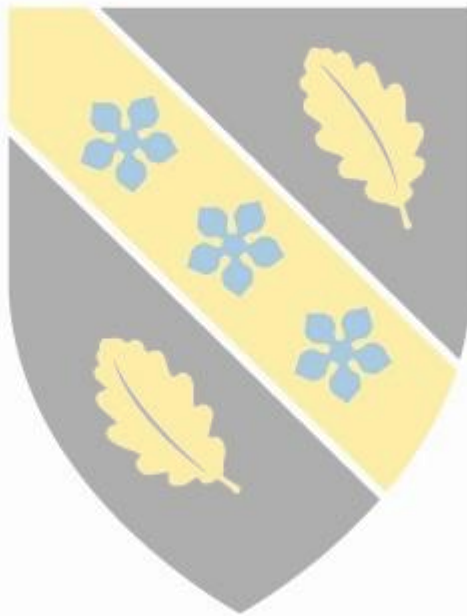




PROGRAMME CONTROL

Construction Management (ACBA6000)

Abstract

Assuming that Swansea City Council have granted planning permission for the construction of a new library building (Y Fforwm), Kier Construction LTD have been appointed as the principle contractor on a NEC Design & Build basis to construct the facility on behalf of the client, UWTSO. This report discusses how Kier will, manage, monitor, and incentivise project performance in accordance to the project programme. Illustrated also are detailed site set-ups and the annexation of project variations.

Adam Meyrick (1706760)

Project & Construction Management

Table of Contents

CHAPTER 1.0: ADDRESSING PERFORMANCE ISSUES IN TERMS OF PRODUCTIVITY AND INCENTIVISATION TO THE CLIENT. 6 - 16

SECTION 1.0.1 PROJECT PLANNING	6
SECTION 1.0.2 TIME, COST & QUALITY	6
SECTION 1.0.3 COST PLANNING AND CONTROL	7
SECTION 1.0.4 COST PLAN	8
SECTION 1.0.5 SITE-SPECIFIC COST STATEMENTS	9

CHAPTER 1.1: ADDRESSING PRODUCTIVITY PERFORMANCE ISSUES AND INCENTIVISATION 16 - 24

SECTION 1.1.1 KEY PERFORMANCE INDICATORS (KPI's)	19
SECTION 1.1.2 BENCHMARKING	19
SECTION 1.1.3 INCENTIVIZATION	20
SECTION 1.1.4 INCENTIVIZATION OF THE CLIENT	22
SECTION 1.1.5 FRAMEWORK AGREEMENTS	23

CHAPTER 1.2: PROJECT SITE SET-UP IN CONSIDERATION TO THE PROXIMITY OF THE IQ BUILDING 25-33 25 - 33

SECTION 1.2.1 SITE SET-UPS	28
----------------------------	----

BIBLIOGRAPHY 34 - 35

APPENDICES 36 - 39

List of Tables

Table 1: <i>Construction stage (Tasks 15-55) total and daily labour costs</i>	9
Table 2: <i>Weekly labour and labour costs</i>	11
Table 3: <i>Pathways Kier apply monetary incentivisation to their workforce</i>	21
Table 4: <i>Pathways Kier apply non-monetary incentivisation to their workforce</i>	22
Table 5: <i>Essential components of the site set-up and justification for their provision</i>	25

List of Figures

Figure 1: <i>Time, cost, quality project management triangle</i>	6
Figure 2: <i>The scope creep balance see-saw</i>	6
Figure 3: <i>Weekly labourers on site x weekly outlay of labour and plant costs</i>	15
Figure 4: <i>Labour and plant cumulative expenditure graph for the construction phase</i>	16
Figure 5: <i>“Budget vs Actual” graph traditionally used to compare budget with actual spend</i> ...	16
Figure 6: <i>Cost increases as the project develops inversely to early design alteration</i>	17
Figure 7: <i>Maslow’s hierarchy of needs, signifies employees most basic needs</i>	20
Figure 8: <i>Car park facility 1 (100-capacity) highlighted in RED</i>	27
Figure 9: <i>Car park facility 2 (200-capacity) highlighted in RED</i>	27
Figure 10: <i>Site Set-up 1</i>	29
Figure 11: <i>Warning Signage</i>	29
Figure 12: <i>Safety Signage</i>	29
Figure 13: <i>Diversion Signage</i>	29
Figure 14: <i>Site set-up 2</i>	30
Figure 15: <i>Site set-up 3</i>	31
Figure 16: <i>Site set-up 4</i>	32
Figure 17: <i>Site set-up 5</i>	33

List of Abbreviations

Abbreviation Clarification

<i>UK</i>	United Kingdom
<i>LTD</i>	Limited
<i>UWTSD</i>	University of Wales Trinity Saint David
<i>RIBA</i>	Royal Institute of British Architects
<i>NEC</i>	New Engineering Contract
<i>APM</i>	Association of Project Managers
<i>BoQ</i>	Bill of Quantities
<i>CIOB</i>	Chartered Institute of Builders
<i>RICS</i>	Royal Institute of Chartered Surveyors
<i>FFE</i>	Fittings, Furnishings, and Equipment
<i>M&E</i>	Mechanical & Electrical
<i>LLR</i>	Lessons Learned Report
<i>PPR</i>	Post Project Review
<i>CDM</i>	Construction (Design & Management)
<i>KPI</i>	Key Performance Indicators
<i>RC</i>	Reinforced Concrete
<i>SIPS</i>	Structural Insulated Panels
<i>BREEAM</i>	Building Research Establishment Environmental Assessment Method
<i>SAP</i>	Standard Assessment Procedure
<i>QS</i>	Quantity Surveyor
<i>TQM</i>	Total Quality Management
<i>JIT</i>	Just in Time
<i>BIM</i>	Building Information Modelling
<i>EVM</i>	Earned Value Method
<i>EV</i>	Earned Value
<i>H&S</i>	Health & Safety
<i>AIR</i>	Accident Incidence Rate
<i>CIRIA</i>	Construction Industry Research and Information Association
<i>TRT</i>	Target Recruitment & Training
<i>SME</i>	Small and Medium Enterprises
<i>SEWSCAP</i>	Southeast and mid-Wales Collaborative Construction Framework
<i>JCT</i>	Joint Contracts Tribunal
<i>EU</i>	European Union
<i>HSE</i>	Health & Safety Executive
<i>CSCS</i>	Construction Skills Certification Scheme
<i>dB</i>	Decibel

1.0 Formulation and Evaluation of Site-Specific Reports for Time, Cost and Quality of Works

The University of Wales Trinity Saint David (UWTSD) have appointed Kier Construction LTD to perform design & build works of a new library building at the SA1 area of Swansea. An NEC3 Option C Design & Build contract exists between the two parties, with the client approving to a £10m budget. In reference to the master Gantt Chart project programme found on **Appendix A.1**, the RIBA Design Stage 1 (Project start-up) commenced on the 16th of March 2020. With the construction stage launching on the 17th August 2020.

1.0.1 Project Planning

The master construction programme is agreed with the client and the project team and is usually compiled by the project planner with the input of in-house team expertise. The programme should include suitable contingencies such as added float to reasonably accommodate future developments such as foreseeable delays/design changes. The Association of Project Managers (APM) defines “float” as *“the amount of time by which a given task within a project can be delayed before it impacts the deadline for the project”*. The most important part of the programme however is the “critical path” – it is imperative that these tasks do not get delayed across the lifecycle of the project’:

“A critical path is the sequence of project network activities which add up to the longest overall duration, regardless if that longest duration has float or not. This determines the shortest time possible to complete the project. There can be ‘total float’ (unused time) within the critical path” (Ray, 2019)

1.0.2 Time, Cost & Quality

Labelled the “Quality Triangle”, **Figure 1** illustrates the trade-offs inherent in any construction project. It demonstrates the relationship between the three client-driven focuses in any project:

1) Time, 2) Cost and 3) Quality, representing the standard that the project must accomplish to be a success. Interconnected with the quality triangle is a phenomenon known simply as “Scope creep” as seen on **Figure 2**. In construction this refers to changes, continuous or uncontrolled in a project's scope, at any point after the project begins (**Jenkins, 2016**). This can occur when the scope of a project is not properly defined or controlled when change procedures are not executed conclusively. Scope creep is one of the main causes of cost increases and programme delays.



Figure 1: Time, cost, quality project management triangle (**Madurai, 2018**).

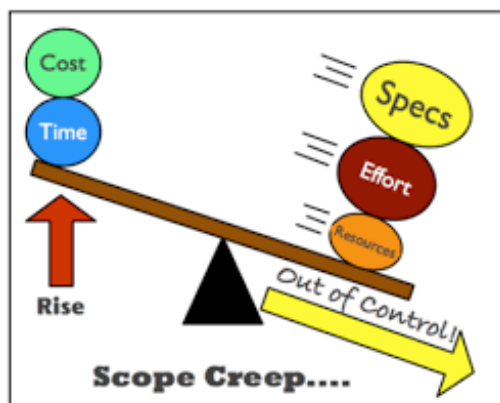


Figure 2: The scope creep balance see-saw (**Chauhan, 2018**).

1.0.3 Cost Planning and Control

Following the establishment of project time, cost, and quality parameters the development of a budget study is undertaken to determine the total cost and returns expected from the project. A cost plan is prepared to include all construction costs and preliminaries. The objective of this cost plan is to allocate the budget to main elements of the project to provide the bases of cost control.

Types of costs

Construction projects are priced using a Bill of Quantities (BoQ); a detailed description of the items needed to finish the project and their associated costs. As such, there are several different cost factors as defined by the Chartered Institute of Builders (CIOB):

Preliminaries

The BoQ contains its own section dedicated to preliminary costs. The Royal Institution of Chartered Surveyors (RICS) definition of preliminaries remains:

“Preliminaries (or 'prelims') may appear in tender documents, providing a description of a project that allows the contractor to assess costs which, whilst they do not form a part of any of the package of works required by the contract, are required by the method and circumstances of the works” (Benge, 2013).

Preliminaries address and communicate to the contractor items that are not directly related to any component, element, or work section; these can include the erection of works such as scaffolding, formwork, plant, and site services.

Measured Works

This is the principle part of the BoQ, which lists all the items of work to be undertaken. The quantities and descriptions of items should be determined in accordance with the RICS rules of measurement. Examples of measured works include:

- Facilitating works,
- Substructure,
- Superstructure,
- Internal finishes,
- Fittings, furnishings, and equipment (FFE),
- Mechanical & Electrical Services (M&E),
- External works.

Provisional Sum

In projects where construction work is commenced pending a complete design, provisional sums are at paramount importance. Essentially, provisional sums are costs included for items of work that are anticipated, in definition:

“A provisional sum is an allowance (or best guess), usually estimated by a cost consultant, that is inserted into tender documents for a specific element of the works that is not yet defined in enough detail for tenderers to accurately price” (Designing Buildings Wiki, 2019).

For the client, the benefits of using defined Provisional Sums are their capacity to pass risk onto the contractor. Owing to the contractor being regarded to have made sufficient allowance for the effect on programme and ensuing running costs.

Dayworks

Daywork is a means of estimation and payment for works based on labour, materials and plant costs, coupled with a mark-up for overheads and profit. This system should only be applied if the normal valuation mechanism is not appropriate.

1.0.4 Cost Plan

It is within the RIBA Design Stage 2: Concept Design (see **Appendix A.2**) a cost plan for the project is formulated. Cost plans are an essential part of a project and are generally prepared by a Quantity Surveyor (QS). They develop through the project, expanding in detail and accuracy as more information becomes available about the nature of the design. The plan should include the best possible estimate of cash flow and should also set targets. The plan should cover all stages of the project and will be an essential in post completion where the contract sum and final account can be compared for continuous improvement measures in the "Lessons Learned Report (LLR)" or "Post Project Review (PPR)". To summarise, a cost plan directly relates to the following:

- Initial cost appraisals,
- Elemental cost plans,
- Approximate quantities cost plans,
- Pre-tender estimates,
- Contract sum,
- Final account.

Cost control

The objective of cost control is to manage the delivery of the project within the approved budget. Regular cost reporting will facilitate the best possible estimate of:

- Project cost to date.
- Anticipated final cost of the project.
- Future cash flow.

Additionally, cost reporting will include the appraisal of::

- Continuing risks to cost.
- Costs in the use of completed facility.
- Prospective savings.

Successful project management and control on this project, it is not appropriate to consider only the past costs and revenues incurred in a project. Managers should also concentrate upon future revenues, future costs and technical problems associated. Particular attention should be given to activities indicating substantial deviation from budgeted amounts. Overruns in cost may be owing to lower than projected productivity, higher than anticipated wage rates, steeper material costs, or other factors (i.e. variations). Even further, minimal productivity could be caused by insufficient training, lack of necessary resources such as equipment or tools, or excessive amounts of re-work to remedy quality issues. To summarise, review of an activities status is only

the first step in project control and project monitoring and incentivization methodologies must be adopted by the principle contractor Kier.

1.0.5 Site-Specific Cost Statements

It is important to analytically important that the number of laborers due to be on site at each week throughout the project is accurately surveyed before programme acceptance for many reasons. Firstly, this methodology certifies that the site will not be overcrowded and will not jeopardize laborers health & safety. This strategy also plays directly into Kiers role as the principle contractor to comply with the Construction (Design & Management) Regulations 2015. Conversely, with lower labourer numbers on site at a specific point during the programme opportunity for additional trades to be on site to accelerate the programme can be easily identified. The number of labourers on site each week can also be benchmarked against other projects of similar value and function.

This is contractor excellent practice as this monitoring can act as an incentivisation mechanism to improve productivity. Additionally, the number of weekly labourers and labour costs can be earmarked as a key performance indicator (KPI) to measure how the project is progressing in accordance to what was programmed. This will permit Kier to make real-time changes to the running of the project to help get the project back on track or to forward-plan any scope-creep the discrepancy should cause. These results can thereafter be scrutinised post-project as a means of continuous improvement.

Perhaps the principle reason although is to analyse the labour cost with the association of plant cost. Given the number of laborers on site, their programmed time on site and labour costs, a labour cash flow forecast can be formulated. This tool will permit the principle contractor to have jurisdiction over redistributing labour and moreover, cost. Exhibiting data in this format furthermore allows the contractor to visually evaluate where costs can be spared, pushing higher profits. Illustrated within **Table 1** are the number of labourers required to complete each activity, in addition to the total and daily labour and plant costs associated with each construction activity. Highlighted in **RED** are the key project phases, inclusive of total duration and total cost data in tandem with the project programme.

Table 1: Construction stage (Tasks 15-55) total and daily labour costs.					
No.	Activity	No. of Labourers	Duration	Estimated Plant & Labour Cost £	Daily Cost £
15	Stage 5 - Construction	-	45w	/ £2,629,475	= £8,349.5
16	Site Establishment	14	2w	/ £16,050	= £1,146.43
17	Site Hoarding, Office & Welfare Facilities	7	1w	/ £7,800	= £1,114.3
18	Site Clearance	7	1w	£ 8,250	= £1,178.6
19	Substructure	-	11w 2d	/ £562,000	= £7,113.9
20	Excavation	5	1w	/ £7,500	= £1,071.2
21	Piling	5	4w	/ £200,000	= £7,142.9
22	Pile Caps and Ground Beams	7	4w	/ £200,000	= £7,142.9
23	Tower Crane Installation	5	1w	/ £15,000	= £2,142.9
24	RC Slabs	10	2w	/ £100,000	= £7,142.9
25	Excavate Drainage Runs	8	1w	/ £15,500	= £2,214.3

26	Lay Drains, Test, Backfill	8	1w 2d	/ £25,000	= £2,777.7
27	Superstructure	-	9w	/ £721,750	= £11,456.4
28	Steel Frame Erection	15	4w	/ £315,000	= £11,250
29	Metal Decking	10	2w	/ £120,000	= £8,571.4
30	Roofing (Warm Roof)	10	2w	/ £94,500	= £6,750
31	Slabs Upper Floors	15	1w 4d	/ £140,000	= £12,727.3
32	Staircase Installations & Lift Shaft	12	2w	/ £52,250	= £3,732.1
33	Envelope	-	11w 3d	/ £543,175	= £6,789.7
34	SIPS Partitions	8	4w	/ £55,500	= £1,982.1
35	Metsec SFS Weatherboards	8	3w	/ £32,500	= £1,547.6
36	Brick & Blockwork, DPM, Cavity Ties & Fire Stops	20	5w	/ £187,750	= £3,650
37	Windows & External Door	7	2w	/ £90,000	= £5,364.3
38	Watertight				
39	Cladding Rails & Metal Profiling Cladding Panel Installation and Flashings	12	2w 3d	/ £162,425	= £10,151.6
40	Remove Tower Crane	5	1w	/ £15,000	= £2,142.9
41	Internals	-	15w 4d	/ £467,500	= £4,289
42	Partition 1st Sideboard	7	3w	/ £35,000	= £1,666.6
43	1st Fix M&E	5	3w 4d	/ £65,000	= £2,600
44	Partition 2nd Sideboard	7	2w 3d	/ £35,000	= £1,666.6
45	Tape and Joint	7	3w	/ £35,000	= £1,666.6
46	Decoration	7	2w 2d	/ £25,000	= £1,562.5
47	Ceilings	7	2w 2d	/ £35,000	= £1,666.6
48	FFE	15	2w	/ £100,000	= £7,142.9
49	Final Fix M&E	5	4w	/ £95,000	= £3,392.9
50	Snag & Clean	5	2w 4d	/ £42,500	= £2,361.1
51	Externals	-	9w 4d	/ £261,500	= £4,023.1
52	Road, Footpath & Carpark Construction	25	6w 2d	/ £178,500	= £4,056.8
53	Soft Landscaping	5	3w 2d	/ £83,000	= £3,608.7
54	Testing & Commissioning	-	3w 3d	/ £57,500	= £2,395.8
55	Commissioning (M & E Certification, BREEAM, SAP, Air Tightness)		3w 3d	/ £57,500	= £2,395.8

Following the establishment of the number of laborers required for each task and their associated daily costs, the formulation of weekly labour and labour cost distribution can occur. In quotation to the project programme document, **Table 2** demonstrates this weekly analysis in tabulated form.

Table 2: Weekly labour and labour costs.						
Week	Weekly Activities	Activity Labourers	Weekly Labourers	Duration	Daily Cost £	Weekly cost
1	Site Hoarding, Office & Welfare Facilities	7	7	1w	X £1,114.3	= £5,571.5
2	Site Clearance	7	7	1w	X £1,178.6	= £5,893
3	Excavation	5	5	1w	X £1,071.2	= £5,356
4	Piling	5	5	1w	X £7,142.9	= £35,714.5
5	Piling	5	5	1w	X £7,142.9	= £35,714.5
6	Piling Pile Caps and Ground Beams	5	13	1w	X £7,142.9	= £57,143.2
		7		3d	X £7,142.9	
7	Piling Pile Caps and Ground Beams	5	13	1w	X £7,142.9	= £71,429
		7		1w	X £7,142.9	
8	Pile Caps and Ground Beams	7	7	1w	X £7,142.9	= £35,714.5
9	Pile Caps and Ground Beams	7	7	1w	X £7,142.9	= £35,714.5
10	Pile Caps and Ground Beams Tower Crane Installation	7	13	2d	X £7,142.9	= £25,000.3
		5		1w	X £2,142.9	
11	RC Slabs	10	10	1w	X £7,142.9	= £35,714.5
12	RC Slabs Excavate Drainage Runs	10	18	1w	X £7,142.9	= £40,143.1
		8		2d	X £2,214.3	
13	Excavate Drainage Runs	8	31	3d	X £2,214.3	= £74,003.7
	Lay Drains, Test, Backfill	8		4d	X £2,777.7	
	Steel Frame Erection	15		1w	X £11,250	
14	Lay Drains, Test, Backfill Steel Frame Erection	8	23	3d	X £2,777.7	= £64,583.1
		15		1w	X £11,250	
15	Steel Frame Erection	15	15	1w	X £11,250	= £56,250
16	Steel Frame Erection	15	15	1w	X £11,250	= £56,250
17	Metal Decking	10	10	1w	X £8,571.4	= £42,857
18	Metal Decking Roofing (Warm Roof)	10	20	1w	X £8,571.4	= £76,607
		10		1w	X £6,750	
19	Roofing (Warm Roof)	10	25	1w	X £6,750	= £97,386.5
				1w	X £12,727.3	

	Slabs Upper Floors	15				
20	Slabs Upper Floors	15	27	4d	X £12,727.3	= £69,569.7
	Staircase Installations & Lift Shaft	12		1w	X £3,732.1	
21	Staircase Installations & Lift Shaft	12	20	1w	X £3,732.1	= £28,571
	SIPS Partitions	8		1w	X £1,982.1	
22	SIPS Partitions	8	8	1w	X £1,982.1	= £9,910.5
23	SIPS Partitions	8	16	1w	X £1,982.1	= £17,648.5
	Metsec SFS Weatherboards	8		1w	X £1,547.6	
24	SIPS Partitions	8	36	1w	X £1,982.1	= £35,898.5
	Metsec SFS	8		1w	X £1,547.6	
	Weatherboards					
	Brick & Blockwork, DPM, Cavity Ties & Fire Stops	20		1w	X £3,650	
25	Metsec SFS	8	35	1w	X £1,547.6	= £42,080
	Weatherboards					
	Brick & Blockwork, DPM, Cavity Ties & Fire Stops	20		1w	X £3,650	
	Windows & External Door	7		3d	X £5,364.3	
26	Brick & Blockwork, DPM, Cavity Ties & Fire Stops	20	27	1w	X £3,650	= £45,071.5
	Windows & External Door	7		1w	X £5,364.3	
27	Brick & Blockwork, DPM, Cavity Ties & Fire Stops	20	27	1w	X £3,650	= £45,071.5
	Windows & External Door	7		2d	X £5,364.3	
28	Brick & Blockwork, DPM, Cavity Ties & Fire Stops	20	27	1w	X £3,650	= £23,249.8
	Partition 1st Sideboard	7		3d	X £1,666.6	

29	Brick & Blockwork, DPM, Cavity Ties & Fire Stops	20	32	1w	X £3,650	= £36,983
	Partition 1st Sideboard	7		1w	X £1,666.6	
	1st Fix M&E	5		4d	X £2,600	
30	Partition 1st Sideboard	7	24	1w	X £1,666.6	= £69,291
	1st Fix M&E	5		1w	X £2,600	
	Cladding Rails & Metal Profiling	12		1w	X £10,151.6	
31	Cladding Panel Installation and Flashings		24			= £64,491.1
	Partition 1st Sideboard	7		2d	X £1,666.6	
	1st Fix M&E	5		1w	X £2,600	
32	Cladding Rails & Metal Profiling	12	17	1w	X £10,151.6	= £58,558
	Cladding Panel Installation and Flashings					
33	Remove Tower Crane	5	42	1w	X £2,142.9	= £39,331.5
	Partition 2nd Sideboard	7		1w	X £1,666.6	
	Road, Footpath & Carpark Construction	25		1w	X £4,056.8	
34	Road, Footpath & Carpark Construction	25	39	1w	X £4,056.8	= £36,950
	Partition 2nd Sideboard	7		1w	X £1,666.6	
	Tape and Joint	7		1w	X £1,666.6	
35	Road, Footpath & Carpark Construction	25	46	1w	X £4,056.8	= £36,741.8
	Partition 2nd Sideboard	7		3d	X £1,666.6	
	Tape and Joint	7		1w	X £1,666.6	
	Decoration	7		2d	X £1,562.5	

36	Road, Footpath & Carpark Construction	25		1w	X £4,056.8	= £39,762.7
	Tape and Joint	7		1w	X £1,666.6	
	Decoration	7		1w	X £1,562.5	
	Ceilings	7		2d	X £1,666.6	
37	Road, Footpath & Carpark Construction	25	39	1w	X £4,056.8	= £36,429.5
	Decoration	7		1w	X £1,562.5	
	Ceilings	7		1w	X £1,666.6	
38	Road, Footpath & Carpark Construction	25	47	1w	X £4,056.8	= £64,331.5
	Ceilings	7		1w	X £1,666.6	
	FFE	15		1w	X £7,142.9	
39	Road, Footpath & Carpark FFE	25	45	2d	X £4,056.8	= £60,792.6
	Final Fix M&E	15		1w	X £7,142.9	
		5		1w	X £3,392.9	
40	Final Fix M&E	5	10	1w	X £3,392.9	= £35,008
	Soft Landscaping	5		1w	X £3,608.7	
41	Final Fix M&E	5	10	1w	X £3,392.9	= £35,008
	Soft Landscaping	5		1w	X £3,608.7	
42	Final Fix M&E	5	15	1w	X £3,392.9	= £46,813.5
	Soft Landscaping	5		1w	X £3,608.7	
	Snag & Clean	5		1w	X £2,361.1	
43	Snag & Clean	5	5	1w	X £2,361.1	= £11,805.5

The tabulated data of **Table 2** has been translated to a clustered-line histogram for ease of analysis (see **Figure 3**). The number of labourers on site each week across the 43-week construction process has been displayed in correlation to the weekly labour and plant costs. Observed is a direct correlation where through the increase of total laborers on site, generally, the weekly cost of labour and plan increases too. The foundations of a “S-curve” is also apparent, this is justified by RICS as:

“The construction S-curve is a graphical report which displays the cumulative progress of a project and is a tool which construction companies use to track a specific metric over time” (RICS, 2019).

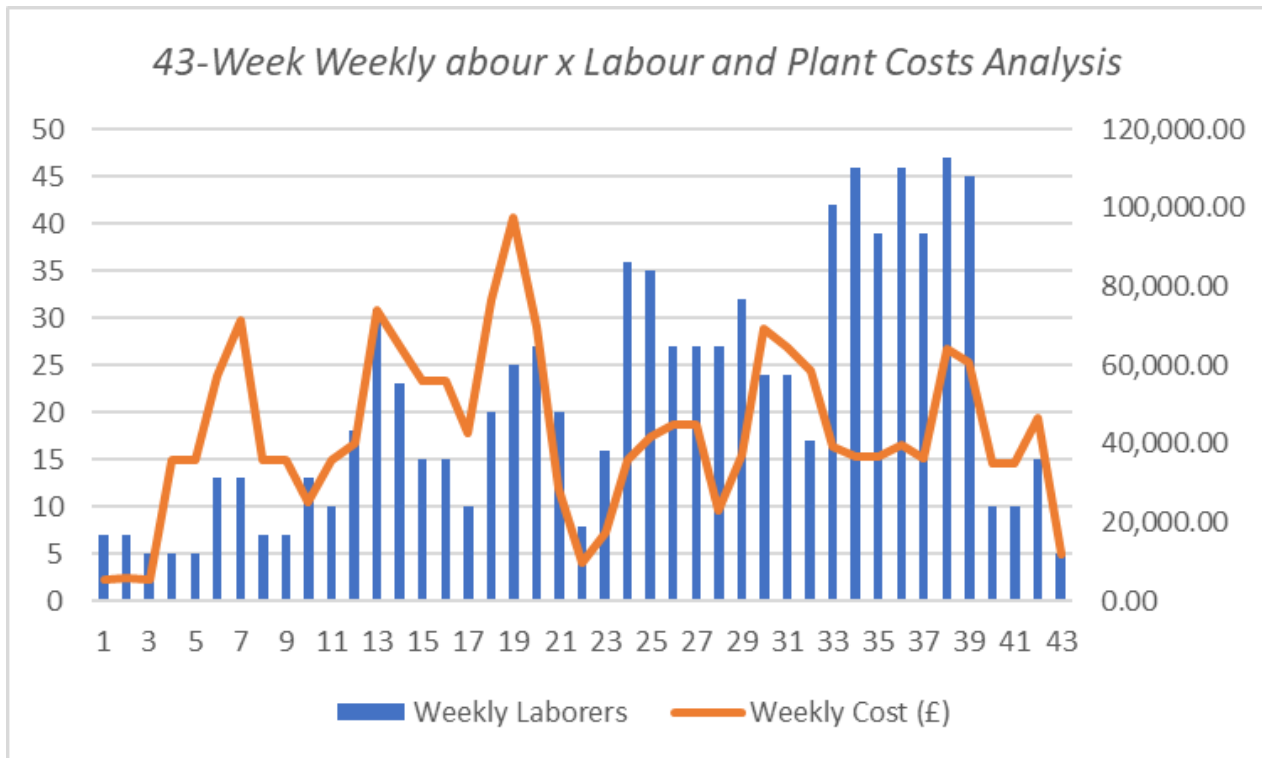


Figure 3: Weekly labourers on site x weekly outlay of labour and plant costs.

As displayed below, the generated cost S-curve demonstrates steep start-up of costs with a “tail-off” as the project nears completion. This is nebulously in line with the sum of labour on site, except for between weeks 33 and 39 where M&E, decorator and roadwork contractors are all on site at once. A climax of costs is observed approximately halfway through the project in week 19 of construction, where the “Roofing (Warm Roof)” and “Slabs Upper Floors” activities are ongoing, succumbing to the cost of £97,386.50.

Following this, this data has been scrutinised to devise a labour and plant cumulative expenditure graph (see **Figure 4**). In definition:

“Cumulative cost curves allow businesses to compare the estimated and actual costs of projects and estimated payoffs and actual payoffs, which allows them to modify projects to meet estimates. Business owners can identify projects that do not meet estimated benefits and modify or scrap them” (Hamilton, 2017).

This tool will allow the Quantity Surveyors (QS’s) at Kier to monitor cash flow throughout the project, assisting with disbursing client payments across the course of the project and in turn calculating contractor interim valuations for works completed to date.

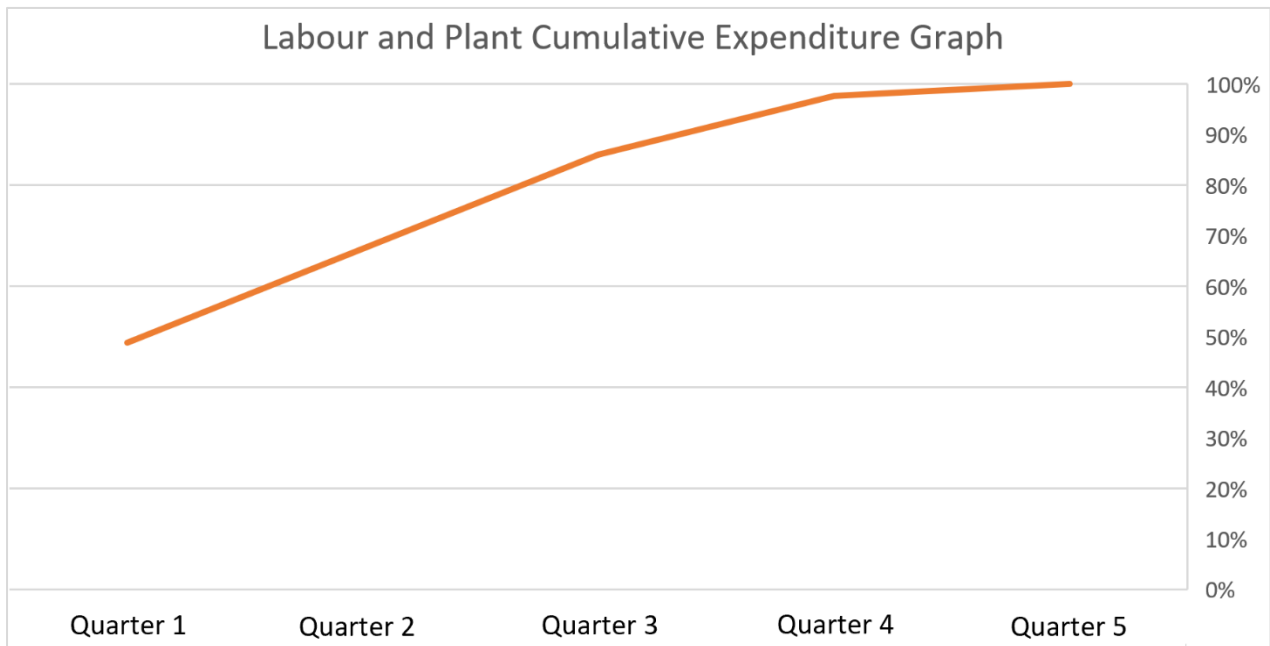


Figure 4: *Labour and plant cumulative expenditure graph for the construction phase.*

This graphical representation illustrates that around 40% of the total project cost is incurred during the first quarter, with a steady increase to 98% by the end of quarter 4. The remaining 2% of labour and plant cost is spent in quarter 5 where the testing & commissioning stage is concluded. The cumulative expenditure graph is an ongoing document that will be utilised by Kier to monitor the budgeted labour and plant costs to the actual spend (see **Figure 5**).

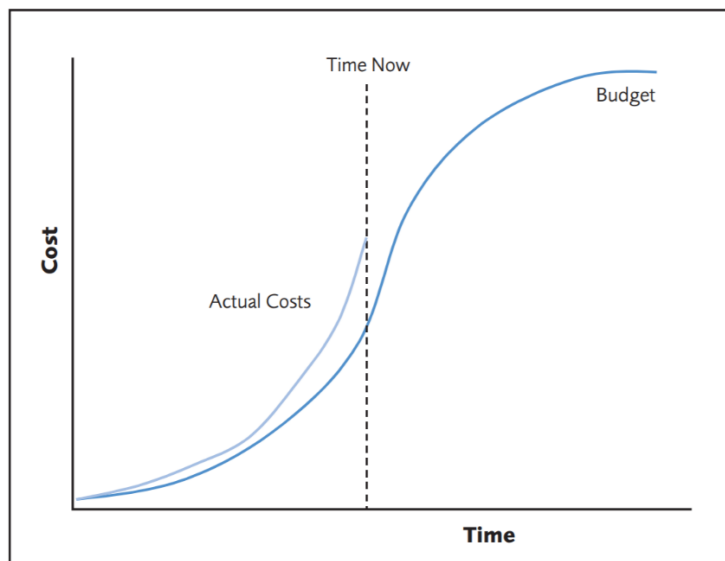


Figure 5: *“Budget vs Actual” graph traditionally used to compare budget with actual spend (Folkmans, 2008).*

To conclude, the subsequent management aspects come collectively to help formulate the final account of the project:

- Budgets,
- Schedules,
- Forecasts
- Progress assessments
- Problem identification
- Corrective actions.

1.1 Addressing Productivity Performance Issues and Incentivisation

When describing the time, cost, and quality graphic (see **Figure 1**), several approaches to improve these key success dynamics have recently come to the fore. Philosophies such as lean construction, value engineering and TQM (total quality management) optimise an organisations behaviour whilst placing client’s satisfaction at the forefront of the strategy.

Lean Construction

Lean construction processes have been developed from the processes used in manufacturing; incorporating improved scheduling of resources and materials to streamline construction, with the addition of just in time (JIT) deliveries. The CIOB states that:

“Lean construction is a way of thinking and delivering value, innovation and growth by doing more with less; less human effort, less equipment, less materials, less time and less space, aligning effort closer to meet customers value expectations” (Curran, 2018).

Lean construction has two central objectives to serve during the construction process:

1. Minimise physical and process waste.
2. Improve the value generation to the client.

Kier Construction can attain these deliverables for the client through instating the below procedures:

- Direct intervention to drive immediate and apparent change (swift reaction to variations).
- Improving communication through making drawings easily available to relevant people (BIMxtra).
- Uptake of Building Information Modelling (BIM).
- Improving work planning and forward scheduling.
- Eliminating activities that do not add value.
- Ensuring the working environment is clean, safe, and efficient.
- Adopting continuous improvement processes.
- Pre-fabrication and modular building to reduce activity on site and better distribute the workload.
- Integrating the supply chain through partnering and collaborative practices.
- Benchmarking techniques and the use of Key Performance Indicators (KPI's).
- Risk management techniques.

Value Engineering

Value engineering is applied to configure project challenges and to identify and eliminate

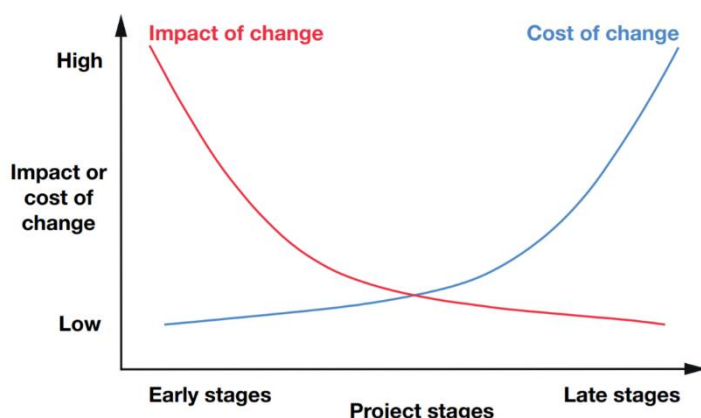


Figure 6: Cost of change increases as the project develops inversely to early design alteration (RICS, 2017).

unwanted costs, while improving function and quality. The aim is to increase the value of products, satisfying the client at the smallest viable cost. In construction, this entails studying the accessibility of materials, construction methods, transportation issues, site restrictions, planning, costs, profits, and so on (Churcher, 2017). Benefits that can be delivered to the client include a reduction in life cycle costs, improvement in quality and reduction in environmental impacts. Value engineering should start at RIBA Stage 1: Preparation and brief where the contractor has the greatest design

control and the total cost of the alteration will have the least impact as seen on **Figure 6**.

The systematic mandate of the value engineering process comprises of:

1. Identifying the main elements of a product, service, or project.
2. Analysing the functions of those elements.
3. Developing alternative solutions for delivering those functions.
4. Assessing the alternative solutions.
5. Allocating costs to the alternative solutions.
6. Developing in more detail the alternatives with the highest likelihood of success.

To instate this methodology simply, value engineering might involve altering window details in the design stage from aluminium lining to uPVC, which as a product is cheaper, has a longer life cycle and is thermally more efficient, conserving the client post-completion costs.

Total Quality Management (TQM)

Working hand-in-hand to the aforementioned methodologies, they mutually fall under the umbrella of Total Quality Management (or TQM) which in definition is: *“a theory of management the purpose of which is to improve an organisation’s ability to deliver quality to its customers on a continuously improving basis”* (**What is quality management?, 2020**). TQM can be operated in construction as a way of approaching the conception, visualisation and achievement of goals to ensure quality and productivity, with an emphasis on innovation and new technology. The typical elements of TQM for Kier to consider include:

- The customer is the ultimate user and wants a quality product at a reasonable price.
- Feedback from customers should be analysed and implemented where necessary.
- Employees should be encouraged and rewarded for good performance.
- Training should be provided regularly to upgrade the skills of employees.
- Conflicts should be avoided, and teams should work in unison toward a common goal.

The fundamental measures in the implementation of TQM are as follows:

- Production of a project quality assurance plan.
- Employees should be made aware of and educated about TQM.
- Steps should be taken to ensure continuous improvement, such as plan, act, check, do (PACD).
- Quality plans and performance should be analytically measured and regularly examined.

Benefits that can be delivered to both Kier and UWTSD from TQM include reduction in quality costs, higher levels of employee and client satisfaction, less remedial work, fewer delays, and a closer relationship with subcontractors and suppliers. To conclude this segment, although these “traditional” measures give a predisposition of the success or failure of a project, they do not provide a fair picture of the project’s execution. Furthermore, their application in construction projects is usually only noticeable at the end of the project, and therefore classified as ‘lagging’ rather than ‘leading’ indicators of performance.

Earned Value Method (EVM)

As touched on in **Figure 5**, another approach to monitoring project of performance is the earned-value method, applied to calculate the earned value (EV). The EV is calculated as the percentage of the work complete (preferably in terms of providing a project deliverable, such as an element of the new facility) at a particular point in time, multiplied by the baseline costs that were budgeted for up to that point in time in an objective manner.

Scholar **(Englert, 2012)** defines EVM as: *“a method for measuring project performance. It compares the amount of work that was planned with what was actually accomplished to determine if cost and schedule performance is as planned”*.

1.1.1 Key Performance Indicators (KPI's)

As previously stated, KPI's are a management mechanism devised to generate information upon 'live' construction activities. KPI's are composed to:

- Monitor costs.
- Follow progress.
- Review client satisfaction.
- Pinpoint strengths and shortfalls.
- Contrast performance across and between projects.
- Monitor specialized areas of a project (i.e. sustainability, safety, waste management).

Instances of how KPI's can be operated on this project include monitoring:

- Cost vs. budget.
- Project progress relative to milestones.
- Number of complaints.
- Number of incidents/accidents.
- The number of working hours spent on different aspects of the works.
- The use of materials (for example, the amount of concrete poured).
- The number of defects.
- The amount of waste generated and the amount of recycling.
- The number of variations.

KPIs can also be employed more broadly as part of a benchmarking tool to evaluate the execution of one project relative to another, in both a business case and project delivery stance.

1.1.2 Benchmarking

In principle: *“Benchmarking is a method of improving performance in a systematic and logical way by measuring and comparing your performance against others, and then using lessons learned from the best to make targeted improvements”* (Introduction to Benchmarking, 2018). It involves addressing the following key issues:

- “Who performs better?”
- “Why are they better?”
- “What actions do we need to take in order to improve our performance?”

Benchmarking can be carried out against within any project that is deemed to be 'best in class'. As such, project performance can be benchmarked in three separate ways; internally (within Kier projects), competitively (against competitors) or generally (a comparison of processes that are the same, regardless of industry). So, what are the crucial drivers for Kier to implement benchmarking processes on this project?

- Concentrates on task improvement and issues critical to success.
- It ensures that improvement targets are based on what has been achieved in practice, which removes the temptation to say, 'it can't be done'.

- Benchmarking provides confidence that Kiers organisation's performance compares favourably with best practice.
- Benchmarking can provide an assurance to clients that 'best value' is being achieved.

Examples of a benchmarks that Kier could set on this project are to firstly, competitively, ensure that the cost should be consistent with other £10m educational projects within the industry to ensure affordability amongst other competitors. Internally, Kier should also aim to benchmark themselves against the organisations Health and Safety (H&S) record and industry-leading Accident Incidence Rate (AIR) of 96 (**Kier, 2019**). To conclude benchmarking, successful benchmarking is dependent on precision of KPI's measured and essentially, targets should adapt if variators or organisations priorities change.

1.1.3 Incentivisation

The term "incentive" is generally used within construction, the term usually refers to attempts to hit targets, increase production or performance in return for financial reward to the individuals and/or organisations involved in the project. Jobs in construction are exceptionally labour intensive. Construction personnel are often required to deal with strict deadlines and high-pressure situations. In some cases, a career in construction can cause a significant mental and physical strain on an individual, damaging their motivation. The best performing construction projects attain a highly motivated and focused workforce.

Incentive mechanisms can therefore be used to motivate personnel or a party to behave in a certain manner or to achieve set targets. They can be financial, non-financial or a combination.

Workers

Illustrated in **Figure 7** Maslow's hierarchy of needs is encapsulated, a popular sociological framework, the graphic represents the truly fundamental human needs at the bottom and the need for self-actualization and transcendence at the top.

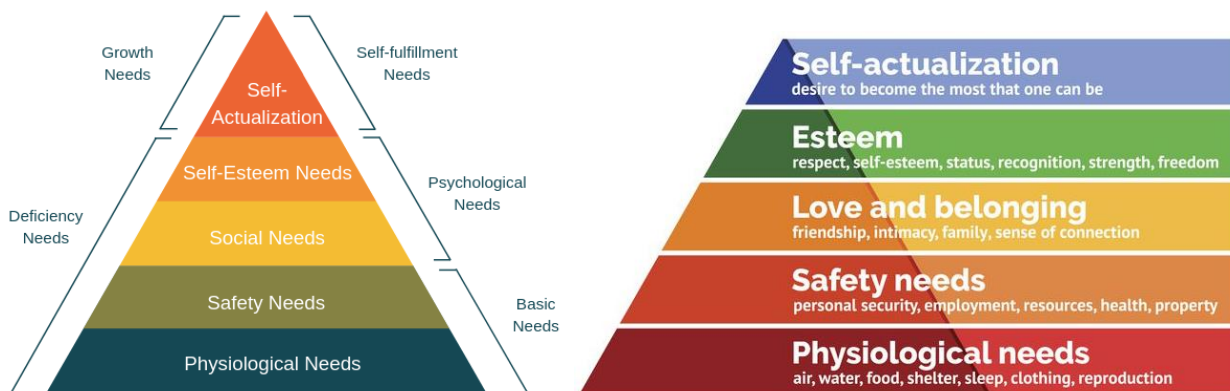


Figure 7: Maslow's hierarchy of needs, signifies employees most basic needs (Hopper, 2020).

Scholarly research articulated by (**Wu, 2012**) ratifies that fulfilling these needs within the workforce results in an increase in productivity. Resultant of this incentivisation, the performance of the project will with anticipation:

- Beat the completion date,
- Beat the construction cost,
- Beat the quality requirements,
- Improve the safety and environmental requirements.

So, how can Kier help incentivise its workforce to meet these basic needs? Although it is impossible to force individuals to remain motivated, there are a variety of monetary strategies that Kier implement to incentivize motivation and performance, including:

- Profit or gain-sharing plans,
- Cash bonuses,
- We pay if you stay,
- Internal pay equity,
- Long-term, stock-based incentives,
- Career development and training,

Additional ways in which Kier proffer monetary incentivisation is underscored on **Table 3**.

Table 3: Pathways Kier apply monetary incentivisation to their workforce (Kier, 2020).	
Holidays	Kier’s annual leave offers a generous 26 days per annum for full time employees and pro rata for part time employees.
Pension	Kier automatically enrolls employees into the Kier retirement savings plan.
Life Insurance	Kier provides free life insurance to all employees
Competitive Salary	Kier endeavours to offer competitive salaries across the Group to ensure they are attracting the best and brightest candidates.
Share Options	Kier offer employees two voluntary share schemes to join. The annual Kier “Sharesave Scheme”, a 3-year savings plan, and the “Share Incentive Plan”, a versatile long-term savings scheme with tax advantages.
Kier Homes	Kier entitle employees to receive up to 10% off the retail price of a new Kier home.

Conversely, examples of non-monetary incentivise Kier perform at a management level to increase productivity include:

1. *Promoting a sense of responsibility among employees:* The more trust an employee is given, the more accountable they will feel about their work. The construction manager must give workers autonomy and freedom but also be clear about what specific tasks need to be completed. **(Grant, 1998)** reaffirms the significance of job enrichment and recognition.
2. *Flexibility in work hours:* Abolishing the traditional timecard can offer construction workers a distinctive opportunity to become more productive. This plasticity allows workers to tackle other aspects of their lives whilst allowing them to better balance home and work commitments.
3. *Recognizing hard work:* Modest acts like monthly or weekly rewards can help increase morale and productivity. These can vary from simple gift cards to an afternoon off work, or even Kiers bonus plan.

*“Implementing an employee reward system will stand to benefit both employees and the business, by providing extra motivation needed, and to tap into many workers’ competitiveness. This not only provides short-term benefits to workers but can also be a powerful retention strategy for businesses **(Employee Incentives That Boost Productivity, 2020)**”.*

4. *Unity:* Construction managers should appreciate that employees are an amalgamation of persons with different ideals, traditions, work ethics, and interests. Team building or group exercises can therefore help in boosting productivity amongst workers and can build strong working relationships.

5. *Communication*: Talking to workers and asking for advice can help discover innovative ways to create incentives. Each group of people is different and not all employee incentives will work for all groups. Taking the time to communicate and listen to employees' ideas can be the initial step in improving productivity and creating a dependable and fulfilled workforce. Analysis by **(APM, 2019)** echoes that job satisfaction is the most important predictor of productivity.

Exploration by **(Appelbaum et al., 2000)** conducted upon a sample of 100 employees in questioning the effectiveness of non-financial incentives in organisations yields encouraging results in regard to the identification of promoting job-enrichment, internal pay equity, managerial skill as the main motivators for job satisfaction and resultant higher productivity. Additional ways in which Kier proffer non-monetary incentivisation is highlighted on **Table 4**.

Table 4: Pathways Kier apply non-monetary incentivisation to their workforce (Kier, 2020).	
Kier Recognition and Awards:	Kier awards its employees for hard work in many ways, such as through the monthly Kier Stars recognition scheme and annual employee awards.
Kier Choices:	Kier Choices is the voluntary flexible benefit scheme offered to Grade 'C' and above employees, this scheme gives the opportunity to select from a range of voluntary health, insurance and lifestyle benefits – from travel insurance and critical illness cover to increasing company life assurance or buying additional leave.
Learning & Development	Kier encourage people to own and drive their personal development so that they can be the best they possibly can be. Sponsoring and funding a wide range of professional body memberships for employees. This development offer is in addition to the technical skills training and support for professional qualification that employees need to perform effectively and safely in their roles.

1.1.4 Incentivisation of the Client

Commissioned by the UK government to investigate the perceived problems with the UK construction industry, the 1994 Latham Report once branded the industry as 'ineffective', 'adversarial', 'fragmented' and 'incapable of delivering for its customers'. Further to these shortcomings, recommendations for remediation were rendered, three of which include:

- Partnering should be used to encourage the establishment of long-term contracting arrangements.
- Firm duties of teamwork with shared financial motivation.
- Risk allocation to the party best able to manage, estimate and carry it.

The formulation of a NEC3 Option C Design & Build contract between Kier and the client, UWTSD, aims to promote partnering, provide financial motives and the distribute risk through the following entities. Whereby both parties have agreed to a 'Target Cost' for the works. Which includes a sub-clause mechanism where the cost saving or overrun is calculated and split between the parties according to an agreed formula - pain/gain share mechanism. This pain/gain share also covers construction risks. These contractual terms are enormously attractive amongst contractors and client alike. Particularly clients, who view the prospect of additional profit or shared loss an incentive of best practice to the contractor [Kier].

However, alluding to barriers to incentivisation on a contractual bases, CIRIA state that “*within the private sector, the use and development of incentivisation schemes is part and parcel of the commercial arrangements to achieve value for money*” (**Richmond-Coggan, 2001**). In other words, incentivisation must be discussed at the earliest tender stages to prove successful and prove value for money, where the incentives are tailored to the project.

To further this remark research concluded by (**Hughes et al., 2012**) state that within South-Wales principally:

“the hypothesis, that the use of incentivisation is a precursor to the achievement of successful partnered projects within infrastructure projects in South Wales and whether the level that the gain/pain share is set at is significant for achieving a successful project, was not substantiated. However, it highlighted the importance of agreement in the pain share/gain share and that setting the target cost can impact on trust within the partnering project”.

This evidence is significant because it suggests that incentivisation mechanisms may not be functioning as well as anticipated. However, it concludes that partnering strategies do definitively form incentivisation to both contractual parties as it signifies trust and a confidence in a certified project outcome.

1.1.5 Framework Agreements

Framework mechanisms are a hugely significant means of financing from government or private organisations. A framework is an agreement with suppliers to establish term governing contracts that may be awarded during the life of the agreement (**Glover, 2017**). In other words, it is a general term for agreements that set out terms and conditions for making specific purchases (call-offs). To help achieve best practice, these terms upon contractors are for the added benefit of:

- Delivering to the Welsh Government agenda (CO₂, social value, sustainability, procurement).
- Social value through Target Recruitment and Training (TR&T).
- Supports local small and medium sized enterprises (SME's).
- Carbon footprint reduction.
- Circular economy.
- Measurable outcomes and performance (KPI's).
- Enhanced energy in use.
- Superior “soft landings”.

So, what do frameworks provide to clients? Simple, assured outcomes through project team and supply chain collaboration, instigating value for money through:

- Standardisation of construction of projects to bring efficiencies in construction that can save money.
- Benchmarking against a wide-ranging scope of projects to guarantee competitiveness with what the market is delivering.
- Consistent workload for the supply chain. This will improve their performance, reduce waste and drive down cost.
- The speed to start on site ensures that costs are kept to a minimum whilst still ensuring that the brief is met.
- Early involvement of supply chain ensures that each element of the works is tested to guarantee right package price.

These mechanisms bring the added benefit of:

- Reduced need for long tender process.
- Programme efficiencies with client final requirements and fittings, these can be progressed during the construction phase to speed up if desired.
- Early contractor involvement permits pre-orders for site surveys, investigations, piling rigs etc.
- Programme certainty.
- Promotion of internal relationships ensure a value adding approach.
- Data base of costs to speed up cost planning and progress in feasibility stages.

So, what frameworks can Kier delve into on this project? Well, the two principle frameworks available in South Wales are SEWSCAP (Southeast and mid-Wales Collaborative Construction Framework) and Scape, of which, are defined below.

SEWSCAP

SEWSCAP is a four-year public sector construction framework used by more than 20 local authorities in Wales in a collaboration between the Welsh Government. The framework has been valued at £1bn with this third iteration of the framework now including lower value lots encouraging new entrants for works. For high value projects, Kier have been selected as highest ranking contractors (**SEWSCAP 3, 2019**). The framework seeks to focus on sustainability, meeting the needs and aspirations in Wales of the Well-being of Future Gens Act (2015) with the framework being a National Association of Construction Framework's (NACF) member. The framework looks to employ NEC4 and JCT forms of contract to stimulate collaboration through two-stage design & build.

Scape

Scape (or Major Works Wales) is part of the National Construction framework that is designed to deliver construction projects between £2m and £20m. In addition to producing eye-catching, efficient and highly serviced buildings, Major Works Wales has been configured to deliver significant levels of local economic engagement, ongoing apprenticeship schemes and extensive community initiatives. Fully compliant with UK and EU procurement rules, scape is a consultancy framework designed to embed efficiency and social value into projects. What's more, scape offer client support using framework management teams. In tandem with SEWSCAP, scape monitors the social value the project generates, including SME engagement, local spend and employment, an array of time, cost and quality indicators, client satisfaction, waste management, training and apprenticeships.

It is decided that SEWSCAP is the preferred framework choice by Kier as this framework is most familiar being used on most of their projects. Additionally, this framework is more lucrative, where in 2019 (SEWSCAP) accounted for more than half of the programme with 85 projects valued at £820 million. The re-tendered framework accounts for 71% of the potential projects still to be approved (**Flood-Page, 2019**).

1.2 Project Site Set-up in Consideration to the proximity of the IQ Building

The complexity of the SA1 development is quickly became evident in the feasibility study. The site which measures approximately 0.85 hectares (2.1 acres approximately) is located within the South Quay, which is situated between the Prince of Wales Dock and Langdon Road. It is located on the east side of the main gateway into the SA1 Swansea Waterfront. The site is also bounded by the UWTSD IQ building which to the East and residential developments to the North (Mariners Court and Llys Hafan). The proximity to these structures and the intricacies associated with a large footfall of pedestrians (students, staff and residents) must be reflected appropriately within the site set-up.

This development is expected to last longer than 30 days and involve more than 500 person days of construction work, therefore the submission of the F10 to the Health & Safety Executive (HSE) is required. Following this, the HSE stipulates that given the magnitude of the development and the quantity of employees on site, Kier must supply the following provisions within the site set-up, as set out on **Table 5**.

Table 5: Essential components of the site set-up and justification for their provision. Source: Health and Safety in Construction (HSE, 2006).	
Component	Provision
Rest Facilities	Facilities should be available for taking breaks and meal breaks. The facilities should provide shelter from the wind and rain and be heated, as necessary. The rest facilities should have: ▪ Tables and chairs. ▪ A kettle for boiling water. ▪ A means of heating food (e.g. a gas or electrical heating ring, or microwave oven).
Toilets	The HSE also recommends a ratio of 1 toilet to 7 persons where portable toilets are emptied once a week. Given the maximum number of laborers on site at peak time is 47 there is the necessity for 7 toilet cubicles.
Drinking Water	A supply of drinking water should be readily available. Where possible, it should be supplied direct from the mains.
Washing Facilities	On all sites, provide basins large enough to allow people to wash their faces, hands and forearms. All basins should have a supply of clean hot and cold, or warm, running water. If mains water is not available, water supplied from a tank may be used.
Changing Rooms	Every site should have arrangements for securely storing personal clothing not worn on site and for protective clothing needed for site work. Men and women should be able to change separately.
First Aid equipment and Areas	The Health and Safety (First Aid) Regulations 1981 requires Kier to provide adequate and appropriate equipment, facilities and personnel to enable first aid to be given to employees if they are injured or become ill at work. The minimum provision for all sites is: ▪ A first aid box with enough equipment to cope with the number of workers on site. ▪ An appointed person to take charge of first-aid arrangements.

	Information telling workers the name of the appointed person or first aider and where to find them. The number of qualified first aiders required depends on the risk of injury on site. As a guide: <table border="1"> <tr> <th>Numbers employed at any location</th><th>Number of first aid personnel</th></tr> <tr> <td>Fewer than five</td><td>At least one appointed person</td></tr> <tr> <td>5 to 50</td><td>At least one first aider</td></tr> <tr> <td>More than 50</td><td>One additional first aider for every 50 employed</td></tr> </table>	Numbers employed at any location	Number of first aid personnel	Fewer than five	At least one appointed person	5 to 50	At least one first aider	More than 50	One additional first aider for every 50 employed
Numbers employed at any location	Number of first aid personnel								
Fewer than five	At least one appointed person								
5 to 50	At least one first aider								
More than 50	One additional first aider for every 50 employed								
Waste Management	Designate storage areas for plant, materials, waste, flammable substances (e.g. foam plastics) and hazardous substances (e.g. pesticides). Flammable materials will usually need to be stored away from other materials and protected from accidental ignition. Do not store materials where they obstruct access routes or where they could interfere with emergency escape, e.g. do not store flammable materials under staircases or near to doors or fire exits								
Site Boundaries	Construction work should be fenced off and suitably signed. This will protect people (especially children) from site dangers and the site from vandalism and theft.								
Site Access	There should be safe access onto and around the site for people and vehicles. Kier should also plan how vehicles will be kept clear of pedestrians, especially at site entrances where it may be necessary to provide doors or gates to achieve this segregation. Doors that open onto traffic routes may need viewing panels or windows. The plan should include how vehicles can be kept clear of pedestrians at vehicle loading/unloading areas, parking and manoeuvring places and areas where drivers' vision may be obstructed.								

Once a project has been commissioned, a series of research tasks will be undertaken to build up a picture of the brief, resulting in a 'site constraints plan'. The site constraints plan includes:

- Details of the demographics of the area.
- Aerial photography.
- Site visits.
- Details of nearby business and residential areas.
- Topographic maps.
- Details of utilities and existing services,

Formerly a car parking facility for the IQ building, the site set-up now inhabits this space. Therefore, to prevent students from parking on curbs surrounding the site, endangering both themselves and their property, Kier have identified two alternative car-parking provisions to operate for the 45 week-duration of this project. **Figure 8** illustrates a small 100-capacity facility 100m to the North-East of the site. Furthermore, **Figure 9** illustrates a much larger 200-capacity car-park area situated adjacent to Sainsburys, Swansea. The car park is directly served by a footpath wielding an approximate 10-minute walk for the students from the IQ building. Combined, this provision of 300 car parking spaces is adequate for the safe and continual operation of the IQ educational asset during the construction phase.

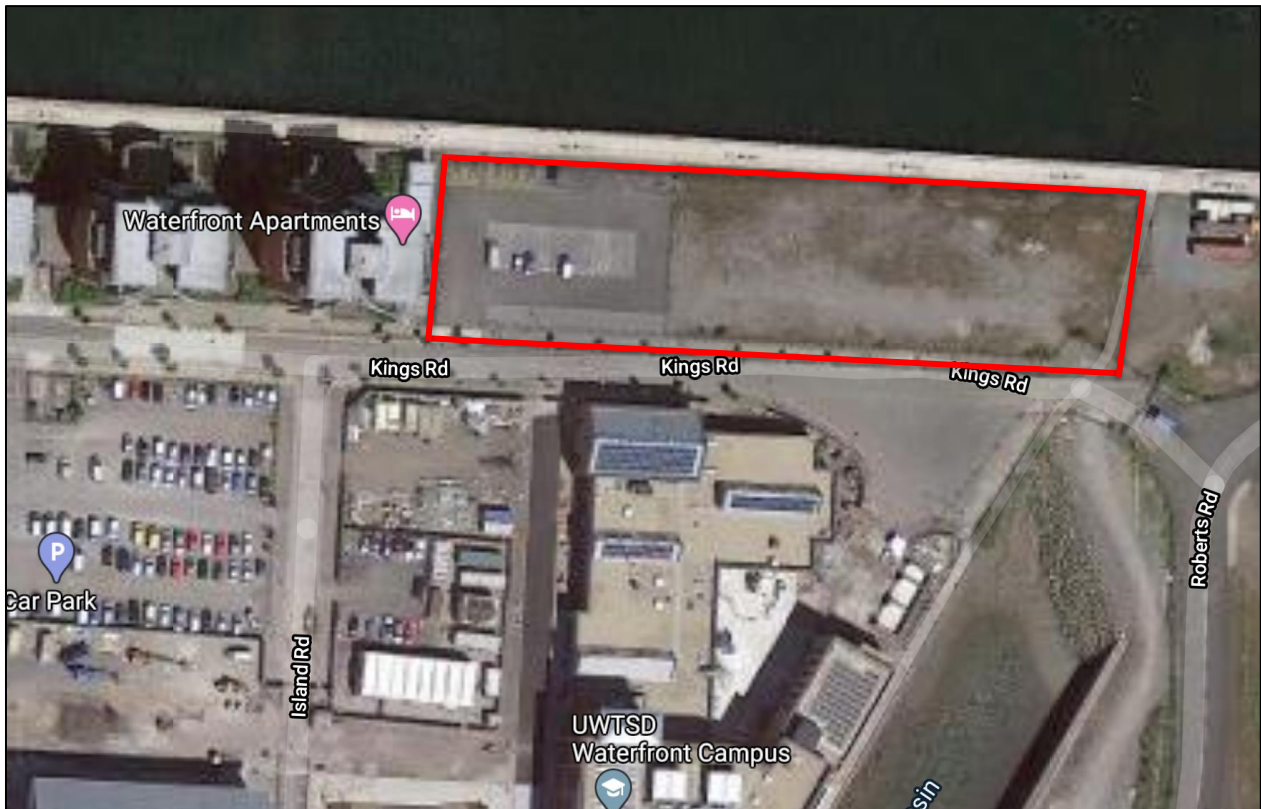


Figure 8: Car park facility 1 (100-capacity) highlighted in **RED** (Google, 2020).

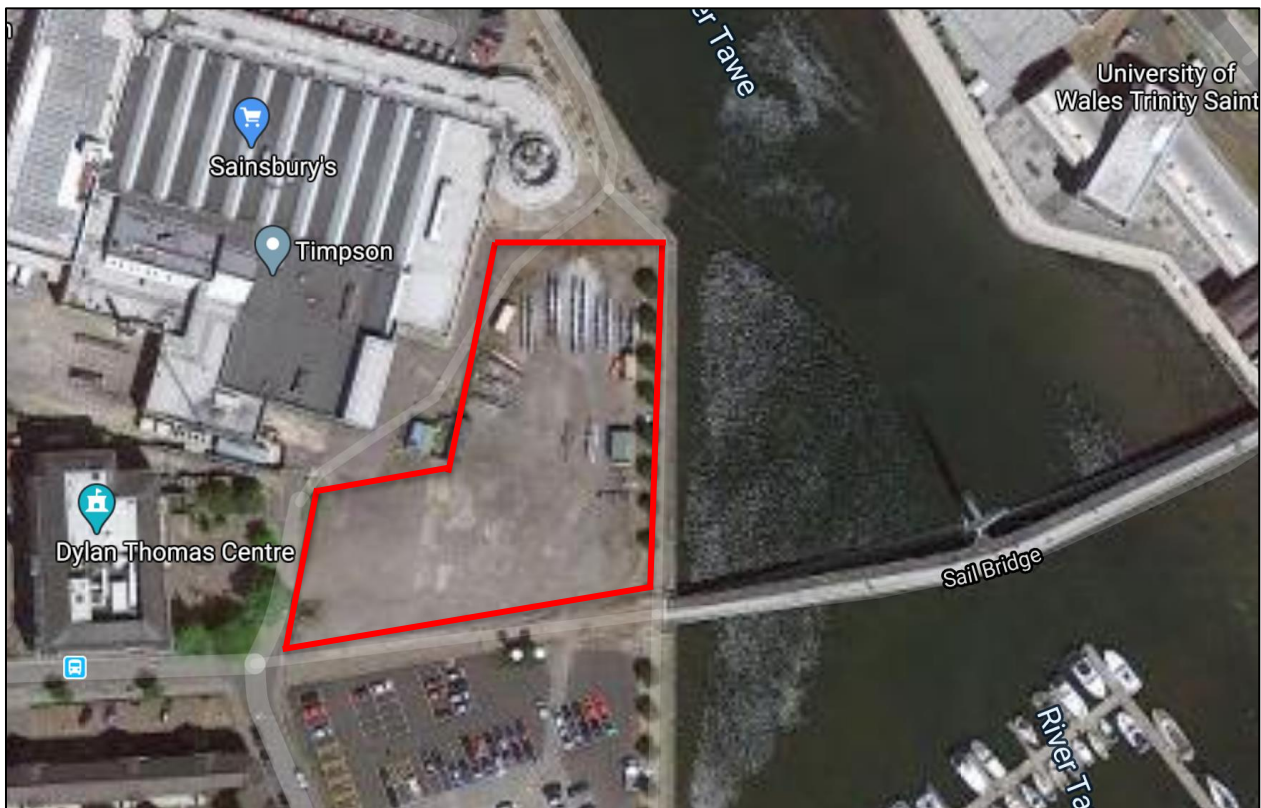


Figure 9: Car park facility 2 (200-capacity) highlighted in **RED** (Google, 2020).

Setting up a construction site correctly is vitally important (**Beynon, 2020**). A health and safety inspector would check the setup of the construction site to ensure all paperwork and documentation is in order. So, what information needs to be exhibited and what documents do

Kier need to provide to ensure the correct construction site set-up? Information that must be displayed on the construction site include:

- Health and Safety law poster,
- Insurance certificates,
- Fire and emergency plan,
- F10.

Kier will ensure that the following documents will be on site for the duration of the project:

- Construction phase plan (as required under CDM 2015),
- Health and safety policy,
- Project documents (i.e. drawings),
- Project surveys.

In addition to these, safety records will also be kept, as permitted by law:

- Site register,
- Induction forms,
- Toolbox talks.

Encapsulated within below are five separate site set-ups at crucial milestones throughout this project which emphasize the evolution of the set-up as the scheme progresses. Explained in detail is also the justification for each alteration, implementation whilst considering the proximity of nearby students, staff, and residents.

1.2.1 Site Set-ups

Set-up 1: Site Establishment (17/08/20) to (09/09/20)

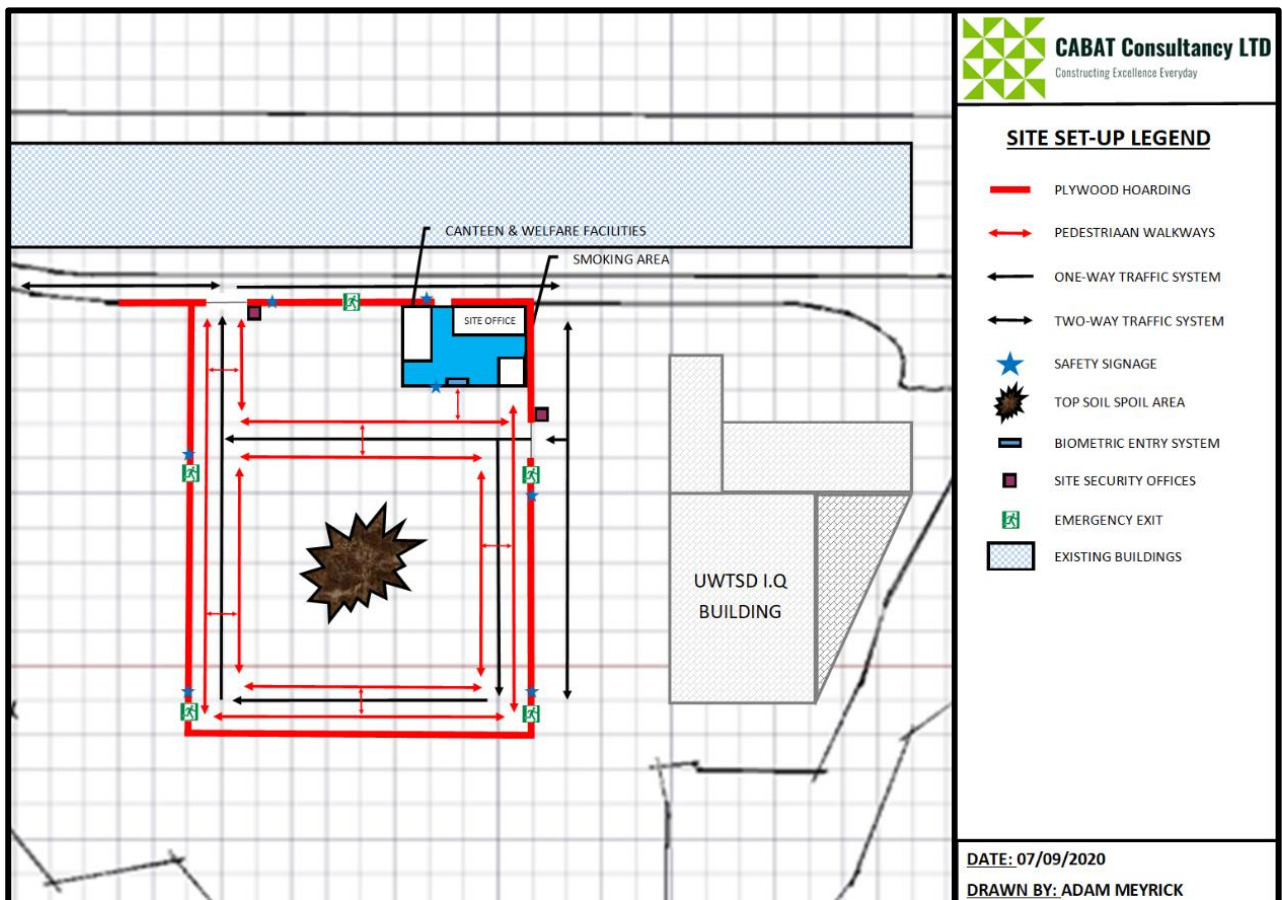


Figure 10: Site Set-up 1.

There are many intricacies of this site set-up, necessitated by the site's proximity to the SA1 historical dockland and sitting adjacent to the existing functioning UWTSD estate and residential high-rise structures. The site is bordered by 2m-high plywood hoarding encapsulating three main access and egress points to the site, one for pedestrian access to site office safe areas and two for the one-way flow of site vehicle traffic. Several emergency exit locations can also be identified, which will be communicated to all workers upon site induction. Fixated upon the site hoarding there will be safety signage spaced repeatedly (**Figure 11**), as well as within site safe areas, as illustrated on **Figure 12**. The site safe area comprises canteen & welfare facilities for workers, site offices, induction & training rooms and a smoking shelter. Furthermore, within the site, traffic flows will also be dictated through signage, as illustrated on **Figure 13**.



Fig.11: Warning Signage (HSE).



Fig. 12: Safety Signage (HSE).



Fig.13: Diversion Signage (HSE).

At both vehicle access and egress locations to the site, site security offices are implemented to control traffic flow, check permits and licences and for general security of the site. Worker access to the site is dictated through a biometric entry system, where each workers CSCS card and permit to work are tethered to an online database to permit entry. An area at the centre of the site has been designated for site clearance and excavation spoil.

Addressing the ongoing issue of UWTSD around the site, the following safety precautions have been put in place:

- Separate walkways for site staff away from the main pavement.
- When material deliveries are made by vehicles with abnormal loads, site marshals will help safely dictate traffic and pedestrian flow to keep students entering the site safe.
- Site noise will be limited to the safe level of 85dB (**HSE, 2018**). This is to both protect the publics hearing and to permit the tranquil study environment to remain.
- CCTV will always be in operation to ensure that criminal activity is reported and to reactively provide tighter security based on the evidence. It is also essential that all trespassers are not injured on site, so before each working day ends, the site must be left in a safe way (i.e. equipment stored away, and all excavations covered up).
- At the main access and egress points a site security attendant will prevent unauthorised personnel such as students to enter the site.
- Debris and dust as a offspring of construction activities will be controlled and cleared outside the site boundary to ensure students to not succumb to slips, trips and falls.
- Additionally, to further control the issue of hazardous dust, wheel washing facilities will be applied to help keep good general housekeeping outside the site, as well as limiting the number of hazardous particles in the air subjected to students.
- As aforementioned, 2m-high plywood hoarding will be implemented to prevent the escape of debris and dust onto the road. It will also prevent students from looking into the site and providing an unclimbable smooth surface, nullifying the prospect of students endangering themselves to enter the site without unauthorised. This hard surface will also look to attenuate the sound from construction activities, again, helping keep UWTSD's learning environment.

Set-up 2: Substructure (09/09/20) to (18/11/2020)

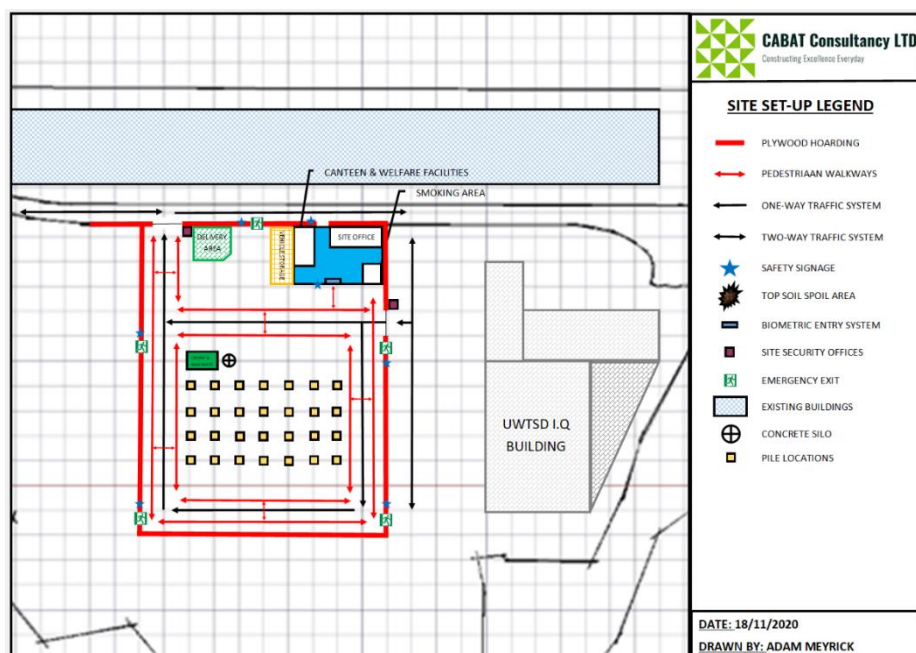


Figure 14: Site set-up 2.

Traffic flows, access/egress and site safe areas remain unchanged at this stage. The addition of a designated delivery area in the North-West corner of the site is accompanied by a vehicle's storage area, necessary for a large site. Access to these two are served efficiently by the traffic system, and their proximity to the building footprint is desirable. Shown on this set-up is the pile locations, beginning to show the building footprint. To complete the changes, a cement & aggregate storage area has been instigated, adjacent to a concrete silo, crucial concreting works in the substructure.

Set-up 3: Superstructure (09/11/20) to (21/01/21)

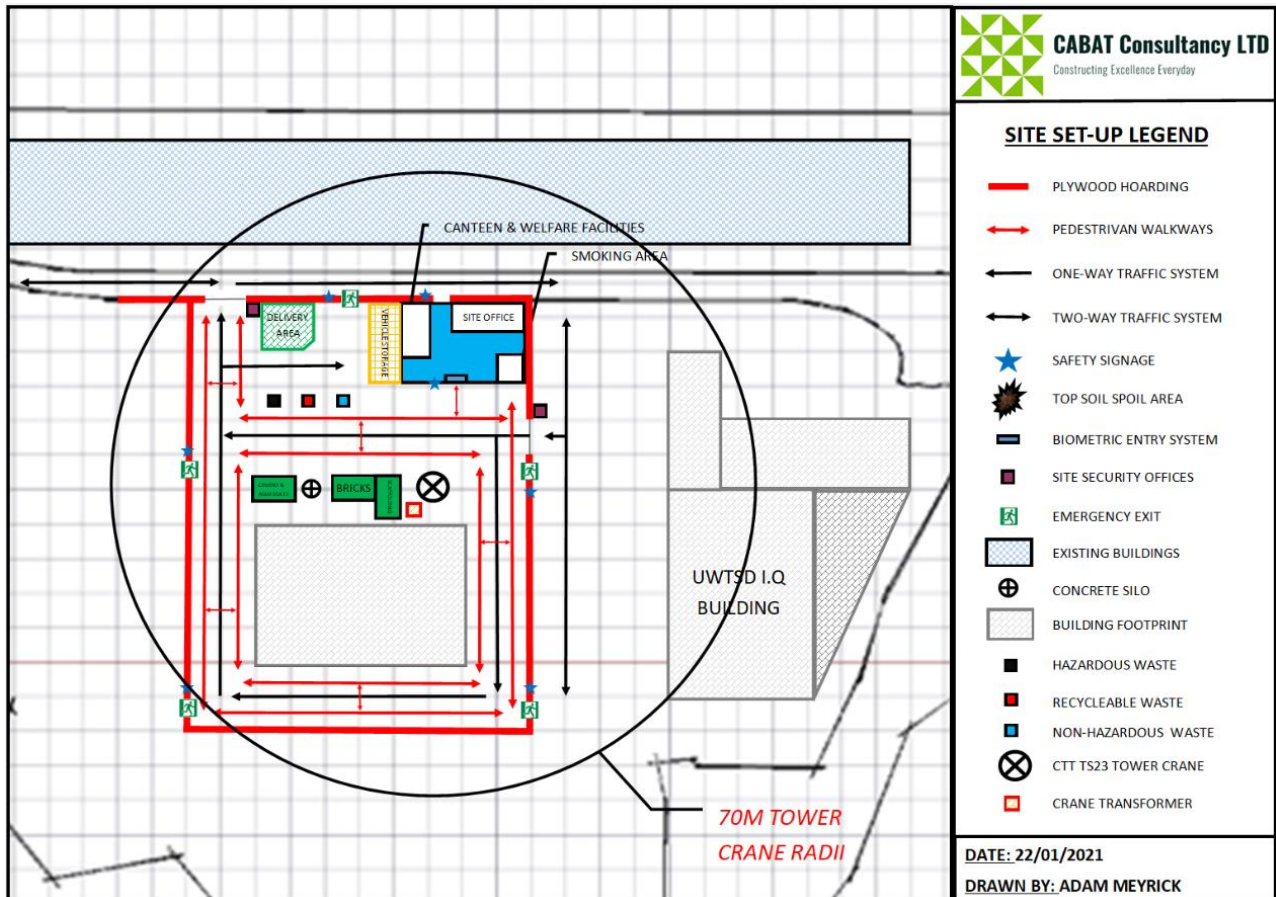


Figure 15: Site set-up 3.

Traffic flows, access/egress and site safe areas remain unchanged at this stage. Set-up 3 reflects the complexities of a sensitive site. The footprint of the structure can now be clearly seen encapsulated within the site traffic management system. The addition of, hazardous, recyclable and non-hazardous waste areas has also been established. It is essential that the hazardous waste is controlled and kept away from all others. Additional storage areas for bricks and scaffold accompany the pre-existing bricks & cement facility. To complete the changes, the implementation of an CTT TS23 tower crane with an 70m radii with oversailing prevention technology has been installed in the North-East of the site, supplemented by a transformer electrical power supply. During this stage, additional safety measures will be implemented to protect students of the UWTSO IQ estate:

- Safety netting or shrink wrap will be provided when scaffolding works are erected to prevent falling objects from falling on workers and the students alike.

- The tower crane will be programmed to work limited to the confines to the site, preventing oversailing loads over external roads and pavements.

Setup 4: Envelope, Internals and Externals (18/01/21) to (14/06/21)

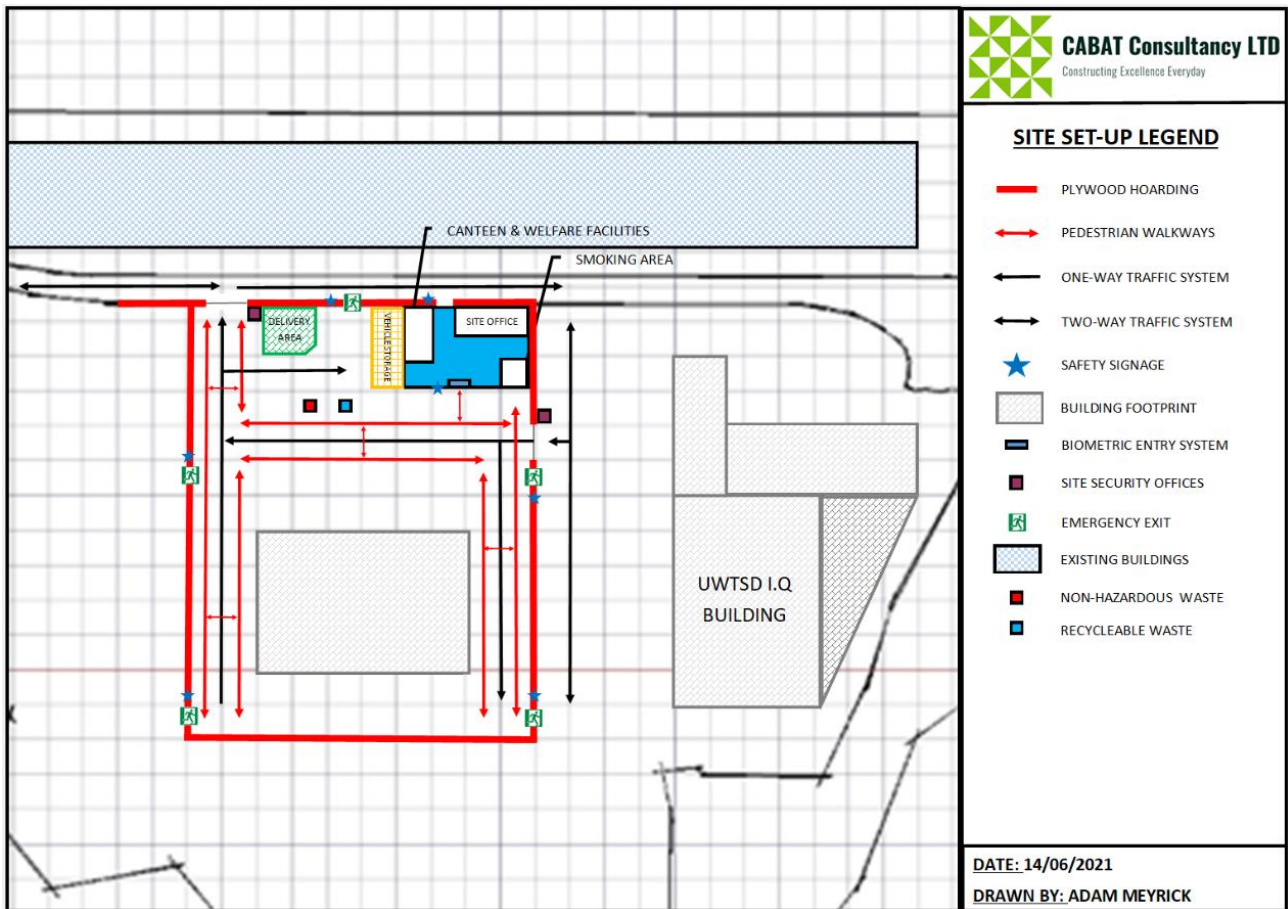


Figure 16: Site set-up 4.

There is a lot of change following the completion of the superstructure. To start, the removal of transport movement systems has begun, beginning with the North-East to South-West flow. This is a direct result of the removal of the cement & aggregate, bricks and scaffolding storage area once serving the road. Additionally, the concrete silo, tower crane and electrical transformer have been eradicated respectively, allowing soft landscaping of said areas to begin. To conclude these changes, the hazardous waste storage area and its contents has been removed and taken for lawful disposal.

Site set-up 5: Testing & Commissioning (16/06/21) to (19/07/21)

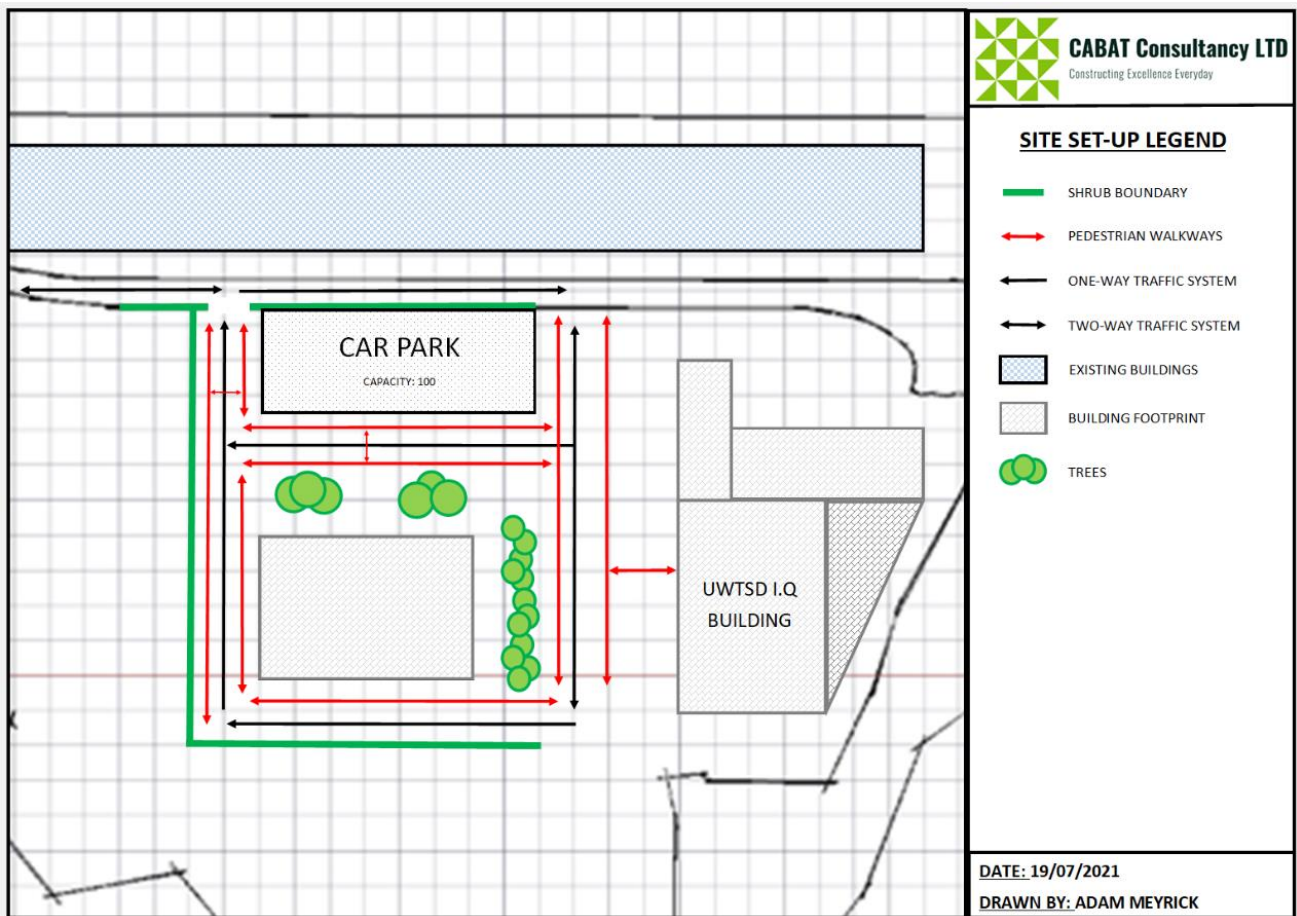


Figure 17: Site set-up 5.

The delivery and vehicle storage areas have been removed as well as the non-hazardous and recyclable waste zones. The site safe area and all its internals has also been removed by a vehicle crane for re-use. These areas have then undergone cut n' turn procedures to be tarmacked, forming the 100-capacity carpark for the facility. The site traffic flow system remains but has been tarmacked, forming the main vehicle route around the facility. Following the removal of the site security offices, the former access and egress points remain, as well as the one-way system. The plywood site boundary has also been replaced by a planted shrub boundary, to complete the flora, trees have also been planted in both the North and South Elevations to promote biodiversity and occupant well-being.

1.3 Project Variations and Scope Creep

The client has requested Kier to bring the project in according to the original completion date, which is 2 weeks earlier than the programme produced. This, an aspect of the aforementioned "scope creep" is where the scope starts to creep, and new functionality must be added to cover the increased scope. This is represented by the quality arm of the triangle, representing the ability of the product to fulfil users' requirements. To reiterate, in this situation Kier have three, and only three options:

- A. Time: Accelerate the project to give more time to add the functionality.
- B. Add cost: Recruit, hire or acquire more laborers and additional materials to do the work.
- C. Cut quality: Trade off some non-essential requirements to meet the new requirements.

The Kier planner and construction manager have identified two ways in which the programme can be completed 2 weeks prematurely. Of which are described in detail below in association to the project cost and quality implications.

Option 1:

The acceleration of Task 49 "Final Fix M&E" (*highlighted on **Appendix A.3***) would allow the programme to be completed two weeks earlier. Programmed for the duration of 4-weeks, the acceleration of this task by 50% will ensue a new 2-week duration.

How will this implicate the project?

Due to the lateness of this task in the project, the cost and quality implications thereafter are minimal. However, Quality of the task itself may suffer deterioration, with a 50% acceleration of time, a parallel 50% increase of labour is required, where laborers may get in each other's way. No additional plan costs are associated here as the M&E subcontractors will supply their own equipment within the cost. Additionally, if of different employers, lines of communication between parties may be weak or have different quality aspirations. Speaking from a cost perspective, a 50% increase in labour also means an additional 50% of cost. So, where the labour and plant costs for this task were £95,000, they have now risen to £142,500, an increase of £47,500. Conversely, overall, this alteration will save the contractor capital, as the project now finishes 2-weeks prematurely, preliminary costs will decrease.

Option 2:

A 2-week earlier start of Task 35 "Metsec SFS Weatherboards" (*highlighted on **Appendix A.4***) will allow the envelope works to commence sooner and overall a 2-week earlier completion of the project.

How will this implicate the project?

This task appears approximately half-way through the construction process and therefore the trade-offs this will have against other aspects of future tasks is unknown. However, this earlier start will be accompanied by an 30% labour and cost increase upon the previous task 34 "SIPS Partitions" to ensure the project is ready for this early start and to counteract adverse quality effects. Although the duration and cost of Task 35 does not change, Task 34 is affected whereby the labour and plant costs for this task were originally £55,500, they have now risen to £83,250, an increase of £27,750. In addition, just as in Option 1 this alteration will save the contractor capital, as the project now finishes 2-weeks prematurely, decreasing preliminary costs.

Variation selection:

Subsequently, following negotiation of the time, cost and quality implications of the variation with the client through the NEC Clause 60 "Compensation Event" (CE) "Option 1" was chosen. This was selected for the following reasons:

- 1) Lateness in the project allows for further scope creep.
- 2) Although variation option 1 is £19,750 more costly, there are less quality "trade-offs" against other tasks.
- 3) 2-week acceleration of programme is achieved.

Bibliography

Appelbaum, S. (2000) 'An analysis of the utilization and effectiveness of non-financial incentives in small business', *Management Development*, 19(9), pp. 733-763.

Benge, D. (2013) *RICS new rules of measurement*. 1st edn.: Royal Institution of Chartered Surveyors (RICS).

Beynon, O. (2020) *Construction site setup - how to setup your office*. Available at: <https://www.atlas-sm.co.uk/blog/construction-site-setup/> (Accessed: 3rd May 2020).

Bryde, J. (2007) 'Incentivising project performance in the construction of new facilities', *Facilities Management*, 5(2), pp. 143-149.

Chauhan, A. 2018. A comprehensive guide to managing scope creep.

Churcher, D. (2017) *Value Management and Value Engineering*. 1 edn.: Royal Institution of Chartered Surveyors (RICS).

Construction dust (2020): Health and Safety Executive (HSE). Available at: <https://www.hse.gov.uk/pubns/cis36.pdf>.

Curran, M. (2018) *Early Implementation of BIM in Architectural Firms: A Qualitative Review of BIM and Lean Construction*. Royal Institution of Chartered Surveyors (RICS).

Employee Incentives That Boost Productivity (2020). Available at: <http://www.constructionworld.org/employee-incentives-boost-productivity/> (Accessed: 24th March 2020).

Evans, S. C. (2017) *NEC3 Compensation Events – a Practical Guide*. Available at: <http://www.stevencevans.com/nec3-compensation-events-a-practical-guide/> (Accessed: 26th February 2019).

Flood-Page, C. (2019) *The 21st Century Schools and Education Programme*: Wales Audit Office.

Folkmans, I. (2008) *Earned Value Management*. Association for Project Managers.

Glover, J. (2017) *Framework Agreements: Practice and Pitfalls*. Available at: <https://www.fenwickelliott.com/sites/default/files/Practice%20and%20Pitfalls.pdf> (Accessed: 26th April 2020).

Hamilton, C. (2017) *What is a Cumulative Cost Curve?* Available at: <https://bizfluent.com/info-12160943-cumulative-cost-curve.html> (Accessed: 3rd May 2020).

Hopper, E. 2020. Maslow's Hierarchy of Needs Explained. *In*: JPEG.

HSE (2019) *Protecting the Public*. Available at: <http://www.hse.gov.uk/construction/safetytopics/publicprotection.htm> (Accessed: 18th April 2019).

Hughes, D. (2012) 'Is incentivisation significant in ensuring successful partnered projects?', *Engineering, Construction and Architectural Management*, 19(3), pp. 306-319.

Introduction to Benchmarking (2018): Building Research Institute (BRE). Available at: <https://constructingexcellence.org.uk/kpis-and-benchmarking/> (Accessed: 21st April 2020).

Jenkins, N. (2016) *A project management primer: basic principles - scope triangle*. Available at: <https://www.projectsmart.co.uk/project-management-scope-triangle.php> (Accessed: 31st March 2020).

Madurai, V. 2018. Time, Cost, Quality. In: JPEG.

Materials storage and waste management (2020): Health and Safety Executive (HSE) (Accessed: 20th March 2020).

Ray, S. (2019) *Understanding Critical Path in Project Management*. Available at: <https://www.projectmanager.com/blog/understanding-critical-path-project-management> (Accessed: 31st March 2020).

Rewards & Benefits (2020): Kier Group PLC. Available at: <https://www.kier.co.uk/careers/rewards-benefits/>.

Richmond-Coggan, D. (2001) *Construction Contract Incentivisation Schemed: Lessons from Experience*. Construction Industry Research and Information Association (CIRIA).

SEWSCAP 3 (2019). Available at: <https://www.theconstructionindex.co.uk/news/view/kier-and-morgan-sindall-come-up-trumps-in-1bn-sewscap-3> (Accessed: 26th April 2020).

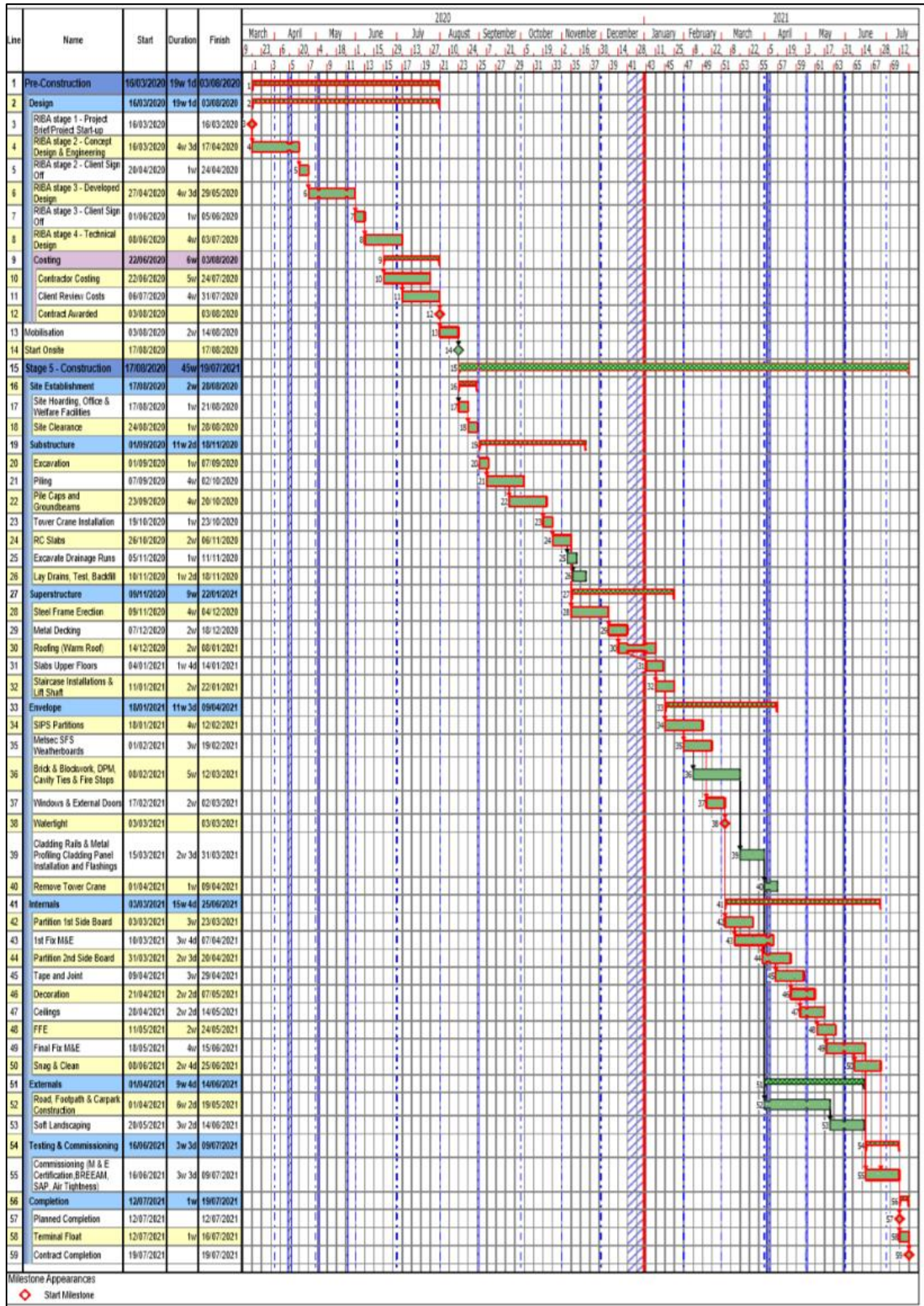
What is quality management? (2020): Association of Project Managers (APM). Available at: <https://www.apm.org.uk/body-of-knowledge/delivery/quality-management/> (Accessed: 21st April 2020).

Wu, W. (2012) 'The Relationship between Incentives to Learn and Maslow's Hierarchy of Needs', 3(7), pp. 1335 – 1342.

Appendices

Appendix A.1: Project Programme.

Description: The project programme for the project is defined below.



Description: The RIBA Plan of Work is an industry-wide tool providing a framework for management team to use on projects with their clients, bringing greater clarity to the different stages of a project, as previously defined, including costs. Cost functions at each design stage are defined in the image below.

The RIBA Plan of Work 2020 organises the process of briefing, designing, delivering, maintaining, operating and using a building into eight stages. It is a framework for all disciplines on construction projects and should be used solely as guidance for the preparation of detailed professional services and building contracts.

Stage Outcome
The best means of achieving the Client Requirements confirmed at the end of the stage

Core Tasks
during the stage

Project Strategies might include:

- Conservation (if applicable)
- Health and Safety
- Inclusive Design
- Net Zero Carbon
- Performance
- Sustainability

See RIBA Plan of Work 2020 for more information on Project Strategies

Core Statutory Processes
during the stage:

Planning
Building Regulations
Health and Safety (CDM)

Procurement Route
Traditional
Design & Build
Management Contract
Construction Management
Contract

Information Exchanges
at the end of the stage

Client Requirements
Business Case

Project Brief
Feasibility Studies
Site Information
Project Budget
Project Programme
Procurement Strategy
Responsibility Matrix
Information Requirements

Project Brief approved by the client and confirmed that it can be accommodated on the site

Architectural Concept
approved by the client and aligned to the Project Brief

Architectural and engineering information
Spatially Coordinated

Spatial Coordination

Technical Design

Manufacturing and Construction

Handover

Use

Projects span from Stage 1 to Stage 6; the outcome of Stage 0 may be the decision to initiate a project and Stage 7 covers the ongoing use of the building.

Stage Boundaries:
Stages 0-4 will generally be undertaken one after the other.
Stages 4 and 5 will overlap in the Project Programme for most projects.
Stage 5 commences when the contractor takes possession of the site for construction.
Stage 6 starts with the handover of the building to the client.
Practical Completion and Defects Liability Period.
Stage 7 starts concurrently with Stage 6 and lasts for the life of the building.

Planning Note:
Planning Applications are generally submitted at the end of Stage 3 and should only be submitted earlier when the threshold of information required has been met.
Approved if a Planning Application is submitted by the end of Stage 5, a proposed development should be determined and it should be clear to the project team which tasks and deliverables will be required.
See Overview guidance.

Procurement:
The RIBA Plan of Work is procurement neutral – See Overview guidance for further information.
Procurement should be adjusted to accommodate the requirements of the project.
Employer's Requirements
Contractor's Proposals

Feedback from Post Occupancy Evaluation
Updated Building Manual including Health and Safety File and Fire Safety Information as necessary

Asset Management
Implement Facilities Management and Asset Management
Understand Post Occupancy Evaluation of building performance in use
Verify Project Outcomes including Sustainability Outcomes

Adaptation of a building for the future
See Overview guidance for further information on Project Strategies

Feedback on Project Performance
Final Certificate
Feedback from light touch Post Occupancy Evaluation

Asset Information
If Verified Construction tasks must be defined

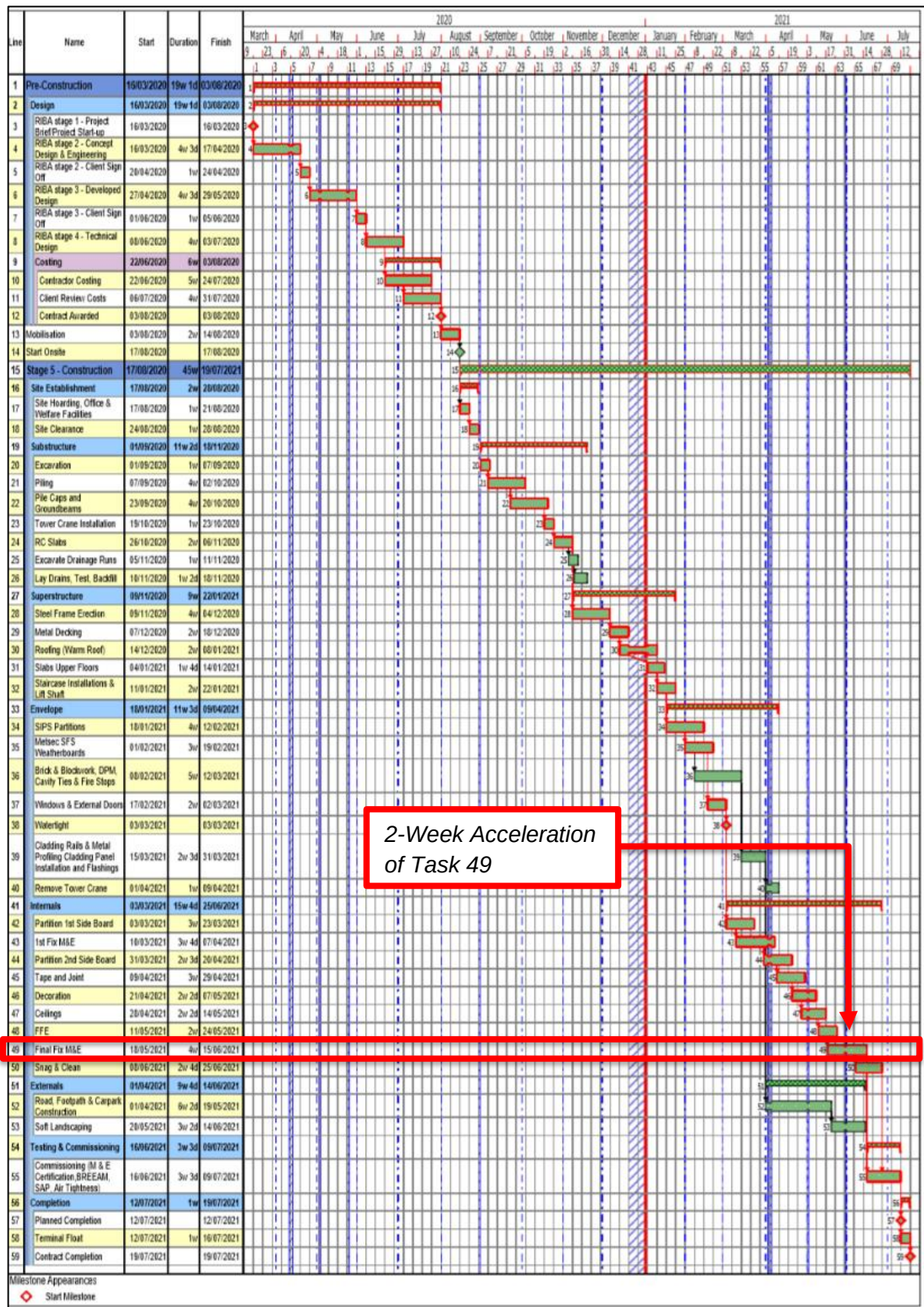
Further guidance and detailed stage descriptions are included in the RIBA Plan of Work 2020 Overview.

See RIBA Plan of Work terms as defined in the RIBA Plan of Work 2020 Overview and set in Build Type

© RIBA 2020

Appendix A.3: 2-week Acceleration Option 1.

Description: The acceleration of Task 49 "Final Fix M&E" (highlighted in **RED**) would allow the programme to be completed two weeks earlier. Programmed for the duration of 4-weeks, the acceleration of this task by 50% will ensue a new 2-week duration



Appendix A.4: 2-week Acceleration Option 2.

Description: A 2-week earlier start of Task 35 "Metsec SFS Weatherboards" (highlighted in **RED**) will allow the envelope works to commence sooner and overall a 2-week earlier completion of the project.

