to the Project Management Body of Knowledge (6th edition), Published date: 2017 (6th edition)
2. K R Sharma, Project Management: Text and Practice Paperback – 1, Atlantic Publishers and Distributors (P) Ltd , January 2021
3. Anna Brzozowska, Arnold Pabian, Barbara Pabian, Sustainability in Project Management; A Functional Approach, CRC Press, 2021
4. Peter J. Edwards, Paulo Vaz Serra, Michael Edwards, Managing Project Risks, Wiley-Blackwell, 2019
5. Ronald Blank, The Basics of Quality Auditing, Productivity Press, 2017

15.11 Answers to Check Your Progress Questions

Following are the answers to the Check Your Progress questions given in the Unit.

1. (c) project closing

A project's activities are terminated when the project has come to a point when further progress is not possible in its implementation. This is called project closing.

2. (d) i, ii, iii, and iv

The steps that are taken by a project organization before closing the project are: Ending the external contracts of the company formally, suspending the assignments of the team members formally, seeking the acceptance of the client formally, making sure of the proper installation and implementation of the delivered output, making sure that proper project documentation is done, submitting the final report and getting it approved, and closing the established relationships internally and externally.

3. (b) Closing by extinction

Closing by extinction is the method of closing a project when it has succeeded in accomplishing the goals set or when it has failed to deliver within the budgeted time and cost. Under closing by starvation, the project comes to an end as a result of declining budgets. Closing by integration is the type of project closing used for technically complex projects, which become a part of the operating system of the organization.

4. (b) Only i, ii, and iv

The reasons for ending a project under closing the project under extinction are: political pressures, mergers and acquisitions, and demergers. The introduction of a new product is one of the reasons for closing successful projects.

5. (a) closing by starvation

The project is closed by starvation when its existence comes to an end as a result of declining budgets, resistance from the top management, when it is politically risky to continue or when the projects have a negative effect on the image of the company in the market. Closing by addition is adopted when 'in-house' projects are to be closed. When a project team undertakes an in-house project for implementing it in the parent organization and if it is successful, the project is closed by incorporating it as a formal part of the organization. Closing by integration is one of the methods by which the project is closed. This method is used for technically complex projects which become part of the organizational system of the organization. Closing by extinction is used to close the project when it has succeeded in accomplishing the goals set or when it fails to deliver within the budgeted time and cost.

6. (a) Closing by addition

Closing by addition is the method followed when integrating an in-house project into the functional and formal part of the organization. Closing by extinction and starvation are the methods followed when it is not feasible to run the project further. Closing by integration is the type of project closing used for technically complex projects which will become a part of the operating system of the organization.

7. (d) i, ii, iii, and iv

Closing by integration is one of the methods by which a project is closed. This type of closing is used for technically complex projects which become part of the organizational system of the organization. There are some significant issues related to the functional aspects of closing a project by integration. They are: Human capital, production, finance, engineering, information systems, marketing, procurement, logistics, and legal.

8. (b) termination manager

The person who is employed to look into the termination of the project is called the termination manager. The termination manager is a person who is well versed with the administrative parameters of project closing. A project manager may also look after the project closing activities of the organization. However, he/she is not specifically employed for this purpose.

9. (b) ceremonial acceptance.

Ceremonial acceptance is given by the client in two cases. The first is where the client accepts the project as closed and the second is when there is no need to measure the conformance of the final product to predetermined standards. Informal acceptance is taken when there is no need to sign on the final report

to acknowledge the project's success. Formal acceptance is taken in situations where the client has a formal acceptance methodology in place while entering into a contract with the project manager.

10. (d) i, ii, iii, and iv

The important topics that need to be covered in the final report are performance of the project, project performance in terms of administration, organizational structure, project and administrative teams and techniques of project management.

11. (b) Documenting the project

Documenting is a crucial and difficult step in closing the project. It enables clients to estimate the time and cost of future projects.

12. (c) Ensuring that the implementation of the project is profitable to the project organization

There are some basic responsibilities that a termination manager has like making sure that all the tasks are accomplished, informing the clients about the completion of the project, making sure that the project documentation is completed, ensuring that the final invoices are sent to the client and cleared, putting all the resources and assets back into the respective positions in the parent and client's organization, getting clearance from the legal consultant, finding out the documents that are worth storing and checking out the proper closing of the project books. Ensuring that the implementation of the project is profitable to the organization is not his/her responsibility.

13. (b) Signing and submitting the final report

The four steps in the termination of a project are in sequence: Getting the client's acceptance, installing the project's delivered output, documenting the project, and signing and submitting the final report.

14. (a) Documenting the project

Documenting the project is one of the most difficult and crucial tasks in project closing. Documenting becomes an input for further training and development required by the project team members. It also helps the project team members to handle any situation by giving insights into how a similar situation was handled in earlier projects.

15. (b) final project

The ability to report project history is one of the significant characteristics of an ideal project management system and project history is best reported in the final project report. The project termination statement is a statement that

is agreed on and signed by the client after he/she accepts the completion of the project to his/her level of satisfaction. The project closing report is another form of preparing the project termination statement. In this type of report, all the topics covered in the final report should be listed along with the suggestions for altering the existing practices.

16. (c) Installing the project's delivered output

Installing the project's delivered output is the second step in the process of closing the project. This involves transferring the product into the client's control. Transferring the project into the client's control is undertaken after the acceptance is received from the client.

17. (a) Acceptance methodology

Acceptance methodology involves the project team proving to the client that the delivered output conforms to the client's specifications. The situation of formal acceptance arises when the client has a formal acceptance methodology in place while entering into a contract with the project manager. Informal acceptance does not require the client to sign on the project final report to acknowledge the project's success.

Project & Operations Management

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