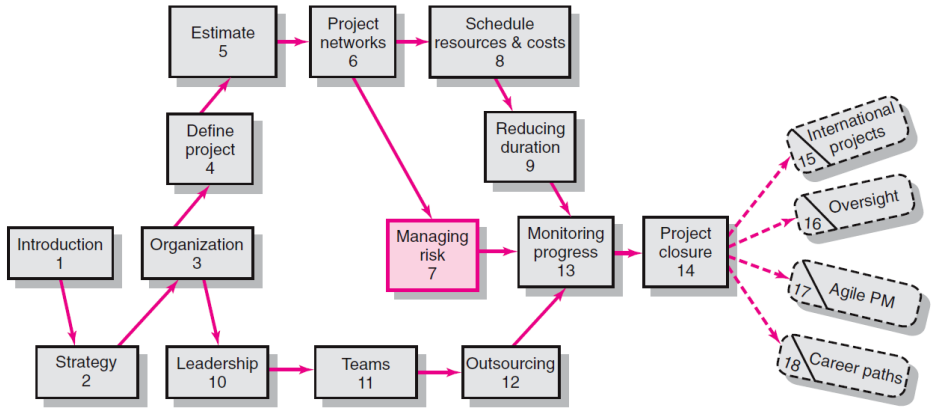
Module : 3
Risk management

Where We Are Now



Risk Management Process

- Risk
  - Uncertain or change events that planning can not overcome or control.
- Risk Management
  - A proactive attempt to recognize and manage internal events and external threats that affect the likelihood of a project's success.
    - What can go wrong (risk event).
    - How to minimize the risk event's impact (consequences).
    - What can be done before an event occurs (anticipation).
    - What to do when an event occurs (contingency plans).

The Risk Event Graph

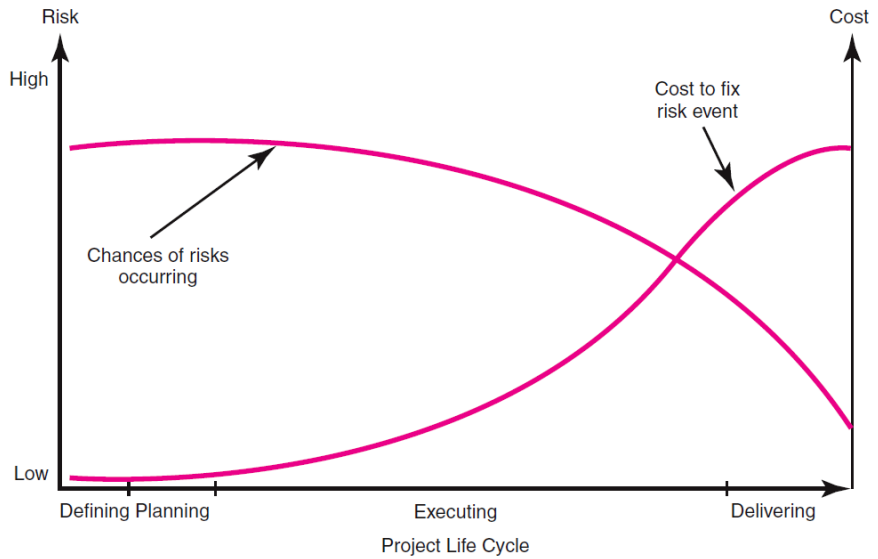
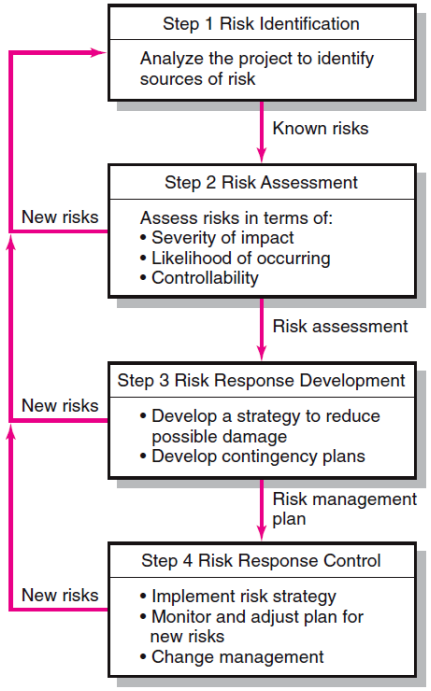


FIGURE 7.1

Risk Management's Benefits

- A proactive rather than reactive approach.
- Reduces surprises and negative consequences.
- Prepares the project manager to take advantage of appropriate risks.
- Provides better control over the future.
- Improves chances of reaching project performance objectives within budget and on time.



The Risk Management Process

FIGURE 7.2

Managing Risk

- Step 1: Risk Identification
  - Generate a list of possible risks through brainstorming, problem identification and risk profiling.
    - Macro risks first, then specific events
- Step 2: Risk Assessment
  - Scenario analysis for event probability and impact
  - Risk assessment matrix
  - Failure Mode and Effects Analysis (FMEA)
  - Probability analysis
    - Decision trees, NPV, and PERT
  - Semiquantitative scenario analysis

The Risk Breakdown Structure (RBS)

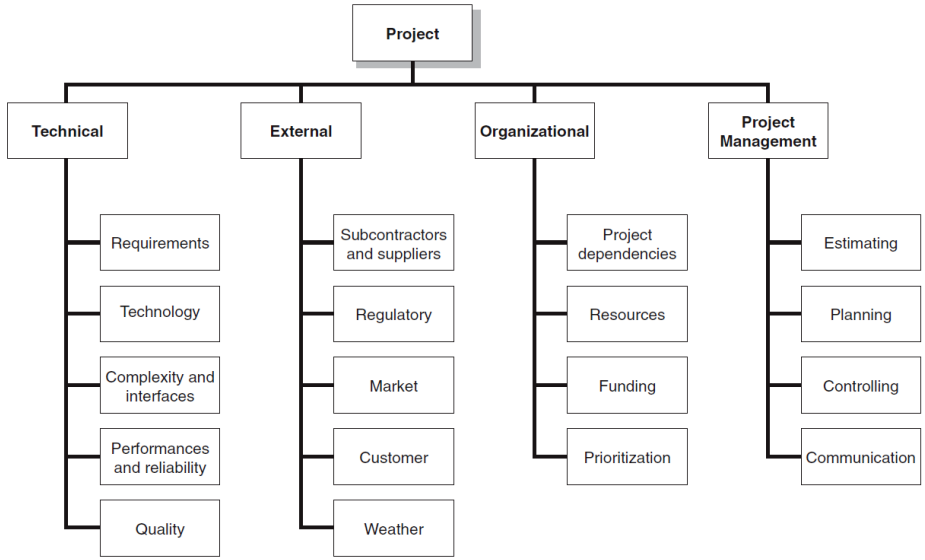


FIGURE 7.3

Partial Risk Profile for Product Development Project

Technical Requirements

Are the requirements stable?

Design

Does the design depend on unrealistic or optimistic assumptions?

Testing

Will testing equipment be available when needed?

Development

Is the development process supported by a compatible set of procedures, methods, and tools?

Schedule

Is the schedule dependent upon the completion of other projects?

Budget

How reliable are the cost estimates?

Quality

Are quality considerations built into the design?

Management

Do people know who has authority for what?

Work Environment

Do people work cooperatively across functional boundaries?

Staffing

Is staff inexperienced or understaffed?

Customer

Does the customer understand what it will take to complete the project?

Contractors

Are there any ambiguities in contractor task definitions?

FIGURE 7.4

Defined Conditions for Impact Scales of a Risk on Major Project Objectives (Examples for negative impacts only)

	Relative or Numerical Scale				
Project Objective	1 Very Low	2 Low	3 Moderate	4 High	5 Very High
Cost	Insignificant cost increase	< 10% cost increase	10–20% cost increase	20–40% cost increase	> 40% cost increase
Time	Insignificant time increase	< 5% time increase	5–10% time increase	10–20% time increase	> 20% time increase
Scope	Scope decrease barely noticeable	Minor areas of scope affected	Major areas of scope affected	Scope reduction unacceptable to sponsor	Project end item is effectively useless
Quality	Quality degradation barely noticeable	Only very demanding applications are affected	Quality reduction requires sponsor approval	Quality reduction unacceptable to sponsor	Project end item is effectively useless

FIGURE 7.5

Risk Assessment Form

Risk Event	Likelihood	Impact	Detection Difficulty	When
Interface problems	4	4	4	Conversion
System freezing	2	5	5	Start-up
User backlash	4	3	3	Postinstallation
Hardware malfunctioning	1	5	5	Installation

Failure Mode and Effects Analysis (FMEA)

Impact × Probability × Detection = Risk Value

FIGURE 7.6

Risk Severity Matrix

Failure Mode and Effects Analysis (FMEA)

Impact × Probability × Detection = Risk Value

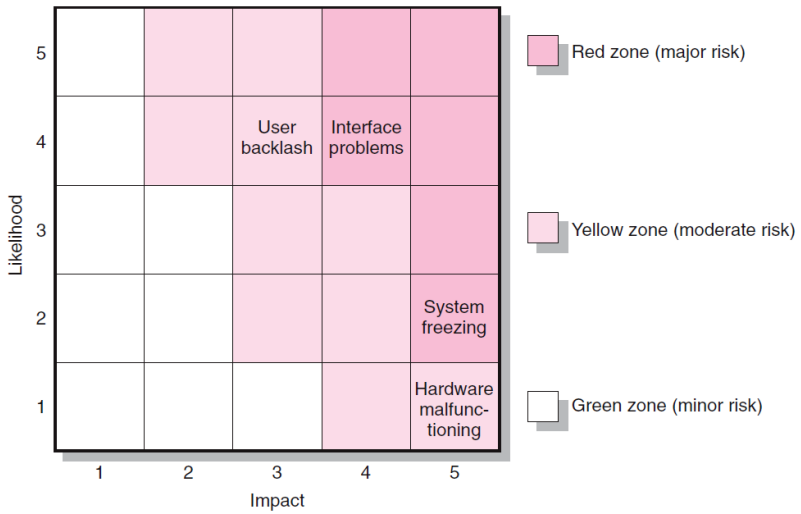


FIGURE 7.7

Managing Risk (cont'd)

- Step 3: Risk Response Development
  - Mitigating Risk
    - Reducing the likelihood an adverse event will occur.
    - Reducing impact of adverse event.
  - Avoiding Risk
    - Changing the project plan to eliminate the risk or condition.
  - Transferring Risk
    - Paying a premium to pass the risk to another party.
    - Requiring Build-Own-Operate-Transfer (BOOT) provisions.
  - Retaining Risk
    - Making a conscious decision to accept the risk.

Contingency Planning

- Contingency Plan
  - An alternative plan that will be used if a possible foreseen risk event actually occurs.
  - A plan of actions that will reduce or mitigate the negative impact (consequences) of a risk event.
- Risks of Not Having a Contingency Plan
  - Having no plan may slow managerial response.
  - Decisions made under pressure can be potentially dangerous and costly.

Risk and Contingency Planning

- Technical Risks
  - Backup strategies if chosen technology fails.
  - Assessing whether technical uncertainties can be resolved.
- Schedule Risks
  - Use of slack increases the risk of a late project finish.
  - Imposed duration dates (absolute project finish date)
  - Compression of project schedules due to a shortened project duration date.

Risk Response Matrix

Risk Event	Response	Contingency Plan	Trigger	Who Is Responsible
Interface problems	Mitigate: Test prototype	Work around until help comes	Not solved within 24 hours	Nils
System freezing	Mitigate: Test prototype	Reinstall OS	Still frozen after one hour	Emmylou
User backlash	Mitigate: Prototype demonstration	Increase staff support	Call from top management	Eddie
Equipment malfunctions	Mitigate: Select reliable vendor Transfer: Warranty	Order replacement	Equipment fails	Jim

FIGURE 7.8

Risk and Contingency Planning (cont'd)

- Costs Risks
  - Time/cost dependency links: costs increase when problems take longer to solve than expected.
  - Deciding to use the schedule to solve cash flow problems should be avoided.
  - Price protection risks (a rise in input costs) increase if the duration of a project is increased.
- Funding Risks
  - Changes in the supply of funds for the project can dramatically affect the likelihood of implementation or successful completion of a project.

Opportunity Management Tactics

- Exploit
  - Seeking to eliminate the uncertainty associated with an opportunity to ensure that it definitely happens.
- Share
  - Allocating some or all of the ownership of an opportunity to another party who is best able to capture the opportunity for the benefit of the project.
- Enhance
  - Taking action to increase the probability and/or the positive impact of an opportunity.
- Accept
  - Being willing to take advantage of an opportunity if it occurs, but not taking action to pursue it.

Contingency Funding and Time Buffers

- Contingency Funds
  - Funds to cover project risks—identified and unknown.
    - Size of funds reflects overall risk of a project
  - Budget reserves
    - Are linked to the identified risks of specific work packages.
  - Management reserves
    - Are large funds to be used to cover major unforeseen risks (e.g., change in project scope) of the total project.
- Time Buffers
  - Amounts of time used to compensate for unplanned delays in the project schedule.
    - Severe risk, merge, noncritical, and scarce resource activities

Contingency Fund Estimate ($000s)

Activity	Budget Baseline	Budget Reserve	Project Budget
Design	$500	$15	$515
Code	900	80	980
Test	20	2	22
Subtotal	$1,420	$97	$1,517
Management reserve	—	—	50
Total	$1,420	$97	$1,567

TABLE 7.1

Managing Risk (cont'd)

- Step 4: Risk Response Control
  - Risk control
    - Execution of the risk response strategy
    - Monitoring of triggering events
    - Initiating contingency plans
    - Watching for new risks
  - Establishing a Change Management System
    - Monitoring, tracking, and reporting risk
    - Fostering an open organization environment
    - Repeating risk identification/assessment exercises
    - Assigning and documenting responsibility for managing risk

Change Management Control

- Sources of Change
  - Project scope changes
  - Implementation of contingency plans
  - Improvement changes

Change Control System Process

1. Identify proposed changes.
2. List expected effects of proposed changes on schedule and budget.
3. Review, evaluate, and approve or disapprove of changes formally.
4. Negotiate and resolve conflicts of change, condition, and cost.
5. Communicate changes to parties affected.
6. Assign responsibility for implementing change.
7. Adjust master schedule and budget.
8. Track all changes that are to be implemented

The Change Control Process

FIGURE 7.9

Benefits of a Change Control System

1. Inconsequential changes are discouraged by the formal process.
2. Costs of changes are maintained in a log.
3. Integrity of the WBS and performance measures is maintained.
4. Allocation and use of budget and management reserve funds are tracked.
5. Responsibility for implementation is clarified.
6. Effect of changes is visible to all parties involved.
7. Implementation of change is monitored.
8. Scope changes will be quickly reflected in baseline and performance measures.

Project name *Irish/Chinese culture exchange* Project sponsor *Irish embassy*
Request number *12* Date *June 6, 2xxx*
Originator *Jennifer McDonald* Change requested by *Chinese culture office*

Description of requested change
1. *Request river dancers to replace small Irish dance group.*
2. *Request one combination dance with river dancers and China ballet group.*

Reason for change
River dancers will enhance stature of event. The group is well known and loved by Chinese people.

Areas of impact of proposed change–describe each on separate sheet
[X] Scope [X] Cost [ ] Other _____
[ ] Schedule [ ] Risk

Disposition	Priority	Funding Source
[ ] Approve	[ ] Emergency	[ ] Mgmt. reserve
[X] Approve as amended	[X] Urgent	[ ] Budget reserve
[ ] Disapprove	[ ] Low	[X] Customer
[ ] Deferred		[ ] Other

Sign-off Approvals

Project manager *William O'Mally* Date *June 12, 2xxx*
Project sponsor *Kenneth Thompson* Date *June 13, 2xxx*
Project customer *Hong Lee* Date *June 18, 2xxx*
Other _____ Date _____

Sample Change Request Form

FIGURE 7.10

Owner Requested Change Status Report—Open Items **Osu—Weatherford**

Rc#	Description	Reference Document	Dates		Amount	Status	Comments
			Date Rec'd	Date Submit			
51	Sewer work offset				–188,129	OPEN	FUNDING FROM OTHER SOURCE
52	Stainless Plates at restroom Shower Valves	ASI 56	1/5/2008	3/30/2008	9,308	APPROVED	
53	Waterproofing Options	ASI 77	1/13/2008		169,386	OPEN	
54	Change Electrical floor box spec change	RFI 113	12/5/2008	3/29/2008	2,544	SUBMIT	
55	VE Option for Style and rail doors	Door samples	1/14/2008		–20,000	ROM	
56	Pressure Wash C tower	Owner request	3/15/2008	3/30/2008	14,861	SUBMIT	
57	Fire Lite glass in stairs	Owner request			8,000	QUOTE	ROM BASED ON FIRELITE NT
58	Cyber Café added tele/OFOI equipment	ASI 65	1/30/2008	3/29/2008	4,628	APPROVED	
59	Additional Dampers in C wing	ASI 68	2/4/2008	3/29/2008	1,085	SUBMIT	
60	Revise Corridor ceilings	ASI 72	2/13/2008	3/31/2008	–3,755	SUBMIT	

OPEN—Requires estimate
ROM—Rough order magnitde
QUOTE—Subcontractor quotes
SUBMIT—RC letter submitted
APPROVED—RC letter approved
REVISE—RC letter to be reviewed
ASI—Architect's supplemental instructions
RFI—Request for information

Change Request Log

FIGURE 7.11

Key Terms

Avoiding risk
Budget reserve
Change management system
Contingency plan
Management reserve
Mitigating risk
Opportunity
Risk
Risk breakdown structure (RBS)
Risk register
Risk profile
Risk severity matrix
Scenario analysis
Sharing risk
Time buffer
Transferring risk

PERT and PERT Simulation

PERT—Program Evaluation Review Technique

- Assumes each activity duration has a range that statistically follows a beta distribution.
- Uses three time estimates for each activity: optimistic, pessimistic, and a weighted average to represent activity durations.
  - Knowing the weighted average and variances for each activity allows the project planner to compute the probability of meeting different project durations.

Activity and Project Frequency Distributions

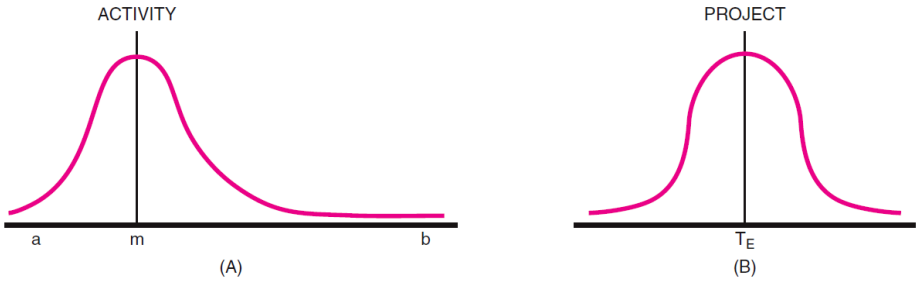


FIGURE A7.1

Activity Time Calculations

The weighted average activity time is computed by the following formula:

$$t_e = \frac{a + 4m + b}{6} \quad (7.1)$$

where t_e = weighted average activity time

a = optimistic activity time (1 chance in 100 of completing the activity earlier under *normal* conditions)

b = pessimistic activity time (1 chance in 100 of completing the activity later under *normal* conditions)

m = most likely activity time

Activity Time Calculations (cont'd)

The variability in the activity time estimates is approximated by the following equations:

The standard deviation for the activity:

$$\sigma_{t_e} = \left(\frac{b - a}{6}\right) \quad (7.2)$$

The standard deviation for the project:

$$\sigma_{T_E} = \sqrt{\Sigma\sigma^2_{t_e}} \quad (7.3)$$

Note the standard deviation of the activity is squared in this equation; this is also called variance. This sum includes only activities on the critical path(s) or path being reviewed.

Activity Times and Variances

Activity	a	m	b	t_e	$[(b - a)/6]^2$
1–2	17	29	47	30	25
2–3	6	12	24	13	9
2–4	16	19	28	20	4
3–5	13	16	19	16	1
4–5	2	5	14	6	4
5–6	2	5	8	5	1

TABLE A7.1

Probability of Completing the Project

The equation below is used to compute the "*Z*" value found in statistical tables (*Z* = number of standard deviations from the mean), which, in turn, tells the probability of completing the project in the time specified.

$$Z = \frac{T_S - T_E}{\sqrt{\Sigma\sigma^2_{t_e}}} \quad (7.4)$$

where T_E = critical path duration
T_S = scheduled project duration
Z = probability (of meeting scheduled duration)

Hypothetical Network

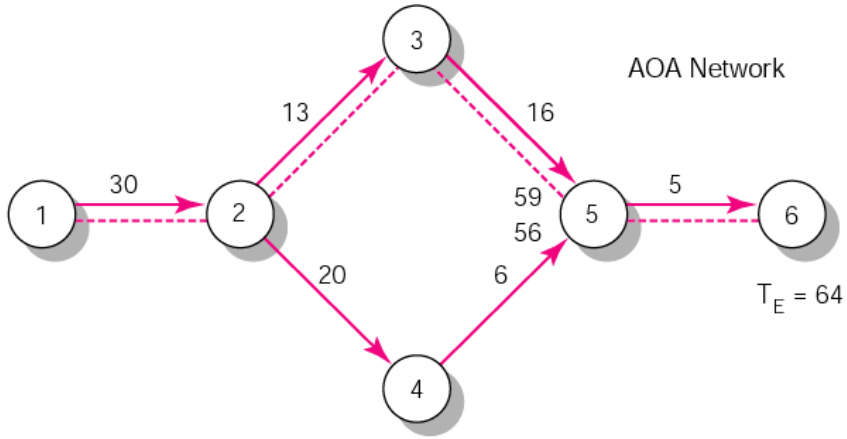


FIGURE A7.2

Hypothetical Network (cont'd)

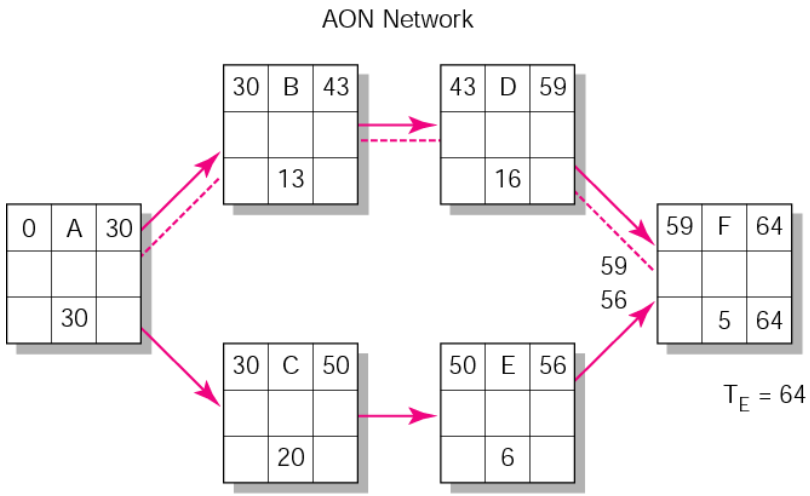


FIGURE A7.2 (cont'd)

Possible Project Duration

Probability project is completed before scheduled time (T_S) of 67 units

$$Z = \frac{T_S - T_E}{\sqrt{\Sigma\sigma^2_{t_e}}} = \frac{67 - 64}{\sqrt{25 + 9 + 1 + 1}} = \frac{+3}{\sqrt{36}} = +0.50$$

$$P = 0.69$$

Probability project is completed by the 60th unit time period (T_S)

$$Z = \frac{60 - 64}{\sqrt{25 + 9 + 1 + 1}} = \frac{-4}{\sqrt{36}} = -0.67$$

$$P \approx 0.26$$

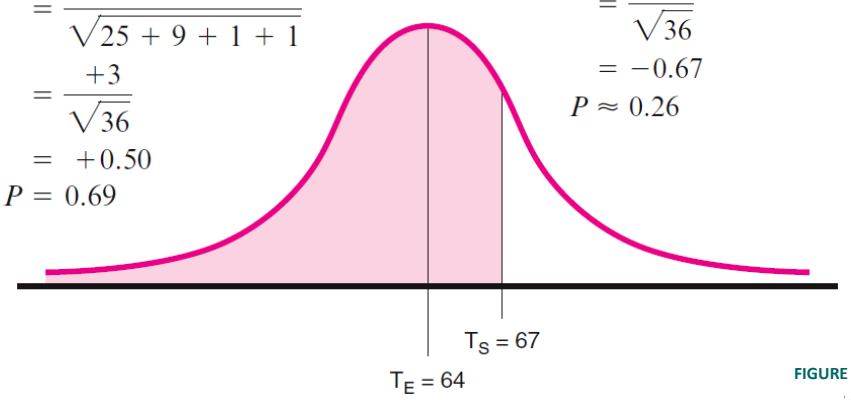


FIGURE A7.3

Z Values and Probabilities

Z Value	Probability	*Z* Value	Probability
−3.0	.001	+0.0	.500
−2.8	.003	+0.2	.579
−2.6	.005	+0.4	.655
−2.4	.008	+0.6	.726
−2.2	.014	+0.8	.788
−2.0	.023	+1.0	.841
−1.8	.036	+1.2	.885
−1.6	.055	+1.4	.919
−1.4	.081	+1.6	.945
−1.2	.115	+1.8	.964
−1.0	.159	+2.0	.977
−0.8	.212	+2.2	.986
−0.6	.274	+2.4	.992
−0.4	.345	+2.6	.995
−0.2	.421	+2.8	.997

TABLE A7.2

Example Problem

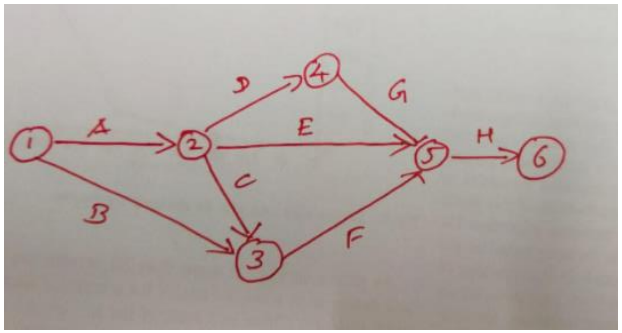
Time – Estimates (in weeks)

Activity	*Preceding activity*	*Most optimistic time (a)*	*Most likely time (m)*	*Most Pessimistic time (b)*
A	None	2	4	12
B	None	10	12	26
C	A	8	9	10
D	A	10	15	20
E	A	7	7.5	11
F	B,C	9	9	9
G	D	3	3.5	7
H	E,F,G	5	5	5

(i) Draw the PERT network for the project.

(ii) Prepare the activity schedule for the project.

(iii) Determine the critical path.

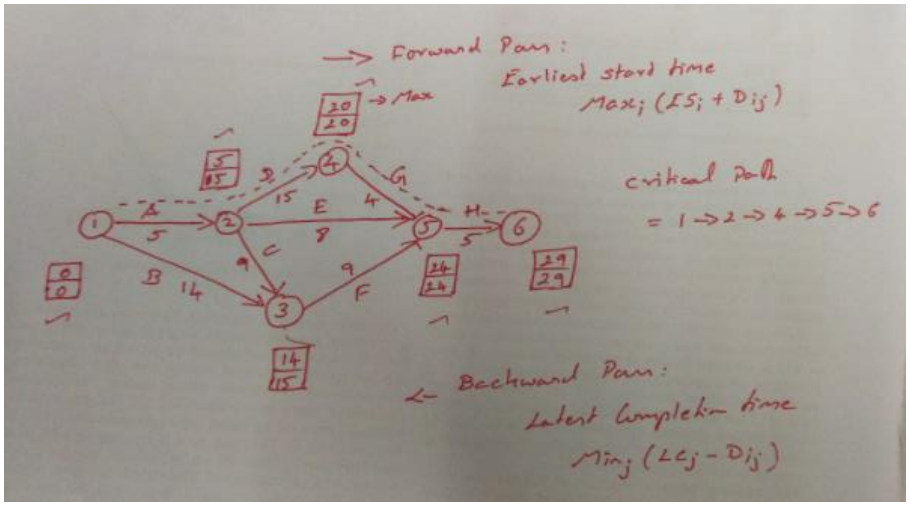


Time – Estimates (in weeks)

Activity	Preceding activity	Most optimistic time (a)	Most likely time (m)	Most Pessimistic time (b)
A	None	2	4	12
B	None	10	12	26
C	A	8	9	10
D	A	10	15	20
E	A	7	7.5	11
F	B,C	9	9	9
G	D	3	3.5	7
H	E,F,G	5	5	5

Calculation activity duration and scheduling times.

Activity	Time estimates			t_e	(σ_t^2)
	a	m	b		
A	2	4	12	5	25/9
B	10	12	26	14	64/9
C	8	9	10	9	1/9
D	10	15	20	15	25/9
E	7	7.5	11	8	4/9
F	9	9	9	9	0
G	3	3.5	7	4	4/9
H	5	5	5	5	0



Activity	Time estimates			t_e	(σ_t^2)	Earliest time		latest time	
	a	m	b			Start	finish	Start	Finish
A	2	4	12	5	25/9	0	5	0	5
B	10	12	26	14	64/9	0	14	1	15
C	8	9	10	9	1/9	5	14	6	15
D	10	15	20	15	25/9	5	20	5	20
E	7	7.5	11	8	4/9	5	13	16	24
F	9	9	9	9	0	14	23	15	24
G	3	3.5	7	4	4/9	20	24	20	24
H	5	5	5	5	0	24	29	24	29

The critical path of the project is 1-2-4-5 -6, critical activities being A, D, G and H

The expected project length is the sum of duration of each critical activity. Expected project length = 5 + 15 + 4 + 5 = 29 weeks.

Variance project length is obtained by summing variance of each critical activity.

$$\text{Variance of project} = \frac{25}{9} + \frac{25}{9} + \frac{4}{9} + 0 = 6$$

Problem

Activity	predecessor	a	m	b	Activity Time (te)	Variance
A	-	5	6	7	6	0.11
B	-	1	3	5	3	0.44
C	-	1	4	7	4	1
D	A	1	2	3	2	0.11
R	B	1	1	9	3	1.78
F	C	1	5	9	5	1.78
G	C	2	2	8	3	1
H	E,F	4	4	10	5	1
I	D	2	5	8	5	1
J	H,G	2	2	8	3	1

Calculation

- Activity A
- Activity time $t_e = \frac{a + 4m + b}{6}$
- = (5+4(6)+7)/6 = 36/6 = 6
- Variance (standard deviation) = $(7\text{-}5/6)^2$
- = 0.11