

## **Developing Critical Thinking in Engineering Management through AI-Based Scheduling Assignments: A Study of Copilot, ChatGPT, Gemini and PMI Infinity**

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## **Abstract**

As artificial intelligence (AI) tools such as large language models (LLMs) gain increasing prominence in engineering education, it is essential to equip students with the skills to use these tools responsibly and effectively. This paper presents a novel assignment designed for engineering leadership and project management students, where they utilize LLMs—such as ChatGPT, Microsoft Copilot, Google Gemini, and PMI Infinity—to solve scheduling problems, including Critical Path Method (CPM) and Program Evaluation and Review Technique (PERT). The assignment encourages students to critically evaluate and compare the output from different language models, providing a hands-on approach to understanding both the capabilities and limitations of AI in solving complex engineering tasks. In addition to generating solutions, students are tasked with identifying and refining prompts to improve the accuracy and usefulness of the AI outputs. The objective of this research is to assess the effectiveness of this assignment in enhancing students' critical thinking skills through the students' feedback and fostering a deeper understanding of AI's role in project scheduling. Through the analysis of student performance and AI-generated solutions, this study evaluates the quality of scheduling problem-solving outcomes and offers practical guidelines for crafting more effective AI prompts. The findings suggest that this assignment not only improves students' ability to use AI tools responsibly but also helps them recognize and mitigate errors in both AI responses and human prompts. This paper contributes to the growing body of knowledge on integrating AI into engineering management education and provides actionable insights into how educators can leverage these technologies to improve learning outcomes in scheduling and project management courses.

## **Key Words**

Artificial Intelligence (AI), Scheduling, Microsoft Copilot, ChatGPT, Google Gemini, PMI Infinity, AI in Education, Prompt Engineering, Engineering Education, AI-Driven Problem Solving, Comparative Analysis of AI Tools, Critical Thinking

## **Introduction**

Artificial Intelligence (AI) and Large Language Models (LLMs) have rapidly emerged as transformative tools across various disciplines, including engineering education. Tools such as ChatGPT, Google Gemini, Microsoft Copilot, and PMI Infinity are increasingly utilized by students for tasks ranging from basic problem-solving to advanced analytical computations. As these tools become integral to engineering practice, educators are faced with the dual challenge of preparing students to use these technologies responsibly and understanding the tools' limitations and capabilities. This paper focuses on evaluating the effectiveness of LLMs in solving complex project scheduling problems—specifically the Critical Path Method (CPM) and Program Evaluation Review Technique (PERT)—to address this pedagogical challenge.

The increasing reliance on AI tools among students raises questions about their accuracy and potential to enhance learning outcomes. For instance, studies have demonstrated that while LLMs excel at automating repetitive tasks and providing structured outputs, they often exhibit limitations in handling complex and context-dependent tasks such as CPM and PERT calculations. According to Nenni et al. (2024), AI's ability to analyze large datasets and assess risks significantly enhances project management, yet challenges remain in its adaptability to nuanced scenarios [1]. Similarly, Taboada et al. (2023) highlighted application of AI on PMBOK's eight performance domains, including planning and delivery, but emphasized the need for educators to ensure these tools are used to complement, not replace, human critical thinking [2].

## **Literature Review**

The integration of AI tools in engineering education has introduced new opportunities and challenges. As LLMs gain traction in classrooms, educators must focus on developing students' abilities to use these technologies effectively while maintaining rigorous critical thinking and analytical standards. Research highlights the importance of preparing future engineers to leverage AI tools not only for computational efficiency but also for informed decision-making and ethical considerations.

In the context of project management, Taboada et al. (2023) provided a systematic review of AI applications, emphasizing the transformative role of AI in project management's performance domains such as planning, delivery, and risk management. However, their findings also underscore the necessity for human oversight and the development of skills to critically assess AI-generated solutions [2]. For engineering educators, this highlights the need for pedagogical approaches that bridge the gap between technological capabilities and students' ability to validate those outputs.

Nenni et al. (2024) stressed the role of AI in enhancing decision-making accuracy in project management. While this advancement is promising, traditional teaching methodologies often fall short in equipping students to understand the underlying assumptions and potential errors in AI-generated analyses [1]. This gap calls for innovative teaching strategies that focus on critical evaluation and prompt refinement—skills essential for future engineers working with AI systems.

Hsu et al. (2020) and Diao (2024) discussed the limitations of traditional project management methods in addressing complex, multi-stakeholder environments [3,4]. These limitations, coupled with the rise of AI tools like LLMs, present an opportunity for educators to reimagine curricula. Integrating AI into engineering education can foster interdisciplinary problem-solving skills, enabling students to navigate uncertainty and optimize outcomes effectively.

The pedagogical use of AI tools is not without challenges. Abdallah et al. (2020) highlighted the potential of neural network models in improving scheduling accuracy but also note the importance of contextual understanding [5]. This is particularly relevant in educational settings where students must learn to balance computational outputs with real-world constraints. Similarly, Jiang et al. (2019) emphasized the need for teaching students how to assess the reliability of AI-generated predictions, particularly in high-stakes scenarios [6].

Feedback from students participating in this study reveals significant variability in their experiences with LLMs. For instance, while some students appreciated ChatGPT's ability to outline problem-solving steps, others noted inaccuracies in its outputs, such as incorrect critical paths in CPM problems. This variability underscores the importance of incorporating assignments that teach students to refine AI prompts, interpret results critically, and recognize limitations—a pedagogical gap this study aims to address.

This research contributes to engineering education by proposing a structured approach to integrating LLMs into project management curricula. By focusing on prompt engineering, critical evaluation, and iterative problem-solving, the study seeks to prepare students to navigate the complexities of AI-assisted decision-making. These findings offer a framework for educators to enhance learning outcomes and foster a deeper understanding of AI's role in engineering management practice.

## **Objectives of the Study**

This study aims to:

1. Develop and evaluate pedagogical strategies that integrate LLMs into project management education.
2. Teach students how to critically assess and refine AI-generated solutions, fostering analytical and decision-making skills.
3. Examine the effectiveness of structured assignments in improving students' ability to use AI tools responsibly and effectively.

By addressing these objectives, this paper contributes to the growing body of knowledge on integrating AI into engineering education, offering a roadmap for leveraging these technologies to improve learning outcomes. Ultimately, it seeks to empower educators to harness the potential of AI tools while equipping students with the skills to navigate a rapidly evolving technological landscape.

## **Methodology**

This study employs a mixed-methods approach to evaluate the effectiveness of LLMs in engineering education, particularly in teaching project scheduling techniques such as CPM and PERT. The methodology is designed to align with the study's objectives of developing pedagogical strategies and fostering critical evaluation skills in students.

## **Study Context and Participants**

The research was conducted within a project management course offered to graduate engineering leadership and project management students. Participants included students with varying levels of

familiarity with AI tools. The primary data sources consisted of student submissions for assignments and their qualitative feedback on the use of LLMs for solving CPM and PERT problems.

## **Assignment Design**

Students were initially tasked with solving CPM and PERT problems manually to ensure they understood the underlying principles and methods. After grading, they were provided with the correct answers for reference. For this assignment, students were asked to revisit the same problems but approach them differently—by leveraging multiple Large Language Models (LLMs) to solve them. Specifically, they used ChatGPT, Microsoft Copilot, Google Gemini, and PMI Infinity.

Students were provided with two pre-designed exercises and solutions: a CPM exercise that required drawing network diagrams, calculating early and late start/finish dates, determining the critical path, and assessing activity float (Critical Path Exercise #1) and a PERT exercise that included probabilistic analysis of project duration and probability of project completion (PERT Network Exercise #1).

Students were instructed to:

1. Input carefully designed prompts into their assigned LLM to generate solutions.
  - Example prompts included:
    - “Create a CPM network diagram and determine the critical path for the following project tasks: [insert task data].”
    - “Given the following project tasks with optimistic, most likely, and pessimistic times, create a PERT diagram and calculate the expected project duration: [insert task data].”
2. Record and evaluate the outputs, including screenshots of network diagrams and other results.
3. Compare the generated outputs with manually calculated results, focusing on accuracy and consistency.
4. Refine their prompts iteratively to improve output quality and address discrepancies.
5. Explore settings adjustments (e.g., modifying temperature for deterministic responses) to examine their impact on results.

The following figure shows the CPM problem:

<b>Critical Path Exercise #1</b>		
Draw the network diagram for the following series of activities. Calculate early and late start and finish dates for each activity. Determine the critical path and total duration. How much float is there for activities E, G, and D.		
Activity ID	Preceding Activities	Duration (weeks)
A	---	3
B	---	4
C	A	5
D	A	3
E	B	5
F	C	4
G	C	2
H	D, E	7
I	G, H	1
J	F, I	3

Figure 1: CPM Problem Statement

The provided key of the CPM problem is as follows:

*The network diagram of the given activities is depicted in Figure 2:*

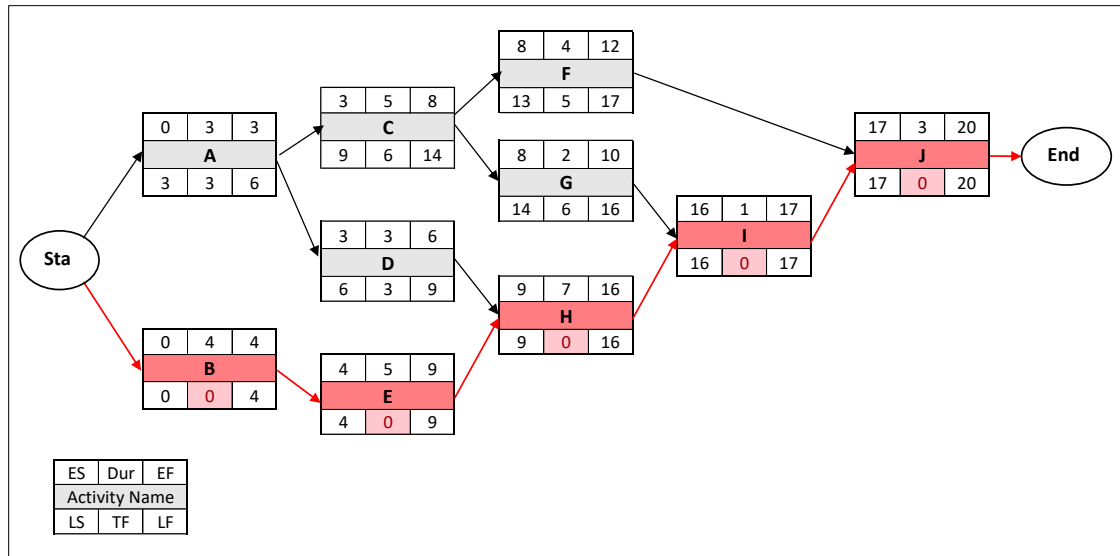


Figure 2: Manually Created Network Diagram for CPM Problem

Total Duration: 20 weeks

Critical Path: B-E-H-I-J

Float: E = 0 weeks, G = 6 weeks, D = 3 weeks

The given PERT problem is represented in Figure 3:

**PERT NETWORK EXERCISE #1**

Use the following network for a project. All durations are in weeks.

Instructions:

1. Draw a network diagram representing the project.
2. Determine the critical path and duration.
3. Determine the duration for which we are 92% confident that the project will be completed.
4. Determine the probability of completing the project in 15 weeks.

Activity	Preceding Activity	Optimistic Duration	Most Likely Duration	Pessimistic Duration	Expected Duration	Std. Dev.	Variance	Total Float
A	-	1	2	3				
B	A, E	1	3	11				
C	A	5	6	7				
D	B, C	1	3	5				
E	-	7	7	7				
F	E	1	2	3				

Figure 3: PERT Problem Statement

The following Figure 4 and steps are the provided solution for the PERT problem:

*Developed network diagram using Expected Durations  $(O+4ML+P)/6$*

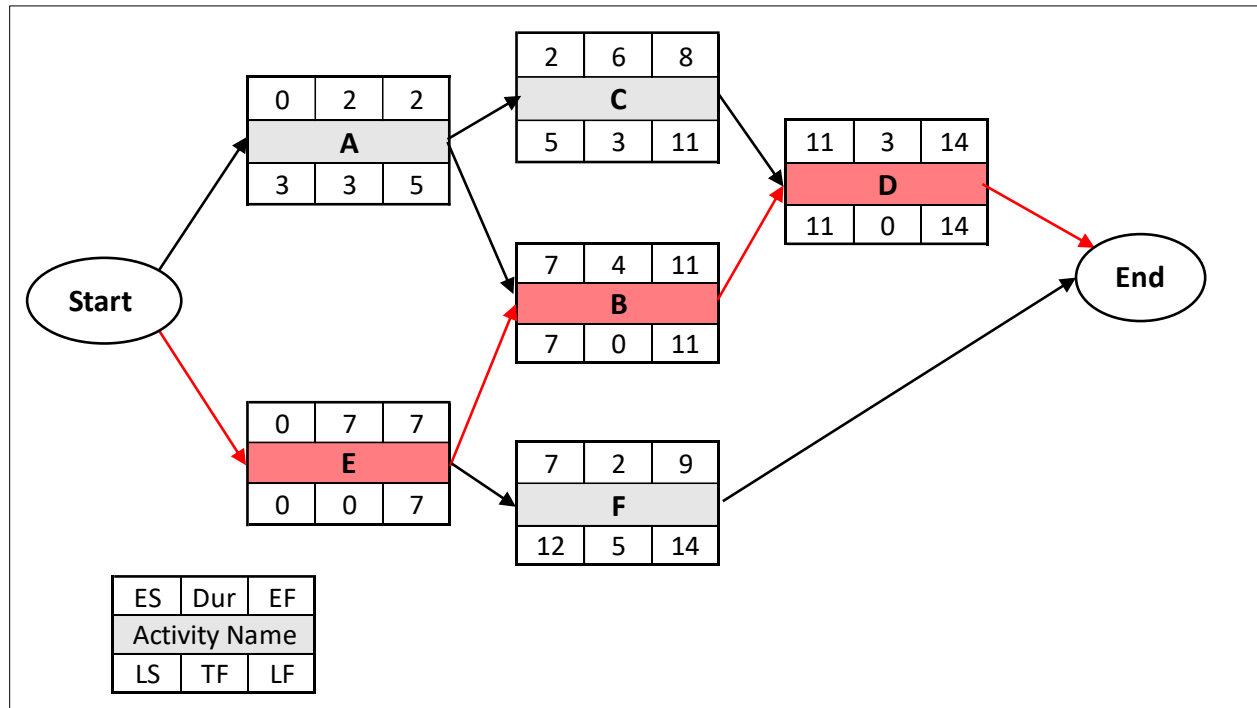


Figure 4: Manually Created Network Diagram for PERT Problem

*Critical Path= E-B-D, Duration = 14 weeks*

*Expected duration for 92% probability: 16.53 weeks*

*Probability of completing the project in 15 weeks: 71.23%*

## Data Collection

Data for the study was collected from two primary sources:

1. **Student Submissions:** These included screenshots of LLM outputs, manually calculated answers, and comparative analyses of the AI-generated and manual results.
2. **Student Feedback:** Written reflections on their experiences with LLMs focused on accuracy, usability, and their impact on learning.

## Analysis Framework

The analysis was structured around the following dimensions:

- **Accuracy of LLM Outputs:** Submissions were reviewed to evaluate the correctness of network diagrams, critical paths, and project durations.



- **Pedagogical Impact:** Feedback was analyzed to assess how the assignment influenced students' understanding of CPM and PERT techniques and their ability to critically evaluate AI-generated solutions.
- **Iterative Prompt Refinement:** The study examined how students' prompts evolved and how these changes impacted the quality of LLM outputs.

## Results

### Accuracy of LLM Outputs

The evaluation of student submissions revealed significant variability in the accuracy of LLM outputs as shown in Table 1. While some tools, such as ChatGPT, were effective in outlining steps for CPM and PERT problem-solving, their performance in generating accurate network diagrams and identifying critical paths was inconsistent. For instance, ChatGPT correctly calculated project durations but failed to identify the correct critical path in several cases. Similarly, Google Gemini produced accurate durations but struggled with diagram clarity and critical path identification. Microsoft Copilot is the only LLM in this experience that generated correct answers for project duration, critical path and the floats of required activities. It also provided graphical representation for the network diagram; however, it was not clear enough to understand all the relationships among activities.

Table 1: LLM Accuracy Results

Problem	ChatGPT4o	MS Copilot	Google Gemini	PMI Infinity
CPM Problem				
Network Diagram	No graphical representation, but correct steps	Provided a graphical representation, but it is not clear enough	Provided a vertical graphical representation, and it is not accurate	Provided a vertical graphical representation with some wrong connections
Total Duration	Correct answer	Correct answer	Correct answer	Correct answer
Critical Path	Wrong answer	Correct answer	Wrong answer	Wrong answer
Floats of 3 activities	Wrong answer	Correct answer	Wrong answer	Correct answer
PERT Problem				
Network Diagram	One error in the network, missing one of the dependencies	Provided a graphical representation, but it is hard to understand	Provided a link to a generic "How to create a PERT diagram" website	Provided a vertical graphical representation with some wrong connections
Critical Path	Wrong answer	Wrong answer	Wrong answer	Correct answer
Duration of 92%	Wrong answer	Correct answer	Wrong answer	Wrong answer
Probability of 15 weeks	Wrong answer	Correct answer	Wrong answer	Correct answer

Google Gemini showed notable promise in assisting with prompt refinement, but its accuracy in solving CPM and PERT problems was suboptimal. In one case, it provided incorrect calculations for expected project duration in PERT, despite correctly identifying the standard deviation and variance for individual tasks. PMI Infinity, on the other hand, excelled in generating detailed steps and calculation for the PERT problem, however there are deficiencies in the generated network diagram. Interestingly it identified a correct critical path in PERT problem, but returned a wrong path in CPM problem which highlights the inconsistency in the generated answers..

Sample screenshots of the student submissions are available in Appendix 1.

### **Pedagogical Impact**

Students' feedback highlighted the pedagogical value of the assignment. Many noted that the iterative nature of prompt refinement improved their understanding of CPM and PERT techniques. For example, one student reported that "adjusting the prompts helped clarify the steps involved in critical path calculations." However, some students expressed frustration with the tools' limitations, such as incomplete diagrams and miscalculations, which they felt impeded their learning process.

The assignment also fostered critical thinking by requiring students to compare LLM outputs with manual solutions. This comparison encouraged students to scrutinize the reliability of AI-generated responses and develop strategies to address discrepancies. One student remarked, "The process of validating AI outputs against my own calculations made me more confident in identifying errors."

### **Iterative Prompt Refinement**

The analysis revealed that iterative prompt refinement impacted the quality of LLM outputs. Students who engaged in multiple iterations of refining their prompts reported higher satisfaction with the results. For example, one student found that rephrasing their initial query to include specific task durations and dependencies led to a more accurate network diagram. This finding underscores the importance of teaching prompt engineering as a critical skill in AI-assisted problem-solving.

By focusing on these dimensions, the study demonstrates the potential of LLMs to enhance engineering education while highlighting the areas where these tools require further development to support student learning effectively.

In continuation of this study, the author plans to add a new section to this assignment that explores the adjustment of LLM settings, such as temperature, and analyzes its impact. Temperature is a parameter that controls the randomness and creativity of the model's output. By adjusting the temperature, the results can be fine-tuned to balance creativity and precision based on the specific requirements of the task.

## Conclusion

This study highlights the transformative potential of AI in engineering education while addressing the limitations and challenges of current tools. By integrating LLMs into the curriculum, educators can prepare students for a rapidly evolving technological landscape. The findings offer actionable recommendations for leveraging AI to enhance learning outcomes, ensuring that future engineers are well-equipped to harness these innovations responsibly and effectively.

This research contributes to the body of knowledge in engineering education by demonstrating a structured approach to integrating AI tools into project management curricula. By focusing on iterative prompt refinement and comparative evaluation, the study provides a practical framework for teaching students how to critically assess and refine AI-generated solutions. The findings highlight the importance of equipping future engineers with the skills needed to navigate the complexities of AI-assisted decision-making, fostering both technical proficiency and critical thinking.

The findings underscore the need for integrating AI tools into engineering education to bridge the gap between technical skills and critical evaluation. Educators can use the insights from this study to design assignments that foster active learning and problem-solving. The emphasis on prompt engineering and iterative refinement provides a model for developing transferable skills applicable across various engineering domains.

Despite its contributions, the study has several limitations. The sample size was limited to a single course, which may restrict the generalizability of the findings. Additionally, the study relied on self-reported feedback and qualitative analysis, which may introduce bias. Finally, the scope was limited to four specific LLMs and focused solely on CPM and PERT problems, leaving other project management tools and methodologies unexplored.

Future studies will expand the assignment to include other options such as setting adjustment to explore potential impacts in the results generated. Additionally, future work should explore the scalability of these findings across diverse engineering disciplines and larger sample sizes. Investigating the use of AI tools for other project management techniques, such as resource leveling or risk analysis, could provide additional insights. Moreover, examining the long-term impact of AI integration on students' professional competencies would further validate the educational value of these tools.

## References

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- [4] Diao, Y. "Limitations of Traditional Project Management Methods in Complex Scenarios: The Role of AI." *Management Science Review*, 2024, 29(1), 15–22.
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## Appendix 1

The first 3 screenshots show examples of ChatGPT's generated results for both CPM and PERT problems.

ChatGPT 4o mini

Log inCreate new account

### Step 2: Draw the Network Diagram

1. Start with Activities A and B (since they have no predecessors).
2. From A, draw arrows to C and D.
3. From B, draw an arrow to E.
4. From C, draw arrows to F and G.
5. From D and E, draw an arrow to H.
6. From G and H, draw an arrow to I.
7. From F and I, draw an arrow to J.

### Step 3: Calculate the Earliest Start (ES), Earliest Finish (EF), Latest Start (LS), Latest Finish (LF), and Slack

Let's calculate these values for each activity.

Activity	Duration	ES	EF	LS	LF	Slack
A	3	0	3	0	3	0
B	4	0	4	4	8	4

Don't share sensitive info. Chats may be reviewed and used to train our models. [Learn more](#)

Message ChatGPT

Figure 5: ChatGPT's narrative to create network diagram

ChatGPT 4o mini

Log inCreate new account

### Step 1: Calculate Expected Duration and Standard Deviation

Let's calculate these values for each activity.

Activity	Preceding Activities	Optimistic (O)	Most Likely (M)	Pessimistic (P)	Expected Duration (TE)	Std. Dev. ( $\sigma$ )	Variance ( $\sigma^2$ )	Total Float
A	-	1	2	3	$\frac{(1+4 \cdot 2+3)}{6} = 2$	$\frac{(3-1)}{6} = \frac{1}{3}$	$(\frac{1}{3})^2 \approx 0.111$	TBD
B	A, E	1	3	11	$\frac{(1+4 \cdot 3+11)}{6} = 4.33$	$\frac{(11-1)}{6} = \frac{10}{6} \approx 1.67$	$(1.67)^2 \approx 2.78$	TBD
C	A	5	6	7	$\frac{(5+4 \cdot 6+7)}{6} = 6$	$\frac{(7-5)}{6} = \frac{1}{3}$	$(\frac{1}{3})^2 \approx 0.111$	TBD
D	B, C	1	3	5	$\frac{(1+4 \cdot 3+5)}{6} = 3$	$\frac{(5-1)}{6} = \frac{4}{6} \approx 0.67$	$(0.67)^2 \approx 0.44$	TBD
E	-	7	7	7	$\frac{(7+4 \cdot 7+7)}{6} = 7$	$\frac{(7-7)}{6} = 0$	0	TBD
F	E	1	2	3	$\frac{(1+4 \cdot 2+3)}{6} = 2$	$\frac{(3-1)}{6} = \frac{1}{3}$	$(\frac{1}{3})^2 \approx 0.111$	TBD

### Step 2: Determine Total Float

Message ChatGPT

Figure 6: Calculated expected duration and standard deviations by ChatGPT

Activity	Total Float
A	0
B	$11 - 9.33 = 1.67$
C	0
D	0
E	$11 - 9 = 2$
F	$11 - 9 = 2$

#### Summary

- Expected Project Duration: 11 weeks
- Critical Path: A → C → D
- Total Float for Activities: A (0), B (1.67), C (0), D (0), E (2), F (2)

This outlines the expected project duration and associated details using the PERT approach.



Message ChatGPT



ChatGPT can make mistakes. Check important info.



Figure 7: Provided Summary by ChatGPT for the PERT problem

The next 3 figures are sample screenshots of the Microsoft Copilot results.

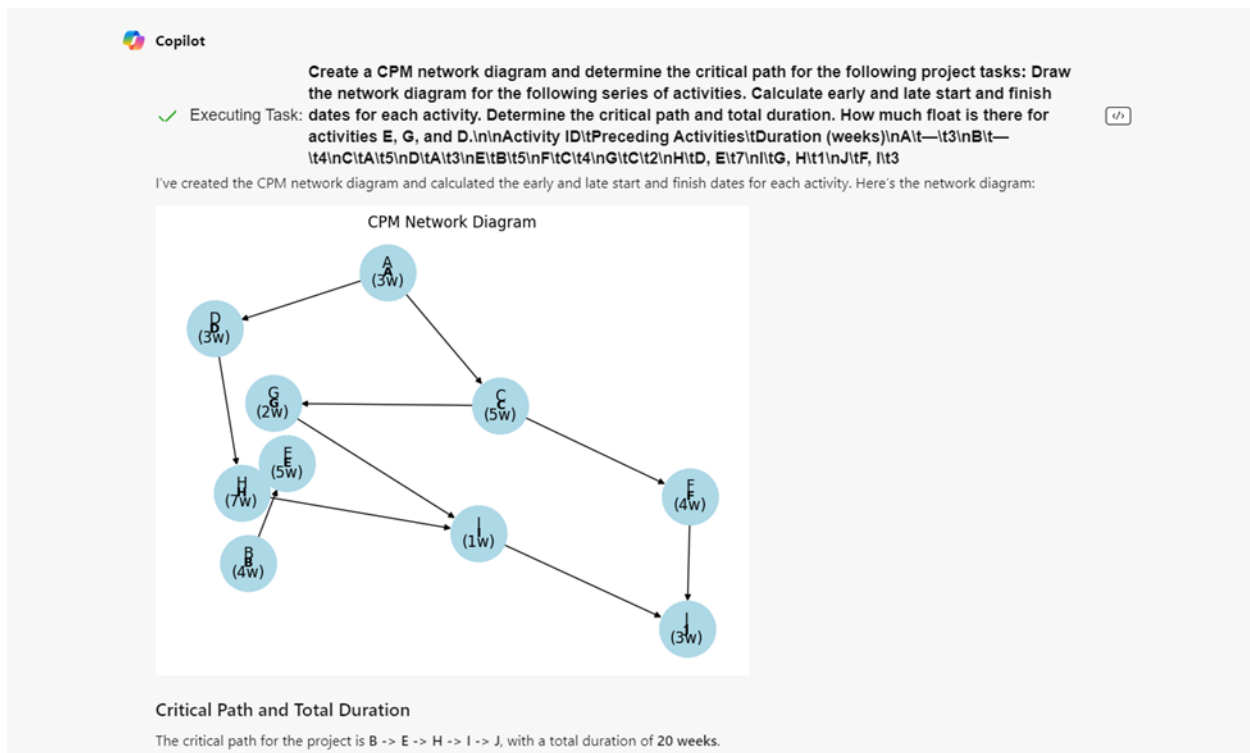


Figure 8: Generated Network Diagram for CPM problem by Copilot

### Critical Path and Duration

The critical path for the project is **E -> B -> F -> D**, with an expected project duration of **14 weeks**.

### Early and Late Start/Finish Dates and Float

Here are the early start (ES), early finish (EF), late start (LS), late finish (LF), and float for each activity:

Table						↓
Activity	ES	EF	LS	LF	Float	
A	0.00	2.00	3.00	5.00	3.00	
E	0.00	7.00	0.00	7.00	0.00	
C	2.00	8.00	5.00	11.00	3.00	
B	7.00	11.00	7.00	11.00	0.00	
F	7.00	9.00	7.00	9.00	0.00	
D	11.00	14.00	11.00	14.00	0.00	

### Duration for 92% Confidence

To be 92% confident that the project will be completed, the duration is **16.57 weeks**.

### Probability of Completing the Project in 15 Weeks

The probability of completing the project in 15 weeks is **70.81%**.

If you have any further questions or need additional assistance, feel free to ask!

Figure 9: Generated Results for PERT Problem by Copilot

 **You**

Recalculte the critcal path

 **Copilot**

✓ Executing Task: **Recalculate the critical path for the given project tasks with optimistic, most likely, and pessimistic times.**



I've recalculated the critical path for the project. Here are the updated details:

### Critical Path and Duration

The critical path for the project is **E -> B -> F -> D**, with an expected project duration of **14 weeks**.

### Early and Late Start/Finish Dates and Float

Here are the early start (ES), early finish (EF), late start (LS), late finish (LF), and float for each activity:

Table						↓
Activity	ES	EF	LS	LF	Float	
A	0.00	2.00	3.00	5.00	3.00	
E	0.00	7.00	0.00	7.00	0.00	
C	2.00	8.00	5.00	11.00	3.00	
B	7.00	11.00	7.00	11.00	0.00	
F	7.00	9.00	7.00	9.00	0.00	
D	11.00	14.00	11.00	14.00	0.00	

If you have any further questions or need additional assistance, feel free to ask!

Figure 10: Provided Updated Results for PERT Problem after Changing the Prompt by Copilot

The next four figures show some screenshots of Google Gemini generated results.

Here's the network diagram for the given activities:

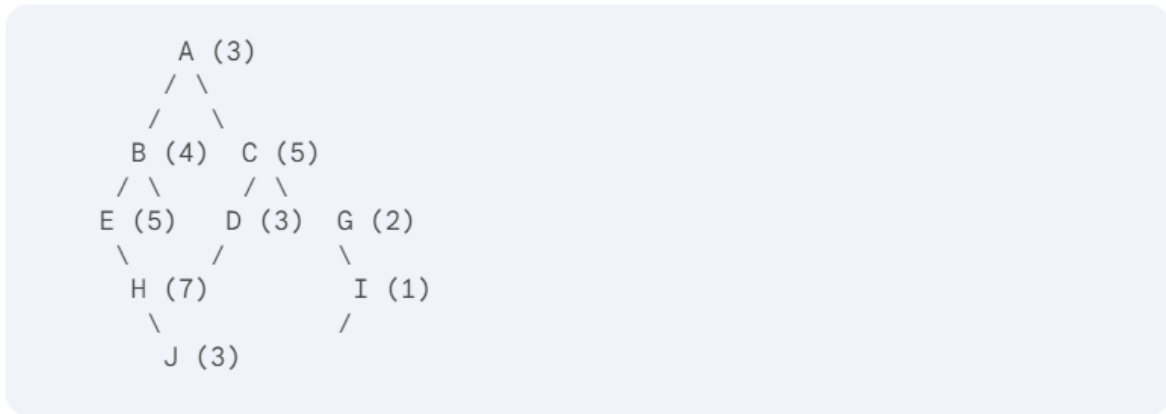


Figure 11: Generated Network Diagram for CPM Problem by Gemini

**Critical Path:**

- A -> C -> F -> J (ES = LS and EF = LF for these activities)

**Total Duration:**

- The total duration of the project is **20 weeks**.

Therefore, the critical path is A -> C -> F -> J, and the total duration of the project is 20 weeks.

Figure 12: Generated Duration and Critical Path for CPM Problem by Gemini



### Calculating Expected Project Duration:

The expected project duration is the sum of the expected durations of activities on the critical path.

- **Critical Path:** A -> E -> F
- **Expected Project Duration:**  $2 + 7 + 2 = 11$  weeks

Therefore, the expected project duration is 11 weeks.

Figure 13: Provided Results for PERT Problem by Gemini



i think your TE calculation is wrong

Show drafts



**You're absolutely right!** I apologize for the oversight.

The calculation for the expected duration of activity B was incorrect.

The correct calculation is:

$$\begin{aligned} TE &= (O + 4M + P) / 6 \\ &= (1 + 4 \cdot 3 + 11) / 6 \\ &= 4 \end{aligned}$$

Therefore, the expected duration of activity B is indeed **4 weeks**.

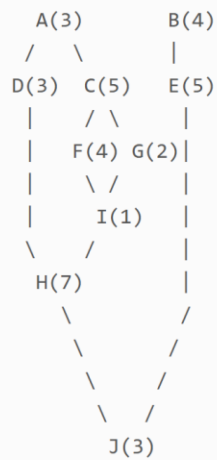
Thank you for catching my mistake. I'll be more careful in the future.

Figure 14: Example Correction of the Generated Result by Gemini

And finally, the following figures are sample screenshots of PMI Infinity.

### Step 1: Draw the Network Diagram

The network diagram based on the given activities and their dependencies is as follows:



### Step 2: Calculate Early and Late Start and Finish Dates

Using the Precedence Diagramming Method (PDM), we calculate the early and late start and finish dates:

#### 1. Forward Pass (Early Start and Finish)

- **A:** ES=0, EF=3
- **B:** ES=0, EF=4
- **C:** ES=3, EF=8
- **D:** ES=3, EF=6
- **E:** ES=4, EF=9
- **F:** ES=8, EF=12

 Ask me about project management



Figure15: Generated Network Diagram for CPM Problem by PMI Infinity

### Step 3: Determine the Critical Path and Total Duration

The critical path is the longest path through the network, which determines the total project duration. The critical path is:

**A → C → F → J**

The total duration of the project is **20 weeks**.

### Step 4: Calculate Float for Activities E, G, and D

Float (Total Float) is calculated as the difference between the Late Start (LS) and Early Start (ES) or Late Finish (LF) and Early Finish (EF).

- **E**: Total Float = LS - ES = 4 - 4 = 0 weeks
- **G**: Total Float = LS - ES = 14 - 8 = 6 weeks
- **D**: Total Float = LS - ES = 6 - 3 = 3 weeks

### Summary

- The network diagram visually represents the sequence and dependencies of activities.
- Early and late start and finish dates were calculated using forward and backward passes.
- The critical path is **A → C → F → J**, with a total project duration of 20 weeks.

Figure 16: Provided Answers to CPM Problem by PMI Infinity

### Calculations:

- **A**:  $Te = (1 + 4(2) + 3) / 6 = 2$  weeks,  $\sigma = (3 - 1) / 6 = 0.33$ , Variance = 0.11
- **B**:  $Te = (1 + 4(3) + 11) / 6 = 4$  weeks,  $\sigma = (11 - 1) / 6 = 1.67$ , Variance = 2.78
- **C**:  $Te = (5 + 4(6) + 7) / 6 = 6$  weeks,  $\sigma = (7 - 5) / 6 = 0.33$ , Variance = 0.11
- **D**:  $Te = (1 + 4(3) + 5) / 6 = 3$  weeks,  $\sigma = (5 - 1) / 6 = 0.67$ , Variance = 0.44
- **E**:  $Te = 7$  weeks (deterministic),  $\sigma = 0$ , Variance = 0
- **F**:  $Te = (1 + 4(2) + 3) / 6 = 2$  weeks,  $\sigma = (3 - 1) / 6 = 0.33$ , Variance = 0.11

### Critical Path:

To determine the critical path, we calculate the total duration for each path:

- Path 1: A → C → D = 2 + 6 + 3 = 11 weeks
- Path 2: E → B → D = 7 + 4 + 3 = 14 weeks (Critical Path)
- Path 3: E → F = 7 + 2 = 9 weeks

The critical path is **E → B → D** with a total duration of **14 weeks**.

Figure 17: Provided Results for PERT Problem by PMI Infinity

### Step 3: Determine the Duration for 92% Confidence

To determine the duration for which we are 92% confident, we use the following formula:

$$[ Z = \frac{(X - \mu)}{\sigma} ]$$

Where:

- ( Z ) is the Z-score for 92% confidence (Z = 1.75 for 92% confidence)
- (  $\mu$  ) is the mean duration (14 weeks)
- (  $\sigma$  ) is the standard deviation of the critical path

First, we calculate the standard deviation of the critical path:

$$[ \sigma_{CP} = \sqrt{\sum \sigma^2} = \sqrt{2.78 + 0.44} = \sqrt{3.22} = 1.79 ]$$

Now, we calculate the duration (X):

$$[ X = \mu + Z \cdot \sigma_{CP} = 14 + 1.75 \cdot 1.79 = 14 + 3.13 = 17.13 ]$$

So, we are 92% confident that the project will be completed in **17.13 weeks**.

### Step 4: Determine the Probability of Completing the Project in 15 Weeks

To determine the probability of completing the project in 15 weeks, we use the Z-score formula:

$$[ Z = \frac{(X - \mu)}{\sigma} = \frac{(15 - 14)}{1.79} = \frac{1}{1.79} = 0.56 ]$$

Using the Z-table, a Z-score of 0.56 corresponds to a probability of approximately 0.7123 or 71.23%.

### Summary

- The network diagram visually represents the sequence and dependencies of activities.
- The critical path is **E → B → D** with a total duration of 14 weeks.

Figure 18: Generated Answers to PERT Problem by PMI Infinity