Seminar In Project Management

Course Code - 707

Network Diagramming Techniques

Lecture # 26
Summary of Previous Lecture

In previous Lecture, we have discussed about

- Earned Value Management
- EVM & WBS
- OBS & WBS
- PMB
- EV, PV, AC
- EVM Class Example
The Work Breakdown Structure is the process of decomposition of project in phases, then control accounts and then to work packages.
Work Breakdown Structure: Example 1

1. Construction of House
   - 285 days
   - 35%
   - 8/1/11 8/31/12

1.1 Land Acquisition & Design
   - 25 days
   - 100%
   - 8/1/11 9/2/11

1.1.1 Land Acquisition
   - 10 days
   - 100%
   - 8/1/11 8/12/11

1.1.2 Design & Approvals
   - 25 days
   - 100%
   - 8/1/11 9/2/11

1.1.3 Connections
   - 10 days
   - 100%
   - 8/15/11 9/26/11

1.1.4 Site camp
   - 5 days
   - 100%
   - 8/15/11 9/2/11

1.2 Civil Works
   - 230 days
   - 35%
   - 8/5/11 7/20/12

1.2.1 Excavation
   - 6 days
   - 100%
   - 8/5/11 9/9/11

1.2.2 Foundations
   - 40 days
   - 100%
   - 9/12/11 11/4/11

1.2.3 DPC
   - 5 days
   - 100%
   - 11/7/11 11/11/11

1.2.4 Brick work
   - 70 days
   - 36%
   - 1/16/12 4/20/12

1.2.5 Lintels
   - 7 days
   - 0%
   - 4/23/12 5/11/12

1.2.6 Roofing
   - 15 days
   - 0%
   - 4/23/12 5/11/12

1.2.7 Doors & Windows
   - 5 days
   - 0%
   - 5/2/12 5/6/12

1.2.8 Flooring
   - 20 days
   - 0%
   - 5/9/12 6/5/12

1.2.9 Plastering
   - 30 days
   - 0%
   - 8/11/12 7/20/12

1.3 Electric Works
   - 17 days
   - 0%
   - 4/23/12 5/15/12

1.3.1 Ducting
   - 2 days
   - 0%
   - 4/23/12 4/24/12

1.3.2 Layout of Cables
   - 7 days
   - 0%
   - 4/23/12 5/12/12

1.3.3 Connections
   - 3 days
   - 0%
   - 5/4/12 5/5/12

1.3.4 Panels & Fixtures
   - 5 days
   - 0%
   - 5/9/12 5/15/12

1.4 Plumbing Works
   - 35 days
   - 0%
   - 4/23/12 6/8/12

1.4.1 Ducting
   - 7 days
   - 0%
   - 4/23/12 5/12/12

1.4.2 Piping
   - 10 days
   - 0%
   - 5/2/12 5/5/12

1.4.3 Connections
   - 3 days
   - 0%
   - 5/16/12 5/18/12

1.4.4 Fixtures
   - 15 days
   - 0%
   - 5/21/12 6/8/12

1.5 Finish Works
   - 60 days
   - 0%
   - 6/11/12 8/31/12

1.5.1 Woodworks
   - 30 days
   - 0%
   - 6/11/12 7/20/12

1.5.2 Paints
   - 10 days
   - 0%
   - 7/23/12 8/3/12

1.5.3 Finishes
   - 20 days
   - 0%
   - 8/6/12 8/31/12
Project Time Management Processes

✓ Plan Schedule Management: Plan Schedule Management is the process of establishing the policies, procedures, and documentation for planning, developing, managing, executing, and controlling the project schedule.

✓ Define Activities: The process of identifying and documenting the specific actions to be performed to produce the project deliverables.

✓ Sequence Activities: The process of identifying and documenting relationships among the project activities.

✓ Estimate Activity Resources: The process of estimating the type and quantities of material, human resources, equipment, or supplies required to perform each activity.
Project Time Management Processes

✔ **Estimate Activity durations:** The process of estimating the number of work periods needed to complete individual activities with estimated resources.

✔ **Develop Schedule:** The process of analyzing activity sequences, durations, resource requirements, and schedule constraints to create the project schedule model.

✔ **Control Schedule:** The process of monitoring the status of project activities to update project progress and manage changes to the schedule baseline to achieve the plan.
Define Activity

✓ An **activity** or **task** is an element of work normally found on the WBS that has an expected duration, a cost, and resource requirements.

✓ A Project is divided into set of manageable activities
Sequence Activities

✓ Involves reviewing activities and determining dependencies.

✓ A dependency or relationship relates to the sequencing of project activities or tasks.

✓ You *must* determine dependencies in order to use critical path analysis.
Dependencies Types

PDM includes four types of dependencies or logical relationships:

✓ **Finish-to-start (FS).** The initiation of the successor activity depends upon the completion of the predecessor activity.

✓ **Finish-to-finish (FF).** The completion of the successor activity depends upon the completion of the predecessor activity.

✓ **Start-to-start (SS).** The initiation of the successor activity depends upon the initiation of the predecessor activity.

✓ **Start-to-finish (SF).** The completion of the successor activity depends upon the initiation of the predecessor activity.
Task / Activity Dependency Types

### Task dependencies

The nature of the dependencies between linked tasks. You link tasks by defining a dependency between their finish and start dates. For example, the "Contact caterers" task must finish before the start of the "Determine menus" task. There are four kinds of task dependencies in Microsoft Project:

<table>
<thead>
<tr>
<th>Task dependency</th>
<th>Example</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Finish-to-start (FS)</td>
<td><img src="https://via.placeholder.com/150" alt="Diagram" /></td>
<td>Task (B) cannot start until task (A) finishes.</td>
</tr>
<tr>
<td>Start-to-start (SS)</td>
<td><img src="https://via.placeholder.com/150" alt="Diagram" /></td>
<td>Task (B) cannot start until task (A) starts.</td>
</tr>
<tr>
<td>Finish-to-finish (FF)</td>
<td><img src="https://via.placeholder.com/150" alt="Diagram" /></td>
<td>Task (B) cannot finish until task (A) finishes.</td>
</tr>
<tr>
<td>Start-to-finish (SF)</td>
<td><img src="https://via.placeholder.com/150" alt="Diagram" /></td>
<td>Task (B) cannot finish until task (A) starts.</td>
</tr>
</tbody>
</table>
Determination of Dependency

Dependencies may be characterized by the following attributes:

- mandatory or discretionary,
- internal or external,

Dependency has four attributes, but two can be applicable at the same time in following ways:

- mandatory external dependencies,
- mandatory internal dependencies,
- discretionary external dependencies, or
- discretionary internal dependencies
Mandatory Dependencies

- Mandatory dependencies are those that are legally or contractually required or inherent in the nature of the work.

- Mandatory dependencies often involve physical limitations, such as on a construction project, where it is impossible to erect the superstructure until after the foundation has been built, or on an electronics project, where a prototype has to be built before it can be tested.

- Mandatory dependencies are also sometimes referred to as hard logic or hard dependencies.

- Mandatory dependencies should not be confused with assigning schedule constraints in the scheduling tool.
Discretionary Dependencies

- Discretionary dependencies are sometimes referred to as preferred logic, preferential logic, or soft logic.

- Discretionary dependencies are established based on knowledge of best practices within a particular application area or some unusual aspect of the project where a specific sequence is desired, even though there may be other acceptable sequences.

- The project team determines which dependencies are discretionary during the process of sequencing the activities.
External Dependencies

- External dependencies involve a relationship between project activities and non-project activities. These dependencies are usually outside the project team’s control.

- For example, the testing activity in a software project may be dependent on the delivery of hardware from an external source.
Internal Dependencies

- Internal dependencies involve a precedence relationship between project activities and are generally inside the project team’s control.

- For example, if the team cannot test a machine until they assemble it, this is an internal mandatory dependency.
Network Diagrams

✓ Network diagrams are the preferred technique for showing activity sequencing.

✓ A network diagram is a schematic display of the logical relationships among, or sequencing of, project activities.

✓ Two main formats are the arrow and precedence diagramming methods.
Project Network Diagram Example (Graphical Depiction of the Network Components)

- **A**: Approval of Application
- **B**: Construction Plans
- **C**: Traffic Study
- **D**: Service Availability Check
- **E**: Staff Report
- **F**: Commission Approval
- **G**: Wait for Construction
- **H**: Occupancy

The Basic Network Structure
Sample Activity-on-Arrow (AOA) Network Diagram for Project X

Note: Assume all durations are in days; A=1 means Activity A has a duration of 1 day.
Arrow Diagramming Method (ADM)

✓ Also called activity-on-arrow (AOA) network diagram.

✓ Activities are represented by arrows.

✓ Nodes or circles are the starting and ending points of activities.

✓ Can only show finish-to-start dependencies.
Process for Creating AOA Diagrams

1. Find all of the activities that start at node 1. Draw their finish nodes and draw arrows between node 1 and those finish nodes. Put the activity letter or name and duration estimate on the associated arrow.

2. Continuing drawing the network diagram, working from left to right. Look for bursts and merges. A burst occurs when a single node is followed by two or more activities. A merge occurs when two or more nodes precede a single node.

3. Continue drawing the project network diagram until all activities that have dependencies are included in the diagram.

4. As a rule of thumb, all arrowheads should face toward the right, and no arrows should cross in an AOA network diagram.
Activity: An activity represents an action and consumption of resources (time, money, energy etc) required to complete a portion of a project. Activity is represented by an arrow.

Event: An event (or node) will always occur at the beginning and end of an activity. The event has no resources and is represented by a circle. The ith event and jth event are the tail event and head event respectively.
Process for Creating AOA Diagrams

**Merge and Burst Events**

One or more activities can start and end simultaneously at an event.

![Merge and Burst Events Diagram](image)

**Preceding and Succeeding Activities**

Activities performed before given events are known as *preceding activities*, and activities performed after a given event are known as *succeeding activities*.

![AOA Diagram](image)

Activities A and B precede activities C and D respectively.
**Dummy Activity**

- An imaginary activity which does not consume any resource and time is called a *dummy activity*.
- *Dummy activities are simply used to represent a connection between events in* order to maintain a logic in the network.
- It is represented by a dotted line in a network.

![Dummy Activity Diagram](image)
a. Two activities starting from a tail event must not have a same end event. To ensure this, it is absolutely necessary to introduce a dummy activity.

b. Looping error should not be formed in a network, as it represents performance of activities repeatedly in a cyclic manner.

c. In a network, there should be only one start event and one ending event.

d. The direction of arrows should flow from left to right avoiding mixing of direction.
Some conventions of network diagram

Activity B can be performed only after completing activity A, and activity C can be performed only after completing activity B.

Activities B and C can start simultaneously only after completing A.

Activities A and B must be completed before start of activity C.

Activity C must start only after completing activities A and B. But activity D can start after completion of activity B.
Example

Construct a network for a project whose activities and their predecessor relationship are given in Table.

<table>
<thead>
<tr>
<th>Activity</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>I</th>
<th>J</th>
<th>K</th>
</tr>
</thead>
<tbody>
<tr>
<td>Predecessor</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>A</td>
<td>B</td>
<td>B</td>
<td>C</td>
<td>D</td>
<td>E</td>
<td>H, I</td>
<td>F, G</td>
</tr>
</tbody>
</table>
Solution: The network diagram for the given problem is shown as follow
Example

Draw a network diagram for a project given in Table

<table>
<thead>
<tr>
<th>Activity</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>I</th>
<th>J</th>
<th>K</th>
<th>L</th>
</tr>
</thead>
<tbody>
<tr>
<td>Immediate Predecessor</td>
<td>-</td>
<td>A</td>
<td>B</td>
<td>A</td>
<td>D</td>
<td>C, E</td>
<td>D</td>
<td>D</td>
<td>H</td>
<td>H</td>
<td>F, H</td>
<td>G, J</td>
</tr>
</tbody>
</table>
Example

An activity network diagram describing the project is shown as below
<table>
<thead>
<tr>
<th>Name of the activity</th>
<th>Starting and finishing event</th>
<th>Description of activity</th>
<th>Predecessor</th>
<th>Time duration (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>(1,2)</td>
<td>Prepare the house plan</td>
<td>--</td>
<td>4</td>
</tr>
<tr>
<td>B</td>
<td>(2,3)</td>
<td>Construct the house</td>
<td>A</td>
<td>58</td>
</tr>
<tr>
<td>C</td>
<td>(3,4)</td>
<td>Fix the door / windows</td>
<td>B</td>
<td>2</td>
</tr>
<tr>
<td>D</td>
<td>(3,5)</td>
<td>Wiring the house</td>
<td>B</td>
<td>2</td>
</tr>
<tr>
<td>E</td>
<td>(4,6)</td>
<td>Paint the house</td>
<td>C</td>
<td>1</td>
</tr>
<tr>
<td>F</td>
<td>(5,6)</td>
<td>Polish the doors / windows</td>
<td>D</td>
<td>1</td>
</tr>
</tbody>
</table>
Solution:

1. Prepare the house plan (4 days)
2. Construct the house (58 days)
3. Fix the doors (2 days)
4. Paint the house (1 day)
5. Polish the doors (1 day)
6. Wiring the house (2 days)
Precedence Diagramming Method (PDM)

- Activities are represented by boxes.
- Arrows show relationships between activities.
- More popular than ADM method and used by project management software.
- Better at showing different types of dependencies.
Example
<table>
<thead>
<tr>
<th>Activity</th>
<th>Description</th>
<th>Immediate Predecessor</th>
<th>Time (weeks)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Survey building site</td>
<td>--</td>
<td>6</td>
</tr>
<tr>
<td>B</td>
<td>Develop initial design</td>
<td>--</td>
<td>8</td>
</tr>
<tr>
<td>C</td>
<td>Obtain board approval</td>
<td>A, B</td>
<td>12</td>
</tr>
<tr>
<td>D</td>
<td>Select architect</td>
<td>C</td>
<td>4</td>
</tr>
<tr>
<td>E</td>
<td>Establish budget</td>
<td>C</td>
<td>6</td>
</tr>
<tr>
<td>F</td>
<td>Finalize design</td>
<td>D, E</td>
<td>15</td>
</tr>
<tr>
<td>G</td>
<td>Obtain financing</td>
<td>E</td>
<td>12</td>
</tr>
<tr>
<td>H</td>
<td>Hire contractor</td>
<td>F, G</td>
<td>8</td>
</tr>
</tbody>
</table>
Example

Construct a precedence network based on the same activity descriptions below.

- Activities H, R2, T1 start the project.
- Activity T2 can start when Activities H, E1 and S are completed.
- Activity E1 also depends on Activity R2.
- Activity X follows Activity H and precedes Activity L.
- Activity E is preceded by Activities T2 and P1.
- The predecessors to Activity G are Activities L, T2 and P1.
- The successors to Activity T1 are Activities E1, S, W and D2.
- Activity P1 cannot begin until Activity W is finished.
- Activity P2 and F follow Activities W and D2, and precede Activities E and R1.
- Activity O2 depends on T2 and P1, and precedes Activity L.
Example: Solution
Summary of This Lecture

In this Lecture, we have discussed about

- WBS
- Project time management processes
- Dependency Types
- Network Diagrams
- AOA Diagram
- AON Diagram
THANK YOU!