

Project Time Management in PMBOK for better Project Scheduling & Control

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Project time management includes the processes required to accomplish timely completion of the project; it involves 7 processes used in developing time schedule. The schedule can have any format. And the schedule has to be revisited many times at the execution and monitoring & control stages to see that the activities are performed on time as per the plan. In case of any change schedule control process has to be performed to bring back the activities on track or to minimize the delay. To understand this knowledge area readers are requested to read my previous articles also.

Plan Schedule Management

The first process in this knowledge area is Plan Schedule Management which comes in the planning process group. Through this process we are establishing the policies, procedures, and documentation for planning, developing, managing, executing, and controlling the project schedule. The key benefit is to provide guidance and direction on how the project schedule will be managed.

Plan Schedule Management: Inputs

1. Project Management Plan
 - Scope baselines (approved scope statement, WBS & WBS dictionary)
 - Other Information
2. Project Charter
3. Enterprise Environmental Factors
4. Organization Process Assets

Plan Schedule Management: T & T

1. Expert Judgment
2. Analytical Techniques
3. Meetings

Plan Schedule Management: Output

1. Schedule Management Plan, includes but not limited to:
 - Project Schedule Model Development
 - Level of accuracy (For example bottom up estimation will be more accurate than three point estimation)
 - Rules of Performance Management
 - Reporting Formats
 - Process Description

Define Activities

The second process in this knowledge area is to Define Activities which comes in planning process group. This is done to identify the specific actions to be performed to produce the project deliverables as activities provide a basis for estimating, scheduling, executing and monitoring and controlling the project work.

Define Activities: Inputs

1. Schedule Management Plan
2. Scope baselines
3. Enterprise Environmental Factors
4. Organizational Process Assets

Define Activities: T & T

1. Decomposition : Refer create WBS process in the Project Scope Management Knowledge area)
2. Rolling Wave Planning: Decompose the work until the requirements are clear, if requirements are not clear stop the decomposition at that level and again do the decomposition after all the requirements are available, this type of planning is called rolling wave planning.
3. Expert Judgment

Define Activities: Outputs

1. Activity List: A list of all the activities that will be performed on the project and a description of each activity
2. Activity Attributes; Detailed description of the activities mentioned in the activity list.
3. Milestone List: A milestone list contains a significant points or events in the project. It is a zero duration activity.

Sequence Activities

The third process in this knowledge area is to Sequence Activities which comes in planning process group. This is the process of identifying and documenting relationships among the project activities. Finding Lead or Lag time between activities should be considered to support a realistic schedule. This can be performed by software or manually.

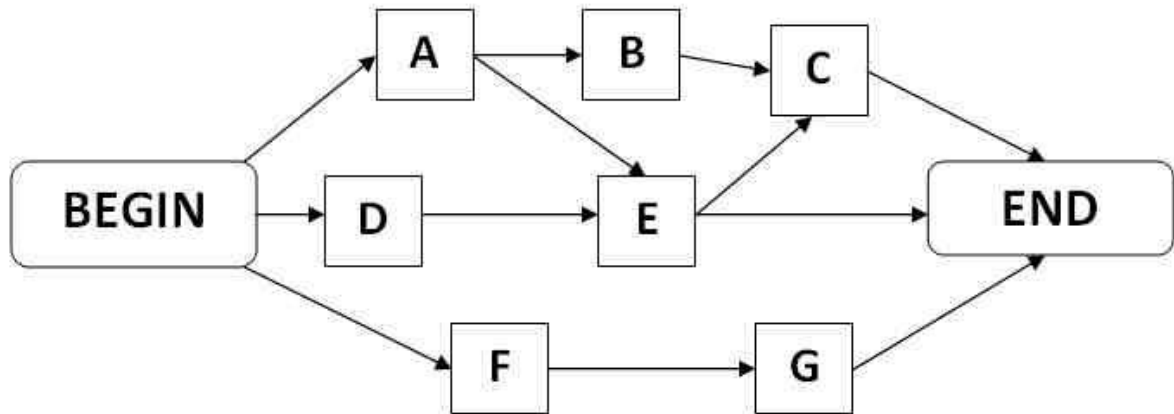
Sequence Activities: Inputs

1. Schedule Management Plan
2. Activity List
3. Activity Attributes
4. Milestone List
5. Project Scope Statement
6. Enterprise Environmental Factors
7. Organizational Process Assets

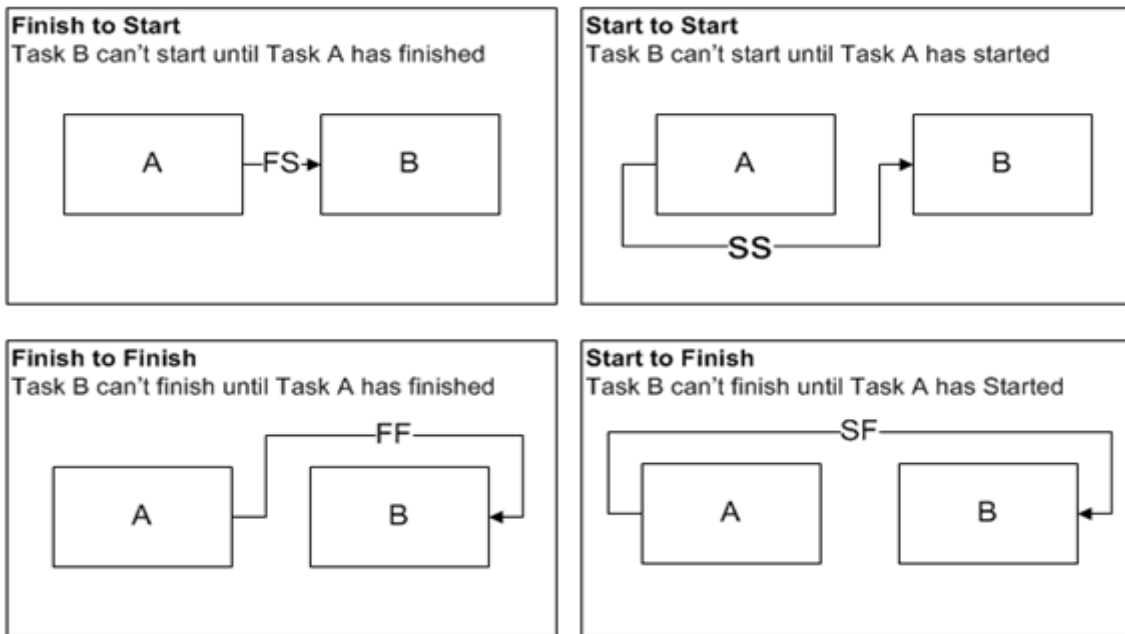
Precedence Diagramming is the most common method of arranging the project activities visually.

Activity on arrows is another method of diagramming to arrange project activities called activity on arrows, and here activities are marked in the arrows than on nodes.

However the common practice is precedence diagramming, that is to arrange project activities in boxes, called nodes, and connected with arrows (**Activity on Node**) as shown in the figure below:-



Task dependencies



- Finish to Start: Foundation work has to be finished to start constructing the frame
- Start to Start: Pouring Concrete has to start to start leveling concrete
- Finish to Finish: Writing of document has to finish for finishing the Editing of document.
- Start to Finish: The duty of a security guard in the second shift can start only after finishing the duty of the guard in the first shift.

Sequence Activities: T & T

1 Dependency Determination

- Mandatory Dependency (hard logic). Foundation work has to be finished to construct the frame is an example for Hard logic

- Discretionary dependency: preferred logic, preferential logic, or soft logic. Project team can decide what to do first or do something in parallel etc., is an example for soft logic.
- External dependencies: After the quality control check, scope validation has to be done by the customer depending upon their convenience, that is an external dependency.
- Internal dependencies: Quality Control check has to be done by the internal quality department is an internal dependency.

2 Applying Leads and Lags

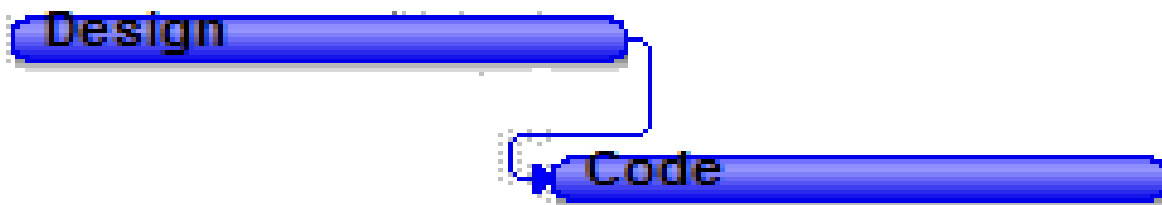


Figure 1 Applying Lead

Figure above shows the lead time taken for the coding activity as the coding activity started before finishing the design activity so there is a lead or gain in the total project duration.

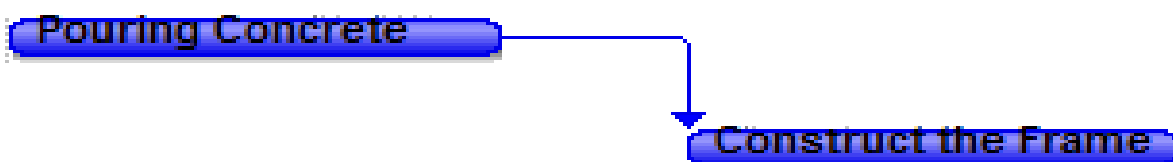


Figure 2 Applying Lag

Figure above shows the lag time as the poured concrete has to be cured to start the construction of the frame, there is a loss or lag in the total project duration due to this curing time.

Sequence Activities: Outputs

1. Project-Schedule-Network-Diagrams (as shown in the precedence diagramming method.)
2. Project Document Updates

Estimate Activity Resources

The fourth process in this knowledge area is to Estimate Activity Resources, this comes under planning process group. This is done to Estimate the type and quantities of materials, human resources and equipment required to perform each activity.

Estimate Activity Resources: Inputs

1. Schedule Management Plan
2. Activity List
3. Activity Attributes
4. Resource Calendars: The availability of resource can be identified from the resource calendar.
5. Risk Register: Output of risk identification process from the project risk management knowledge area.
6. Activity Cost Estimates (There are 3 types of estimation in PMBOK Activity Resource Estimation, Activity Duration Estimation and Activity Cost Estimation these activities are done almost parallel in reality)
7. Enterprise Environmental Factors
8. Organizational Process Assets

Estimate Activity Resources: T & T

1. Expert Judgment
2. Alternatives Analysis
3. Published Estimating Data (Resource Rates can be obtained from the publication by the government departments)
4. Bottom-up Estimation (Estimate from Activity level to work package level and to control of accounts level and to determine total project cost.
5. Project Management Software

Estimate Activity Resources: Outputs

1. Activity Resource Requirements

2. Resource Breakdown Structure (Work package level resource break down structure can be created for better decision making)
3. Project Document Updates

Estimate Activity Duration

This is the fifth process in this knowledge area that is Estimate Activity Duration which is in planning process group. This process of approximating the number of work periods needed to complete individual activities with estimated resources.

Estimate Activity Duration: Inputs

1. Schedule Management Plan
2. Activity List.
3. Activity Attributes
4. Activity Resource Requirements
5. Scope Statement
6. Risk Register
7. Resource Breakdown Structure Enterprise Environmental Factors
8. Organization Process Assets
9. Resource Calendar

Estimate Activity Duration: T & T

1. Expert Judgment
2. Analogous Estimating (Top-down) - Use actual values of a similar previous project
3. Parametric Estimating (Algorithm using statistical relationship with historical data)
4. Group Decision making techniques (Can be done in a group)
5. Reserve Analysis (Contingencies for known risk and management reserve for unknown risk)
6. Three-point Estimate
 - Triangular Distribution $T_e = (T_o + T_m + T_p) / 3$

- Beta Distribution (PERT) $T_e = (T_o + 4T_m + T_p) / 6$
(Where T_e = Total estimate, T_o = Total optimistic, T_m = Total most likely and T_p = Total Pessimistic)

Estimate Activity Duration: Outputs

1. Activity Duration Estimates: Quantitative estimates of the likely duration of each activity as well as the range of possible results (10 ± 2 day) based on the estimation techniques adopted.
2. Project Document Updates

Develop Schedule

The sixth process in this knowledge area is to Develop Schedule which is in planning process group; this is the process of analyzing activity sequence, durations, resource requirements, & schedule constraints to create a project schedule. Developing an acceptable schedule is often an iterative process.

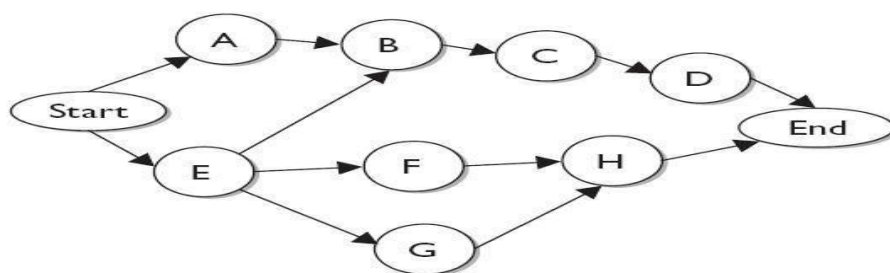
Develop Schedule: Inputs

1. Schedule Management Plan
2. Activity List
3. Activity Attributes
4. Project Schedule Network Diagrams
5. Activity Resource Requirements
6. Resource Calendars
7. Activity Duration Estimates
8. Project Scope Statement
9. Risk Register
10. Project Staff Assignment
11. Resource Breakdown Structure
12. Enterprise Environmental Factors
13. Organizational Process Assets

Develop Schedule: T & T

1. Schedule Network Analysis - Network can be analyzed and critical path found, for time management of the project.
2. Critical Path Method (Described below in detail)
3. Critical Chain Method (is similar to Critical Path, but adding buffers for risk management; use YouTube to learn more in detail)
4. Resource Optimization Techniques
 - Like Resource Leveling to manage resource timings
5. Modeling Techniques
 - What-if scenario analysis to make schedule models
6. Leads and Lags (discussed above)
7. Schedule Compression (explained below in the topic duration compression)
 - Crashing
 - Fast tracking
8. Scheduling Tools

Critical Path



Critical path is the longest duration path through a network diagram which represents the shortest time to complete the project.

To find the critical path from the above diagram let us say that activity A has 2 days duration, B has 3 days, C has 2 days, D has 5 days, E has 3 days, F has 5 days, G has 3 days and H has 4 days duration. (Readers are requested to draw the above diagram in a plain paper and mark the duration on the figure).

First we have to do the forward pass to determine the early start, early finish and project duration and second the backward pass in this we will get late start, late finish and total slack

of each activity. Now let us do the **forward pass**. (Now readers can mark the following forward pass on the top of the nodes (early start on the left top and the early finish on the right top) and in the backward pass mark the figures in the bottom of each node (late finish on the right bottom late start on the left bottom))

Early start of activity A =1, Early finish of activity A is Early start+Duration-1 that is $(1+2-1) =2$
Early Start of activity B=4 (because A is finished in 2 days & E is finishing in 3 days, since there is a path convergence, we will take the greatest value in the forward pass), Early Finish of activity B is $(4+3-1) =6$

Similarly Early start of activity C=7, Early Finish of Activity C is $(7+2-1) =8$
Early Start of D=9, Early Finish of Activity D is $(9+5-1) =13$
Early Start of E=1, Early Finish of Activity E is $(1+3-1) =3$, Early finish of activity E is $(3+3-1)=5$
Early Start of F=6, Early Finish of F is $(6+5-1) =10$
Early Start of H=11, Early Finish of H is $(11+4-1) =14$
Early Start of G is 4 (as activity E has 3 days to complete), Early Finish of G is $(4+3-1) =6$

Therefore the longest path is **E—F—H** of duration 14 days

Now we have to do the **backward pass** as follows:

Late finish of activity D is 14 days, Late start of activity D is (late finish-duration+1) that is $(14-5+1) =10$
Late finish of activity C is 9 and late start of activity C is $(9-2+1) =8$
Late finish of activity B is 7 and late start of activity B is $(7-3+1) =5$
Late Finish of activity A is 4 days Late start of activity A is $(4-2+1) =3$
Late finish of activity H is 14 days, late start of activity H is $(14-4+1) =11$
Late finish of activity F is 10 days, late start of activity F is $(10-5+1) =6$
Late Finish of activity E is 5 days, late start of activity E is $(5-3+1) =3$
Late finish of activity G is 10 days, late start of activity G is $(10-3+1) =8$

Late finish minus early finish will give the slack of each activity (do it on the figure you have drawn with the marked figures for better understanding)

Slack of A=4-2=2, B= 7-6=1, C=9-8=1, D=14-13=1, **E=5-5=0**, **F=10-10=0**, G=10-6=4, **H=14-14=0**

The critical path is the least flexible path which gives slack time as zeros; therefore the critical path is **E---F---H with duration of 14 days**; that means it is the duty of the project manager to see that the correct resources are available to these activities at the right time. Any missing on that will cause the project delay. The employees working on the activity E, F & H should be given leave only after ensuring the suitable substitution.

Float

Total float (Slack): the amount of time an activity can be delayed without delaying the project end date or/and intermediary milestone. In the above case activity A has 2 days, B has 1 day and so on.

Free Float (Slack): the amount of time an activity can be delayed without delaying the start of its successor. In the above case Activity A can start 1 day after starting E, Also there is a 4days free float between activity B and G on activity F and so on.

Project Float: the amount of time a project can be delayed without delaying the externally imposed project completion date.

Duration Compression: Duration compression is a special case of mathematical analysis to shorten the project schedule without changing the project scope

- Crashing: cost & schedule tradeoffs are analyzed to determine how to obtain the greatest amount of compression for the least incremental cost by adding more resources to activities, this usually increases the cost.
- Fast-tracking: doing activities in parallel that would normally be done in sequence. Fast tracking often results in rework and usually increases risk.

Develop Schedule: Outputs

1. Schedule Baseline
2. Project Schedule
 - Milestone Charts
 - Bar Charts
 - Schedule Network Diagrams
3. Schedule Data
4. Project Calendar
5. Project Management Plan Updates
6. Project Document Updates

Control Schedule

The seventh process in this knowledge area is the Control Schedule, which is coming under monitoring and control process group. This is the process of monitoring the status of the

project to update project progress and manage changes to schedule baseline. This is also concerned with:

- Determine current status of the project activities
- Influence the factors that cause changes or delay
- Manage actual changes as they occur to reduce the risk

Control Schedule: Inputs

1. Project Management Plan
2. Project Schedule
3. Work Performance Data
4. Project Calendars
5. Schedule Data
6. Organizational Process Assets

Control Schedule: T & T

1. Performance Reviews
 - a. Trend Analysis
 - b. Critical Path Method
 - c. Critical Chain Method
 - d. Earned Value Management
2. Project Management Software
3. Resource Optimization Techniques
4. Modelling Techniques
5. Leads and Lags
6. Schedule compression
7. Scheduling Tool

Control Schedule: Outputs

1. Work Performance Information
2. Schedule Forecasts
3. Change Requests
4. Project Management Plan Update

- Schedule baseline
 - Schedule Management Plan
 - Cost baseline
5. Project Document Updates
 6. Organizational Process Assets Updates

The knowledge of this section will help the project manager to keep the activities on track on time and he can concentrate on moving resources to critical path to avoid project delay and he can constantly monitor the changes in the schedule and remedial action can be taken to avoid or reduce the risk of project delay until the project is successfully completed.

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