8.1 Introduction

For purpose of planning and execution, a project is successively broken down into smaller manageable work elements called activities or tasks. Time-duration, resources and inputs are planned and assigned to individual activities for their execution. A schedule of activities is prepared based on time estimates and the precedence relationships between activities.

Once the project commences, review of project progress is done for the purpose of monitoring and control. Monitoring is collecting information concerning the progress of the project. Control involves using the data obtained through monitoring to bring actual performance into congruence with the plan (Meredith and Mantel, 1989). Some common factors affecting the amount of monitoring in a project are the cost of monitoring, total duration of the project, average time span of the tasks involved, the degree of completion of the project's groundwork, the urgency of the project, and exposure to delays due to unforeseen circumstances (Krupp, 1984). Yin [2010] has emphasized the need to recognize and rank the important factors affecting time and budget target. He has analyzed various methods of time and budget control and concluded that the managers should combine different control techniques to reach the success of a project.

Execution, monitoring and control processes are quite interlinked. Faniran et al. [1998] have observed that while much emphasis is given to development of plans for project implementation; hardly any emphasis is given to development of formalised plan for monitoring and controlling project progress. The control action may also lead to modification of plan. Caroline at el. [2009], have observed that project tasks are very often undertaken on the basis of extremely informal planning. They have stressed on structured decision-making process with regard to project management. This chapter presents a structured approach for execution, monitoring and control of project activities at operational level. The scope of this work is limited to operational aspects of task execution and does not include
8.2 Project Execution Process

The project work in any large or medium sized project is generally executed by a team. The team manager is assigned sizable amount of work to be done during a time duration ranging from three to six months. The work may pertain to single project or multiple projects. The work is successively broken down into smaller work elements called activities or tasks. Then a schedule of activities is prepared. The schedule is based on precedence relationship between activities and the estimates of their duration. The team manager assigns the work to different team members (officers/supervisors) and contractors. We may refer to them as activity agents. The team manager selects the activities that should be done during a period, usually week, fortnight or month. At the end of each period, he compares this to the schedule and plans everything that will be done during the following period. Since there are constraints of resources and managers' time, he generally gives greater attention and priority to critical activities over others.

The activity agents check the availability of resources/inputs and other pre-requisites. If it is found that necessary resources/inputs and other pre-requisites to execute some activities are not available (or not likely to be made available during the period), effort is made to sort out the issues so that these activities can be taken up for execution in the next period. In general, when a delay happens in a specific period, it becomes necessary to compensate in the planning for the following period. During the re-planning the work schedule of a period, the activities that are brought forward from previous period are given priority.

The activity agents are bound by some form of obligation or contract to complete the activities within specified time and cost. Agents need support for execution of activities. They need facilities and inputs to execute the activities. The activity-agents at a higher level are also responsible for the activities that are assigned to activity-agents at their lower level. So they also have the responsibilities to sort out any issue/problem that may arise during execution of activities. The process of project execution, monitoring and control is shown in figure 8.1. It involves three essential steps.

1. Identification of the critical activities so that more attention or priority may be
Model for Project Execution

given to these activities. This involves rating of activities on some characteristics to differentiate between critical and non-critical activities.

2. Pre-review to check if the conditions and pre-requisites required for executing an activity are fulfilled or can be fulfilled.

3. Execution of activities and review. This involves organization all inputs, doing the work, and solving problems that arise during execution.

![Diagram of project execution process]

Figure 8.1: The process of project execution, monitoring and control

The traditional CPM and PERT methods assume finish-to-start relationship between activities. But in practice, finish-to-start relationship between activities is not rigidly followed in most cases. There are other types of relationships as well, such as start-to-start, start-to-finish, and finish-to-finish. Sometimes due to unavailability of equipments, material or other problems, it becomes necessary to interrupt an activity and start another activity by deviating from the predetermined sequence. So in a real life project, the relationship among activities is sometimes quite fuzzy and complex. A number of software, information systems, and mathematical algorithms have been developed to match the complexities of project management. However gap still exists because many of the issues of project management are too difficult to be solved by mathematical programming. This is the reason why many project managers find structured approach as a hindrance rather than a useful aid.

In order to be useful, the structured approach should be:

- Simple and easy to follow
- Data on activities, issues, decisions and implementation results be properly
stored for decision making

- Decision making model should permit subjective and qualitative evaluation of data

Based on above guiding principles, a structured approach has been proposed in this chapter for execution of project activities at operational level.

8.3 Activity Classification and Prioritization

The activities are generally planned and scheduled on daily or weekly basis. Periodic progress reporting and use of earned value concept are useful project monitoring tools for senior managers. But monitoring is also necessary at operational level, for which large numbers of activities have to be monitored. Practically it is difficult to thoroughly monitor each and every activity. The managers need to pay greater attention to critical issues associated with critical activities.

The current CPM framework only distinguishes activities with respect to their time-criticality and represents sequencing rationale using precedence relationships. But sometimes due to contingency situations, the project managers change the sequence of project activities. So there can be other criteria of criticality. Marcia Filipa Lopes Catarino et al. [2009] used Delphi technique to identify the critical activities into several groups, ordered by their importance for the project success. Caroline et al. [2009] have presented a model for project management using multi-criteria decision aid method, with the aim of ranking activities which deserve special attention. Bonsang [2006] has presented an activity classification scheme based on how rigidly an activity is bound with other activities.

So the criticality of an activity is determined from its process characteristics. Some of the characteristics of activities are as follows.

i. Effect on other activities: To what extent the delay in execution of a work-element affects other activities

ii. Technology Content and Quality Requirement: To what extent technical expertise/supervision is needed for executing the activity; and to what extent the quality of execution of activity affects the quality of the project

iii. Requirement of Internal Coordination: To what extent different functional departments/sections are involved in execution of the project and to what extent coordination, conflict-resolution and teamwork is needed among them
iv. Coordination with External Agencies: To what extent coordination/liaison is required with government and other such external agencies.

The activities can be rated on each process characteristic. Then process criticality index of activity can be determined as under.

\[ PCI = p_1w_1 + p_2w_2 + p_3w_3 + p_4w_4 \]

Where \( p_1, p_2, p_3 \) and \( p_4 \) are rating of activity on different process characteristics and \( w_1, w_2, w_3 \) and \( w_4 \) are weights assigned to these characteristics.

The above list of characteristics is suggestive. Depending upon type of projects and project objectives some characteristics may be dropped or more characteristics can be included and suitable weights can be assigned accordingly.

8.4 Pre-Review for Activity Execution

Some amount of effort and preparatory work is needed for starting an activity. If an activity is rescheduled in the last minute, the effort used in preparatory work is wasted. This may result in considerable monetary loss and decrease in commitment of concerned project agent. Similarly stopping an activity mid-way causes delay and loss. The need for monitoring to check the availability of important inputs and resources before an activity is taken up for execution has been emphasized in previous chapter. In the same chapter a checklist has been presented for this purpose.

The status of preceding activities, availability of key materials, availability of key resource persons, and availability of key equipments/machines are some important parameters that should be evaluated to determine the level of readiness for executing an activity. Index to determine the level of readiness for executing an activity can be expressed as under.

\[ R = r_1w_1 + r_2w_2 + r_3w_3 + r_4w_4 \]

Where \( R \) is readiness index for executing an activity, \( r_1, r_2, r_3 \) and \( r_4 \) are rating of current resource availability on different parameters for executing an activity and \( w_1, w_2, w_3 \) and \( w_4 \) are corresponding weights assigned to these parameters.

So if resource readiness index for executing an activity is below a specified level, it
may be preferable to reschedule the work rather than stop the work midway.

8.5 Plan, Issues and Decisions

Plans are design too. Plan contains design. Both may be considered as synonyms. The project plan specifies the following.

- What is to be made? (Design)
- How it is to be made? (Process/ methodology)
- What will be needed? (Inputs)
- When will it be made? (Schedule)

A plan is feasible if design is technically OK, methodology is appropriate, all inputs of desired attributes are available or can be made available and time duration specified in the schedule is adequate.

Success of project execution depends on its plan. If a plan is really good, no problem should arise during its execution. But such ideal plans are generally non-existent. Even if a plan is an ideal one, the changes in the environment may still create problem in its execution. Actually problems do arise during execution of different tasks. The problems may be referred to as "issues" that need to be resolved for execution of tasks. Some common types of issues that arise during execution of tasks are given in table 8.1.

<table>
<thead>
<tr>
<th>Typical Issues during Task Execution</th>
<th>Typical Decisions on Issues</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design is not clear or appears to be defective.</td>
<td>Clarification or modification in design</td>
</tr>
<tr>
<td>Methodology is not clear or appears to be inappropriate.</td>
<td>Clarification or modification in methodology</td>
</tr>
<tr>
<td>Particular inputs required as per plan is not available</td>
<td>Use of substitute inputs</td>
</tr>
<tr>
<td>Cost is higher than estimation</td>
<td>Approve higher cost or make certain cost trade-off</td>
</tr>
<tr>
<td>Schedule not feasible</td>
<td>Reschedule</td>
</tr>
<tr>
<td>Primary agent is not available</td>
<td>Assign to alternate agent</td>
</tr>
</tbody>
</table>

Decisions on minor issues may be taken by the activity agents at their own level and thus these issues may not be reflected. But when an issue cannot be resolved
by the activity agent, it has be reflected and resolved by some other agent, who is generally higher to him in the organizational hierarchy. We may refer this agent as the "Decision Maker (DM)". An activity-agent at higher level may act as a decision-maker to issues raised at lower level. The DM may take decision by consulting his group members or some experts on the particular issues.

Managers’ role involves decision making to sort out issues that are encountered during execution of project plan as depicted in figure 8.2.

8.6 Decision Making for Activity Execution

Simon [1960] has proposed a well-known model for describing the decision making process. According to his model the decision making process consists of three phases as follows.

1. Intelligence Phase: Identification of situations requiring some decisions to be taken
2. Design Phase: Finding out the possible alternative decisions that can be taken in the given situation
3. Choice Phase: Selecting a decision or course of action from available alternatives

The Simon model is the fundamental model of decision-making process. However, there are two aspects that need to be addressed in decision-making an
organizational setup.

- Decision-making activities in different phases such as intelligence, design and choice are generally done at different managerial levels
- Decision-making is generally done as per certain formal procedures

Execution of project activities is carried forward through the decision making process. The managerial efficiency is derived from how fast the issues are identified and resolved through decision-making; and how fast the decisions are communicated and acted upon. The process of execution, monitoring and control are quite interlinked as depicted in figure 8.3.

Figure 8.3: Relationship between execution, monitoring and control

The activity agents raise requisitions to get necessary inputs such as resources, equipments, and material required for the activities. Next they direct the resources to get work done. But seldom, they get all the required inputs in time. The activity agents also face problem during task execution. Resolution of problems / issues involves three steps: (1) analyze issues to determine possible solutions, (2) select the best solution and make proposal to higher authority, (3) get approval from higher authority. The control actions are nothing but decisions that are taken either to resolve certain issues or to avail certain opportunities.

8.7 Structured Documentation

Structured approach requires keeping records of all activities and their up-to-date status, issues and decisions. The structure of sample data-file for activity detail is given in box 8.1.
Model for Project Execution

Box 8.1: Structure of sample data-file for activity detail

<table>
<thead>
<tr>
<th>I. Data-file: Activity_detail</th>
</tr>
</thead>
<tbody>
<tr>
<td>Activity ID. _____________  Work Package ID. _______________</td>
</tr>
<tr>
<td>Activity value: ____ ( A - High / B - Medium / C - Low )</td>
</tr>
<tr>
<td>Work content: _____ in Man hours</td>
</tr>
<tr>
<td>Duration: _____ in days</td>
</tr>
<tr>
<td>Activity Criticality Index: ____ ( A - High / B - Medium / C - Low )</td>
</tr>
</tbody>
</table>

Once an activity is scheduled and due for execution, it may be either under execution, or under hold for want of necessary pre-requisites, or under completion. Its status may be updated in activity_status data-file. The structure of sample data-file for activity status is given in box 8.2.

Box 8.2: Structure of sample data-file for activity status

<table>
<thead>
<tr>
<th>II. Data-file: Activity_status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Activity ID. _______________</td>
</tr>
<tr>
<td>Schedule start date: ________</td>
</tr>
<tr>
<td>Actual start date: ________</td>
</tr>
<tr>
<td>Activity Readiness Index at start: ____ ( A - High / B - Medium / C - Low )</td>
</tr>
<tr>
<td>Present status: ____ ( E - Under Execution / H - Under Hold / C - Completed )</td>
</tr>
</tbody>
</table>

The activities are executed by workmen. The managers' job is to identify issues and take decisions. Often the issues are resolved in informal manner. In a structured approach, it is desirable that the issues are listed serially so that the issues are not missed due to oversight. The issues may be initiated in a summary sheet form. A sample form for the purpose is given in box 8.3.
Project monitoring can be done by monitoring of issues. So the status of issues may be properly recorded and updated in issue_detail data-file. The structure of sample data-file for recording issue detail is given in box 8.4.

**Box 8.4: Structure of sample data-file for issue detail**

<table>
<thead>
<tr>
<th>III. Data-file: Issue_detail</th>
</tr>
</thead>
<tbody>
<tr>
<td>Issue Number: ________</td>
</tr>
<tr>
<td>Initiation date: ________</td>
</tr>
<tr>
<td>Importance: ______ (A - High / B - Medium / C - Low)</td>
</tr>
<tr>
<td>Present status: ______ (P - Under Proposal / D - Under Decision Approval)</td>
</tr>
</tbody>
</table>

By keeping records of activities and issues, the team manager will be able to generate information required for project execution at operational level, such as:

i. List of critical activities and their status

ii. List of live issues by type, importance, date and their status
The progress report in a structured manner will also help in better control. A sample report is given in box 8.5.

**Box 8.5: Sample form for activity progress report**

<table>
<thead>
<tr>
<th>Particulars</th>
<th>Number</th>
<th>Work content in man-hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Activities completed before start of period</td>
<td>______</td>
<td>______</td>
</tr>
<tr>
<td>Activities completed during the period</td>
<td>______</td>
<td>______</td>
</tr>
<tr>
<td><strong>Total:</strong></td>
<td>______</td>
<td>______</td>
</tr>
<tr>
<td>Activities under execution at end of period</td>
<td>______</td>
<td>______</td>
</tr>
<tr>
<td>Activities under hold at end of period</td>
<td>______</td>
<td>______</td>
</tr>
<tr>
<td>Activities due for execution in coming period</td>
<td>______</td>
<td>______</td>
</tr>
<tr>
<td><strong>Total:</strong></td>
<td>______</td>
<td>______</td>
</tr>
</tbody>
</table>

Similarly structured report on issues will also help in better control on resolution of issues. A sample report is given in box 8.6.

**Box 8.6: Sample form for report on resolution of issues**

<table>
<thead>
<tr>
<th>Particulars</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Issues resolved before start of period</td>
<td>______</td>
</tr>
<tr>
<td>Issues resolved during the period</td>
<td>______</td>
</tr>
<tr>
<td><strong>Total:</strong></td>
<td>______</td>
</tr>
<tr>
<td>Live issues at end of period</td>
<td>______</td>
</tr>
<tr>
<td>Issues for which proposals have been made</td>
<td>______</td>
</tr>
<tr>
<td>Issues that have been referred to external agency</td>
<td>______</td>
</tr>
<tr>
<td><strong>Total:</strong></td>
<td>______</td>
</tr>
</tbody>
</table>

Since quantitative data were not available for some parameters, qualitative assessment was used as a means for analysis.
8.8 Conclusion

Any real project is very complex. A number of software and information systems have been developed to match the complexities of project management. However, gap still exists because many of the issues of project management are too difficult to be solved by mathematical programming. Project activities are also much non-routine in nature as compared to production. This poses problems to devise a structured method and to work in a structured way.

Due to above reason, it is very difficult to objectively determine many aspects related to project activities. So it is proposed that subjective review by technical experts can be an effective tool in a project execution scenario to determine:

- Criticality index of each activity for selective monitoring and control
- Readiness index of each activity (extent to which prerequisites necessary to execute an activity have been fulfilled) to initiate execution

It is also proposed that problems (issues) encountered during execution be listed and sorted out in a structured manner. The structured approach should make use of knowledge and intuitive judgement of managers and should not impose rigid procedures. The structured approach should be simple and flexible so that it is not seen as a hindrance.