

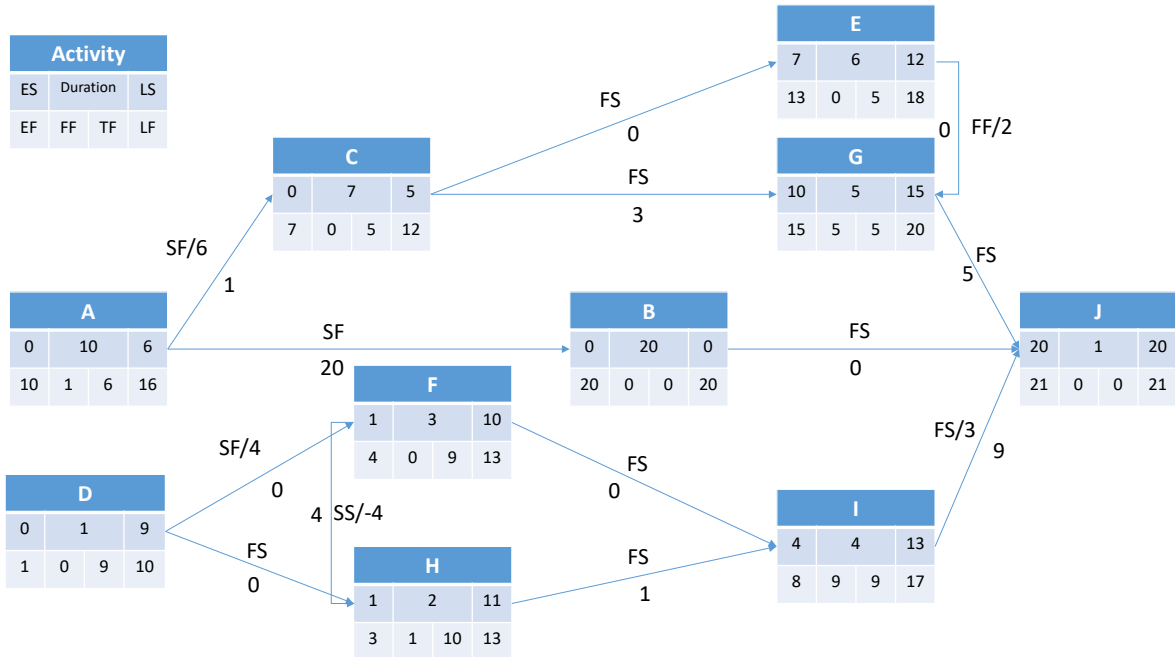
Triplos IIB/IIA

4D16 CONSTRUCTION AND MANAGEMENT

1

- (a) (i) Free Float = smallest Lag value of all links leaving from an activity node, whereas Lag = time between early finish of an activity & early start of next activity.
(ii) Yes. It occurs when Total Float (A) < Lag (A-B) when $LF(A) - EF(A) < ES(B) - EF(A)$

(b)



Critical path: B-J

(c)

Act.	Dur.	Res.	LS	TF	/	1	2	3	4	5	6	7	8	9	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#				
A	10	4	1	1	X	4	4	4	4	4	4	4	4	4																								
B	20	1	0	0	X	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
C	7	3	5	5	X										3	3	3	3	3	3	3	3	3															
D	1	3	9	9	X										3																							
E	6	1	12	5	X																1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
F	3	1	10	9	X												1	1	1																			
G	5	2	15	5	X																																	
H	2	2	11	10	X											2	2																					
I	4	4	13	9	X																4	4	4	4														
J	1	5	20	0	X																																	5
Total Resources						5	5	5	5	5	5	5	5	5	5	7	6	7	7	5	5	4	4	6	6	6	6	7	3	3	2	2	2	2	5			

The revised total project duration is 26 days.
1 extra labourer would bring the total duration to under 22 days.

2

- (a) (i) **Job Overhead** = job costs not specifically associated with particular work item;
Company Overhead = company costs not specifically associated with particular job.

(ii) Decreasing a project's duration may increase or decrease total cost, depending on whether additional direct costs (required to decrease durations) are greater than or less than indirect cost savings of decreasing project's duration.

(b)

Activities	Cost		Duration (days)		Crash cost/Unit Time (£/day)	Maximum Crash Allowed (days)
	Crash	Normal	Crash	Normal		
A	£4,000	£1,600	2	8	£400	6
B	£2,600	£2,100	5	7	£250	2
C	£5,000	£4,000	1	4	£333	3
D	£3,800	£3,500	2	3	£300	1
E	£1,500	£1,000	3	9	£83	6
F	£900	£800	2	3	£100	1
Sum		£13,000				

Step	Paths	Duration	Activities	Project Duration after Crash	Crash Cost (£)	Cumulative Direct Cost (£)	Corresponding Indirect Cost (£)	Cumulative Total Cost (£)
			Crashed					
0	A-C	19		19	£0	£13,000	£5,775	£18,775
	A-D-C	13		13				
	A-B-D-C	21		21				
	A-B-E-D-C	21		21				
	A-B-E-F-D-C	15		15				
1	A-C	19	B by 2 days	19	£500	£13,500	£5,225	£18,725
	A-D-C	13		13				
	A-B-D-C	21		19				
	A-B-E-D-C	21		19				
	A-B-E-F-D-C	15		13				
2	A-C	19	C by 3 days	16	£1,000	£14,500	£4,400	£18,900
	A-D-C	13		13				
	A-B-D-C	19		16				
	A-B-E-D-C	19		16				
	A-B-E-F-D-C	13		10				

When the overall project duration is 19 days, the minimum overall cost is £18,725.

3

(a)

Risk: An event that may or may not happen and could have either a positive impact (opportunity) or a negative impact (threat) on the objectives of a project or organisation.

Issue: An event that has happened and requires immediate management attention.

Uncertainty: Inherent variability in performance that lies within acceptable boundaries.

(b)

1. Assess risks: risks must first be assessed using qualitative (individual exposure) or quantitative (aggregate exposure) means.

2. Address risks: this process involves exploring how risks can be addressed. For example, this can typically be undertaken using threat and opportunity matrices as shown below:

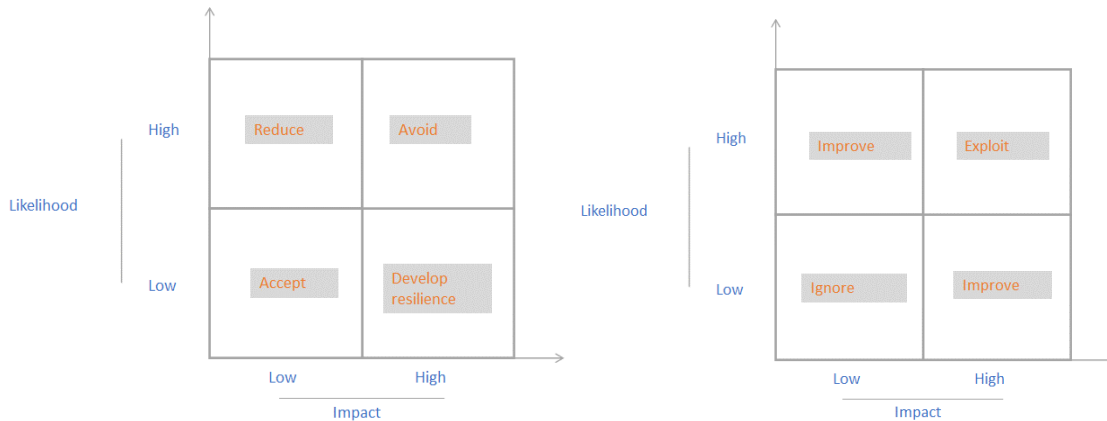


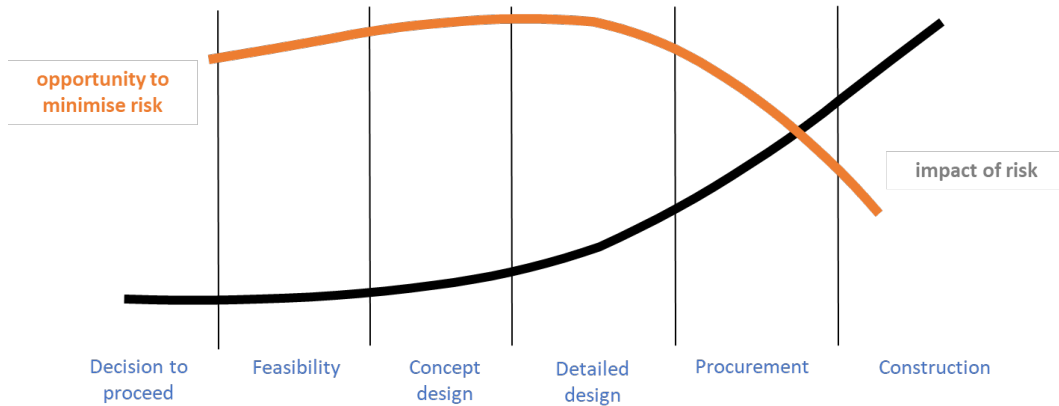
Figure: Threat and opportunity matrices for addressing risk

3. Identify risks: identify specific risks using a risk assessment and maintaining a risk register.

4. Report risks: for the top risks, consider their impact, whether they are capable of being mitigated and when they are likely to be mitigated. On that basis, determine whether risks should be reported and to whom.

5. Monitor risks: Risks should be monitored using risk management performance indicators. Effective monitoring involves consideration of (a) whether the risks are raised throughout the project life cycle; (b) whether all risks are assigned to the most appropriate owner; (c) whether risks are reviewed regularly; (d) whether risks have owned, timebound mitigation or exploitation plans; and (e) whether the 'red' risks are escalated to senior management.

(c)



(d)

Design

Either of the following is a suitable response:

- Where possible, ensure designs are mature before starting construction to minimise change.
- Standardise components and designs to better enable integration into an operation 'whole' at the end of the project.

Management

Any one of the following is a suitable response:

- Setting an end date many years in advance becomes overly onerous and unrealistic as the project develops.
- Establish the best key performance indicators (KPIs) that provide the most accurate representation of the current project status, not what looks good to the management board.

Procurement

Either of the following two responses is suitable:

- Ensure oversight of any problems accumulating across individual procurement contracts to avoid hidden systemic risk.
- Fixed price contracts do not always give cost certainty particularly when complex interdependencies are involved.

(e)

(i) Students can pick any relevant example.

Cause: statement of fact: sub-optimal tunnelling operations caused increased settlements in parts of London.

Risk: the increased settlements may become significant and may exceed design thresholds.

Impact: the settlements may cause movement and damage to nearby infrastructure.

(ii)

The process involves:

- Identifying hazards
- Establishing who may be harmed and how
- Evaluating risks and deciding on management measures
 - Elimination; Mitigation; Containment
- Recording significant findings and necessary actions
- Reviewing the assessment and updating as necessary

Risk assessment should identify three appropriate hazards and their corresponding likelihood of occurrence and the associated severity to calculate risk.

Example risk assessment:

Hazard	Likelihood of occurrence (range 1 to 4 with 4 being most likely)	Severity (range 1 to 4 with 4 being most severe)	Risk 1 – lowest risk 16 - greatest risk
Trips due to uneven ground surface	2	2	4
Falling debris from building damaged by tunnelling	1	4	4
Flooding arising from damage to buried water/wastewater services	3	3	9

4

(a)

The choice of a particular procurement strategy largely depends on a client's required balance of cost, quality and time risks.

Cost: what is the balance between the return or benefit to be achieved against the investment to be made?

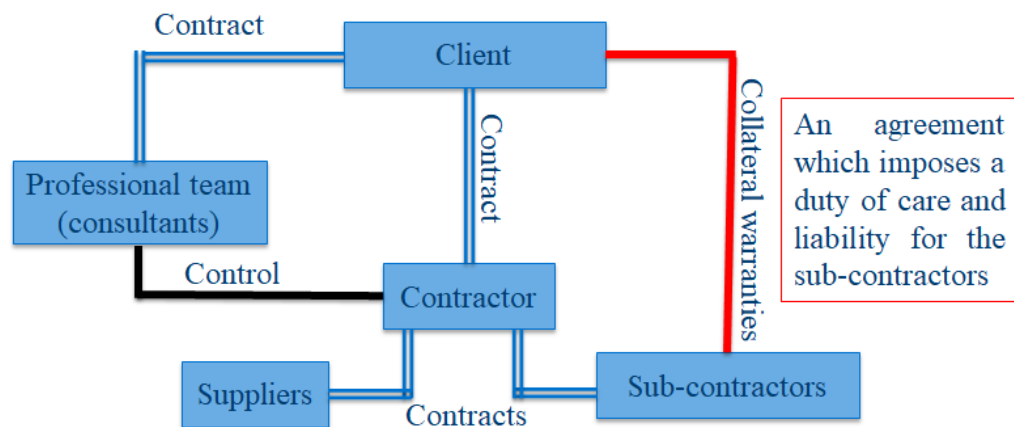
Quality: What measure of control should be exerted over materials and workmanship?

Time: Is a 'fast track' project with a short programme a priority?

(b)

(i)

- (1) Traditional →
- The design process is separate from construction
 - Documentation (drawings, BQ, etc...) must be prepared before invitation to tender
 - Client has control over the design through their consultants



(ii)

Client

Advantages: There is greater transparency over actual costs. Construction quality is likely to be greater because there is no incentive for the contractor to cut costs.

Disadvantages: This approach is riskier for the client because they may end up paying significantly more.

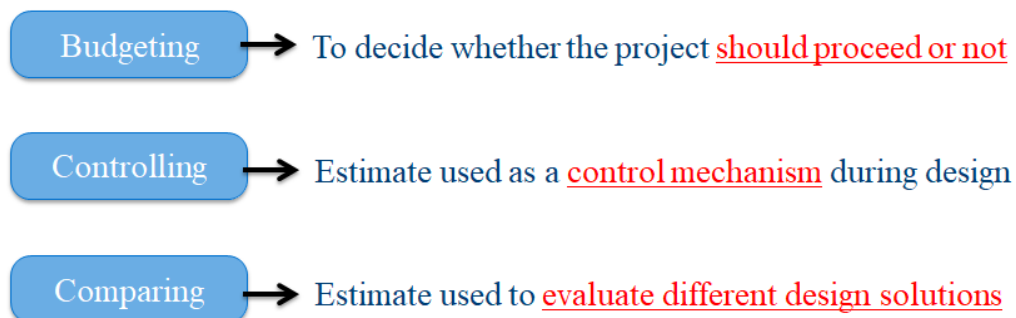
Contractor

Advantage: This approach results in much less risk for the contractor and profits are not susceptible to variable material prices / inflation.

Disadvantage: This approach requires increased transparency, and the open book approach can still lead to significant conflict surrounding costs. There is also less 'wiggle room' for the contractor to increase profits through value engineering during the project.

(c)

(i)



The two methods are:

(1) Functional Unit Method – Rate per unit of facility;

(2) Superficial Method – Rate per type of floor area.

The functional unit method is simpler and quicker compared to the superficial method. However, the functional unit method is also cruder and the superficial method tends to be more accurate.

(ii) Time is considered in two main ways:

(1) cost of materials through the use of price indices;

(2) time value of money to calculate return on investment (using discount factors).

(d)

(i)

Design Option A			
Year	Cash Flow (£M)	Discount Factor	Present value (£M)
1	0.97	0.90	0.87
2	0.75	0.81	0.61
3	0.80	0.73	0.58
4	0.85	0.66	0.56
5	0.40	0.59	0.24
Tender Sum	<u>3.77</u>		<u>2.86</u>

Design Option B			
Year	Cash Flow (£M)	Discount Factor	Present value (£M)
1	0.30	0.90	0.27
2	0.50	0.81	0.41
3	0.75	0.73	0.55
4	1.00	0.66	0.66
5	1.50	0.59	0.89
Tender Sum	<u>4.05</u>		<u>2.76</u>

Even though Design Option B has the greater tender sum, Design Option A has the greatest net present value when time value of money is taken into account. Therefore, the recommendation should be to proceed with Design Option A.

(ii)

Note all cash values below in £million.

Design Option A								
Year	Cash Flow	Old steel costs	Old PI	New PI	New steel costs	New cash Flow	Discount Factor	Present value
1	0.97	0.50	250	250	0.50	0.97	0.90	0.87
2	0.75	2.50	263	281	2.68	0.57	0.81	0.46
3	0.80	3.75	276	338	4.59	-0.04	0.73	-0.03
4	0.85	4.00	289	422	5.83	-0.98	0.66	-0.64
5	0.40	1.25	304	527	2.17	-0.52	0.59	-0.31
Tender Sum	<u>3.77</u>		-	-		-		<u>0.36</u>

Design Option B								
Year	Cash Flow	Old steel costs	Old PI	New PI	New steel costs	New cash Flow	Discount Factor	Present value
1	0.30	0.75	250	250	0.75	0.30	0.90	0.27
2	0.50	3.25	263	281	3.48	0.27	0.81	0.22
3	0.75	3.50	276	338	4.29	-0.04	0.73	-0.03
4	1.00	2.25	289	422	3.28	-0.03	0.66	-0.02
5	1.50	0.25	304	527	0.43	1.32	0.59	0.78
Tender Sum	<u>4.05</u>		-	-		-		<u>1.22</u>

Recommend Design B with NPV = £1.22 million

5

(a)

(i)

Cash method: Income/expense is considered only when cash actually received/expended. This is a simple and straightforward approach. There is no attempt to match revenues with related expenses and tax liability occurs only when payment is received. An income statement prepared on the basis of this approach will not be accurate in terms of profit/loss. Balance sheet will not be an accurate reflection of a GC's financial condition. This approach is entirely inadequate for credit and banking.

Accrual method: Using this method, income is taken into account during the period earned, regardless of whether payment is received or not. Expenses are also entered as incurred during the period, regardless of whether paid during the period or not. This is a more complex process and maintains connection between revenues earned and associated expenses. It requires more elaborate accounting records system.

The cash method should be recommended because the projects are likely small-scale for a start-up and this approach is simple and there are less onerous accounting requirements.

(ii)

Percentage of completion method: Taxes are paid regularly over project fiscal years.

Advantage for contractor: this method reduces risk of possible higher tax rate at the end of the project which can be beneficial for a contractor.

Completed contract method: taxes deferred until the contract is completed.

Advantage for contractor: Contractor does not have to pay tax until the end such a key benefit is that the money could be invested in the interim. However, a disadvantage is that this incurs considerable risk.

(b)

(i) Checks/questions to consider: Does the owner have the money to pay? What is the owner's credit rating? Credit capacity? Financial strength?

A dummy company or subsidiary may indicate the client's perception of increased risk which therefore may also indicate more risk for the contractor. Those formed just for this project may have no financial record and limited financial resources.

(ii) Financial and credit services, industry trade groups, other GCs who have dealt with this owner.

(c)

(i)	2021	2020
Quick ratio = cash + debtors / current liabilities	1.43	1.29
Current ratio = current assets / current liabilities	1.43	1.29
Total liabilities to net worth = total liabilities/ shareholder equity	2.96	3.21
Percent net income = profit before tax / turnover	0.32	

Quick ratio is greater than 1 which indicates liquidity / good.

For current ratio, 1.5-2 is considered good and these numbers are on the low side of healthy. The current ratio is the most significant short-term financial health measure. Both ratios have increased since 2020 indicating that the company's liquidity is relatively healthy.

Total liabilities to net worth is relatively high (ideally 1-2) indicating more financing with debt and therefore slightly greater risk. This is likely due to the impacts of Covid and is therefore understandable and not a major cause for concern.

Percent net income is typically low for a construction company. The calculated value is on the low end of what one might expect for a successful project indicating notable risk. Again, there may also be residual impacts of Covid.

In summary, the turnover suggests that the company is a major player. There are no major causes for concern in these ratios and the recommendation should be for the project to proceed.

(ii) The debt-to-equity ratio is already quite high and given the back-drop of Covid and higher lending rates, additional financing with debt is unlikely to be optimal. To minimise risk to rising tax rates, financing via retained earnings, which remain substantial in 2021 appears the most appropriate route.

