Risk management

This lecture will touch upon:

- Definition of ‘risk’ and ‘risk management’
- Some ways of categorizing risk
- Risk management
  - Risk identification – what are the risks to a project?
  - Risk analysis – which ones are really serious?
  - Risk planning – what shall we do?
  - Risk monitoring – has the planning worked?
- We will also look at PERT risk and critical chains

Some definitions of risk

'the chance of exposure to the <u>adverse consequences of future events'</u> -PRINCE2

'<u>an uncertain event or condition that, if it occurs,</u>
<u>has a positive or negative effect on a project's objectives'</u>

-PM-BOK

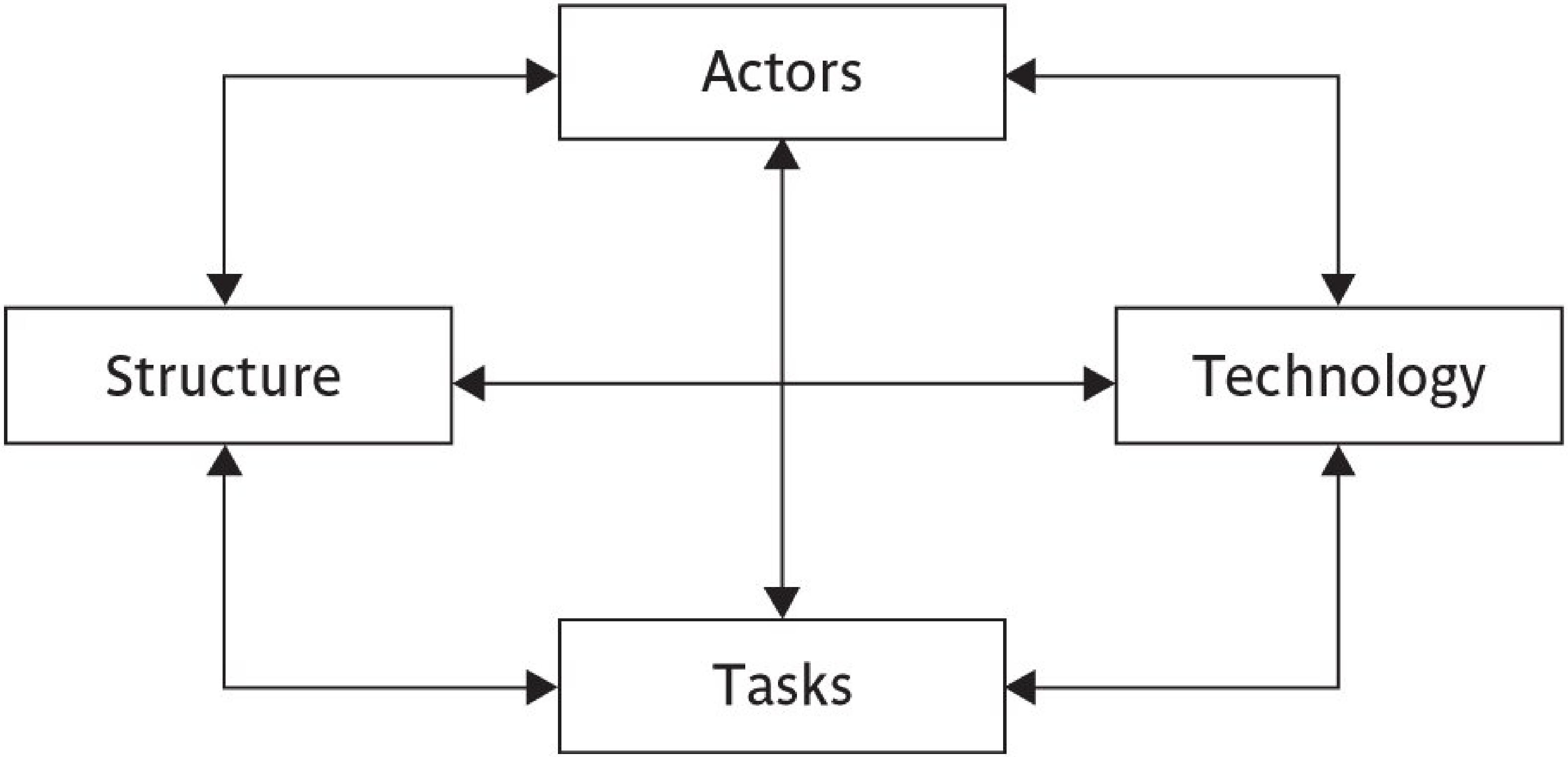
Some definitions of risk

Key elements of a risk:

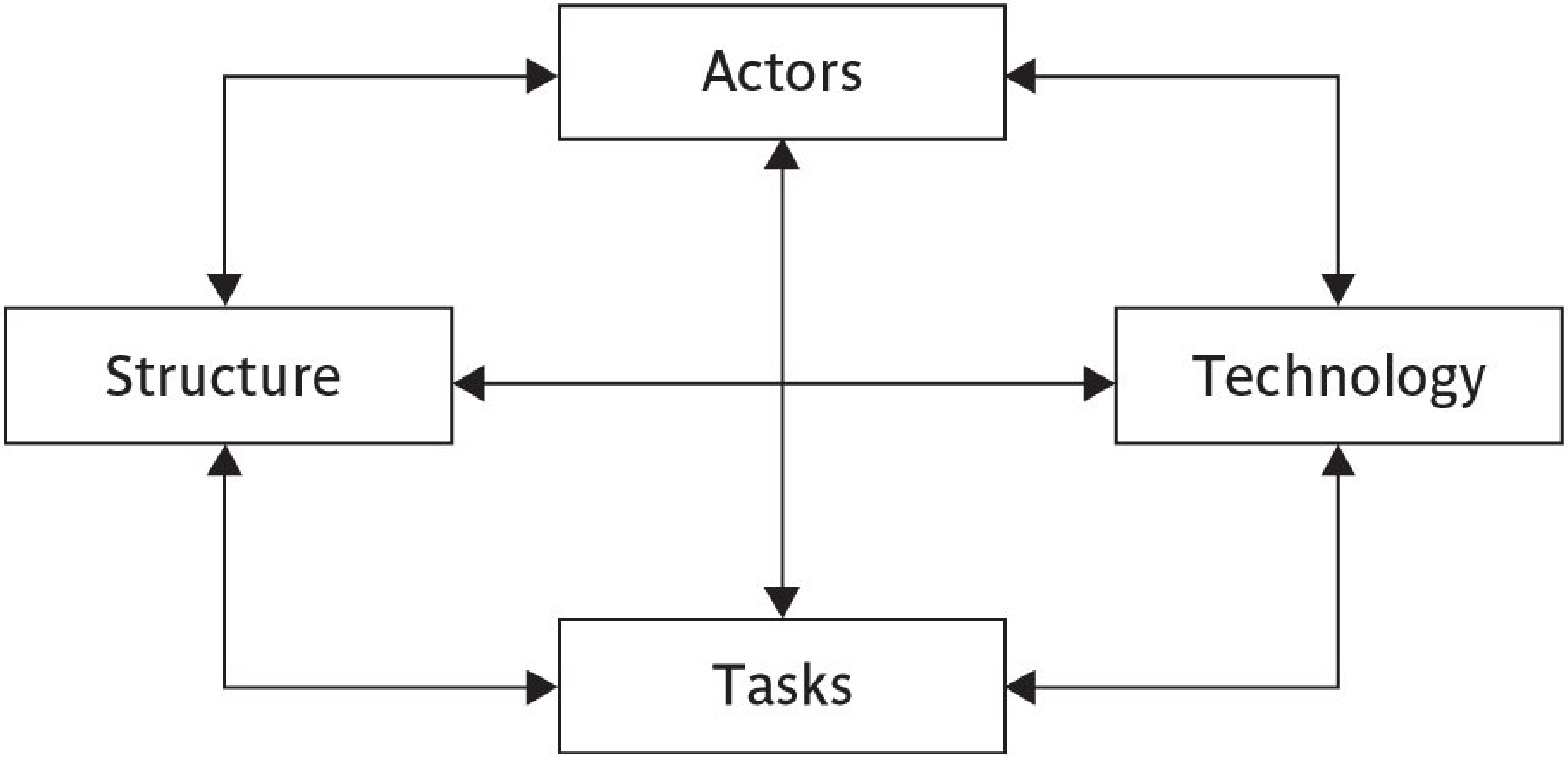
1) Risks relate to **possible future** problems, not current ones

2) They involve a possible cause and its effect(s)
   e.g. developer leaves > task delayed

Categories of risk

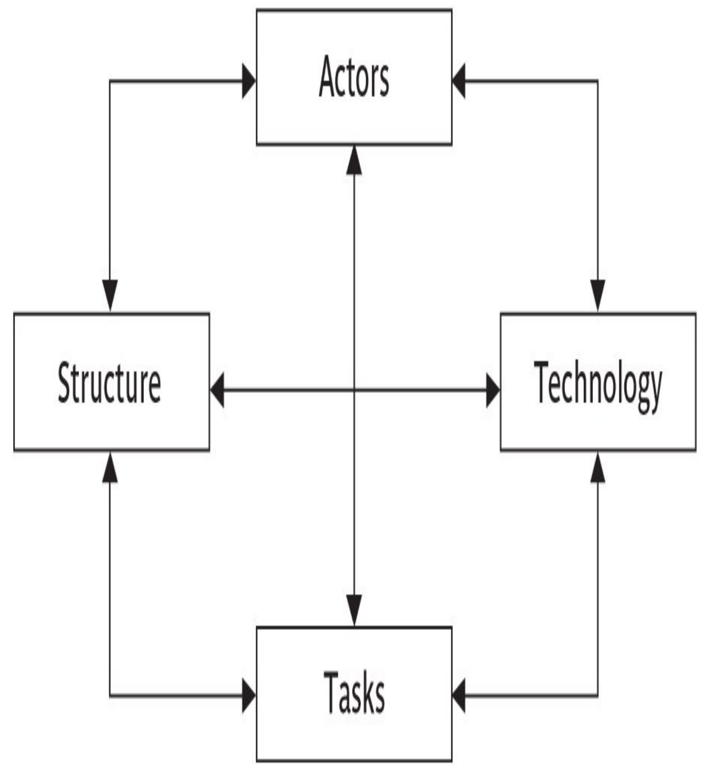


Lyytinen’s sociotechnical model of risk



Lyytinen’s sociotechnical model of risk

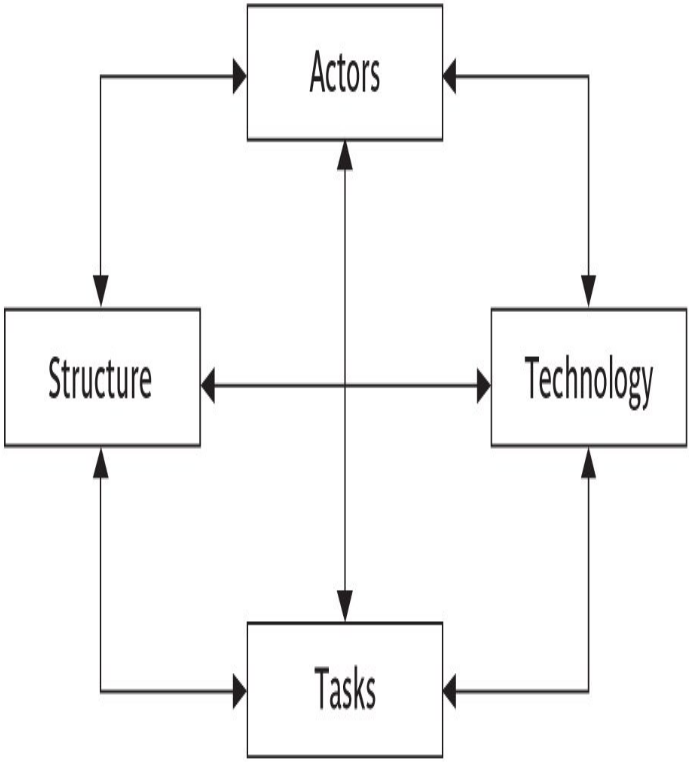
- The planning for risk includes these steps:
- Actors:
  - All people involved in the development of the application in question.
- <u>High staff turnover leads to expertise of value to the project being lost.</u>



Lyytinen’s sociotechnical model of risk

The planning for risk includes these steps:

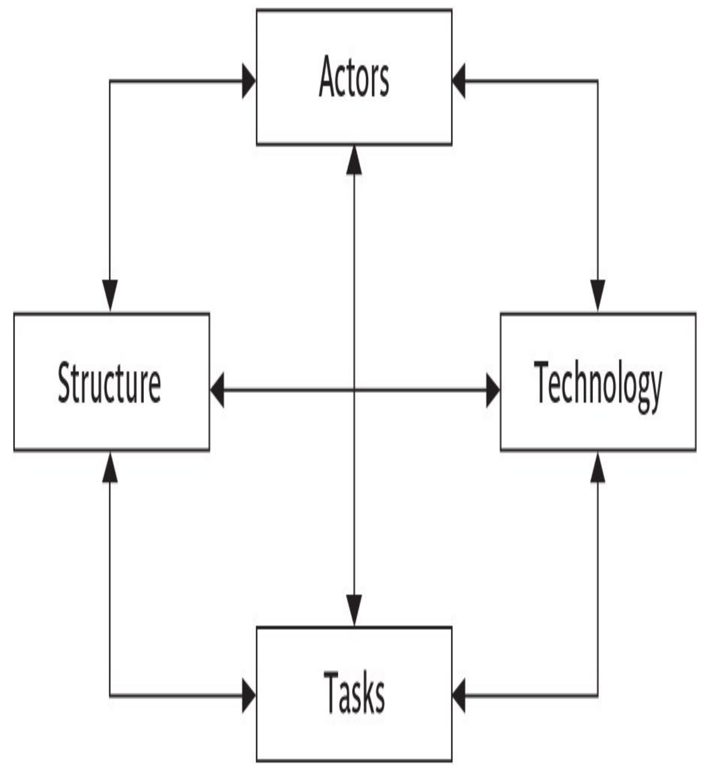
- Technology : Encompases both
  - technology used to <u>implement the application</u> and
  - <u>that embedded in the delivered products.</u>
- Risk could relate to appropriateness of the technologies and to possible faults within them.



Lyytinen’s sociotechnical model of risk

The planning for risk includes these steps:

- Structure:
  - describes the management structures and systems, including those affecting planning and control

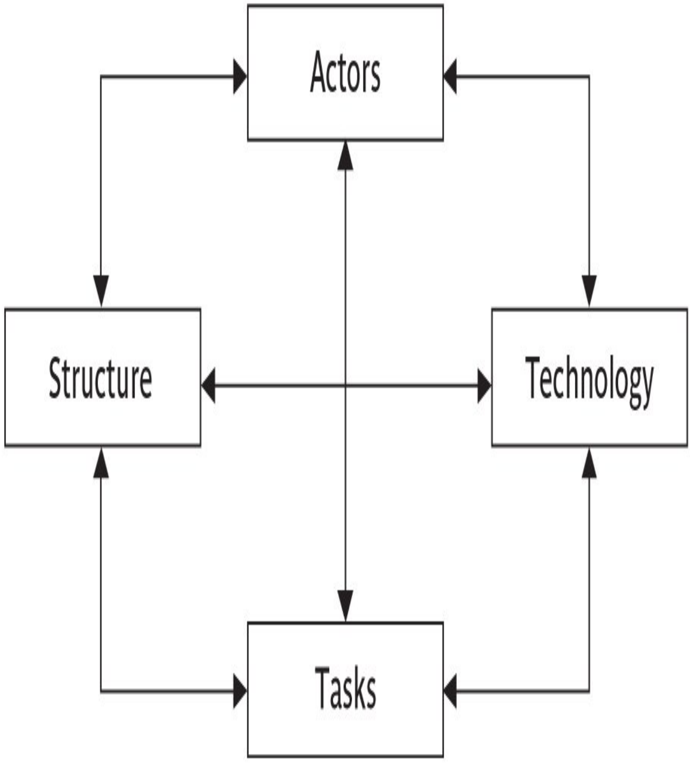


Lyytinen's sociotechnical model of risk

- Tasks: relates to the work planned

For Eg:- The complexity of the work might lead to delays-

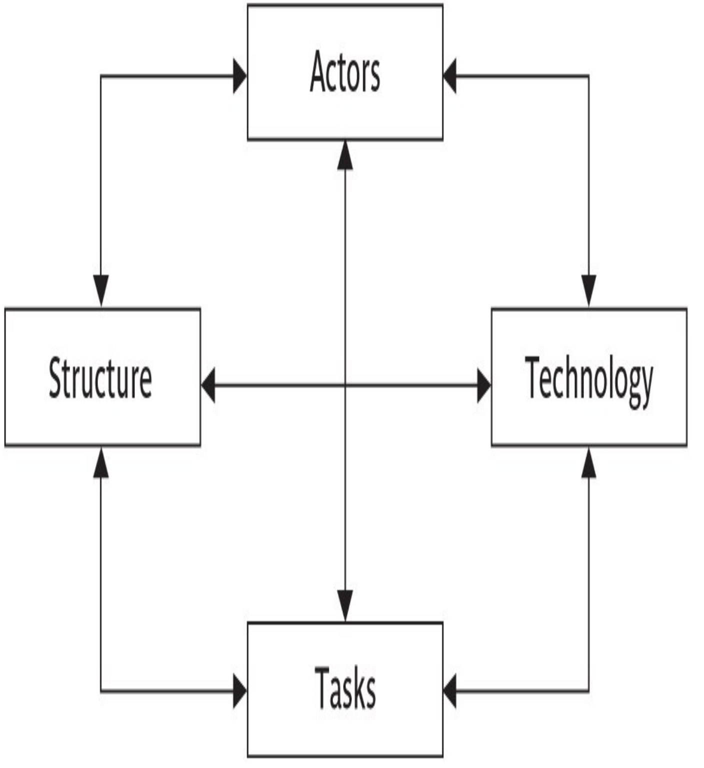
because of the additional time required to integrate the large components.



Lyytinen’s sociotechnical model of risk

- **<u>All boxes are interlinked</u>**
- **<u>Risks often arise from relationships between factors.</u>**

- For example Technology and People.
- If <u>a development technology is novel</u> then the <u>developers might not be experienced</u> in its use and delay results.



A framework for dealing with risk

The planning for risk includes these steps:

- Risk identification – what risks might there be?
- Risk analysis and prioritization – which are the most serious risks?
- Risk planning – what are we going to do about them?
- Risk monitoring – what is the current state of the risk?

Risk identification

Approaches to identifying risks include:

- Use of checklists –
  - Lists of the risks found to occur regularly in Software development projects.
  - usually based on the experience of past projects
  - **Representatives of stakeholders to examine checklists**

Risk identification

- Brainstorming –
  - getting **knowledgeable project stakeholders** together to pool concerns
  - **Representatives of stakeholders should be brought together**
  - **Using their individual knowledge of different parts of the project and the problems that might occur.**

Risk identification

- Causal mapping –
  - identifying possible chains of cause and effect
  - Countermeasures of each risk

Boehm's top 10 development risks

Risk	*Risk reduction techniques*
Personnel shortfalls	**Staffing with top talent**; job matching; **teambuilding; training and career development; early scheduling of key personnel**
Unrealistic time and cost estimates	**Multiple estimation techniques**; design to cost; incremental development; **recording and analysis of past projects**; standardization of methods

Boehm's top 10 development risks

Risk	*Risk reduction techniques*
Developing the wrong software functions	**Improved software evaluation;** formal specification methods; **user surveys; prototyping**; early user manuals
Developing the wrong user interface	Prototyping; task analysis; **user involvement**

Boehm’s top ten risk - continued

Gold plating	Requirements **scrubbing, prototyping, design to cost**
Late changes to requirements	**Change control,** incremental development
Shortfalls in externally supplied components	**Benchmarking, inspections**, formal specifications, **contractual agreements, quality controls**

Gold Plating

For example: after having met the requirements, the project manager or the developer works on further enhancing the product, <u>thinking the customer will be delighted to see additional or more polished features</u>, rather than what was asked for or expected.

<u>The customer might be disappointed in the results, and the extra effort by the developer might be futile</u>

<u>Gold plating is also considered a bad project management practice</u> for different project management best practices and methodologies such as Project Management Body of Knowledge (PMBOK) and PRINCE2.

Boehm’s top ten risk - continued

Shortfalls in externally performed tasks	**Quality assurance procedures,** competitive design etc
Real time performance problems	**Simulation, prototyping, tuning**
Development technically too difficult	**Technical analysis,** cost-benefit analysis, prototyping , **training**

Risk Assessment/Risk prioritization

- List of risks is endless
- Estimating the risk exposure for each risk using formula:

<u>Risk exposure (RE)</u>
<u>= (potential damage) x (probability of occurrence)</u>

Risk Assessment/Risk prioritization

Potential damage: a money value
e.g. a flood would cause £0.5 millions of damage

Probability:
Chance of occurrence
Eg- 0.00 (absolutely no chance) to 1.00 (absolutely certain) e.g. 0.01 (one in hundred chance)

RE = £0.5m x 0.01 = £5,000
Crudely analogous to the amount needed for an insurance premium

Risk Assessment/Risk prioritization

- If there were 100 people chipping in £5,000 each, there would be enough for the 1 in 100 chance of the flooding.

- If there were 2 floods then the system collapses!

Risk Assessment/Risk prioritization

- The calculation of risk exposure above assumes that the amount of damage sustained will always be the same.

- There could be varying amounts of damage
  - Eg- As software development proceeds, more software is created and more time would be needed to re-create it, if it were lost.

Risk Assessment/Risk prioritization

- With some risks, there could be gains also.
  - Eg-The testing of a software component is scheduled to take six days, but is actually done in three days.

Table 7.1 *Part of Amanda's risk exposure assessment*

	Hazard	*Likelihood*	*Impact*	*Risk exposure*
R1	Changes to requirements specification during coding	8	8	64
R2	Specification takes longer than expected	3	7	21
R3	Staff sickness affecting critical path activities	5	7	35
R4	Staff sickness affecting non-critical activities	10	3	30
R5	Module coding takes longer than expected	4	5	20
R6	Module testing demonstrates errors or deficiencies in design	4	8	32

- Barry Boehm suggested-
- Both the risk losses/damage and probabilities need to be assessed in the range of 0 to 10.
- The two values could be multiplied to get a notional risk exposure.

Qualitative descriptors

- Even using indicative numbers in the range of 0 to 10, rather than precise money values and probabilities is not completely satisfactory.

- Values are likely to be subjective
- Different analysts pick different numbers

Qualitative descriptions

- Another approach is to use **Qualitative descriptions**
  - **of the possible impact and the likelihood of each risk.**

- **Consistency between assessors** is facilitated
  - by associating each qualitative description with range of values.

Qualitative Descriptors of risk probability and associated range values

Probability level	*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 descriptors of impact on cost and associated range values

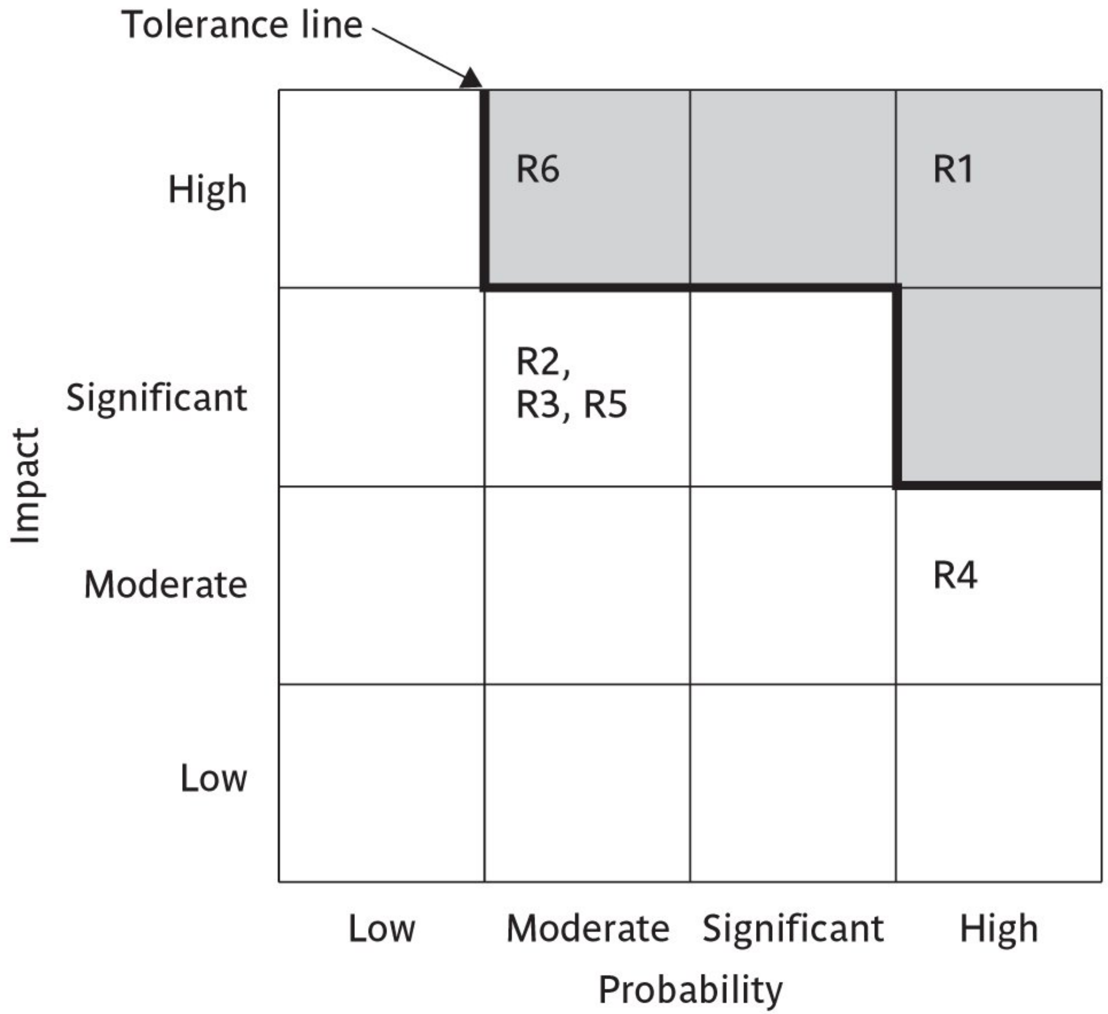
Impact level	*Range*
High	Greater than 30% above budgeted expenditure
Significant	20 to 29% above budgeted expenditure
Moderate	10 to 19% above budgeted expenditure
Low	Within 10% of budgeted expenditure.

- The potential amount of damage has been categorized in terms of impact on project costs.

Probability Impact Matrix

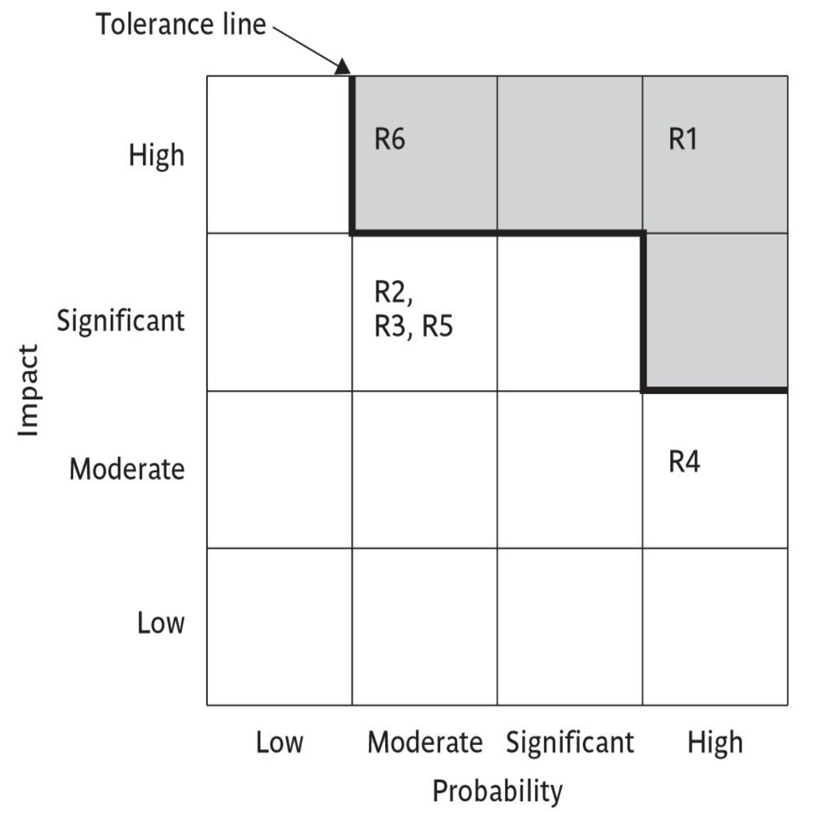
- When the potential damage and likelihood of a risk are defined by qualitative descriptors,
  - the risk exposure cannot be calculated by multiplying the two factors together.
- Solution- Probability Impact grids

Probability impact matrix



Probability Impact Matrix

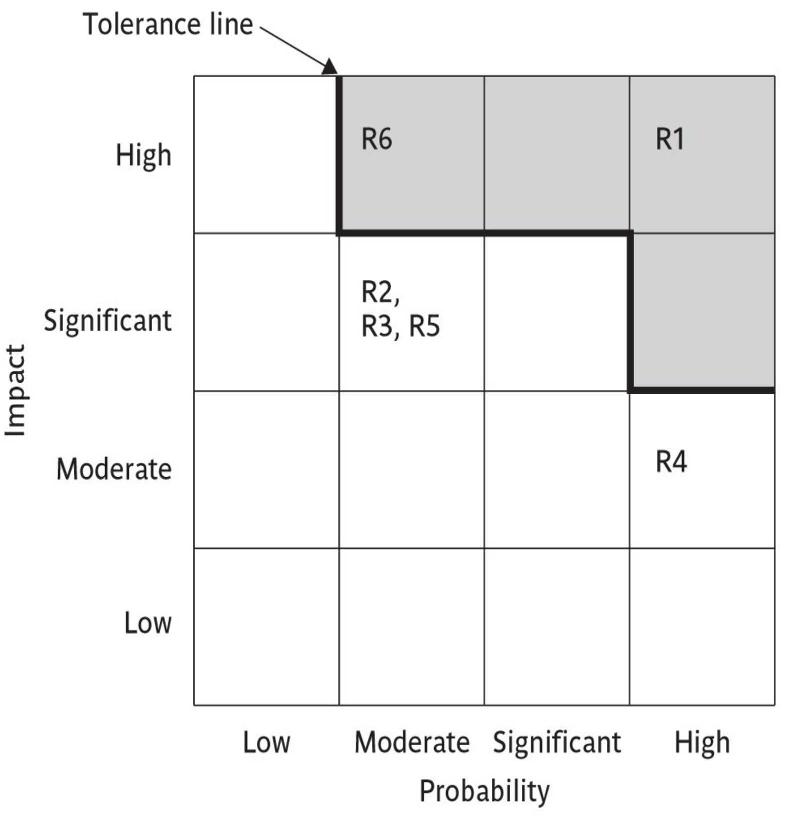
- Risk exposure is indicated by the position of the risk in a matrix.



Probability Impact Matrix

- Some of the cells in the top right of the matrix have been zoned off by a tolerance line.

- Risks that appear within this zone have a degree of seriousness that calls for particular attention.



Risk planning

Having identified major risks and allocated priorities, the task is to decide how to deal with them.

Risks can be dealt with by:

- Risk acceptance
- Risk avoidance
- Risk reduction
- Risk transfer
- Risk mitigation/contingency measures

Risk acceptance

- This is do-nothing option.
- Ignore some risks in order to concentrate on the more likely or damaging risks.
- The damage inflicted by some risks would be less than the costs of action that might reduce the probability of a risk happening .

Risk avoidance

- Some activities may be so prone to accident that it is best to avoid them altogether.

Risk transfer

- Risk is transferred to another person or organization.
- <u>With software projects, an example :Software development task is outsourced to an outside agency for a fixed fee.</u>

- <u>You might expect the supplier to quote a higher figure to cover the risk that the project takes longer than the average expected time.</u>

Risk reduction leverage

Risk reduction leverage =

$(RE_{before} - RE_{after})$/ (cost of risk reduction)

RE_{before} is risk exposure before risk reduction e.g. 1% chance of a fire causing £200k damage

RE_{after} is risk exposure after risk reduction e.g. fire alarm costing £500 reduces probability of fire damage to 0.5%

RRL = (1% of £200k)-(0.5% of £200k)/£500 = 2

RRL > 1.00 therefore worth doing

PERT CHART

- Program Evaluation and Review Technique
- Developed for Fleet Ballistic Missiles Program
- Saved considerable time in development of the Polaris missile

PERT CHART

Using PERT to evaluate the effects of uncertainty

Three estimates are produced for each activity

- *Most likely time (m)*
- *Optimistic time (a)*
- *Pessimistic (b)*

PERT CHART

PERT requires three estimates:

- *Most likely time*: the time we would expect the task to take under normal circumstances. We shall identify this by the letter *m*.
- *Optimistic time*: the shortest time in which we could expect to complete the activity, barring outright miracles. We shall use the letter *a* for this.
- *Pessimistic time*: the worst possible time, allowing for all reasonable eventualities but excluding 'acts of God and warfare' (as they say in most insurance exclusion clauses). We shall call this *b*.

Expected Duration

PERT combines these three estimates to form a single expected duration $t_{e:}$

‘expected time’ $t_e = (a + 4m + b) / 6$

Activity Standard Deviation

A quantitative measure of the degree of uncertainty of an activity duration estimate may be obtained by calculating the standard deviation *s* of an activity time, using the formula

- 'activity standard deviation' S = (b-a)/6
- Proportional to the difference between the optimistic and pessimistic estimates.
- Used as a ranking measure of the degree of uncertainty or risk for each activity.

Table 7.6 provides additional activity duration estimates for the network shown in Figure 6.29. There are new estimates for *a* and *b* and the original activity duration estimates have been used as the most likely times, *m*. Calculate the expected duration, t_e, for each activity.

Activity	Optimistic (*a*)	Activity durations (weeks) Most likely (*m*)	Pessimistic (*b*)
A	5	6	8
B	3	4	5
C	2	3	3
D	3.5	4	5
E	1	3	4
F	8	10	15
G	2	3	4
H	2	2	2.5

TABLE 7.6 PERT activity time estimates

Advantage of PERT

- Places an emphasis on the uncertainty of the real world.
- Rather than saying

“The completion date for the project is……………..”

- We say

“WE expect to complete the project by………………………………”

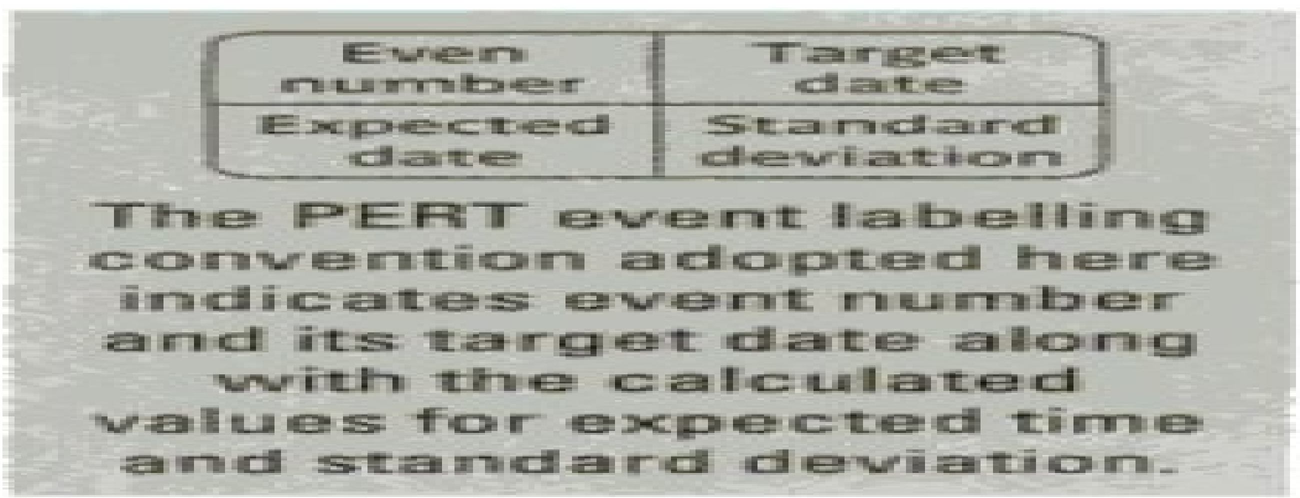
Advantage of PERT

- Focuses on Uncertainty of estimation of activity durations.
- Requesting three estimates for each activity emphasizes that we are not certain about what will happen.

PERT Event Labelling Convention

- The **expected durations are used to carry out a forward pass** through a network using the same method as the CPM technique.

- The calculated event dates are not the earliest possible dates but the dates by which we **expect to achieve those events.**



The PERT event labelling convention adopted here indicates event number and its target date along with the calculated values for expected time and standard deviation.

The forward pass (activity-on-arrow network.)

- Using AOA Network
- Can be represented by AON Network also.

Table 6.1 An example project specification with estimated activity durations and precedence requirements

Activity		*Duration (weeks)*	*Precedents*
A	Hardware selection	6	
B	Software design	4	
C	Install hardware	3	A
D	Code & test software	4	B
E	File take-on	3	B
F	Write user manuals	10	
G	User training	3	E, F
H	Install & test system	2	C, D

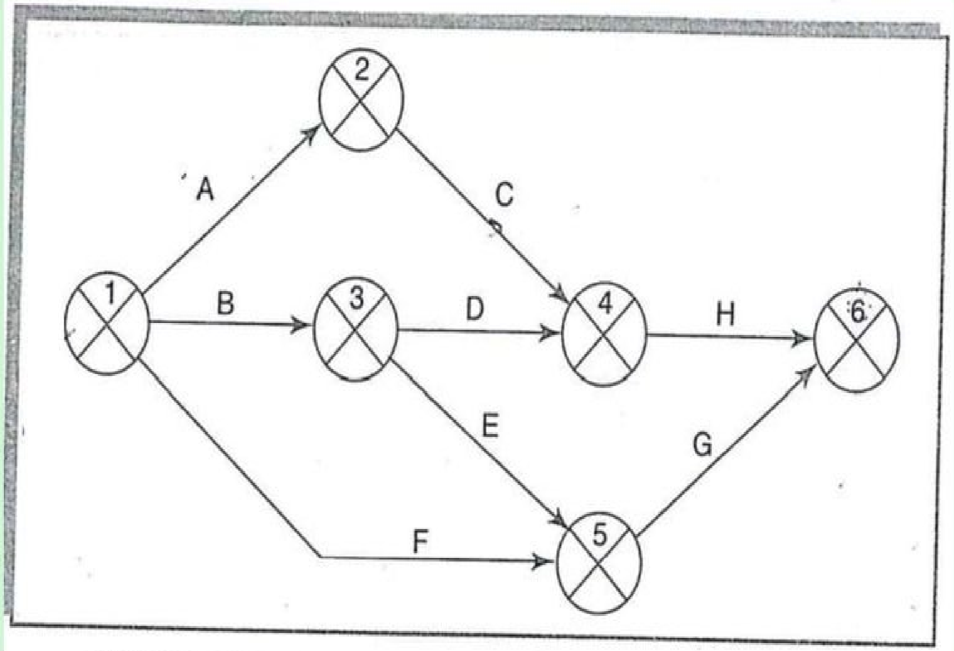


FIGURE 6.18 An activity-on-arrow network

PERT Network

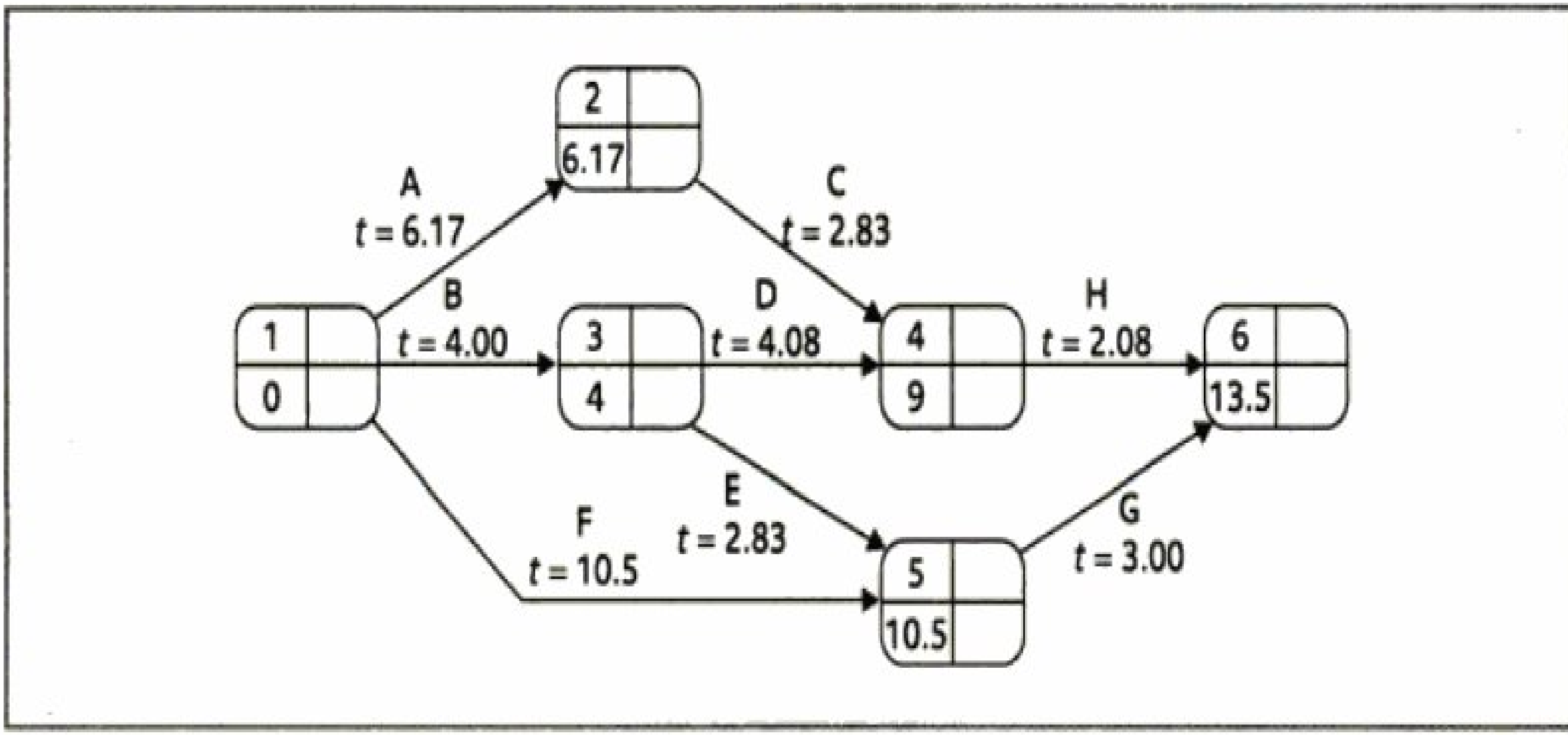


FIGURE 7.6 The PERT network after the forward pass

PERT CHART

Activity	Activity durations (weeks)				
	Optimistic (a)	Most likely (m)	Pessimistic (b)	Expected (t_e)	Standard deviation (s)
A	5	6	8	6.17	0.50
B	3	4	5	4.00	0.33
C	2	3	3	2.83	0.17
D	3.5	4	5	4.08	0.25
E	1	3	4	2.83	0.50
F	8	10	15	10.50	1.17
G	2	3	4	3.00	0.33
H	2	2	2.5	2.08	0.08

TABLE 7.7 Expected times and standard deviations

PERT Network

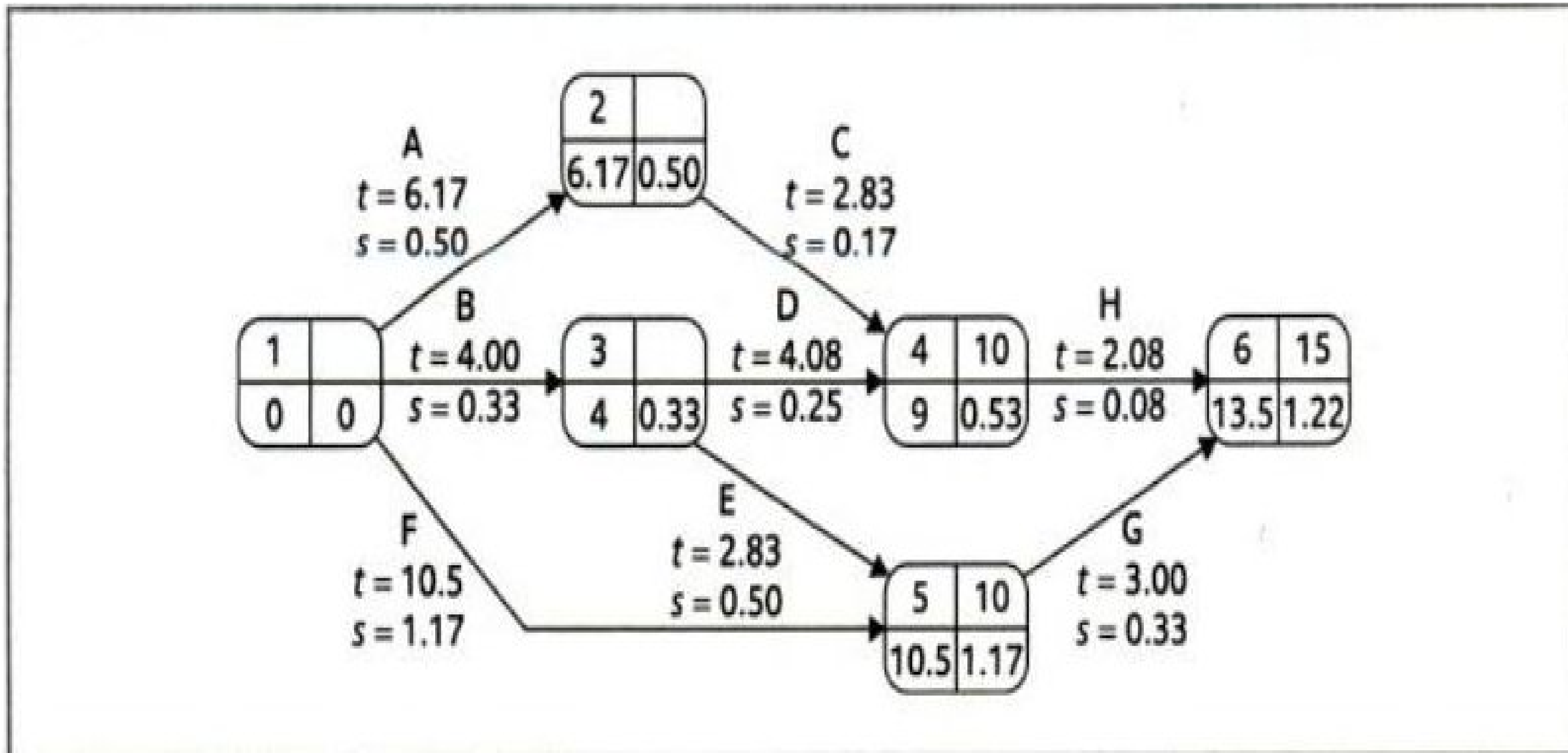


FIGURE 7.7 The PERT network with three target dates and calculated event standard deviations

PERT Network

Calculating the standard deviation of each project event

> The square of the standard deviation is known as the variance. Standard deviations may not be added together but variances may.

Standard deviations for the project events can be calculated by carrying out a forward pass using the activity standard deviations in a manner similar to that used with expected durations. There is, however, one small difference – to add two standard deviations we must add their squares and then find the square root of the sum. Exercise 7.8 illustrates the technique. One practical outcome of this is that the contingency time to be allocated to a sequence of activities as a whole would be less than the sum of the contingency allowances for each of the component activities. This has implications that can be exploited in critical chain project management, which are discussed in the next section.

Calculation of SD for each event

The standard deviation for event 3 depends solely on that of activity B. The standard deviation for event 3 is therefore 0.33.

For event 5 there are two possible paths, B + E or F. The total standard deviation for path B + E is $\sqrt{(0.33^2 + 0.50^2)} = 0.6$ and that for path F is 1.17; the standard deviation for event 5 is therefore the greater of the two, 1.17.

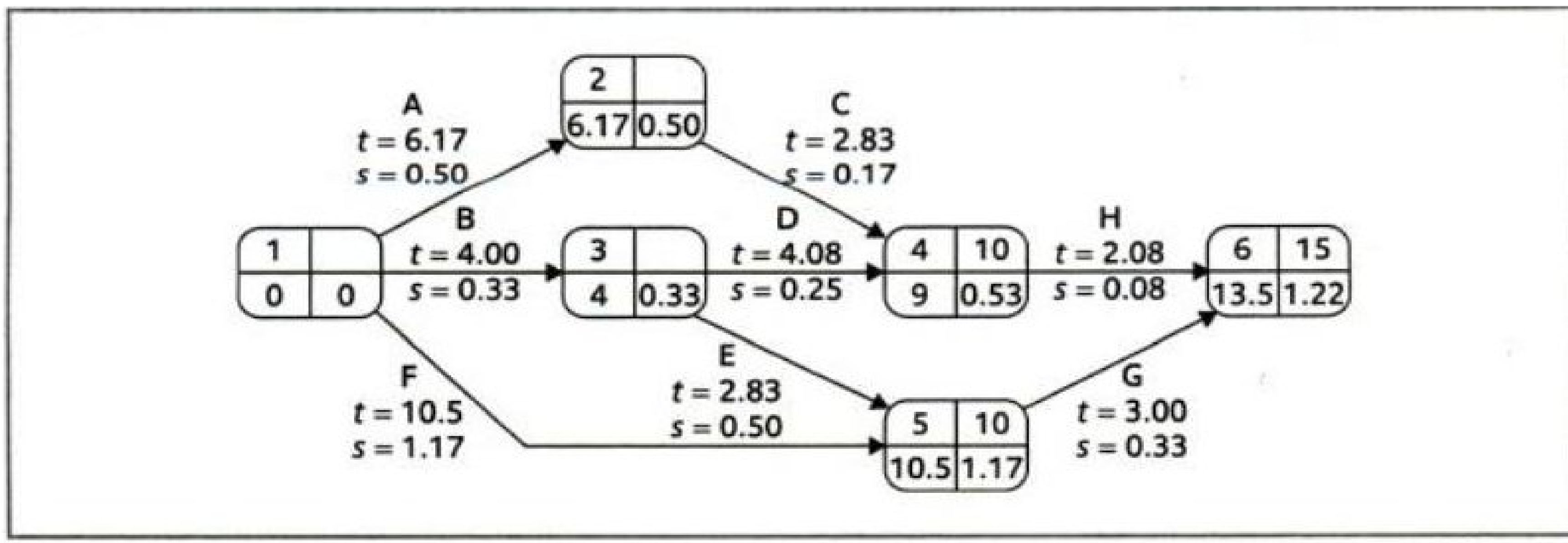


FIGURE 7.7 The PERT network with three target dates and calculated event standard deviations

Calculation of SD for each event

For Event 4

- Either A+C chain or B+D chain
- A+C=$\sqrt{0.5^2 + 0.17^2}$=0.53
- B+D=$\sqrt{0.33^2 + 0.25^2}$= $\sqrt{0.1089+0.0625}$= $\sqrt{0.1714}$=0.41
- As 0.53>0.41, SD for Event 4=0.53

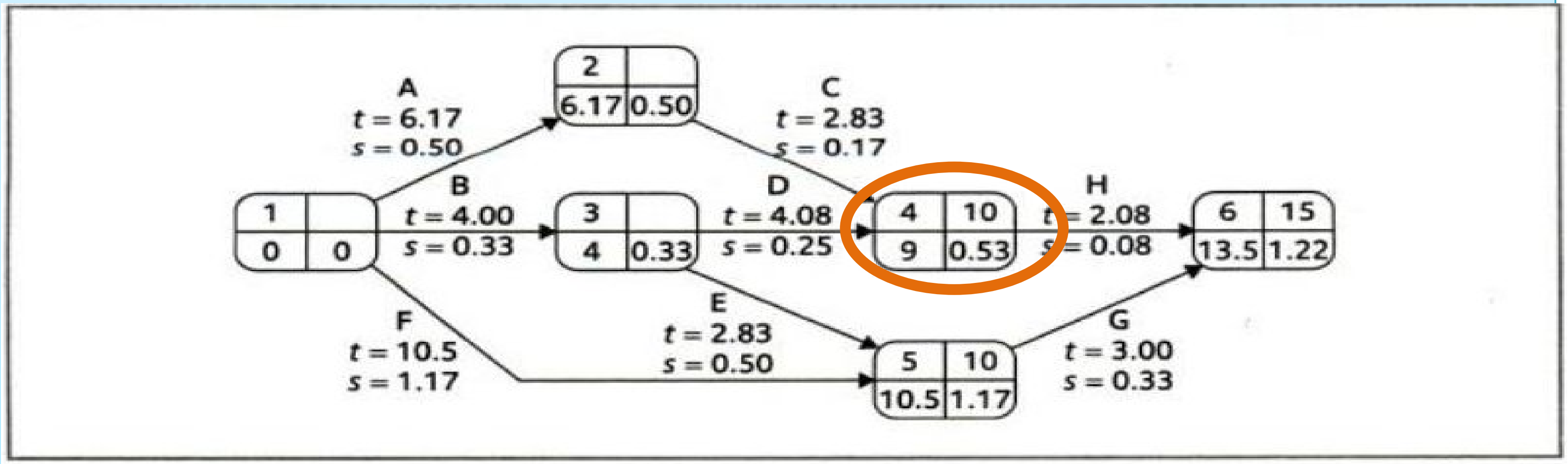


FIGURE 7.7 The PERT network with three target dates and calculated event standard deviations

Calculation of SD for each event

For Event 6

- Either A+C chain or B+D chain
- B+E+G=$\sqrt{0.33^2 + 0.50^2 + 0.33^2}$=
- B+D+H=$\sqrt{0.33^2 + 0.25^2 + 0.08^2}$= $\sqrt{0.1089+0.0625 + 0.0064 +}$ = $\sqrt{0.1778}$=0.421
- F+G=$\sqrt{1.17^2 + 0.33^2}$= 1.215=1.22
- A+C+H

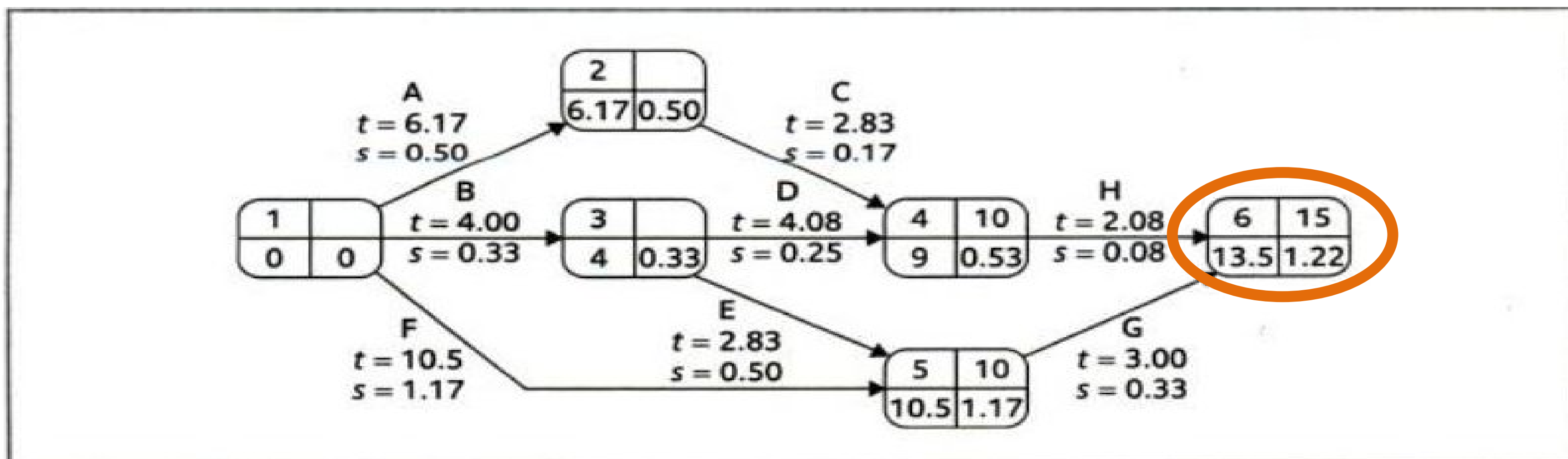


FIGURE 7.7 The PERT network with three target dates and calculated event standard deviations

Calculation of Te for each event

For Event 4

- Either

1. Te Event 2 + Te Activity C=6.17+2.83=9
2. Te Event 3 + Te Activity D=4+4.08=8.08

- Out of 1 and 2, 1 is greater than 2, so Te of event 4 is 9

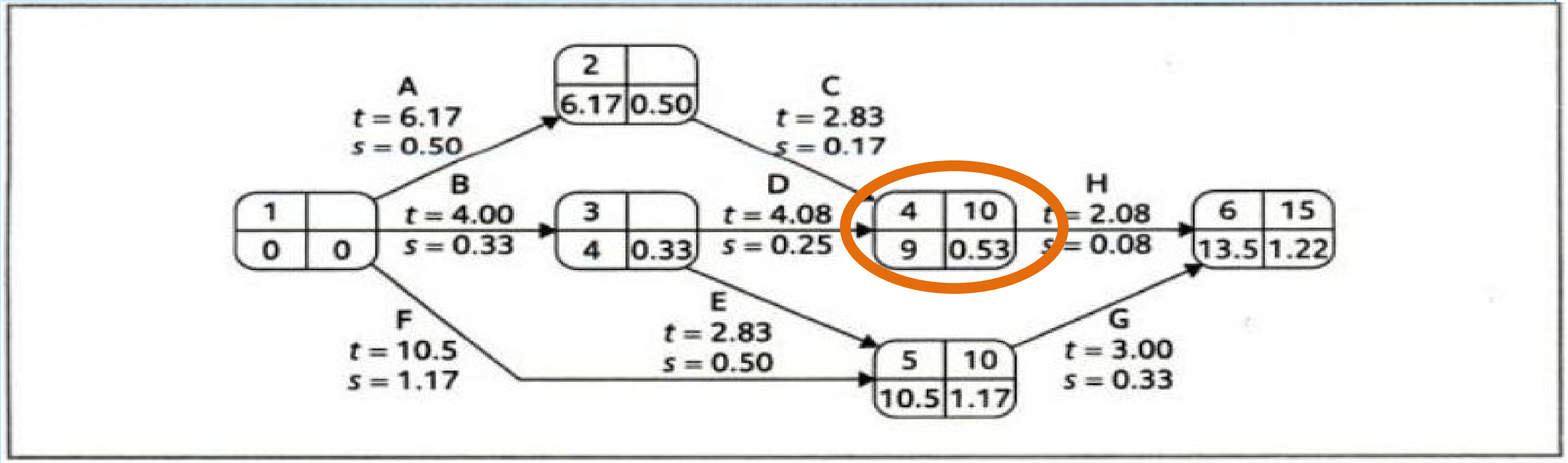


FIGURE 7.7 The PERT network with three target dates and calculated event standard deviations

The PERT technique uses the following three-step method for calculating the probability of meeting or missing a target date:

- calculate the standard deviation of each project event;
- calculate the z value for each event that has a target date;
- convert z values to a probabilities.

The Likelihood of meeting targets

Suppose that we must complete the project within 15 weeks at the outside. We expect it will take 13.5 weeks but it could take more or, perhaps, less. In addition, suppose that activity C must be completed by week 10, as it is to be carried out by a member of staff who is scheduled to be working on another project, and that event 5 represents the delivery of intermediate products to the customer, which must take place by week 10. These three target dates are shown on the PERT network in Figure 7.7.

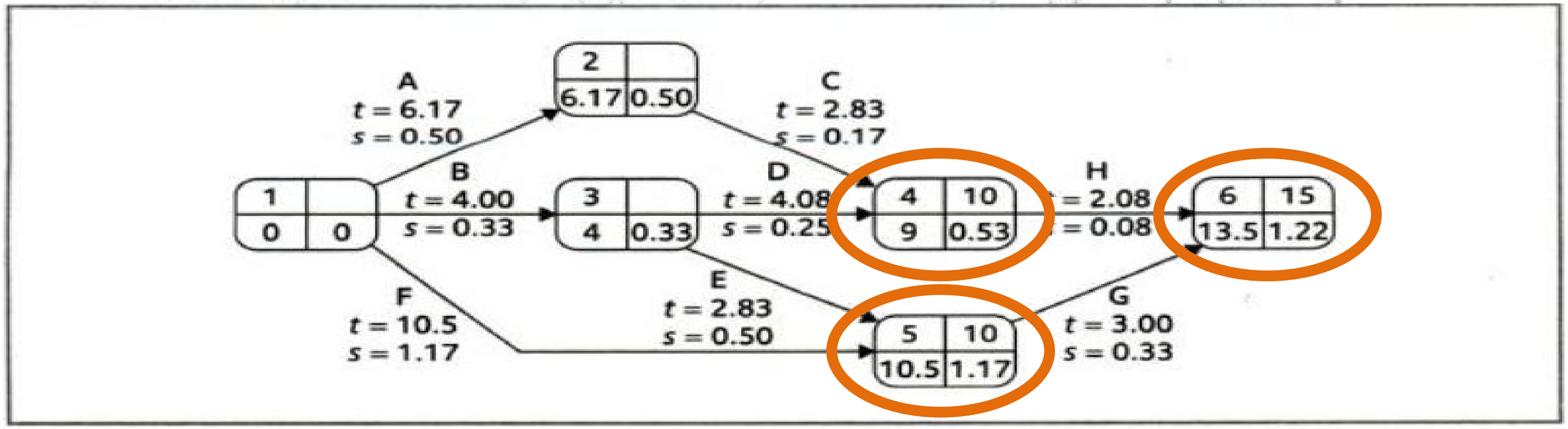


FIGURE 7.7 The PERT network with three target dates and calculated event standard deviations

Advantage of PERT

- Provides a method for estimating the probability of meeting or missing target dates.
  - There might be only a single target date- the project completion
  - But we might have additional intermediate targets.