

I'm not a robot

























ASSA ABLOY SA is a company specializing in door opening solutions. One part of the company focuses on manufacturing pin tumbler and lever locks for multiple brands including Union, Yale and Multi-Lock. The production line used to produce padlocks is a perfect example of a network system; the steps are shown in Table 1. Using this example, the CPM (critical path method) will be explained fully. For the purpose of the example, a batch of 200 padlocks will be taken as the sample for the data recorded. Table 1: Steps followed to produce padlocks. Extra costs are associated with the activities if the manager wants to reduce the overall time (or critical path). These costs can be seen from table 2, as well as the maximum reduction in time per activity. Table 2: Costs of making reductions in the duration of the activities. CPM Explained. The CPM will be explained using the above example to develop a basic understanding of the steps involved. Figure 1: Process of CPM Figure 2: Demonstration of the use of dummies solving the problem (by hand) 1. Drawing the Project Network The first step of the CPM is to draw the project network. The steps are shown below. Figure 3: The steps for drawing the activity on an AOA network. Figure 4: ASSA ABLOY's process for manufacturing padlocks. 2. Determining early event time (ET) and late event time (LT) ET(1) = 0ET(2) = ET(1) + 0.5 = 0.5ET(3) = ET(2) + 1 = 1.5ET(4) = ET(3) + 0.8 = 2.3ET(5) = ET(3) + 1.4 = 2.9ET(6) = ET(4) + 1 = 3.3ET(7) = ET(5) + 1.2 = 4.1 ET(6) + 0 = 3.3ET(8) = max between : ET(3) + 1.5 = 3 ET(7) + 0 = 4.1ET(9) = ET(8) + 0.4 = 4.5ET(10) = ET(9) + 1.4 = 5.9ET(11) = ET(10) + 0.5 = 6.4 (Longest time to complete activities) Figure 5: Early event time and late event time for given problem.3. Determining the total float (TF) and free float (FF) Figure 6: Determining the total float (TF) Figure 7: Determining the free float. 4. Determine the critical pathThe critical path is the longest path from the start node to the finish node. An activity with a total float of zero is a critical activity. A path from node 1 to the finish node that consists entirely of critical activities is the critical path.As can be seen from above, the critical path is: 1 - 2 - 3 - 5 - 7 - 8 - 9 - 10 - 11Linear Programming application In the above formula represents the time assigned to the connecting activity with activity . By setting one ensures that the preceding activity is completed first.Objective function: min z = x11 - x1Subject to: x2 >= x1 + 0.5 (arc(1,2) constraint) x3 >= x2 + 1 (arc(2,3) constraint) x4 >= x3 + 0.8 (arc(3,4) constraint) x5 >= x4 + 1 (arc(4,6) constraint) x6 >= x4 + 1 (arc(4,6) constraint) x7 >= x5 + 1.2 (arc(5,7) constraint) x8 >= x3 + 1.5 (arc(3,8) constraint) x9 >= x8 + 0.4 (arc(8,9) constraint) x10 >= x9 + 1.4 (arc(9,10) constraint) x11 >= x10 + 0.5 (arc(10,11) constraint) x3 >= x7 (dummy arc(6,8) constraint) x4 >= x6 (dummy arc(6,9) constraint) All activities have the same duration of 1. Crashing the project when the time of an activity can be reduced at an additional cost is a different LP needs to be taken into consideration. This usually occurs when a project needs to be completed in a time shorter than the current critical path. For the ASSA ABLOY example the following will happen: A = the time reduction for the last activity.....J = the time reduction for the last activity. To determine the minimum cost the following LP will need to be solved. Also assume that the path time required is 6.3 hours.Objective function: min z = 20A + 200B + 0C + 0D + 35E + 80F + 100G + 20H + 20I + 0JSubject to: A = x10 + 0.5 - J (arc(10,11) constraint) x8 >= x6 (dummy arc(6,8) constraint) x8 >= x7 (dummy arc(7,8) constraint) x11 = 0 x10 = 0 The first 10 constraints are for the reduction in time for each activity. As can be seen from the graph below, the cost increases exponentially as the path time decreases. Graph 1: Cost and path relationship See also AI that writes essays - writes 10x faster with GPT-3 The critical path method is one of the most important concepts in project management; however, many students have difficulties in its application. In this post, you will learn how to calculate the critical path of a project step by step following practical examples. Before you start we recommend you to review our post how to create a PERT CPM chart step by step with examples; where we explain how to graphically represent the relationships between the activities of a project. Creating the chart of project is the starting point to calculate our critical path. You can also check our online critical path method calculator that performs the steps to calculate the critical path automatically. What is the Critical Path Method?The Guide for Project Management (better known as PMBOK Guide), defines the critical path as: "The sequence of scheduled activities that determines the duration of the project". To complete a project, we must perform all the activities that compose it. Some activities can be done simultaneously, but others must be done in a certain order. For example, if I am going to build a house, I must first build the walls before painting them. Of all the sequences of activities that make up the project, the one that has the longest duration will be the critical path, and it determines the total project time. As a consequence, the critical path method specifies the algorithm for finding this path. Why is Critical Path Important? By identifying the critical path, teams recognize the most important tasks to be performed in a project. Further, an delay in a critical path activity can cause the entire project to be delayed, so managers take extra care to ensure those activities take place as planned. Important Projects may have multiple critical paths. What methods are used to calculate the Critical Path?The methods used to calculate the critical path are the Project Evaluation and Review Technique (PERT) and the Critical Path Method (CPM). The PERT and CPM methods began to be developed in the 1950s to assist managers in scheduling, monitoring and controlling large, complex projects. The CPM method (1957) was implemented as a procedure to assist in the construction and maintenance of chemical plants. The PERT technique was developed independently in 1958 for the U.S. Navy's Polaris project. Although both methods are similar, they used different techniques to estimate task durations. The PERT method used three different time estimates for the duration of each task, plus it calculated the probability of completing the project at a given time. The CPM method used a single duration for each task; however, it also analyzed the additional costs that would be incurred if the project is accelerated. The differences between the two techniques are now considered to be minimal; therefore, we can refer to both as an overall method called PERT CPM. How to calculate the critical path? To calculate the critical path we will follow the following steps: Step 1: Obtain the project data. Make a list of all the activities of the project along with their dependencies and their specific times. Step 2: Elaborate the network diagram. We have written a post that explains how to elaborate the project network diagram step by step. Step 3: Calculate the Early Start and Late Start Times. Determine the Early Start and Late Start Times for each activity. Step 4: Calculate the Early Finish and Late Finish Times. Determine the Early Finish and Late Finish Times for each activity. Step 5: Calculate the slack time. The critical path must be determined by finding out the slack for each activity of the project. The activities whose slack are the ones making up the critical path. How to Calculate Early Start, Late Start, Early Finish, Late Finish and Slack (Float) To visualize the calculation of these values, we will use the following graph representation of the activity: Duration (t). Indicates the time it takes to complete the activity. Early Start Time (ES): This is the earliest time that an activity can be started assuming all previous activities have been completed beforehand. For activities that have more than one precedent, the ES is the greatest of the late start time of their precedents. See also Critical Path Method Calculator - PERT and CPM Diagram Early Finish Time (EF): This is the earliest time that an activity can finish. It is equal to the early start time plus its estimated duration (t): EF = ES + t Late Finish Time (LF): This is the latest time at which an activity can be completed without delaying the entire project. It is obtained by equaling the late start time of the activity that immediately follows. If activities have more than one task immediately following them, the LF will be the least of the late start time of those activities. Late Start Time (LS): It is the latest time an activity can begin without delaying the whole project. It is equal to the Late Finish Time minus the expected duration of that activity (t): LS = LF - t Slack - Float (S): A period of time when an activity can be delayed without causing the entire project to be delayed. All activities contained in the critical path have zero slack. Here is how it is calculated mathematically: S = LS - ES = LF - EF We will illustrate these concepts with an example: Imagine that your professor asks you to write an essay to be submitted in 15 days. According to the length of the topic, it will take you approximately 1 week to prepare it. If you are a very responsible person, you will probably start the essay as soon as possible. The earliest start time (ES=0), represents the first moment when you can start your essay: if you start your project at point 0; you will have it ready at point 7. That final value represents the early finish time (EF=7). Now let's suppose that you like to do your activities at the last minute; we likely you want to finish your essay right on the day of the presentation. That day would be point 15 and represents the late finish time (LF=15). You cannot exceed that point because you will no longer submit the paper on time. In order for you to finish your paper on the 15th day, you have to start 7 days earlier (the time it takes to do the rehearsal), therefore you must start on the 8th day. This point represents the late start time (LS=8). If you start after this date you will not be able to submit your work on time. The 8 free days you have between the time you start work and the date of submission is the slack (float) in your activity. Slack = LS - ES = LF - EF Slack = 8 - 0 = 15 - 7 = 8; we change the scenario and our teacher gives us only the one-week deadline to submit the essay. We will no longer have any free time (slack) so I must start working on the essay from the very beginning to get it done on time. Since this activity has no chance of being delayed, we call it a critical activity. In project management, it is required to calculate these values for each activity which is achieved through a two-path process: a forward path to calculate ES and EF, and a backward path to calculate LS, LF and slack (float). This procedure will be detailed by means of solved examples: Example 1: Draw the activity-on-node (AON) project network associated with the following activities for Dave Carhart's consulting company project. Activity Immediate Predecessor(s) Time (Days) A - 3 B A 4 C A 6 D B 6 E B 4 F C 4 G D 6 H E, F 8 How long should it take Dave and his team to complete this project? What are the critical path activities? Solution 1: The network diagram would look as follows: The development of this diagram was explained in detail in our article on creating PERT CPM diagrams. The number at each node represents the duration of each activity. Forward path We will now perform the forward path to calculate the ES and EF with an analysis of each activity. Start node: This dummy node has all values equal to zero. Activity A: Since it is the first activity, its ES will be equal to the EF of the starting node (zero); the EF is calculated as follows: ES is calculated as follows: See also How to create a PERT Chart step by step: AON Network EF = ES + activity time EFA = 0 + 3 = 3 Activity B: It has as precedent only activity A; therefore its ES will be equal to the EF of activity A. In the same way as the previous node, the EF of activity B is calculated by adding its ES + the corresponding time: EFB = 3 + 4 = 7 Activity C: It has as precedent only activity A; therefore its ES will be equal to the EF of activity A. The EF of activity C is calculated by adding its ES + the corresponding time: EFC = 3 + 6 = 9 Activity D: It has as a precedent only activity B; therefore its ES will be equal to the EF of activity B. The EF of activity D is calculated by adding its ES + the corresponding time: EFD = 7 + 6 = 13 Activity E: It has as a precedent only activity B; therefore its ES will be equal to the EF of activity B. The EF of activity E is calculated by adding its ES + the corresponding time: EFF = 7 + 4 = 11 Activity F: It has as precedent only activity C; therefore its ES will be equal to the EF of activity C. The EF of activity F is calculated by adding its ES + the corresponding time: EFF = 9 + 4 = 13 Activity G: It has as precedent only activity D; therefore its ES will be equal to the EF of activity D. The EF of activity G is calculated by adding its ES + the corresponding time: EFG = 13 + 6 = 19 Activity H: This activity has two precedents: E and F; therefore its ES will be equal to the highest EF of both activities. In this case, activity F has the highest value with 13. The EF of activity H is calculated by adding its ES + the corresponding time: EFH = 13 + 8 = 21 End Node: The end fictitious node is joined with the last activities G and H; and the highest value of the EF of both activities is placed as ES: 21. This value represents the total duration of the project. As this node has zero duration (because it is fictitious) its EF will be equal to 21 + 0 = 21. Backward path To finalize the critical path calculation we will perform the backward traversal to calculate the LF and LS, starting from the final node; placing the values at the bottom of the node as follows: End Node: For the end node the LF value is equal to the project duration (21). The LS is calculated by subtracting the LF minus the duration (zero). LSEnd = 21 - 0 = 21 Activity H: Since the final node is the only successor to activity H, its LF will be equal to the LS of the final node (21). The LS of activity H is calculated by subtracting its LF minus its duration: LSH = 21 - 8 = 13 Activity G: Since the end node is the only successor of activity G, its LF will be equal to the LS of the end node (21). The LS of activity G is calculated by subtracting its LF minus its duration: LSG = 21 - 6 = 15 Activity F: Since activity H is the only successor of activity F, its LF will be equal to the LS of activity H (13). The LS of activity F is calculated by subtracting its LF minus its duration: LSF = 13 - 4 = 9 Activity E: Since activity H is the only successor of activity E, its LF will be equal to the LS of activity H (13). The LS of activity E is calculated by subtracting its LF minus its duration: LSE = 13 - 4 = 9 Activity D: Since activity G is the only successor of activity D, its LF will be equal to the LS of activity G (15). The LS of activity D is calculated by subtracting its LF minus its duration: LSD = 15 - 6 = 9 Activity C: Since activity F is the only successor of activity C, its LF will be equal to the LS of activity F (9). The LS of activity C is calculated by subtracting its LF minus its duration: LSC = 9 - 4 = 5 Activity B: How activity B has as successors activities D and E, its LF will be equal to the smaller value of the LS of both. In this case, since both have a value of 9; that value will be the LF of activity B. The LS of activity B is calculated by subtracting its LF minus its duration: See also AI that writes essays - writes 10x faster with GPT-3LSB = 9 - 4 = 5 Activity A: How activity A has as successors activities B and C, its LF will be equal to the smaller value of the LS of both. In this case, the lowest value is that of activity C (3); therefore, that value will be the LF of activity A. The LS of activity A is calculated by subtracting its LF minus its duration: See also AI that writes essays - writes 10x faster with GPT-3LSA = 3 - 3 = 0 Initial Node: Using the same analysis as above we complete the values of the initial node with zero. Finally we calculate the slack for each node with the following formula: Slack = LS - ES = LF - EF The final graph would look like this: The activities with zero float (marked in red) are the critical activities. In this example, these activities follow a single path that will be our critical path: A - C - F - H. Total project time is 21 days. Example 2: Shirley Hopkins is developing a program in leadership training for middle-level managers. Shirley has listed a number of activities that must be completed before a training program of this nature can be conducted. The activities, immediate predecessors, and times appear in the accompanying table. Activity Immediate Predecessor Time (days) A - 2 B - 5 C - 1 D B 10 E A D 3 F C 6 G E F 8 Provide the following: AON diagram for these precedencies What is the critical path? What is the total project completion date? What is the slack time for each individual activity? Solution 2: We will solve this example by showing the results and analysis of our critical path method calculator: Each activity is broken down by its precedents and descendants: Predecessor Activity Successor Start - A A A - E Start - B B B - D Start - C C C - F B - D D D - E A - E D - E E - G C - F F - G E - C G C - G End This table serves as a guide to build our network diagram. Two dummy activities were added to show the start and end. The activities with 0 (zero) slack are the ones that make up the critical path. CPM Network Diagram CPM Network Diagram with Calculations of ES, EF, LS, LF and Float The following table presents the results to determine the critical path: Early Start (ES): It is equal to the Early Finish to the activity's precedent. If it has more than one precedent, the highest value is taken. Early Finish (EF): It is equal to the Early Start of the activity plus its duration (t). EF = ES + t. Late Start (LS): It is equal to the Late Finish minus its duration (t). LS = LF - t. Late Finish (LF): It is equal to the late start of the activity that follows. If it has more than one successor, the lowest value is taken. Slack (S): It can be calculated in two ways. S = LS - ES = LF - EF. Activities with zero clearance make up the critical path. Activity Time Early Start (ES) Early Finish (EF) Late Start (LS) Late Finish (LF) Slack (S) A 2 0 2 13 13 B 5 0 5 0 0 C 1 0 1 11 12 D 10 5 15 15 0 E 3 15 18 15 18 0 F 12 18 18 18 18 0 G 6 18 24 18 24 0 The critical path is: B - D - E - G The total project time is: 26 hours Final Reflection The critical path shows us the main activities that will determine the total time of the project; that is why Project Managers must be aware of the fulfillment of each one of them. This does not mean that the other activities should be neglected; on the contrary, if they are delayed longer than their slack, the project will have problems to finish on time. With the help of our entry, we are confident that you will gain more understanding about the CPM technique and how it can be used to calculate critical path. Finally, we invite you to follow us on our social networks and join our Facebook group where we can exchange more information with the participants. In the world of complex projects, delivering on time is a must.A realistic and meticulous planning approach is crucial to ensuring success. You may not have superhuman capabilities, but you have the critical path method. This powerful technique can help you manage projects efficiently by precisely analyzing task dependencies and critical sequences! This article explains the critical path method, its benefits, use cases, and main elements. It also provides step-by-step guidelines and shows you how helpful project management software like ClickUp makes implementing the method easier, even for beginners.Save Time With ClickUp's Critical Path Analysis Template Summarize this article with AI ClickUp Brain not only saves you precious time by instantly summarizing articles, it also leverages AI to connect your tasks, docs, people, and more, streamlining your workflow like never before. The critical path is a series or sequence of must-do tasks determining the project's overall timeline. We call such tasks critical activities or critical tasks, and they're essential for the successful and timely execution of a project. [Easily see the critical path timeline, schedule, and activities in the customizable drag-and-drop Gantt chart view in ClickUp Summarize this article with AI ClickUp Brain not only saves you precious time by instantly summarizing articles, it also leverages AI to connect your tasks, docs, people, and more, streamlining your workflow like never before. The critical path method (CPM) is a project management technique for identifying the longest sequence of dependent tasks in a project. It helps project managers understand which tasks are critical (i.e., if delayed, they will delay the entire project) and which have float (i.e., can be delayed without affecting the overall timeline). It also helps them determine the shortest possible project duration. Also known as critical path analysis (CPA), the critical path method helps project managers form accurate schedules across the entire project. They identify critical dependent tasks by calculating their duration using a specialized formula (or critical path algorithm). They also often use Gantt charts or other diagrams to visualize and better understand the project timeline. Project managers use this to get a bird's-eye view of the entire project and its dependent tasks to make better decisions.Did You Know: The critical path method was developed in the 1950s by Remington Rand's James E. Kelley and DuPont's Morgan R. Walker, who were looking to cut costs associated with inefficient scheduling. The pair also invented the Program Evaluation and Review Technique (PERT), a similar method often used alongside the critical path method.CPM and PERT are project management methodologies for planning and scheduling. They are used to identify the sequence of tasks that must be completed before other tasks can start, or they have to start simultaneously. To continue with our house-building example—you can't start furnishing a room until you've finished the flooring and the wall paint has fully dried. [The network critical path diagram is a flowchart for visualizing your project's timeline and task dependencies. It consists of nodes, which are usually represented with rectangles or circles, and connectors, i.e., arrows. Visualizing the structure of activities this way makes it easier to understand and identify the critical activities. A critical path diagram sometimes highlights areas in different colors to stand out from the non-critical task sequences. You can also use Gantt charts and PERT charts to visualize your project timeline and critical paths, but more on that in the how-to section! The critical path method consists of a series of calculations to determine the duration of tasks and the critical path. The primary metrics are:Earliest start time (ES): The earliest possible date you can start an activity considering the dependenciesEarliest finish time (EF): The earliest possible date you can complete an activity considering its ES and durationLatest start time (LS): The last possible date you can start an activity before causing a significant project delayLatest finish time (LF): The latest possible date you can complete a task based on its LF and durationTask duration (t): The total amount of time it takes to complete an activityThe critical path formula has two parts, which we'll explain below. We use the forward pass to calculate the ES and EF. The ES of the first activity on any path will always be 1 since it indicates the start, i.e., the first day of your project. The ES of all other activities equals the earliest endpoint of the preceding activity plus 1:ES = EF of preceding activity + 1The EF equals the sum of ES and the duration of the activity minus 1:EF = ES + t - 1With the backward pass, we calculate the LS and LF.The LF of the last activity on any path will always be the same, as it indicates the end, i.e., the last day of the project. The LS of an activity equals the difference between LF and the duration of the task plus 1:LS = LF - t + 1The LF of an activity equals the LS of the succeeding activity minus 1:LF = LS of succeeding activity - 1The float or slack represents how long a non-critical task can be delayed without affecting the entire project timeline. Critical tasks don't allow delays, so their float score is automatically 0. There are two types of float:Total float: The amount of delay that doesn't affect the project completion date (LS or LF) - ES or EF)Free float: The amount of delay that doesn't affect the start date of the succeeding task (ES of succeeding activity - EF of current activity)Also Read: Steps to Efficient Project Time Management Summarize this article with AI ClickUp Brain not only saves you precious time by instantly summarizing articles, it also leverages AI to connect your tasks, docs, people, and more, streamlining your workflow like never before. Now that you've mastered all the elements of the critical path method, it's time to put your knowledge to the test. In this section, we'll show you how to calculate your project's critical path in six steps. The first thing you should do is determine the project scope. Collect all your activities in one place and define your goals, budget, and deadline. Build your Work Breakdown Structure (WBS) and use this to create a complete list of every task the project entails.List all tasks in a project to determine its scopePro Tip: ClickUp's List View provides you with the perfect framework to list all the tasks, subtasks, and relevant information about them in Custom Fields, such as start and due dates, etc.Not a fan of spreadsheets and lists? Project managers can do everything in a Kanban-style ClickUp Board view as well to stay on top of the project schedule, uncover resource constraints, and see actual progress toward project completion. Accurately identifying dependencies is crucial for successful time estimation and planning. Discuss with your team and use your previous experience to determine the most logical order of tasks. This will help you identify tasks that must be tackled first, as well as those that can be taken up in parallel.Add relationships and task dependencies using ClickUp Tasks to see how tasks impact one anotherUse a network diagram, work breakdown structure (WBS), PERT chart, or any other visualization method to make the complex project structure more comprehensible. Draw the flowchart and arrange tasks based on their chronological order and dependencies.Make your project timeline easier to grasp with a network diagram, PERT chart, or another methodYou can use pen and paper, have editing or drawing program, or project management software like ClickUp.Pro Tip: ClickUp's Whiteboard helps you create critical path diagrams quickly. Use shapes and connectors to create the structure. Add additional elements like images and documents to make the diagram more informative.Although different in terms of structure, Gantt charts are also a convenient way to envision the sequence of tasks in a project and estimate their duration. The next step is to define the t for each task, i.e., how many days it will take to complete it.Estimate based on your experience, historical data, and industry standards. Consult others, particularly experts, to gain multiple perspectives and make the most accurate predictions.Discover the longest sequence of critical activities and how much leeway you have with non-critical onesUsing the formula shared earlier, calculate the ES, LS, EF, LF, and slack. Begin with the first task, which has a start time of 1, then define the EF and LF based on its duration. Repeat the same for all other tasks. The longest sequence of critical activities (those that have 0 slack) is your critical path. You can also have multiple critical paths. Pro Tip: ClickUp's Gantt charts make these calculations much more manageable. In your project Gantt chart, choose the Show option again, but this time, enable Critical Path and/or Slack Time.The critical path will show up with a different color scheme, highlighting tasks with the blocking dependency in red. With the Slack Time option enabled, a purple striped bar will appear alongside non-critical activities to depict the wiggle room they allow for. Another way to discern critical from non-critical tasks is by adding priority tags and color codes. For instance, you can assign critical activities with a high-priority tag and non-critical activities with a low-priority tag, and the software will color them accordingly. Finally, start bringing your project to life task-by-task. As you go through tasks, you might realize some aren't necessary or run into unexpected resource constraints. The delay caused by such events is called the critical path drag. Monitor activities closely to ensure added plan changes in time by closely monitoring your targets and progress, you can ensure your project stays on the right path at all times. [Use ClickUp's Goal Tracking feature to stay on track to hit your goals with clear timelines, measurable targets, and automatic progress tracking.Pro Tip: In ClickUp, you can ClickUp Goals and automatically track progress. Choose between task, numerical, monetary, and True/False targets to then manage them all in one place.If you opt for a project management tool like ClickUp, you can spare yourself from the manual and repetitive work.Instead of starting from scratch, use the pre-built ClickUp Critical Pathway Analysis Template. Navigate through your project and determine its critical path by using the ClickUp Critical Pathway Analysis List TemplateClickUp's CPA template makes it easy to map out the tasks that are essential for project success. It also helps you identify potential areas of risk.Determine the best sequence of tasksSchedule tasks in order to meet deadlines Summarize this article with AI ClickUp Brain not only saves you precious time by instantly summarizing articles, it also leverages AI to connect your tasks, docs, people, and more, streamlining your workflow like never before. Remember our house-building example from earlier? Let's expand on it! We'll show you how to apply the critical path analysis to a real-life example. We'll be using the same ClickUp Critical Pathway Analysis Template. Let's start by listing all the tasks we need to take to build a house:Planning and designSite preparationFoundation constructionFraming and structural workInstallationsPaintingFurnishingLandscapingWe'll also jot down the subtasks. For instance, in the planning and design stage, those would include:Hiring an architectDetermining the house layoutAcquiring all the permits We'll also define the project's desired start and end date—May 18 to Mar 5. ClickUp Whiteboards leverage AI and seamless integration with all of your workNext, we'll create a diagram in ClickUp Whiteboards. Considering the dependencies and allotting larger shapes to tasks that require the longest time, we'll create the flowchart to visualize the work ahead.To define task relationships in ClickUp, right-click on a task and select the Dependencies option. You can choose between types of dependencies:Finish-to-start: The task cannot start until the preceding task is completedFinish-to-finish: The task cannot finish until the preceding task is completedStart-to-start: The task cannot start until the preceding task startsStart-to-finish: The task cannot finish until the preceding task startsAlso Read: Measure Estimated Time of Completion in Project Management Summarize this article with AI ClickUp Brain not only saves you precious time by instantly summarizing articles, it also leverages AI to connect your tasks, docs, people, and more, streamlining your workflow like never before. While CPM is a powerful project management tool, it has several limitations that project managers should be aware of.CPM relies on fixed estimates for task durations, but in reality, projects often face uncertainty (unexpected delays, scope changes, resource availability issues). For instance, in a software development project, coding might take longer due to unforeseen bugs. Workaround: Use PERT charts (Program Evaluation and Review Technique), which consider best-case, worst-case, and average estimates.CPM assumes unlimited resources, meaning tasks on the critical path might require the same team members or equipment, leading to scheduling conflicts. For example, if two critical tasks need the same expert, one task will be delayed. Workaround: Use resource leveling or the critical chain method (CCM) to optimize resource allocation.This method focuses only on the critical path, but non-critical tasks may become critical if delayed. For instance, a delayed content review in a marketing project may later block website development. Workaround: Regularly update the project schedule and monitor near-critical tasks.ClickUp's Project Schedule Template is your ticket to streamlined project planning and managementGet ClickUp's Free Project Schedule TemplateCPM works best for linear, sequential projects, but agile projects (software development, marketing campaigns) involve iterative work that CPM struggles to model. In Agile development, for example, tasks change dynamically based on feedback, which CPM doesn't easily accommodate. Workaround: Use Agile methodologies (Scrum, Kanban) alongside CPM for adaptive project management.As projects grow in size, CPM diagrams become complicated and hard to manage with hundreds of tasks and dependencies. For instance, a large construction project with thousands of interdependent tasks can make CPM overwhelming. Workaround: Use project management software like ClickUp to automate scheduling. Check out ClickUp's Free Forever plan to learn more.CPM doesn't account for external risks like supplier delays, economic downturns, or natural disasters. Raw material shortages might disrupt a factory's production timeline, which CPM won't flag. Workaround: Combine CPM with risk management strategies, such as Monte Carlo simulations.Also Read: Free Project Management Templates for All Types of Projects Summarize this article with AI ClickUp Brain not only saves you precious time by instantly summarizing articles, it also leverages AI to connect your tasks, docs, people, and more, streamlining your workflow like never before. The critical path method can be an excellent helping hand when dealing with a demanding project. It enables you to meticulously assess and sequence tasks, ensuring that you meet deadlines, keep the project schedule in order, maintain healthy client relationships, and drive actual progress and growth.When your tasks are sorted out, the rest of the project falls into place.Project managers should combine CPM with other techniques like Agile, resource management, and risk analysis to create a more resilient project plan. This comes together even more effectively when you have a modern project management solution like ClickUp at hand. Get started with ClickUp today! Summarize this article with AI ClickUp Brain not only saves you precious time by instantly summarizing articles, it also leverages AI to connect your tasks, docs, people, and more, streamlining your workflow like never before. The Critical Path formula calculates the earliest and latest start and finish times for tasks in a project. The goal is to find the longest sequence of dependent tasks (the critical path) that determines the shortest possible project duration. The key formulas involved are:Earliest Start (ES) = Earliest Finish (EF) of the previous taskEarliest Finish (EF) = ES + Task DurationLatest Finish (LF) = Minimum LS of the next taskLatest Start (LS) = LF - Task DurationSlack (Float) = LS - ES (If Slack = 0, the task is on the critical path)By applying these formulas across all tasks, project managers can identify which tasks must stay on schedule to prevent project delays.The Critical Path Algorithm consists of two main parts: 1. Forward pass (earliest times calculation): This step determines the earliest start (ES) and earliest finish (EF) times for each task, starting from the beginning (ES = 0) and moving forward. Earliest Start (ES) = 0 and Earliest Finish (EF) = 5 and task duration = 5. Backward pass (latest times calculation): This step calculates the latest start (LS) and latest finish (LF) without delaying the project deadline.Latest Finish (LF) = Minimum LS of the next taskLatest Start (LS) = LF - Task DurationExample: If a task must finish by Day 12 and takes 4 days, then: Everything you need to stay organized and get work done.