MASTER OF COMPUTER SCIENCE/
MASTER OF SCIENCE IN COMPUTER SCIENCE

MCS 4204 –
Software Project Management and Quality Assurance

Project Risk Management

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Intended Learning Outcomes

- At the end of this topic, you'll be able to;
  - **Identify** potential risks in software projects
  - **Categorize** and **prioritize** risks
  - **Quantify** the likely effect of risks
  - **Decide** on the risk **actions**
  - **Make plans** to deal with risks

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What is a risk?

- An uncertain event or condition that can cause a threat or opportunity to the project.
- An unforeseen event that can impact the project's cost, schedule, or quality.
- Relates to the future
- Measured in terms of probability of occurrence (high-low) and consequences (loss: high-low)
- Involves cause and effect
- Risk Categories
  - Known/Predictable/Unpredictable

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Risk Management (RM)

- An attempt to minimize the chances of failure or take the opportunity caused by unplanned events/risks.
- Aim to identify, quantify and take actions to minimize the effect of negative risks or face the positive risks
- Risk management involves additional cost
  - RM is cost effective only if the cost of RM is considerably less than the loss incurred
- It's not easy to measure the total cost of RM
- Involves two key components:
  - risk assessment and
  - risk control

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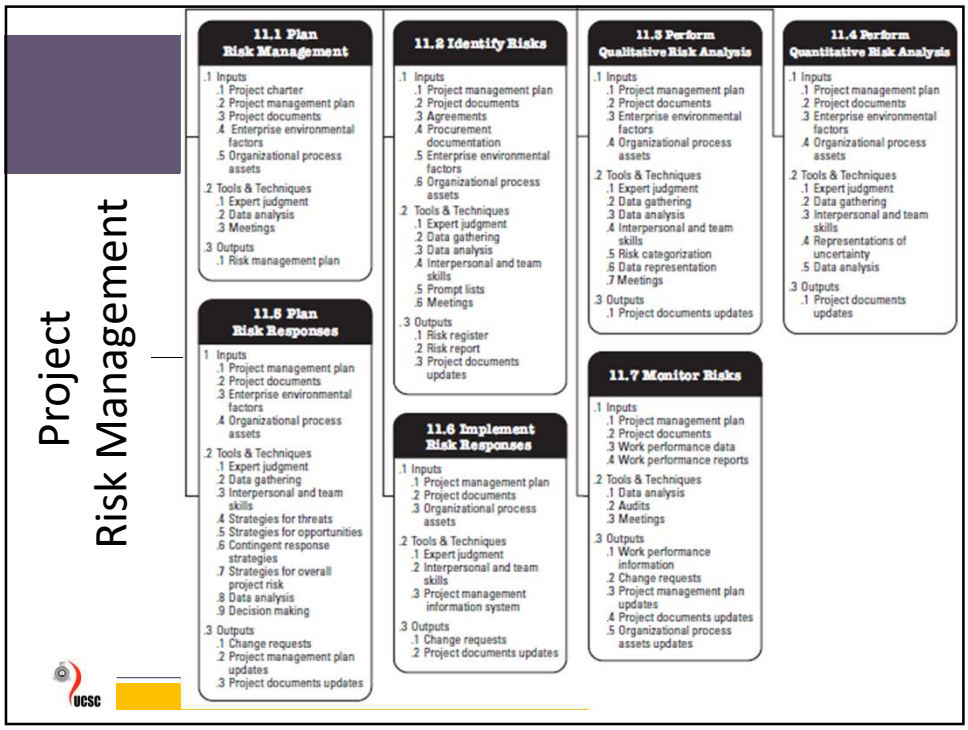

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Activity

- What are the processes in the risk management process group?

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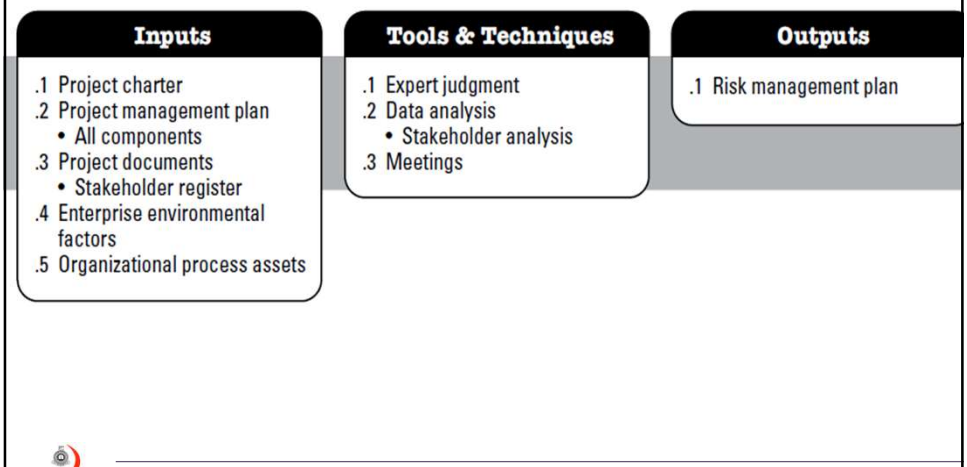
1. Plan Risk Management



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Components of Risk Management Plan

1. **Risk strategy:** The general approach to managing project risks
2. **Methodology:** The approaches, tools, and data sources to perform risk management
3. **Roles and responsibilities:** Risk management team and their responsibilities
4. **Funding:** Funds needed to perform Risk Management activities. Establishes protocols for the application of contingency and management reserves.
5. **Timing:** Defines when and how often the Project Risk Management processes will be performed
6. **Risk categories:** Provides a risk breakdown structure (RBS)

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Components of Risk Management…Contd.

7. **Stakeholder risk appetite:** Measurable risk thresholds around each project objective
8. **Definitions of risk probability and impacts:** Definitions specific to the project context and reflect the risk appetite and thresholds
9. **Probability and impact matrix:** Opportunities and threats represented in a common probability and impact matrix
10. **Reporting formats:** Format of the risk register, risk report and other outputs from the risk management process
11. **Tracking:** Describe how risk activities will be recorded and how risk management processes will be audited

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2. Risk Identification

- Two main approaches;
  1. Checklist
     - Lists a set of risks that have been found more likely to occur and
     - Suggests countermeasures for each risk
  2. Brainstorming
     - Representatives of the main stakeholders discuss and identify the problems that might occur
- Can do a SWOT analysis

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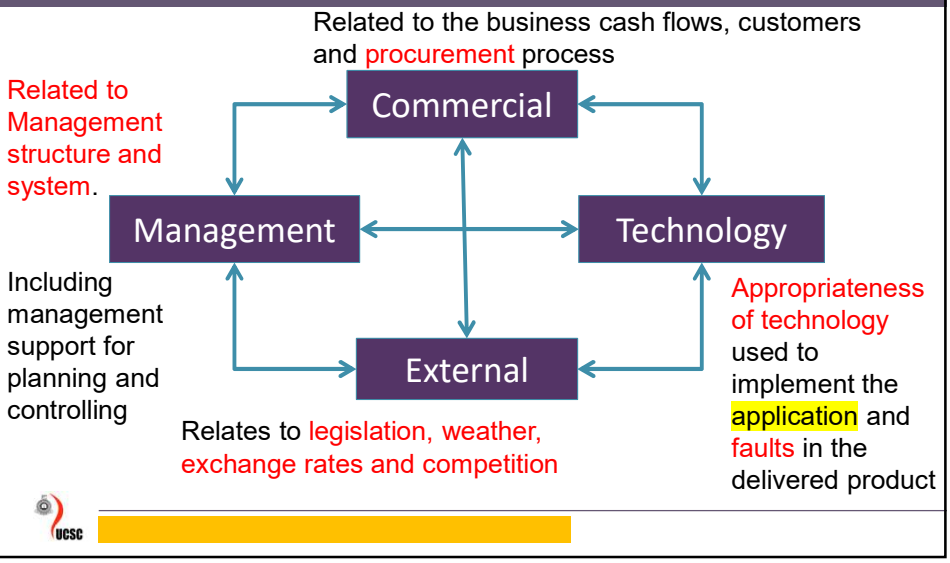
Categorizing Risk



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RBS

Prepare a Risk Breakdown Structure by categorizing all risks affecting the project's life cycle.

RBS LEVEL 0	RBS LEVEL 1	RBS LEVEL 2
0. ALL SOURCES OF PROJECT RISK	1. TECHNICAL RISK	1.1 Scope definition
		1.2 Requirements definition
		1.3 Estimates, assumptions, and constraints
		1.4 Technical processes
		1.5 Technology
		1.6 Technical interfaces
		Etc.
	2. MANAGEMENT RISK	2.1 Project management
		2.2 Program/portfolio management
		2.3 Operations management
		2.4 Organization
		2.5 Resourcing
		2.6 Communication
		Etc.
	3. COMMERCIAL RISK	3.1 Contractual terms and conditions
		3.2 Internal procurement
		3.3 Suppliers and vendors
		3.4 Subcontracts
		3.5 Client/customer stability
		3.6 Partnerships and joint ventures
		Etc.
	4. EXTERNAL RISK	4.1 Legislation
		4.2 Exchange rates
		4.3 Site/facilities
		4.4 Environmental/weather
		4.5 Competition
		4.6 Regulatory
		Etc.

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RBS for Software Development : https://www.pmi.org/learning/library/risk-breakdown-structure-understand-risks-1042

e.g. RBS

LEVEL 0	LEVEL 1	LEVEL 2	LEVEL 3
Project risk	Product engineering	Requirements	Stability Completeness Feasibility …etc…
		Design	Functionality Interfaces Testability …etc…
		Code & unit test	Feasibility Testing Coding/implementation …etc…
		Integration test	Environment Product System …etc…
		Engineering specialities	Maintainability Reliability Security …etc…
	Development environment	Development process	Formality Process control Product control …etc…
		Development system	Capacity Reliability System support …etc…
		Management process	Planning Project organisation Management experience …etc…
		Management methods	Monitoring Configuration management Quality assurance …etc…
		Work environment	Cooperation Communication Morale …etc…
	Program constraints	Resources	Staff Budget Facilities …etc…
		Contract	Type of contract Restrictions Dependencies …etc…
		Program interfaces	Customer Subcontractors Corporate management …etc…

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3-4. Perform Risk Analysis

- Risk Probability Definitions and Impacts

SCALE	PROBABILITY	+/− IMPACT ON PROJECT OBJECTIVES		
		TIME	COST	QUALITY
Very High	>70%	>6 months	>$5M	Very significant impact on overall functionality
High	51-70%	3-6 months	$1M-$5M	Significant impact on overall functionality
Medium	31-50%	1-3 months	$501K-$1M	Some impact in key functional areas
Low	11-30%	1-4 weeks	$100K-$500K	Minor impact on overall functionality
Very Low	1-10%	1 week	<$100K	Minor impact on secondary functions
Nil	<1%	No change	No change	No change in functionality

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3. Qualitative Method of Risk Estimation

Probability	Range
High	Greater than 50% chance of happening
Significant	30-50% chance of happening
Moderate	10-29% chance of happening
Low	Less than 10% chance of happening

Qualitative description of risk probability and associated range values

Impact Level	Range
High	More than 30% above budget expenditure
Significant	20-29% above budget expenditure
Moderate	10-19% above budget expenditure
Low	Within 10 % of budget expenditure

Qualitative descriptors of impact on cost and associated range values

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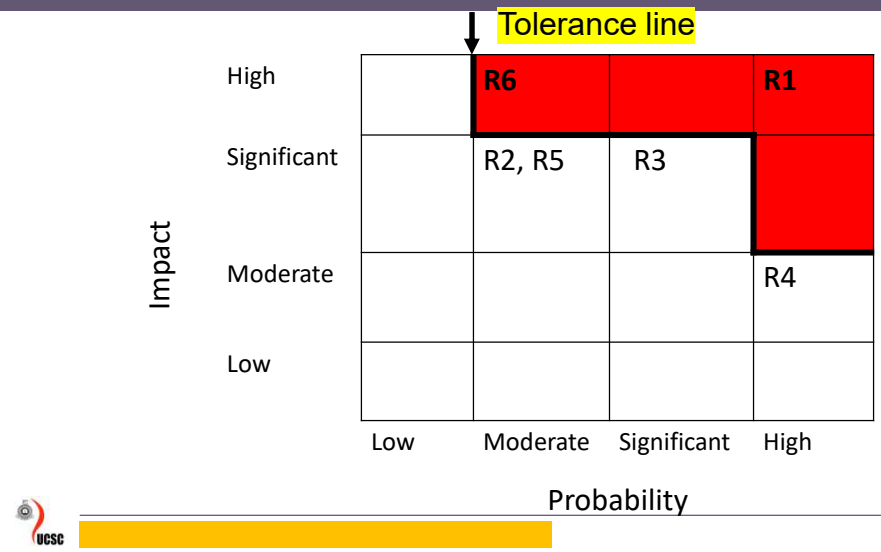
A probability impact matrix



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4. Risk Assessment: Quantitative methods

- Risk Exposure: ***Expected Value*** of the loss for the risk

Risk Exposure = Risk Likelihood x Risk Impact

RE(R) = Prob(R) x Loss(R)

- Risk Likelihood: The probability of a risk.
- Risk Impact: The total loss incurred if the risk happens.

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Probability and Impact Matrix with Scoring Scheme

Probability	Threats					Opportunities					Probability
Very High 0.90	0.05	0.09	0.18	0.36	0.72	0.72	0.36	0.18	0.09	0.05	Very High 0.90
High 0.70	0.04	0.07	0.14	0.28	0.56	0.56	0.28	0.14	0.07	0.04	High 0.70
Medium 0.50	0.03	0.05	0.10	0.20	0.40	0.40	0.20	0.10	0.05	0.03	Medium 0.50
Low 0.30	0.02	0.03	0.06	0.12	0.24	0.24	0.12	0.06	0.03	0.02	Low 0.30
Very Low 0.10	0.01	0.01	0.02	0.04	0.08	0.08	0.04	0.02	0.01	0.01	Very Low 0.10
	Very Low 0.05	Low 0.10	Moderate 0.20	High 0.40	Very High 0.80	Very High 0.80	High 0.40	Moderate 0.20	Low 0.10	Very Low 0.05	
	Negative Impact					Positive Impact					

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Risk Assessment Contd....

- E.g.

A project depends on a data center which is vulnerable to fire. It is estimated that there is a 1 in 1000 chance fire actually happening. If a fire occurred a new computer configuration could be established for Rs.500,000. Find the risk exposure.

RE(R) = Prob(R) x Loss(R)

RE=1/1000 x 500,000 =Rs.500

This is the minimum sum an insurance company would require as a premium.

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Calculating Risk Exposure

Factor	P	C	RE
Late delivery from COTS vendor ACME	0.25	28 days	7 days
ACME API integration delay	0.6	15 days	9 days
Additional unit testing needed; 3% more classes than first estimated	0.9	20 days	18 days
Beta test group reports that they may not be able to fit us into their pipeline until May 1 instead of April 1	0.5	30 days	15 days
TOTAL RISK EXPOSURE			49 days

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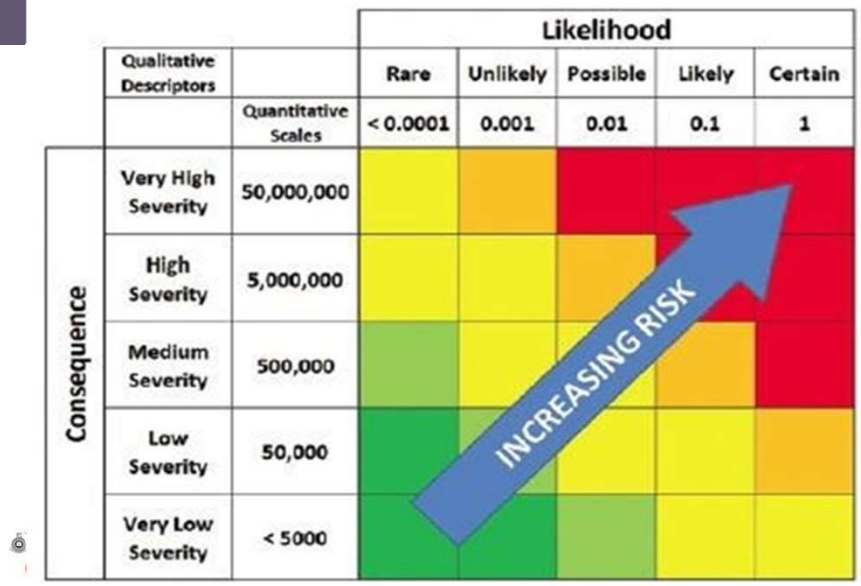
Prioritizing Risks



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Prioritizing Risks: Factors to be considered

- Reducing risk exposure by **reducing Likelihood and Impact**
- Confidence in risk assessment
  - Some risk assessments are very poor
- Compound risks
  - Some risks depend on others
- The number of similar risks

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5. Plan Risk Responses

How to deal with risks?

- **Risk Acceptance (Tolerate)**
  - Approval of operations under exposure to the risk, according to the organizations policies and criteria for risk acceptance
  - Should also involve provision for recovery under business continuity management
- **Risk Avoidance (Terminate)**
  - Changing of re-engineering the business process
  - Terminate the activity giving rise to risk

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Risk Planning …contd.

- **Risk Reduction (Treat)**
  - Application of security controls
  - Treat risk with appropriate control measures and mechanisms
- **Risk Transfer**
  - Transfer the risk to another party
  - Insurance or outsourcing

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6. Implement the Risk Response Plan

1. Execute the risk response plan to manage the project risks.
2. Track all risks in the risk register.
3. Integrate the risk response plan into the project management plan and schedules.
4. Implement a method to monitor, control, and track the risk response plan.
5. Include a mechanism for addressing the risk response plan when intended results are not achieved.

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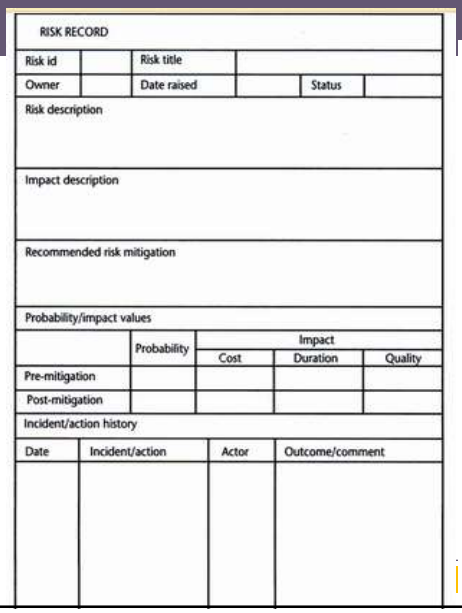
Maintaining the Risk Register



RISK RECORD

Risk id		Risk title			
Owner		Date raised		Status	
Risk description					
Impact description					
Recommended risk mitigation					
Probability/impact values					
	Probability	Impact			
		Cost	Duration	Quality	
Pre-mitigation					
Post-mitigation					
Incident/action history					
Date	Incident/action		Actor	Outcome/comment	

- Refer to the project plan and record the most threatening risks in a risk register.
- After starting the project, all emerging risks need to be added.
- Review and amend the register at regular intervals.
- Close the entry once the relevant risky activities are completed.

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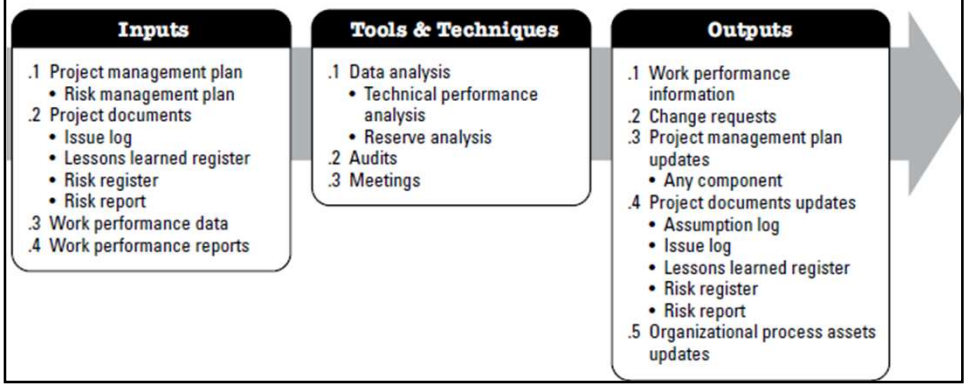
7. Monitor Risks

The process of monitoring the implementation of risk response plans, tracking identified risks, identifying and analyzing new risks, and evaluating risk process effectiveness throughout the project.



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Deciding Risk Reduction Action

- Some risks can be avoided or reduced immediately
- For others decide based on;
  - Cost vs. Benefits
  - Risk Reduction Leverage (RRL)

$$RRL = \frac{RE\ before - RE\ after}{Risk\ Reduction\ Cost}$$

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Example: Use of RRL

$$RRL = \frac{2500 - 150}{40000} = 0.059$$

Risk		Probability of occurring	Total loss if it occurs	Risk Exposure	
Competitive strike		10%	25K	2500	
Countermeasure	**Total cost**	**New risk probability**	**New total loss**	**New RE**	**RRL**
Advertising campaign	40K	3%	5K	150	0.059
Price promotions	30K	5%	10K	500	0.067
Simultaneous launch	10K	8%	15K	1200	0.13

Highest RRL indicates most cost-effective countermeasure

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Activity

ABA association needs to find the total risk exposure to their project. The following table lists two major risks that ABA has identified, the probability of each risk, and the estimated delay each can cause. Complete the following table by calculating the total risk exposure.

Risk Factor	**Probability**	**Delay (Days)**	**Risk Exposure**
1. Delay in purchasing required software to develop the media elements	0.8	45	
2. Video recording delay	0.5	15	
Total risk exposure			

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The following table lists some countermeasures identified to reduce the impact of the risks with ABA's project. Find the most cost-effective countermeasures to address the two risks.

Risk	Countermeasures	Cost (Rs.)	New Risk Probability	New total delay	New Risk Exposure (days)	Risk Reduction Leverage
1.	A. Start the procurement process early by spending the deposits.	10,000	0.6	30 days		
	B. Obtain software from software-as-a service	50,000	0.7	35 days		
2.	C. Hire expert cameraman	75,000	0.3	7 days		
	D. Recruit another cameraman	50,000	0.4	10 days		

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Evaluate the effects of uncertainty

- Techniques to take account of the uncertainties in the duration of activities within a project
  - PERT (Program Evaluation Review Technique)
  - Monte Carlo /Probability simulation
  - Critical Chain Management

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Using PERT

- Most likely time (m)
- Optimistic time (a)
- Pessimistic time (b)
- (Single) Expected Duration (t_e)

$$t_e = (a + 4m + b)/6$$

- Activity Standard Deviation (s)

s = (b – a)/6

s ∝ (b-a) is used to rank the measure of degree of uncertainty or risk of activity

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Exercise 1: Calculate T_e and S

Activity	a (wk)	m (wk)	b (wk)	T_e (wk)	s (wk)
A	5	6	8	6.17	0.50
B	3	4	5		
C	2	3	3	2.83	0.17
D	3.5	4	5		
E	1	3	4	2.83	0.50
F	8	10	15		
G	2	3	4		
H	2	2	2.5	2.08	0.08

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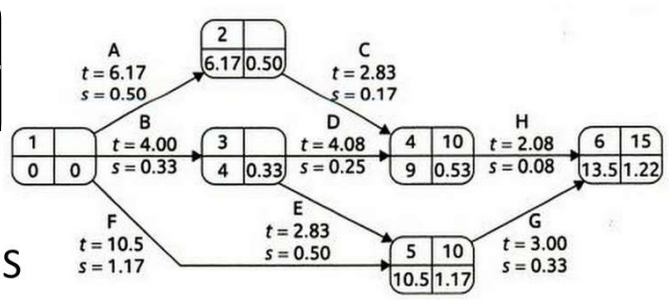
Using expected duration

- Used to carry out forward pass through a network
- Uses the same method as CPM technique
- Calculated event dates are the dates by which we expect to achieve those events

Event Number	Target date (T)
Expected date (Te)	Standard deviation



$$\sqrt{S1^2 + S2^2} = S$$

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Probability of meeting/missing targets

- The entire project as well as events may have target dates. Also, certain tasks may have to be completed by a target date
- Three step method of calculating the probability of meeting/missing the target.

1. Calculate the standard deviation for each event
2. Calculate the z value for each event having a T
3. Convert the z values into probabilities

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Calculating z value

- Calculated for each node that has a target date
- Equivalent to the number of standard deviations between node's expected and target dates

$$z = (T_{target} - T_{expected}) / s$$

e.g., Z value for event 6 is;
Z = (15-13.5)/1.22 = 1.23

6	15
13.5	1.22

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Exercise 2

- Calculate the z values for each of the events 4 and 5.

4	10
9	0.53

5	10
10.5	1.17

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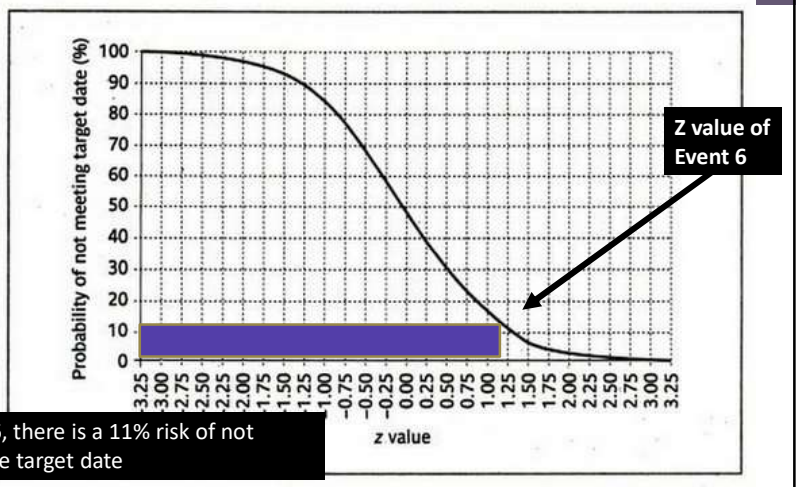
Convert z value into probability

This graph is the equivalent of tables of *z* values, also known as standard normal deviates, which may be found in most statistics textbooks.



For event 6, there is a 11% risk of not meeting the target date

FIGURE 7.8 The probability of obtaining a value within *z* standard deviations of the mean for a normal distribution

In MS Excel, use =(1-NORM.S.DIST(z,TRUE))*100

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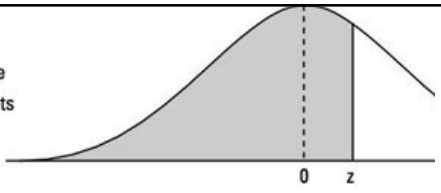
Number in the table represents $P(Z \leq z)$



Meeting the target: 89%
Not meeting the target: 11%

z	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	.5000	.5040	.5080	.5120	.5160	.5199	.5239	.5279	.5319	.5359
0.1	.5398	.5438	.5478	.5517	.5557	.5596	.5636	.5675	.5714	.5753
0.2	.5793	.5832	.5871	.5910	.5948	.5987	.6026	.6064	.6103	.6141
0.3	.6179	.6217	.6255	.6293	.6331	.6368	.6406	.6443	.6480	.6517
0.4	.6554	.6591	.6628	.6664	.6700	.6736	.6772	.6808	.6844	.6879
0.5	.6915	.6950	.6985	.7019	.7054	.7088	.7123	.7157	.7190	.7224
0.6	.7257	.7291	.7324	.7357	.7389	.7422	.7454	.7486	.7517	.7549
0.7	.7580	.7611	.7642	.7673	.7704	.7734	.7764	.7794	.7823	.7852
0.8	.7881	.7910	.7939	.7967	.7995	.8023	.8051	.8078	.8106	.8133
0.9	.8159	.8186	.8212	.8238	.8264	.8289	.8315	.8340	.8365	.8389
1.0	.8413	.8438	.8461	.8485	.8508	.8531	.8554	.8577	.8599	.8621
1.1	.8643	.8665	.8686	.8708	.8729	.8749	.8770	.8790	.8810	.8830
1.2	.8849	.8869	.8888	.8907	.8925	.8944	.8962	.8980	.8997	.9015
1.3	.9032	.9049	.9066	.9082	.9099	.9115	.9131	.9147	.9162	.9177
1.4	.9192	.9207	.9222	.9236	.9251	.9265	.9279	.9292	.9306	.9319

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Exercise 3

(a) Calculate the t_e and s (b) Draw the PERT chart (c) Explain the possibility of meeting the following target dates.

Target Dates: Project completion: 46, Event 5: 30 & Event 6: 38

Activity	Dependency	T_a	T_m	T_b	t_e	s
A	-	8	10	12		
B	A	5	7	9		
C	A	1	2	3		
D	B	6	8	10		
E	C, D	2	3	5		
F	-	11	13	17		
G	E, F	4	6	8		
H	G	9	11	14		

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Exercise 4

- Describe the pros and cons of using PERT technique to identify project risks.

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Exercise 5

- A s/w project has the following activity estimates.

1. Draw the PERT network and find Te and SD of each activity.

Activity	Estimated duration (weeks) Optimistic	Most likely	Pessimisti
1-2	3	6	15
1-3	2	5	14
1-4	6	12	30
2-5	2	5	8
2-6	5	11	17
3-6	3	6	15
4-7	3	9	27
5-7	1	4	7
6-7	4	19	28

2. Find the critical path and expected duration of the project.
3. The client wants the s/w in 38weeks. What is the probability of meeting this deadline?

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Exercise 6 : Draw the PERT network diagram

Activity	Estimated Duration (in months)		
(A-F)	Optimistic	Most Likely	Pessimistic
1-2	2	2	14
1-3	2	8	14
1-4	4	4	16
2-5	2	2	2
3-5	4	10	28
4-6	4	10	16
5-6	6	12	30

1. Draw the project network diagram to find the critical path.
2. Find the expected duration and the st. deviation for each activity.
3. What is the expected duration of the project?
4. What is the probability that the project will be completed eight months earlier than the expected duration of the project?

Z	0.50	0.67	1.00	1.33	2.00
P	0.3085	0.2514	0.1587	0.0918	0.0228

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