

Problems Set: Project Management

Milwaukee Paper Manufacturing has identified the eight activities that need to be performed in order for the project to be completed.

Activity	Description	Predecessors	Time
A	Build internal components		2
B	Modify roof and floor		3
C	Task Arrangement	A	2
D	App Design	A, B	4
E	Purchase facilities	C	4
F	App propaganda	C	3
G	App Coding	D, E	5
H	App Improvement	F, G	2

Exercise 1 Critical Path Method

a) Draw an Activity-on-Node (AON) graph based on the schedule above. (Quiz Question)

b) Calculate the ES, EF, LS, LF and slack time of each activity.

Activity	Predecessors	Time	Early Start	Early Finish	Late Start	Late Finish	Slack
A		2					
B		3					
C	A	2					
D	A, B	4					
E	C	4					
F	C	3					
G	D, E	5					
H	F, G	2					

c) Report the critical path and calculate the duration of this project. (Quiz Question)

Exercise 2 Program evaluation and review technique (PERT)

Now consider this project under three-time estimates.

Activity	Expected Time	Optimistic (a)	Most Likely (m)	Pessimistic (b)	Variance
A		1	2	3	
B		2	3	4	
C		1	2	3	
D		2	4	6	
E		1	4	7	
F		1	2	9	
G		3	4	11	
H		1	2	3	

a) Calculate the expected time of each **activity** and the variance of the completion time of the **project**.

b) Show the critical path.

c) What is the estimated time of the critical path?

d) Assume the estimate time is normally distributed, what is the probability that the completion time is larger than 16? Smaller than 14? Between 14 and 16? (Quiz Question)

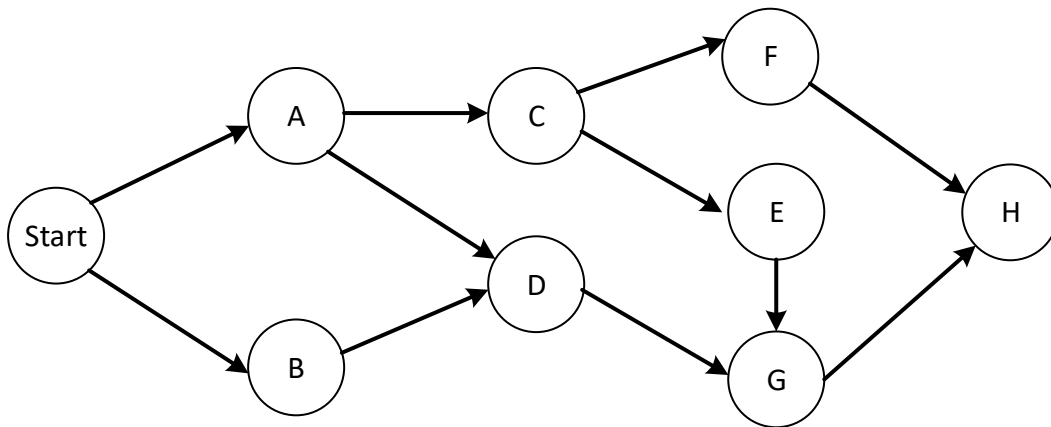
Solutions

Milwaukee Paper Manufacturing has identified the eight activities that need to be performed in order for the project to be completed.

Activity	Description	Predecessors	Time
A	Build internal components		2
B	Modify roof and floor		3
C	Task Arrangement	A	2
D	App Design	A, B	4
E	Purchase facilities	C	4
F	App propaganda	C	3
G	App Coding	D, E	5
H	App Improvement	F, G	2

Exercise 1 Critical Path Method

a) Draw an Activity-on-Arrow (AOA) graph based on the schedule above.



b) Calculate the ES, EF, LS, LF and slack time of each activity.

Activity	Predecessors	Time	Early Start	Early Finish	Late Start	Late Finish	Slack
A		2					
B		3					
C	A	2					
D	A, B	4					
E	C	4					
F	C	3					

G	D, E	5				
H	F, G	2				

Activity	Early Start	Early Finish	Late Start	Late Finish	Slack
A	0	2	0	2	0
B	0	3	1	4	1
C	2	4	2	4	0
D	3	7	4	8	1
E	4	8	4	8	0
F	4	7	10	13	6
G	8	13	8	13	0
H	13	15	13	15	0
	Project	15			

c) Report the critical path and calculate the duration of this project.

Critical Path: A → C → E → G → H

$$\text{Duration} = 2 + 2 + 4 + 5 + 2 = 15$$

Exercise 2 Program evaluation and review technique (PERT)

Now consider this project under three-time estimates.

Activity	Expected Time	Optimistic (a)	Most Likely (m)	Pessimistic (b)	Variance
A		1	2	3	
B		2	3	4	
C		1	2	3	
D		2	4	6	
E		1	4	7	
F		1	2	9	
G		3	4	11	
H		1	2	3	

a) Calculate the expected time of each activity and the variance of the completion time of the project.

Activity	Expected Time	Variance
A	2	0.111111
B	3	0.111111
C	2	0.111111
D	4	0.444444
E	4	1
F	3	1.777778
G	5	1.777778
H	2	0.111111
	Project	3.111111
	Std.dev	1.763834

The variance of the completion time of the project is 3.11.

b) Show the critical path.

Activity	Early Start	Early Finish	Late Start	Late Finish	Slack
A	0	2	0	2	0
B	0	3	1	4	1
C	2	4	2	4	0
D	3	7	4	8	1
E	4	8	4	8	0
F	4	7	10	13	6
G	8	13	8	13	0
H	13	15	13	15	0
	Project	15			

Critical Path: A → C → E → G → H

c) What is the estimated time of the critical path?

$$\text{Duration} = 2 + 2 + 4 + 5 + 2 = 15$$

d) Assume the estimate time is normally distributed, what is the probability that the completion time is larger than 16? Smaller than 14? Between 14 and 16?

Expected Completion Time = 15, Variance = 3.11

Calculated by Excel

$$P(X > 16) = 1 - P(X < 16) = 0.285$$

$$P(X < 14) = 0.285$$

The normal curve is symmetric at $X=15$ so $P(X > 16) = P(X < 14)$

$$P(14 < X < 16) = P(X < 16) - P(X < 14) = 0.430$$