- CPM and PERT

Critical Path Method (CPM)

A strategy for surveying plan adaptability and distinguishing undertakings fundamental for project culmination is the critical path method (CPM). In the project, the executives, the basic way is the longest succession of undertakings that should be done on time for the task to be done. If crucial tasks are postponed, the project will also be delayed.

CPM Key Elements

The elements of CPM in project management are as follows:

Earliest Start Time (ES)

The initial stage in the project is when an activity can be begun. You cannot make this decision without initially understanding whether you have any task dependencies.

Latest Start Time (LS)

The very last second when a task can be started without affecting the timeline for your project.

Earliest Finish Time (EF)

The earliest a task can be finished is determined by its duration and earliest start time.

Latest Finish Time (LF)

The latest that a task can be finished is calculated using its duration and latest start time.

Float

The concept of "float" refers to how long an activity can be postponed without affecting its task order or the project timeline. The critical path tasks have no float since they cannot be delayed.

CPM can advise sage on setting priorities, distributing resources, and scheduling projects.

There are various reasons to use this method, including the ones listed below:

Improves Future Planning

Improves future planning by utilizing CPM to compare expectations with actual progress. Future undertaking thoughts can be affected by the information accumulated from progressing projects.

Facilitates More Effective Resource Management

It lets project managers prioritize tasks, giving them a better understanding of how and where to deploy resources.

Helps Avoid Bottlenecks

Project bottlenecks can cost precious time. By outlining project dependencies using a network diagram, you can more accurately decide which tasks can and cannot be finished in parallel. After that, you can adjust your schedule accordingly.

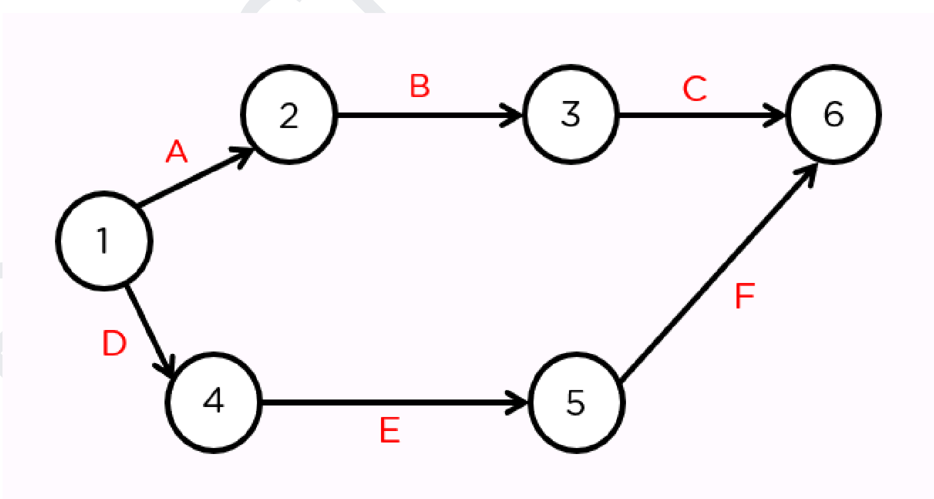
With the help of CPM, we'll be able to create a model that enables you to determine the following:

Tasks required to complete the project

Dependencies between tasks

The duration required to complete an activity

Now, before we can get started with CPM or Critical Path Method, we'll have to understand two major concepts which are Events and Activities. To help understand them better, let's have a look at the network diagram (which is also the output) of the process.



This output represents some of the most important parts of the process: Events and Activities.

Event

Events are represented by a circle and will occur at the start and end of an activity. Event 1 is the tail event and Event 2 is the head event. In the case of our example, the events are 1, 2,3,4, 5, and 6. Taking into consideration, nodes 1 and 2, and the connection between them, 1 will be referred to as the tail event, and 2 will be referred to as the head event.

Similarly, for 2 and 3, 2 is the tail event, and 3 is the head event.

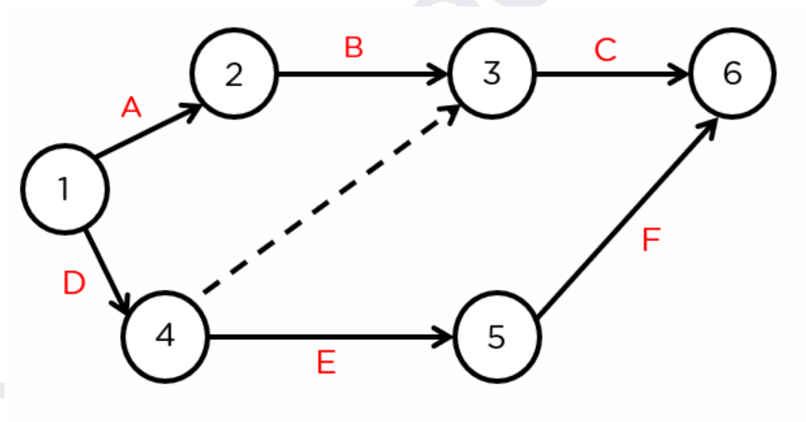
Activity

Activities represent action and consumption of resources like time, money, and energy required to complete the project. In the case of our example, A, B, C, D, E, and F represent the activities taking place between their respective events.

Dummy Activity

A dummy activity represents a relationship between two events. In the case of the example below us, the dotted line represents a relationship between nodes 4 and 3.

The activity between these nodes will not have any value.



Other rules to consider

The network should have a unique starting and ending node. In the case of our example, event 1 represents a unique starting point and 6 represents the unique completion node

No activity can be represented by more than a single arc (the line with an arrow connecting the events) in the network

No two activities can have the same starting and ending node.

Now, let's talk about the process of the Critical Path Method with an example.

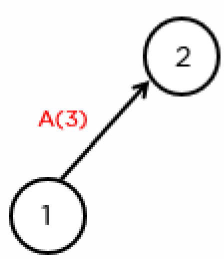
The Critical Path Method

The objective of the question below is to determine the critical path, based on the information available, like activity, immediate predecessor, and duration (which in this case, we'll take as months)

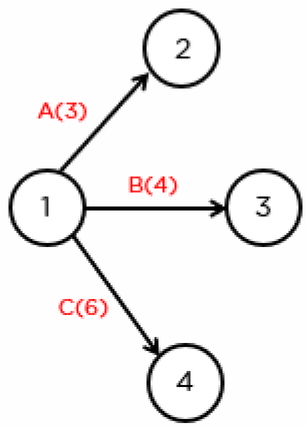
Activity	Immediate Predecessor	Duration (Mon)
A	-	3
B	-	4
C	-	6
D	B	3
E	A	9
F	A	1
G	B	4
H	C, D	5
I	C, D	4
J	E	3
K	F, G, H	6
L	F, G, H	3
M	I	6
N	J, K	9

First, let's analyze the activities and their immediate predecessors.

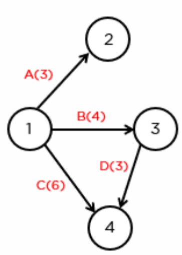
Activities A, B, and C don't have any immediate predecessors. This means that each of them will have individual arcs connecting to them. First, we'll draw nodes 1 (which is the starting point) and 2. We'll add the activity on the arc, along with the duration.



We'll have to also keep in mind that A acts as the immediate predecessor for both nodes E and F. Similarly, let's draw the arcs for nodes B and C.

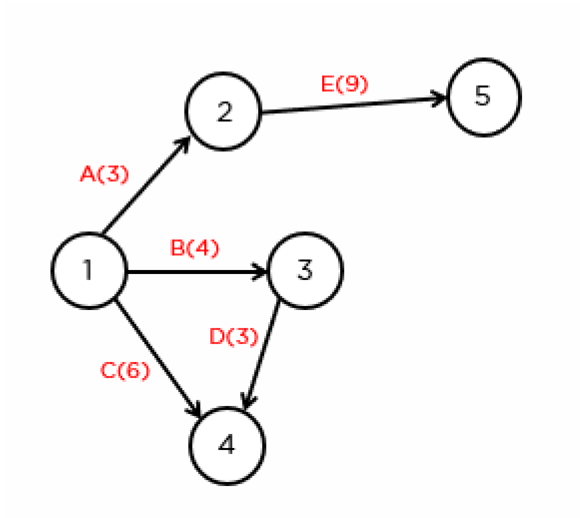


Before we can draw the nodes for activity D, a quick look at the table will tell us that it is preceded by activity B and that a combination of activities C and D act as immediate predecessors for activities H and J. This means that both activities C and D have to connect at some point. That's why we'll be drawing an arc from events 3 and 4.

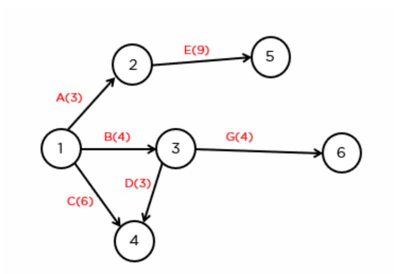


So now, we've completed activities A, B, C, and D of the critical path method. Next, let's take a look at activity E.

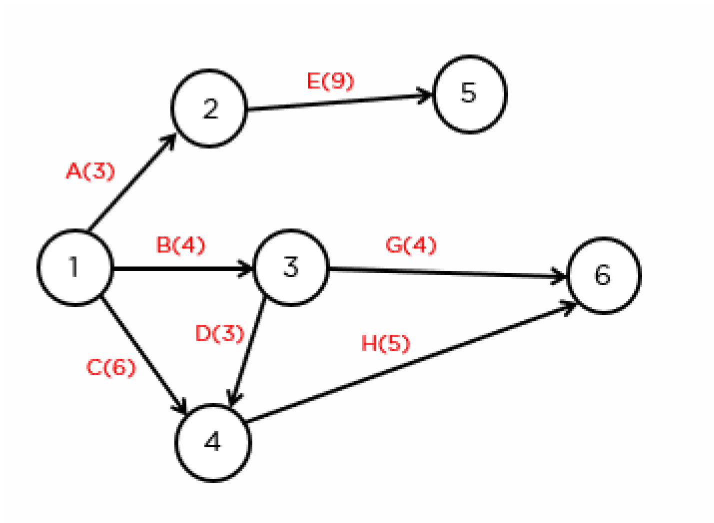
Activity E is preceded by activity A and acts as the immediate predecessor for activity J. Since this is an independent activity, we'll be able to draw an arc like this.



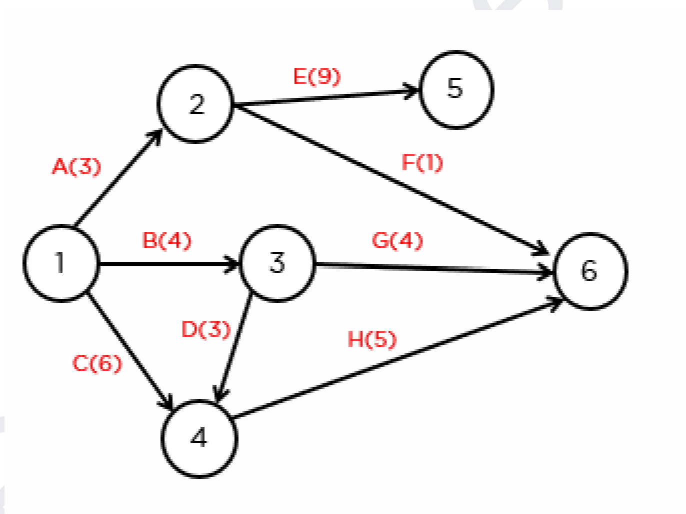
If we have a look at activity F, it's preceded by activity A, and a combination of F, G, and H act as immediate predecessors for the activities K and L. So let's wait before we take it up. Instead, let's shift our attention to activity G. It's preceded by B. So, we'll draw it like so.



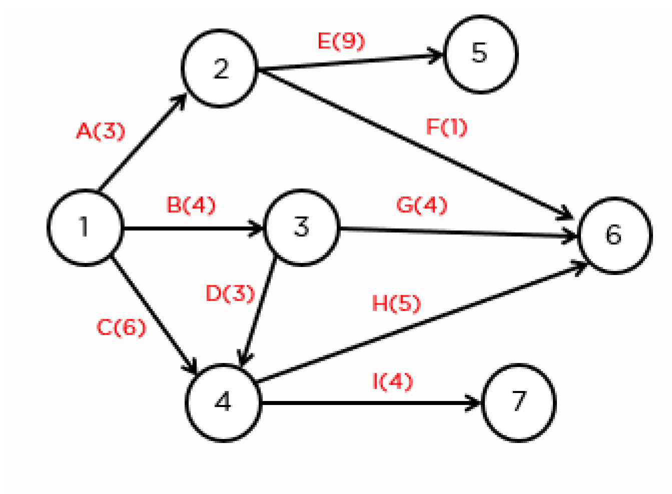
Now, let's take a look at activity H. It is preceded by both C and D and will act as the immediate predecessor for K and L, along with F and G. So, we can connect node 4 to 6.



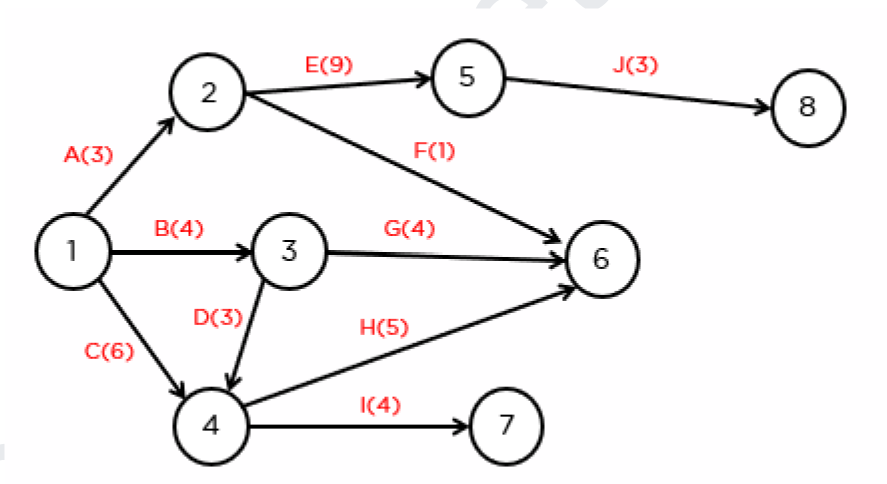
Now that we've done that, let's go back to activity F. Now that we know where activities G and H connect to, we can combine nodes 2 and 6, fulfilling the conditions required for activities K and L.



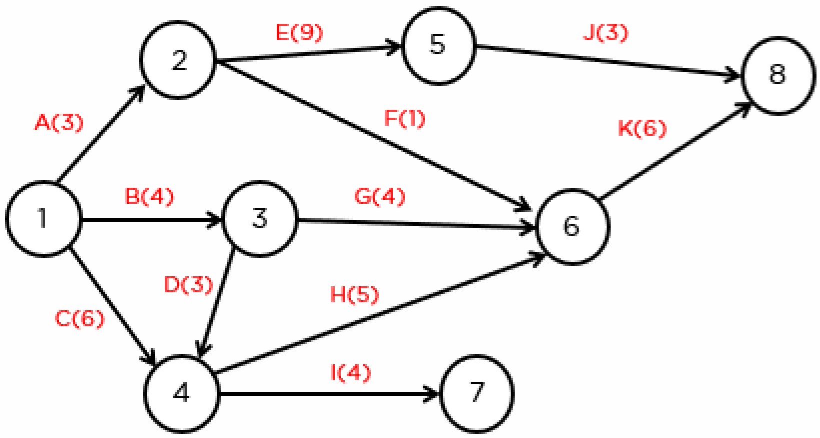
Following this, we have an activity I. The activity I is preceded by activities C and D. It also acts as an immediate predecessor to activity M. Since it's an independent activity, we can draw it like so.



Next, let's take a look at activity J. Activity J is preceded by activity E. We can also see that a combination of J and K will act as an immediate predecessor for activity N. We can then draw an arc like this.

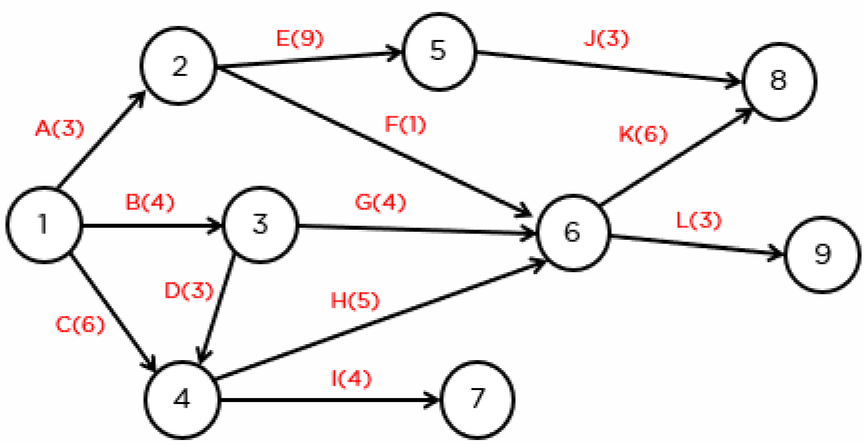


Let's go on to activity K. Here we can see that K is preceded by F, G, and H. It also acts as an immediate predecessor to activity N. So, we'll connect nodes 6 to 8.

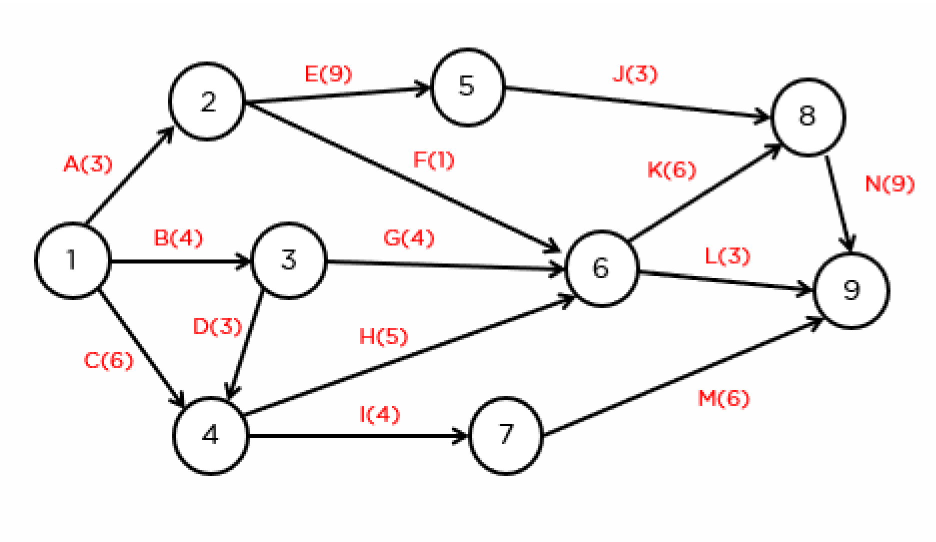


Next, let's continue with activity L. The table now shows that L, M, and N don't act as immediate predecessors for any other activity. Hence it can be assumed that it'll connect to the final node.

L is preceded by activities by F, G, and H. The arc can be drawn like so.



We'll now go to activity M. This activity is preceded by activity I. Similarly, we can connect an arc from node 8 to 9 for activity N.



Now, the network is complete!

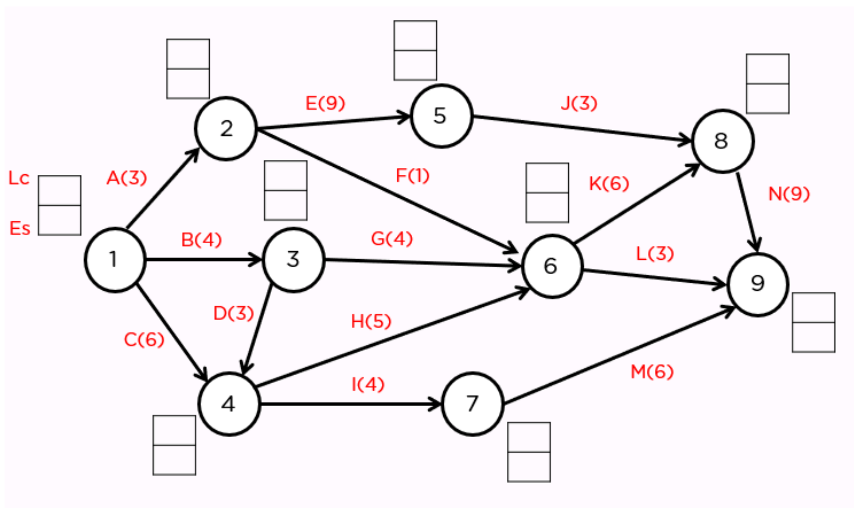
Now, to find the critical path. For this, we'll need to find two values, Earliest Start Time (Es) and Latest Completion Time (Lc).

The process of determining the Es for all events is called a forward pass.

The process of determining the Lc for all events is called a backward pass.

Let's get into the forward pass. For this, first, we'll need to create boxes at all nodes. These are then divided into two. The lower half of the box represents the earliest start time of the node, while the upper half represents the latest completion time.

Your network diagram should look something like this.



Pros and Cons of CPM

The pros and cons of the critical path method (CPM) are as follows:

Pros of Using CPM in Project Management

The pros of using CPM are as follows:

Effective Communication: All phases of a project's life span must be considered when creating critical path method schedules. The program's structure becomes more achievable and firm when the skills shared by various team members are integrated.

Easier to Prioritize Tasks: Project managers can more effectively prioritize tasks and estimate the float of each one by determining the critical path. Float indicates the amount of time a task may be put off before it affects when it will be completed. A lower float indicates a greater priority.

Accurate Scheduling: CPM is a popular and dependable methodology for enhancing the precision of project schedules. Several project managers utilize CPM with the Programme Evaluation and Review Technique (PERT), which supports teams in estimating overall project length.

Better Visualisation: Gantt charts and CPM network diagrams, which show critical path timelines, can help project managers understand a project's timeline and progress more quickly. These visual tools allow them to understand a project's direction more intuitively than a less eye-catching alternative.

Cons of Using CPM in Project Management

Some of the cons of using the critical path method are as follows:

Multiple Complexities: Several moving elements and detailed computations are involved in the CPM. The software may automate the computations, but entering accurate data requires thorough research and leaves room for human error.

Limited Applicability: Not every project type is suited to the critical path method. Projects requiring creativity, like product design or research work, that tend to come along in unforeseen forms fail to lend themselves well to CPM.

Less Understanding of Resources: The critical path method also lacks sufficient understanding of how resource limitations impact project schedules. The accessibility of equipment or labor resources is not considered in the network diagram or CPM schedule.

Step by Step Guide on How to Find the Critical Path With Examples

The time of essential and non-critical tasks can be used to identify the critical path. This is a list of the steps, along with examples.

<u>List Activities</u>

List all the venture exercises or errands essential to create the expectations utilising a work breakdown structure. The rest of the CPM is built on the list of activities provided in the work breakdown structure.

<u>Identify Dependencies</u>

Choose the occupations based on your work breakdown structure that is interconnected. This can identify any task that can be finished alongside other chores.

These task dependencies are based on the example mentioned above:

- Task A is necessary for Task B.
- Task B is necessary for Task C.
- C and D can be carried out concurrently.
- Task D is necessary for Task E.
- Task F depends on Tasks C, D, and E.

An activity sequence, which will be utilized to identify the critical path, is a set of dependent tasks.

Create a Network Diagram

The network diagram, a flowchart that depicts the order of tasks, must then be created from the work breakdown structure. Each task should be represented by a box, with task relationships shown by arrows.

Until the overall project timetable is determined, you will add other time-bound components to the network diagram.

Estimate Task Duration

You must first estimate each activity's length before determining the critical path, which is the longest series of critical tasks.

Try these to get a sense of the time:

- Using knowledge and experience to make educated assumptions
- Estimating using information from past projects
- Estimating using established industry practices

Try the forward pass and backward pass technique instead:

- Forward pass: This method uses a previously stated start date to determine early start (ES) and early end (EF) dates. ES is the direct ancestor with the highest EF value; EF is calculated as ES plus duration. The calculation begins at ES of the first action with 0 and moves forward through the schedule. Establishing ES and EF dates enables early resource allocation for the project.
- A backward pass determines the dates for late starts (LS) and late finishes (LF). LF is the lowest LS value among immediate successors, and LS is LF - duration. The calculation begins with the final action on the timetable and works its way backward.

The scheduling flexibility of each activity can then be determined using the early and late start and end dates.

Calculate the Critical Path

Although the critical path can be determined manually, adopting a critical path algorithm can save time.

Below are the steps:

Step 1: Next to each action, note the start and end times.

The initial activity lasts for the allotted period and starts at 0.

The start time of the next activity is determined by the finish time of the previous one, and the end time is calculated by multiplying the start time by the duration.

Do this for each activity.

Step 2: To discover how long the entire sequence lasted, look at the last activity in the sequence's end time.

Step 3: The critical path is the series of operations that takes the longest time.

You can construct the entire project schedule around the critical path once it has been identified.

Calculate the Float

It illustrates how much extra time could be added to the task without impacting other activities or the project's deadline for completion.

The project's degree of flexibility can be determined by identifying the float. Use the resource known as "float" to cover project risks or unforeseen problems.

The dates of critical tasks are fixed since they have zero floats. Positive float tasks go on the non-critical route, where their delay won't affect the project's completion. Non-critical jobs might be skipped if you need more time or resources.