School of Built Environment

Understanding programme use and delays in construction projects: A boundary object approach

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Abstract

Managing time in work or complex projects that involve multiple organisations and professionals is challenging. This is particularly visible when it comes to delay incidents. One tool frequently used to manage time is a programme. Most research into programmes focuses on the relationship between time-related variables and performance. A second literature considers the role of programmes in coordinating the work of multiple groups, but much of this is quite superficial. This thesis extends that work by exploring how a programme in the everyday coordination of project team members around delay incidents. A boundary object approach is used to explore a London case in which multiple programmes are used extensively and two Southeast cases with limited engagement with a programme. The contrast offers insights into differences in the formality and extent of engagement in the construction and management of delays. Data was obtained using observations, interviews, and documents.

The results highlight six ways in which different project groups engaged with programmes. First, it shows that different project groups constructed time differently (linearly or cyclically) in designing programmes and organising work. This led to the multiplication or reproduction of the initial programme, with each version adjusted to the needs and interests of specific groups. These multiple versions served by mediating the relationship between different project groups and were reconciled through project group meetings and discussions. Second, the research found that the mode of engaging with a programme (formal or informal) varied across the three cases. In the London case, project groups used versions of the programme formally at six different types of meetings, including: progress meetings, labour forecast meetings, progress review meetings, programme revision meetings, internal supplier meetings and joint inspection meetings. In the Southeast cases, project groups engaged informally with programmes with quick verbal exchanges. Third, the three case projects demonstrated different uses of the programme at different moments. Uses included: to distribute task and responsibilities at multiple levels, to manage project resources at multiple levels, to manage the expectations of project groups, to support firms to negotiate their interests, to capture knowledge of activities and agreements at multiple levels and to communicate the progress of work in percentages at multiple levels. The way project groups used a programme in delay incidents depended on the context and were responses that usually involved avoiding financial losses of placing or not placing workers, materials, or equipment to work. Fourth, the case projects demonstrated that project groups used programmes to socially construct delays. In the London case, project groups used programmes to construct delays as concrete and visible by recording negative slip values and positioning a drop line on the programme. In contrast, project groups in the Southeast cases treated delays informally and did not record them on the programme, thereby rendering them invisible or abstract. Fifth, the case projects demonstrated that project groups responded to visible and invisible delays differently. In the London case, project groups responded to visible delays with negotiations around the formal extension of deadlines, leading to a reconstruction of slip values on the public or construction programme. They also responded to delay incidents with a mutual accommodation of the work and programme. In the Southeast cases, project groups responded to abstract or invisible delays with negotiations that extended the project duration, without any formal recording of specific delays. The three case projects showed that it is only

after project members used a programme to count or interpret and then label the progress of a project as delayed, that they began to treat or view the project as delayed. Sixth, the case projects showed that the programme played different roles in different delay incidents. In the London case, project groups used versions of programme in three ways: to halt the position of a drop line on the construction or public programme instead of moving it to a current date, to skip with the drop line periods that were unproductive and to develop a mapping of slip values as delays at multiple levels (zones, subzones, and areas). In contrast, project groups in the Southeast case used versions of the programme to discuss delays and issue early warning notifications. Delay incidents led project groups to adjust initial forms of organising with a changing understanding of a programme when programmes move between groups.

On the basis of these findings, this research argues that the multiplication of a programme into different versions and the modes of engagement enabled different project groups in different contexts to develop realistic responses to deadlines. The contrast between the London and Southeast cases suggests that project groups use programmes informally when they have a history of working together. However, in situations where project groups have no prior business relationship or distrust each other, they engage more formally with a programme to penalise firms that breach contractual agreements.

Declaration

I confirm that this is my own work and the use of all material from other sources has been properly and fully acknowledged.

Oluseun Olukemi Olubajo
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Publications

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Chapter 1: Introduction

1.1 Background

Time management today is an area of interest in several disciplines partly because the markets are very competitive, and people like to control the pace of their work or projects. The mismanagement of time is also of interest because it leads project stakeholders and researchers to believe that they have lost control, or that their projects are veering out of control. A review of 32-time management studies between 1982 to 2004 showed varying effects of time management on stress, job satisfaction and perceived control of time (Claessens et al., 2007). This shows that the perception that time is managed or mismanaged are both important to individuals, teams, and organisations involved in work or projects in different sectors of the economy.

In the construction industry, managing time is continually important and has been linked to two intrinsic aspects of construction practice in literature. The first is the use of project management tools such as programmes to manage time in construction processes. There is an increasing need for stronger collaboration in processes involving diverse teams and a reliance on project management tools to facilitate this (Chasanidou et al., 2016; Galloway, 2006). The second aspect are overruns in time also referred to as delays in construction processes or work. These aspects are related to the process of managing time and are part of the dynamic intricacies involved in trying to control the progress of construction work.

Most of the current studies on managing time in construction are often approached from a macro level and tend to focus heavily on one aspect of managing time at the expense of the other. This approach provides little opportunity to understand holistically the dynamic intricacies involved in the way people or organizations manage time and little is known regarding the decisions, events, contexts, and interactions that lead to certain outcomes. This indicates a need to understand the aspects and mechanisms involved in managing time in construction at a micro level by focusing on delay incidents. This is because the way time is managed at a micro level sits at the heart of project processes and plays a significant role in the success of project teams or organisations. This research adopts an interpretivist position and would, therefore, be of value to practitioners wishing to understand micro-level processes involving the use of planning tools that are expected to promote the achievement or attainment of project goals or objectives. The research outcome would also be of value to practitioners seeking stronger collaboration between members in organisations or teams when managing time in complex projects.

1.2 Research problem

Managing time in work that involves multiple organisations and professionals often leads to tension over delay incidents. Delays are a concern to project parties, policy makers and have been described as lateness by Ballesteros-Pérez *et al.* (2018) or time overrun (Semple *et al.*, 1994). This concern persists because time is an important characteristic that defines how projects are set up, developed, and evaluated. One tool frequently used to manage time involving different parties is a programme. The term programme refers to a time management tool that has been described differently in the project management literature as a schedule, timeline or plan, while the associated activity can be described as scheduling, planning, or programming (Hartley, 1993; Herroelen and Leus, 2005; Idoro, 2012; Bohøj *et al.*, 2010). The choice of terminology varies by country or region, but for the purpose of this research, the UK convention is adopted and 'programmes' and 'programming' are used.

In the UK construction practice, a contractors' programme is required in most standard form of building contracts, as it is used for calculating the length of delays that can justify an extension of the contract period. Therefore, the way that contracts are prepared tells us that an underlying assumption is that programmes are meant to deal with delays (Ballesteros-Pérez *et al.*, 2017).

Research into programmes has focused on two main streams. The first is a technical literature that emphasizes patterns between time related variables and performance. This has been described as the traditional project management approach to programmes and assumes that time and delays in projects can be managed by merely changing the way that activities are calculated. This approach is prescriptive and offers no mechanism or explanation on how project groups engage with a programme in specific incidents of delay. Proponents of this approach adopt a technical/resource management posture that focuses on two main aspects namely : 'activity attributes' as described by De Marco (2011) and risk inherent in an activity (Nasir *et al.*, 2003). However, focusing on these aspects might be misplaced, because attention is given to the technical features of a programme rather than people, organisations and the way programmes are used in specific incidents such as delays. The second is a qualitative literature that focuses on the role of a programme in coordinating work of multiple groups. This approach studies the coordination of people and organisations that is quite superficial. However, detailed understanding of how disparate project groups use a programme every day and when confronted with delays in the context of a construction project is limited. These two streams of research on

programmes have not investigated in detail the actual response of project groups to specific delay incidents in the context of a live construction project.

Research into delays in construction also focused on two streams. The first is a quantitative literature that focused on the relationship between potential causes of delays and the performance of projects. This approach assumes that merely calculating levels of potential causes or factors of delay is the secret to improving time performance. This approach is prescriptive and does not offer any explanation or mechanism on how people from different firms with different interests or priorities use programmes to interpret the meaning of a delay in the context of a project. Proponents of this approach according to Al Sehaimi and Koskela (2008) suggest technical recommendations that do not address the problem of delay. The second stream is a qualitative literature that focuses on people that are interrelated or interdependent in projects. This approach assumes that the application of more effort in coordination can minimise delays in a project. However, these two streams treat delays objectively and exogenously to people's experience or action and, do not consider the role of programmes in addressing specific delay incidents in the context of a construction project.

A boundary object approach is adopted in this research to understand how disparate project groups use a programme every day and when confronted with delays in the context of a construction project. The boundary object approach assumes that programmes mediate between social worlds or communities of practice and are plastic enough to adapt to local needs of project groups or environments and the constraints of several groups using it, yet robust enough to maintain a common identity across sites. They are weakly structured in common use and become strongly structured in individual site use. Boundary objects have interpretive flexibility i.e. they have different meanings for different users, inhabiting different social worlds, but their structure is common enough to make them recognizable to multiple users. This focus on a programme as an object that inhabits disparate social worlds on a construction project site sheds light on many different interpretations from project members, decisions, negotiations with a programme in delay incidents and modes of use of the programme.

This approach challenges the assumptions that the outcome of a project can be managed by merely calculating the levels of potential sources of delay and introduces a sociological dimension to the problem. Adopting this approach shifts the focus on delays from technicalities to a situated response of project groups to specific delay incidents with or without a programme in an uncertain business environment such as construction. Such situated investigations and response

of project members to delay incidents have been ignored in previous studies on programmes and their use. It is worth noting that no matter how sophisticated a programme is, its usefulness depends on the people who run the project (Morton and Ross, 2008). The section that follows presents a formal statement of the aim and objectives of this research.

1.3 Aim and objectives

The aim of this research is to explore how a programme that interfaces distinct project groups functions in the context of a construction project and how it varies across incidents and case projects. Informed by boundary object theory, this research emphasizes two aspects namely: action and cooperation in processes (Star, 2010). First, the programme as a boundary object is something project groups act on in delay incidents or use in response to delay incidents. Secondly, the boundary object approach assumes that different project groups can cooperate and work together without total consensus. These two aspects focus attention on decisions, different interpretations, and negotiations of project groups with a programme in response to delay incidents. Following on from the above aim, the research objectives guiding this research are:

1. To explore how time is constructed in a programme
2. To explore ways that project groups engage with a programme
3. To understand the role of a programme for the different project groups.
4. To explore the different interpretations of a delay in different project groups.
5. To understand how different project groups interact when responding to delays incidents.
6. To compare the role of a programme in project group responses to delay incidents.

These six research objectives provide rich insights into the similarities and differences in how project groups use programmes in the context of three construction projects. The contribution of the boundary object approach in this research is to enable people manage time and delays more effectively in projects such as construction. This contribution would help develop realistic programmes and realistic expectations with responses rather than a mechanistic programme and persistent delays. The section that follows describes the thesis structure.

1.4 Thesis structure and summary

Chapter one presents the research problem. This is followed by an overview of the literature on programmes and fields the thesis relates to and aims to contribute to, the research question and outlines the structure of the thesis. This introduction chapter also specifies the aim and objectives of the research.

Chapter two positions this research in a review of literature on delays, project planning tools, programme use, and introduces the boundary object approach that is adopted in this research.

The literature review is structured in five parts as follows: first, a critical examination of the positivist literature on delays. The aim is to underline the role programmes play or do not play in delays. Second, a critical examination of the positivist literature on planning and planning tools with a focus on programmes. Most of the research in this area adopt the traditional project management approach. Third, a review of the qualitative literature on delays. The aim is also to underline the role of programmes. Fourth, a review of the interpretivist literature on tools in occupational communities, organisations, or dispersed teams with a focus on programmes. This interpretivist literature adopts the modern project management approach. Chapter two concludes with a theoretical framework that first discusses literature on boundary work in construction projects (regarded as temporary organisations that often lead to tension) and then a boundary object approach for analysing how distinct project groups engage with a programme in delay incidents.

Chapter three presents and justifies the research approach that is adopted in gathering data and answering the stated research question and objectives. The research design chapter is structured in five parts: the first part discusses the research approach, the second part offers a discussion of the sampling approach adopted and includes the background of the cases (London case and Southeast cases) with three case projects selected for this research, the third part discussed the method used to obtain data, the fourth part offers a discussion of the data analysis described empirically in vignettes and compares the cases, the fifth part discusses the limitation of the research design, the sixth part discusses the ethical considerations involved in doing this research.

Chapter four presents an empirical description of the recladding works in London that were developed with formal engagement with a set of programmes. This chapter is structured in three main parts. First, it provides the background for the analysis of London case and four buildings. Second, it offers an analysis of four buildings presented in four vignettes that narrate delay

incidents identified in the course of recladding four different buildings and responses. The vignettes describe how project groups engage with or without a programme in delay incidents in recladding four buildings and considers three main aspects: (1) the issues that led to specific delay incidents and how project members found out (2) what project members did to address the delays and who was involved (3) what changes key project members made with or perhaps without the programme in response to those incidents of delays. Third, the chapter concludes with a summary of the empirical issues that emerged from observed patterns in the recladding of the four buildings in the London case.

Chapter five presents an empirical description of two road projects (a safety improvement and drainage remedial project) in Southeast England that were constructed with limited engagement with general programmes. This chapter is structured in three parts: first, the background of the analysis of the two road projects. Second, an analysis of the road projects presented in two vignettes that narrate delay incidents identified in the course of executing the two road projects in Southeast England and responses. The vignettes describe how project groups engage with or without a programme in delay incidents in executing the road projects and considers three main aspects: (1) the issues that led to specific delay incidents and how project members found out (2) what project members did to address the delays and who was involved (3) what changes key project members made with or perhaps without the programme in response to those incidents of delays. The fifth chapter concludes with a summary of the empirical issues that emerged from observed patterns in the two road projects in the Southeast cases.

Chapter six discusses the research findings with the theoretical position or lens that the cases (London case and Southeast cases) studied in this research consist of different project groups that use a programme as a boundary object and explains how the findings agrees or disagrees with previous literature or studies on tools such as programmes.

This chapter is divided in to six main sections, corresponding to the six objectives. The first section discusses different ways time is constructed in programmes within and across the cases as a basis of relations between the different project groups. The second section discusses the different modes or ways (formal and informal) project groups engaged with versions of the programme in the cases (London case and Southeast cases). The next section discusses the role of programmes and examines what project groups actually do with the programme in the cases and how in such doing, project groups shape the programme that shapes their work in project meetings, after

meetings and through email correspondences. The fourth section discusses the way different project groups interpret delay incidents within and across the cases (London case and Southeast cases). The fifth section discusses how project groups interacted when responding to incidents of delays within and across the cases. The sixth section compares the different roles that programmes play in different delay incidents within and across the three cases. Each section is concluded with a paragraph that reflects on how boundary object theory helps us to understand what a programme does.

The concluding chapter provides an overall summary of the thesis, highlights the findings that addressed the stated research aim and objectives. This is followed by the contribution to knowledge, implications and recommendations of directions for future research.

Chapter two: Literature review

2.1 Introduction

The previous chapter presented the research problem that is twofold: an objective view or treatment of delays and limited research on the use of programmes in a live project. They are related because they are both linked to the management of time. However, the problem of programme use in delays is the primary lead in this research. This chapter positions this research in a review of literature on delays, project planning tools, programme use, and introduces a boundary object approach that is adopted in this research. The literature review is structured in five parts as follows: first, a critical examination of the positivist literature on delays. The aim is to underline the role programmes play in delays. Second, a critical examination of the positivist literature on planning and planning tools with a focus on programmes. Most of the research in this area adopt the traditional project management approach. Third, a review of the qualitative literature on delays. The aim is to underline the role of programmes. Fourth, a review of the interpretivist literature on tools in organisations or project teams with a focus on programmes. This interpretivist literature adopts the modern project management approach. This chapter concludes with a theoretical section that reviews literature on boundary work in construction projects (regarded as temporary organisations) and another literature on a boundary object approach on programmes as the theoretical framework for analysing how distinct project groups engage with a programme in specific delay incidents. The section that follows provides a critical examination of the positivist literature on delays.

2.2 Positivist literature on delays

Delay is a concern related to time and an underlying assumption in the literature is that delays are objective and exist apart from the interpretation of stakeholders in a project. Scholars often adopt a positivist approach to delays and assume a relationship between causal factors of delays and the performance of projects. Many authors explore the levels of delay causes and the effect on the outcome of a project. Odeh and Battaineh (2002), Aibinu and Jagboro (2002), Assaf and Al-Hejji (2006) and Sambasivan and Soon (2007) share this assumption and argue that the outcome of a project can be managed by merely calculating the levels of potential sources of delay in different countries. For example Odeh and Battaineh (2002) surveyed contractors and consultants to identify the major causes of delay in Jordan. Their survey measured the level of importance of 28 delay causes in traditional projects and was analysed using the rank correlation. Their result indicated that labour productivity was the most important delay cause for the

contractor and inadequate experience was the most important for the consultant. They claim that the levels of delay causes would guide in improving the performance of construction projects and firms. This claim is deterministic as performance does not depend on the levels of causes in the past and offers no explanation on how professionals are guided.

In the same way, Assaf and Al-Hejji (2006) surveyed three project parties and examined the frequency and level of severity of 73 delay sources on a four-point scale to determine a common source of delay in Saudi Arabia. They calculated importance index for each source of delay and compared the degree of agreement of the importance of different parties using a correlation test. Their result indicated a good agreement between the parties and that both owners/consultants specified that the contractor/labour are sources of delays, while the contractor specified that the owners and consultant are the highest source of delay. They claim that the most common source of delay identified by the three parties is change order and 70% of projects experienced time overruns. This approach is mechanistic and based on the idea that all parties have the same interpretation of a delay. These studies above on countries in the Middle East assume that past delays are linked to the performance or outcome of a project and argue that the performance of a project can be improved by simply calculating the levels of potential sources of delay.

In contrast to studies above that focused on exploring the major causes of delays in the Middle East , Aibinu and Jagboro (2002) surveyed three participant groups and examined the effect of delays on the completion of projects in Nigeria. They measured the effects of the delays based on frequency using a 5-point scale, calculated the relative importance index and conducted a linear regression test on two key variables namely cost and time using initial and final durations/sums. Their results indicated that time /cost overrun were the most frequent effects and delays had significant effects on time and cost of a project. They claim that accelerating activities and contingency allowances can mitigate the effects of construction delays. It is not clear how people's perception or experience can simply identify or control construction delays in practice. In the same way, Sambasivan and Soon (2007) surveyed three project participants and examined the relationship between the cause and effects of delays on completion in Malaysia. They measured the importance index of 28 causal factors with six effects of construction delay on a five-point Likert scale to identify the five most important causes of delays for the three participants and tested the degree of agreement using a correlation analysis test. Their result indicated 10 causal factors were the most important including improper planning by the contractor and a significant relationship between the causal factors and the effects. They claim

that there is an empirical relationship between each cause of delays and the effects namely: time overrun, cost overrun, dispute, arbitration, litigation. This claim agrees with Aibinu and Jagboro (2002) argument on the link between perception and main causes of delays, but does not take into account the context that led to emergence of the delays. These two studies above in different countries assume that there is an empirical relationship between factors that cause delays and the performance or completion of projects in different countries and argue that delays can be determined or controlled based on people's perception or experience in the past.

Earlier studies that focus on exploring the major causes of delays in the Middle East share similar assumptions with the studies that focus on the effects of delays on completion in Nigeria and Malaysia. These positivist studies adopt a similar approach and assume that there is a relationship between the potential causes of delays and the performance or completion of a project and concentrate their argument on the grounds that merely calculating the levels of potential causes or factors of delay is the secret to improving the time performance or outcome of a project. However, this positivist approach is prescriptive and does not offer any explanation or mechanism on how people from different firms with different interests or priorities interpret the meaning of a delay in the context of a construction project. None of the above studies on delays consider whether people use planning tools such as programmes to respond to specific delays in the context of a construction project. This indicates that there is a need for detailed interpretivist investigations that explore how people in construction engage with a programme in the context of a construction project to respond to specific delay incidents. Taking this into account would change their analysis from a focus on levels or factors to responses that are situated and complement the above studies. The discussions that follow builds on the positivist discussions on delay and provides a review of the positivist literature on planning and planning tools such as programmes (whether they involve delays).

2.3 Positivist approach to planning and planning tools

Programmes can be regarded by scholars as planning tools and this section focuses on positivist research into planning and planning tools in projects. Discussions of planning in the project management literature generally assume that the performance or outcome of a project can be fully described or determined by the levels of planning committed to a project and that planning tools can be used to represent desired outcomes. Authors argue that planning can lead to greater chances of project success and seek to optimise planning to achieve a desired success outcome. More specifically, time as an outcome of project planning has been explored with a focus on

programmes using the traditional project management approach. This approach assumes that planning tools such as programmes can be used to represent time in a project. Authors that share this assumption argue that time can be controlled by merely changing different variables of planning. The section that follows examines key studies on planning as correlates of project outcome and whether planning involves the use of programmes.

2.3.1 Planning as correlates of project outcome

Positivist scholars in construction often assume that planning plays a significant role in a project's outcome. According to Morris (2013) planning in project management started in the 19th century and focused on three main aspects namely: quality, cost and time. These three aspects were referred to by Atkinson (1999) as the "iron triangle" and are often used as parameters for measuring project outcome or success. For example, Pinto and Slevin (1988) , Shrnhur *et al.* (1997), and Dvir *et al.* (2003) shared this assumption on how to measure project outcome or success. All three argued that the quality, cost, and time of a project can be fully described and determined at the planning phase of a project. For example, Pinto and Slevin (1988) surveyed project managers and examined a relationship between 10 critical factors in project management and four aspects of project success in four phases of a project on a 7-point scale. They used regression analysis and tested the significance of the critical factors with the aspects of success as well as the relative stability across four phases. Their result indicated that plans/programmes were predictive of project success in the four phases. Building on this study, Shrnhur *et al.* (1997) surveyed project managers and examined the relationship between 13 success factors and four elements of overall project success using a 7 point scale. They correlated success factors with the four overall project successes and analysed the variance for projects completed and ongoing. Their result indicated that different elements of success were more important at different times with respect to the moment of project completion. They claimed that project success is time dependent. In the same vein, Dvir *et al.* (2003) surveyed project stakeholders and examined the relationship between three levels of planning and three criteria of success on a 7- point scale. They correlated the levels of planning with three measures of project success. Their result indicated the levels of planning had a positive and significant relationship. They claimed that levels of planning positively correlate with project success. This approach is prescriptive as project success in practice does not necessarily depend on merely correlating levels of planning.

It can be seen that these three authors adopt a similar approach and share the assumption that the outcome or performance of a project can be defined and determined by planning and argue

that levels of planning can determine the outcome of a project. These studies prescribe the circumstances people will meet on projects and fail to explore in detail the way people actually utilise planning techniques or tools designed to represent time such as programmes in construction. Taking this into consideration would extend the above studies and complement their approach. The section that follows builds on the positivist discussions on planning and explores positivist literature on planning tools as representations of time to underline their arguments.

2.3.2 Planning tools as representations of time

Several studies have explored the use of planning tools and argue that different planning tools can be used to visually represent time to monitor and control a project. For example, Galloway (2006) surveyed construction professionals on the benefits of using four planning tools in projects namely: critical path method-CPM, programme evaluation review technique-PERT, 4D planning and line of balance method. The author explored the percentage usage, primary use and observed higher percentages of professionals preferred to use CPM and PERT. The percentage results also indicated that a major reason professionals used the four planning tools was to look ahead or visually represent time that helped time management, time savings, timely completion of a project or time extensions. The author claims that planning tools are beneficial as a project control tool for planning, executing, and monitoring a project. It is not clear how calculating percentages implies that a planning tool is beneficial, and this approach does not take into account how people use planning tools in the context of a project. Taking this into account would change their analysis from percentages of perceptions and focus on actual use in a live context. In the same way, Tory *et al.* (2013) focused on developing a visual planning tool and explored visual techniques that are useful in supporting construction programme modification and comparison. They implemented and evaluated a tool: TAPM- (Tool for Advanced Programme Management) on features that supported a user to visually represent three aspects namely: graphical representation of constraints type, interactive representation of network chains, comparison of alternatives. The evaluation involved inspecting the usefulness of supporting features as 12 students developed a construction programme for a 5-storey building project. Their result indicated that the tool provided higher levels of support compared to Microsoft project with response times of p- values lower than 0.05. They claim that their tool enhances the traditional programme and benefits professionals that manage and update complicated construction programmes. In the same way, Pellerin and Perrier (2018) focused on 29 planning tools and

examined the characteristics of the planning tools in project planning and control for a period of 10 years. They compared problems and contributions of the 29 planning tools in 33 studies and observed that projects have been represented using network planning techniques and programming. They claim that two traditional planning tools or programmes namely: CPM (critical path method) and PERT (programme evaluation review technique) were originally made for keeping project on time and are widely used in practice in their modernised forms. These studies compare different tools and share the assumption that planning tools such as programmes can be used to visually represent time in projects. They argue that identifying the best planning tools is beneficial and supports professionals in managing and controlling time in projects. However, this prescriptive approach offers no explanation on the way planning tools such as programmes that represent time are used in construction or operations every day and in events of delay. Taking this into account would change their analysis from simply comparing planning tools and extend the focus of their studies. The section that follows builds on the positivist literature on planning and focuses on the positivist literature on programmes as a planning tool in managing time, which has been regarded by Spalek (2016) as the traditional project management approach.

2.3.3 Traditional project management approach to programming and programmes

Discussions of programmes exist in the operations management and construction management literature, adopting varying approaches. One approach assumes that the secret to improving performance is to improve the way that activities are calculated or arranged in a programme or programming. A common example is to examine the relationship between tightness of activities and performance. The term 'activity' describes the smallest unit of analysis represented in a programme and is defined as an item of work that can be carried out without interruption.

A second approach assumes that changes to the way activity attributes are calculated would improve the capacity of a programme to mitigate disruptions and examine a relationship between resilience in programmes and the activity attributes in a baseline programme. The term 'activity attribute' describes measurable characteristics of an activity that are integral to programmes and can represent any of the following: trip, duration, start date, float, completion date, safety or buffer value or size, slack, flexibility, relations, dependency relationships, cycle time, rework, daily appointments, queue lengths, and man-hours. Authors that begin with this assumption propose numerous improvements that enhance programmes, with changes that focus particularly on certain aspects described as attributes of an activity by De Marco (2011), as well as the risk

inherent in activities (Nasir *et al.*, 2003). The discussion that follows explores the first approach in studying the programming of resources and performance in operations or service delivery.

2.3.3.1 Resource programming and performance of services

This section reviews studies on the programming (timing) of resources in the operations management literature (service delivery). This approach assumes that changes to the way activities are calculated or arranged can optimise time performance of a service with available resources. Performance in operations generally describes an outcome of a prearranged process with available resources. Xiao *et al.* (2017), Emde *et al.* (2018), Scurich and John (2014), and Baydokht and Noori (2014) begin their research with this assumption and argue that the secret to an optimal use of resources and time in delivering a service depends on how activities are calculated or arranged. For example, Xiao *et al.* (2017) focused on daily physician appointments with patients and explored the impact of revisits on daily appointment of patients that booked in advance. This approach simulated a stochastic programming model that considers revisits to optimise the performance of daily appointments. The result showed that daily appointment became tightly crowded and therefore either capacity is built, or fewer patients are attended to, to reduce overtime on the physician and overall cost. They claim that programming cannot serve all patients on the same day taking revisits into consideration and a referral mechanism can balance patient access and physician workload. This prescriptive approach does not explain how the programme model was used in the context of a live project and in specific incidents.

In the same way, Emde *et al.* (2018) focused on milk deliveries and explored ways of assigning electric vehicles of limited battery capacity to run milk trips before their battery capacities required recharge. This approach developed a programming model of proposed solutions. Their model generated performance data sets for slow and fast charging batteries that was tested at a manufacturing warehouse. A performance comparison showed solutions that are very fast in solving large instances in split seconds, however those solutions do not offer a fair distribution of the workload on the vehicle fleet. They claim that a programme with optimum solution and battery charge rate is realistic and capable of balancing the workload almost perfectly. This claim is not supported because comparing calculations of different performance data set does not imply that programming solutions are realistic and can balance workloads perfectly. This approach is prescriptive and will not fit all situations. These studies assume that the secret to improving services delivered is to change the way activities are arranged and argue that optimum

programming solutions can balance the workload of a service with access to a physician or milk delivery.

In contrast to studies that focused on programming of patients or milk deliveries, Baydokht and Noori (2014) focuses on the timing/programming of traffic lights and explored ways of reducing traffic congestion or queues for eight traffic lights. This approach developed a fuzzy programming model that presented a sequence of light changes with minimal queue lengths and used a case study of a four-way intersection. Traffic control data was obtained from the department of municipality in Tehran and imputed into their proposed model to produce a proposed traffic programme. The results showed that the traffic programme proposed by fuzzy programming model at the intersection led to less traffic compared to the programme used by the traffic control centre of Tehran's municipality. They claim that programming traffic lights is more practical and closely resembles real life situations. This claim is not supported by merely comparing model outputs with traffic data and does not necessarily imply that programming traffic lights are more practical or closely resemble traffic situations in real life. In the same way, Scurich and John (2014) focused on the timing/programming of security search options and used an online survey to explore the preference of the public on traditional or randomized security programme. This approach measured the perceptions for search options under five attributes and analysed their variances with probabilities of detection in three security locations i.e., an airport, stadium, and a vehicular checkpoint. Their result showed that the traditional security programme was rated as both safer and fairer than the randomised programme for everyone. They claim that the randomised programmes are more convenient than the traditional approach and averagely no single factor is sufficiently salient to affect public's preference. It is not clear how calculations that compare the perceptions on different security search options imply that a programming option is safe, fair, or convenient.

Earlier studies that focussed on the programming of patients and milk deliveries share many of the assumptions with the studies that focus on programming of traffic lights and security search options. These studies focus on the technical solutions that seek to optimise the time performance (timing) of a service with available resources and concentrate their arguments on the grounds that the timing/programming of a service can be optimised by merely changing the way that activities are calculated and arranged. Their discussions begin with this assumption and focus primarily on patterns between time-related variables. However, these changes do not necessarily correlate with any improvement on the timing of services, and evidence of

performance improvements in time is never offered. None of the above studies consider situations where programming is used by people every day and in specific incidents of delays in the context of a project. This indicates that there is a need for investigations that adopt an interpretivist approach into programmes in order to develop insights on how the management of time with a qualitative response to specific delays might be better understood. The section that follows builds on the discussions on performance with a focus on construction alone and underlines the major argument.

[1]2.3.3.2 Construction programmes and construction performance

In contrast to studies that focused on performance in operation management, this section explores studies in construction alone and assumes that changes to the way activity durations are calculated can improve construction performance. This assumption on performance is similar to earlier reviewed studies in planning. Construction performance generally describes an outcome of a prearranged construction process. Abuwarda and Hegazy (2016), Nepal *et al.* (2006), Gurcanli *et al.* (2017) begin with this assumption, and argue that construction programmes influences the performance or outcome of construction projects. These authors assume that the performance of construction work is linked to how tight or loose activities are arranged in a construction programme. The concept of tightness refers to attributes between activities in a construction programme network with minimum float, slack, and no flexibility. For example, Abuwarda and Hegazy (2016) focused on flexibility between sequential activities and explored the relationship between flexible activity relations and construction performance. Relations refers to the degree of tightness between sequential activities in a dependency relationship. Hard relations mean activities are tightly knitted with no flexibility, while soft relations have some degree of flexibility. This activity attribute was operationalised in Abuwarda and Hegazy's study. Abuwarda and Hegazy (2016) conceptualised construction programmes as activities with flexibility and used a case study of a six-activity programme to explore ways of representing flexible ranges of overlapping options between any two sequential activities. This conceptual framework was used to produce a programme crashing model that stimulates activities in construction to meet strict deadlines. They claim that construction projects can be optimally accelerated by combining, crashing, and overlapping decisions. This claim is not consistent with their evidence because

[1] The ideas in sections (2.3.3.2 and 2.3.3.3) are in a paper published in Emerald Publishing Limited.

Olubajo, O., Hughes, W., & Schweber, L. (2019). Construction Programmes and Programming: A Critical Review. In 10th Nordic Conference on Construction Economics and Organization.

calculating overlapping options that tightens sequential activities in a programme does not necessarily correlate with swift completion of activities. This approach is prescriptive because the proposed overlapping does not fit all situations and how people use these options to make decisions when there are delay incidents is not fully explained.

In the same vein, the tightness of activities was also investigated in Nepal *et al.* (2006). They conceptualised programmes as target decisions with pressures on construction processes and used a questionnaire survey of 102 professionals to explore the influence of pressured decisions on perceived performance of 38 projects in Singapore. This approach measured the levels of pressured decisions and their influence on three aspects of project performance namely: quality, work rate and productivity of site work. The influence of four target decisions representing varying degrees of tightness in construction activities was tested using levels of agreement to hypothetical statements of pressure on performance, mean and standard deviation. These authors claim that large amounts of target pressures can slow down work rates of construction by lowering the quality of the work. This claim contrasts with Abuwarda and Hegazy (2016) argument on construction performance, as work rates do not depend only on pressure levels. Moreover, this approach takes no account of the context of construction projects as a commercial activity involving different firms with varying priorities of time and interests.

Building on this work, decisions in programming mentioned earlier can be made after comparing or weighing alternative cycle times. This activity attribute was studied by Gurcanli *et al.* (2017) and assumed to influence performance in construction. Cycle time refers to a portion of time that represents repeated occurrences from the start to the end of the same group of activities in a sequence. This activity attribute is operationalised in Gurcanli *et al.* (2017) study. Gurcanli *et al.* (2017) conceptualised programming in construction as a comparative analysis of productivity in crew sizes. They undertook a case study of truck crews in Turkey and compared the productivity outputs of excavator-loader-dump truck-crews in residential projects. They compared field observations recorded and simulated-cycle time outputs of 3 and 4 truck crews. Their results showed divergent effects on the duration of activities in a project. They claim that using simulated techniques and past data of time estimates can assist in developing precise estimates for programmes. This claim is not supported by simply comparing calculations of different simulated outputs and does not necessarily correlate to improvements in construction performance. A significant limitation in this approach is that it does not fully explain the way different people in a

project site use the time estimates to negotiate various firm or business interests every day or at specific moments.

Hegazy *et al.* (2011) further developed Nepal *et al.* (2006) argument on quality as an outcome and explored how construction activities of low quality can lead to rework. This activity attribute was studied by Hegazy *et al.* (2011)and assumed to influence construction performance. Rework refers to work that maybe defective or flawed that has to be repeated. Hegazy *et al.* (2011) conceptualised programmes in a more dynamic way that incorporates activities that are repeated. This approach applies techniques developed using a computer prototype to correct a construction programme and include rework. Progresses made in executing a project was illustrated daily by comparing initial, actual, and remaining durations with percentage completions in a construction programme. The results of this comparison produced a corrective action plan using site reports of a case project that compressed a construction programme from 13 to 11 days. Hegazy *et al.* (2011) claim that programming can be more responsive to the specific timing of various progress events. It is not clear why calculating repeated activities at certain times implies that programmes are reactive or responsive.

The authors mentioned above assume that changes to the way activities are arranged or calculated can control the sequence and timing of construction activities and assume that construction performance is influenced directly by construction programmes. However, they offer no explanation or mechanism as to how changes would necessarily correlate with improvements in the performance of time in construction projects. They do not consider the social or commercial context of a construction project or the way people/firms with different priorities or business interests would engage with programmes at different moments. Taking this into account would change the focus of their analysis from a technical angle and concentrate on people practices every day, and in specific moments of delays. For example, a contractors' programme is required in most building contracts in the UK, as it is used for calculating the impact of the sort of delays that can warrant an extension of the contract duration or period. Therefore, contrary to assumptions widely-held that the purpose of construction programmes is to avoid delayed completion, the way that contracts are prepared tells us that the purpose of programmes is to deal with delays (Ballesteros-Pérez *et al.*, 2017).

2.3.3.3 Construction programmes and resilience

In contrast to the first approach that focused on the relationship between programmes/ programming and performance, this section explores the second approach on the way time performance of construction processes is influenced by exogenous or endogenous risk in activities. This focus is exemplified by Nasir *et al.* (2003), Song *et al.* (2009), Roghanian *et al.* (2017). These authors assume that knowledge of risks inherent in construction activities will improve the capacity of project managers to mitigate disruptions in real time. Authors who begin with this assumption argue that resilience of construction programmes depends on the attributes or features of activities in a "baseline" programme i.e., a programme with a plan against which progress can be measured. For example, risk inherent in an activity can determine the duration of activities. This feature or attribute of an activity was investigated by Nasir *et al.* (2003) and assumed to influence the resilience of construction programmes. Duration refers to the length of time apportioned to an activity in a construction programme. Nasir *et al.* (2003) conceptualised resilience in construction programmes as an evaluation of risk inherent in activities and explored how risks related to building processes could aid in estimating probable time values for an activity. They examined case projects, progress reports and produced a risk model for analysing construction programmes. Nasir *et al.* claim that their programme-risk-model can provide a basis to determine likely extent of delays. This argument is not supported by simply evaluating risk in past projects as some activities proceed in variance to the sequence or arrangement of previous projects. Delays do not always occur based on how activities are prearranged, therefore cannot predetermine the timing of future construction events. This approach is based on the idea that the problems in past projects will occur in a similar way in future projects. It is not clear how this approach would account for unforeseen events that are at variance with the sequence in past projects.

In the same way, the knowledge of risk in construction can influence the allocation of resources to activities such as labour. This activity attribute was also investigated by Song *et al.* (2009) and assumed to influence the resilience of construction programmes. Song *et al.* (2009) conceptualised resilience in construction programmes as the use of construction knowledge in the design process and examined the influence of knowledge input on baseline programmes. This knowledge at the inception stage was referred to as contractors' input, experience, or involvement. They developed a baseline simulation model that set out percentage estimates on the frequency of delays for certain elements in a process. Song *et al.* (2009) claim that including

contractors' knowledge in the design will lead to reduced labour hours and project duration. However, this argument is not supported by their evidence because their data was drawn from a case involving a partnered and integrated supply chain, without comparing data from a fragmented case that did not include early contractor involvement.

Some authors argue that the effects of risk in construction activities can be moderated with the value or size of a buffer. This activity attribute was also investigated by Roghanian *et al.* (2017) and assumed to influence the resilience of construction programmes. "Buffer value or size" refers to an amount of protection or cushion inserted in an activity against disruptions and is represented as a portion of additional time in a baseline programme. This activity attribute is operationalised in Roghanian *et al.* (2017) study. Roghanian *et al.* (2017) conceptualised resilience in construction programmes by exploring ways of protecting a baseline programme. Their approach examined a seven-activity case study and aimed at minimising the weight of uncertainty in non-routine construction projects to produce a model. A model of how construction programmes can be applied with a proposed method of buffer sizing was developed using a fuzzy set theory to overcome programme-risk more efficiently. Their model set out a proposed buffer size or value. A comparison of the existing buffer value with the proposed buffer value from the model indicates a reduced completion time. Roghanian *et al.* (2017) claim that construction projects can be programmed to neutralise delays and disruptions with buffer values and, thereby, be timely. It is not clear how such a prescriptive approach can help in practice because delays and disruptions in construction processes do not depend on the way buffers are calculated but, rather, in the way that people (in firms) use prearranged sequences in programmes when there are disruptions or delays in specific events.

Earlier studies on time performance in operations/services delivered and construction share many of the assumptions as the studies on resilience. In the studies on resilience, authors assume that changes to the way activity attributes are calculated will improve the capacity of a construction programme to mitigate disruptions or delays. These approaches treat delays objectively and focus on the unique attributes of activities in a baseline programme. Their arguments are concentrated on the grounds that time and delays in construction can be managed merely by changes in the way that activities are calculated. Their discussions begin with this assumption and focus primarily on patterns between time-related variables. However, these changes do not necessarily correlate with any improvement in construction performance, and evidence of improvements in time or removal of delays is never offered. None of the above

studies on programme/programming considers the way various parties utilise or engage with programmes in specific incidents of delays in a construction project as a commercial or social context. This indicates that there is a need for investigations that adopt an interpretivist approach in order to develop insights into the management of time and delays in construction projects. The section that follows builds on the positivist discussions on programmes with a focus on the qualitative literature on delays and examines the role programmes plays or do not play on the subject of delay.

2.4 Qualitative research on delays

This section focuses on qualitative studies on delays in projects with authors that assume that people in projects are interrelated or interdependent. This approach explores how individuals or parties that are interrelated interact during delays on a project and work together to avoid or minimise the occurrence of delays. Han *et al.* (2009); Mello *et al.* (2015) share this assumption and argue that delays can be avoided using past lessons or stronger efforts in coordination. For example, Han *et al.* (2009) interviewed five project managers to understand the critical cause of delays in a high speed railway in Korea. They traced who was responsible for causing delays by focusing on the most delayed segment out of three segments (the roadbed construction segment) and identified issues or causes of delays on the railway project. Han *et al.* (2009) results indicated that the most delayed segment was due to five issues: a route change, resistance from residents that involved negotiations in acquiring the site that pushed the construction date of successive activities, new structural design changes, prolonged approval with permits and underground obstacles. They claim that lessons learnt from engineers can help to better prepare or respond to potential causes for megaprojects and that social or political issues in addition to time, cost and quality should be considered to successfully manage a project. This claim is superficial and does not consider how different people use planning tools such as programme to interpret the meaning of specific delays in an incident. Taking this into consideration would change their objective treatment or analysis of delays and would explain better the social or political issues related to time.

In the same way, Mello *et al.* (2015) observed/interviewed 32 managers/stakeholders to understand how to mitigate delay across companies involved in a ship building project. They analysed the interaction between a ship designer, equipment supplier, material suppliers, ship producer and owner to understand the role of coordination in avoiding delays in an engineer-to-order supply chain. They developed an influence diagram linking problems with a causal loop

relationship on the project performance across five departments to understand the activities carried out by the ship designer that delayed the activities performed by the ship producer and vice versa, as well as how interdependent activities between companies were coordinated across different departments. Their analysis showed increased interactions between departments in the two companies with increased concurrency in engineering and production activities that led to interdependence to handle changes i.e., increased efforts in coordination. They claim that it is possible to avoid delays through greater interaction to shorten the lead time. It is not clear how more interaction or effort in coordination would automatically remove specific delays.

The above studies assume that people are interrelated or interdependent in different projects and argue that delays can be avoided or minimised merely with greater interaction or effort in coordination or by learning from the past. However, this approach treats delays objectively as though everyone shares the same interpretation and offers no explanation on how people from different firms and interests or priorities interpret delays in the context of a construction project. None of the above studies considers the role that planning tools such as programmes play in the management of time on the subject of delay. Taking this into account would change their analysis on delays and introduce a social dimension to delay events with a detailed explanation of programme use. This indicates that there is a need for interpretivist investigations that explore the meaning of delays and how people from different firms use tools every day in the context of a live project to respond to delay incidents. Taking this into account would change the focus of analysis from avoiding delays and provide a deeper understanding of the meanings attached to people's actions or responses in specific delay incidents. The section that follows builds on the discussions on the role of programmes in delays and focusses on interpretivist literature on the use of tools with a focus on a programme.

2.5 Interpretivist approach to tools

In contrast to positivists approach discussed earlier that focus on the mathematical and technical approach to delays and planning tools such as programmes, this section provides a review of the non-technical approaches that focus on people engaging with tools every day in organisations or projects teams. The literature in this section concludes with studies that focus on programme use and adopt a modern project management approach on programmes in project teams.

2.5.1 Research into the use of tools in organisations or project teams

Most studies on the use of tools focus on individuals or groups and their engagement in different processes. Several approaches have been adopted with an assumption that tools are used to represent different aspects of a project or process. A considerable number of authors share this assumption and explore the role of different tools in different settings: design tool (Minneman and Bly, 1991), artefacts (Orlikowski, 2002), objects (Bechky, 2003), information sharing tool (van Leeuwen and van der Zee, 2005), design artefact (Luck, 2007), visual objects (Ewenstein and Whyte, 2009), knowledge tools (Sage *et al.*, 2010), material artefact (Tryggestad *et al.*, 2010; Jarzabkowski *et al.*, 2013), project alignment tool (Ollus *et al.*, 2011), visual tool and task management tool (Chasanidou *et al.*, 2016). Three arguments dominate discussions on the use of tools: first, some authors claim that tools play a distinct role in creating and sharing knowledge in organisations. Second, other authors argue that tools play a role in enabling the alignment or collaboration of teams. Third, some other authors contend that tools play a role in enabling people in dispersed locations to become more actively involved in processes. The section that follows presents studies under the first argument and explores the role of tools in creating and sharing knowledge in organisations.

2.5.1.1 The use of tools to create and share knowledge

A drawing is a type of tool and can be used in organisations to create or develop knowledge. This is the argument of authors who study how drawings and artefacts are used to represent aspects of a project or product. For example, Bechky (2003) observed technicians, engineers and assemblers in a manufacturing organisation and explored the use of engineering drawings as a tool to share knowledge across three groups involved in the production of a semiconductor. The study showed that the understanding of product changed to fit the local environments of the three groups. The author claims that the drawings generated deeper understanding of the product and knowledge process within the organisation. Although drawings differ from programmes in representing the form of a product instead of time, this study is useful in investigating how the understanding of programmes could help generate a deeper knowledge of the construction process and delay incidents. In the same vein, Ewenstein and Whyte (2009) studied the use of tools such as drawings and sketches as visual representations of a botanic garden in project design. They observed/ interviewed staff of an architectural organisation. They explored how staff used drawings and sketches to work, talk, learn, coordinate, make contributions. They observed that knowledge developed through constantly unfolding tools that

were used to stabilise some aspects of design and evolve others. They claim that tools have an unfolding nature that is constantly in flux as the project evolves, drawings change, new issues and needs for knowledge or learning arise. Although design development differs from construction work in developing an idea that represents a finished product, an implication from this study is that drawings are similar to programmes and may have a changing nature or can be used to coordinate or make contributions. This is useful in investigating knowledge developed as programmes constantly change and issues such as delays arise. These studies assume that drawings and sketches are tools used to represent a project or product and argue that design or products develop through a changing use or changing understanding of a tool.

In contrast to studies that focus on the use of drawings to create and share knowledge in one place. Orlikowski (2002) focused on the use of artefacts and observed/ interviewed project managers and software engineers in a high tech-organisation spread over 5 continents. The author explored the use of three artefacts: software tools, communication media, project plans in developing products for operating systems. The study indicated that the project managers and engineers used the artefacts to do five things: share identity, interact face- to-face, align their effort, learn by doing and lastly, support participation by involvement. The author claims that members of the organisation used the artefacts as tools to competently do global product development as a capability that is collective and distributed. A difference between artefacts in Orlikowski (2002) and programmes is that the latter is a time related artefact and an implication is that programmes can be used in a project to interact, align efforts, learn, and support participation by involvement. This is useful in this research in exploring how project members who are geographically distributed can collectively use a programme to respond to delay incident on a project site.

Similarly, Jarzabkowski *et al.* (2013) focused on artefacts and explored how managers used five material artefacts in appraising insurance deals with observations/interviews. The artefacts include pictures, maps, data packs, spreadsheets and graphs that represented physical assets and capital allocations of an organisation. Their study illustrated that managers used artefacts to represent a part of the knowledge process involved in appraisal work and enacted five situated practices: physicalizing, locating, enumerating, analysing, and selecting that evolved with an unfolding use of the artefacts. They claim that managers use artefacts to enact practices and develop a type of knowledge in the appraising process to select a deal by replacing the physical details with abstract representations. The implication is that programmes are similar to artefacts

and can be used to represent the construction process or enact practices that evolve with a changing use of a programme. This is useful in investigating how programmes are used to appraise construction processes and select or decide how to respond in the event of a delay. These studies assume that artefacts can be used to represent different aspects of work processes in developing a product or appraisal work and argue that artefacts are tools that can be used to learn, develop knowledge, and enact collective ways of doing work or taking decisions.

Earlier studies that focus on the use of drawings share similar assumptions to the studies that focus on the use of artefacts. These studies assume that drawings and artefacts are tools that can be used by people to represent different aspects of production or work processes. These studies explored how different groups localised or dispersed used different tools in different settings and argue that using tools enables people to generate deeper knowledge, collectively work together in production, and take decisions in organisations. These studies imply that investigating the use of programmes in this research offers insights on the role of programmes in coordinating work, making contributions, and deciding how to respond every day to specific events in a project.

2.5.1.2 The use of tools to enable team collaboration

In contrast to studies above that argue that tools play a role in creating and sharing knowledge, this section reviews studies that argue that the use of tools enables team to collaborate and work together. For example, Kaplan (2011) focused on the use of PowerPoint technology by managers in strategising and used observation, interviews and documentary sources to understand how managers use PowerPoint to make strategy in a telecommunications equipment manufacturing organisation. The author analysed the way managers used PowerPoint software to mediate interactions. The analysis showed that PowerPoint use enabled managers to; propose ideas, make decisions, share information, request information, convince others, brainstorm, or generate ideas, direct or set the scope of a discussion, align viewpoints, get feedback, and gain support. The author claims that the use of PowerPoint mediates two discursive practices of strategy making namely: collaborative efforts to negotiate ideas and cartographic efforts to settle interests (i.e., draw boundaries to resolve conflict of interests). Although, PowerPoint technology differs from programmes as a virtual medium to display anything instead of time, an implication is that this is useful in investigating how programmes are used to mediate collaborative efforts to negotiate tension and settle interests every day or in events of delays.

In the same vein, Chasanidou *et al.* (2016) focused on a tool for collaboration and explored the use of a task management tool -UpWave in team collaboration. They interviewed employees

from public and private companies of different specialisation that use UpWave. Their results showed that the firm specialization and team structure shaped the way the task management tool was used. They claim that the task management tool -UpWave- enables team collaboration in the process and through motivation. This approach does not take into account how people in a temporary project use tools everyday nor does the study examine in depth the use of tools in specific incidents but, it does suggest that team structure may shape the use of programmes.

It can be seen from the above-mentioned studies that these authors assume that PowerPoint and UpWave are tools that can be used in an organisation to represent desired tasks for managers or employees in teams. These studies explored how teams in public or private firms use different types of tools in different tasks and argue that using these tools play a role in mediating team interactions and negotiating ideas to work together. These studies imply that investigating the use of programmes in this research offers insights on the role of programmes in mediating interactions and negotiating ideas for teams to work together.

2.5.1.3 The use of tools enables active involvement

In contrast to the above studies that argue that tools play a role in mediating the interactions of teams in one place, this section reviews studies that argue that tools enable dispersed people to become more actively involved in design work. For example Minneman and Bly (1991) focused on a multi-user drawing tool used by dispersed persons and observed the activities surrounding the use of a multi-user drawing tool in design exercises. They compared design activities of two-persons using the shared drawing tool with those of three-persons in a dispersed design exercise. Their results indicated no difficulties attributable to the involvement of a third user. They claim that drawing tools offer support for alternative forms of participation in collaborative work. Though this research is not focused on design exercises, an implication from this study is that a programme is similar to the drawing tool and can be used by several dispersed persons in construction. This is useful in investigating how programmes can support alternative forms of participation in collaborative construction work. In the same vein, Tryggestad *et al.* (2010) focused on objects in design that were circulated across actors in different sites and explored the effect of objects on a client's project goal. They reconstructed chains of past events using document trails to understand the relationship between objects (i.e., sketches, pictures, sculptures, and models) and client's goal. They analysed the accounts of various actors involved in the construction of a skyscraper 'the turning Torso' who used the objects to communicate and negotiate design ambitions through repeated trials. Their analysis showed that the design of the

turning torso developed as a result of the involvement of people and changes to the clients' design goal. They claim that objects perform an active role in mediating and resolving tensions between aesthetic and functional interests of the different and dispersed actors. An implication from this study is that programmes are similar to the circulated objects and may be used to actively involve or resolve tension of dispersed actors with different interests and change construction goals. This is useful as the project-based nature of construction work means that it involves interaction of individuals who are geographically and temporally dispersed.

It can be seen from the above-mentioned studies that these authors assume that drawing tools, artefacts or objects can be used to represent, share, or circulate design inputs or goals to dispersed people in different projects. These authors explored how different localised or dispersed groups used different tools in different setting and argue that the use of tools enable participants or actors that are dispersed to communicate design inputs, make design changes, and become more actively involved. These studies imply that investigating the use of programmes in this research offers insights on the role of programmes in enabling people in construction projects that are localised or dispersed to communicate inputs, make construction changes, and become more actively involved in resolving tensions. These three dominant arguments on the use of tools contribute to this research by drawing the implication that planning tools such as programmes can be used to represent different aspects of a project or process and investigating the use of programmes is useful in understanding how localised or dispersed participants or actors might become more actively involved every day and in specific incidents such as delays in the context of a construction project. The section that follows builds on the interpretivist literature on the use of tools and provides a review of the interpretivist literature on the use of programmes that adopts the modern project management approach.

2.5.2 Modern project management approach to programmes

In contrast to positivists discussions on programme that focused on a mathematical or technical approach to programmes and programming, this section reviews non-technical approaches described by Stretton (2007) as the modern management approach . This approach focusses on people, groups, processes, and the use of programmes in a specific context. Two distinct approaches have been used to study programmes namely: Actor-network approach and boundary object approach. The actor network approach assumes that processes involving non-human/human actors (including programmes) are fluid or open and explores the use of programmes in shaping the outcome of design work or building work. The second approach

assumes that programmes inhabit diverse social worlds and explore their role in coordinating different work groups. The contribution of these approaches lies in the insights which it offers on how distinct project group engage with programmes with a situated response to specific delays.

2.5.2.1 The use of programmes to actively shape work processes

Studies on tools such as programmes often limit their analysis to activities at the conceptual phase of projects and effectively explore the production of designs (similar focus on designs in section 2.5). An example of a design based study can be seen in the study on visual materials by (Whyte *et al.*, 2007). They adopted Actor network theory to compare the way programmes were used by groups in a component manufacturing firm with models/ drawings in another firm and discovered time related changes associated with programme use. They claim that programmes are treated as fixed or changing when used collectively to coordinate work and, changes determine the rate and way in which knowledge develops in interactions. The implication is that investigating programme use in construction can help provide a detailed understanding of how programmes are treated in events of delay and whether the way they are treated impact the rate and way in which design develops in a project. In contrast to a focus on design, Tryggestad *et al.* (2013) explored how programmes and the survival of frogs shape interests, stakeholders and temporalities on a building project. They adopted Actor network theory and analysed the emergence of temporalities i.e., conceptions of time connected to human, frogs (non-human stakeholders), and interests. They observed that the project developer had a challenge aligning two different programmes since the programme of the project is linearly structured, but frogs live in cycles and managing the frogs meant that a different temporality (cyclical) be considered such that a special time programme was constructed for them. They claim that project temporalities can multiply in interaction with programmes and the emergence of new non-human stakeholders. These studies show that programme use often changes when collectively used in design or building work and these changes develop in a project during interactions that includes aligning the temporalities of different stakeholders. However, the above studies fail to explore in-depth programme use by different people in interpreting or responding to specific events such as delays.

A major limitation of the Actor network approach is that objects or tools are attributed equal agency to people by virtue of their position within a network. This approach obscures the degree and priority of agency between human actors or non-human actors when managing time and considers objects such as programmes as actors that have the capacity to shape the outcome of

processes or settings involving different professionals as opposed to people shaping processes based on decisions and the way objects or tools are used in a local environment to manage time. This is the reason that Actor network theory is rejected in favour of boundary object approach. The discussions that follow presents a theoretical section that reviews literature on boundary work and programmes as boundary objects as the theoretical framework that is adopted in this research.

2.6 Theoretical framework for analysis

This section concludes this chapter with a theoretical literature that discusses two aspects: first, a discussion of the literature on boundary work in construction projects (regarded as temporary organisations) that often involves tension between people or groups. The aim is to underline the role programmes play or do not play in construction work that often involves different people, groups or firms with conflicting interests or priorities. Second, a discussion of the theoretical literature on the boundary object approach to programmes as the theoretical framework for analysing how distinct project groups engage with a programme every day and in specific delay incidents.

2.6.1 Tension in boundary work and the temporary nature of projects

Tension is inherent in construction projects that involves temporary and multiple teams. This tension in temporary and multiple teams has been described as boundary work in literature and adopt an interpretivist approach. Two arguments dominate the discussions on boundary work: first, some authors assume that members in projects can adjust tasks or processes of organising to linear or cyclic perceptions of time as a basis of social relations and examine how time is managed within and across different project groups. Lundin and Söderholm (1995) and Whyte and Nussbaum (2020) share this assumption and argue that transition with a disjuncture in time can be managed to ensure continuity across changing forms of organising . In contrast, other authors assume that work involving multiple teams leads to tension over power, roles and hierarchal relations and examine the governance structure and temporary practices of project teams. Van Marrewijk *et al.* (2016) and Stjerne *et al.* (2019) share this assumption and argue project actors or partners engage in temporary practices of harmonization and negotiation to resolve tension and ensure progression in projects.

The two dominant arguments contribute to this research by offering insights on how project groups might adjust tasks or processes of organising to linear or cyclical perceptions of time as a

basis of social relations and negotiate or resolve tension to ensure progress. For example, Lundin and Söderholm (1995) developed a framework of projects as temporary organizational settings. They used four concepts (time, task, team, and transition) to analyse the actions of temporary and permanent organisations or firms. Their analysis showed differences as permanent organizations are defined by goals rather than tasks, survival rather than time, working organization rather than team and production processes rather than transition. The creation of a project involved the introduction of boundaries in time, space, task, and who is to be involved. They claim the role of time in firms differs from projects (temporary organizations), as time is conceived as eternal in firms and temporary or running out in projects. In addition, time can be socially interpreted as linear in new forms of organising or cyclical in old forms of organising with repetitive actions. Social organisational processes adjust to linear or cyclical perception of time as a rationale for arranging social relations. This point is useful in investigating the perceptions of time and social relations in work of different project groups on a construction project. In the same way, Whyte and Nussbaum (2020) focused on temporary forms of organising and explored how project transition from a temporary form of organizing to a permanent or routine form of organizing. They interviewed managers on the role of artifacts in the transition of three megaprojects to gain new insight on how transition is accomplished. They found that transition involved boundary work when project ends and operations began, to ensure continuity across changing forms of organising and perceptions of time (linear or cyclical). This is useful in investigating transition and continuity when a project group delays in finishing their work, and another group begins their work on a project with different forms of organising and perceptions of time (linear or cyclical). They claim that transition involved the use of artifacts to share knowledge and manage the disjuncture over time to ensure continuity across changing forms of organizing. This is useful in investigating transition between groups and the use of programmes to share knowledge and manage disjuncture over time to ensure continuity across changing forms of organising. These studies assume that members in projects can adjust tasks or processes of organising to linear or cyclic perceptions of time as a basis of social relations and argue that transition with a disjuncture in time can be managed to ensure continuity across changing forms of organising.

In contrast to studies that focus on tasks or forms of organising, Van Marrewijk *et al.* (2016) focused on power and governance structure in projects and examined how project members establish order or maintain clear roles and harmonious relations in the face of conflict. They used observations and interviews to study the roles, relations and collaboration between principal and agent in a canal expansion project. They analysed conflict over roles and hierarchal relations of

the client and agent in the canal expansion project to understand how project members renegotiate power struggles in conflict. Their results showed that project members negotiate hierarchical relations in situ by engaging in a variety of collaborative practices, relational and talk aimed at harmonizing relations or contesting the emerging hierarchal relations. They claim that power struggles in conflict triggered project led partners to engage simultaneous practices of harmonization and contestation (conflict-ridden negotiations) over mutual roles and hierarchal relations in the everyday execution of the canal project. Although the role of a programme is not considered, this study is interesting and useful in exploring the way project groups engage in practices of harmonisation and negotiations over delay incidents in a project.

In the same way, Stjerne *et al.* (2019) focused on temporary norms or practices and examined temporary practices that project actors or partners utilise to resolve the temporary tensions arising from divergent understanding of time in an interorganizational project. This divergence is informed by temporary norms such as weekly meetings, programmes, budget periods and deadlines. They analysed interviews, observations, and documents and found three temporary practices (framing, synchronizing, and hyping) that project actors or partners used to resolve three temporary tensions rooted in organisational culture and routines namely: time horizon tension, pacing tension and continuity tension. They claim that project actors or partners used temporary practices to negotiate, resolve temporary tensions and ensure project progression. This is useful for this research in exploring temporary practices that distinct project groups enact and use to negotiate or resolve tensions due to delays to ensure project progression.

Earlier studies in this section that focus on temporary forms of organising in projects share similar assumptions with studies that focused on power and governance structure in projects. These studies assume that tension is inherent in projects with multiple groups and members can adjust tasks or processes of organising to linear or cyclic perceptions of time as a basis of social relations. These studies argue that boundary work and tension involving a disjuncture in time or struggle for power can be managed or negotiated to ensure progress or continuity across project groups with different forms of organising. These studies imply that investigating boundary work of construction and tension involving delays is useful to understand how project groups resolve or negotiate delays to ensure continuity across different forms of organising and perceptions of time (linear or cyclical) in a project. However, these studies do not explicitly explore the role of programmes in resolving tension. The section that follows builds on the discussions on tension in

boundary work or work involving temporary and multiple teams and presents a review of the boundary object approach on programmes as the theoretical framework for this research.

2.6.2 Coordinating disparate social worlds

This section focuses on studies that conceptualise programmes as boundary objects and projects to consist of disparate social worlds. This approach assumes that programmes mediates between the social worlds on a project and explores the role of programmes within and across diverse groups in different environments. Yakura (2002); Sapsed and Salter (2004); Chang *et al.* (2011); Chang *et al.* (2013) and Tillement and Hayes (2019) share this assumption and argue that programmes enables diverse members to visually capture interactions of work, negotiate interests at different levels and coordinate works. These studies offer insights on how programme use might enable diverse people or groups on a construction project negotiate and respond to delay incidents in different environments.

This approach is adopted as the theoretical framework in this research for analysis. The decision to adopt a boundary object approach as the theoretical framework for this research is because the boundary object theory emphasizes two aspects namely: action and cooperation in processes (Star, 2010). First, the programme as a boundary object is something project groups act on in delay incidents or use in response to incidents of delays. Secondly, the boundary object approach assumes that different project groups can cooperate and work together without total consensus.

The literature on programmes as boundary objects draws on an original study by Star and Griesemer (1989) on scientific work at a museum. They explored how diversity and cooperation coexisted in museum workers with a view to deal with the challenge of representation in intersecting social worlds. They analysed two activities in the museum: the method of standardisation and the use of boundary objects to understand how tensions in viewpoints were reconciled or how the interests of disparate social worlds were translated. This framework of analysis has been extended to studies on programmes based on Nandhakumar and Jones (2001) assumption that work practices can be decomposed into activities that could be standardised and performed by disparate groups.

Yakura (2002) is a key example of a study that adopted a boundary object approach. Yakura (2002) focused on programme use in information technology work and explored how programmes that are mono-temporal functioned in a context with diverse participating groups. The author observed consultants and a client interface with a programme for six months in a project that

involved installation and modification of a software package. The author adopted this approach to understand the role of programmes in dealing with the challenges of sustaining collective action and negotiating arrangements. The study identified four themes on the role of programmes: (1) basic functions of programming, (2) allocating and synchronising work activities, (3) creating multiple and divergent interpretations of time, (4) providing a locus for negotiation among groups. The author claim that programmes render time to be visible, concrete, and negotiable for participating groups to coordinate their work. The implication is that programmes can allow delays to be visible, concrete, and negotiable for project groups to coordinate a response. This is useful in this research to investigate how a diverse project group use a programme to render delays visible, concrete and negotiable for participating groups to coordinate every day and at specific incident.

In the same way, Sapsed and Salter (2004) focused on programme use in firms involved in information computing and analysed the role of integrated programmes in dispersed work of six managers at different locations in geographically dispersed projects. Unlike Yakura (2002), Sapsed and Salter (2004) interviewed managers confronted with relational difficulties associated with diversely located groups and observed that localised practices override global agreements. They argued that programmes are ineffective boundary objects with dispersed projects groups where there is lack of face-to-face interaction or clear lines of authority. This position counters Yakura (2002) argument and shows that programmes had limited functions in coordinating work of dispersed groups that do interact face to face. These studies show that programmes use plays a role in coordinating work of diverse participating groups either localised or dispersed and the absence of face-to-face interactions when using the programme was unproductive. The implication is that investigating how programmes function across localised and dispersed work groups in this research can help provide a better understanding of delayed projects even when there is a lack or reduced face-to-face interaction.

In contrast to studies that focus on programme use in information technology and computing work, Tillement and Hayes (2019) focused on programme use in fuel production at a nuclear processing plant and explored the role of a planned maintenance programme in interrelated activities of five worker groups. They used semi-structured interviews to analyse the views of five worker groups: managers, planners, maintenance supervisors, operators, and contractors on the role of programmes. Although internal programme practices in the contractor's department was not explored, the authors observed a relationship between maintenance and production in the

views. Their results showed that programme use enabled balanced decisions between what should be brought to light (visible) and what should remain hidden from view (invisible). They claim that programme use allows members of different social worlds to discuss and negotiate maintenance tasks that are critical for organising the plant under two aspects: interface management of work groups to enable cross department coordination and mindful organising that sustained diversity of viewpoints. The implication is that programmes use can enable balanced decisions between which delays should be brought to light (visible) and which delays should remain hidden from view (invisible). This is useful in this research to investigate how programmes can allow members of different firms to discuss and negotiate issues or tasks that are delayed to enable interorganisational coordination.

In the same way, Scarbrough *et al.* (2012) focused on programme use in the production of computer games and analysed the role of milestone programmes across different developer groups in the production of computer games. They used interviews and observations to understand the process of product design work by different developer groups. They observed that the milestone programme exhibited the capacity to represent and interrelate with other objects, that enabled groups respond to emerging aspects of the works and represent aspects of the work temporarily. This capacity has implications for this research as a programme can interrelate with other objects every day and in different incidents. They claim that milestone programmes support coordination under conditions of emergence and coordination of the practices of the different developer groups within a time limited process. These studies show that programme use enabled diverse work groups involved in production processes to negotiate tasks, decide on which task should be visible or invisible and coordinate their work practices across different departments under conditions of emergence. The implication in this research is that investigating the role of a programme across different groups in a construction project can help provide better understanding of members response with a programme to decide on which delays should be visible or invisible and delay events that involves coordination.

In contrast to studies that focus on programme use in production processes, Chang *et al.* (2011) focused on programme use in construction projects and explored the use of an integrated master programme (IMP) as a boundary object in a megaproject to address difficulties in collective sense making due to their complex nature. The authors interviewed project members; obtained documents and made observations to understand the role of IMP in temporary phases of eight projects i.e., beginning, middle and end phases. The interviews probed: how members trade off

timeline and project success, and how members manage milestones contributing to the project goal. The authors analysed data obtained within and across cases and identified two key themes on the role and outcome of IMP: first, IMP functioned at multiple levels and adjusted to multiple perceptions of times in four aspects (1) visual representation, (2) local adaption i.e., in four project groups (3) mapping the system and (4) project contract. Second, sensemaking outcome in three aspects: (1) facilitating shared understanding (2) negotiating project needs or challenges and (3) enabling multiple interpretations of project time. They claim that IMP enabled project groups to develop shared understanding of interactions or interdependencies and negotiate through multiple interpretations. The implication is that programmes can enable project groups to develop shared understanding of delays and negotiate through multiple interpretations. This is useful in this research to investigate how programmes function every day and in specific incident of delay at multiple levels and to make sense of specific delay incidents.

In the same way, Chang *et al.* (2013) focused on a megaproject and explored IMP use by members in the megaproject and data collection. Their interview focused on communication and time management to understand the role of IMP in the temporary phases of four projects. The authors analysed data obtained within and across the cases and identified four dominant themes on the role of IMP: (1) as visual objects representing the project (2) mapping the system i.e., project (3) creating shared understanding and (4) facilitating negotiation. They claim that IMP use enabled members to capture three aspects: (1) shared goals of the project system and sub-systems (or subproject) and bind them together, (2) to capture the evolution of projects as complex adaptive systems with smaller interdependent subsystems i.e., subprojects. (3) to capture multiple interactions of stakeholders interdependently working together as a visual outcome to guide in creating a shared understanding and negotiation in the project. This claim supports Chang *et al.* (2011) argument that IMP use enables members to develop shared understanding of interactions or interdependencies and negotiate through multiple interpretation in a project.

These studies show that programme use enabled project groups to capture interaction and interdependencies at multiple levels to guide in developing a shared understanding or negotiations. The implication is that investigating the role of programmes for project stakeholders in this research can help provide a better understanding on how professionals or firms at multiple levels can visually represent delays in a project, capture interaction and delays, map delays, create a share understanding of delays, depend on each other, facilitate negotiations on delays through multiple interpretations.

It can be seen that earlier studies that focus on programme use in information technology and production processes share similar assumptions with studies that focus on programme use in mega construction projects. These approaches in the studies focus on programme use in group work and assume that programmes can be used as a boundary object by diverse works groups from different social worlds to represent tasks, products, and work processes in different settings such as firms, plants, and projects. They explore the role of programmes within and across diverse participating groups in different environments and argue that programmes interrelate with other objects and enable localised and dispersed project groups at multiple levels to: visualise time as concrete or visible, develop multiple interpretations of project time (linear or cyclic), decide on what should be visible or invisible, develop shared understanding, capture interactions or interdependencies, negotiate through multiple interpretation, coordinate work under emerging conditions. However, these studies fail to explore in detail programme use every day and in events or incidents such as delays. These studies imply that investigating programme use in localised and dispersed project groups can provide a detailed understanding of how a programme that interfaces different project groups function every day and in an event of specific delays in a construction project. More specifically, these studies raise the following questions: What role do programmes play in specific delays incidents within and across diverse participating groups in different environments? How do project groups render or construct delays? Do project groups develop multiple interpretations of a delay in specific incidents? How do project groups decide on which delay should be visible or invisible in an incident? How do project groups develop shared understanding in events of delay? How do project groups capture delays and interactions or interdependencies in events of delays? How do project groups use programme to negotiate through multiple interpretations of a delay? How do project groups coordinate work and respond when there is a delay incident? The section that follows introduces the boundary object approach as the theoretical framework adopted in this research for analysing how distinct project groups engage with a programme in delay incidents.

2.6.3 Summary section of framework

This research adopts boundary object theory and a qualitative research approach. Although there are interpretivist studies on programmes, the discussion has mainly been on coordinating work with a limited understanding of what happens every day and in specific delay events or incidents.

The application of boundary object theory in this research offers to take into account programme use every day and what happens in specific events or incidents such as delay in a construction

project rather than focusing on the technical aspects of a programme. The advantages of this theory based on the above reviews on programme use is that the boundary object approach focuses on five mechanisms that can play out in different settings to guide in analysing the dynamics involved in project groups response to specific delay incidents. These mechanisms include visual capture, locus of negotiation, vehicle for communication, instrument of coordination and share understanding.

A boundary object approach assumes that programmes mediate between social worlds or communities of practice and are plastic enough to adapt to local needs of project groups or environments and the constraints of several groups using it, yet robust enough to maintain a common identity across sites. In addition, programmes as boundary objects have interpretive flexibility i.e. they have different meanings in different social worlds, but their structure is common enough to more than one world to make them recognizable, a mean of translation.

A focus on a programme as an object that inhabits disparate social worlds of a construction project or site sheds light on layers of interpretations from project members, decisions, negotiations with a programme in delay incidents and modes of use of the programme every day.

The underlying research question of how project groups engage with programmes is divided into six empirical questions to be explored in project meetings sessions, after meeting sessions, through email correspondences as follows:

1. How is time constructed in programmes within and across project cases as a basis of relations between project groups?
2. How do project group engage with a programme and, do modes of engagement vary across incidents and cases?
3. What role do programmes play in a project with different project groups?
4. How do project groups interpret delays and, does this vary across incidents and cases?
5. How do project groups respond when confronted with delay and, does this vary across incidents and cases?
6. How do project groups engage with a programme in a delay incident, and does it vary across incidents and between cases?

These objectives will be pursued when investigating case projects to obtain relevant contextual description and data from naturally occurring delay events or incidents. Figure 2.1 presents the model that informs the empirical investigation of the study. Issues related to the way interacting project groups manage time are often complex and multi-dimensional. The research objectives

seek to unravel these complex issues at a micro level and offers important insights that can stimulate better interactions for researchers or practitioners that use programmes in collaborative work or construction settings. The way programmes are used (every day and during incidents of delay) and it's potential to support interactions between social groups in construction projects forms the focus of the empirical investigation of this research.

Four key concepts have been selected as the framework for this research namely: (1) the main social groups on a project, (2) the programme (as a boundary object) that mediates the interacting project groups, (3) delay incidents and (4) the mechanisms (five) at play as project groups engage with a programme for boundary exchange. The mechanisms include: (1) visual capture, (2) locus of negotiation, (3) vehicle for communication, (4) instrument of coordination and (5) shared understanding (See figure 2.1). These concepts emanate from relevant literature on the role of a programme in occupational communities.

The interacting project groups to be considered include a client, a contractor, subcontractors, and material/ labour supplier. The individuals or teams on a project to be considered as belonging to the same social group include members from the same organization. For example, the client in figure 2.2 is considered as social group 1, the contractor is considered as social group 2 and two subcontractors are considered as social groups 3 and 4. The five mechanisms selected in the framework would be considered at different events or incidents of delay at a micro level. A focus on specific incidents of delays offers rich contextual description on the mechanisms at play as project groups engage a programme and shifts the empirical investigation in this research from a macro level to a micro level analysis with a trail on the people involved in specific locations, at specific dates and at distinct times. The nature of boundary objects to be considered are versions of the programme used and shared by (1) the client and the contractor, (2) the contractor and the subcontractors, or (3) the subcontractor and the material/ labour supplier that basically comprises of a start date, a duration, and a finish date. The delay incidents or events to be considered would be marked by issue(s) that led to a specific incident, the responses of participants involved to the incident, and changes made to address that delay incidents. By utilizing these concepts of the framework in figure 2.1, this research illuminates the complex issues that unfold as interacting project groups engage with a programme as a boundary object every day and during incidents of delay.

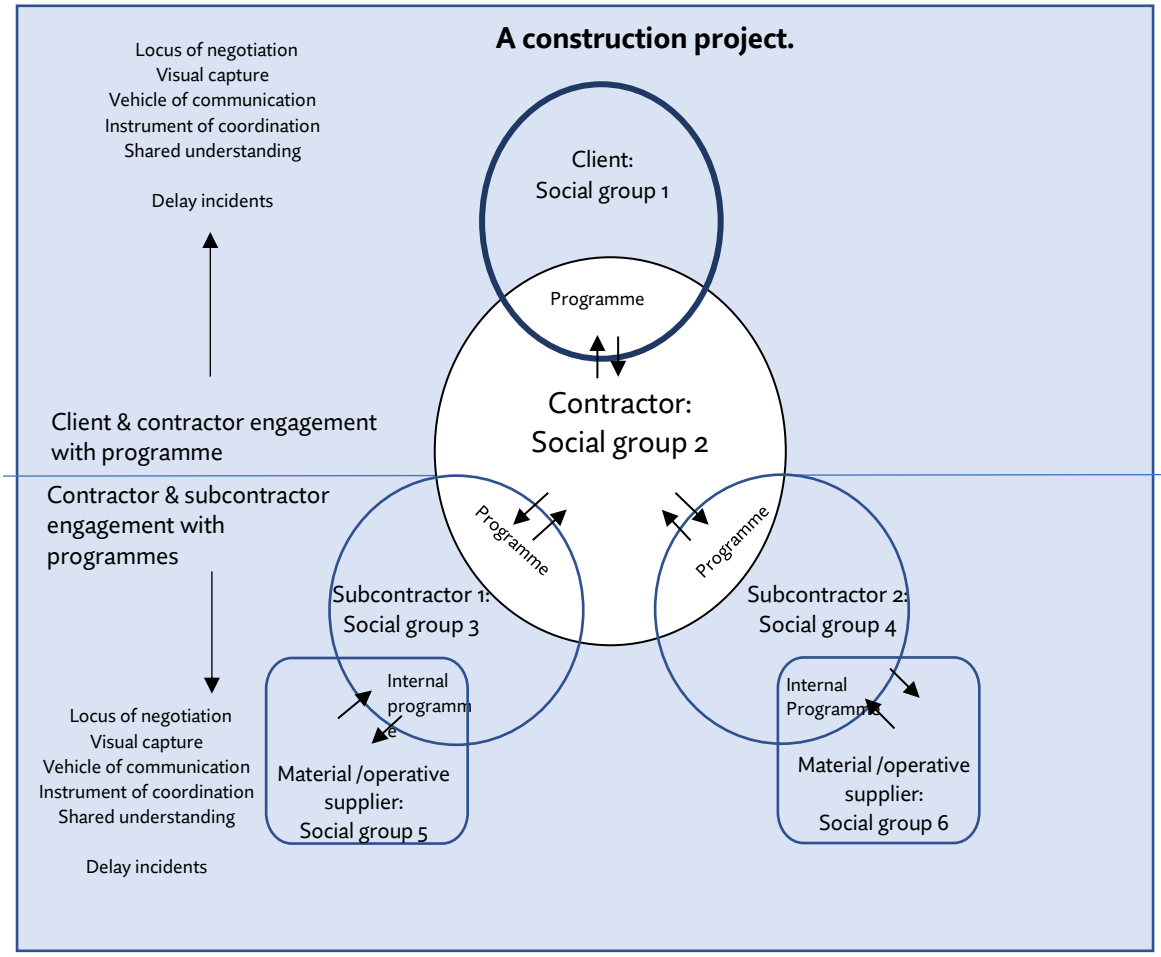


Figure 2: 1 Diagram illustrating interacting social worlds (project groups) on a project

Chapter three: Research design

3.1 Introduction

The previous chapter presented a review of literatures on planning tools, programme use and delays and introduced the theoretical framework used in this research. This chapter presents the research design adopted in gathering data and is structured in six sections: the first part briefly discusses the research approach. The aim is to justify the ethnographic approach that was used, the second part offers a discussion of the sampling approach adopted and includes the background of one London case and two Southeast cases selected for this research, the third part discusses the method used in this research to obtain data, the fourth part offers a discussion of the data analysis that compares the cases, the fifth part discusses the limitation of the research design, the sixth part discusses the ethical considerations involved in doing this research. The section that follows introduces the research strategy and approach.

3.2 Overall research process

The overall strategy adopted in this research is a comparative case study method that explores and analyses at a micro level the similarities, differences, and patterns across three selected case projects that share a common focus of how a programme functions in the everyday coordination of project groups around delay incidents. According to Bazeley (2020) comparing cases is an established approach in literature that deepens our knowledge or sensitivity to data by exploring the similarities or differences across cases and noting patterns, issues or behaviours with the aid of matrix or tabular display. This strategy was chosen because it is useful in analysing and understanding the mechanisms between small groups in face-to-face interactions in small settings.

3.3 Research approach

This research adopted a qualitative and ethnographic approach that involved three case projects, observations, interviews, and document analysis. This approach was chosen because qualitative research addresses "how questions" (Pratt, 2009). According to Maxwell (2012) qualitative research is useful in understanding the meaning, context of a phenomena studied, and particular events or processes that make up these phenomena over time in a natural setting. This supported a research approach that focuses on project groups; engaging with a programme, interpretation of programmes, the meaning of delays in specific incidents and the context of a construction project as the setting.

A qualitative and ethnographic approach is appropriate for the problem of this research as multiple contexts were examined and the meaning of delays from different groups were explored. According to Fossey *et al.* (2002), a qualitative approach provides detailed accounts on the processes of communication and patterns of social interactions within social groups. This also informed a research approach that focuses on detailed accounts of the processes of communication between project members and patterns of social interaction with a programme within project groups on a construction site.

There are several designs in qualitative research, however, a key benefit of an ethnographic approach, according to Shah and Corley (2006) is that people or social actions can be studied within the context of where it happens and data can be collected either through interviews or observations (Ball and Ormerod, 2000). This is an established approach in literature for looking at the problem of this research and informed a decision to investigate project groups every day, and at specific incidents where it happens within the context of ongoing construction projects. This approach involved the use of observations, collecting documents, and conducting formal or informal interviews.

One methodological assumption about doing ethnographic research is that researchers study social action or phenomenon from inside (Bourke, 2014). Therefore, to explore delays, I decided to be immersed in selected construction projects and take the view of an insider. This condition was necessary for me to be able to think in the symbols or words used by data subjects. Within Construction Management Research, this immersed approach aligns with prior ethnographic studies by authors such as Laryea and Hughes (2010) in bidding firms, Pink *et al.* (2010) in a construction project, Adamson and Holloway (2012) in funeral meetings, Shipton (2013) in a hospital project, Fellows *et al.* (2021) in construction sites to study different phenomenon. These ethnographic studies involved making decisions on gaining access, positionality, developing accounts and ethics to gain insights in different contexts which shaped the data obtained in the London and southeast cases selected for this research. The discussion that follows discusses the approach used to sample case projects investigated in this research.

3.4 Sampling

Three cases were selected for analysis in this research. One case in London that involved the recladding of a building project and two road network improvement projects in southeast England. The cases were selected because each type of construction project had a defined scope of works that would potentially exhibit different characteristics that are useful in understanding

intrinsic aspects of how distinct project groups engaged with a programme around delay incidents. Six vignettes were selected for analysis in this research to allow for a comparison within and across the three cases. Four vignettes in the London case involving four different buildings were selected and two vignettes in the Southeast case involving different road projects were selected for analysis. The four vignettes in the London case were selected for two reasons. The first reason is that the main contractor hired two distinct subcontractors i.e., firms that would potentially exhibit different mechanisms in the way the worked as a group that are useful in understanding intrinsic aspects of how distinct project groups engaged with a programme around delay incidents. The second reason that the four vignettes in the London case was selected was to allow for an even comparison of the recladding works executed by the subcontractors. This is because one subcontractor only executed the recladding of two buildings out of a total of eleven buildings. The two vignettes in the Southeast case were also selected for two reasons. The first reason is that the main contractor hired two distinct subcontractors i.e., firms on two different road projects that would potentially exhibit different mechanisms in the way the worked as a group that are also useful in understanding intrinsic aspects of how distinct project groups engaged with a programme around delay incidents. The second reason that the two vignettes were selected was also to allow for an even comparison. This is because the main contractor executed multiple road projects in Southeast England for the client that involved several subcontractors.

Two major criteria were used to select construction projects in the UK for investigation. The first criteria considered was that the projects were ongoing building or civil engineering projects which aligns with the unit of analysis of this research. The second criteria considered was that the projects involved a range of construction professionals from different firms that all used a programme in executing the project. This was important because in order to study delays and how project groups engaged with or without a programme, project members from different firms needed to be on the construction project. A building project located in London and two road projects located in Southeast England were selected with the assistance of a project manager and commercial manager respectively on those projects who I knew (see below for details). Then after a confirmation of access and a reflection on the characteristics of the project, the three projects were adopted for the research.

The building project in London involved recladding works and was adopted because it involved over 15 construction professionals from five different firms: a contractor, two subcontractors,

suppliers, project consultants, equipment providers and a client that used a set of programmes to execute the recladding works. I had no experience in recladding projects, but I knew that there would be plenty of delay incidents to investigate. Other important criteria used to select the recladding project is the setting of site offices and a meeting room on the construction site which eased the accessibility to meetings, construction professionals, and follow up conversations. The stage of the recladding process was also a criterion used to select the recladding project because the recladding of several buildings had not commenced, while a few buildings were completed. The location of London was another criterion used to select the recladding project as it took me a travel time of 1 hour 11 minutes using the underground trains to access or visit the project site. The location of the recladding project fitted with the resources available for the project.

The Southeast cases involved a safety improvement project and a drainage remedial project. These road projects were selected because they involved over 9 construction professionals from four firms; the contractor, two subcontractors, line-marking contractors, traffic contractor and a client that used programmes to execute the two road projects. I had no experience in road projects, but I knew that there would be plenty of delay incidents to investigate on the two road projects. The stages of the safety improvement and drainage projects was a criterion used to select the two road projects as they had just commenced. The location of Southeast England was another a criterion used to select the road projects as it took me a travel time of 30 minutes on the train to access the safety improvement project and it took me 2 hours on the bus to access the drainage remedial project. The location of the road projects fitted with the resources available for the project as relocating to Southeast England would have proven to be too costly. These criteria were used to select the three case projects because ethnographic research is typically resource intensive.

3.4.1 Background of the three case projects

The research was carried out on project groups at the construction sites in London and Southeast England that were designed before commencing and involved different phases. The case project in London involved the recladding of 11 multistorey buildings and was required for the safety of residents after a major fire incident occurred in England. The recladding process involved four steps namely: (1) the removal of existing ACM (aluminum composite material) panels, (2) the installation of a new EPDM rubber (ethylene propylene diene monomer) on the frame or carrier system, (3) the installation of fire barriers with insulation, and (4) the installation of new aluminum panels. The recladding of the 11 multistorey building was funded by a housing authority. At the

start of the field work, the recladding project was in the twelfth month of an overall programme that spanned 2 years and 28 weeks using a JCT form of contract. The recladding of the 11 multistorey building was staggered because of residents living in the buildings and was arranged to start in the following order block: J, H, D, C, B, G, F, E, A, K1 and K2. A consultant was appointed by the housing authority for the duration of the recladding project.

The two projects in southeast England were required for the safety of residents that live adjacent to two different roads in two different towns. The first road project in southeast England involved safety improvement works that was broken into four major steps: (1) the relocation of utility services, (2) the widening of the carriageway of a road, (3) the construction of a traffic island and (4) the full reconstruction of a footway. The first road project was funded by a local county council in Southeast England. At the start of the field work, the safety improvement project was in the fourth week of the programme that was spanning 7 weeks using a New Engineering Contract (NEC) 3 option A alongside a service contract. The second road project in Southeast England involved a drainage remedial work that was broken into three steps: (1) the excavation and installation of new catch pits, soak-aways and precast chambers, (2) the connection of the installed drainage items with carrier pipes, (3) the reinstatement of footways and verge areas. The second road project was funded by the same local county council in southeast England. At the start of the field work, the drainage remedial project was in the first week of the programme that was spanning 3 weeks using a NEC 3 option A alongside a service contract. The differences in character of the case projects selected such as the type of construction and contract allowed for a comparison on how distinct project groups engaged with a programme to respond to specific incidents of delays. The section that follows describes the method adopted in this research for data collection in the case projects.

3.5 Data Collection

This section describes the method used to gain access to the case projects in London and Southeast England to collect data. The description is divided into six sections namely: getting into each case, getting started, observations, interviews, documents/records and leaving each case project.

3.5.1 London case

This section describes decisions taken during the field work to gain access into the London case to collect data.

3.5.1.1 Getting into the London case:

The research carried out on the case project in London was for a period of 13 months. I became aware of the recladding project through the project manager, a post graduate student at the University of Reading who was working at the time with the contractor, and this provided an important research opportunity. My familiarity with the project manager of the contractor's firm gave me a point of ethnographic access on which I began to build rapport and relationships with other project members on the recladding project.

After making calls to the project manager, we met to talk, and he agreed to speak to his director of his firm to see if he would allow me to carry out some research on the recladding project. At this point, I prepared consent forms and a research information summary sheet that outlined the research aim and what the research entailed and emailed it to the project manager who used it to explain to his director. Immediately it was confirmed that the director had no issues with the summary sheet, the project manager provided me with the site address and a date to meet face to face to discuss more details about the research. In this regard, the project manager played an important 'gatekeeper' role by allowing me into the recladding project to which I would have had no, or a very slim chance of accessing.

The project manager on the recladding project held a prominent position on the recladding project. When I began to negotiate access to the site for the recladding project, he had just been in the position of project manager for 4 months. His position assisted with access to the recladding project and influenced the receptive attitude of some project members towards me, during my field work and interviews.

The project manager facilitated the initial access to the recladding project and then invited me to visit the project office on site to meet four project members face-to-face to discuss the details of the research as contained in the information sheet and consent forms. First, I met the project manager and we discussed for 30-minute. Second, the project manager introduced me to the operation manager, and we talked for another 30-minutes. Third, the project manager introduced me to the contract manager and director, and we had a brief discussion. The meetings were friendly and revolved around what I wanted to research on, the history of the recladding process. At the end of the meetings, the project manager said the director and project members were happy for me to start coming to the project site and for progress meetings. He gave me a tour around the 11 multistorey buildings on the project site. After this initial visit, the project manager sent an email to confirm that they have all agreed to support the research.

I visited the project site after receiving the email and the project manager assigned me a desk in his office that he shared with the site manager and an assistant site manager. The project manager introduced me to other staff on the site and arranged with an assistant site manager/ temporary works supervisor to give me a site induction to ensure I was fully informed about the organisation, the operation of the site and safety requirements. The assistant site manager/ temporary work supervisor concluded the induction and registered me on their fingerprint biometric clocking system so that I could clock in when I came to the office in the morning and clock out when I was leaving in the evening.

The project manager introduced me to project members at the beginning of weekly project meetings as a researcher with an observer status. Based on this position of access to the project, project members involved in the recladding project initially saw me as someone who was linked to the project manager and the contractor's firm. This was partly because, the project manager initially introduced me to them. However, during the project, introductions no longer became necessary in weekly project meetings as rapports was built with members and this rapport was useful in obtaining project documents on the 11 buildings and arranging interviews. This mediating role played by the project manager was similarly observed in Pink *et al.* (2010) when a friendly worker mediated the researcher's presence in order for the researcher to gain the trust of site workers in a construction site. This friendly worker introduced and vouched for the researcher occasionally to site workers during window installations to understand the manner in which migrant construction workers communicated. The assistance of the project manager as a mediator was key in building rapport and this rapport was useful in understanding the modes of engagement with the programme.

3.5.1.2 Getting started and participating in the London case

The plan was to observe how project groups engaged with or without a programme for a couple of months, however participating in the recladding project lasted for 13 months. During this time, observations were carried out, past records on minutes/programmes were obtained from February 2019 to March 2020, interviews were conducted, and additional records from July 2020 to February 2021 were obtained. The initial 2 months was conducted at the project site with some time spent at the office and in progress meetings. Subsequent months involved virtual observations of weekly project meetings on Microsoft teams due to the outbreak of the COVID-19 pandemic and email exchanges or correspondences.

As I did not have a formal role on the recladding project, my time was mostly spent observing project meetings, taking notes, receiving emails exchanged between the participants and generally being present when they were doing their work.

While I was present at the project site and not attending meetings, I spent some of my time studying programmes or equipment layout on site and asking those present in the office questions which I followed up in emails. This is consistent with ethnographic traditions in trying to speak to as many people as possible (Fetterman, 1998; Delamont, 2004). Before and after meetings provided me the opportunity to talk to some members of the project team and briefly discuss actions and delay events that happened in the past. These brief discussions and emails according to Marcus (1995) is a solicited method of developing accounts during observations that involved probing, informally asking questions, or having informal conversations that are useful in understanding frequently spoken words and phrases . The section that follows describes three sources of data obtained during the field work in the London case.

3.5.1.3 Physical observations on site

The first source of data collected during the field work was physical observation. In ethnographic research, the researcher is the instrument of data collection and data is shaped by the way a researcher positions himself or herself in relation to data subjects in a field (Bourke, 2014). My role in the London case project was an observer who according to Kawulich (2005) is a researcher who is not a member but present in group activities to collect data. I took pictures, short notes, jottings of phrases and issues of interest on a notebook as observation notes and later developed it into a thick empirical description to narrate how project groups engaged with or without the programme when confronted with specific delays in each block. Three aspects were the focus of the observations in the London case project: first, moments and modes that the project team engaged with or without the programme in meetings, after meetings, prior to meetings in email exchanges or correspondences (showing who discussed with whom). Second, the progress of the recladding process on each block: onsite, discussed at meetings, recorded on the programme, or reported in email exchanges or correspondences. Third, moments that specific delay events or incidents were reported or discussed in the meetings, mentioned in emails exchanges or correspondence, and recorded on the programme. My observation notes also covered distinct decisions in project meetings when members of the project team engaged with each other and used the programme. These observations contributed to developing the stories of how the programme that interfaced distinct project groups functioned in specific delay incidents.

Prior to the outbreak of the pandemic, my note taking during the weekly meetings was unnoticeable as everyone else who attended the meeting also made notes. After meetings, I reflected on what I observed to determine the relationship with the three aspects and issues of interest. In total, 4 days of physical observations was documented in the London case project that involved 2 project meetings from February 2020 to March 2020. The section that follows describes how data was collected through digital or visual observations at the recladding project in London.

3.5.1.4 Digital/ visual observations of progress meetings

This section describes how the ethnographic approach was adapted with digital or visual methods to obtain data in the London case project which have been described by Ardévol (2012) and Pink (2012) as virtual or visual ethnography due to COVID-19 and the introduction of internet technology.

The recladding works at the London case project stopped temporarily from March 2020 to June 2020 due to COVID-19 and a UK nationwide lockdown. I did not anticipate that I would need to attend/ observe project meetings virtually. However, as the outbreak of the COVID-19 pandemic restricted human contact and project meetings, it became necessary to explore alternative ways to progress the research observations. I emailed the project manager to ask about the project and he confirmed that they would resume progress meetings virtually on the 3rd July 2020 instead of physically on site. I asked for permission to attend meetings virtually and he confirmed via email that they are happy for me to attend. He instructed a project member to email me meeting invitations (Microsoft Team links) every week which he did from July 2020 to February 2021 to connect virtually. I attended weekly progress meetings remotely and the project manager copied me into emails exchanged that had recent programmes attached between project team members.

At the first virtual meeting, the project manager introduced me again to project members at the beginning of the virtual meeting as a researcher with an observer status and they said greetings. I knew most of those faces in meetings prior to the lockdown and built rapports with them. When meetings began, I took observation notes differently as online observations involved watching text and images on the computer screen rather than watching people directly. This form of participation required listening closely most times and doing observations quietly like someone who was lurking. This is a common issue with online ethnographers who study online phenomena by lurking (Garcia *et al.*, 2009). According to Murthy (2008) the presence of a researcher in a virtual

field site is often viewed as physically invisible. However, at the end of virtual meetings, the project manager asked me if I had any question to check whether I was still with them.

After virtual meetings, I later developed the observation notes relevant to specific incidents of delay. A difference between the physical and virtual was difficulties in accounting for non-verbal aspects of communication such as facial expressions and body language (Garcia *et al.*, 2009). In total, 55.8 hours of online observation was documented in the London case project that involved 28 virtual project meetings spanning from July 2020 to February 2021. Murthy (2008) argues that balancing a combination of a physical and digital ethnography demarginalizes the voice of participants and gives a variety of ways to tell a story. This is because the accounts from online methods of observation adopted was limited in the amount of non-verbal means of communications and at the same time very comprehensive. The section that follows describes how additional data was obtained through online interviews.

3.5.1.5 Online interviews with project members in the London case

Towards the end of the observations in the London case, I started to arrange and carried out online interviews with relevant members of the project team who engaged with the programme in daily operations and project meetings. Initially, I did not anticipate that I would need to do interviews remotely. However, as the field work progressed, it became apparent that specific incidents of delay discussed in meetings and reported in email exchanges needed to be probed further to trace who else was involved, the chain of events and to understand in detail how project groups interacted with the programme and each other. In total, I carried out 12 online interviews in the London case with project members from three different firms as follows: six interviews with project members from the contractor's firm namely: operations manager, project manager, contract manager, assistant site manager/ temporary works supervisor, quantity surveyor and design coordinator. Four interviews with project members from one subcontractor firm namely: the site manager, the design and logistic manager, the London branch manager. Two interviews with project members from another subcontractor firm namely: the construction director and the site project manager. The adoption of online ethnographic interviews was similarly used by Fellows *et al.* (2021) to overcome the obstacles of the pandemic and explore the work of informal interpreters on construction sites. The online interviews adapted in this research were useful in overcoming restrictions to project members during the pandemic who were dispersed in locations and away from the project site.

Questions of interest included: how did you find out there was a delay on a block? What issues led to specific delays incident recorded, reported, or discussed in meetings? How did the specific delay incident reported or discussed affect you or your work? What did you do as a response to that delay incident? Who was involved in how you responded to this delay incident? How did you go about fixing it? What happened after you got involved in the delay incident? Other questions of interest include was the programme revised due to a specific delay incident? Were you involved in revising the programme for specific delay incidents? What did you do when you revised the programme? Who else was involved in revising the programme? How did your firm or team respond to conflicts in a programme?

For some of the project members, I had limited access to during the field work and so the interviews were very useful in gaining insights on their experiences in delay incidents and team engagement with the programme. For individuals that I already had access to during the fieldwork, the interviews helped to provide additional insights into events or incidents of delays in the past and their experience. This yielded a richer empirical account on the process involved in dealing with specific incidents as Ricoeur (1984) stated that stories in interviews describe sequence of actions that reveal hidden aspects of situations and people involved.

Arranging with participants to participate in interviews was facilitated by the project manager, although some participants did not respond to emails partly because they were too busy. Some studies present getting access as an event where permission is obtained formally at the beginning of the field research process. However, this view is misleading as indicated by Laryea and Hughes (2011). Their study shows that gaining access is a process that involves negotiating permission with firms or organisations at several stages in the research. This approach was adopted in the London case as obtaining permission to observe people, actions in the recladding project was not a single event.

I found that majority of the interviews with project members were friendly, open, and provided interesting insights that resonated with the observations. One similarity between observations and interviews as identified by Phelps and Horman (2009) and Atkinson (2009) is the need to build rapport with the participants and part of the reason that participants were open in the interviews can be attributed to the mere fact that I had been meeting some of those faces regularly in meetings for several months. This agrees with Long and Johnson (2000) assertion that prolonged involvement enhances recognition and the discovery of rich insights. In addition, assurances of confidentiality and anonymity were promised to participants that encouraged

participants to talk about sensitive matters associated with incidents of delay that involved other project members.

To summarise, the interviews discussed above provided rich data on what to reflect and make sense of the data being collected through observation.

3.5.1.6 Documents and records obtained in the London case

The third source of data collected during the field work were printed and electronic documents of eight types namely: (1) minutes of past weekly progress meetings, (2) minutes of weekly worksheet from forecast meetings, (3) past programmes, (4) past labour levels, (5) current programmes, (6) current worksheets of forecast meetings, (7) current minutes of progress meetings and (8) email exchanges. From the beginning of the field work, I started assembling printed documents received such as the site plan of the project site, recent minutes of meetings attended and studied the layouts of equipment for each block on the recladding project. However, after two months of observation, it became apparent that specific incidents of delay evidenced on the recladding project and discussed in meetings needed to be studied further to trace and understand the chain of events. My familiarity with the project manager gave me a point of access to the electronic documents/records. I contacted the project manager via email, and he confirmed that he is happy to provide these documents and he referred me to the operations manager who kept electronic records of the recladding project. I contacted the operations manager and immediately it was confirmed that permission has been granted, he provided me with electronic versions of the documents. In this regard, the project manager played another important role as a mediator by allowing me to access the past document records of the recladding project to which I would have had no, or a very slim chance of accessing.

Four aspects were of interest in the documents: first, the project background information, developments, changes in the recladding project over time and processes of working by the project teams. These aspects were highlighted in Bowen (2009) as a primary purpose of documents in providing information or context. Second, historical context of past delay incidents or events, historical roots of issues that led to specific delays and conditions surrounding how project groups engaged with the programme. Third, past decisions, past agreements between project members, past actions, and the consequences. Fourth, unclear phrases, issues on specific interest that generated questions for interviews.

The time span of the documents (electronic) obtained prior to the UK nationwide lockdown was as follows: first, the minutes of past weekly progress meetings spanned from 22nd May 2019 to 13th March 2020. Second, the weekly worksheet minutes of forecast meetings (4th October 2019 to 19th March 2020), past programmes (4th April 2019 to 20th March 2020) including past drafts programmes, and past labour levels (1st September 2019 to 14th November 2020). When site operations resumed after the outbreak of the pandemic and associated lockdown, I continued to receive electronic records of current programmes, minutes, worksheets of forecasts and email correspondence from (17th July 2020 to 23rd February 2021). This was made possible by the project manager who copied me into email exchanges between the project teams that had attached progress programmes showing modifications of the programme. The section that follows describes the process of leaving the recladding project.

3.5.1.7 Leaving the London case

The process of exiting ethnographic research has not been discussed extensively as compared to gaining access. This is partly because researchers exit or leave the field for various reasons (Troman *et al.*, 2005). These reasons include economic limitations, continuously observing similar or repeated practices and when it is no longer practicable to obtain more data.

Two months before the end of the observations and after conducting 12 interviews, it became apparent that no new project member cared to respond to reminders to participate. 10 out of the 11 blocks had been completed with the last block, (block A) having 40% of recladding works remaining. I thanked the project manager and informed him that I would be concluding the research when the recladding works finished. He advised that I should stay in touch, and feel free to contact them or visit at any point if I had any questions. He informed project members at the next virtual meeting, and I thanked the attendees for their support for my research. Many of the participants also encouraged me to keep in touch and assured me that I could contact them as and when required. Immediately block A was 100% complete, they stopped sending me online invitations to attend project meetings in March 2021. The section that follows describes the approach adopted in the two road projects in Southeast England.

3.5.2 Southeast cases

This section describes decisions taken during the field work to gain access and collect data in the two road projects in Southeast England.

3.5.2.1 Getting into the Southeast cases:

The research carried out on two road projects in different towns in Southeast England was for a period of 5 months. My familiarity with the commercial director in the contractor's firm gave me a point of ethnographic access on which I began to build rapport and relationships with other construction professionals especially with the project managers on the two road projects.
I became aware of the road projects through the commercial director who an alumnus of the University of Reading. He was working with the contractor at that time, and this provided an important research opportunity. After calling the commercial director, we met to discuss my research and he agreed to speak to the director of his firm and some project managers to see if they would allow me to carry out some research. At this point, I prepared consent forms and a research information summary sheet that outlined the research aim and what the research entailed and sent it to the commercial director who used it to explain it to his director and the project managers. Immediately it was confirmed that they had no issues with the summary sheet, the commercial director sent me an email to confirm that they were happy to support my research. He provided me with the phone numbers of the project managers at the road projects to meet face-to-face to discuss more details about the research. In this regard, the commercial director played an important 'gatekeeper' role by allowing me into the road projects to which I would have had no, or a very slim chance of accessing.

The role of the commercial director on the road projects was a prominent position. He had been on that position on the road projects from inception, prior to when I began to negotiate access to the site for the road projects. His position assisted with access to the road projects and influenced the receptive attitude of some professionals towards me, during the field work and interviews.
After receiving the email and making calls to the project managers, I visited the sites of the road projects with my own personal protective equipment as they project managers instructed. We discussed the details of the research as contained in the information sheet and they two project managers at the different project sites agreed to support my research. They introduced me to the subcontractor on site to ensure I was fully informed about the project and the operation of the site. Based on this position of access to the road projects, participants involved in the road projects initially saw me as someone who was linked to the commercial director. This was partly because he initially introduced me to the project managers at the beginning as a research student. During the fieldwork, I built relationships with the project managers and this rapport was useful in obtaining project documents and arranging interviews.

3.5.2.2 Getting started and participating in the Southeast cases

The plan was to observe how project groups engaged with or without a programme for a couple of months, however participating in the road projects lasted for 5 months. During this time, observations were carried out on site, site diaries were studied, the head office of the contractor was visited, documents were obtained, and interviews were carried out. The office of the contractor firm was 2 hours away by train from the safety improvement project and 1 hour away by train from the drainage remedial project. The two road projects had different project managers and were 1 hour 50 minutes apart by bus. As I did not have a formal role on the two road projects, my time was mostly spent observing interactions of the project team, taking notes, and generally being present when they were doing their work.

3.5.2.3 Physical observations at the Southeast cases

The first source of data collected during the field work on the two road projects were observations. I took pictures, short notes, jottings of phrases and issues of interest on a notebook which I later developed into observation notes and then later into a thick empirical description that narrated how project groups engaged with or without a programme when confronted with specific delays. Three aspects were the focus of the observations in the road projects: first, moments and mode that the project team interacted with or without the programme in response to events or incidents. Second, the progress of the road projects. Third, moments that specific delay events or incidents were discussed onsite and how the project team responded. This approach in the field observations was similarly adopted by Pink *et al.* (2010) to examine the manner in which migrant construction workers communicated to coordinate curtain wall installations and showed that migrant construction workers mapped positions communicated in a manner that was informal and invisible. This was useful in this research in investigating informal and invisible modes of engaging with the programme to coordinate the road projects.

My observation notes also covered distinct decisions on site, how members of the project team engaged with each other on site. These observations contributed to developing the stories of how the programme that interfaced distinct project groups functioned in specific delay incidents. My note taking during field visits were done at regular intervals away from everyone else so that they do not feel uncomfortable. After the field visit, I reflected on what I observed to determine the relationship with the three aspects and issues of interest. In total, I made six field visits from November 2019 to February 2020 to the two road projects-three to each road project. The section that follows describes how data was collected through interviews.

3.5.2.4 Online interviews with project members in the Southeast cases

At the end of the two road projects, I started to arrange and carried out interviews with relevant members of the project team who were involved in daily operations or engaged with the programme. I did not anticipate that I would need to do interviews. However, as the field work progressed, it became apparent that specific incidents of delay needed to be probed further to trace who was involved and to understand in detail how project groups interacted with or without the programme. In total, I carried out five interviews in the Southeast cases with project members from two different firms as follows: four interviews with project members from the contractor's firm namely: commercial director, project manager for the safety improvement project, project manager for the drainage remedial project and project supervisor. One interview with the director of the subcontractor firm hired at the drainage remedial project. Arranging with participants to participate in interviews was facilitated by the commercial director. Questions of interest included: How did you find out there was a delay on the road project? What issues led to specific delays incident reported or discussed? How did the specific delay incident, reported or discussed affect you or your work? What did you do as a response to that delay incident? Who was involved in how you responded to this delay incident? How did you go about fixing it? What happened after you got involved in the delay incident?
Other questions of interest include was the programme revised due to specific delay incident? Were you involved in revising the programme for specific delay incidents? What did you do when you revised the programme? Who else was involved in revising the programme? How did your firm or team respond to conflicts in a programme?

For some of the project members, I had limited access to during the field work and so the interviews were very useful in gaining insights on their experiences in delay incidents and team engagement with or without the programme. For individuals that I already had access to during the fieldwork, the interviews helped to provide additional insights into events or incidents of delays in the past and their experience. The adoption of interviews in the road projects supported accounts obtained in field observations. This is similar to the approach used by Laryea and Hughes (2010) in offices on bid teams and involved using interviews with directors as well as market/operational participants to support accounts from field notes, daily diaries with questions during observations.

3.5.2.5 Documents and records obtained in the Southeast cases

The third source of data collected during the field work in the road projects were printed and electronic documents of four types namely: preconstruction information, construction phase plans, detailed drawings for the drainage works, story board/award letter, site diary records and pictures. From the beginning of the field work, I started assembling printed and electronic documents on the two road projects to trace incidents of delay and understand the chain of events. My familiarity with the project managers on the two road projects gave me a point of access to the electronic documents/records. I contacted the project managers via email, and they confirmed that they were happy to provide electronic versions of the records and hard copies on site.

3.5.2.6 Leaving the Southeast cases

Field observations at the road projects ended in March 2020, after which interviews were conducted. I informed the commercial director that the works had ended, and I would be ending the research. He advised that I should stay in touch and feel free to contact them if I had any questions. He informed project managers in an email, and they assured me that I could contact them as and when required. The section that follows discusses method used to analyse the data obtained from the two road projects.

3.6 Data analysis

This section explains how the data obtained was analysed in three parts: first, initial analysis during observations. Second, analysis after data collection ended. Third, analysis in the writing up of detailed vignettes for the three case projects. The process of analysing the data obtained was a continuous and reflective action that involved me constantly asking questions or questioning the data. This questioning of the data according to Long and Johnson (2000) is essential in analysing qualitative research and involves the rigour of examining my own beliefs, the belief/judgement and actions of data subjects in different settings or spaces in the three case projects. According to England (1994), a lack of reflexivity leaves ethnographic accounts as journalism, devoid of rigor or deep thinking which is the core of interpretivist research. This absence of reflection has been criticised by Schweber (2015) in interpretivist research because of a neglect of theory. Using the concepts of boundary object theory was essential for me to overcome my bias, move beyond common sense interpretation and understand how a programme function.

The first part of the analysis started during the field work observations and continued after I ended data collection. After observations in both cases, I made observation notes and developed the observation notes. I reflected on the notes, pictures and studied progress programmes alongside meeting minutes to better understand the different mechanisms at play as project groups interacted with the programme and responded to specific delays in different spaces. It was after I left the three case projects that I spent more time in sorting and analysing in detail the data. The observation notes, transcribed interviews and extracts from documents were stored in NVivo software to form one large data set.

The second part of the analysis started after the data obtained was stored in the NVivo software. I studied printed and electronic documents obtained at the three case projects multiple times and began to code specific delay incidents and the mechanisms involved as project members responded in observations, interviews, and documents. The data set was arranged in chronological order, dated, and either represented a field visit, interviews, meeting, or important discussions in emails exchanged between project members. It was easy to navigate through the different types of data because they were labelled and dated.

I focused on specific delay incidents and the chain of events. Three criteria were used to select incidents of delay for investigation. Moments that were: (1) noted repeatedly in project meeting discussions that led to changes or informed future reactions and responses (2) labelled with texts in minutes/emails or visually on the programmes and (3) echoed again in the interviews as a project group shared understanding. I traced how project groups engaged with or without a programme when responding to delay incidents within and across the cases. For the purpose of this research, what constitutes a programme as a boundary object is the visual or written document that is socially constructed by several parties as they make sense, name, represent and enact boundaries of time as a locus for their actions and activities. Three aspects were considered in analysing specific delay incidents namely: (1) the issues that led to specific delays incidents and how project members found out, (2) what project members did to address the delays and who was involved, (3) what changes key project members made with or perhaps without the programme in response to those specific delays. I drew upon different data types, gathered evidence on these three aspects and compared the mechanisms for patterns and themes. For the purpose of this research, each case project consists of distinct social worlds and what constitutes a boundary between people in one social world from another is that the people that work for the

same firm share the same interests, culture or priorities and belong to one social world. For example, the social world of the contractor's firm or subcontractor's firm (See figure 2.1).

The third part of the analysis involved writing up detailed vignettes that produced an ethnographic account that described empirically how project groups engaged with or without a programme when responding to specific delay incidents. The description was interwoven with analysis and involved combining accounts from the documents, pictures, observation notes, and interviews. Five mechanisms for engaging with or without the programme were used in analysing the dynamics involved in how project groups responded to delay incidents namely: visual capture, locus of negotiation, vehicle for communication, instrument of coordination and share understanding. I produced six vignettes that included four vignettes for the London case and two vignettes for the Southeast cases. The four vignettes in the London case were selected to allow for a comparison between two different subcontractors that were hired for four blocks (J, D, G and F). The two vignettes on the road project allowed for a comparison between two different subcontractors that were hired for the two road projects. After comparing the vignettes within and across for patterns, the analysis was concluded by highlighting key empirical issues. The section that follows discusses the limitations and ethical considerations involved in undertaking ethnographic research.

3.7 Limitations

This section discusses limitations in the research design that arose from two aspects namely: limitations in the method of collecting data and method of analysis.

Limitations in the method of collection is that aiming for a rich empirical description has practically limited the number of case projects this research can investigate. Investigation into events and processes prior to the beginning of the field work observations relied on documents and interview accounts to identify specific delays in the past that were prior to start of the research.

Limitations with the online methods of collecting data through observations is the limitation to non-verbal means of communications in the London case. The implication is that the period of the story with online observation would be told with limitations in non-verbal communications.
One similarity between the JCT contract at the London case and the NEC option A contract at the Southeast cases was that a programme of works was required. However, a difference is that the JCT contracts allows for time and price variation to be dealt separately and so an extension of time does not automatically guarantee a price adjustment, but the NEC allows for time and cost

to be grouped together under the compensation event. The implication is that the contract type may inform how project group respond to variations on the projects and how risks would be borne by project groups in both cases as JCT offers clients higher control over project delivery with a balance of risk between the client and contractor. Whereas, in the NEC options that is usually preferred for infrastructure and public works allows for joint burden of the risk.

One potential limitation of the ethnographic approach adopted in this research is "observer effect " i.e. how people behave in the presence of an observer. Kawulich (2005) observed that people interacting in natural settings alter their behaviour when an observer is present in their work environment. Hence, participants tend to modify their behaviour whenever their actions or activities are observed. This tendency may affect the quality of data, authors also argue that people over time get accustomed to observer and assume their normal behaviour as the interaction progresses and they become consumed in their task. The section that follows discusses the ethical considerations involved in undertaking this research.

3.8 Ethical considerations

This section discusses the ethical considerations involved in the three case projects when undertaking ethnographic research regarding confidentiality and anonymity. Before starting the research, ethical approval was obtained from the University of Reading in accordance with the established procedure. Before the start of the field work at the recladding project: the director, project manager, operations manager and contract manager were issued copies of the research summary sheet and consent forms that had been approved by the ethics committee. These key individuals then disseminated this information to members on the project involved in the research. Also, before the start of the field work at the Southeast cases, the commercial director, the two project managers, and a project supervisor were also issued copies of the research summary sheet and consent forms and disseminated the same to other members that had been approved by the ethics committee. The summary sheet was also issued to everybody in the three case projects who participated in the interviews. The summary sheets outlined the measures used to ensure confidentiality and anonymity, by ensuring that names of individuals, the location and identity of construction projects and firms were changed and not revealed. I reiterated the confidentiality and anonymity of my research whenever I deemed it necessary to do so in order to put the participants at ease and at the beginning of the interviews. I also told them that they were free at any point to stop or refrain from responding to questions they felt sensitive. My role as a researcher and my research interests were overt on the cases and at no point were any

concerns expressed about the research topic and what I would do with the data. I was repeatedly introduced by the project manager and commercial director respectively in the three case projects at meetings and at site visit which involved people who were not aware of my role.

Chapter four: Results in the London case

4.1 Engaging with a programme in delay incidents in the London case

How do distinct project groups engage with a programme in a recladding project? This chapter presents four vignettes of specific delay incidents in which project groups engaged with a programme in the same recladding project. The discussion in the vignettes considers three main aspects: (1) the issues that led to specific delays and how project members found out, (2) what project members did to address the delays and who was involved, (3) what changes key project members made with or perhaps without the programme in response to those incidents of delays.

4.2 Background of the London case

The analysis in the vignettes that follows focuses on the relationship between six actors: a housing authority, residents, consultants, a contractor, two subcontractors, cladding material suppliers, and their different roles in the recladding of 11 multistorey buildings in London. The analysis in the vignettes illustrated six distinct types of meetings in which project groups formally engaged with versions of the programme regularly. These include progress meetings, review meetings, forecast meetings, revision meetings, internal supplier meetings, Joint inspection meetings.

In 2019, a housing authority signed a contract with Marble Construction Ltd. to replace the external cladding of 11 multistorey buildings in London. In February 2019, Marble Construction signed a contract with Starlin Construction to procure panels/materials and hire skill operatives to replace the existing cladding for the buildings. Then ten months later in November 2019, Marble Construction noticed that Starlin Construction was overstretched and signed another contract with Eagle Construction to also procure panels/materials and hire skill operatives to replace the existing cladding for two buildings (block G and F). Marble Construction hired elevating equipment and engaged those two firms (Starlin and Eagle Construction) in 2019 as subcontractors to purchase new cladding materials and hire operatives skilled in replacing the old cladding. The two subcontractor firms engaged manufacturers to produce and supply new cladding materials that Marble Construction stored on site. There are residents and balconies in the 11 buildings and the two firms were responsible for notifying Marble Construction and the residents when they need access to the cladding at those balconies. The housing authority hired consultants to check the quality of works executed by Marble Construction Ltd.

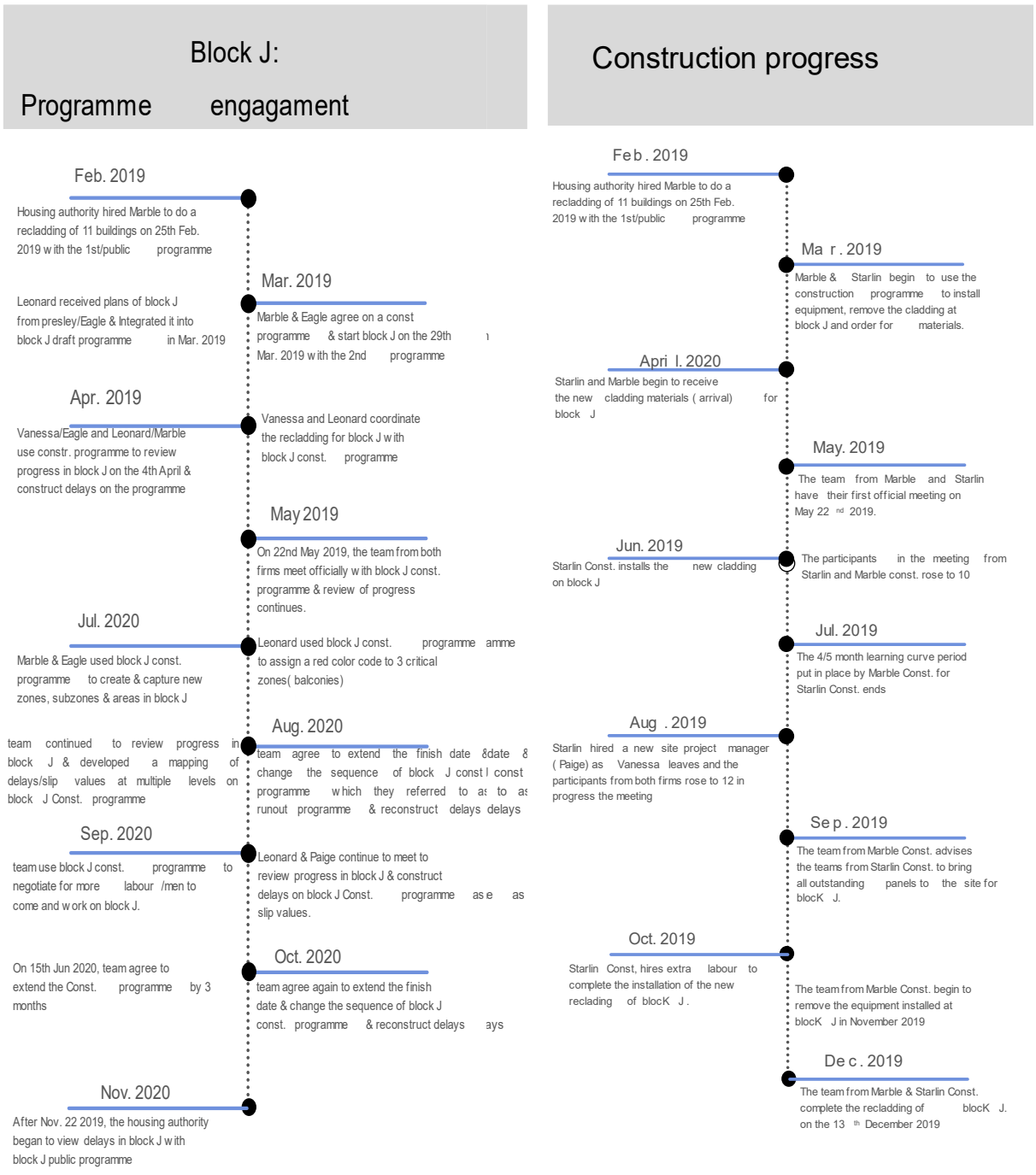
This research identified specific delay incidents in the process of recladding four selected buildings (block J, D, G and F) in the project that are key to understanding how project groups

engage with a programme. The analysis of the four buildings allows for a comparison between how Starlin Construction and Eagle Construction engaged with the programme. The chapter concludes by highlighting five key empirical issues: first, that the recladding project has project actors or members in four project groups that created and adapted multiple versions of the programme to meet their local needs and to relate with other groups. Second, that project groups constructed and interpreted project time differently in the versions of the programme as either linearly with a new form of organizing or cyclically with repetitive works or organizing that involved hiring equipment or fixer operatives. Third, project groups used different versions of the programme in different contexts to do different things. Fourth, project groups used versions of the programme to socially construct delays as either abstract and invisible or concrete and visible with negative slip values. Fifth, project groups responded to visible delays on versions of the programme with negotiations that involved formal changes to the sequence of activities, an extension of the deadline that led to a reconstruction of the slip values on the public and construction programme.

4.3 Vignette I

This first vignette tells a story of delays conceptualized differently by project groups in the process of recladding block J that involved six versions of the programme. The project groups involved in block J used versions of block J programme to socially construct delays as either abstract and invisible or concrete and visible with slip values on respective programmes. Block J was due to be handed over to the housing authority on the 22nd of November 2019. However, the housing authority did not receive a complete work until 13th December 2019. This was viewed by the housing authority as a delay of three weeks. Marble Construction and Starlin Construction agreed to complete the same block J on 27th September 2019, and both see 13th December 2019 as an 11-week delay. Addressing successive delays in block J involved the team from both firms, especially four main project members namely: Leonard (Marble Construction), Vanessa (Starlin Construction), Boaz (Marble Construction), Curtis (Starlin Construction), and Jerome (Marble Construction). The story presents five key moments on block J: (1) beginning the recladding project and creating a draft programme for block J, (2) removal of existing cladding after creating two programmes for block J; the construction and public programme , (3) arrival of new cladding materials and issues that led to a social construction of delays, (4) response to issues and the reconstruction of delays by extending the deadlines and reducing the slip values and (5) the

completion of block J at a delayed date of 13th December 2019 with runout programmes. (See Figure 4.1)



Block J	Apr.18,2019	May 3,2019	Jun 11, 2019	Jul 9,2019	Aug 6, 2019	Sep 6,2019	Oct 17,2019
% Complete	7	8	27	46	51	64.83	80.93
Slip value	-1 Wk, 3d	-2 Wks, 3d	-1 Wks, 1d	-1 Wk ,4d	-4Wks, 4d	-5d	-20d

Figure 4. 1: Timeline of programme use, progress, and slip values in Block J

4.3.1 Beginning the recladding works with block J

The story of delays conceptualized differently by project groups in handing over block J on 13th December 2019 started with an object called a 'draft programme' that was created by an operations manager, Leonard Heather and involves the team from both firms using the draft programme as a locus to negotiate different interests. On 25th February 2019, Marble Construction hired Starlin Construction to replace the cladding at block J, Leonard integrated construction plans he received from Presley-a programmer at Starlin Construction into a draft programme. Leonard's background is in planning, and since 2010 he has been working for Marble Construction. Leonard put together two overall programmes for the 11 buildings. In the first overall programme, Leonard outlined start/finish dates and durations for the 11 buildings for the housing authority. In the second (overall) programme, he outlined earlier start/finish dates and smaller durations for the same buildings adapted for the interest of Marble Construction for negotiations and dealings with the subcontractor firm (Starlin Construction). Leonard referred to the first programme covering the 11 buildings as the public programme and to the second programme with the start/finish date and duration for block J only as "block J draft programme". For example, Leonard's account below illustrates how he created the two programmes, introduced boundaries in time for the housing authority and Marble Construction and adapted the draft programme of block J by accommodating the subcontractor's plan and adjusting or 'massaging' dates. This process is illustrated in Leonard's observation below when he said:

> .... I coordinate the strategy of executing the works and provide the "access "such as the mini-cranes, mast climbers, monorails, scissors lifts and scaffolds for the subcontractors to work. First, I prepare an overall (sectional) programme for the project which is described as a draft programme and receive information of proposed plans from subcontractors for the different blocks on the project. In those proposed plans, a subcontractor breaks the external cladding for a block into manageable tasks and labels them as zones based on a modified elevation of a block with different parts to be cladded. This proposed plan is fed into my draft programme for a block and then I 'clean it up' i.e., harmonise the logistics. I sit down with the subcontractors to discuss their proposed plans: start date, duration in weeks, end date for each zone and then 'massage the dates' i.e., adjust the programme before the draft programme becomes clean. A cleaned programme is referred to as a 'second draft' and the cleaning of a programme involves "massaging the dates' until every concerned party is happy or agrees before it is 'published' or made available to all parties i.e., the contractor, subcontractors, housing authority and residents or the public...
>
> Interview, February 22nd, 2020

As evidenced in the above quote, Leonard integrated the construction plans of subcontractors and sat down with them to discuss before adapting a draft programme to the needs of Marble Construction and each subcontractor for each block in the recladding project. Leonard referred to this process of adapting the draft programme as 'harmonise' or 'massaging dates or 'cleaning'. Leonard treated an adaptation of this draft programme as a new type of programme and referred to it as a second draft. He treated an adapted draft programme that met the interest of Marble construction and the subcontractor as another type of programme and referred to it as "published". This illustrates how project groups began to introduce boundaries, construct project time, and ascribe different labels to the different types of programmes. The cleaning, massaging, or adapting of the programme until every party is happy illustrates how project groups began to use the draft programme as a locus to negotiate and agree. The above quote illustrates three things: first, how boundaries in time were socially constructed for the different project groups such as Marble Construction, the subcontractors, and the housing authority. Second, the quote also illustrates how the programme became weakly structured in common or group use. Third, the quote illustrates how Marble, and the subcontractor began to actively use the draft programme as a locus for negotiating the terms for working with each other and on the way, they want the recladding work to develop or proceed. By the end of this initial moment, the programme had been transformed into three versions: the overall construction programme, the overall public programme, and the draft programme for block J. Only the draft programme and the subcontractor's programme were mobilized in discussions of dates, durations, and zones.

4.3.2 Removing the existing cladding on block J

After creating the three programmes, Leonard and members from Starlin Construction used Block J draft programme to create a construction programme to coordinate the removal of existing cladding and installation of new cladding. On 29th of March 2019, Leonard, and Curtis - a commercial director at Starlin Construction-used the modified draft programme to agree on a construction programme for block J with a start date of 25th March 2019, duration of 26 weeks and a finish date of 27th September 2019. This dates/duration differs from the agreement the housing authority had with Marble Construction to start block J on 25th February 2019, with a duration of 39 weeks and a finish date of 22nd November 2019 because of earlier finish dates and shorter durations.

After this agreement, Leonard circulated block J construction programme to project team members in Marble Construction and Starlin Construction. Jerome-a site manager in Marble

Construction-began to use this construction programme to hire elevating equipment on the project site. At the same time, Vanessa- a Construction manager for Starlin Construction- also began to use the same programme beside Starlin's own construction programme to order aluminum cladding panels and hire operatives to remove the existing cladding in block J. The way the team from Starlin Construction used the construction programme to arrange with supplier is illustrated in Lingard's observation (logistic and design manager/ Starlin Construction) below when he said:

> .....We have supply meetings on a weekly basis which is on Wednesday and that involves me, our site project manager, a new logistics manager on site who manages the deliveries of all the panels, stores them, arranges them down in the basement, forecasts the panel delivery dates and checks that those panels are going to be arriving on time from our supplier. He calls them directly on a daily basis and then we have a meeting on a weekly basis with our supplies just to chat that everything's on track. In those suppliers' meetings, we use our programme that has the dates which is in our tracker, so if they have got a problem then we look back at our programme and see how that's going to affect it. We discuss with the supplier our programme and tracker, and then if there is a delay, we then cross check it with the contractor's construction programme if we can. If the delay is going to affect the projects and we can't get over it, then we speak to the (project manager) contractor, but that's the last resort we try and get over ourselves. The public dates, I don't look at, we just look at the contractor's construction programme and our own programme and that is it, but all the guys in our office, the panel suppliers and everyone involved in this job that works for Starlin Construction works with Starlin-programme, but we check on a weekly basis against the contractor's construction programme to check that we're in line with it.....
>
> Interview, October 27th, 2020

The above quote illustrates two points: first, Lingard's quote "…. *We have supply meetings on a weekly basis which is on Wednesday…. check that those panels are going to be arriving on time from our supplier…. we use our programme that has the dates which is in our tracker…."*illustrates how the team from Starlin Construction in internal meeting chase the items ordered using their own programme. Second, the quote "……. *we then cross check it with the contractor's construction programme if we can. If the delay is going to affect the projects…."*illustrates that the team from Starlin Construction move from engaging with their programme to engaging with the construction programme to reconcile and translate different interpretations of project time. The section that follows describes the way the team from both firms began to actively use block J construction programme to work and construct delays by assigning negative slip values.

4.3.3 Arrival of new cladding for block J and construction of delays

Not long after creating the construction programme, Vanessa began to receive the new cladding which Jerome stored in the site. They cooperated by reporting on orders received and Leonard and Vanessa agreed on operatives to station at various equipment that Jerome installed around block J. On 18th April 2019, Leonard and Vanessa began to use the construction programme for block J to review (or evaluate) the progress on the removal of existing cladding, and installation of new cladding. Vanessa recorded two percentage values on block J construction programme namely: a current percentage of work completed of 7.0% and a planned percentage completion of 13.86% for block J. Leonard subtracted 7.0% of the total duration of 26 weeks from 13.86% of 26 weeks planned for 18th April 2019 and assigned/recorded a negative slip value of (-1 week, 3 days) on the same programme. Then Leonard used the current percentage value (7%) and the negative slip value of (-1 week, 3 days) from the review to position a drop line behind the current date- 18th April 2019- in block J construction programme. This illustrates how Vanessa and Leonard began to use block J construction programme to construct delays by assigning negative slip values when the current percentage of work done in block J was less than the planned percentage. This was captured visually with a drop line on block J construction programme before sharing it to the team from both firms. This instance also indicates that Leonard and Vanessa began to view and treat block J as delayed only after they measured or counted the progress and labelled block J as 1 week and 3 days delayed.

After Leonard labelled block J as delayed, Jerome and Vanessa continued to use the programme to coordinate the installation of equipment for more areas at block J, remove existing cladding and review the progress and construct delays also referred to as 'slip values', 'slipping' or 'slippage'. On 22nd May 2019, for the first time 4 members of Marble Construction: Leonard, Jerome, Boaz- an assistant site manager - and Albert- a site supervisor - formally met with two members of Starlin Construction: Vanessa and Declan-an assistant manager- to discuss the progress of block J with two additional blocks- blocks H and D. At this first progress meeting, the six attendees discussed the progress of block H and D generally because they had not yet split block H and D into zones. They also discussed progress on block J by talking about the arrival of cladding materials and setting up of equipment under 10 zones they created. In June 2019, Leonard and Vanessa continued to review the progress in the 10 zones and capture the percentage of work completed, planned percentage completed and delays as negative slip values for the 10 zones for subsequent meetings.

Soon after the first meeting, the members at progress meetings rose to 10 participants and they continued to meet weekly to discuss the arrival of materials, operatives to hire, installation of new cladding, updates on the percentage of works completed against planned percentage completed and delays as slip values at the 10 zones in block J construction programme. This illustrates how the team from both firms used the construction programme to collectively manage resources mapped out in zones. In July 2019, the 10 members in the meeting agreed to break down the three zones: they broke zone 3 into 10 activities that included 6 balconies, zone 5 into 14 activities that included 7 balconies, and the rooftop zones into 3 subzones and 12 activities. This illustrates how the team from both firms used the construction programme for block J to create smaller manageable tasks as responsibilities in areas.

Again, after the meeting, Leonard captured these new subzones and activities to update block J's construction programme and shared this with 10 members prior to the next progress meeting. This active engagement enabled both project groups to use block J's construction programme to do four things namely: first, to manage different expectations as the operations manager managed the creation of different programmes to serve different audiences. Second, to assign responsibilities or tasks and break the work in block J into smaller manageable areas for operatives to handle. Third, to coordinate construction resources at multiple levels such as the delivery of materials, installation of equipment at the 13 zones and hiring of site operatives to work. Fourth, to review the progress weekly and construct delays by assigning percentages of works completed and slip values to places in block J. These slip values were visually captured by the operations manager on the construction programme at multiple levels to produce a map of visible or concrete delays at multiple levels (overall block, zones, subzones, and areas). This suggests that the construction programme played a role in coordinating the team from both firms prior to and in progress meetings and enabled members from both firms to depend on each other at multiple levels.

The above sections provide a general overview of key moments in starting block J and how the team from both firms began to remove the existing cladding, receive the new cladding, and construct visible delays by assigning slip values at multiple levels on block J construction programme. The section that follows describe how the team from both firms began to install the new cladding, issues that led to delay incidents in block J and how project members found out.

Figure 4. 2 Team from Marble and Starlin Const. using a construction programme at a meeting (7/8/2020)

4.3.4 The issues with recladding block J (installing the new cladding)

The team from both firms had just begun to install the new cladding when three issues led to incidents of delays in block J. The first of these three was with the issue of limited storage space for panels/materials. The second issue that led to delay incidents was that Starlin Construction began to miss planned finish dates for three balconies in the construction programme that were critical to the completion of block J. The third issue that led to delay incidents in block J was that some panels received for block J were either of bad quality, unfit, delivered late or missing on site.

Beginning with the first issue of limited storage space for panels/materials. It started in June 2019 when Marble Construction struggled to find more space to store the panel materials as Starlin Construction began more blocks. Jerome said (in a meeting): "...the basement storage will need more space as we start more blocks .... Dean asked if offsite storage is an option for pallets and for how long...." (Minutes June 18th, 2019). As evidenced in this quote, the team from both firms began searching for options to address the shortage in space. This was partly because Marble Construction and Starlin Construction started 4 new blocks in addition to block J within a short period of two months. This suggests that using specific construction programmes for each block obscured knock-on effects from other construction programmes and indicates there was little comparison of programme across the blocks. Leonard's priority was to group the start date of those four new blocks very close to each other: blocks H and D had start-dates of 13th and 16th May 2019, block C had a start date of 5th June 2019, and block B had a start date of 13th July 2019 as he initially outlined in the second overall programme– referred to as overall construction programme. In July 2019, the team from both firms used the overall construction programme to discuss the beginning of more blocks. The team from Starlin Construction and their suppliers were overwhelmed by the panel/material orders required for operatives to work on multiple blocks and this introduced delays in block J. In October 2019, Leonard asked the logistic and design manager from Starlin Construction to concentrate on getting all panels to site. Leonard (in

a meeting) told "……Lingard, all panels need to be onsite for final 7 weeks …" (Minutes, October 3rd 2019). As evidenced in the above remark, a discussion in the progress meetings in October 2019 was that the team from Starlin Construction should focus on ensuring all the new panels required to complete block J were produced and delivered to site as the finish date drew closer. Then the team from Starlin Construction contacted their suppliers to concentrate on delivering all panels for block J before attending to other orders.

Not long after starting the additional blocks, a second issue that led to incidents of delay was that Starlin Construction began to miss planned finish dates for three balconies in the construction programme that were critical to the completion of block J. This is partly because the team from Starlin Construction and their suppliers were stretched by the panel/materials and operatives required for multiple blocks. Towards the end of July 2019, "Boaz queried 3 areas that Vanessa said their works would be complete. He said that the 4-5 months learning curve is over and moving forward there cannot be any "slipping of programme" (Minutes, July 23rd, 2019). As evidenced in this quote, the team from Marble Construction did not conceptualize or view negative slip values as delays on block J until the expiration of the learning curve period of 4-5 months. Boaz- the assistant site manager at Marble Construction- reported that three areas in block J were slipping i.e., delayed after seeing the review of progress in block J construction programme. Curtis, from Starlin Construction, argued that this was due to the additional work in more blocks. This additional work from multiple blocks stretched their capacity and their suppliers to produce, store and dispense more panels/material for operatives to work. This slowed down the recladding work on balconies located at three zones out of 13 zones in block J and introduced delays. Simply put, panels/material were not available when needed, and operatives had trouble completing the balconies at zone 3, zone 5 and the roof top/courtyard zone. This illustrates the role of the construction programme in constructing delays at the balconies of the three zones.

A third issue that led to delay incidents in block J was that some panels received for block J were either of bad quality, unfit, delivered late or missing on site. These issues introduced delays in the recladding of three critical zones that also delayed the overall completion. Leonard labelled these three zones as critical path areas in meeting minutes and on block J construction programme using a red box for over 8 weeks because the three zones continued to show higher negative slip values compared to the remaining 13 zones. The issue of bad quality, unfit and late deliveries is illustrated below in Lingard's observation (logistic and design manager/ Starlin Construction) when he said:

> ...I found out that we had a delay at the ground floor area in Block J which is the first block when it was brought up at a weekly progress meeting with Marble Construction. It was brought up in that meeting and then it was followed through in writing to let us know the progress. We ordered panels that turned up bad for a small area on the ground floor walkway down into the courtyard, they were bad quality and we had installed them to close up the ground floor area. There was no insulation, residents can go through and pull this off. When Marble Construction informed us of the badly fitted panels, we replied to Marble Construction and said, we are not happy with this, our supplier let us down. We got another supplier involved to remake those panels. So, we replaced those panels within a two-week period with the correct quality which we got signed off by the quality assurance managers from Marble Construction and it was a week to two weeks quicker than the standard lead time on those panels. We got a supplier to do overnight shifts and bring in extra labour to turn those panels around quicker because each block has a hand over date, so we pulled out all the stops to try and get it over the line, and we got a different supplier involved because the supplier at the time was letting us down. We were informed in writing of this delay as they updated their programme and put a drop line to say we are behind which they issue through to us. We tried to resolve that with our tracker. On our panel tracker, we've got a column in there which is called supplier acknowledgement date, we have a programme date on the left, we then had supply acknowledgement daily on the right which could be 2 weeks later, and that panel tracker is then issued to Marble Construction as well, so they are aware that we had got a delay....
>
> Interview, October 27th, 2020

The above quote illustrates three points: first, that Lingard found out about their delay in block J at the regular progress meetings when the team from Marble Construction used the construction programme to label the progress at the ground floor area in block J as delayed.

Second, the above quote illustrates that the team from Starlin Construction addressed the visible delay in the ground floor area by agreeing to involve another supplier that worked longer hours (overnight) to remake the bad panels and negotiate for extra operatives to catch up towards lost time. Third, the team from both firms in this moment negotiated solutions on the critical balconies and agreed to break three troubled zones into manageable areas. These linked responses to visible or concrete delays in block J suggest that the delay incidents in block J led the team from both firms to make adjustments that mutually accommodates the work and block J construction programme that involved Starlin Construction reconciling the recladding work to fit the construction programme as well as Marble Construction changing the construction programme by introducing new zones to accommodate the recladding work. This process and how the team from Marble Construction introduced a learning curve period was explained by Cain when he observed that:

> .... I found out that there was a delay when I went through the dates on block J construction programme. According to block J construction programme, block J should have finished by September 2019. When I came in October 2019, block J was still ongoing, so this indicates clearly, there is a delay. To understand how far back the project was then, I went through the original construction programme issued earlier- with a lack of scope and lack of planning. I would say roughly, we were looking at a delay that was already more than 3-4 months. On this project we have two different dates: there is a public programme date and there is the construction programme dates. I am going to talk about the construction dates here, so the construction dates were roughly 3-4 months out, for the first 2 blocks, which is blocks J and H when I came over in October 2019. We already knew this delay was happening and how long it is taking roughly, but I revised the construction programme to make or put a realistic programme, basically because we were still within the public programme date. I am not going to talk about the public dates, because we are talking about construction delays and the construction programme. A learning curve was already happening for those two blocks, but for me to understand the problem we were facing, we needed to do the actual thing and not in the conceptual stage of this is how we are going do it by the previous team. So, a reality of how long it took was a basis that helped me to set up realistic dates, but even after I set the realistic dates, there are situations of scope change again for example removing of polystyrene. However, we had delays between the floors and what we did was we accelerated the resources- operatives- to work on those floors and we finished block J in December 2019. So, looking at the programme is one thing and when you go out on site and have a look, we should be finished, so what happened exactly is we asked questions- why is it delayed and then I found it is a lack of information, scope change and initial planning did not consider all these concerns with the access because it is a live building with people living there....
>
> Interview, October 16th, 2020

The above quote illustrates six points: first, the project manager-Cain's quote "*.... this indicates clearly, there is a delay ....*" illustrates that delays can be conceptualized superficially and at this moment Cain conceptualized the delay in block J abstractly because he had not yet gone through the initial construction programme for block J to subtract the time difference. Second, Cain joined the recladding project in October 2019 and engaged the current construction programme for block J with the narrative features (of start date, finish date, drop line, percentage work completed, and percentage work planned) to understand the state of block J. This suggests that the construction programme played the role of enhancing continuity when there are changes in project team members. Third, the quote "*the original construction programme*" illustrates that there was a prior construction programme for block J- ending on September 27th, 2019- that he consulted to understand that block J was 3-4 months delayed. This suggests that the original construction programme agreed between Marble and Starlin Construction to finish block J on 27th September 2019 played the role of constructing a key delay that was conceptualized by Cain the project manager in October 2019, because this delay compared to others recorded on the construction programme exceeded the original final or finish date. Fourth, the above quote "*I*

revised the construction programme to make or put a realistic programme basically, because we were still within the public programme date" suggests that the two programmes for block J played different roles at this moment as they were used to manage different expectations as the team from both firms moved from using the construction programme to checking the public programme when the final dates of the construction programme was exceeded. Fifth, the above quote "*learning curve period was already happening"* shows that although the team from Marble Construction labelled block J as delayed on the construction programme with slip values, it wasn't viewed as delayed because a learning curve period was introduced by Marble Construction as time for the team from Starlin Construction to develop together a collective way of using block J construction programme to work. This suggests differences in the way the construction programme was used as recorded delays were treated differently during the learning curve period and after or outside of it. Sixth, the above quote "*we asked questions"* illustrates a limitation in what the current construction programme for block J told him and that the team from both firms often met to discuss, fill in any gaps and interrogate aspects that were not captured in the construction programme to be able to trace problems, identify lapses in responsibilities, apportion blame, brainstorm solutions, and negotiate responses.

The above section illustrates three issues that led to different incidents of delays as the team from both firms began to install the new cladding on block J and used the construction programme more actively. The issues included limited storage space, the production and delivery of bad quality panels that were unfit and difficulties in replacing the cladding at the balconies of residents. The quotes above illustrate that the way the team constructed delays due to limited storage space in one moment differed from another moment when they produced or delivered bad quality panels. This is also different from the way the team constructed delays in another moment when they struggled to complete the balconies and illustrate the role played by block J construction programme in socially constructing delays as visible or concrete with slip values in different moments due to different issues. The sections that follow describe the team's response to visible or concrete delays in block J construction programme that led to a formal reconstruction of slip values.

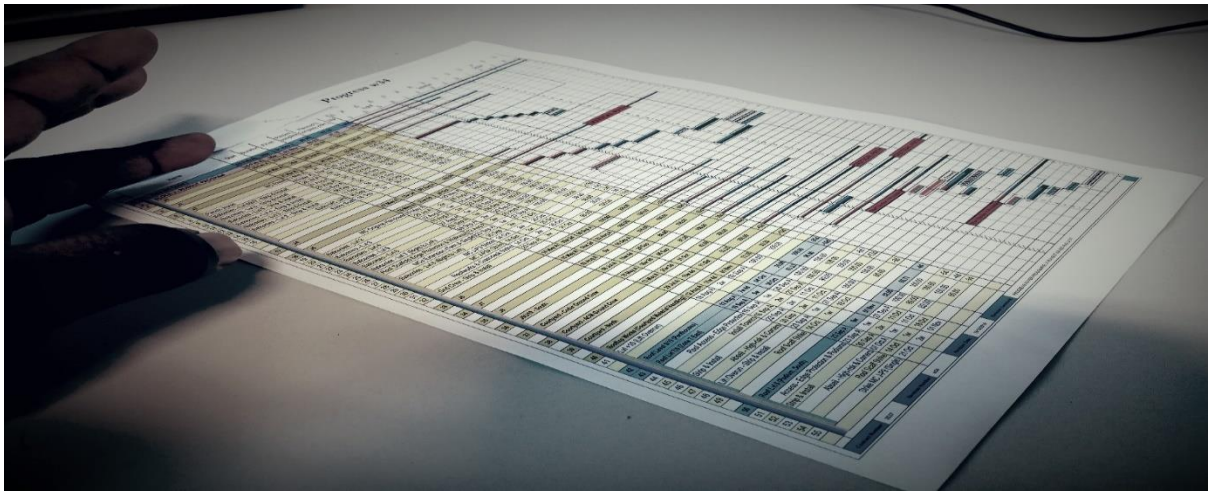


Figure 4. 3 Block J construction programme at week 34(16/10/ 2019)

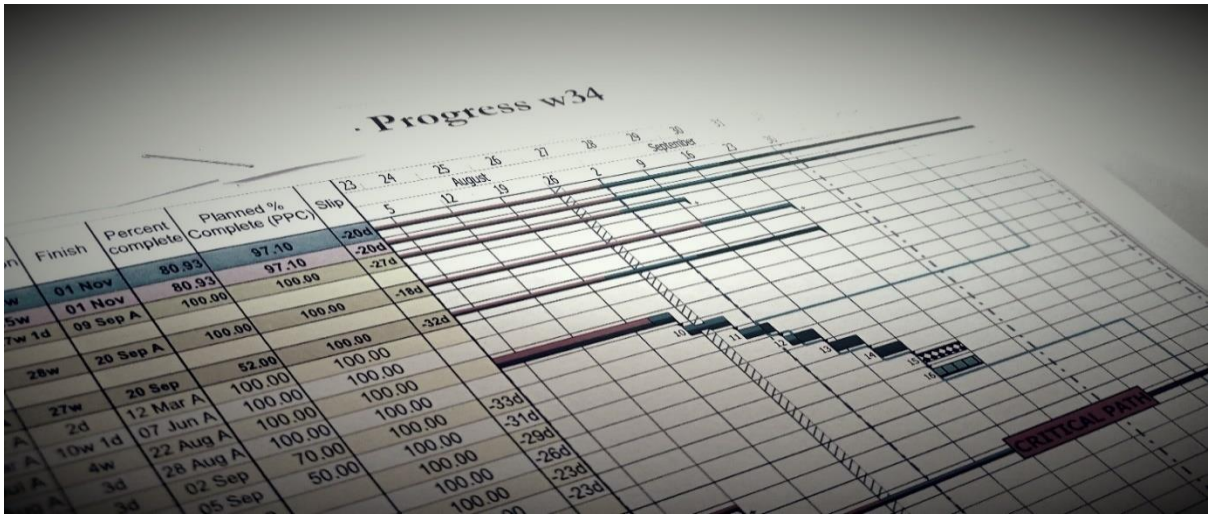


Figure 4. 4: Block J construction programme at week 34(16/10/ 2019) and slip values

4.3.5 Response to visible delays in block J

Two key moments shaped the way the team from both firms responded to the issue of panel/material orders overstretching Starlin Construction and their suppliers. The first part is connected to Starlin Construction and visible or concrete delays in block J on or before 27th September 2019. This involved the team from both firms using block J construction programme to agree on an extension to the finish date. The second part is connected to Marble Construction response and visible or concrete delays in handing over block J to the housing authority on or before 22nd November 2019. This involved the team from both firms using block J construction programme to agree on an extension to the finish date to align with the finish date of block J public programme. The team's responses to these successive delays at key moments builds on the concerted efforts of members of Starlin Construction to bring all remaining panels/materials for block J to the site. These moments also present the way project groups engaged with versions of

the programme for block J. The section that follows describes the way the team from both firms actively used block J construction programme to socially reconstruct slip values at multiple levels by trying a new sequence and a formal extension of the deadline for block J. (See Figure 4.1)

4.3.5.1 Formally extending the deadline for block J and a new visible sequence

Taking the first response of project groups to visible or concrete delays viewed in block J on or before 27th September 2019. This part of the story picks off from August 2019 and describes how team members from both firms socially reconstructed slip values and delays twice in block J by changing the sequence of working and extending the finish date in block J construction programme. As Starlin Construction began to work on 4 more blocks in the space of two months, Leonard and Vanessa invited more members from both firms to the weekly progress meetings. In August 2019, the attendees at the meetings rose to 12 with 5 members from Marble Construction and 7 members from Starlin Construction. Leonard shared updates on block J construction programme with all 12 members in weekly meetings and electronically via emails. This translated into increased engagement with the construction programme inside and outside the meetings. Leonard and Vanessa continued to review the progress on the recladding at 13 zones in block J and developed a mapping of slip values at multiple levels (overall, zone, subzone, and activities) for discussion at weekly progress meetings. They reviewed the progress by comparing the planned completion date with percentages against current dates and percentage completed at the different levels (overall, zone, subzone, and activities). Those weekly meeting discussions enabled the team from both firms to discuss issues at multiple levels, interrogate aspects that are troubled, brainstorm solutions, gain feedback and continued to show that the balconies located at zones 3, 5 and roof top were critical and impeding the completion of the recladding work on block J.

In the first week of August 2019, Starlin construction hired a new site manager-Mr. Paige- to replace Vanessa. On 6th August 2019, Leonard and Paige met in the morning to review the progress on the recladding at 13 zones in block J prior to the progress meeting at 10:30 am. Paige recorded an overall completion of 51% on the construction programme and Leonard recorded a negative slip of -4 weeks, 4 d on the same programme before sharing it with the 12 members at the 10: 30 am meeting. Leonard reported in the meeting that block J was 4 weeks and 4 days delayed and Curtis- a commercial director with Starlin Construction- replied that they would not be able to complete block J before 27th September 2019. Curtis pushed back on the deadline for block J and the 5 members of Marble Construction in the meeting agreed to increase the duration

for completion by 5 weeks. Paige and Leonard changed the sequence for the remaining recladding works, changed the start date from 25th March 2019 to 25th February 2019 and formally extended the finish date in block J construction programme from 27th September 2019 to 1st November 2019. Leonard referred to the new sequence as a "*runout programme"* and captured the extension in block J construction programme on 21st August 2019. The new finish date- 1st November 2019- led Leonard to recalculate the slip value for block J and reduce it from (-4 weeks,4d) to (-5d). He treated block J to be 5 days delayed instead of 4 weeks, 4 days and moved the drop line forward at zones and subzones. He also reduced the slip values at the 13 zones. This illustrates how Leonard and the team from Starlin Construction first reconstructed slip values and delays in block J.

In September 2019, the team from Marble Construction were brainstorming and discussing solutions to a zone that was viewed as delayed. "Leonard said (in a meeting) … Balconies in zone 3 (critical path) started on 29th July 2019 and the Mast Climber is going over 6 months– need to accelerate, can we try with 4 guys?" (Minutes, September 6th, 2019). As evidenced in the quote above, block J construction programme enabled Leonard from Marble Construction to interpret that a Mast Climber at zone 3 has overstayed and has been hired for over 6 months. This illustrates that when Starlin Construction left equipment to overstay on site, it goes against the interest of the team from Marble Construction. This suggests that the team from Marble Construction responded to visible or concrete delays by using block J construction programme to brainstorm or negotiate solutions to avoid further financial losses due to an idle, unused, or underutilized equipment. In October 2019, the team from Starlin Construction treated the delay in block J by increasing the operatives hired at block J. Paige said (in a meeting) "… Extra labour has been brought in to finish block J, we are not robbing from other blocks…." (Minutes, October 3rd, 2019). As evidenced in the quote above, the team from Starlin Construction viewed block J as delayed and treated the finishing of block J as a priority and changed the number of operatives hired in October 2019. Paige increased the operatives he hired for block J to address the issue of delay in block J. As the finish date of 1st November 2019 drew closer, Paige said at the meeting that his decision to increase the operatives to finish block J would not work against the progress in blocks H, D C and B.

On 17th October 2019, after they reconstructed the slip values and delays in block J, Leonard and Paige reviewed the progress of the recladding at 13 zones- prior to another progress meeting- and shared it with 12 members at the meeting. Paige recorded lower percentage completion for

those three critical zones 3 (52%), and 5 (65.38%) and courtyard– ground crew (42.50%) compared to remaining 10 zones in block J construction programme. At the same time, Leonard recorded higher negative slip values for zone 3 (-32d), zone 5 (-12d) and courtyard– ground crew (-44d) compared to remaining 10 zones and an overall slip value of (-20d) for block J. Then Leonard visually captured delays at 7 balconies in the three critical zones in block J construction programme by halting the drop line at September 2nd, 16th, 28th, 2019 instead of positioning it under the current date of 17th October 2019. When the progress meeting began, Leonard shared this update on block J construction programme in the meeting and reported that block J is 20 days delayed. Curtis opposed the deadline for block J and 5 members of Marble Construction at the meeting again agreed to increase the duration by 3 weeks to align with the finish date in the public programme, 22nd November 2019. Paige and Leonard again changed the sequence for the remaining recladding works at block J and formally extended the finish date from 1st November 2019 to 22nd November 2019. After they made these changes, Leonard again recalculated/reduced the overall slip value for block J in the construction programme from (-20d) to (-7d). He also reduced the slip values at the zones, subzones, activities and moved the drop line forward at the zones and subzones. This illustrates how Paige and Leonard socially reconstructed the slip values and delays in block J the second time.

The above events illustrate that recladding block J involved an intersection of the social worlds of two project groups namely: Marble Construction and Starlin Construction. The events also reveal differences in the interests and priorities of these social groups in the way the team from two firms used the construction programme as a locus to negotiate new sequences and to agree to extend the deadline for block J. This was because Starlin Construction did not finish the balconies of residents at three critical zones as planned and this introduced delays in the handing over block J on or before 27th of September 2019. The events illustrate that Starlin Construction agreed with the team from Marble Construction twice to extend the deadline from 27th of September 2019 to 1st November 2019 and then 22nd November 2019 to address visible or concrete delays. This led the finish date of the construction programme to coincide with the finish date in the public programme. The above events suggest that the team from both firms responded to delay incidents with a situated use of block J construction programme to socially construct and reconstruct slip values by negotiating a change in the sequence of working in the construction programme. The section that follows describes events that led to another key response to visible or concrete delays that was viewed by the housing authority after completing the recladding in block J for handing over by engaging with the public programme.

4.3.6 Removing equipment at block J and closure

Taking the second response of project groups to visible or concrete delays in block J on or before the 22nd of November 2019 (in handing over block J to the housing authority). This part of the story continues from October 2019. In contrast to the way team members actively engaged with the construction programme for block J, the team from Marble Construction and the housing authority rarely engaged with the public programme for block J until the recladding works exceeded 22nd November 2019- the finish date in the public programme- and eventually finished on 13th December 2019 (3 weeks later).

Before exceeding November 22nd, 2019, the housing authority came for regular site visits, but it was only after 22nd November 2019 that the team from Marble Construction and the housing authority began to use the public programme to treat days beyond 22nd November 2019 as delays. The 3-week delay to the public programme differs from the successive delays identified earlier when the team from both firms used block J construction programme to review the progress. This is because Marble Construction and Starlin Construction agreed to complete block J on 27th September 2019 and equally see 13th December 2019 as an 11-week delay. This illustrates that the three project groups involved in recladding block J engaged different versions of the programme differently and this enabled these project groups to socially construct and reconstruct slip values as delays. First, Starlin Construction used their construction plans in their programme that was linked to panel trackers, supplier acknowledgements that enabled their team to keep track of their suppliers and interpret supplies were delayed. Second, Marble Construction used block J construction programme that is linked to a "Hold-point system" which enabled their team to keep track of the subcontractors, equipment, and view when block J was delayed. Third, the Housing authority used the public programme that enabled them to hand over the site for block J, come for visits and interpret when block J was delayed.

Leonard and Paige continued to use block J construction programme until 13th December 2019 to coordinate and finish the recladding work at the 13 zones in block J. At the same time, Jerome-the site manager from Marble Construction- used the percentage complete recorded at zones in the construction programme to begin striking down equipment from September 2019 and bring closure to all construction activities in block J.

This vignette illustrated the story of successive delays that were conceptualized differently by project groups in the process of completing the recladding of block J that involved six versions of

the programme. Three project groups used versions of block J programme to socially construct delays as either abstract and invisible or concrete and visible with slip values. Block J was due to be handed over to the housing authority on 22nd November 2019. However, the housing authority did not receive a complete work until 13th December 2019. This was viewed by the housing authority as a delay of three weeks. Marble Construction and Starlin Construction agreed to complete the same block J on 27th September 2019, and both see 13th December 2019 as an 11-week delay. The vignette illustrated that Marble and Starlin Construction used versions of block J programme to agree to extend the deadline or finish date in block J construction programme and reconstruct slip values at multiple levels. The evidence presented at different moments in this vignette I suggests that different project groups engaged different versions of the programme differently in delay incidents. The section that follows present the second vignette on delay incidents in block D and how project groups engage with a programme.

Figure 4. 5 New external cladding installed at block J

4.4 Vignette II

This second vignette tells a story of delays conceptualized differently by project groups in block D that involved five versions of the programme. The project groups involved in block D used versions of block D programme to socially construct delays as either abstract and invisible or concrete and visible with slip values on respective programmes. On 17th June 2019, Marble Construction hired Starlin Construction to replace the cladding of block D. Block D is the third building that the two firms started and was due to be handed over to the housing authority on the 21st of May 2020. However, the housing authority did not receive a complete work until 14th August 2020 because on 23rd March 2020, the site was shut down for 3 months due to a UK nationwide lockdown caused by the COVID -19 pandemic. This was viewed as a delay of 3 months by the housing authority and Marble Construction. Marble Construction and Starlin Construction agreed to complete the same block D on 6th December 2019, and both see 14th August 2020 as a

35-week and 6 days delay. The project manager for Marble Construction pushed back against the initial public programme/duration for block D and disagreed with the deadline of 21st May 2020. Addressing successive delays in block D involved the team from both firms, especially six main project members namely: Leonard, Vanessa, Curtis, Jerome, Cain, and Donnie. In October 2019, Marble Construction assigned Cain and Donnie to the recladding project. The story presents four key moments on block D: (1) the beginning of the works and the creation of block D construction programme, (2) the removal of existing cladding, (3) the arrival of new cladding materials and issues that led to visible delays in the installation of the new cladding, and (4) response to a lock down and the shutdown of the site for 3 months. (See Figure 4.6)

Block D	Jun 11, 2019	Jul 12, 2019	Aug 6,2019	Sep 6,2019	Oct 17,2019	Nov 7,2019	Jan 24,2020
% Completion	0	11.20	11.20	27.33	38.51	46.53	88
Slip	-3 week, 2d	-4 weeks, 1d	-8 weeks, 1d	-7d	-28d	-41d	-1d

Block D	Feb 14,2020	Feb 21,2020	Feb 28, 2020	Mar 6,2020	Mar 13,2020	Mar 20,2020	Jul 16,2020
% Completion	89	90	91	91	94	94	98.42
Slip	-9d	-9d	-8d	-9d	-19d	-1d	4d

Figure 4. 6: Timeline of programme use, progress, and slip values in block D

4.4.1 Beginning the recladding works in block D

The story of delays conceptualized differently by project groups in handing over block D on 14thAugust 2020 started when Leonard created the second (overall) programme with the start/finish date and duration only for block D which he referred to as 'block D draft programme' and involves the team from both firms using the draft programme as a locus to negotiate their interests. Leonard initially planned that Block D should start on 16th May 2019, but after the team from both firms met for the first time on 22nd May 2019, Leonard reported that there are errors with block D phasing plan and strategy for "accessing" equipment that he had received from Presley. Vanessa and Presley changed the plan and issued the changes to Leonard to integrate into the draft programme for block D. On 17th June 2019, after 3 weeks of modifying block D draft programme, Leonard and Vanessa used the modified programme to agree on a construction programme for block D with a start date of 17th June 2019, duration of 24 weeks, 4days and a finish date of 6th December 2019. This dates/duration differs from the agreement the housing authority had with Marble Construction to start block D on 29th July 2019, with a duration of 42 weeks, 4 days, and a finish date of 21st May 2020- public programme. This suggests that versions of the programme played a role in creating different understanding or expectation on when block D should start and conclude for different project groups.

After agreeing on a construction programme, Leonard circulated block D construction programme to the team from both firms and they began to use block D construction programme to count the progress in weeks and discuss block D in progress meeting. Jerome began to use this construction programme to hire elevating equipment for block D. At the same time, Vanessa also began to use the same programme to order new aluminum cladding panels. This section above illustrates the way the team from both firms actively used block D draft programme to begin works and create block D construction programme. The section that follows describes how team members from Marble Construction and Starlin Construction actively used block D construction programme to coordinate the removal of existing cladding.

4.4.2 Installing equipment around block D and removal of cladding

After Vanessa ordered for materials and Jerome began to receive equipment, the team from both firms began to use the same construction programme to coordinate the recladding works by reporting on orders received and agreed on operatives to hire at various equipment installed around block D to strip or remove the existing cladding. On 12th July 2019, Leonard and Vanessa began to use block D construction programme to review (evaluate) the progress of the recladding

works at block D prior to a progress meeting: Vanessa recorded an 11.20% percentage completion and a planned percentage complete of 33.3% on block D construction programme. Leonard deducted 11.20% of the duration (24 weeks, 4days) from 33.3% of 24 weeks, 4days and assigned/ recorded a negative slip value of -4 weeks, 1 day on the construction programme. When the meeting began, Leonard shared this update on block D construction programme and reported that block D is 2 weeks delayed.

On July 23rd, 2019, the team from both firms created 5 zones from block D. After the meeting, Leonard captured the new 5 zones in block D construction programme and the team from both firms began to use these zones in subsequent meetings to discuss the installation of equipment. On August 6th, 2019, Leonard said that block D was overrunning planned dates and there was a need to revise the dates. On 30th August 2019, the team from both firms created two subzones under the penthouse zone with start/finish dates. After that meeting, Leonard captured those two subzones in block D construction programme and the team from both firms began to use those subzones in subsequent meetings to also discuss the installation of equipment. This suggests that the programme played a role in reviewing progress and breaking the recladding works into smaller manageable tasks.

On 6th September 2019, Leonard and Paige met to review (evaluate) the progress of the recladding works prior to the weekly progress meeting. Paige recorded on the construction programme, a percentage completion of 27.33% and a planned percentage complete of 50.58% for block D. He also recorded the percentage completed at 4 zones ranging from 28.56% to 49.52%. Leonard recorded an overall slip value of (-7d) for block D, negative slip values at 4 zones ranging from (-9d) to (-4d). When the meeting began, Jerome listed in the meeting, equipment he installed and handed over at the 4 zones. Then Leonard asked Paige to chase the delivery of materials for operatives to use the equipment put in place. This suggests that the programme played a role in following up distributed task and responsibilities. The section above illustrates the way the team from both firms began to install hired equipment, review the progress of works weekly and break block D into smaller manageable task that created new zones and subzones. The section that follows describes the arrival of the new cladding material and the issues that led to delay incidents in block D.

4.4.3 Issues with block D

The team from both firms had just begun to use the installed equipment when three issues led to incidents of delays in block D. The first of these three was with the issue of shortages of operatives

to use the equipment to remove the old and install the new panels/materials. The second issue that led to incidents of delay was that Starlin Construction began to struggle with access to the balconies of residents at three critical subzones– the wintergardens- under the north zone to replace the cladding there. The third issue that led to incidents of delay was a nationwide lockdown that lasted for three months due to the COVID-19 pandemic.

Beginning with the first issue of shortages of operatives to use the equipment to remove the old and install the new panels/materials. On 3rd October 2019 Leonard asked the team from Starlin Construction to bring more men to work at three zones namely: the courtyard zone, penthouse zone and the lift overrun subzone. On 10th October 2019, the team from both firms in a meeting agreed to create 3 subzones with 19 activities under the north zone, and a subzone to the penthouse zone with seven activities under three zones. After this meeting Leonard captured the 4 new subzones and activities in block D construction programme. On 17th October 2019, Leonard and Paige met and reviewed (evaluate) the progress of the recladding works before the progress meeting. Paige recorded a percentage completion of 38.51% and a planned percentage completion of 84.17%. He also recorded percentage completion ranging from 24.29% to 60% at the zones and subzones. Leonard recorded a slip value of (-28d) for block D and negative slip values at the five zones, 6 subzones and 33 activities ranging from (-5d) to (-47d). When the meeting began, Leonard shared the programme in the meeting and asked the team from Starlin Construction again to bring more men to the north zone, courtyard zone, penthouse zone and the lift overrun subzone. The shortage is illustrated below in Leonard's observation (operation manager/ Marble Construction) when he said:

> ...I meet members of Starlin and Eagle (subcontractors) separately on Thursday to agree a 2-week labour forecast. This used to be part of the trade progress meeting, but it consumed too much time on one narrow aspect of the work. This labour forecasts used to be our biggest issue with Starlin Construction (subcontractor). We would erect access systems (equipment) and it would be underused and even sat idle. We have a column in the labour forecast for the maximum labour we agree on, and this is how we compare 'utilization' for example if they can work on the scaffold with 10 men but only allocate 2, we have a talking point. When we started this with Starlin Construction (subcontractor), they were on about 60% utilization, and we pay for the access. We also have a row in the labour forecast for the Starlin and Eagle(subcontractor) labour subcontractors. It was meant for an automated calculation– we need labour for the job, the subcontractors need to know how to divide the work between their labour subcontractors. Again, we are trying to produce a worksheet that helps all parties. At the side of each labour forecast, I write any important notes/comments if not relevant to this forecast but maybe coming up into the next forecast. I render a row yellow to say this is a critical path (priority, must not

> decrease labour from these areas whatsoever), red– outstanding questions that come up in our meeting that need answering as soon as possible, ideally before the trade's progress meeting the following day at the latest...
> The idea of the progress meeting is to troubleshoot the construction programme for what we need to achieve and to keep on construction programme, mitigate knock-on issues & highlight forthcoming risks to achieving our goal...
>
> Interview, 18th March 2020

As evidenced above, the quote by Leonard from Marble Construction illustrates four points: first, is that the quote "…. *I meet members of Starlin and Eagle (subcontractors) separately on Thursday to agree a 2-week labour forecast. ….. This labour forecasts used to be our biggest issue with Starlin Construction (subcontractor). We would erect access systems (equipment) and it would be underused and even sat idle …."* illustrates that Leonard and Paige often met to agree on the operatives to hire in advance for the equipment set up at block D and at this moment Starlin Construction was not hiring enough operatives to use the equipment. This suggests that the programme played a role in managing the use of resources such as equipment and operatives. Second, the quote "…. *we compare 'utilization' for example if they can work on the scaffold with 10 men but only allocate 2, we have a talking point. When we started this with Starlin Construction (subcontractor), they were on about 60% utilization, and we pay for the access …."* illustrates that even after Leonard and Paige agree on the operatives to hire, the number of operative Paige hires was less than agreed and this led to incidents of delay on the work progress. Third, the quote "…. *At the side of each labour forecast, I write any important notes /comments if not relevant to this forecast but maybe coming up into the next forecast. I render a row yellow to say this is a critical path (priority, must not decrease labour from these areas whatsoever), red– outstanding questions that come up in our meeting…..*" illustrates that Leonard and Paige linked the labour forecast to the construction programme and responded to delay incidents by using the labour forecast as a record document to regulate the operatives hired in block D by assigning different colour coding on concerned areas. This suggest that the team from both firms mobilized weekly labour forecasts as a record document alongside the construction programme to label delayed areas with colour coding so that they can treat resources at such areas with a sense of priority. Fourth, the quote "…. *we need labour for the job, the subcontractors need to know how to divide the work between their labour subcontractors….."* illustrates a limitation as construction programmes are not directly related to resources but can be used to break down the project into smaller resources such as operatives which the team from both firms learnt during the project. This suggests that the programme plays a role in translating project time into smaller tasks and

manageable resources. Fifth, the quote "……*The idea of the progress meeting is to troubleshoot the construction programme for what we need to achieve and to keep on programme, mitigate knock-on issues & highlight forthcoming risks to achieving our goal…..*" illustrates another limitation in the construction programme that the team from both firms use the progress meetings alongside the labour forecast to raise potential issues of risk or significance that may not be formally captured in the construction programme for attention. This suggests that the programme plays a role in finding solutions to current and anticipated problems.

Not long after the team began to remove the old cladding, a second issue that led to delay incidents was that Starlin Construction began to struggle with access to the balconies of residents at three critical subzones– the wintergardens- under the north zone to replace the cladding there. On 7th November 2019, Leonard and Paige again reviewed the progress on block D before the meeting. Paige recorded a percentage completion of 46.53% and a planned percentage of 94.92%. He also recorded percentage completion ranging from 28.29% to 55.71% for all the zones and subzones in block D construction programme. Leonard recorded on the same programme a negative slip value of (-41d) for block D and negative slip values ranging from (-28d) to (-47d) for the five zones and six subzones. Then, Leonard visually captured the delayed balconies (negative slip values) at different levels by halting the drop line at 9th, 7th, and 16th September 2019 instead of positioning it under the current date of 7th November 2019 in block D construction programme. When the meeting began, Leonard shared the updates on block D construction programme and said that the north zone (37.83%) and courtyard zone (36.11%) have the lowest percentage completion with higher slip values. Cain and Donnie asked Leonard to meet with the team from Starlin Construction on Wednesday, 20th November 2019 to revise block D construction programme. This illustrates the issue that made the team from Starlin Construction to miss planned finish dates at two critical zones and a subzone in block D construction programme. This introduced delays in finishing those balconies and delayed the handing over of block D.

Not long after the troubles in accessing the balconies of residents, a third issue that led to delay incidents was a nationwide lockdown that lasted for three months due to the COVID-19 pandemic. On 23rd March 2020, the UK government imposed a nationwide lockdown that prevented people including construction workers from transiting and this stopped the team from both firms from progressing the recladding work in block D for the next 12 weeks. On 15th June 2020, the team from both firms gradually began to mobilise back to site with measures put in place to control the spread of the corona virus. On 24th June 2020, the team from both firms

agreed to continue having the weekly progress meetings online with the aid of Microsoft teams starting from 3rd July 2020 and exchanged emails of updates to block D construction programme prior to and during the meetings to discuss the progress of the recladding work in block D.

The section above illustrated three issues that led to different incidents of delay and key moments when the team from both firms began to actively use block D construction programme to install the new cladding at block D. The issues included shortages in operatives hired to replace the cladding, difficulties in accessing resident balconies to replace cladding and an outbreak on a pandemic that shutdown the site for 3 months. The quotes above illustrate that the way the team constructed delays due to shortages in operatives in one moment differed from difficulties in accessing resident balconies in another moment. This also differed from way the team constructed delays in another moment due to the outbreak on a pandemic that shutdown the site for 3 months. These issues illustrate the role played by the construction programme in socially constructing delays as visible or concrete with slip values in different moments due to different issues. The sections that follow describe the team's response to visible or concrete delays in block D construction programme that led to a formal reconstruction of slip values.

4.4.5 Response to the issues and visible delays in block D

Two key moments shaped the way the team from both firms responded to the three issues described above. The first part is connected to Starlin Construction and visible or concrete delays in block D on or before 6th December 2019. This involved the team from both firms using block D construction programme to agree on an extension to the finish date on three separate occasions. The second part is connected to a 3-month lockdown and handing over of block D to the housing authority on or before May 21st, 2020. This involved project groups agreeing to use block D public and construction programme to skip the 3 months that the site was shut down due to the lock down. The team's response to these successive delays builds on Marble Construction efforts in assigning two new staff: Cain- (new project manager) and Donne (new contract manager) in October 2019 to take over the management of the project. The section that follows describes the way the team from both firms actively used block D construction programme to socially reconstruct slip values at multiple levels by trying a new sequence and a formal extension of the deadline for block D. (See Figure 4.6).

4.4.5.1 Formally extending the deadline in block D and a new visible sequence

Taking the first responses of project groups to visible or concrete delays in block D on or before 6th December 2019. This part of the story continues from 21st August 2019 and describes how the team from both firms used block D construction programme to extend the finish date, change the sequence of working and reconstruct slip values in block D construction programme. On 21st August 2019, Leonard met with Paige, Presley, and Lingard to revise block D construction programme. Paige opposed the deadline, and they agreed to extend the finish date from 28th October 2019 to 6th December 2019 and then changed the sequence of working at the zones, subzones, and activities to align with this new finish date. After this extension, Leonard and Paige reviewed the progress on block D construction programme and recalculated/reduced the slip value at block D from (– 8 weeks, 1d) to (-7d). He also reduced the negative slip values at the zones. This illustrates how Leonard and the staff from Starlin Construction first reconstructed the slip values and delay in block D.

On 20th November 2019, Leonard met with Paige, Presley, and Lingard to revise block D construction programme as instructed by Cain. Paige pushed back on the deadline, and they agreed to extend the finish date from 6th December 2019 to 3rd April 2020 and then change the sequence of working at the zones, subzones, and activities to align with this new finish date. After this meeting, Leonard met with Paige to capture the changes on block D construction programme and recalculated/reduced the slip value at block D from (–41d) to (-1d). He also reduced the negative slip values at the zones (especially the troubled north and courtyard zone), subzones, and activities to (-10d) and below. This illustrates how Leonard and 3 staff from Starlin Construction again reconstructed the slip values and delay in block D the second time.

Aside from extending the deadline, the staff of Marble Construction introduced a quality assurance sign off documents record with a 5-scale hold-point. This is illustrated below in Jan's observation (quality assurance manager/ Marble Construction) when he said:

> ...We have a quality assurance check system based on five hold-points from the start, which is the main structure of the wall up to the finishing of the panels of the cladding, so I follow these five steps in order to close an area. When they open new areas, I go there and check hold-points, so what I do is just ensure every step is correctly done.
> Hold–point–1 means after the ACM (Aluminium composite materials) panels and the Kingspan installation has been removed, we make sure that the brackets, the cladding installation is in good condition and has no holes, then the brackets are correctly installed with the panel packers behind the C- Channel. The panel packer and the moving joints are

in correct position, dead load bracket in the bottom is on top of the slab and all the rest is slightly in bracket, there are no bends, holes, and the brackets are satisfactory. That's most of it on the hold-point-1, it is just the back structure and the cladding and of course the EPDM (ethylene propylene diene monomer rubber) on top of the frames on sides of the frames doesn't have any damages holes, and in this job we do find the EPDM on all frames, so even if we find good EPDM, let's say EPDM on top of the frame is in good shape, we still have to install a new EPDM membrane on top of everything, so it's not necessary to put them on the side, but it's mandatory to have a new EPDM on top of every frame in this job. EPDM is a membrane that the stops the water to go back to the frame under the spacing inside the home or inside home.

Hold-point-2 is the fire barriers. This is the installation of the fire barriers, we had to install vertical fire barriers to all the frames in the job, then on the sides of the frames and on the party walls.

Hold-point–3 is the insulation, rockwool insulation.

Hold-point-4 is panels installing and alignment, correct alignment of the panels.

Hold-point-5 is the finishing, any angles that need to be installed or flashings, any scratches that you may encounter.
I have to be prepared for final sign off. We ensure that the area remains clean after work, so we had to clean additional, let's say dirt on windows, balustrades. We ensure the area also very clean, all clean before we finish our work, so since this is not part of actual construction, just a part of handing over the area in a clean state, very clean and organized...

Interview, 23rd October 2020

As evidenced above, the quote by Jan from Marble Construction illustrates two points: first, is that the quote "…. *We have is a quality assurance check system based on five hold-points from the start…… up to the finishing of the panels of the cladding, so I follow these five steps in order to close an area……*' illustrates that the team from Marble Construction mobilized a record document linked to the construction programme to monitor the quality of work completed by Starlin Construction. Second, the quote "……*I have to be prepared for final sign off…… this is not part of actual construction but a part of handing over……"* illustrates that handing over recladding works in block is tied to meeting quality standards that is verified and signed by the team from Marble Construction. The process of linking sign off records of quality assurance or checks to the construction programme is illustrated in Cain's remark below:

…. The assistant managers monitor the progress on site, they look at what the fixers are doing. I issue a programme to them, and I'll ask those assistant managers questions on how the subcontractors are progressing because the construction programme is linked to a quality assurance system. If the quality assurance with a graded hold point system is not passed (hold-point-1, hold-point-2, hold-point-3, hold-point-4, hold-point-5), this

> means there is a delay on programme, so when an assistant manager says hold-point-3 is complete, hold-point-4 is complete and then hold-point-5 is complete, we know that we are progressing. So, a subcontractor needs to complete 5 hold-points to earn 100%, because hold-point-1 is 20%, hold-point-2 is 20% and hold-point-3 is 20% and normally when we discuss in the progress meeting, we are following these hold-points, so completing hold-point-1 to hold-point-3 means 60% progress on a particular area. This hold point system is informally linked as you wouldn't see these documents, but you will always hear in the meetings when we talk about quality assurance as the last section, then I'll ask the question, how we're doing with the progress. Then when I update the progress report(programme), I put the drop line, and that dropline works basically on those five points, so when I say 70% or 60 %, I am referring to the hold point system……
>
> Interview, 16th October 2020

As evidenced above, the quote by Cain from Marble Construction illustrates three points: first, is that the quote "…. *The assistant managers monitor the progress on site, they look at what the fixers are doing. I issue a programme to them, and I'll ask those assistant managers questions on how the subcontractors are progressing because the construction programme is linked to a quality assurance system….* illustrates that Cain linked sign-off records of 5 steps as 5 hold-points in the recladding process to the construction programme. This suggests a limitation in the construction programme and that quality record documents linked to the construction are mobilised by the team from both firms to confirm compliance with quality standards and the progress of works. Second, the quote "……*completing hold-point-1 to hold-point-3 means 60%…….. this hold point system is informally linked as you wouldn't see these documents, but you will always hear in the meetings……."* illustrates that the assistant managers use the sign-off record to judge the percentage completed or planned percentage. Paige and Leonard use these percentages to review the progress of the recladding. This suggests that quality record documents linked to the construction programme play a role in socially constructing delays with slip values.

On 14th February 2020, Leonard and Paige met to review the progress of the recladding works prior to the weekly progress meeting. Paige increased the percentage completed from 88% on 24th January 2020 to 89% 14th February 2020. Leonard increased the negative slip value for block D from (-1d) on 24th January 2020 to (-9d) in 14th February 2020 on block D construction programme. He also recorded slip values at five zones with higher slip values at the three subzones– the wintergarden- under the north zone which he labelled as critical zones on block D construction programme. When the progress meeting began, Cain said that the wintergardens at the north zone are critical in handing over block D.

On 6th March 2020, Cain said in the progress meeting that the balconies were slow, Paige responded that they had difficulties accessing the balconies of residents at three subzones– the wintergardens- under the north zone and placed the works at the west bridge zone on hold. This introduced delays in completing block D. On 13th March 2020, Leonard met with Paige, Lingard, and Presley to revise block D construction programme and dates to access the balconies. Paige pushed back on the deadline, and they agreed to extend the finish date in block D construction programme once again from 3rd April 2020 to 15th May 2020 and changed the sequence of working on balconies at the wintergardens of the three subzones in block D. After the revision meeting, Leonard captured these changes on block D construction programme, recalculated/reduced the slip values for block D from (– 19d) on 13th March 2020 to (-1d) on 20th March 2020. He also reduced the negative slip values at multiple levels especially the three critical subzones under the north zone. This illustrates how Leonard, Paige, Presley, and Lingard reconstructed the delay at multiple levels in block D and reduced the slip values the third time.

The events described above illustrate the way the team from both firms socially reconstructed visible delays at block D three times by extending the finish date and changing the sequence of working in block D construction programme. This was because Starlin Construction missed planned completion dates at three critical subzones (the wintergardens) under the north zone. This introduced delays in the handing over block D. The events also illustrate that each time the team from both firms agreed to extend the finish dates, Leonard reduced the slip value assigned at multiple level in block D construction programme. The section that follows describes the way the team from both firms used block D construction programme to skip the 3 months due to the lockdown that shut down the site.

4.4.5.2 Skipping the lockdown when the site was shut down for Three months

Taking the response of project groups to the 3 months lockdown and the handing over of block D to the housing authority on or before May 21st, 2020. This part of the story continues from 15th June 2020, after the lockdown and describes the way the team from both firms actively used block D construction programme to skip the three months that the site was shut down due to COVID-19 and extend the finish date at multiple levels the zones, subzones, and areas) in block D. On the 23rd of March 2020, the UK government imposed a nationwide lockdown that shut down the site and construction activities till 15th of June 2020.

On 15th June 2020, Cain (Marble Construction) and Donnie (the contract manager at Marble Construction) pushed back on the deadline in public programme and the representatives of the housing authority agreed to extend the finish date in block D public programme by 12 weeks. After that agreement, Cain changed the finish date in block D's public programme from May 21st, 2020, to 14th August 2020. Then Cain and Donnie had virtual discussions with Curtis, Lingard and Paige and agreed to capture the 12 weeks inactive period. Then Cain shifted the drop line to 15th June 2020 on the construction programme. He introduced two new activities in block D construction programme under the north zone namely: "*lockdown*" and "*back to work ramping up*". He recorded a start date of 23rd March 2020, a duration of 12 weeks, a finish date 12th June 2020 and a 100% completion for the lock down activity in block D's construction programme. He also recorded a start date of 15th June 2020, a duration of 2 weeks, a finish date of 26th June 2020 and 100% completion for the second activity- back to work and ramping up. Cain increased the duration in block D's construction programme from 45 weeks, 1 day to 58weeks. He used the drop line to skip the months of April and May 2020 and changed the finish date on block D construction programme from 15th May 2020 to 14th August 2020- to align with the new finish date in the public programme for block D.

On 1st July 2020, Cain increased the duration in both programmes. He attached an updated construction programme for 4 blocks including block D and wrote an email to Paige. In the email, Cain asked Paige to provide an update on the progress (percentage complete) on the recladding works on 4 blocks including block D against the first virtual progress meeting on 17th July 2020 (after the 12 weeks lockdown). The email Cain wrote to Paige and copied (3) members of Marble Construction read:

> Paige, please find the attached revised programmes for block D, C, B and E.
> During our weekly update, we require your progress (percentage complete) to be filled for our discussion on progress.
> Jerome said, can we also carry out this progress review ourselves, so we can discuss in the meeting ….
>
> Email conversion, 1st July 2020

When Paige received Cain's email, he printed the same programme Cain sent and used a blue pen to strike out old percentages at subzones and activities on block D construction programme. Then Paige wrote with the blue pen the percentage completed of 98.42% and planned completion of 97.44%. On 16th July 2020, Paige scanned this updated construction programme for block D, attached the updated construction programme and wrote a reply email to Cain and three

members of the team from both firms– site manager, assistant site manager and site supervisor. The reply email Paige wrote and shared this with three members of Marble Construction read:

> Please see % updated
>
> Email conversation: 16th July 2020, 4: 50 pm

When Cain received Paige's email, he used the current percentages received from Paige to calculate and change the slip values at multiple levels by deducting the (percentage complete) 98.42% of 58 weeks duration from (planned percentage) 97.44% of 58 weeks duration for 17th July 2020 in block D construction programme. Cain changed the negative slip value for block D from (-1d) on 20th March 2020 to a positive slip value of (4d) on 16th July 2020. This illustrates how the team from both firms skipped the 3 months that the site was shut down, formally extended the finish date in the construction programme and socially reconstructed or reduced the slip values and delay in block D at multiple levels in block D for the fourth time. Then Cain wrote a reply email back to Paige with a list of comments on the recladding works on the 4 blocks including block D in the night- 16th July 2020. The comments Cain wrote in email and copied 10 members of the team from both firms read:

> "Paige, please find attached site progress as per 17.07.2020 for Block D C B E (based on your updates).
> Can we discuss below concerns /slips on our meeting with a mitigation plan?
> Block D:
> Level 3 winter gardens currently 1-week delay. (CRITICAL) and all other 95% completions should be 100%.
> For overall completion 3 weeks left. 07.08.2020.
> Quality Assurance documents to be fully issued to the contractor-group except remaining winter gardens....."
>
> Email conversation:16th July 2020, 11: 08 pm

On 17th July 2020, when Paige received Cain's email, he replied the comments raised on the updated construction programme for 4 blocks including block D. Paige wrote a reply email back to Cain with further comments in the morning before the progress meeting. The reply email Paige wrote and shared with the 10 members of the team read:

> " Block D:
> Level 3 my mistake 100% all Quality Assurance done.
> Regarding the winter gardens, we have started sending over the Quality Assurance for west 100%, south 100%, east 100% north work in progress....."
>
> Email conversation: 17th July 2020, 8.27 am

At 10:30 am on 17th July 2020, when the virtual meeting began, the team from both firms discussed the progress of work since they returned or mobilized back to site and talked about the percentages, negative slip values at multiple levels.

As evidenced above, the emails exchanged between Cain, Paige and members of both teams illustrate that the construction programme was used as a vehicle to communicate on the percentage progress of work and slip values prior to and in the virtual progress meetings. This suggests that the programme plays a role in negotiating new sequences of working when there are tensions of interest between project group. The programme also played a role in visually capturing new agreements between project groups.

On 23rd July 2020, as construction activities began to pick up at the project site, Cain asked Paige to provide weekly update of the progress of the 4 blocks handled by Starlin Construction including block D. Paige again reviewed the progress of the recladding work and changed the percentage completed in block D. He printed the same programme he received from Cain and used a blue pen to strike out old percentages for resident balconies at level 2 (94%), level 3 (60%), level 6 (60%) level 5 (50%) and ground crew (70%) on block D construction programme. Then Paige wrote with the blue pen current percentages for level 2 (100 %), level 3 (100%), level 6 (95%) level 5 (95%), ground crew (90%). Then he scanned this update on the construction programme for block D and sent the same programme to Cain and 10 members of the team from both firms. When Cain received the email from Paige, he used these current percentages received from Paige to change the slip values at the zone, subzone and activity levels by deducting the percentage of the durations at the zone, subzone and activity from planned percentage for the same areas on the construction programme for 4 blocks including block D. Cain changed the slip value for block D from (4d) on 17th July 2020 to (2d) 23rd July 2020 on the construction programme. Then Cain wrote a reply email back to Paige with a list of comments on the recladding works on the 4 blocks including block D on 23rd July 2020.

On 14th of August 2020, Starlin Construction completed the work, and the housing authority came for regular site visits. The team from both firms continued to use block D construction programme until 14th August 2020 to coordinate and finish the recladding work at block D. On 15th August 2020, Marble Construction began to dismantle all elevating equipment installed at block D for Starlin Construction and removed all equipment at the ending of August 2020.

This vignette illustrated the story of successive delays conceptualized differently by three project groups in the process of completing the recladding block D that involved five versions of the programme. Three project groups used versions of block D programme to socially construct and reconstruct delays as concrete and visible with slip values. Block D was due to be handed over to the housing authority on 21st May 2020. However, the housing authority did not receive a complete work until 14th August 2020 due to a nationwide lockdown that shut down the site for 3 months. This was viewed as a 3-month delay by Marble Construction and Housing authority. Marble Construction and Starlin Construction agreed to complete the same block D on the 6th of December 2019, and both see 14th August 2020 as a 35-week and 6 days delay. The events also illustrate that Starlin Construction and Marble Construction used versions of block D programme to change the sequence, extend the deadline four times to reconstruct/reduce the slip values for block D at multiple levels. The evidence presented at different moments in the vignette II suggest that different project groups engaged different versions of the programme differently in delay incidents. The vignette that follows describes the story of delay incidents when Marble Construction hired another subcontractor - Eagle Construction to takeover block G and replace the cladding in block G.

4.5 Vignette III

This third vignette tells the story of delays conceptualised differently by project groups in the process of recladding block G that involved five versions of the programme. The project groups involved in block G used versions of block G programme to socially construct delays as either abstract and invisible or concrete and visible with slip values recorded on respective programmes. On 25th November 2019, Marble Construction hired another firm- Eagle Construction to replace the cladding of the sixth building which was due to be handed over to the housing authority on 23rd October 2020. The work was completed on 2nd October 2020, but on 23rd March 2020, the site was shut down for 3 months due to a UK nationwide lockdown caused by the COVID-19 pandemic. Marble Construction and Eagle Construction agreed to complete the same block G on 8th June 2020 and equally see 2nd October 2020 as a 16-weeks, 4 days delay. Adam, the project manager for Eagle Construction pushed back against the initial construction programme/duration for block G and disagreed with the deadline of 8th June 2020. Addressing successive delays in block G areas involved the team from both firms, especially six main project members namely: Leonard (Marble Construction), Cain (Marble Construction), Donnie (Marble Construction), Jerome (Marble Construction), Jayden (Eagle Construction) and Adam (Eagle Construction). In

October 2019, Marble Construction reassigned Cain and Donnie to the recladding project to take over the management. The section that follows describes five key moments that led to: (1) Beginning the works in block G and the creation of block G construction programme, (2) the removal of existing cladding at block G, (3) the issues that led to visible delays, and (4) the team's response to visible delays in block G and a lockdown period. (See Figure 4.7)

Block G	Jan 24,2020	Jan 31,2020	Feb 7,2020	Feb 14,2020	Feb 21,2020	Feb 28,2020	Mar 6,2020
% Completion	10	11	12	18	20	22	23
Slip	-12d	-16d	-19d	-12d	-15d	-19d	-12d

Block G	Mar 13,2020	Jul 17,2020	Aug 27,2020
% Completion	44	77.53	84.12
Slip	-8d	-2d, 1h	-3d,2h

Figure 4. 7: Timeline of programme use, progress, and slip values in block G

4.5.1 Beginning the recladding works at block G

The story of delays conceptualized differently by project groups in handing over block G on 30th October 2020 began when Leonard created the second (overall) programme with the start/finish date and duration only of block G which he referred to as 'block G draft programme' and involves the team from both firms using the draft programme as a locus to negotiate their interests. Marble Construction initially planned that Starlin Construction would execute block G and Leonard's priority was that block G should begin on 20th August 2019 with a duration of 24 weeks and end on 18th February 2020 in the second (overall) programme. However, at the end of August 2019, the team from Starlin Construction pushed back on the initial dates and agreed with Leonard to modify the following: the start date from 20th August 2019 to 23rd September 2019, duration from 24 weeks to 25 weeks, 2days and the finish date from 14th February 2020 to 17th April 2020 in the Block G draft programme. Towards the end of October 2019, the team from Marble Construction decided to relieve Starlin Construction of two buildings (block G and F) because they were overstretched and hired a new firm (Eagle Construction) to handle those two buildings.

On 8th November 2019, Leonard received construction plans from Jayden, the construction director for Eagle Construction and integrated the plans into block G draft programme. After Leonard integrated those plans, he modified block G draft programme by "massaging or harmonizing the dates" based on feedback and comments he received from Jayden. On 20th November 2019, Leonard and Jayden used the modifications to block G draft programme to agree on a construction programme for block G with a new start date of 25th November 2019, a duration of 25 weeks, 2 days, and a new finish date of 8th June 2020. This dates/duration differs from the agreement the housing authority had with Marble Construction to start block G on 6th January 2020, with a duration of 42 weeks and a finish date of 23rd October 2021 because they had smaller durations and earlier start/finish dates. Leonard circulated block G construction programme to the team from Marble Construction and Eagle Construction and they began to use the same programme to count the progress of the recladding work in weeks starting from week 40. Jerome began to use this new construction programme for block G to hire elevating equipment on the project site. At the same time, Jayden also began to use the same programme to order the new cladding materials. On 21st November 2019, the team from both firms met for the first time. Three members of Marble Construction: Leonard, Cain and Donnie met with four members of Eagle Construction: Jayden, Zika, Stefan (assistant managers) and Oliver (site supervisor) to discuss the progress of block G and F. When the meeting began, the seven attendees began to discuss the

installation of elevating equipment and Leonard asked Jayden to send an updated construction programme for further review. The events above describe how the team from both firms began works in block G and created a construction programme to coordinate the recladding works beginning with the removal of the old cladding.

4.5.2 Removing the existing cladding at block G

After the first meeting, the team from both firms began to use block G construction programme to coordinate where to install elevating equipment. On 29th November 2019, the team from both firms met and used block G construction programme to discuss equipment installed at the north and west elevation (for operatives to climb and remove existing recladding). Jerome said a gantry and mast climber will be installed for high levels of the north elevation on 6th December 2019. He also said that monorails will be installed at the west elevation of the north phase-one on the first week of January 2020. Jayden replied that he will begin to remove the existing cladding at the north section on 9th December 2019. This is how the team from both firms began to use block G construction programme to coordinate equipment and operatives to work at areas they created during the meeting.

On the 12th of December 2019, the team met at the weekly progress meeting, Jayden asked for detailed design information for the panels at the ground floor and Cain told Jayden to attend design team meetings. Cain said that the design details will be resolved early part of January 2020 by Ronnie or the consultants and works in that area should be on hold (halted). He then asked Leonard and Jayden to finalize block G construction programme. After the meeting, Leonard visually captured the halt on the works at the ground floor Block G north elevation (phase 1) by positioning the drop line on block G construction programme on 2nd December 2019 instead of moving it to 12th December 2019.

On 23rd December 2019, the team from both firms went on a Christmas and New year holiday and Leonard visually captured this holiday on the construction programme by shading the days. On 6th January 2020, the team from both firms resumed and began regular meetings on 10th January 2020. When the meeting began, Cain asked Jayden to hire an experienced work supervisor on site to manage his works effectively. Cain said Marble Construction currently believes the performance of Eagle Construction is not adequate and the team from Marble Construction will be closely monitoring this. Jayden said that works on ground floor Block G north elevation (phase 1) are currently on hold due to design detail clarification. He said he removed panels at the area in

question for detailed inspection by consultants on 15th January 2010 and works are ongoing at the first 2 levels even though he is yet to hand over. Jerome said Block G west elevation cradle will be handed over on 13th January 2020 and Jayden said the number of operatives at this area will rise from 4 to 10 on 13th January 2020.

On 24th January 2020, the team from both firms scheduled a joint inspection with the housing authority and the consultants before the weekly progress meeting for the day. Leonard and Jayden met just before the joint inspection to review (evaluate) the progress of the recladding works at block G. Jayden recorded a percentage completion of 10% and planned percentage completion of 21% for block G on the construction programme. He also recorded current and planned percentages for 9 zones and 25 activities for the zones ranging from 10% to 100%. Leonard deducted 10% of the 25 weeks, 2day duration from 21% of the same duration and recorded a slip value of (-12d) for block G. He also recorded slip values for the 9 zones and 25 activities ranging from (-6d) to (-28d). He recorded the highest negative slip value of (-28d) for the ground floor Block G north elevation (phase 1) because works in that area were on hold. Leonard visually captured the delays on the works at the ground floor Block G north elevation (phase 1) by halting the drop line on 2nd December 2019 on block G construction programme instead of moving it to 23rd January 2020. This illustrates how Leonard and Jayden began to use block G construction programme to construct delays as concrete and visible with slip values and the drop line on the programme. The section above illustrates the way the team from both firms began to use block G construction programme to coordinate the equipment installed, reviewing the progress of works and map out the work into smaller manageable task such as zones and subzones. The section that follows describes issues that led to delay incidents in block G.

4.5.3 The issues with block G

Two months into recladding of block G, the team from both firms had just begun to install the new cladding when three issues led to incidents of delay in block G. The first of these three was the issue of poor-quality workmanship. The second issue that led to incidents of delay was poor site management and an unfinalized construction programme. The third issue that led to incidents of delay was a nationwide lockdown that shut down the site for three months due to the COVID-19 pandemic.

Beginning with the first of issue of poor-quality workmanship. On 23rd January 2020, after the joint inspection, the team from both firms met to discuss the remarks and feedback from the joint inspection. The summary of concerns discussed between the team from both firms is below:

> ..... Ronnie said the officials of the housing authority/ consultants saw unsecured panels and raised concerns over safety. He said he was not satisfied with incomplete works such as gaps, untidy works, use of damaged brackets and said when the housing authority asked questions about incomplete or poor workmanship, he could not give reasonable answers which raised further concerns over the site management of Eagle Construction. He said that Starlin Construction has been on the job for a lot longer than Eagle Construction, but Marble Construction employed them as a specialist (Façade) Design and Build subcontractor for this job.
>
> Cain added that the housing authority is not happy with the performance of Eagle Construction in two aspects: workmanship and site management and wanted these aspects resolved as soon as possible. He told Jayden to fulfil their quality assurance requirements.
>
> Jayden replied that Zika will issue permits for upcoming balcony works and Oliver is solely responsible for quality assurance from now on.
>
> Donnie said quality assurance documents have issues of wrong dates or photos and inspected areas were altered after inspection.
>
> Cain said that dates and photos on Quality Assurance documents cannot be altered and need to be recorded timely. He said these alterations questioned the credibility of the Quality Assurance paper works. He said when Eagle Construction requests for a hold-point inspection, they should send a formal notification by email.
>
> Jayden replied that he will take these points and address them from next site inspection. He said the delays on designs and pending request for information is affecting the progress on site.
>
> Donnie said that pending design issues or information unresolved should continually be on record as delays and notified Marble Construction. He said Marble Construction cannot accept any Quality Assurance issues on site moving forward and this needs to be fixed.
>
> Jayden said the design responsibility of Eagle Construction does not cover fire strategy.
>
> Cain replied that they should continue sending request for information all the same as it needs to go to the housing authority as Eagle Construction is a Design and Build (D&B) contractor on this job. He added that the current conditions such as failed client inspections are affecting Marble Construction's relationship with the housing authority.
>
> Jayden said Eagle Construction would continue to raise request for information on areas that are uncovered even though the details already happening elsewhere on job. He said the construction programme originally did not allow for items currently such as replacing

> all HH and rails, some C-section, and all vertical and horizontal fire barriers, as well as additional EPDMS. He also said the construction programme is to be reviewed at the end of the month and end date of the programme will not be compromised.....
>
> Minutes, 23rd January 2020

As evidenced above, the meeting remarks illustrate five points: first, the remark by Ronnie "*.....unsecured panels ..... incomplete works such as gaps, untidy works, use of damaged brackets and....*" illustrates that the team from Eagle Construction had trouble in measuring up to their obligations of quality and this introduced delays. Second, the remark by Cain "*.... the housing authority is not happy with the performance of Eagle Construction in two aspects: workmanship and site management .....*" illustrates that the poor-quality workmanship was related to the general management of the site. This suggests that the team from Eagle Construction struggled with the responsibility or task of managing the recladding of block G according to specified quality. Third, the remark by Donnie that "..... *quality assurance documents have issues of wrong dates or photos, and inspected areas were altered after inspection.....*" and Cain that *"..... when Eagle Construction requests for a hold-point inspection, they should send a formal notification by email...."* illustrates that the team from Eagle Construction had difficulties with the sign-off record documents linked to the construction programme. This suggests that the programme played a role in ensuring the quality of works executed at multiple levels was met. Fourth, the remark by Jayden that "*.... the delays on designs and pending request for information is affecting the progress on site....."* and Donnie that "*.....pending design issues or information unresolved should continually be on record as delays and notified to Marble Construction. .....*" illustrates that Jayden at this moment blamed design issues for the delays rather than the poor-quality workmanship or the way the team in his firm used the construction programme or sign-off document records linked to the programme. Fifth, the remark by Jayden *"..... the construction programme originally did not allow for items currently such as replacing all HH and rails, some C-section, and all vertical and horizontal fire barriers, as well as additional EPDMS..... the construction programme is to be reviewed at the end of the month and end date of the programme will not be compromised....."* illustrates that Jayden at this moment argued that additional work items that were not initially allowed for in block G construction programme are what led to the delays rather than the way the team in his firm used the construction programme to manage the recladding works. This illustrates the first issue that led to delay incidents in recladding block G.

Not long after the joint inspection, the second issue that led to incidents of delay was poor site management and an unfinalized construction programme. On 31st January 2020, the team from both firms met and Leonard said Block G north elevation area is currently on delays and slowly progressing. Cain asked Jayden to produce a drawing and proposal for the ground floor Block G north elevation. Cain asked why the works at the lift overrun area has not started as planned on the construction programme since equipment was ready since 13th January 2020. Zika said he could not comment on labour operatives and construction programme. Cain asked the team from Eagle Construction to increase the operatives. This illustrates that the team from Eagle Construction cooperated and worked together with Marble Construction even when there was a lack of consensus or agreement on the construction programme, unresolved design issues and inadequate supply operatives on site.

On 7th February 2020, Leonard and Jayden met to review (evaluate) the progress of the recladding works at block G prior to another progress meeting. When the review began, Jayden recorded a percentage completion of 12% and planned percentage completion of 32% for block G. He also recorded current and planned percentages for 9 zones and 30 activities ranging from 10% to 100%. Leonard deducted 12% of the 25 weeks, 2days duration from 32% of the same duration and recorded a slip value to (-19d). He also recorded slip values for the 9 zones and 25 activities ranging from (-5d) to (-38d). He recorded the highest negative slip value of (-38d) for ground floor Block G north elevation (phase 1) since the works at this area was on hold. When the meeting began, Cain said Block G north elevation works is currently delayed. Zika replied that they will catch up on this and they will increase the operatives. He also said he had informed Jayden and they will issue a revised construction programme. Cain said equipment are getting installed as planned previously.

On 9th February 2020, Jayden hired a new project manager– Adam Gonzalez- to manage the recladding in block G and F for Eagle Construction. Adam took over from Jayden and began to manage the team from Eagle Construction. This was because Cain said the performance of Eagle Construction was not adequate and requested that Jayden on 6th January 2020 hires a new experienced work supervisor on site to manage his works effectively.

On 21st February 2020, Leonard and Adam used block G construction programme to review (evaluate) the progress of the recladding works at block G prior to a meeting. When they began the review, Adam recorded a percentage completion of 20% and planned percentage completion of 47 %. He also recorded current and planned percentages for the 9 zones and 25 activities under

block G ranging from 10% to 100%. Leonard compared the planned with the current percentages and recorded an overall slip value of (-15d). He also recorded slip values for the 9 zones and 25 activities ranging from (-5d) to (-48d). He recorded the highest negative slip value of (-48d) for the ground floor Block G north elevation (phase 1) since works on that area was on hold. Leonard visually captured the delay on the works at the ground floor Block G north elevation (phase 1) and continued to halt the drop line on 2nd December 2019 on block G construction programme instead of moving it to 21st February 2020. He also halted the drop line for 9 activities out of the 25 activities at several levels in block G construction programme.

When the meeting began, Cain said block G is 3 weeks behind construction programme. Damon (Assist. Manager- Marble Construction) said that north elevation and cradle zone has not been offered or cleared for hold-point-4 yet. Cain added that Block G north elevation zone has a 20-day delay and works are ongoing with the ground crew. Adam said works started this week at the lift overrun zone. Jerome said that erection of scaffold at the East elevation is still ongoing. Cain said that it is over 3 weeks, and he has not yet received a finalized construction programme for block G. The issue of poor site management and poor quality is illustrated below in Adam's remark (site project manager/ Eagle Construction) when he said:

> ...I deal with the team on site, that are installing the works and I make sure that we have the right available labour for the men to install. Also, we had quality issues here, so effectively I make sure that there is one person in our meetings, and someone take responsibility for it. So, I'd say right quality control, who's going to take ownership of it, so I gave each individual person here roles and tasks to do so that it is defined. We started finding that panels were being manufactured to wrong sizes or there were errors being made in manufacturing. Now the standard process that we had was, we were looking at anything between 4 to 5 weeks to get these panels replaced which we didn't have time to do, so I got the owners of the company down here, I explained the problem that they had with their panels, that they've manufactured wrong and they assured me that they could turn these panels around within one to 2 weeks rather than 4 to 5 weeks. So, my next question was if you can do that with panels that are your fault. You can also do that with panels that were my fault. I mean, we design them wrong, if you can do it within 2 weeks. I then set up with the head of production and with the commercial director of our (suppliers) weekly meetings, some of these meetings could be quite protracted, we could have something like about 30 panels that were waiting to be manufactured. We could have another 20 panels that needed to be put on to that list. But on a weekly meeting with teams up, there will be someone from our firm or me the project manager, someone from the office, that would be their production manager and there will be their commercial director and every week we run through all the panels. We then managed to minimize, although the risk was still there, we managed to minimize the time taken in correcting that problem that we had. So, all of a sudden, Marble Construction could see that before we

> had elevations, which weren't finished and would roll on for weeks, and weeks, and weeks. They would know that if there's a couple of holes in those screens that those holes would be filled within 2 weeks. So again, it is to have confidence on the programme to say look we should have finished by then. These are the issues but it's going to take a couple of weeks and then it'll be close, they could see that happening and I was reporting it. It's a good thing to be honest as well, to a degree to Marble Construction because trying to hide things you just might get caught. So that's really what I brought into the project, it was honesty, a programme that could be delivered, a programme that they could have confidence in...
>
> Interview, November 3rd, 2020

As evidenced above, the quote by Adam from Eagle Construction illustrates four points: first, is that the quote "…. *I deal with the team on site, that are installing the works and I make sure that we have the right available labour for the men to install. Also, we had quality issues here, so effectively I make sure that there is one person in our meetings, and someone take responsibility for it. So, I'd say right quality control, who's going to take ownership of it, so I gave each individual person here roles and tasks to do alright so that it is defined…."* illustrates that when Adam took over in February 2020, distributing tasks and responsibilities or roles to individuals or team on site was connected to the incidents of delays in block G. This suggests that the programme played a role in site management and in defining the roles and responsibilities of supervisory staff. Second, the quote "…….*so I got the owners of the company down here, I explained the problem that they had with their panels, that they've manufactured wrong, and they assured me that they could turn these panels around within one to 2 weeks rather than 4 to 5 weeks…."* illustrates that Adam at this moment responded to delay incidents by having meetings with the supplier firms and negotiating earlier production dates. This suggests that the programme plays a role in negotiating earlier production dates. Third, the quote "…. *We then managed to minimize, although the risk was still there, we managed to minimize the time taken in correcting that problem that we had, so all of a sudden, Marble Construction could see that before….. So again, it is to have confidence on the programme to say look we should have finished by then……"* illustrates that Adam's response to issues that led to delays at this moment involved meetings with suppliers, negotiations to reduce corrections that increased confidence in the programme. This suggests that the programme plays a role in negotiating solutions involving quality and managing the expectations of project groups. Fourth, the quote "……*So that's really what I brought into the project, it was honesty, a programme that could be delivered, a programme that they could have confidence in*..." illustrates that Adam, at this moment used his own programme to tell the team from Marble Construction what he could deliver to restore confidence in Eagle Construction on

the recladding project. This suggests that a programme plays a role in managing expectations. This illustrates the second issue that led to delay incidents in block G.

Not long after Adam took over and began to manage the recladding of block G, the third issue that led to incidents of delay was a nationwide lockdown that shut down the site for three months due to the COVID-19 pandemic. On 23rd March 2020, the UK government imposed a nationwide lockdown that prevented people including construction workers from transiting and this stopped the team from both firms from progressing the recladding work in block G for the next 12 weeks. The way the team from Eagle Construction responded to the lockdown delay is illustrated in Jayden accounts below:

> .... the construction site was closed but Eagle Construction was still working in the background on design issues during the 12 weeks, our design team and engineers were working with Marble Construction, the consultant to resolve these issues over the lockdown of 12 weeks. We didn't go a contractual route with Marble Construction, we didn't want to come across as a contractual company, we wanted to come across as a collaborative team player. Eagle Construction isn't a contractual company, and I don't think Marble Construction come across as a contractual company either. We could have gone to Marble Construction and said look this is the contract situation spelled out in plain English, but we didn't feel that there was a need to do that because it was outside of Eagle Construction control, outside of Marble Construction, there was a national lockdown where you couldn't come in and perform your work. On the other side of the coin, Marble Construction could have exercised their contractor's right, and said that Eagle Construction you were meant to finish in the middle of lockdown, what happened? and you got to respond contractually. So, my view is that you just don't go firing shots when you don't need to. When we remobilized, we were told there was a certain mobilization plan and a slow start put in place to get back on to site, into full production. I think it was probably 3 or 4 weeks of a slow start, so we couldn't go into full production, and we were only allowed to work on certain areas. Marble Construction put these restrictions in place and once we were told we were back in full production, we revised the construction programme. We picked up where we left off and moved our duration, basically moved where we're at and then just change the dates. We got Adam back in June, he revised the programme, basically done a new programme and said now, now we're back in, here's our plan....
>
> Interview, November 3rd, 2020

As evidenced above, the quote by Jayden from Eagle Construction illustrates four points: first, is that the quote "..... *We didn't go a contractual route with Marble Construction* .....I *don't think Marble Construction come across as a contractual company either.....we didn't feel that there was a need to do that because it was outside of Eagle Construction control, outside of Marble Construction, there was a national lockdown where you couldn't come in and perform your work...."* illustrates that the team from both firms at this moment did not adhere strictly to

contract and block G construction programme when the site was shut down for 3 months due to the COVID-19 Pandemic. This suggests that the programme played a role in interpreting what is or what is not a delay in an incidence and not adhering strictly to the initial end date in a programme does not imply that the project has failed, or the project team are incompetent. Second, the quote "..... *Marble Construction could have exercised their contractor's right and said that Eagle Construction you were meant to finish in the middle of lockdown, what happened? and you got to respond contractually. So, my view is that you just don't go firing shots when you don't need to...."* illustrates that according to the construction programme, the team from Eagle Construction were supposed to finish block G in June 2020, but Marble Construction did not treat the missed dates in block G, as a failure of the recladding project. Third, the quote "..... *we revised the programme. We basically picked up where we left off and moved our duration, basically moved where we're at and then just change the dates....."* illustrates that Jayden and Adam at this moment responded to the period of three months lockdown by moving the dates and duration in block G construction programme. This suggests that the programme played a role of simply skipping periods that were mutually unproductive.

The above section illustrates three issues that led to different incidents of delay as the team from both firms removed existing cladding and installed the new cladding in block G. The issues included: poor-quality workmanship, poor site management and lastly a three-month nationwide lockdown due to the COVID-19 pandemic. The quotes above illustrate that the way project groups interpret delays due to poor-quality workmanship in one moment differed from the way the team responded to poor site management in another moment. This also differed from the way project groups interpreted delays due to a three-month nationwide lockdown due to the COVID-19 pandemic in block G in another moment and illustrates different roles played by the construction programme in negotiating solutions, managing expectations, and assigning roles or responsibilities. The section that follows describes the way the team from both firms responded to visible and concrete delays in block G construction programme that led to a formal reconstruction of slip values.

4.5.4 Response to visible delays in block G

Two key moments shaped the way the team from both firms responded to the issues described above. The first part is connected to Eagle Construction and visible or concrete delays in block G on or before 8th June 2020. This involved the team from both firms using block G construction programme to agree on an extension to the finish date and change the start date. The second part

is connected to the response to a lockdown period of 3 months. This involved project groups agreeing to use block G public and construction programme to skip the 3 months that the site was shut down due to the lock down. The team's response to these successive delays builds on Eagle Construction efforts in hiring new staff on the project and developing a collective way of working together. These moments also account for changes key project members made engaging with the construction programme. The section that follows describes the way the team from both firms actively used block G construction programme to socially reconstruct slip values at multiple levels in recladding block G by trying new sequences and a formal extension of the deadline. (See Figure 4.7)

4.5.4.1 Formally extending the deadline in block G and a new visible sequence

Taking the first response of project groups to visible or concrete delays in block G on or before 8th June 2020. This part of the story continues from 28th February 2020 and describes how the team from both firms used block G construction programme to extend the finish date, change the sequence of working and reconstruct slip values. On 28th February 2020, Leonard and Adam met prior to the regular progress meeting and used block G construction programme to review (evaluate) the progress of the recladding works at block G. When the review began, Adam recorded a percentage completion of 22% and planned percentage completion of 55%. He also recorded current and planned percentages for 9 zones and 25 activities under block G ranging from 10% to 100%. Leonard deducted 22% of the 25 weeks, 2-day duration from 55% of the same duration and recorded a slip value of (-19d) on block G construction programme. He also recorded slip values for the 9 zones and 25 activities ranging from (-5d) to (-53d). He recorded the highest negative slip value of (-53d) for ground floor Block G north elevation (phase 1) since works in that area was still on hold. Leonard visually captured the delays on the works at the ground floor Block G north elevation (phase 1) by halting the drop line on 2nd December 2019 on block G construction programme instead of moving it to 28th February 2020. He also halted the drop line for 9 activities out of the 25 activities at several levels in block G construction programme.

After the meeting on 28th February 2020, Leonard and Adam met to finalise the revision of block G construction programme as instructed previously by Cain on 14th February 2020. Adam pushed back on the deadline, and they both agreed to increase the duration from 25 weeks, 2 days to 27 weeks, 4 days, extend the finish date in block G construction programme from June 8th, 2020, to June 24th 2020, change the sequence which involved reducing the zones from 9 to 7 and introduce works involving stripping and installation of cladding at 6 balconies under the east zone. After

they revised block G construction programme, Adam recalculated/reduced the overall planned percentage from 55% to 44%. He also reduced the planned percentages at 6 zones. Leonard recalculated/reduced the negative slip value for block G from (-19d) to (-12d). He also reduced the negative slip values at the 6 zones and moved the drop line at the zones forward by 16 days. This illustrated how Leonard and Adam first reconstructed the slip values at multiple levels in block G.

On March 13th 2020, Leonard and Adam met to review (evaluate) the progress of the recladding works at block G prior to another progress meeting. When the review began, Adam recorded a percentage completion of 44% and planned percentage completion of 55%. He also recorded current and planned percentages for 7 zones and 25 activities under the zones ranging from 10% to 100%. Leonard deducted 44% of the duration 27 weeks, 4 days from 55% of the same duration and recorded a slip value of (-8d). He also recorded slip values for the 9 zones and 25 activities ranging from (-3d) to (-25d). He recorded the highest negative slip value of (-25d) for ground floor Block G north elevation (phase 1). Leonard visually captured the progress on the works at the ground floor Block G north elevation (phase 1) and moved the drop line to 10th February 2020 on block G construction programme instead of moving it to 13th March 2020.
The events described above illustrate the way the team from both firms agreed to extend the finish date in block G construction programme and reconstructed slip values at multiple levels (overall, zones, subzones, and activities) in block G which reduced the slip values. This was because Eagle Construction began to miss planned dates, and this introduced delays in block G. The section that follows describes the way the team from both firms actively used block G construction programme to skip 3 months that the site was shut down due to a nationwide lockdown before handing over of block G.

4.5.4.2 Skipping a lockdown period when the site was shut down for Three months

Taking the second response of project groups to the three months lockdown period and handing over of block G to the housing authority on or before 23rd October 2020. This part of the story continues from 15th June 2020 after a three-month lockdown that started on 23rd March 2020 and describes the way the team from both firms actively used block G construction programme to skip the three months that the site was shut down due to COVID-19 and extend the finish date at multiple levels for the zones, subzones, and activities in block G.

On 15th June 2020, Cain moved the drop line from 23rd March 2020 and skipped inactive months of April and May 2020 due to the nationwide lockdown and placed the drop line on 15th June 2020

in block G's construction programme. He attached a copy of this update on block G construction programme and emailed it to Donnie, Jayden, and Adam before they met virtually on the 15th June 2020 to discuss. They agreed that the team from Eagle Construction should use two weeks starting from 15th June 2020 and ending on 26th June 2020 to mobilise back to site. Adam argued on the deadline for block G in the construction programme and they also agreed to increase the duration at 7 zones by 12 weeks due to the lockdown and to review the progress in block G by month end after Eagle Construction has mobilized backed to site. Adam said he would contact the suppliers for new delivery dates for orders from panel manufacturers. This illustrates how the team from both firms used block G construction programme to skip periods that the site was shut down due to COVID-19.

After the virtual meeting and discussion, Cain and Donnie continued to discuss with Adam and Jayden on revising block G construction programme. On 1st July 2020, Adam opposed the deadline for block G in the construction programme and Cain responded that he does not want to extend the hand over date in the public programme. Cain added that he does not want a 12-week extension to block G construction programme due to the lockdown to lead to an extension of the finish date (23rd October 2020) in the public programme. On 17th July 2020, they agreed to change: the start date of block G from 25th November 2019 to 1st November 2019 and increased the duration from 27 weeks, 4 days to 44 weeks, 4 days, extend the finish date from 24th June 2020 to 30th September 2020 and created a new subzone with 3 activities. After the agreement, Adam and Cain met to review the progress on works in block G: Adam recorded a 77.53% percentage complete and a 70.72% planned percentage complete. He also recorded percentages at the zones and activities. Cain changed the slip value from (-8d) in March 2020 to (-2d, 1h) on 17th July 2020. He also recorded lower negative slip values for zones and positive slip values for 5 activities. This illustrates how Cain, Donnie, Jayden, and Adam again reconstructed the slip values the second time at multiple levels in block G construction programme to avoid an extension of the finish date of the public programme.

On 27th August 2020, Cain and Donnie met to discuss block G construction programme with Adam and Jayden. Adam faulted the deadline of block G and they agreed again to change: the sequence working, and increase the duration from 44 weeks, 4 days to 45 weeks, 1 day, extend the finish date from 30th September 2020 to 2nd October 2020. Then Adam recorded a percentage complete of 84.12% and planned percentage complete of 86.47%. He also recorded percentages at the zones and activities. Cain also changed the slip value from (-2d,1h) in August 2020 to (-3d,2h). He

also recorded negative slip values for 6 zones, a positive slip values for the east zone (11d) and 5 activities. This illustrates how Cain and Adam reconstructed the delay with slip values at multiple levels in block G construction programme the third time.
The team from both firms continued to use block G construction programme to coordinate the recladding work at block until Eagle Construction completed the works on 2nd October 2020 and Marble Construction dismantled elevating equipment to hand over on 23rd October 2020.

This vignette illustrates the story of successive delays conceptualized in recladding block G that involved five versions of the programme and the way project groups actively used block G construction programme to avoid an extension in block G public programme and socially construct delays as concrete and visible with slip values on the construction programme. This involved project groups engaging different versions of the programme differently and this enabled the project groups to construct and interpret delays differently. The events above also illustrate that Eagle Construction and Marble Construction actively used versions of block G programme to change the sequence of recladding, extend the deadline three times, and reconstruct slip values three times by extending the finish date, increasing durations, and changing the start date at multiple levels. The incidents of delay in block G illustrate that project groups responded to the visible or concrete delays with a situated use of versions of block G programme to negotiate a new sequence for recladding, extend the finish date for block G, reconstruct slip values, and skip a 3-month period when the site was shutdown. The points evidenced in this vignette demonstrate different moments where different project groups engaged different versions of the programme differently in delay incidents. The vignette that follows describe the story of delay incidents in block F when Marble Construction hired Eagle Construction instead of Starlin Construction to replace the cladding at block F.

4.6 Vignette IV

This fourth vignette tells the story of delays conceptualized in block F that involved five versions of the programme. The project groups involved in block F used versions of block F programme to socially construct delays as either abstract and invisible or concrete and visible with slip values on respective programmes. On 25th November 2019, Marble Construction hired Eagle Construction to replace the cladding of Block F. Block F was the seventh building that the two firms started and was due to be handed over to the housing authority on the 19th of January 2021. Marble Construction and Eagle Construction agreed to complete block F on 8th July 2020, however block F was not completed until the end of November 2020. In December 2019, Eagle

Construction uncovered structural defects at the lift shaft or core tower in block F that slowed the works down at the north zone and then in March 2020, all works stopped for 3 months due to a UK nationwide lockdown caused by the COVID-19 pandemic. The site project manager for Eagle Construction pushed back against the initial construction programme/duration for block F and disagreed with the deadline of July 2020. The team from Marble Construction and Eagle Construction agreed to change the construction programme for block F to begin in January 2020 and end in November 2020. Addressing successive delays in block F involved the team from both firms, especially five main project members: Leonard (Marble Construction), Cain (Marble Construction), Donnie (Marble Construction) Jayden (Eagle Construction) and Adam (Eagle Construction). The section that follows describes five key moments that led to (1) Beginning the works in block F and the creation of block F construction programme, (2) the removal of existing cladding at block F, (3) the issues that led to delays in block F including the discovery of structural defects at the lift shaft or core tower at the north zone, and (4) the team's response to visible delays in block F and a lockdown period. (See Figure 4.8)

Block F: Programme engagement	Construction progress

Block F	Jan 31, 2020	Feb 7,2020	Feb 14, 2020	Feb 21,2020	Feb 28,2020	Mar 6, 2020	Mar 13,2020
% Completion	0	3	5	7	9	9	26
Slip	-5d	0	-3d	-5d	-10d	-14d	-2d

Block F	Mar 20, 2020	Jul 17,2020	Sep 4, 2020,
% Completion	29	63.50	77.07
Slip	4d	-3h,58 min	-6d

Figure 4. 8: Timeline of programme use, progress, and slip values in Block F

4.6.1 Beginning the recladding work in block F

The story of delays conceptualized differently by project groups in handing over block F on 30th November 2020 began when Leonard created the second (overall) programme with the start/finish date and duration of block F only which he referred to as the 'block F draft programme' and involves the team from both firms using the draft programme as a locus to negotiate their interests. Marble Construction initially planned that Starlin Construction would execute block F and Leonard prioritised that block F would begin on 1st October 2019 in the second (overall) programme, but as October 2019 approached the team from Starlin Construction pushed back on the start date and Leonard changed the start date of block F to 23rd December 2019, with a duration of 25 weeks and a finish date of 12th June 2020. However, when Marble Construction noticed that Starlin Construction was overstretched, they decided to hire Eagle Construction take over and execute the recladding of block F. On 21st November 2019, Leonard received construction plans from Jayden- the Construction director for Eagle Construction- and integrated the plans into block F draft programme. After Leonard integrated those plans, he modified block F draft programme by "massaging or harmonizing the dates" based on feedback and comments he received from Jayden. Leonard changed the start date from 23rd December 2019 to 27th January 2020, decreased the duration from 25 weeks to 22 weeks, 4 days and moved the finish date from 12th June 2020 to 8th July 2020. This date/duration differs from the agreement that the housing authority had with Marble Construction to start block F on 23rd March 2020, with a duration of 43 weeks, 2d and a finish date of 19th January 2021.

On 23rd January 2020, Leonard and Jayden used block F draft programme to agree on a construction programme for block F with a start date of 27th January 2020, a duration of 22 weeks, 4 days, and the finish date of 8th July 2020. This illustrated the role of versions of the programme in creating different expectations for different project groups.

Leonard circulated block F construction programme to the team from Marble Construction and Eagle Construction to coordinate the recladding works. Jerome began to use the same programme for block F to hire elevating equipment on the project site. At the same time, Jayden also began to use the same programme to order new cladding materials/panels. On 24th January 2020, the team from both firms began to use block F construction programme in weekly progress meeting to discuss equipment received and operatives to hire. Leonard moved the drop line to the current week (24th January 2020) in block F construction programme and labelled this update of block F construction programme as "week 49 progress". He continued to use updates of the

construction programme every week to count the progress of the recladding work in weeks before sharing it at subsequent meetings. The above section illustrates the way the team from both firms actively used block F draft programme to create block F construction programme. The section that follows describes the way the team from both firms began to remove the existing cladding and actively use block F construction programme to socially construct delays at multiple levels.

4.6.2 Installing equipment in block F and removing existing cladding

The section describes the way the team from both firms actively used block F construction programme to break down block F into smaller manageable tasks called zones to install equipment used to remove existing cladding and the social construction of delays as visible or concrete with slip values.

On 30th January 2020, Leonard and Jayden met to review the progress of the works in block F prior to the regular progress meeting. Jayden recorded 2% as planned percentage complete, and Cain recorded a negative slip value of (-5d) on block F construction programme. When the meeting began, the team from both firms agreed to break block F into 9 zones and Leonard captured these zones with start dates, durations, and finish dates in block F construction programme.

On 14th February 2020, Leonard and Jayden met again to review the progress of the works in block F prior to another meeting. Jayden recorded an overall percentage completion of 5% and a planned percentage complete of 8%. He also recorded percentages at 9 zones and for 29 activities. Cain calculated and recorded an overall slip value of (-3d) for block F. He came about this slip value for block F by deducting 5% of the total duration of 22 weeks, 4 days completed for block F from 8% of 22 weeks, 4 days planned for 14th February 2020 and assigned/recorded a negative value of (-3d) in block F construction programme. He also calculated and recorded negative slip values for the 9 zones and activities. Then Leonard used the current percentage of 5% and negative slip value of (-3d) from the review to position the drop line at the current date of (14th February 2020) in block F construction programme, but halted the drop line for three areas at 10th February 2020 instead of moving it to 14th February 2020 namely: north ground crew zone, north elevation, and west elevation. When the meeting began, Jerome said amongst other things that the mast climber at the chimney section of the north elevation will be handed over to Eagle Construction in the coming week- 17th February 2020. Jayden replied that works will begin in the coming week- 17th February 2020. Jerome said that the monorail at the West elevation will be handed over in the coming week- 17th February 2020. Then Cain said revisions to block F

construction programme has not been finalized yet, and asked Jayden to issue his comments and finalize with Leonard. The events above illustrate the way the team from both firms began to actively use block F construction programme to map out the recladding work in block F which they broke down into smaller manageable tasks called zones, install equipment at the different zone used to remove the existing cladding and socially construct delays as visible with slip values. The section that follows describes three issues that led to delay incidents in block F.

4.6.3 The issues with block F

The team from both firms had just begun to remove the existing cladding when three issues led to delay incidents in block F. The first of these three was the issue of structural defects at the lift shaft or core tower discovered at the north zone and a lengthy design approval process that was unexpected. The second issue that led to delay incidents was poor site management and the reason a skilled or experienced site manager was newly hired to adequately coordinate the task and responsibilities of recladding block G and F. The third issue that led to delay incidents was a nationwide lockdown that lasted for three months due to the COVID-19 pandemic.

Beginning with the first issue of structural defects at the lift shaft or core tower discovered at the north zone. This led Jayden to halt the recladding work at this zone to seek clarification from the team from Marble Construction and the consultants on the structural design details. The team from Eagle and Marble Construction could not find sufficient design details for this tower lift shaft to proceed with the installation of the new cladding. This further halted the recladding work at the north zone until the team from Eagle Construction were able to design and obtain approval for structural engineering calculations of the core tower or lift shaft from the consultants. The approval from the consultants took 2-3 months long before it was given. When Eagle Construction received the approval of the design at the north zone, the team from both firms argued that they were entitled to more time and negotiated with the team from Marble for a change in the sequence of work on block F because of the new engineering design for lift shaft or core tower. This process is illustrated below in Damon's observation (assistant site manager/ temporary works supervisor- Marble Construction) when he said:

> ...I got to know that there was a delay in block F that same day that Eagle Construction started to strip out the old panels. They stripped out every cladding material and I saw after we checked that it didn't look right. We (the site managers) and team on site realized that Eagle Construction had a different structural design there, so they needed to stop, take pictures, and send those to the designers. We asked questions let's say 2-3 days

> straight after we stripped out the entire tower and when we found out that the recladding at the core tower or lift shaft would be delayed. We didn't know how long this is going to be delayed to be honest. The designers said that they don't have any structural details and we (Marble Construction) did not find the wind load calculations, so now some calculations needed to be done there, but then we also realized that some structural elements in some places were wrong there, they didn't do the design correctly at the time, so we needed to change that as well and then on the sides were the steel beams, they were dropping, so we had to change those as well, for the steel beams, there were not enough fixings and packers. We then asked Eagle Construction how long it is going to take for the clad materials to be procured and we found out together, all this led to I think about two to three months delay there, so we had all the calculations, all the right materials. So, the absence of the structural elements details was the cause of that delay, and this led to a revision the programme for Block F, because honestly these programmes here are made up, they are done in such a way that we can forecast these delays. So myself, the project manager, the contract manager and Eagle Construction revised the programme, but not so much, as we still hit the dates. I think we revised the construction programme but not the public programme....
>
> Interview, October 28th, 2020

As evidenced above, the quote by Damon from Marble Construction illustrates four points: first, is that although Damon judged that recladding works at the north zone had the potential of being delayed due to structural/engineering defects on the cladding carrier system, he did not have an idea or know precisely the magnitude of the imminent delay when it was discovered. This suggests that Damon conceptualized the potential of a delay as abstract and invisible at this moment. Second, the above quote *"…. these programmes here are made up, they are done in such a way that we can forecast these delays…."* illustrates that he understands that the construction programme is not accurate, yet they can be used to predict a future likelihood of delay and manage the progress. This suggests that the role played by the construction programme at this moment was not necessarily about accuracy but served to mediate between the two firms. Third, the above quote *"the absence of the structural elements details was the cause of that delay*" illustrates that Damon apportioned blame externally on the lack of engineering design details rather than blaming the construction programme or the team from Eagle Construction. Fourth, the above quote "*I think we revised the construction programme, but not the public programme"* illustrates that the same delay in one moment was interpreted differently by Marble Construction and the housing authority as the delay was visible on block F construction programme, but not on block F public programme. This suggests that the way the two project groups engaged with the construction and public programme differed at this moment when responding to this delay incident. This is because the public programme and the housing authority were not involved when

works at the north elevation zones was halted and did not see any need to revise the public programme. However, the team from Eagle and Marble Construction responded to the delay incidence at the north zone by revising the construction programme for block F.

The process of revising the construction programme for block F is further illustrated below in Adam's observation (the site project manager for Eagle Construction) when he said:

> ... We had delays with the lift shaft or core tower. I found out that there would be delays at the core tower when we opened up the area, looked at the substructure of the core tower and saw that the fixings to the structure and the rails were not sufficient to carry the load. I spoke to Cain (project manager), Donnie (contract manager) and Lee (the design coordinator) about the core tower and I wrote emails on this as well, because you need to have written evidence. We conducted an engineer's review of it, it came back with certain criteria that we had to do an engineering calculation on it and send for approval to the consultants. I was reporting on this on a weekly basis, and I went to Marble Construction and said, we still haven't got approval, we still haven't got approval. That took an awful long time and came back with a lot of questions. We asked where the original engineering calculations was, give us and we'll just supplement, but no one could find those engineering calculations, so we had to start from scratch which took something in the region of 2 months, over 2 months to get engineering approval and that caused the delay. I think it ran through June and July 2020. We got the approval in August 2020. I had to manufacture it, so that took 4 weeks through August 2020.
>
> When we finally got approval of the engineering calculations for the substructure, I went to Marble Construction and their team and I issued them a new construction programme for block F. It was like 10-12 weeks fixed duration within that programme to have that work started and then finished, they didn't really like it, but I said, look effectively until now, this is my new prototype, what you got to be mindful of is, we should have finished this at the end of September 2020 and this is now when we can start this core tower area, this is my entitlement and my entitlement was 12 weeks. This is when I can start and unfortunately, this is when we're now going to finish and it was only a case of moving that duration to when I could start, and I think the actual duration was till the middle of November 2020. Now they didn't like it, but they had to accept it because there was an entitlement for the duration of works. We had a joint programme that was agreed from my programme and their construction programme on the duration of time for that tower and they said, is there anything you can do to help us out. I said we will do the best to see how quick we can finish it....
>
> Interview, November 3rd, 2020

As evidenced above, the quote by Adam from Eagle Construction illustrates three points: first, that Adam found out initially about the potential of a delay when the cladding was opened and subsequently found out about the substantial delay after obtaining approval and calculating his "entitlements". This suggests that Adam initially conceptualized the potential of a delay as abstract and invisible and subsequently conceptualized the substantial delay as concrete or visible on

block F construction programme. Second, the quote "... *over 2 months to get engineering approval and that's what caused the delay* ..." illustrates that Adam at this moment apportioned a blame externally on the engineering approval process rather than blaming the construction programme or individual that developed the programme. Third, the above quote "*When we finally got approval ..... I issued them a new construction programme for block F..... they didn't really like it, but I said ..... we should have finished this at the end of September 2020 and effectively this is now when we can start this core tower area, this is my entitlement, and my entitlement was 12 weeks..... Now they didn't like it, but they had to accept it because there was an entitlement for the duration of works. ..."* illustrates how a delay was socially constructed as Adam at this moment pushed back against the deadline in block F construction programme, argued for more time from the team from Marble Construction and introduced a new construction programme for block F that was not pleasant to the team from Marble Construction. This suggests that the construction programme served as a locus for negotiating and settling disputes or claims between the team from both firms to agree and continue working together.

The process of negotiating with the construction programme for block F is further illustrated below in Adam's observation (the site project manager for Eagle Construction) when he said:

> ....So that was a key issue, because the lift core activity within that programme became the critical path, until we finished the lift core, we could not complete the project on block F, so the lift core was delayed by 2 months, the start and the completion then set itself outside all the other activities and became the critical path and that's why the programme was changed both mine and their construction programme to reflect the critical path was on the lift core. The position I was taking was really down to an extension of time, hence the fact I'd actually written on this saying when is this going to be approved, it is taking an awful long time. What should normally be not more than 2 weeks within the contract duration for approval, ended up with over 2 months, so as a result through no fault of our own, we were going to have to need an extension of time to complete that work and normally that then activates additional prelims, management costs.
> This is how we changed the programme because the size of the panels for the tower core area hadn't changed in block F and all the panels had already been manufactured. It was strengthening of the substructure for wind loads and dead loads, so it was more to do with changing the thickness of rails, the size of bolts, the stuck beams, and the metal support beams. We had to get half of those remanufactured because they weren't sufficient to be installed, so we went to the various suppliers for fixings, for rails, for the stuck beams and they said it was going to take between 3 to 4 weeks to manufacture. We had an engineering report given to us that was agreed (that was a date), we had for procurement, there's an entitlement for procurement, which is 4 weeks, and I had an entitlement for installation which was 16 weeks, so that was what I then put on the programme. I adjusted the programme and issued that to my team, then issue the

> programme before the progress meeting to Cain and Donnie. I brought the new programme for block F to the meeting to discuss it with them. Once I knew that the material had been ordered, I said this is now the programme because we go through each activity and I said this particular activity will not now finish until the middle of November 2020 and their faces dropped and everything went quiet, and I said that is my entitlement on your construction programme, I have been given 16 weeks to finish and I have now this date when I can start and I want 16 weeks on from that, and that's going to take me to the middle of November 2020...
>
> Interview, November 3rd, 2020

As evidenced above, the quote by Adam from Eagle Construction illustrates two points: first, the quote "..... *that's why the programme was changed both mine and their construction programme to reflect the critical path was on the core that the lift core* ...." illustrates that the delay incident led to changes in Eagle Const. programme for block F and block F construction programme used by Marble Construction. This suggests that delay incident on a programme used by a project group can have a knock-on effect on another programme used by another project group. Second, the above quote *"so we went to the various suppliers .....and they said it was going to take between 3 to 4 weeks to manufacture, so effectively we had an engineering report given to us that was agreed, that was a date, we then had for procurement. There's an entitlement for procurement, which is 4 weeks and then I had an entitlement for installation which I think was 16 weeks so that was what I then put on the programme*....." illustrates how Adam crafted reasons for an extension and the delay at the lift shaft or core tower led to a mutual accommodation of the work and the construction programme as the team from Eagle Construction changed orders from suppliers and the team from Marble Construction agreed to change the construction programme. The process of constructing delays involved mobilizing other current records that are linked to the programme which is illustrated below in Jan's observation (the quality assurance manager for Marble Construction) when he said:

> ..... I share the same office with Damon, and we work closely, he was doing the quality assurance, but I came in order to take this work from him and allow him to do other duties, so we are both doing quality assurance but, what I am doing now is still under his supervision. We place different floor plans and elevations of blocks and recladding on the wall as our manual tracker. So, what I do if I know I have been to an area and Eagle Construction has progressed this area is just to erase the previous hold-point and put a new one, so this is how I work and then at the end I do my tracker on the computer and finish the work. To cross check what subcontractors claim they have done, I try to attend to the areas again and find out by looking at the construction programme and the respective elevation that needs to be finished. When I see some pushing back from the construction programme, I try to find out what is the issue and I try to help our team and their team too by providing them with access or go find out what's the problem with the

> panels or the angles- why is there a pushing back and try to contribute to it as much as I can in that direction.
> I found out about the lift shaft/core tower in block F and consequent delay in block F when Eagle Construction opened the cladding to check what was behind in December 2019, because I assisted in that. They opened a few panels to check what was behind and they found that the design was different throughout the wall, so that was the first thing that gave it all, they saw that the firebreak wasn't or hasn't been installed yet, so they had to take that into consideration as well and when they removed the insulation, they saw the brackets were different, different rails, and horizontal fire break. So, this had been discussed with the consultants- designers and the designers of Starlin Construction as well. They agreed on where to use the same system but change or introduce a new horizontal fire-breaker halfway through the tower from ground level to level nine. Around level 5, we had to introduce a different fire breaker which we have not used in this site since we started. Eagle Construction had to wait for a response from the designers for block F. This pushed back a little bit on the tower progress because we had to ensure the distance from the mast climber to the back of the wall was a bit bigger or larger than the maximum accepted distance from the mast climber, so we had to introduce a safe system of work by introducing some mast climber with extensions, after the panels were removed. We introduced small mast climber to remove the panels and then introduce an extension tree to work close to the panel and then we did so again to install the panel.....
>
> Interview, October 23rd, 2020

As evidenced above, the quote by Jan (the quality assurance manager) illustrates two points: first, the quote "…. *We place different floor plans and elevations of blocks and recladding on the wall as our manual tracker. So, what I do if I know I have been to an area and Eagle Construction has progressed this area is just to erase the previous hold-point and put a new one, so this is how I work and then at the end I do my tracker on the computer and finish the work…..*" illustrates that Jan used manual trackers such as floor plans or elevations of block F with a quality control record system known as hold-points beside the construction programme to visually trace or track the progress of the recladding works on block F executed by the team from Eagle Construction. This suggests that there is a limitation in how much information that the construction programme can capture especially on current progress. Second, the quote "……*To cross check what subcontractors claim they have done, I try to attend to the areas again and find out by looking at the construction programme and the respective elevation that needs to be finished. When I see some pushing back from the construction programme, I try to find out what is the issue and I try to help our team and also their team too*……" illustrates that Jan's responsibility involved checking claims of the team from Eagle Construction on progress with the aid of the manual tracker and block F construction programme. This suggests that the team from Marble mobilized trackers as

current records linked to the construction programme to check claims and track the progress of recladding in block F.

The process of constructing delays involves linking another current record of quality (hold-point-system) with the construction programme and this is illustrated below in Jan's observation (the quality assurance manager for Marble Construction) when he said:

> .... Because the design was different, we went forward with different areas, building up other sides. We were ready to start the core tower in January 2020, but we could not because we were still waiting for answers or response from the consultants. So, we opened up or offered access to equipment in different areas, so that we do not stay behind the construction programme, and then start the lift shaft later. I think that was a logical solution to take, if we cannot work here, let us go ahead with another elevation that could be pushed back by the construction programme. Our managers and the manager of the Eagle Construction together in a meeting agreed and decided that if we cannot work on the left, let us work on the right, so we moved and provided access for equipment to a different area so as not to lose too much from the construction programme for block F.
>
> My role in inspecting/quality assurance gives Marble Construction an idea or confirms where a subcontractor actually is with the work, so they can know where to put the drop line on the programme. Sometimes we stay with Cain when he updates the construction programme, and he asks us where we are with that elevation and with that hold-point, and we give him the real situation on time. He would ask us how many percent, what's the percentage of that elevation, then we would say based on our quality assurance we are about 50% of value, so with this outcome, he can put himself in front of the construction programme or behind on that part, but he always informs us when we are back, or we're pushed back of the construction programme. So, he informs us when there is a delay or pushback, and we also inform him of the progress. This is sometimes done in a meeting, sometimes in his office by discussion with Jerome, Damon and Callen and Bond....
>
> Interview, October 23rd, 2020

As evidenced above, the quote by Jan (the quality assurance manager) illustrates two points: first, the quote ".... *we went forward with different areas, building up other sides*....." illustrates that Jan responded to incidents of delay by progressing with other areas pending when approval of the engineering details for the lift shaft or core tower was obtained. Second, the quote ".... *Sometimes we stay with Cain when he updates the construction programme, and he asks us where we are with that elevation and with that hold point, and we give him the real situation on time. He would ask us how many percent, what's the percentage of that elevation, then we would say based on our quality assurance we are about 50% of value.* ...." illustrates the process that Cain and Jan take to know current percentage of work done compared to planned works and how they update the construction programme that is linked to current records such as trackers and the hold-points in

discussions. The way the team from both firms responded to incidents of delay involved project member attending design meetings sessions illustrated below in Lee's observation (the design coordinator for Marble Construction) when she said:

> .....It's always the danger of working with existing buildings as you never know what you're going to get until you actually unwrap it and find what's there. Despite our best efforts to find all the information, for some reason block F which should have been exactly the same design detail as block E wasn't, when we took the cladding off, now it's frustrating and annoying for everyone, because then you got redesign issues, you've got to redesign areas, you've got to take what you got and make sure it works with what you're proposing, so it was very unfortunate, so the defect and this is the problem and this is the reason that we brought Starlin Construction back unto this project, we knew if we uncovered a defect, something that they didn't do properly the first-time around, we basically had them over a barrel, because they had done it badly their first-time around. So, they would always have to make it good at their own cost, not at our own cost and nobody else. Starlin Construction were doing block E and sort of as luck would have it or would not have it Eagle Construction, we're doing the lift shaft in block F and G and what happened was that the construction couldn't be justified for various reasons. I'm not a structural engineer, so I can't go into the absolute detail, but what was actually there was very difficult to justify the design for and that's it, that was a Starlin Construction defect because they did it originally. So, the decision was taken that Starlin Construction will design block E, F & G lift shafts because they are your responsibility. They made a mess of this, they've got to pick up the issue and to be fair, that's what Starlin Construction did, they picked it up, the justified the design. We got the old design justified and Eagle Construction then took on that design and completed it. It's quite complicated, but what we're seeing is Starlin Construction, this is your own defect and we've got 12 years and you're not through your 12 years yet, so you've got to pick up your defect, you didn't build it right the first time, you got to put it right and they did, and that's what we've done...
>
> Interview, October 23rd, 2020

As evidenced above, the quote by Lee (the design coordinator) illustrates two points: first, the quote *".... despite our best efforts to find all the information, for some reason ...."* illustrates a false assumption that the delay incident in block F was due to missing information that was erroneously left out at the beginning of the project. This suggests that Lee blamed the lack of information as the reason for delays in block F instead of the of the construction programme. Second, the quote ".... *this is the reason that we brought Starlin Construction back unto this project, is that we knew if we uncovered a defect right, something that they didn't do properly the first-time around, we basically had them over a barrel, because they had done it badly their first-time around. So, they would always have to make it good at their own cost, not at our own cost and nobody else....."* illustrates that the existing cladding was initially done by Starlin Construction 12 years ago and Marble Construction hired them again in 2019 to execute the recladding because

they could rely on them to bear cost in disputes. This suggests that construction firms have greater confidence in working with firms they have worked in the past to save money, protect business interest, and avoid tension.

The way the team from both firms responded to incidents of delay with the aid of the programme is illustrated below in Lee's remark (the design coordinator for Marble Construction) when she said:

> ...I found out that there was there was a problem when Eagle Construction took off the cladding material and we found there was a different steel frame on the building of F and G and when the designer of Eagle Construction went to justify the design and couldn't. We had ongoing design meetings monthly, these were open issues that we discussed at the meeting and how to resolve them and how to overcome. This was during the COVID-19, it right in the middle of it, it sort of started in March 2020 and continued until recently to the June, July 2020 time. The design of the brackets was with Eagle Construction and it's for consultants to check and agree that that they meet the specification, so it was the consultant and the engineer of Eagle Construction who checked all the engineering structural calculations. There is the primary steel work and then there's the helping hand brackets and the frames. So there's more than one thing, so there was a different primary steelwork frame design, and then there was the helping hand brackets, and then there was the cladding rails. It's a case of taking what's there, getting the consultants to confirm what they're happy with and then it's just a case of trying to structurally do calculations to justify what's there until you get to the point that you can't do it, and then you have to try, get another means of doing it, so adding different brackets rails or fixing points. So, it was an exchange of information between Eagle Construction, consultants for over a period of probably 6-8 weeks, yeah it took a long time to resolve this before everyone was happy with the wind loads, the movement factors, it was quite a long process. So, through this period Eagle Construction couldn't work or couldn't proceed with the Construction on the lift-core area of block F and it became very difficult because they didn't have absolute understanding or knowledge of the original design. We couldn't unearth the original design, I went through, I trolled all my records, all my structural information and couldn't find that, housing authority portal apparently didn't have the information and Starlin Construction were struggling to find their own design information, so at that point, when it became a sort of stalemate situation, that's when the decision was made here Eagle Construction step back Starlin Construction, this is your fault, this is your entirely your defect and you have got to resolve it, so they took it away and obviously, they have, probably got a lot more information than they divulge to us and they resolved it over a period of time. So, Starlin Construction had to give Eagle Construction the help. So, because of this redesign (back and forth) and inability to proceed with the work, the delay was absorbed. It was really sort of absorbed within that COVID situation. It was absorbed in the public programme, but not in block F construction programme, as there was a need to revise the sequence.....
>
> Interview, October 27th, 2020

As evidenced above, the quote by Lee (the design coordinator) illustrates two points: first, the quote that "…. *We had ongoing design meetings monthly, this were open issues that we discussed at the meeting and how to resolve them…."* illustrates that the team from both firms responded to incidents of delay by regularly meeting collectively to discuss solutions. Second, the quote "…. *because of this redesign (back and forth) and inability to proceed with the work, the delay was absorbed. It was really sort of absorbed within that COVID situation. It was absorbed in the public programme, but not in block F construction programme as there was a need to revise the sequence……"* illustrates that the way Marble Construction and the housing authority engaged with the block F public programme in response to this incident of delay differed from the way the team from Marble and Eagle Construction engaged block F construction programme, as the public programme was not affected. This suggests that the construction programme at this moment served as a locus for negotiation in absorbing delays that would have led to tension between Marble and Eagle Construction. The process of revising block F construction programme is illustrated in Cain's remark below when he said:

> …I found out that the work in block F would be delayed when the panels and polystyrene were removed, so what happened was when Eagle Construction stripped the panels and were about to do the installations, they realized the fixing were not correct. The issue was the previous carrier system installed could not take the wind loading. Also considering the changes in the material from ACM to Aluminium. They saw there is a problem with the existing structure and were not sure, it will take the wind load. So, they had to provide a calculation as they replace the ACM panel with Aluminium panel. When the consultants looked at the design of their submission, they realize it's not going to work with existing structure, and existing bracket system. The load is different, so Eagle Construction had to run through some more calculations. The brackets needed to come out, fixing details needed to be changed and the time for processing this design was initially not allowed for on block F. The designers of Eagle Construction, because Eagle Construction are design and build subcontractors, our consultant and five consultants all reviewed the calculation, design and approved a design. Our understanding initially was that the recladding involved taking off the ACM, putting back the Aluminium installation. We had to resolve the design and that took roughly back and forth the month of February 2020. In March 2020 we started to resolve the design and the COVID hit, so we finalized the design by end of June 2020, because no one was working on site or they couldn't come and inspect, there was no one to do the load test. I had to get involve and make the calls to push the design process, because I need to tell them it is affecting the construction programme. We could not mitigate the delay on block F, and that is why block F construction programme went six weeks late. We could not change the sequence there, because to replace the cladding on that lift core, we needed to work from top and come down and hence we had a delay there. We were working on one floor at a time with our construction programme, so we changed to working at 2 floor levels at the same time, by increasing the operatives. We were supposed to finish block F at the end of September 2020, but now we're finishing

> it maybe by end of this month or middle of November 2020.We forecasted the delay for block F and still didn't hit the dates, because we didn't know initially how long the design approval was going to take because we had COVID-19 and when we finally revised the construction programme, it's came up the end of week of November 2020....
>
> Interview, October 19th, 2020

As evidenced above, the quote by Cain/ the project manager illustrates four points: first, the quote "*.... I found out that the work in block F would be delayed when the panels and polystyrene were removed.....*" illustrates the potential of a delay at block F and at this moment Cain conceptualised the delay in abstract terms which is also invisible because he had not yet calculated or formally evaluated the value of the delay on block F construction programme. This suggests that delays can be conceptualised as either abstract or concrete and visible or invisible but at this moment Cain conceptualized the delay abstractly/invisibly as his way of superficially labeling the potential of delay taking place in block F. Second, the quote "*..... I had to get involve and make the calls to push the design process, because I need to tell them it is affecting the construction programme. We could not mitigate the delay on block F, and that is why block F's construction programme went six weeks late.....*"illustrates that Cain responded to the lengthy approval process by putting pressure on the team from both firms in the design meeting sessions, however he was unable to maintain the initial sequence of working or finish date in block F construction programme because Adam refused or argued for more time. This illustrates how Cain at this moment began to interpret the extent of the delay incident at block F and assigned a value of six weeks late. Third, the quote "*.....We were working on one floor at a time with our construction programme, so we changed to working at 2 levels at the same time, by increasing the operatives.....*" illustrates that the delay incident led to a mutual accommodation of the work and construction programme as the team from Marble and Eagle Construction adjusted the number of floors they were working from 1 to 2 with more operatives , and at the same time revised or adjusted the construction programme for block F. Fourth, the quote "*.....We were supposed to finish block F at the end of September 2020, but now we're finishing it maybe .....middle of November 2020.We forecasted the delay for block F and still didn't hit the dates because we didn't know initially how long the design approval was going to take because we had COVID-19 and when we finally revised the construction programme, it's came up the end of week of November 2020.....*"illustrates that Cain used block F construction programme to do three things: change the finish date, forecast delays due to the approval process and then revise the programme. This suggests that the construction programme played the role of managing expectations of the team from both firms.

Not long after the structural defect at lift shaft or core tower was uncovered, the second issue that led to delay incidents was poor site management as the team from Eagle Construction lacked a skilled or experienced site manager to adequately coordinate the task and responsibilities of recladding block F. On the 10th January 2020, in a progress meeting Cain told "*.....Jayden to hire an experienced working supervisor on site to manage their works effectively. Currently, the team from Marble Construction believe performance of Eagle Construction is not adequate will be closely monitor.....*" (Minutes, January 10th, 2020). On 9th February 2020, Jayden hired a new project manager– Adam Gonzalez- to manage the recladding in block G and F for Eagle Construction.

On 28th of February 2020, Adam and Leonard met to review block F construction programme prior to another weekly progress meeting. Adam recorded a percentage complete of 9% and planned percentage complete of 17% for block F. Leonard assigned/recorded a slip value of (-10d) to block F. He came about this slip value in the review by deducting 9% of 22 weeks, 4 days from 17% of 22 weeks, 4 days for the 28th of February 2020 in block F construction programme. Adam recorded percentages for 9 zones, 36 activities and Leonard assigned slip values for these zones and activities ranging from (26d) to (-15d). He recorded the highest negative slip value (-15d) for the north elevation zone. Then Leonard used the current percentage value and negative slip value from the review to position the drop line at current date- of 28th February 2020 - in block F construction programme, but halted the drop line for the ground crew and west cradle zone at the 14th February 2020 instead of 28th February 2020. When the meeting began:

> Cain said: a 3-week delay is currently observed in block F, and asked Adam to revise block F Construction programme.....
> Jerome said: the mast climber at the chimney section of the north elevation has been handed over to Eagle Construction on 17th February 2020....
> Adam said: he is waiting for the structural calculations and works is ongoing at ground crew zone. He added that works have begun at the single mast climber at the East Elevation on 17th February 2020.
> Cain said: he has not received any revisions to block F construction programme yet.
> Jerome said: that the monorail at the West elevation has been handed over on 17th February 2020.

The above meeting discussions illustrates how the team from both firms used block F construction programme to report on equipment installed at different places and coordinate operatives to remove existing cladding and install the new cladding.

On 6th March 2020, Leonard and Adam met again to review the progress in the recladding prior to another weekly progress meeting. Adam maintained a percentage complete of 9% and increased the planned percentage complete to 22% for block F. He also recorded percentages at 9 zones and for 36 activities that ranged from 7% to 100%. Leonard assigned a slip value of (-14d) to block F and recorded it on the construction programme. He also recorded slip values at the 9 zones and 36 activities ranging from (34d) to (-20d). He recorded the highest slip value (-20d) for the north elevation zone and west cradle zone in block F construction programme. Then Leonard used the current percentage value and slip values from the review to position the drop line at current date- of 6th March 2020 - in block F construction programme, but halted the drop line for the ground crew at 14th February 2020 instead of 6th March 2020. The process of Adam taking over the team from Eagle Construction on site and recruiting skilled or experienced workers is illustrated in his accounts below:

> .... We weren't making much progress and as a result of that my operations director was being asked to come over by Marble Construction to give some responsibility to the way that the project was evolving and was being progressed, so effectively, he couldn't spend the time doing it. The project manager we had here was struggling, so they asked me to come in really to take on two roles to give confidence back to Marble Construction. Effectively to get on top of the project and secondly to release my operations director to obviously do the roles that he should be doing in the company, which is not virtually being a project manager on one particular job. So, my role was really to be here as a stabilizer to stabilize the project, give them a point of contact, but they are outside my operations director, but I would then take on board and effectively, I then reorganize the management structure here and got the job back on track.
>
> What I've done is when I arrived in here, I looked at the management structure, I got rid of two site managers, brought another site manager in. So effectively, I sat here for a couple of weeks and saw who was doing what and who was talking to who and really the only way you succeed on any project or anything really is that you got to get the team to buy into you, alright they must buy into the project and they must buy into to each other and support each other, if that's not happening, then effectively you haven't got a team if you haven't got a team, you're not gonna be able to cope with all the issues and the responsibilities that are there, so I came in and I switched over to the site management and so I sacked two site managers and brought other people in. Then I then took over the programming of the project. So, then I redid the programme, now you had a Marble programme, and I had my programme, I knew what we can achieve, so I then had to take that to Marble Construction whether they liked it or not, and tell them well you may have your programme, you may want to finish it by then, but either yes, it's gonna happen or no it's not gonna happen...
>
> Interview, November 3rd, 2020

As evidenced above, the quote by Adam (site project manager/ Eagle Construction illustrates three points: first, the quote "…. *The project manager we had here was struggling, so they asked me to come in really to take on two roles to give confidence back to Marble Construction……. my role was really to be here as a stabilizer to stabilize the project……"* illustrates that the team from Eagle Construction at this moment struggled to do the task and responsibility they were hired to do even when they had a construction programme for block F, and this made Marble Construction lose confidence. This suggests that the way the team from Eagle Construction used the construction programme in the process of recladding mattered more than the programme itself. Second, the quote "…… *when I arrived in here, I looked at the management structure alright, I got rid of two site managers, brought another site manager in…."* illustrates that Adam changed members of the team from Eagle Construction that as they engaged or used block F construction programme to manage the task or responsibility of recladding block F. This suggests that programme use and responding to delay incidents is a collective action and the team developed a collective way of working together to respond to incidents of delay. Third, the quote"…. *you got to get the team to buy into you, alright they must buy into the project, and they must buy into to each other and support each other……. I then took over the programming on the project. So, then I redone the programme, alright now you had a Marble programme, and I had my programme*……." illustrates that Adam at this moment changed the way his team performed their tasks and responsibilities based on the way he used and changed his programme and block F construction programme. This suggests that construction programmes play a role in performing task and responsibilities.

The process of Adam using the programme to assign task and responsibilities to the team from Eagle Construction on site is illustrated in his accounts below:

> …. So you got to bring honesty into it, so that's when you can start being honest, but at the same time once you've done your programme and you told them that this is what needs to be done. You've then got to start delivering on that to bring the confidence in. So, I was there too, on a daily basis, I would make sure that the team spoke with each other. We have internal meetings that I hold, I'd look at the weak links in effectively what was still outstanding and the risks on this were effectively that it was a cladded building and what was behind the cladding in certain areas, we didn't know and at the time, no one seems to be that worried about opening up areas to see what was behind, to see what the issues were to get the design resolved because if you don't complete design, you cannot manufacture alright, but if you do not manufacture, you cannot install, so it's as simple as that, so the first risk that we had on this job were, we had to make sure that all elements of this job we've gone behind it.

> We knew what was behind it, we knew if there's any issues with that and then we could then get the design closed out, so I was dealing with the design department and I was dealing with the team on site, which were installing the works and I was making sure that we have the right available labour for the men to install, but also we had quality issues here, so effectively I was making sure that there was one person and what I used to do in these meetings and then at first initial meetings, is that I would make someone take responsibility for it, okay, so I'd say right quality control like who's gonna take ownership of it. So, if they wouldn't take ownership, then I give some ownership to someone so someone needs to be accountable for it and effectively you can't keep passing the buck: I thought he was doing it or I thought she was doing it. Someone has to take ownership so that's what I gave each individual person here roles and tasks to do alright so there it was defined.
>
> So that was the first initial thing we had on design, we then realized that we had issues with manufacture. We had a survey that was done and we then started finding that panels were being manufactured to wrong sizes or there were errors being made in manufacturing, now the standard process that we had was you were looking at anything between 4 to 5 weeks to get these panels replaced which we didn't have time to do, so I got the owners of the company down here, I explained the problem that they had with their panels, that they've manufactured wrong and.....
>
> Interview, November 3rd, 2020

As evidenced above, the quote by Adam (site project manager/ Eagle Construction illustrates two points: first, the quote"..... *We have internal meetings that I hold, I'd look at the weak links in effectively what was still outstanding and the risks on this we're effectively that it was a cladded building and effectively what was behind the cladding in certain areas*....." illustrates that Adam and his team at this moment changed the way his team performed their tasks and responsibilities' as they engaged collectively with the programme regularly in internal meetings to check for weak links in the team. This suggests that construction programmes play a role in monitoring task and responsibilities distributed to team members. Second, the quote "…. *so, I was dealing with the design Department, and I was dealing with the team on site..... and what I used to do in these meetings and then at first initial meetings, is that I would make someone take responsibility for it, okay, so I'd say right quality control like who's gonna take ownership of it. So, if they wouldn't take ownership, then I give some ownership to someone, so someone needs to be accountable for it....."* illustrates that Adam led the team from Eagle Construction to develop collectively a way of using block F construction programme that enabled them take or own responsibilities and perform their task at multiple levels.

Not long after Jayden hired Adam to manage the recladding of block G and F, the third issue that led to delay incidents was a nationwide lockdown that lasted for three months due to the COVID-

19 pandemic. On 23rd March 2020, the UK government imposed a nationwide lockdown that prevented people including construction workers from transiting and this stopped the team from both firms from progressing the recladding work in block F for the next 12 weeks. On 15th June 2020, the team from both firms gradually began to mobilise back to site with measures put in place to control the spread of the corona virus and this was the reason the number of operatives hired initially were low and gradually rose. On 24th of June 2020, the team from both firms agreed to continue having the weekly progress meetings online starting from 3rd July 2020 with the aid of Microsoft teams and exchanged emails of the construction programme prior to and during the meetings to discuss the progress of the recladding work in block F. The way Adam and the team from Eagle Construction responded to the lockdown and 3 months delay is illustrated in his accounts below:

> .....I had probably one or 2 meetings a week with my directors in Eagle Construction that were not so regular I think and later, once a fortnight and then once every 3 weeks. I was meeting up on Microsoft teams with Donnie, Cain, the Quantity surveyor from Marble Construction at the end of every month for the financial side of things, so there wasn't a lot more to do apart from that, because you know everything was shut down. It wasn't just the UK or Ireland, it was virtually the world, the whole world that was shut down for at least 6 to 8 weeks and then people started coming out from it. We revised our own programme to accommodate a 12-week lockdown and we just shifted it. We had stopped there in March 2020 and then when we came back would be like the next day, but there was room within the construction programme. I looked and I reprogrammed everything on my programme, so it had all in a straight line what we could do, Cain then had/introduced I think 2 weeks mobilization on his construction programme, so I wasn't worried about mobilization the first week. He had his construction programme, and I had my new programme. I issued my new programme to Cain and then I sat down with him on that programme, and I said this is what we can do. I think I had my site manager and project manager in here just making sure that things are getting sorted out and then the second week we had a very small or limited amount of labor in here, so again both of those weeks, I discounted those, and I then took the start of the 3rd week when our programme would recommence. What they did during the lock down is that they were advising us where we're now on lockdown, we're now on partial lockdown, we're now actually back up and running again and if you want us to, we can start fabricating your materials, cause obviously they were there, some of their orders have been closed down, so they were in a position to say, you got your various schedules, do you want us to complete these and we can manufacture them, we could hold them off site for you, cause they were looking for work as well, so there is communication with our suppliers. The ones that were working, the ones that still weren't working and there is communication with yourselves and Marble Construction and everything. So there were meetings, there weren't massive meetings. It didn't take long, and you know just so everyone knew where we were, and again with the subcontractors on my installation subcontractors, they were obviously shut down, but they were asking us and floating out when are you going back,

> when you're looking at going back, so there was communication going on in the background.....
>
> Interview, November 3rd, 2020

As evidenced above, the quote by Adam (site project manager/ Eagle Construction) illustrates two points: first, the quote "…. *We revised our own programme to accommodate a 12-week lockdown and we just shifted it. We had stopped there in March 2020 and then when we came back would be like the next day, but there was room within the construction programme …."* illustrates that Adam at this moment responded to the delays due to the lockdown by revising his firm's programme that involved skipping or accommodating a period of 12 weeks when the site was shut down. This suggests that Adam moved from engaging with his own programme at this moment to engaging with block F construction programme. This suggests that programme played a role in managing and reconciling difference in interests of his firm and Marble Construction. Second, the quote "…….. *Cain then had/introduced I think 2 weeks mobilization on his construction programme…. I issued my new programme to Cain and then I sat down with him on that programme…."* illustrates that Adam at this moment responded to the lock down period by using his programme as a vehicle to communicate his expectations to Cain and the revisions they both made to the two versions of the programme differed. This suggests that the programme played the role of negotiating tensions in expectations as a result of the period the site was shutdown. The way Cain and the team from both firms responded to the lockdown delay is illustrated in his accounts below:

> ……. We just pushed three months into the construction programme. Everyone was under lockdown, so we sent them emails, we are shutting down from this date, which is 24th of March 2020, and we told them we are starting back when things start to move on. Later we told them we are starting back again from June 15, 2020. It was mainly me and Donnie that were involved in the decisions/changes and then upper chain of our Marble's senior management. They make the decision when we can start. So, we communicated via email to the subcontractors, the residents, the housing authority, and the consultants. We said, we are stopping the work and then later we told them, we are starting the works on June 15, 2020. The first 2 weeks, I allowed a time limit for the mobilization, because people are all over the country, some are already out of the country, so they need to get back- the subcontractors, their operatives- and then from July 1st week , we gradually increased the number of the operatives on site and we had a delay of 14 weeks because of COVID- 19, we just pushed the construction programme 14 weeks back. So, we had a meeting and what we did was, we ask for their programme to be issued to us, but I know, or we know how many weeks was impacted by the delays. We added extra 2 weeks for the mobilization and the subcontractors agreed on that. The meeting involved the project managers for Eagle Construction- Adam and Jayden- and for Starlin Construction, it was

> Paige, Lingard, Curtis, with me and Donnie from Marble Construction. It's happened during the weekly meetings, but what we did was again, we don't do some of this stuff formally and we make a phone call and we discussed over the phone and then we set up the programme basically.
>
> Interview, November 3rd, 2020

As evidenced above, the quote by Cain (project manager/ Marble Construction illustrates three points: first, the quote "…. *We just pushed three months into the construction programme…."* illustrates that Cain at this moment responded to the shutdown of the site due to the pandemic by simply revising the construction programme to accommodate the 3 months that the shutdown lasted. This suggests that the programme played a role of visually capturing events or periods unproductive. Second, the quote "…. *we had a meeting and what we did was, we ask their programme be issued to us, but I know, or we know how many weeks was impacted by the delays. We added extra 2 weeks for the mobilization and the subcontractors agreed on that…."* illustrates that the changes in understanding of a programme when programmes move between groups and at this moment, the team from each firms used their respective programmes as a vehicle to communicate changes, to acknowledge delays, negotiate and agree a return back to site. This suggests that programmes play a role in adjusting initial forms of organising when there are incidents of delay, and this led to a changing understanding of a programme when programmes move between groups. Third, the quote, "…….*but what we did was again, we don't do some of this stuff formally and we make a phone call and we discussed over the phone and then we set up the programme basically…..'* Illustrates that the process of returning back to site after the 3 months shutdown involved informal agreements outside the regular formal meetings that may be captured in the construction programme. This suggests that response to delay incidents may involve formal and informal modes of engagement with versions of the programme.

The difference in the way different project groups engaged versions of the programme as they responded to the three-month lockdown is illustrated in Cain's accounts below:

> …. Eagle Construction issued their programme and when I extended the construction programme, they accepted the construction programme. As I said before, we have been working with Starlin Construction for over 15 - 20 years, so the relationship helped us. Eagle Construction is new to us, so they issued formally a programme, so this is the difference between the two subcontractors. When we revised the construction programme, we sent this to the parties on the project level- the subcontractors and consultants. But we didn't send this to the housing authority or residents, they are managed with the public programme. So we already pushed the public programme 14 weeks, but we don't need to discuss the construction programme with the housing

> authority or the resident, that's only for the internal process. So we revised the public programme, but it's not impacting to any of the construction activities which we suffered for 12 to 14 weeks, we just move 12 to 14 weeks. So the numbers of operatives rose during pre-lockdown, when I started the numbers increased on this project. After lockdown the numbers got back to the pre-lockdown stage. So that's the reason behind it, because soon as we came out of the lockdown, we finished two blocks that were ready to finish, so we complete the blocks basically. We don't need to go back to the pre-construction, pre-lockdown levels. So the resources gradually increase, not to the pre-lockdown level. When we started, we gradually increased, from 40 number, 60 number, 70 number then we came to 110. A 110 was the maximum number wage we had after the lock down, the numbers then are not going down because in finishing apartments now we're working on 70. .....
>
> Interview, November 3rd, 2020

As evidenced above, the quote by Cain (project manager/ Marble Construction illustrates three points: first, the quote "*.....we have been working with Starlin Construction for over 15 - 20 years, so the relationship helped us. Eagle Construction is new to us, so they issued formally a programme, so this is the difference between the two subcontractors.....*" illustrates differences in the modes of engagement between Starlin and Eagle Construction when responding to delay of the 3 months shutdown. This suggests that project groups are likely to use programmes informally when they have a history of working together or built trust as Marble Construction and Starlin Construction indicated. Second, the quote "*.....When we revised the construction programme, we sent this to the parties on the project level- the subcontractors and consultants. But we didn't send this to the housing authority or residents, they are managed with the public programme.....*" illustrates that at this moment the team from Marble Construction revised the public and construction programme differently before issuing them separately after the delay of the shutdown. This suggests that the programme played the role of managing the expectations of project groups before and after delay incidents. Third, the quote "..... *So, the numbers of operatives rose during pre-lockdown..... After lockdown the numbers got back to the pre lockdown stage..... So, we don't need to go back to the pre- construction, pre-lockdown levels. So, the resources gradually increase, not to the pre-lockdown level. When we started, we gradually increased, from 40 number, 60 number, 70 number then we came to 110.....'* illustrates that at this moment Cain responded to the 3 months lockdown by using block F construction programme to change the number of operatives hired on site. This suggests that the construction programme plays a role in managing the resources before and after delay incidents.

The above section illustrates three issues that led to different incidents of delay as the team from both firms removed existing cladding and installed the new cladding. The issues included: structural defects uncovered at the lift shaft or core tower with a lengthy approval process, poor site management and the lack of skilled or experienced site manager to manage the team of Eagle Construction and lastly a three-month nationwide lockdown due to the COVID-19 pandemic. The quotes above illustrate that the way project groups interpret delays due to structural defects/lengthy approval in one moment differed from the way the team interpret delays due to the lack of skilled or experienced site manager/supervisors in another moment. This also differed from the way project groups interpret delays due to the three-month nationwide lockdown due to the COVID-19 pandemic in block F in another moment and illustrate different roles played by the construction programme in negotiating solutions to different issues. The section that follows describes the way the team from both firms continued to actively use block F construction programme to socially reconstruct visible delays before handing over completed works for block F.

4.6.4 Response to the issues and visible delays in block F

Two key moments shaped the way the team from both firms responded to the issues described above. The first part is connected to Eagle Construction and visible or concrete delays in block F on or before the 8th of July 2020. This involved the team from both firms using block F construction programme to agree on an extension to the finish date. The second part is connected to Marble Construction and the lockdown period when the site was shut down for three months. This involved project groups using block F public and construction programme to skip the 3 months that the site was shut down due to the lockdown. The team's response to these successive delays builds on the efforts of members at design team meetings to approve the structural engineering calculations. The section that follows describes the way the team from both firms actively used block F construction programme to socially reconstruct slip values at multiple levels by trying a new sequence and a formal extension by backdating. (See Figure 4.8).

4.6.4.1 Creating new areas and backdating block F construction programme

Taking the first response of project groups to visible or concrete delays in block F on or before 8th July 2020. This part of the story continues from 9th March 2020 and describes the way the team from both firms used block F construction programme to break the north elevation in to smaller

manageable task, backdate the start date and reconstruct the slip values in block F at multiple levels.

On 9th March 2020, Leonard and Adam met to revise block F construction programme prior to the next progress meeting on 13th March 2020. Adam pushed back on the deadline for block F and Leonard agreed to change the sequence of recladding the north zone that had the highest slip value and created the following: 2 subzones (north flank and north tower subzone), 3 mini-subzones and 34 activities. They also changed the following: the start date from 27th January 2020 to 20th January 2020, extended the duration from 22 weeks, 4 days to 23 weeks, changed the finish date from 8th July 2020 to 2nd July 2020 in block F construction programme. After creating new areas and backdating the start date, Adam changed the total percentage complete from 9% to 26% and increased the planned percentage complete from 22% to 24%. He also recorded percentages at 9 zones and for 36 activities that ranges from 11% to 100%. Based on these percentages, Leonard recalculated/reduced the overall slip value from (-14d) to (-2d). He also reduced the negative slip values for the zones and activities in block F construction programme especially the north elevation from (-20d) to (-1d). This illustrates how Leonard and Adam reconstructed the slip values in block F construction programme and delays for the first time at multiple levels in block F.

On 13th March 2020, the team from both firms met after revising block F construction programme to discuss the progress of the recladding. At the meeting, Leonard said that he and Adam had finalized the revision of block F construction programme. Then Adam said he will conclude the structural calculation with the consultants. He also said that he observed a new detail at the west elevation zone and discussed this detail in the last design meeting. He added that he will raise a request for information and detail to be agreed by the consultants.

On 20th March 2020, Leonard and Adam met again to review block F construction programme prior to another weekly progress meeting starting around 10am. Adam recorded a total percentage complete of 29% and planned percentage complete of 31%. He also recorded percentages at 9 zones and for 36 activities. Leonard recorded a positive overall slip value of (4d). He also recorded positive and negative slip values for the zones and activities in block F ranging from (27d) to (-18d). He recorded the highest slip value of (-10d) for the monorail west /east zone. Then Leonard used the current percentage and slip value from the review to position the drop line under the current date (of 20th March 2020) in block F construction programme but halted the drop line at 9th March 2020 for the monorail west /east zone.

These events above illustrate that the way the team from both firms responded to incidents of delays by actively using block F construction programme to break block F into smaller task in the north elevation, backdate the start date, change the sequence, change the finish date, and socially reconstruct the slip values in block F. The section that follows describes the way the team from both firms used block F construction programme to skip three months that the site was shut down and extend the finish date as a response to a nationwide lockdown.

4.6.4.2 Skipping and extending the deadline in block F construction programme

Taking the second response of project group to the lockdown period when the site was shut down for three months. This part of the story continues from 15th June 2020, after the lockdown that started on 23rd March 2020 and describes the way the team from both firms actively used block F construction programme to skip the three months that the site was shut down due to COVID-19 and extend the finish date at multiple levels for the zones, subzones and activities in block F.

On 15th June 2020, Cain moved the drop line from the 23rd of March 2020, skipped inactive months of April and May 2020 due to the lockdown and placed the drop line on the 15th of June 2020 in block F construction programme. He attached a copy of this update on block F construction programme and emailed it to Donnie, Jayden, and Adam before they met virtually on 15th June 2020 to discuss. They agreed that the team from Eagle Construction should use 2 weeks to mobilize back to site, starting from 15th June 2020 and ending on 26th June 2020. They also agreed to change the sequence and increased the duration at 7 zones by 12 weeks due to the lockdown delay. Cain said they would review the progress in block F by month end after Eagle Construction has mobilized backed to site. Adam said he required new delivery dates for orders from panel manufacturers.

On 17th July 2020, Adam pushed back on the deadline in block F construction programme due to the lockdown and Cain agreed to change two things: the sequence of working and increase the duration from 23 weeks to 42 weeks, extend the finish date from 2nd July 2020 to 13th November 2020. After this agreement, Adam and Cain reviewed the progress on works in block F: Adam recorded a 63.50% percentage complete and a planned percentage complete of 63.50%. He also recorded percentages at the zones and activities ranging from 24.44% to 100%. Cain changed the overall slip value from (4d) on 20th March 2020 to (-3h, 58 min) on 17th July 2020. He also recorded lower negative slip values for zones and positive slip values for 5 activities. This illustrates how Cain and Adam again reconstructed slip values at multiple levels in block F construction

programme. The process of revising the construction programme for block F is illustrated below in an email Cain sent to Adam and copied the team from both firms:

> .....As discussed, please find attached progress updates.
> We will review the programme for block F by the end of this month again based on lift shaft progress. As this currently showing completion mid November 2020. We need to improve on this .....
>
> Email conversation: 13th August 2020

As evidenced above email, the remark of Cain in August 2020 illustrates two points: first, the remark, *".....As discussed, please find attached progress updates...."* illustrates that Cain and Adam at this moment had discussions on the block F and Cain updated block F construction programme to capture the progress of works before sharing it via email. This suggests that the block F construction programme moved between Eagle Construction and Marble Construction and was used a vehicle to communicate formally on the percentage of works completed, slip values, and reconcile progress. Second, the email remark "..... *We will review the programme for block F by the end of this month again based on lift shaft progress....."* illustrates that Cain at this moment was monitoring the progress at multiple levels especially at the north elevation zone where the lift shaft or core tower is located. This suggests that the programme played a role in mapping out the progress in areas under block F for Cain to single out critical areas to concentrate efforts on.

On 4th September 2020, Cain and Adam met again to review the progress on block F: Adam recorded a percentage complete of 77.01% and a planned percentage complete of 80.07%. He also recorded percentages at the zones, subzones, mini-zones, and activities ranging from 30% to 96.67%. Cain recorded a slip value of (-6d). He also recorded negative and positive slip values for the zones, subzones, mini-zones, activities with the north level 9 flank zone having the highest value (-38d). The team from both firms continued to use block F construction programme to coordinate the recladding work at block F until Eagle Construction completed the works on 13th November 2020. Marble Construction dismantled the elevating equipment and handed over the complete work to the housing authority on 30th November 2020 which was still within the public programme for block F.

This vignette illustrates the story of successive delays conceptualized differently in recladding block F involving five versions of the programme and the way project groups actively used block F construction programme to avoid an extension in block F public programme and socially

reconstruct delays as either abstract and invisible or concrete and visible with slip values at multiple levels. This involved project groups engaging multiple versions of the programme differently and this enabled the project groups to construct and interpret delays differently. The events also illustrate that Eagle Construction and Marble Construction actively used block F construction programme to change the sequence of recladding, change the start date, extend the duration twice and reconstruct slip values twice at multiple levels. The incidents of delay in block F illustrate that project groups responded to visible and concrete delays with a situated use of block F construction and public programme to negotiate a new sequence for recladding, extend the finish date for block F and skip three months that the site was shutdown. The points evidenced in this vignette demonstrate different moments where different project groups engaged different versions of the programme differently in delay incidents. The section that follows concludes this chapter by highlighting key empirical issues drawn from the four vignettes and comparing the way project groups responded to incidents of delays in the four selected buildings.

4.7 Empirical issues in the recladding project

The purpose of the analysis in this chapter is to understand in detail how a programme that interfaces distinct project groups functions in the London case project and to study variations.

The four vignettes above demonstrated that the recladding project in London had six main actors namely: the housing authority, the residents, Marble Construction, the subcontractors (Starlin Construction or Eagle Construction), the consultants and cladding material suppliers. The vignettes demonstrated six distinct meetings that project groups engaged formally or informally with versions of the programme regularly in the recladding project namely: progress meetings, review meetings, forecast meetings, revision meetings, internal supplier meetings, Joint inspection meetings (see Figure 4.1).

The four vignettes demonstrated that different project groups in different contexts engaged different versions of the programme differently in delay incidents and the evidence presented demonstrate five empirical issues.

The first issue is that the recladding project has project actors in four main project groups that created and adapted multiple versions of the programme to meet their local needs. These

versions of the programme served as a basis in mediating the relationship between different project group and were reconciled through project group meetings and discussions. For example, Marble Construction created and used the public programme to relate with the housing authority, Marble Construction also created and used the construction programme to relate with Starlin/Eagle Construction. Starlin/Eagle Construction created and used their own subcontractors programme to relate with fixer operatives and supplier/manufacturers. These three versions of the programme had different start date and finish dates. The consequence is that the different project groups worked to different understanding of how the recladding of each building should start and conclude and this led to differences in their expectations.

The second issue is that the vignettes demonstrated that project groups constructed or interpreted time differently by creating versions of the programme (that adjusted to either a linearly perception of time with new forms of organizing or cyclic perception of time with repetitive hiring of equipment or fixer operatives). This is shown in each vignette for each block. For example, the housing authority organised the recladding of the 11 blocks to start and finish one after the other in the public programme and conceptualised time linearly. In contrast, Marble Construction conceptualised time cyclically and repeatedly organised (installed, dismantled, or transferred) elevating equipment at different places or blocks. Marble Construction engaged Starlin or Eagle Construction to repeatedly utilise those elevating equipment. This was a reason why Marble Construction were often concerned when equipment was idle, unused, or underutilised. In contrast, the subcontractors (Starlin and Eagle Construction) organised the delivery of cladding material or panel and operatives to utilise the elevating equipment and conceptualised time both linearly and cyclically because the recladding of each block involved both new and repetitive process of removing existing cladding and installing new cladding.

The third issue is that the vignettes demonstrated that project groups on the recladding project used different versions of the programme in different context to do different things. For example, Marble Construction actively used construction programmes to hire and coordinate the installation and removal of elevating equipment at multiple levels. Eagle and Starlin Construction used their own programme to track suppliers on the delivery of panels materials or hire operatives. Marble Construction and Starlin Construction used the construction programme to negotiate their priorities and new start or finish dates. Marble Construction used the public and construction programme respectively to manage the expectations of the housing authority and subcontractors. Marble Construction used the public and construction programme to capture

knowledge of activities or agreements at multiple levels and communicate about the progress of the project at multiple levels. The housing authority used the public programme to visit the site and disburse payments. These differences in the way project groups engaged with versions of the programmes are similar in the vignettes and are partly because the four project groups had different interest or priorities.

The fourth issue is that the vignettes demonstrated that project groups used versions of the programme to socially construct delays as either abstract and invisible or concrete and visible with slip values and the position of the drop line. This is similar in each vignette as project groups actively used the different versions of the programme to interpret the same delay differently. Each vignette showed that the meaning of a delay in one incidence varied across the four project groups on the recladding project. For example, when Marble Construction used the construction programme to conceptualize a delay as concrete at a zone, subzone or activity and singled out areas that led to tension. This tension did not exist for the housing authority that used the public programme to interpret delays. This difference in the way project groups constructed delays was similar in the vignettes and are partly because the four project groups engaged different versions of the programme to conceptualize delays. In addition, the way project groups used versions of a programme in delay incidents depended on the context and were responses that usually involved avoiding financial losses of placing or not placing workers, materials, or equipment to work.

The fifth issue is that the vignettes illustrated that project groups responded to visible or concrete delays on versions of the programme with negotiations that involved formal changes to the sequence of activities and formal extension of the deadline that led to a reconstruction of the slip values on the construction and public programme. This is similar in each vignette as the four project groups actively used versions of the programme to change the sequence of recladding, increase the duration, and change finish or start dates in the construction or public programme that led to a reduction in the slip values. However, one difference between the vignettes is that project groups in vignette III and IV agreed to change the start date in the construction programme to avoid an extension of the finish date in the public programme or engaging with the housing authority. Project groups responded to delay incidents with a mutual accommodation of the work and programme and changed members of the different projects groups from passively engaging with the programme to active users. Delay incidents led project groups to adjust initial forms of organising with a changing understanding of a programme when programmes move between groups. A summary of these empirical issues in the London case is presented in Table 4.1 below.

Table 4: 1 Summary table of the distinctive and common findings across the different groups and vignettes in case I

S/N		Vignette I	Vignette II	Vignette III	Vignette IV
1	**Time was constructed in case I with several versions of the programme as a basis of relating between the different project groups in the London project.**	**There are three main project groups involved with block J in vignette one:** the housing authority, Marble Construction and Starlin Construction. These three project groups adapted and created six versions of block J programme as the interacted frequently with each other. Block J was the first building to be reclad. **The first version is the overall public programme**. The housing authority and Marble Construction created this programme. The public programme for block J was not revised. **The second version is the overall construction programme**. Marble Construction and Starlin Construction created this programme that is high level and has shorter durations and earlier than the public finish date. **The third version is block J draft programme**. Marble Construction and the equipment providers created this programme based on the time apportioned for block J in the overall construction programme. This programme involved more details compare to the first or second version. **The fourth version is block J construction programme.** Marble Construction and Starlin Construction created this programme. **The fifth version is the subcontractor's (Starlin Construction) internal programme**. Starlin Construction created this internal programme to accommodate fixer operatives and manufacturers of panels.	**There are three main project groups involved with block D in vignette two**: the housing authority, Marble Construction and Starlin Construction. These project groups adapted and created five versions of block D programme as the interacted frequently with each other. Block D was the third building to be reclad. **The first version is the same overall public programme for the eleven buildings. The** housing authority and Marble Construction revised this programme due to a 3-month lockdown to accommodate an extension**.** **The second version is the same overall construction programme for the eleven buildings.** This programme is high level. **The third version is block D draft programme**. Marble Construction and equipment providers created this programme that had more details compared to the first and second versions. **The fourth version is block D construction programme.** Marble Construction and Starlin Construction created this programme to reclad the different areas in block D. They revised this programme to accommodate the 3-month lockdown **The fifth version is the subcontractor's (Starlin Construction) internal**	**There are three main project groups involved with block G in vignette three:** the housing authority, Marble Construction and Eagle Construction. These three project groups created and adapted five versions of block G programme as the interacted with each other. Block G was the sixth building to be reclad. **The first version is the same overall public programme for the eleven buildings.** Marble Construction and Eagle Construction avoided an extension of this programme by backdating the start date of block G construction programme when there was a 3-month lockdown. **The second version is the same overall construction programme for the eleven buildings.** Marble Construction and Eagle Construction used this programme that was created. **The third version is block G draft programme**. Marble Construction and equipment providers created this programme based on the time apportioned for block G in the first version which involved more details compared to the first and second version. **The fourth version is block G construction programme.** Marble Construction and Starlin Construction began to create this programme. But when Starlin Construction was overstretched, Marble Construction hired	**There are three main project groups involved with block F in vignette four:** the housing authority, Marble Construction and Eagle Construction. These three project groups created and adapted five versions of block F programme as the interacted with each other. Block F was the seventh building to be reclad. **The first version is the same overall public programme for the eleven buildings.** Marble Construction and Eagle Construction avoided an extension of this programme by backdating the start date of block F construction programme when there was a 3-month lockdown. **The second version is the same overall construction programme for the eleven buildings.** Marble Construction and Eagle Construction used this programme that was created. **The third version is block F draft programme**. Marble Construction and equipment providers created this programme based on the time apportioned for block F in the overall construction programme which involved more details compared to the first and second version. **The fourth version is block F construction programme.** Marble Construction and Starlin Construction began to create this programme. But when Starlin Construction was

		The sixth version is block J runout programme. Marble Construction and Starlin Construction created this runout programme.	**programme**. Starlin Construction created this internal programme to accommodate fixer operatives and manufacturers of panels. **NOTE: T**he housing authority, Marble Construction and Starlin Construction revised block D public and construction programme respectively to accommodate an extension to the construction finish date caused by lockdown**.**	Eagle Construction to recreate this programme. They revised this programme by backdating the start date to accommodate the 3 -month lockdown. **The fifth version is the new subcontractor's (Eagle Construction) internal programme**. Eagle Construction created this internal programme to accommodate the different fixer operatives/ manufacturers of panels. **NOTE:** Marble Construction and Eagle Construction revised block G construction programme alone. A revision of block G public programme was avoided.	overstretched. Marble Construction hired Eagle Construction to recreate this programme. They revised this programme by backdating the start date to accommodate the 3-month lockdown period. **The fifth version is the new subcontractor's (Eagle Construction) internal programme**. Eagle Construction created this internal programme to accommodate the different fixer operatives/ manufacturers of panels. **NOTE:** Marble Construction and Eagle Construction revised block F construction programme alone. A revision of block F public programme was avoided.
2	**The way project groups in case I engaged with a programme in the context of the London project.**	The housing authority, Marble Construction and Starlin Construction in vignette one formally engaged versions of block J programme in five different meetings. **The first is progress meetings.** Marble and Starlin Construction used the construction programme in this meeting to formally record or count the duration of the recladding weekly, label them as progress updates, to discuss, and to coordinate the recladding of each block which was documented in weekly minutes. **The second is labour forecast meetings**. Marble and Starlin Construction used block J construction programme with Starlin's internal programme in this meeting weekly to agree on the fixer operatives to hire to use elevating equipment installed at different places in block J for the next two weeks.	The housing authority, Marble Construction and Starlin Construction in vignette two also formally engaged versions of block D programme in five different meetings. **The meetings in vignette two are similar to the five mentioned in vignette one.**	The housing authority, Marble Construction and Eagle Construction in vignette three formally engaged versions of the block G programme in five different meetings. **The meetings in vignette three are similar to the five mentioned in vignette one.**	The housing authority, Marble Construction and Eagle Construction in vignette one engaged the versions of the block J programme formally in five different meetings. **The meetings in vignette four are similar to the five mentioned in vignette one.**

		The third is review meetings. Marble and Starlin Construction used block J construction programme with Starlin's internal programme in this meeting prior to progress meetings to evaluate the progress and record update on the percentage of the recladding work completed, percentage of the recladding work planned, slip values, and highlight areas that are critical for forecasting. **The fourth is** revision meetings. Marble and Starlin Construction used block J construction programme in this meeting to revise the sequence of working and visually capture agreements that includes breaking down block J into smaller manageable portions. **The fifth is internal meetings.** Starlin Construction used internal programme to accommodate manufacturers or suppliers to discuss the timing of items ordered or deliveries that are recorded on the subcontractor programme and on trackers. **The sixth is Joint inspection meetings.** Marble Construction, consultants and the housing authority used the public programme to do a joint inspection for the recladding works.			
3.	**The role of a programme in the different project groups case I**.	The housing authority, Marble Construction and Starlin Construction **in vignette one used versions of block J programme to do eight different things.** These uses include (1) to construct different interpretations of project time for projects groups. (2) to distribute task and responsibilities at multiple levels. (3) to manage project resources at multiple levels, (4) to manage the expectations of the different project groups, (5) to enable firms negotiate their interest or priorities, (6) to capture knowledge of activities and agreements at multiple levels, (7) to enable project groups	The housing authority, Marble Construction and Starlin Construction **in vignette two used versions of block D programme in a similar way as the eight mentioned in vignette one.**	The housing authority, Marble Construction and Eagle Construction **in vignette three used versions of block G programme in a similar way as the eight mentioned in vignette one.**	The housing authority, Marble Construction and Eagle Construction **in vignette four used versions of block F programme in a similar way as the eight mentioned in vignette one.**

		communicate about the progress of the project at multiple levels, (8) and to socially construct the meaning of a delay.			
4.	**The way different project groups constructed the meaning of a delay at different incidents, and variations across case I.**	The housing authority, Marble Construction and Starlin Construction in vignette one used versions of block J programme to socially construct different meanings of delays in an incident. Examples of two incidents: **One incidence of difference was when Starlin Construction was still within their 4- 5 month learning curve period. T**he team from Marble Construction did not view block J as delayed even though they used block J construction programme to construct delays as concrete with negative slip values. **A second incidence of difference is when block J progress is within public programme duration or date**. When Marble and Starlin Construction used block J construction programme with an earlier finish date to identify or label a delay in recladding. Interestingly, the housing authority used block J public programme with later finish dates did not view the same block as delayed because the recladding was within public programme duration or dates.	The housing authority, Marble Construction and Starlin Construction in vignette two used versions of block D programme to socially construct different meanings of delays in an incident. Examples of three incidents. **One incidence of difference was when Starlin Construction was no longer within their 4- 5 month learning curve period.** When **Starlin Construction began block D in June 2019 which was after the learning curve period.** The team from Marble Construction used block D construction programme to construct delays as concrete with negative slip values. **A second incidence of difference is also when block D progress is within public programme duration or date**. When Marble and Starlin Construction used block D construction programme with an earlier finish date to identify or label a delay in recladding. Interestingly, the housing authority used block D public programme with later finish dates did not view the same block as delayed because the recladding was within public programme duration or dates. **A third incidence of difference is when there was a 3-month lockdown**. Marble and Starlin Construction did not use block D construction programme to identify or label the 3-month delay in recladding with negative slip values. Similarly, the housing authority and	The housing authority, Marble Construction and Eagle Construction in vignette three used versions of block G programme to socially construct different meanings of delays in an incident. Examples of an incident. **One incidence of difference was when there was a 3-month lockdown**. Marble and Eagle Construction did not use block G construction programme to identify or label the 3-month delay in recladding with negative slip values. Similarly, the housing authority and Marble Construction did not use block G public programme to identify or label the 3-month delay in recladding with negative slip values.	The housing authority, Marble Construction and Eagle Construction in vignette three used versions of block G programme to socially construct different meanings of delays in an incident. Example of two incidents. **One incidence of difference was when block F progress is within public programme duration or date**. Marble and Eagle Construction used block F construction programme with an earlier finish date to identify or label a delay in recladding. Interestingly, the housing authority used block F public programme with later finish dates did not view the same block as delayed because the recladding was within public programme duration or dates. **A second incidence of difference was when there was a 3-month lockdown**. Marble and Eagle Construction did not use block F construction programme to identify or label the 3-month delay in recladding with negative slip values. Similarly, the housing authority and Marble Construction did not use block F public programme to identify or label the 3-month delay in recladding with negative slip values.

			Marble Construction did not use block D public programme to identify or label the 3-month delay in recladding with negative slip values.		
5.	**The way different project groups interacted when responding to delay incidents, and variations across the vignettes in case I.**	The housing authority, Marble Construction and Starlin Construction in vignette one responded differently to delay incidents with the different versions of block J programme. Marble and Starlin Construction used block J construction programme and responded to delay incidents by apportioning blame externally to three things namely: (1) Starlin Construction blamed limited storage space for panels/materials. (2) Marble Construction blamed Starlin Construction for missing planned finish dates for three balconies in the construction programme that were critical to the completion of block J. (3) Starlin Construction blamed suppliers for some panels received for block J that were either of bad quality, unfit, delivered late or missing on site. Marble and Starlin Construction used block J construction programme to mutually accommodate the recladding work and the construction programme. Marble Construction used block J construction programme in a non-adversarial acknowledgement of delays with Starlin Construction when construction finish date was exceeded. Similarly, Marble Construction used block J public programme in a non-adversarial acknowledgement of delays with the housing authority when public finish date was exceeded.	The housing authority, Marble Construction and Starlin Construction in vignette two responded differently to delay incidents with the different versions of block D programme. Marble and Starlin Construction used block D construction programme and responded to delay incident by apportioning blame externally to three things namely: (1) the shortages of operatives to use the equipment to remove the old and install the new panels/materials. (2) that Starlin Construction struggled with access to the balconies of residents at three critical subzones– the wintergardens- under the north zone to replace the cladding there. (3) that a nationwide lockdown lasted for three months due to the COVID-19 pandemic. Marble and Starlin Construction used block D construction programme to agree on an extension to the finish date on three separate occasions.	The housing authority, Marble Construction and Eagle Construction in vignette three responded differently to delay incidents with the different versions of block G programme. Marble and Eagle Construction used block G construction programme and responded to delay incident by apportioning blame externally to four things namely: (1) pending design issues and unresolved information, (2) additional works not initially provided (3) lack or absence of structural engineering details (4) lengthy process of obtaining engineering approval Marble and Eagle Construction used block G construction programme to agree on an extension to the finish date and changed the start date.	The housing authority, Marble Construction and Eagle Construction in vignette three responded differently to delay incidents with the different versions of block F programme. Marble and Eagle Construction used block F construction programme and responded to delay incident by apportioning blame externally to four things namely: (1) pending design issues and unresolved information, (2) additional works not initially provided (3) lack or absence of structural engineering details (4) lengthy process of obtaining engineering approval. Marble and Eagle Construction used block F construction programme to mutually accommodate the recladding work and the construction programme. Marble Construction used block F construction programme to avoid further financial losses and tensions with the housing authority. Marble and Eagle Construction used block F construction programme to agree on an extension to the finish date.

	Comparing the role of programmes in different delay incidents and across vignettes.	The housing authority, Marble Construction and Starlin Construction in vignette one used versions of block J programme differently in delay incidents. Marble and Starlin Construction used block J construction programme in three ways in delays incidents namely (1) to halt the position of the drop line on the construction or public programme instead of moving it forward to a current date. (2) to skip with the drop line periods that were unproductive or inactive on the construction or public programme. (3) to develop a mapping of slip values as delays at multiple levels for different zones, subzones, or areas. **Marble and Starlin Construction used block J construction programme alongside three current artifacts or records** namely: (1) panel trackers for block J (2) hold-point-system for block J that were signed off (3) two-week labour forecast sheets for block J to construct the meaning of delays in an incident.	The housing authority, Marble Construction and Starlin Construction in vignette two also used versions of block D programme differently in delay incidents like vignette one. **Marble and Starlin Construction used block D construction programme alongside three current artifacts or records namely**: (1) panel trackers (2) hold-point-system that were signed off (3) two-week labour forecast sheets to construct the meaning of delay incidents except the delay incident that involved a 3 month lock down.	The housing authority, Marble Construction and Eagle Construction in vignette three also used versions of block G programme differently in delay incidents like vignette one. **Marble and Eagle Construction used block G construction programme alongside three current artifacts or records** namely: (1) panel trackers for block G (2) hold-point-system for block G that were regularly signed off (3) two-week labour forecast sheets for block G to construct the meaning of delays incident except the delay incident that involved a 3 month lock down.	The housing authority, Marble Construction and Eagle Construction in vignette four also used versions of block F programme differently in delay incidents like vignette one. **Marble and Eagle Construction used block F construction programme alongside three current artifacts or records** namely: (1) panel trackers for block F (2) hold-point-system for block F that were regularly signed off (3) two-week labour forecast sheets for block F to construct the meaning of delays incident except the delay incident that involved a 3 month lock down.

Chapter five: Results in the Southeast cases

5.1 Engaging with a programme in delay incidents in the Southeast cases

How do distinct project groups engage with a programme in a safety improvement and drainage remedial project? This chapter presents two vignettes of specific delay incidents in which project groups engaged with programmes in each project. The discussion in the vignettes considers three main aspects: (1) the issues that led to specific delays and how project members found out, (2) what project members did to address the delays and who was involved, and (3) what changes key project members made with or without the programme in response to those delay incidents.

5.2 Background of the Southeast cases

The analysis in the vignettes that follow focuses on the relationship between four actors: a county council, a contractor, two subcontractors, their material suppliers, and their different roles in the safety improvement and drainage remedial projects in Southeast England. The analysis in the vignettes illustrated informal meetings, quick verbal discussions and invisible sequencing that project groups used to coordinate construction activities in the two projects.

In 2009, a county council in southeast England signed a transportation service contract for a period of ten years with Kingsway construction Limited to provide planned and reactive network maintenance, civil engineering works, traffic signals and urban traffic management control services on 3200 km of their road network. This contract expired in 2019 and was renewed for another four years till 2023. In 2019, Kingsway construction signed contracts with two firms namely: Emerald construction and Diamond construction. On 6th November 2019, Kingsway construction signed an NEC 3– option A contract with Emerald construction to execute a safety improvement works in Southeast England. On 21st November 2019, Kingsway construction signed another NEC 3- option A contract with Diamond construction to execute a drainage remedial project in the same Southeast England. Kingsway construction designed the scheme of works for the two projects, arranged with the transport department of the county for road lanes to be temporarily closed during construction, hired traffic control companies to regulate traffic, and contacted utility companies to locate and relocate utilities where necessary in those projects. Emerald and Diamond construction hired operatives, equipment and purchased materials in the two projects.

This research identified specific delay incidents in the process of executing the safety improvement and drainage remedial project that are key to understanding how project groups engage with a programme. The analysis of the two road projects allows for a comparison between how Empire and Diamond construction engaged their respective programmes. The chapter concludes by highlighting five key empirical issues: first, that the road project has project members in project groups that created multiple versions of the programme to meet their local needs and to relate with other groups. Second, that project groups constructed and interpreted project time differently in the versions of the programme as either linearly with new forms of organizing or cyclically with repetitive works. Third, project groups used different versions of the programme in different contexts to do different things. Fourth, project groups treated delays informally and did not record them on versions of the programme, thereby rendering them invisible and abstract. Fifth, project groups responded to invisible or abstract delays with negotiations that extended the project duration without any formal recording or reconstruction of specific delays. The section that follows presents the first vignette that tells a story of delays treated informally by different project groups in a safety improvement work.

5.3 Vignette I

The first vignette tells the story of delays treated informally by different project groups without any formal records on three versions of a programme in a safety improvement project, thereby rendering the delays invisible or abstract. The safety improvement project was to be handed over to a county council in Southeast England on 7th February 2020. However, the county council did not receive a complete work until 14th February 2020. This was viewed by the county council as a 1-week delay. Kingsway construction and Emerald construction agreed to complete the same safety improvement project on 6th December 2019, and both see 14th February 2020 as a 39-day delay. Addressing delays incidents in the safety improvement project involved the team from both firms, especially six main project members namely: Gregory (Kingsway Construction), Jairus (Kingsway Construction), Jermaine (Kingsway Construction), Ronald (Emerald Construction), Magnus (Kingsway Construction) and Gerrard (Kingsway Construction). The story presents five key moments in the safety improvement project: (1) beginning the safety improvement project and the creation of two programmes for the safety improvement project: a programme and a construction programme, (2) Kingsway Construction hiring Emerald Construction to execute the project, (3) the relocation of the fibre optic cable and issues that led to invisible delays, and (4) the

response to invisible delays. The section that follows describe the beginning of the safety improvement works when two versions of the programme are created. (See Figure 5.1).

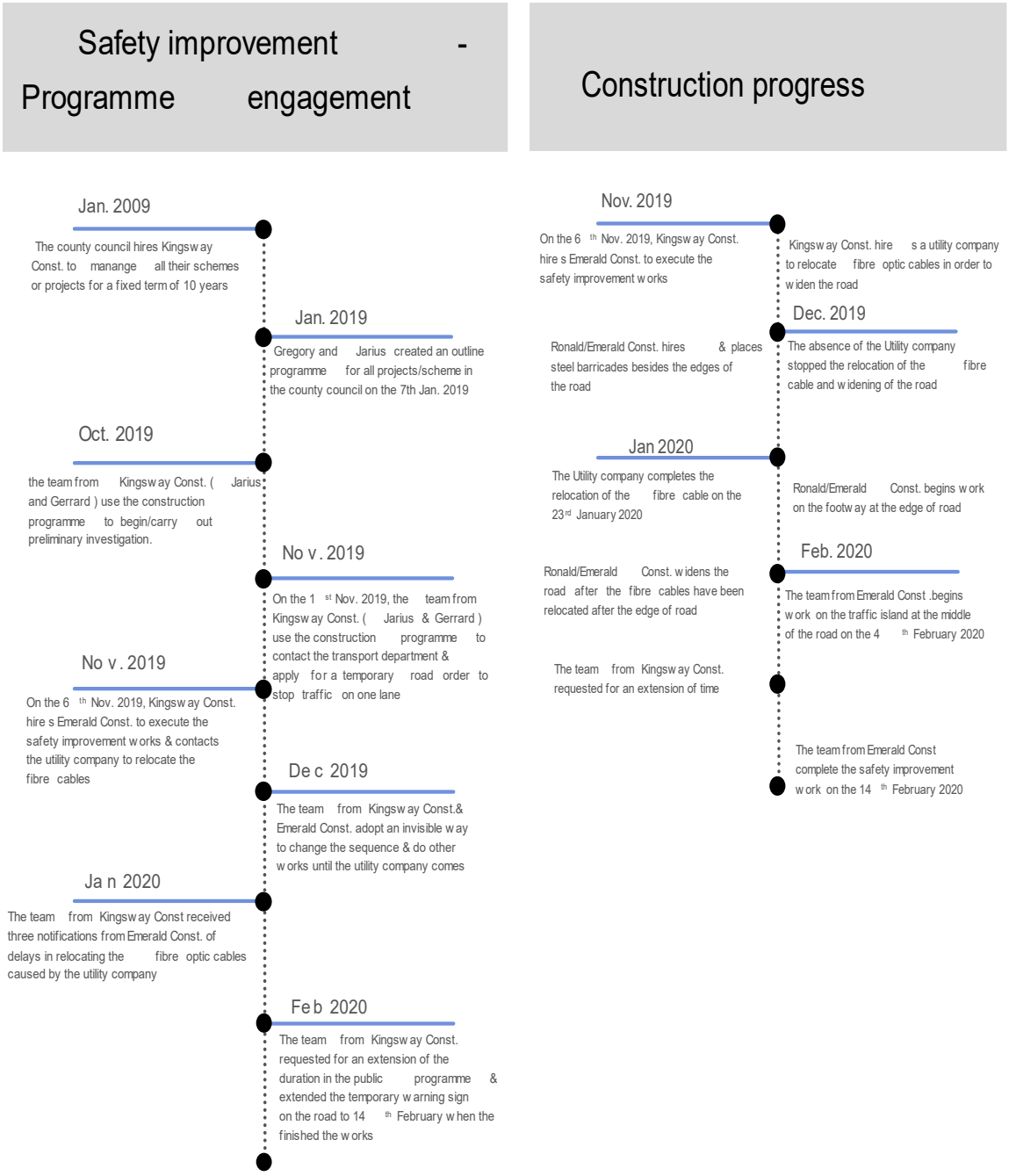


Figure 5. 1: Timeline of programme use and progress in the safety improvement project

5.3.1 Beginning the safety improvement project

The story of delays treated informally by different project groups in completing the safety improvement project on 14th February 2020 began with an object called an 'outline programme' created by a delivery manager, Gregory Smalls and involves the team from Kingsway Construction and the county council using the outline programme as a basis to negotiate their interest and begin preliminary investigatory works.

On 7th January 2019, Gregory and his team put together a programme that outlined several projects for the financial year of 2019 that included the safety improvement and drainage remedial project amongst others. Gregory oversees a portfolio of projects for the county council and Jairus Smith, a project manager who oversees the safety improvement project is part of his team in Kingsway construction. Jairus has a background in business and civil engineering and has been working for Kingsway construction since 2018.They used the outline programme to put together two programmes for the safety improvement project.

The first programme was a table with 4 rows and two columns (See figure 5.2). The first column presented 4 rows with 4 phases (or milestones) of the safety improvement project in each row and the second column presented 4 rows with start dates only and durations of the four phases in each row. The second column had November 2019 as the deadline to finish the first phase in the first row and a start date of 31st January 2020 with a duration of 5 days for the fourth phase in the fourth row. This phased or milestone programme for the safety improvement project is what Jairus referred to as the programme which was used for negotiations or dealing with the county council.

The second programme was also a table with 5 rows and two columns (See figure 5.3). The first column presented 5 rows with a list of multiple activities in each row and the second column presented 5 rows with start and finish dates of those activities in each row with earlier dates in each row compared to the phases in the first programme. The first column and third row presented four activities as the beginning of the same safety improvement project with 6th November 2019 as the start date with a 3-day duration. The first column and fifth row presented three activities as the end of the safety improvement project with 25th November 2019 as the start date and 6th December as the end date. This detailed programme for the safety improvement project is what Jairus referred to as the construction programme which was for negotiations or dealings with the subcontractor firm (Emerald Construction).

In October 2019, Jairus and Gerrard (a designer at Kingsway construction) used the outline programme to begin preliminary investigatory works to identify and mark out locations of underground utilities at the project site in a town in Southeast England. This involved Jairus and Gerrard doing a CAT-survey with a CAT-scan or a CAT penetrator radar to identify the locations of utility to prevent the subcontractor they planned to hire from damaging them. On 1st November 2019, Gregory and Jairus contacted the transport department of the county council to obtain a temporary road order to suspend or close half of the road (the length of 6 car spaces) from 4th November 2019 (the start date of the construction programme) and ends on 7th February 2020 (the end date in the programme).

The process of creating the outline programme is illustrated in Magnus (Commercial manager-Kingsway construction) account below:

> .....My role as a commercial manager is to manage and look after the contract from a commercial and contractual point of view and administering the terms and conditions of that contract. When we engage a subcontractor for a specialized or regular works, I write the subcontractor agreement, make it ready and get it signed by the subcontractor. So, looking after all of the commercial and contractual matters on the contract whether they be with the county council or whether they be managing the subcontractors. It is like getting target costs prepared for the county council because what happens in the transport contract is that, in the beginning of a financial year, we are provided with a list of his schemes which the county council wants us to deliver, and they assign us a budget for the whole year. When we receive that list, our delivery manager prepares a programme, rough programme or outline programme to let the county council know which schemes we're going to deliver at what time in the given financial year so the county council will have a rough idea when these schemes will start and they can get ready for the management team to look after receiving like target cost and get all necessary documents and required processes to be completed before we start putting target cost together and submitting to the county council getting them agreed with the county council and then taking these schemes to the site to deliver. So, our delivery manager prepares the outline programme. This programme gives a high-level sort of information to the county council that from this month on this date to this date, we will be delivering this scheme.....
>
> Interview, November 2nd, 2020

As evidenced above, the quote of Magnus (the commercial manager for Kingsway Construction) illustrates three points: first, the quote "…. *When we receive that list, our delivery manager prepares a programme, rough programme, or outline programme to let the county council know which schemes we're going to deliver at what time …. will have a rough idea when these schemes will start, and they can get ready….*" illustrates that the outline programme was created as a

medium to decide or agree when projects would be done in the county based on a budget provision. This suggests that programme plays a role in distributing schemes/tasks and deciding their timing.

Second, the quote "…. *after receiving like target cost and get all necessary documents …. and submitting to the county council getting them agreed with the county council and then taking these schemes to the site to deliver…."* illustrates that the outline programme mediates between the processes of preparing target costs, approvals from the county council, the delivery of the project team on site. This suggests that programme plays a role in mediating actors involved in preliminary processes to make actors ready to enter contractual agreements. Third, the quote "…. *This programme gives a high-level sort of information to the county council that from this month on this date to this date, we will be delivering this scheme*…." illustrates that the outline programme compiled projects or schemes with dates for the council and was very general. This suggests that the outline programme was not created for the purpose of precision or accuracy in construction work. This illustrates that the outline programme plays a mediating role between the team from Kingsway construction and the council in the safety improvement project.

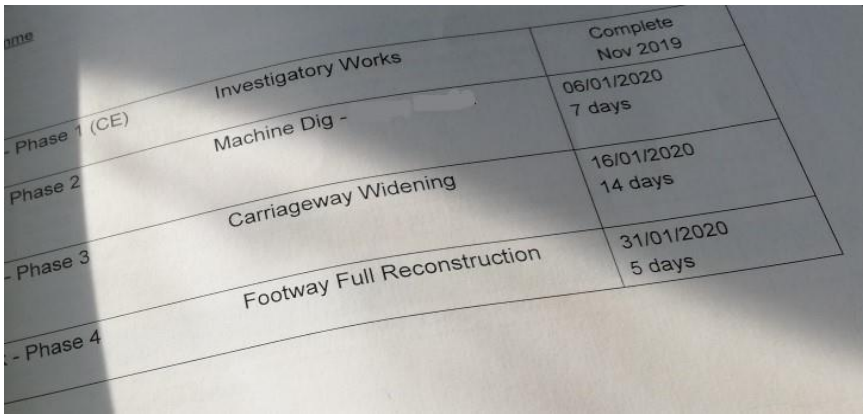
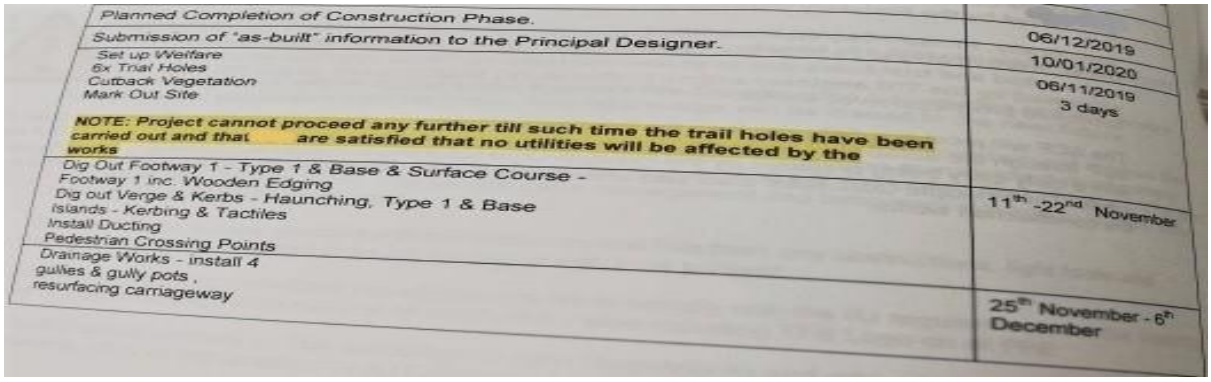


Figure 5. 2: The programme for the safety improvement project

5.3.2 Hiring Emerald Construction

On 6th November 2019, Kingsway construction hired Emerald construction to execute the safety improvement project. Jairus and Jermaine (a supervisor from Kingsway construction) had a meeting with Dannie (a manager from Emerald construction) and Ronald (supervisor from Emerald) to talk about the project. Jairus gave Dannie a job pack that included a construction phase plan with a construction programme and drawings specifying the positions of the utilities on the site. The team from both firms in the meeting agreed to be speaking in the morning daily

to jointly coordinate the works. The construction programme of the safety improvement works involved four phases or milestones namely: (1) relocating underground fibre optic cables to the side of the road, (2) widening of the road, (3) constructing a new pedestrian traffic island at the center of the road, and (4) installing a traffic control light beside the new traffic island. The section that follows describes the way the team from Kingsway and Emerald Construction used the construction programme without formally adapting or changing it.



Planned Completion of Construction Phase.	06/12/2019
Submission of "as-built" information to the Principal Designer.	10/01/2020
Set up Welfare 6x Trial Holes Cutback Vegetation Mark Out Site **NOTE: Project cannot proceed any further till such time the trail holes have been carried out and that are satisfied that no utilities will be affected by the works**	06/11/2019 3 days
Dig Out Footway 1 - Type 1 & Base & Surface Course - Footway 1 inc. Wooden Edging Dig out Verge & Kerbs - Haunching, Type 1 & Base islands - Kerbing & Tactiles Install Ducting Pedestrian Crossing Points	11th -22nd November
Drainage Works - install 4 gullies & gully pots , resurfacing carriageway	25th November - 6th December

Figure 5. 3: The construction programme for the safety improvement project

5.3.3 Contacting the utility company

This section describes how the team from both firms engaged the construction programme to coordinate the relocation of the fibre optic cable. After the team from both firms concluded the first meeting or discussions, Jairus contacted a utility company (Golden Media) to come and dig the ground on site to relocate the fibre optic cables that were identified by Gerrard in preliminary investigations/the drawings. At the same time Ronald hired operatives to install safety barriers on the site near the cables in the ground that needed to be dug out and relocated.

On 11th November 2019, Jermaine discussed with Ronald verbally on site his work plans for the day, prior to when Jairus came to site. Jermaine asked about the depth of the fibre cables and Ronald responded that it was shallow, and that the utility company had not yet come.

The process of adopting verbal exchanges onsite to coordinate work daily rather than formally adapting the programme is illustrated below in Jairus account when he said that:

> ...we carry out 5-minute briefing in the morning just to have a quick discussion. What we're doing today? What have we come across? Are there any issues and we look to resolve those issues, so communication channels are open almost daily ...
>
> Interview, December 4th, 2020

As evidenced above, the quote by Jairus illustrates two points: first, the quote *".....we carry out 5-minute briefing in the morning just to have a quick discussion* ....." illustrates that the team from both firms relied heavily on quick verbal discussions to organize or sequence activities daily and did not use the construction programme in discussions to coordinate their work, thereby adopting sequences of working that are invisible. This suggests that quick discussions or verbal exchanges helped the team from both firms to verbally layout out their plans daily and sequence them in discussions instead of updating or changing the programme. Second, the quote "....*so communication channels are open almost daily...."* illustrates that the team from Kingsway and Emerald Construction used daily verbal discussions as a medium to verbally capture agreements, knowledge and negotiate changes or adjustments in plans or sequence of working. This suggests that the team from both firms informally organised the safety improvement project with verbally arranged plans daily or sequences. The above section illustrates how the team from both firms began the safety improvement project and contacted the utility company to come and relocate the fibre cables. The section that follows describes the issue that led to incidents of delays in the relocating the fibre optic cables and what members did to address them.

5.3.4 The issue with the safety improvement project that led to invisible delays

The team from Emerald Construction had just installing safety barriers on site when one issue with two sides led to delay incidents. The first side to the issue is that a utility company that Jairus contacted to dig the ground and relocate the fibre optic cables on 6th November 2019 failed to do so until 23rd January 2020. Therefore, the team from both firms could not proceed further to (phase 3) widen the carriage of the road. The second side to the issue is that Kingsway Construction was trying to avoid the financial commitments of relocating the fibre cables and this delayed the relocation.

The first side to issue was illustrated in Jairus (project engineer/ scheme manager) account below when he said that:

> ... in order to widen the carriage way of the road, the underground fibre optic cables had to be relocated. My arrangement with Golden media to relocate those cables on or before 6th January 2020 was unsuccessful until 23rd January 2020. They were unable to resource adequately in time. The reason why we couldn't really proceed then is because we were relying on them to come in. Typically, their lead times were quite up 6 months waiting before booking them in. We came into the Christmas period and what should have been a 2-day job and we're hoping it'll get done before the Christmas break was not successful. This delay in relocating the existing fibre optic cables affected expansion works on the carriage way of the road to the left side.

> Phase III of the works (widening the road) was to be completed before Christmas in 2019. However, this was not possible and so we reassigned Emerald construction to another scheme pending when Golden Media services relocated the cables. Emerald construction could push for delay damages and apply for compensation. However, this would ruin business relationship with Kingsway construction and the county council. I discussed with my manager and the network improvement team to allow for an additional ten more days so that a new completion date of 14th February 2020 is in place....
>
> Interview, December 4th, 2020

As evidenced above, the quote by Jairus, illustrates five points: first, the quote *".....My arrangement with Golden media to relocate those cables on or before 6th January 2020 was unsuccessful until 23rd January 2020....."* illustrates that the utility company did not adhere strictly to initial arrangements made with Jairus and no formal record of this unsuccessful arrangement was made on the programme or construction programme, thereby rendering the delay incident invisible. This suggests that the team from both firms treated the delay informally and did not record them on any of the programmes. Second, the quote "..... *their lead times were quite up 6 months waiting before booking them in....."* illustrates that Jairus referred to dates or timing even though he did not formally update the construction programme or programme. This suggests that Jairus and the utility company had different interpretations of the deadline or understanding on the deadline to relocate the fibre optic cable. Third, the quote "..... *We came into the Christmas period and what should have been a 2-day job and we're hoping it'll get done before the Christmas break was not successful. This delay in relocating the existing fibre optic cables affected expansion works on the carriage way of the road to the left side...."* illustrates that Jairus at this moment viewed the relocation of the cables in 2019 as delayed based on the dates in the construction programme, however, based on phased programme and the start date of 6th January 2020, this phase had not yet begun. This suggests that versions of the programme played a role in interpreting incidents of delays differently. Fourth, the quote "..... *Phase III of the works (widening the road) was to be completed before Christmas in 2019...."* illustrates that Jairus at this moment referred to finish dates in the construction programme to interpret when phase III was to be completed but did not formally record delays on the programme or construction programme. This suggests that programme dates served as reference points in monitoring progress. Fifth, the quote "..... *Emerald construction could push for delay damages and apply for compensation. However, this would ruin business relationship with Kingsway construction and the county council...."* illustrates that Emerald Construction response to the incident of delay at this moment was to protect their business relationship with Kingsway Construction or the council rather than proceed with legal or punitive actions for breach of contract agreements. This

suggests that project groups that have a history of working together are more likely to treat delay informally. Sixth, the quote "…. *I discussed with my manager and the network improvement team to allow for an additional ten more days so that a new completion date of 14th February 2020 is in place…."* illustrates that the team from Kingsway Construction at this moment responded to the invisible delays with verbal discussions and agreements that extended the project duration, without any formal recording of specific delays. This suggests that Kingsway Construction treated delays with verbal discussions with his manager to adopt a new sequence of working without formally capturing this on any version of the programme, thereby adopting invisible sequences to arrive at the new finish date.

The above points illustrate that different project groups used the finish dates in the different versions of the programme and treated delay informally, thereby rendering them invisible and abstract. The project groups responded to invisible delays in relocating the fibre cables with negotiations that extended the project duration without any formal recording or reconstruction of the invisible delay.

The second side to the issue that led to incident of delay in relocating the fibre optic cable is illustrated in Jermaine account (project supervisor/ Kingsway Construction) below when he said that:

> … the statutory drawings we got showed that there are a lot of services in that area. Once we located the services, it was now the responsibility of Kingsway construction and the service providers to move those services. So, we had a slight delay because Kingsway construction were not too keen in calling the utility service company to come and relocate the same services that was found there because with things like that, you have to bear in mind the cost implication in it. Kingsway construction did not want to bear the cost or either wanted to pass it on to the supply chain. But, at some point they decided who actually pay for the cost of the diversion.
> I knew about the delay when we did a trial hole, we found out that the cable depth was shallow to put in our ducts, the statutory drawings we got was that the cable were a bit deeper than what we actually saw when we were doing our trial holes on site. So that was a straight delay….
>
> Interview, October 29th, 2020

As evidenced above, the quote by Jermaine, illustrates two points: first, the quote *"……it was now the responsibility of Kingsway construction and the service providers to move those services. So, we had a slight delay because Kingsway construction were not too keen in calling the utility service companies to come and relocate the same services ……"* illustrates that Jairus used a verbally discussed sequence of working or organising to negotiate between a cost interest (target

cost) and the priority of time (finish date in the programme) for Kingsway Construction. This suggests that the construction date and verbally discussed sequence played a role in distributing responsibilities between project groups and avoiding financial commitment.

Second, the quote *"…. because with things like that, you have to bear in mind the cost implication in it. Kingsway construction did not want to bear the cost or either wanted to pass it on ……. they decided who actually pay for the cost of the diversion……"* illustrates that the team from Kingsway Construction at this moment wanted to avoid the financial responsibility of relocating the cables which led to the delay. This suggests that project groups treat delays differently when there are no financial implications compared to when there are financial implications.

The way project groups engaged the programme involved informalities and this was illustrated in Magnus's account (Commercial manager – Kingsway Construction) below when he said that:

> …. In that particular scenario, it was statutory undertakers that caused the delay. It's their estate, so they can come at any time and start working, they're not obliged to let us know what time they will be coming or not coming and whether they're concerned we are there or not there. So a statutory undertakers issue is like a legal issue, we can't influence them, now all these risk normally sit with the county council because this is outside of the control of Emerald construction and even outside of the control of Kingsway construction.
> If they were involved properly, I don't think this would have happened to be honest with you. The statutory undertaker issue comes into 2 forms: first, is to make them part of our programme and see when they are available, then second, is to adjust our programme, now this wasn't done. So, I would say it was a poorly planned programme. Well, you know it's them telling us when they will be available. So, we have to adjust our programme as well, you can't force the statutory undertakers….
>
> Interview, November 2nd, 2020

As evidenced above, the quote by Magnus, illustrated four points: first, the quote *"……it was statutory undertakers that caused the delay…."* illustrates that Magnus blamed the utility company (Golden Media) for the delay incident rather than the programme or his team. This suggests that project groups responded to delay incidents by apportioning blame to others. Second, the quote "……*If they were involved properly, I don't think this would have happened to be honest with you…."* illustrates that engaging informally with a programme obscures people's involvement in a project. This suggests that the mode (formal or informal) of engaging with programmes has implications on people's involvement in a project. Third, the quote "……*make them part of our programme and see when they are available…. then second is to adjust our programme, now this wasn't done…."* illustrates that Jairus at this moment did not mutually accommodate the availability of every party when creating or adapting the construction programme. This suggests

that programme use plays a role in negotiating people's availability or the way project groups want to depend on each other. Fourth, the quote "*...So, I would say it was a poorly planned programme....*" illustrates that Magnus blamed Jairus (project manager) and the way work was arranged for the delay incident.

The above section illustrates the issue that led to a delay incident as the team from both firms began to install safety barriers on site. The section that follows describes the way the team from both firms responded to invisible delay.

5.3.5 Response to invisible delays

Two key moments shaped the way the team from both firms responded to the issue and invisible delays described above. The first part is connected to Emerald Construction and invisible delays on or before 4th February 2020. This involved the team from both firms adopting an invisible way of sequencing the activities to proceed with other aspects of the safety improvement project. The second part is connected to Kingsway construction and the handing over of the safety improvement project on or before 14th February 2020.This involved the team from Kingsway Construction pushing back on the deadline and the council county agreeing to an extension of 7 days that changed the hand over date from 7th February 2020 in the programme to 14th February 2020. This response to invisible delays builds on the efforts of the team from both firms to protect business relationship. The section that follows describes the way the team from both firms adopted invisible sequences to coordinate activities. (See Figure 5.1).

Figure 5. 4 Relocated fibre optic cables after widening the road on the (23/1/ 2020)

5.3.5.1 Adopting an invisible way to sequence work

Taking the first response invisible delays on or before 4th February 2020 and connected to Emerald Construction. This part of the story continues from November 2019 when the utility company failed to turn up to relocate the fibre optic cables on the project site.

The way the team from Emerald Construction responded to this incident of delay is illustrated in Jairus account below when he said that:

> …. we received official emails from Emerald construction of change events and early warning notices three times. The utility company failed to commit to the programme. Unfortunately, Golden Media, who were to relocate one of their fibre optic cables for us promise that they would do it before the Christmas period last year-2019, but they didn't turn up until the new year-2020. That actually put a three-week project delay on our construction programme and unfortunately, there was no mechanism for us to penalize them and so we were totally at their mercy. We could have followed it up if we wanted to really look at some sort of detailed contracts between us. But I think the cost of what it would have cost to try pursuing Golden Media would have significantly been more expensive than the potential delay….
>
> Interview, December 4th, 2020

As evidenced above, the quote by Jarius, illustrated three points: first, the quote *"……we received official emails from Emerald construction of change events and early warning notices three times…"* illustrates that the team from Emerald Construction at this moment responded to the incident of delay by writing early warning notifications rather than recording them on the construction programme. This suggests that the team from both firms treated delays informally and did not record them on any of the programmes. Second, the quote "……*That actually put a three-week project delay on our programme…."* illustrates that Jairus at this moment viewed the failure of the utility company to turn up as a delay on the project rather than relocation of cables without any formal record explaining how. Third, the quote "…. *there was no mechanism for us to penalize them and so we were totally at their mercy……. I think the cost of what it would have cost to try pursuing Golden Media would have significantly been more expensive than the potential delay…."* illustrates that Jairus at this moment could not do anything in response to the delay or the utility company to avoid any financial losses. This suggests that project groups treat delays differently when there are no financial implications compared to when there are financial implications.

The process of responding to invisible delays without formal records or changes to versions of the programme is illustrated below in Jairus account when he said:

> .... So, what we then had to do rather than continuing the sequence, which was originally planned and programmed for the construction is to change our sequence. We had to basically start half a job and put the relocation to hold and then move on to the opposite of the road and continue there. It just meant that the sequence had to change. Now with the sequencing having to change, that meant our traffic management had to be assessed and set out differently and what the public were expecting in terms of the way the traffic moved past that road changed. So, these were the impacts and there was obviously risk of us getting backlash. Some negative comments and feedback from the public and potential impact it could have on generally motorists and the network. So, these were things we had to try to accommodate and try to mitigate any concerns. We had to change sequence to manage delay... this is what we did we change our sequencing....
>
> Interview, December 4th, 2020

As evidenced above, the quote by Jairus, illustrated three points: first, the quote *".....what we then had to do rather than continuing the sequence, which was originally planned and programmed for the construction is to change our sequence..."* illustrates that the team from both firms responded to invisible delays with new work sequences that were invisible and informal. Second, the quote "..... *We had to basically start half a job and put the relocation to hold and then move on to the opposite of the road and continue there. It just meant that the sequence had to change...."* illustrates that invisible delays led the team from both firms at this moment to adopt invisible sequences and adjust the initial way they organized to progress other areas. Third, the quote ".... *So, these were things we had to try to accommodate and try to mitigate any concerns. We had to change sequence to manage delay... this is what we did we change our sequencing...."* illustrates that delay incidents led to a mutual accommodate the work and initial plans in the discussed as the team from Kingsway Construction started a job halfway and then moved to the opposite of the road.

The above section illustrates that the team from both firms responded to invisible delays on or before 4th February 2020 by adopting invisible ways of sequencing work in quick verbal discussions. The section that follows describes the way Kingsway Construction responded to invisible delays with negotiations that involved extending the project duration without any formal recording of delays before handing over.

5.3.5.2 Extending the duration and closure

Taking the second response to invisible delays on or before 14th February 2020 that is connected to Kingsway Construction. This part of the story continues from 31st January 2020 after relocating the fibre cables and involved verbal exchanges to extend the duration and coordinate the work

of four sub-groups namely: operatives, traffic manager, line marking contractors and the electrical contractors.

On 1st of February 2020, Ronald sent two operatives to begin the construction of a pedestrian traffic island. They operatives had discussions with Jermaine on site and set out the location of the traffic island on the middle of the road. After setting out the traffic island, they operatives started to cut and scrape out the tarmac in the shape of a rectangular pit. On 3rd February 2020, Jairus contacted Gregory over the phone to discuss the potential of the remaining works exceeding the finish date in the programme and a delay in completing the safety improvement project. Jairus pushed back on the deadline and Gregory agreed to ask the county for a 7-day extension of the duration by additional 10 days that moved the finish date from 7th February to 14th February 2020. Gregory made a formal application to the county that was approved.

The response to invisible delays that involved an extension in duration is illustrated in Jermaine account below when he said:

> .... we had delays in relocating the fibre optic cables and this is the reason why we just changed the end date on the caution traffic warning sign from 7th February 2020 to a new end date 14th February 2020....
>
> Field conversation, February 10th, 2020

As evidenced above, the quote by Jermaine, "*.....we had delays in relocating the fibre optic cables and this is the reason why we just changed the end date on the caution traffic warning sign....*" illustrates that the team from Kingsway Construction at this moment responded to invisible delay incident by extending the duration and captured this with the new date on the traffic caution sign to 14th February 2020 (See Figure 5.5) without any formal record .

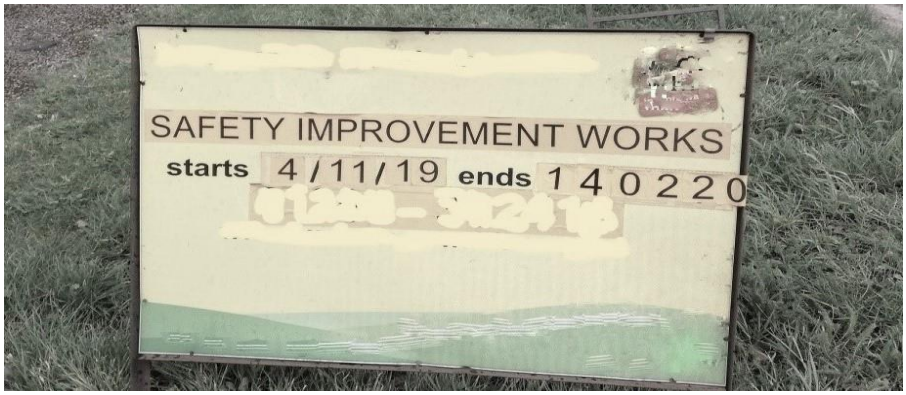


Figure 5. 5: Revised temporary road order (warning sign) for the safety improvement project

On 4th of February 2020, Ronald sent four operatives led by a gang leader, Nick, to the site to complete the scraping of the tarmac and install kerb stones in a rectangular pit to erect a traffic island. However, the pit was smaller than the dimension specified in the drawings. This was because only half of the road was accessible to the operatives, as the remaining half was used for vehicular traffic. The operatives stopped working and did not know what next to do in the afternoon. Nick spoke to Jairus on the site and was advised to relocate some of the traffic safety cones to achieve the correct dimension. The operatives completed cutting and installation of kerbs to complete the traffic island. This illustrates how the team from both firms used quick verbal discussions to resolve problems and coordinate resources.

On 10th February 2020, Ronald sent another gang of 5 operatives led by Harry (the gang leader) to place asphalting or surface course on the widened portion of the road and the new traffic island within 2 days. The operatives began the asphalting at the widened portion of the road before proceeding to traffic island. Jermaine reminded the operatives to compact the asphalting and advised the traffic control officer managing the vehicular traffic to change the closed lane where necessary and still leave one lane for vehicles coming from both sides. This illustrates how the team from both firms used quick verbal exchange to coordinate the asphalting process.

On 12thFebruary 2020, Harry and the operatives finished the asphalting on the traffic island and footway at 12:04 pm in the afternoon. Jairus invited a road marking contractor to begin markings. At 12:07 pm, the operative began laying tactile pavements in the traffic island with concrete. At the same time, the road marking contractors began to mark new lines on the road. At 1 :00 pm Jairus instructed Harry to remove the remaining kerbs because he was expecting an electrical contractor the next day to begin the installation and wiring of a traffic light on the traffic island before leaving the site. The electrical contractor finished the installation and wiring of a traffic light on the traffic island on 14th February 2020.This illustrates how the team on site used quick verbal exchanges and invisible sequences of working to coordinate the work of different site or sub- groups.

This first vignette tells the story of delays treated informally by different project groups without formal records on three versions of a programme in the safety improvement works, thereby rendering the delays invisible or abstract. The safety improvement project was to be handed over to a county council in southeast England on 7th February of 2020. However, the county council did not receive a complete work until 14th February 2020. This can be interpreted by the county council as a 1-week delay in completing the safety improvement works. Kingsway construction

and Empire construction agreed to complete the same safety improvement project on 6th December 2019, and both see 14th February 2020 as a 39-day delay.

The events in the story illustrated four points: first, that project groups on the safety improvement works engaged informally with versions of the programme every day and in delay incidents. This informality in engagement was illustrated when project groups used quick verbal exchanges and invisible sequences daily to coordinate work. Second, the different project groups on the safety improvement project interpreted the incident of delay differently. Third, version of the programmes played six different roles in different project group namely: to assign responsibilities and task, to manage expectations of project groups, to negotiate increase in duration, to map out availability for groups to depend on each other, to coordinate the activities of multiple operatives or specialist workers, to budget for projects, to issue or extend a temporary road order to close half of the road. Fourth, project groups responded to abstract or invisible delay without negotiations that extended the project duration without a formal record or reconstruction of specific delays. The section that follows describes the story of delays treated informally by project groups in a drainage remedial work.

5.4 Vignette II

The second vignette tells the story of a delays treated informally by project groups without any formal records on three versions of the programme in executing a drainage remedial project, thereby rendering the delays invisible or abstract. The drainage remedial project in a village town in the same county council (Southeast England) was to be completed on 4th December 2019. However, the county council did not receive completed works until 14th February 2020 because of slow approvals from owners of a golf course to install soak-aways beside the golf course. Kingsway Construction and Diamond Construction agreed to complete the same drainage remedial project on 4th December 2019 but with an earlier start date. This can be interpreted by the county council as 2 months, 12 days delay in completing the drainage remedial project.

Addressing delays incidents in the drainage remedial project involved the team from both firms, especially six main project members namely: Gregory (Kingsway), Graham (Kingsway), Vincent (Diamond), and Gerrard (Kingsway). The story presents four key moments in drainage remedial work: (1) beginning the drainage project and the creation of two programmes: a programme and a construction programme, (2) Kingsway Construction hires Diamond Construction to execute the project, (3) Meeting with residents with affected by the flood, and (4) The issue of slow

approval from a golf course owner that led to invisible delays. The section that follows describes the beginning of drainage project and the creation of the two programmes. (See Figure 5.6).

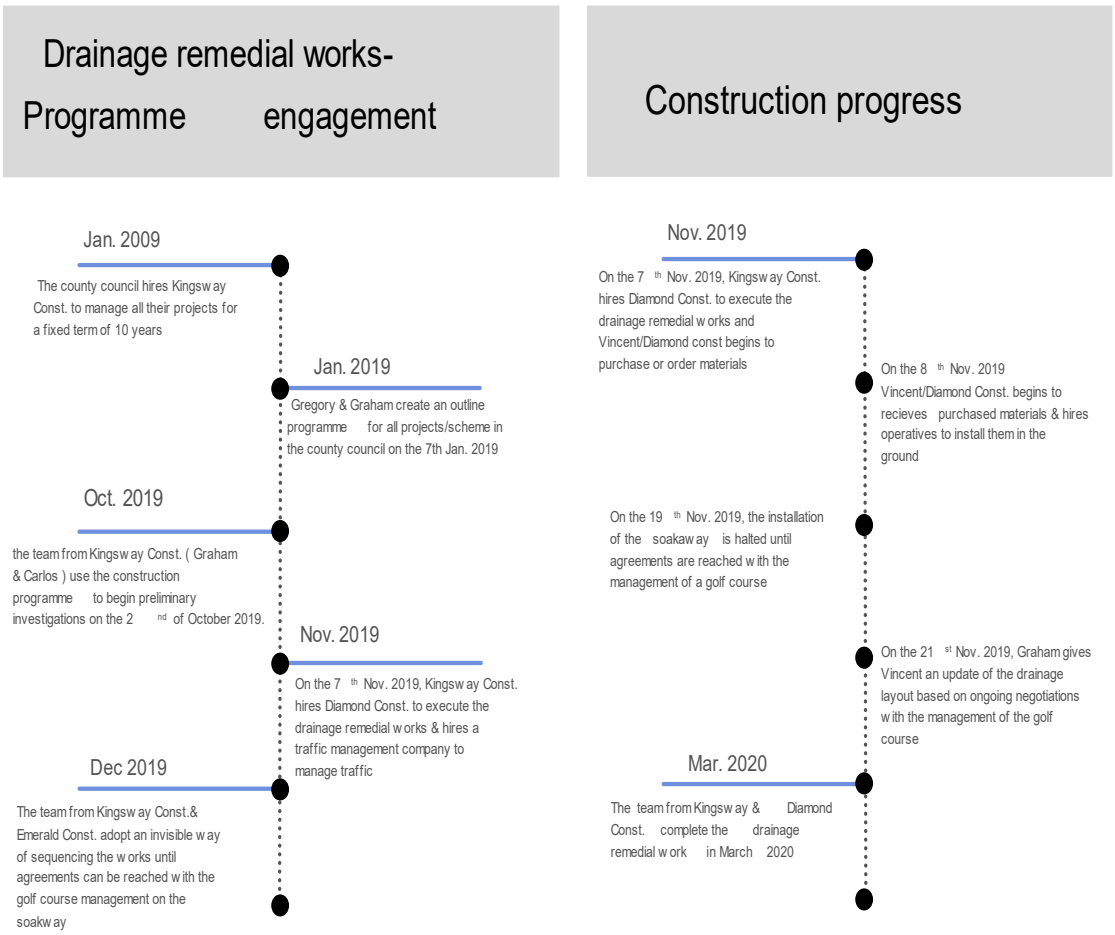


Figure 5. 6: Timeline of programme use and progress in the drainage remedial project

5.4.1 Beginning the remedial drainage project and investigatory works

The story of delays treated informally by project groups in executing the drainage remedial project began with an object called the 'outline programme' created by Gregory and involved the team from Kingsway Construction and Diamond Construction using the outline programme as a basis to negotiate their interest and begin investigatory works.

On 7th January 2019, Gregory and his team put together a programme that outlined all the projects for the financial year of 2019 including the drainage remedial project. Graham Owen is part of this

same team and oversees the drainage remedial work as the project manager. His background is in civil engineering, he has been working for Kingsway construction since 2018. They used the outline programme to create two programmes for the drainage remedial project. The first programme presented an outline of start/finish dates and durations for negotiations and dealing with the county council with a start date of 21st November 2019 and end date of 4th December 2019. This programme was referred to by Graham as the programme. The second programme presented an outline of start/finish dates and durations for negotiations and dealing with a subcontractor with a start date of 7th November 2019 and end date of 4th December 2019. This programme was referred to by Graham as the construction programme.

On 2nd October 2019, Graham, and a designer Carlos Richie carried out a CAT- survey of a residential area in the village town prone to flooding using a CAT-scan and a CAT penetrator radar. Graham made coloured markings on the ground with red, blue, pink, green to help the subcontractor they planned to hire to distinguish the different utilities they identified. On 8th October 2019, Carlos designed the layout of the drainage remedial project. The drainage remedial work involved four main aspects namely: (1) installation of chambers and 3 catch pits, (2) installation of a 4m x 1.5m perforated soak way, (3) installation of 4 number of 1500mm x 2500 mm deep soak-away, and (4) connection of the carrier lines to the catch pit and chambers to the soak-away. This illustrates how the team from Kingsway construction began the drainage remedial works by starting with the preliminary investigatory works. The section that follows describes the hiring of Diamond Construction and meetings with a golf course owner.

5.4.2 Hiring Diamond Construction and meeting with the golf course owner

On 7th November 2019, Kingsway Construction hired Diamond Construction to execute the drainage remedial project with the construction programme and Graham hired a traffic control contractor to manage the traffic of the vehicles on the road. Graham met with the Director of Diamond Construction, Vincent in the morning. They briefly discussed the project and Vincent began to order for catch pits, chambers, and pipes. On 8th November 2019, Vincent used the coloured markings made by Graham and Carlos to discern which areas to dig and which areas/pipes to ignore and consulted the drainage layout prepared by the team from Kingsway Construction. Vincent began to receive purchased construction materials such as pre-cast perforated concrete chamber rings (soak-away), 300 mm black pipe and hired operatives to install them in the ground as indicated on the drainage layout.

On 19th November 2019, Graham and Carlos had a meeting with the management of a golf course facility (the owner and the general manager of the golf club). This was because the drainage remedial project involved the installation of 4 number of 1500mm x 2500 mm deep soak-away beside the golf course. When the meeting began Graham and Carlos informed the management of the golf course facility that they intend to install large soak-aways to help drain the water off the public highway and are seeking to gain their approval. The owner and the general manager of the golf club asked for design details to study before approving this request. This illustrates the way the team from both firms coordinated the drainage remedial project.

5.4.3 Meeting with residents affected by flood

On 21st November 2019, Graham and Carlos had another meeting with resident that they described as a flood action group. This group comprised of three separate individuals namely: 6 affected residents (houses that are being flooded), a Water company (that manages the foul sewer system) and a local councilor. When the meeting began, Graham talked about the flooding history and current situation in regard to surface water emanating from the highway and the foul sewerage back flowing into the houses. After the meeting Graham met briefly with Vincent and gave him a Job pack i.e., documents for the works, statutory plans (that had been updated recently with the positions of underground utilities), a CAT-report and they discussed briefly the scope of the drainage remedial project.

The way Graham sequenced activities with quick discussions to coordinate works daily is illustrated below in Graham's account when he said:

> ..... there is no specific construction programme due to the size of the works. On a small scheme like this, we would normally discuss the method and programme of installing the drainage items at the site induction on the first day of the works rather than having a formal works programme. Some of the things we consider include is there any access issues for residents or businesses i.e., to shops, petrol stations, funerals, school holidays etc. If any of these are applicable, then we would plan our works around these events....
> On this project, we go to site daily and we normally have a 5-minute meeting just to run over the progress of the work and any issues. We also carry out a safety audit and we check all the paper work and machineries for the purpose and look at the appropriate licenses in place and permits to work, so we fill out a site diary just taking notes of what they are doing and that just show progress of the works and that satisfies the commercial department at the end because if they are charging us for a digger to be on site for 2 weeks and only use it for four days, then in theory it shouldn't be paid for the digger for 2 weeks. So, we manage the works that way, we have our daily catch up, we turn up on site. So, it is an informal meeting; it is not like a large project we run where you have everybody

> gets in a room once a month and you have a progress meeting. It is normally just dealt with the daily site visits, the daily site diary, and any change in scope with a site variation instruction for short site visit, so that is how we manage on site and that's how we keep on top of the works to make sure it has been built correctly to right standard using the right materials and there is no health and safety issues.....
>
> Field conversation ,November 21st, 2019

As evidenced above, the quote of Graham (the project manager for Kingsway Construction) illustrates three points: first, the quote "…. *there is no specific construction programme due to the size of the works. On a small scheme like this, we would normally discuss the method and programme of installing the drainage items at the site induction on the first day of the works rather than having a formal works programme…."* illustrates that Graham coordinated the activities with the team from Diamond by discussing the activities involved on site. This suggests that the team from both firms adopted verbal exchanges/verbal or invisible sequences to coordinate the activities of site groups. Second, the quote "……. *we go to site daily and we normally have a 5-minute meeting just to run over the progress of the work and any issues……. So, we manage the works that way, we have our daily catch up, we turn up on site…."* illustrates that Graham used daily discussions to verbally capture the progress of the drainage remedial project and resolve issues. This suggests informality in engaging with programmes as the team from both firms did not formally update or change the programme or construction programme. Third , "….*So, it is an informal meeting……..It is normally just dealt with the daily site visits, the daily site diary and any change in scope with a site variation instruction for short site visit, so that is how we manage on site and that's how we keep on top of the works……."* illustrates that the team from both firms often met informally to discuss daily on site and adopted a verbally sequenced programme as a way to manage the drainage remedial project. This suggests that the verbally discussed programme with an invisible sequence of working played a role in coordinating the activities of the groups on site. The discussions in the informal meetings provide a quick platform to verbally consider and accommodate issues that could interrupt the progress of the works. The three points illustrate informality in the way the team from both firms engaged with the construction programme and organized the work. The section that follows describes the issue that led to delay incidents in the drainage remedial project.

5.4.4 The issue with the drainage project that led to invisible delays

The team from both Diamond Construction just began to excavate trenches, and position precast chambers when one issue led to delay incidents. The issue was that owner of the golf course had

not yet agreed or approved for Diamond construction to install the 4 number of 1500mm x 2500 mm deep soak-away beside their golf course as indicated in the design. This slowed down construction activities and led to incidents of delay in the drainage remedial project. This issue was illustrated in Vincent (Diamond construction) account below when he said:

> .... We did work on the outside. That's what we did, we worked around, we did the work all on the outside until we were able to get onto the inside to the golf course so. It was in the pre-construction information. They made it known to us that there will be an earlier delay in trying to get into the golf course, so we programmed all our work outside first which give us enough time for them to have the negotiation to get into the golf course. It wasn't a surprise. So we didn't fully resources like we should have done. We under-resource to take us to the point of where we can get in.....
>
> Interview, December 8th, 2020

As evidenced above, the quote of Vincent illustrates three points: first, the quote "…. *We did work on the outside. That's what we did, we worked around, we did the work all on the outside until we were able to get onto the inside to the golf course so…."* illustrates that the team from both firms at this moment responded to incidents of delays by developing a new sequence of working in verbal exchanges that completed all works that were outside the golf course until accessibility was possible. This suggests that delay incidents led the team from both firms to adjust initial forms of organizing or work sequences around activities that are contentious. Second, the quote "……. *It was in the pre-construction information. They made it known to us that there will be an earlier delay in trying to get into the golf course……"* illustrates that the team from Kingsway Construction did not have a confirmed or accurate date on when they could access the golf course when they hired the team from Diamond Construction with a construction programme, yet they went ahead. This suggests that they team from both firms were not after an accurate construction programme but began the project because they believed they can use the programme to mediate between their firms in contention. Third, the quote "……*so we programmed all our work outside first which give us enough time for them to have the negotiation to get into the golf course. It wasn't a surprise, so we didn't fully resources like we should have done. We under-resource to take us to the point of where we can get in…"* illustrates that the team from Diamond Construction responded to invisible delays by under-resourcing pending when the approval process from the golf course owner was sorted. This suggests that delay incidents led the team from Diamond Construction to briefly adjust their sequence of working until Kingsway Construction gained approval for works to locate the soak-away.

On 14th February 2020, after gaining approval, the team from both firms proceeded to work inside the golf course and installed the 4 number of soak-aways to complete the drainage remedial project.

The above section illustrates the issue that led to invisible delays in the safety improvement project. The issue was a slow approval from the owner of the golf course that denied Diamond construction access to install the 4 number of 1500mm x 2500 mm deep soak-away beside the golf course as indicated in the design.

The above four key moments in this vignette illustrate the story of delays treated informally by project groups without any formal records on the three versions of the programme in the drainage remedial project.

The events in the story illustrate that project groups on the drainage remedial project engaged more informally with the construction and public programme than formally every day and when there was an incident of delay. The drainage remedial project was to be completed on 4th December 2019. However, the county council did not receive completed works until 14th February 2020 because of slow approvals from owners of a golf course to install soak-aways beside the golf course. Kingsway Construction and Diamond Construction agreed to complete the same drainage remedial project on 4th December 2019 but with an earlier start date. This can be interpreted by the county council as a 2-month, 12 days delay in completing the drainage remedial project. (See Figure 5.6).

The events in the story illustrate four points: first, that project groups on the drainage remedial project engaged informally with versions of the programme every day and in delay incidents. This informality in engagement was illustrated when project groups used quick verbal exchanges and invisible sequences daily to coordinate work. Second, the different project groups on the drainage remedial project interpreted delay differently. Third, the versions of the programmes played six different roles in different contexts for project groups namely: to assign responsibilities and task, to manage expectations of project groups, to negotiate increase in duration, to coordinate the activities of multiple operatives or specialist workers, to budget for projects, to issue or extend a temporary road order to close half of the road. Fourth, project groups responded to abstract or invisible delay without negotiations that extended the project duration without a formal record or reconstruction of specific delays. They also responded to invisible delay with a mutual accommodation of the work(under-resourcing) and verbal exchanges.

5.5 Empirical issues in the Southeast cases

The purpose of the analysis in this chapter is to understand in detail how a programme that interfaces distinct project groups functions in a safety improvement and drainage remedial projects in Southeast England and to study variations. The two vignettes above demonstrated that the safety improvement and drainage remedial project in Southeast England had three project groups namely: the county council, Kingsway construction, the subcontractors (Diamond construction and Emerald construction). The vignettes demonstrated informal meetings, quick verbal exchanges and invisible sequences that project groups used to coordinate construction activities in the two projects (See figure 5.1).

The two vignettes demonstrate that different project groups in the Southeast cases created and engaged different versions of the programme without formally capturing delays on the programme in an incident. The project groups in the two vignettes did not use the different versions of the programme to capture agreements or changes in the Southeast cases, but rather adopted quick verbal discussions daily or invisible ways of sequencing activities and coordinate work.

The two vignettes demonstrate that different project groups in different contexts informally engaged different versions of the programme in delay incidents and the evidence presented demonstrate five empirical issues.

The first issue is that the two projects have project actors in three project groups that created multiple versions of the programme to meet their local needs and to relate with other groups. For example, Kingsway Construction created and used the outline programme and the programme to relate with the county council, Kingsway Construction also created and used the construction programme to relate with Diamond/Emerald Construction. These three versions of the programme had different start date and finish dates. The consequence is that the different project groups worked to different understanding of how the road projects should start and conclude. This led to differences in their expectation.

The second issue in that the vignettes demonstrate that project groups constructed or interpreted project time differently in the versions of the programme. For example, the county used the outline programme in a financial year to fund projects one after the other and conceptualised time linearly. At the same time, Kingsway Construction used the outline

programme repeatedly to organize construction activities and conceptualised time cyclically as follows : (1) repeatedly searching for the position of utilities on different project sites under the county, (2) using the location of utilities to repeatedly prepare designs for each project under the county, (3) temporarily closing half of the road repeatedly so that Emerald or Diamond Construction can work with traffic, and (4) applying for regular payments on the different projects under the county council. The subcontractors (Emerald and Diamond Construction) used the dates in the construction programme and their own programme to begin works, hire operatives, purchase construction materials, and to apply for regular payments. The subcontractors conceptualised time linearly in each project with new forms of organising. The project groups in the Southeast case used quick verbal exchanges and adopted informal or invisible sequences to organise work.

The third issue that is demonstrated in the vignettes is the project groups in the two projects used different versions of the programme in different contexts to do different things such as: The county council use the outline programme to budget for each project, Kingsway Construction uses the outline programme to carry out preliminary investigatory works, Kingsway Construction use the programme and construction programme to issue or extend a temporary road order to close half of the road, Kingsway Construction uses the construction programme to contact the service provider to relocate cables and hire the traffic management specialist to manage traffic works. The differences in the way project groups engaged with versions of the programmes are similar in the two vignettes and are partly because the project groups had different interest or priorities.

The fourth issue is that the vignettes demonstrate that project groups in the Southeast cases treated delays informally and did not record them on the three version of the programme, thereby rendering them invisible or abstract. The two vignettes showed that project groups issued early warning notifications when construction activities were disrupted instead of capturing delays on versions of the programme. The two vignettes illustrated that project groups referenced dates in versions of the programme to interpret the meaning of a delay in an incident and the meaning varied across the three project groups on the two projects. For example, when Kingsway construction referenced the dates in construction programme to interpret a delay on an activity that led to tension, the county did not view this as a delay or tension because they used the programme with different dates. In addition, project groups treat delays differently when there are no financial implications compared to when there are financial implications.

The fifth issue is that the vignettes demonstrate that project groups in the Southeast cases responded to abstract or invisible delays with negotiations that extended the project duration, without any formal recording or reconstruction of specific delays and without any formal changes to the sequence of working. This is similar in both vignettes as the three project groups changed the sequence of working after increasing the duration but did not formally update the programme or construction programme.

The evidence presented in this chapter suggests that different project groups on the safety improvement and drainage remedial project engaged informally with different versions of the programme in delay incidents. A summary of these empirical issues in the Southeast cases is presented in Table 5.1 below.

Table 5: 1 Summary table of the distinctive and common findings across the different groups and vignettes in case II

S/N		Vignette I	Vignette II
1	**Time was constructed in case II with several versions of the programme as a basis of relating between the different project groups in the road project.**	**There are three main project groups involved with the safety improvement works in vignette one:** the county council, Kingsway Construction and Emerald Construction. These three project groups created and adapted three versions of the programme for the safety improvement works as the interacted frequently with each other. **The first version is the outline programme**. The county council and Kingsway Construction created this outline programme to capture several projects for that financial year that included the safety improvement project. This outline programme was high level or general with start and finish dates for the different projects. **The second version is a programme for** the safety improvement works. Kingsway Construction created this programme (based on the time apportioned for the safety improvement work in the outline programme). This programme was also high level and was divided into four milestone or phases with a start date and duration (see figure 5.2). **The third version is the construction programme**. Kingsway Construction and Empire Construction created this programme for the safety improvement works to visually capture more details and had earlier finish dates compared to the second version. N.B: The finish date of the second version of the programme was revised.	**There are three main project groups involved with the drainage remedial works in vignette two**: the county council, Kingsway Construction and Diamond Construction. These three project groups created and adapted three versions of programme for the drainage remedial works as the interacted frequently with each other. **The first version is the same outline programme**. The county council and Kingsway Construction created this outline programme to capture several projects for that financial year that included the drainage remedial project. This outline programme was high level or general with start and finish dates for the different projects. **The second version is a programme for** the drainage remedial project**.** Kingsway Construction created this programme (based on the time apportioned for the drainage remedial work in the outline programme). This programme was also high level. **The third version is the construction programme**. Kingsway Construction and Diamond Construction created this programme for the drainage remedial works to visually capture more details and had earlier finish dates compared to the second version.
2	**The way project groups in case II engaged with a programme in the context of the London project.**	The county council, Kingsway Construction and Emerald Construction in vignette one informally engaged the three versions of the programme in two meetings. The first meeting was at the beginning of the project to discuss the method or programme. The team from Kingsway and Emerald Construction used this first meeting to do verbally discuss the method of construction and the programme for the safety improvement project. The second meetings were informal meetings that involved quick verbal discussions to run over and catch up on progress. The team from Kingsway and Emerald Construction used quick verbal exchanges in informal meetings to agree or stay up to date on the progress of the safety improvement project	The county council, Kingsway Construction and Diamond Construction in vignette two also informally engaged the three versions of the programme in two meetings. The meetings are similar to the two mentioned in vignette one.
3.	**The role of a programme in the different project**	The county council, Kingsway Construction and Emerald Construction in vignette one used versions of programme for the safety improvement work to do seven different things. These include (1) to construct different interpretations of project time for projects groups. (2) to distribute task and responsibilities at multiple levels. (3) to manage project resources at multiple levels, (4) to manage the expectations of the different project groups, (5) to enable	The county council, Kingsway Construction and Diamond Construction in vignette two used versions of block D programme in a similar way as the seven mentioned in vignette one**.**

	groups case II.	firms negotiate their interest or priorities, (6) to capture agreements made initially at multiple levels, (7) to enable project groups communicate about the progress of the project at multiple levels.	
4.	**The way different project groups constructed the meaning of a delay at different incidents, across case II.**	The county council, Kingsway Construction and Emerald Construction in vignette one used versions of the programme for the safety improvement work to treat delays informally and did not record them on the programme, thereby rendering them invisible or abstract.	The county council, Kingsway Construction and Diamond Construction in vignette two also used versions of the programme for the drainage remedial work to treat delays informally and did not record them on the programme, thereby rendering them invisible or abstract.
5.	**The way different project groups interacted when responding to delay incidents across the vignettes in case II.**	The council county, Kingsway Construction and Emerald Construction in vignette one responded differently to delay incidents with the different versions of the safety improvement project. The main project groups responded to abstract or invisible delays with negotiations that extended the project duration, without any formal recording of specific delays. The safe improvement projects showed that it is only after project members used a programme to interpret and then label (verbally) the progress of a project as delayed, that they began to treat or view the project as delayed.	The Council County, Kingsway Construction and Diamond Construction in vignette two responded differently to delay incidents with the different versions of the drainage remedial project. The drainage remedial projects also showed that it is only after project members used a programme to interpret and then label (verbally) the progress of a project as delayed, that they began to treat or view the project as delayed.
6.	Comparing the role of programmes in different delay incidents and across vignettes.	The county council, Kingsway, and Emerald Construction in vignette one used versions of the programme to discuss delays and issue early warning notifications.	The county council, Kingsway, and Emerald Construction in vignette two also used versions of the programme to discuss delays and issue early warning notifications.

Chapter six: Discussion

6.1 Introduction

The previous results chapters traced delay incidents in six vignettes and presented an analysis of how distinct project groups engaged with programmes in three case projects. The purpose is to understand in detail how a programme that interfaces distinct project groups functions in the context of a construction project and to study variations across incidents and case projects. This chapter discusses the research findings through the lens of boundary object theory. According to Star and Griesemer (1989), boundary objects are plastic enough to adapt to local needs or environments and the constraints of several parties employing them, yet robust enough to maintain a common identity across sites. They are weakly structured in common use and become strongly structured in individual site use. Boundary objects have different meanings in different social worlds, but their structure is common enough to more than one world to make them recognizable, a mean of translation. With this lens, the discussion that follow addresses the aim of this research which is to understand the phenomena of how a programme that interfaces distinct project groups functions and explains how the findings agrees or disagrees with previous literature or studies on tools such as programmes.

The findings illustrated that different project groups engaged different versions of a programme differently in delay incidents within and across the three cases. This chapter is divided in to six main sections, corresponding to the six objectives set out in chapter one. The first section discusses different ways project groups constructed time in the programme within and across the three case projects as a basis of relationship between the different project groups. The second section discusses the formal and informal ways or modes project groups engaged with versions of the programme in the three cases. The next section discusses the role of programmes and examines what project groups actually did with the programme in the three cases and how in so doing, project groups shaped the programme that shapes their work in project meetings, after meetings and through email correspondences. The fourth section discusses the way different project groups interpreted delay incidents within and across the three cases. The fifth section discusses how project groups interacted when responding to visible and invisible delays within and across the three cases. The sixth section compares the role that programmes played in different delay incidents within and across the three cases. Each section concludes with a paragraph that reflects on how boundary object theory helps us to understand what a

programme does. The section that follows discusses the research findings to address the first objective of this research and explains how the findings agrees or disagrees with previous literature or studies on programmes.

6.2 Objective 1: constructing time in a programme as a basis of social relations

The first objective sets out to explore how is time constructed in a programme within the three cases as a basis of relations between the different project groups. It also explored whether the way time is constructed in the programme varied across the cases.

Evidence presented in chapter four and five demonstrated that project groups created and used multiple versions of the programme as a basis to relate with one another in the London case and Southeast cases. For example, the four vignettes in the London case illustrated five type of programmes that were created and used as a basis for social relations between three main project groups. First, Marble Construction created/used the overall construction programme and the overall public programme as a basis of relating with the subcontractors and housing authority respectively. Second, Marble Construction created the draft programmes as a basis to relate with subcontractors before reaching an agreement. Third, the housing authority used the public programme created by Marble Construction as a basis of relating with Marble Construction and constructed time linearly in organizing access to all the blocks and residents. Fourth, Marble Construction created/used the construction programme as a basis of relating with Starlin/ Eagle Construction and constructed time cyclically in organizing (repetitive) the hire of elevating equipment, transfer of equipment, reinstallation of equipment at each block or balcony of residents. Fifth, Starlin/ Eagle Construction (the subcontractors) created/used their own subcontractor's programme as a basis of relating with fixer operatives/supplier/ manufacturers of panels and constructed time linearly for the production of panels and cyclically for operatives that replace the panels.

The public programme in the London case enabled the housing authority, consultants, and the residents to know when each block began and when to grant Marble Construction access to the premises. The construction programme in the London case enabled members of Marble Construction to know when to hire/install elevating equipment and when installed equipment were idle, unused, or underutilized. Third, Starlin/ Eagle Construction(subcontractors) in the London case created/used their subcontractors programme as a basis of relating with the panel/cladding manufacturers/fixer operatives and constructed time linearly and cyclically in

organizing the production of panels and hiring of fixer operatives. These three versions of the programme were created and used in the recladding project/London case to mediate between the housing authority, the consultants, Marble Construction, Starlin/ Eagle Construction, panel/cladding manufacturers and fixer operatives, and their different forms of organising. The mediation involved negotiating interests, reconciling differences, harmonising tension in events of delay and adjusting new or old / repetitive forms of organising to linear or cyclically perception of project time.

The findings in the London case illustrated that Marble Construction used the construction programme to ensure continuity of the recladding works when Starlin Construction was overstretched and hired Eagle Construction to also hire fixer operatives and use the elevating equipment to remove and install new cladding on the 11 buildings. A similar phenomenon can be seen in the findings reported in Whyte and Nussbaum (2020) that studied the role of artifacts in transition to manage the disjuncture over time and ensure continuity across changing forms of organizing.

Similarly, the two vignettes in the Southeast cases illustrated that project groups also created multiple versions of the programme as a basis to relate with one another on the safety improvement and drainage remedial project. For example, the two vignettes in the Southeast cases illustrate three types of programmes that were created as a basis of social relations namely: first, the county council created and used the outline programme for all projects in the Southeast England as a basis of social relations with Kingsway Construction. The county council used the programmes taken from the outline programme as a basis of relating with the general public/ Kingsway Construction for the safety improvement and drainage remedial project. Second, Kingsway Construction created/ used the construction programme as a basis of social relations with Emerald/ Diamond Construction. These three versions of the programme were created and used in the safety improvement and drainage remedial project to mediate between the county council, Kingsway Construction, Emerald/ Diamond Construction, utility company, traffic management company and their different forms of organising. The mediation also involved negotiating interests, reconciling differences, harmonising tension in interests in events of delay and adjusting new or old / repetitive forms of organising to linear or cyclically perception of project time.

Preliminary investigatory works to locate services and a temporary road order to close half of the road was a repetitive action in Southeast cases. The outline programme in Southeast cases

enabled Kingsway Construction to construction time cyclically and know when to begin the preliminary investigatory works to locate the position of services and close half of the road for works to commence. The county council expected different projects for the financial year to start and finish sequentially one after the other and they conceptualised time linearly. The subcontractors (Emerald and Diamond Construction) in Southeast cases received new designs with details of the scheme, and payments to procure construction materials or operatives and conceptualised time linearly for each project because each project involved new organising with sequential process of constructing the traffic island or drainage pipes.

The above findings in the two cases challenge the assumptions in the existing literature of a single programme that is operated on a project with a mechanistic view of programme use. Also, the findings on the way time was constructed (linearly or cyclically) in the versions of the programme as a basis of social relations agrees with studies by Tryggestad *et al.* (2013) and Whyte and Nussbaum (2020) where project groups adjusted new or old/repetitive forms of organising to linear or cyclical perceptions of project time. These discussions are important to construction professionals that have different relationships with different actors or groups on a construction site.

The section that follows discusses programme engagement in project groups and examines the way project groups engage with a programme in the two case projects.

6.3 Objective 2: exploring formal and informal modes of programme engagement

The second objective set out to explore how project groups engaged with a programme in the context of a project (formal and informal). It also asked whether modes of engagement vary across cases.

Evidence presented in chapter four and five demonstrated two modes of engagement with versions of the programme in the three cases: formal and informal. The four vignettes in the London case illustrated that project groups formally engaged versions of the programme regularly at six distinct moments or meetings: first, at progress meetings where the team from Marble Construction and subcontractor-groups (Eagle/ Starlin Construction) used the construction programme to formally record or count the duration of the recladding process weekly and label them as progress updates, to discuss, and to coordinate the recladding process in each block that was documented in weekly minutes; Second, at labour forecast meetings, where the team from both firms used the construction programme and subcontractors programme weekly to negotiate and agree on the fixer operatives to hire to use elevating

equipment installed at different blocks or places for the next two weeks ;Third, at review meetings where the team from both firms used the construction programme and subcontractors programme prior to the weekly progress meetings to evaluate the progress and record update on the percentage of the recladding work completed, percentage of the recladding work planned, slip values and highlight areas that are critical for forecast operatives; Fourth, at revision meetings where the team from both firms used the construction programme to revise or change in the sequence of working and visually capture agreements that includes breaking down the blocks into smaller manageable portions; Fifth, at internal supplier meetings, where the subcontractors (Starlin/Eagle Construction) meet with manufacturers or suppliers to discuss the timing of items ordered or deliveries that are recorded on the subcontractor programme and on trackers; Sixth, at Joint inspection meetings, where Marble Construction, consultants and the housing authority used the public programme to do a joint inspection with the client for the recladding works. This illustrates six distinct moments or meetings that project groups in the London case formally used versions of the programme to record or capture changes.

In contrast, the two vignettes in Southeast cases illustrated that project groups often discussed verbally the programme or construction programme and did not use versions of the programme to record /count the duration of the project nor label progress but simply recorded workers on site and activities for the day daily on a site diary. The implication is that the passage of time was counted invisibly or informally without the programme rather than record /capture changes or agreements formally on the programme. Second, the project groups in the Southeast cases did not meet formally every week with updates of the programme to discuss/coordinate progress but met informally and briefly in the morning for 5 minutes or over the phone to have quick daily discussions to run over work items. The implication is that a project can be coordinated informally with invisible sequences and through regular verbal discussions or exchanges. Third, project groups in the Southeast cases did not formally evaluate the progress of the road projects and did not record percentages of work completed, planned percentages, or slip values on the programme or construction programme but rather used the daily verbal discussions to catch up on progress. This implies that the progress of a project can be communicated informally without a programme and through brief verbal discussions. Fourth, project groups in the Southeast cases did not use versions of the programme to visually capture agreements, revisions, or changes in sequences of working but remembered agreements or changes in sequences verbally or informally. Fifth, project groups in the Southeast cases did not have regular meetings with suppliers to discuss the timing of orders or deliveries but communicated with suppliers

informally. This implies that the timing of order or deliveries can be managed informally without having to update a programme or track when they will be delivered.

The evidence presented in the London case and Southeast cases demonstrated that the project groups had different interests that often led to tension on the project. In the London case for example, Marble Const. (the main contractor) and their staff were interested in completing the recladding work as soon as possible with the lowest equipment cost to make profit on each contract. This is a reason why the staff of Marble Const. on different occasions didn't want equipment they hired for the subcontractors (Eagle or Starlin) to stay idle or unused because they would lose money for unused or idle equipment. The interest of the housing authority is that they want the recladding of the 11 blocks they have paid for to be completed at agreed dates with good quality. This is a reason why officials of the housing authority release cash at intervals and were coming to regular intervals for inspection or site visits. The interest of the two subcontractors is to produce the new cladding at the lowest cost and replace the old cladding at the lowest labour cost to make profits. This is the reason why the subcontractors (Eagle or Starlin) were interested in how they could hire and optimize the number of operatives to use equipment (hired by Marble Const.) The subcontractors (Eagle or Starlin) received monthly payments from Marble Const. for the works completed at agreed times and don't want to lose money in the interim payments every month.

Five insights can be drawn from the discussion above: first, tensions of interest were a rule governing the way project groups moved between engaging with versions of the programme at different moments in the two cases. For example, Marble Construction in the London case moved from engaging with the construction programme most of the time to engaging with the public programme when the finish dates were missed or exceeded due to the pandemic or poor quality. Also in the London case, Starlin Construction moved from engaging with their own programme to engaging with the construction programme in meetings with Marble Construction to brief them of current issues with deliveries or fixer operatives. This was different in the Southeast cases, as Kingsway Construction moved from referencing only the start/ finish dates in the construction programme to referencing the start/finish dates in the programme when the finish dates were inching closer. These moments in chapter four and five illustrated that the rules governing the way project groups moved from engaging a version of the programme to another across the three cases differed when there was tension between their interest or priorities of finishing at specific dates. Second, project groups were either collectively engaging with versions of the programme

at different meetings or individually engaging as demonstrated in the three cases. Third, adapting versions of the programme as demonstrated in the three cases were primarily because of the collective engagement or agreement rather than with individuals engaging alone. This was illustrated in the London case as versions of the programme were weakly structured in common use and became strongly structured in individual site use. Fourth, project groups at different moments in the London case engaged more formally with the programme compared to Southeast cases that involved informal engagements and adopted a verbally discussed programme. This informal engagement with the programme limited the participation of some project groups as evidenced in the safety improvement work with the utility company-Golden Media in the Southeast case. The formal engagement enabled project groups in the recladding to be more actively involved in the recladding process at multiple levels and agrees with the position of Tryggestad *et al.* (2010) on objects that performed an active role in mediating and resolving tensions between different actors. Fifth, the operation manager (Marble Construction) and the site project manager (Starlin/Eagle Construction) in the London case used the review meetings to reconcile differences in the versions of the programmes they used or way the project groups perceive time before they could formally evaluate and record the progress of the recladding works on the construction or public programme. The formal and informal modes of engagement discussed above illustrate that different project groups engaged differently with different versions of the programme.

This finding challenges the assumptions in the existing planning literature that there are prescribed ways to engage or use programmes or that programmes can fully prescribe the circumstances professionals or project groups will meet on all construction projects. For example, Abuwarda and Hegazy (2016) produced a programme crashing model and claimed that construction projects can be optimally accelerated by combining, crashing, and overlapping decisions. The finding challenges prescriptions that optimally accelerate as versions of the programmes were actively engaged formally or informally in the cases. It also challenges Ballesteros-Pérez *et al.* (2019) argument that activity crashing and fast tracking techniques can result in the best overall outcome. This assumption is unrealistic and independent of people.

The evidence presented in the Southeast cases illustrated that in contrast to the six meetings in the London case, project groups in Southeast cases only held two interactive meetings namely: (1) the first or initial meeting, at the beginning of the project to discuss the method or programme (2) informal meetings that involved quick verbal discussions to run over and catch up on progress.

This finding is similar to studies on the importance of informal means of communicating in occupational communities. For example, Pink *et al.* (2010) examined the language and skills of migrant workers during curtain wall installations to understand the manner in which the workers communicated and discovered that migrant workers had evolved a means of communication that consisted of mixing different languages, gestures and mobile links to coordinate installations. Pink *et al.* (2010) claim that migrant construction workers communicated in a manner that was informal and invisible. This type of informal communication between migrants who don't speak the same language differs from the findings as project groups in the Southeast cases speak the same language and used verbal discussions to communicate changes in the work sequence instead of changing the programme.

The findings on different modes of engagement with a programme supports studies in literature that programme can be treated differently. For example Whyte et al. (2007) studied programmes and drawings in two firms and found that these visual objects are variously treated as fixed or changing when used collectively to make or produce designs. A similar phenomenon can be seen in the findings as project groups adopted different modes in engaging with versions of the programme either collectively or individually, formally, or informally and fixed or changing to carry out construction.

The implication of the evidence presented in chapter four and five is that programme engagement or use in practice is a situated action that is flexible or open to different modes of engagement. These challenges the assumptions in the traditional management literature on programmes as project groups in the London case largely adopted formal modes of engagement, but project groups in the Southeast cases largely adopted the informal mode of engaging with a programme to communicate, negotiate onsite or over the phone with an invisible way of sequencing or coordinating the activities. For example Hayes-Roth and Hayes-Roth (1979) developed a model of planning to incorporate suggestions and decisions and claimed that his model is flexible enough to handle the complexity and variability of people's planning behavior. This assumption is similar to the findings as modes of engagement with a programme varied at different moment across the cases and should not be prescribed for professionals or project groups on projects.

A theoretical reflection of the evidence presented in chapter four and five demonstrates that the three cases can be categorized into three main project groups namely: the client or public group (the housing authority or county), the contractor-group (Marble Construction or Kingsway

Construction), the subcontractor-group (Starlin/ Eagle/Emerald/Diamond Construction). However, It can be argued that based on the nature of interactions, these three groups are not distinct social worlds as Star and Griesemer (1989) conceptualized the group of actors in museum work, as they three project groups intersect and overlap each other in meetings . The assumption that the three project groups are social worlds is partly because the programme inhabits the intersection between the project groups in the three cases and fashioned a medium to guide the way project groups can relate because of differences in contractual responsibility, training, line management. The evidence presented in chapter four and five demonstrated that in both cases, project groups interacted more closely and frequently with the programme as a boundary object than the museum workers interacted with objects in the museum work. This suggests that when interactions are more continuous, this changes the way a boundary object functions compared to a case where there are limited group interactions.

Another reflection in the paragraphs above is that the programme as a boundary object functioned as a flexible object that enabled the three categories of project groups to interact with each other formally or informally and move from engaging with one programme to engaging with another version of the programme. The findings show that versions of the programme played an active role in structuring how the categories of project groups decided to depend on each other (social relations). As a boundary object, the programme in the three cases were weakly structured in common use and became strongly structured in individual site use. This was illustrated as project groups collectively changed the programme more frequently in group meetings than in individual programme use. This illustrated that the programme played a role in supporting meetings that involved formal and informal interactions and cooperation between project groups.

The summary of the discussions in this section is that programme engagement by project groups in practice is a flexible and situated action that is shaped by the decision of project members in that context rather than an absolute pattern. Agreements or changes can be visually captured formally on a programme or informally with a verbally discussed programme. On the basis of the evidence presented in the three case projects, this research argues that mode of engagement by project groups varied across incidents and cases. The section that follows discusses the role of programmes and examines what project groups actually did with programmes in the three cases and how in such doing, project groups shape the programme that shapes their work in project meetings, after meetings and through email correspondences.

6.4 Objective 3: the roles programmes play in projects

The third objective of this research is to understand the role of a programme in the different project groups in the three cases. This was achieved by comparing the role of programmes across incidents.

Evidence presented in the three cases demonstrated eight uses of the programme. These include to construct different interpretations of project time for projects groups, to distribute task and responsibilities at multiple levels, to manage project resources at multiple levels, to manage the expectations of the different project groups, to enable firms negotiate their interest or priorities, to capture knowledge of activities and agreements at multiple levels, to enable project groups communicate about the progress of the project at multiple levels, and to socially construct the meaning of a delay.

Evidence presented in chapter four and five demonstrated that the first way (thing) that a programme functioned (did) was to enable project groups to develop different interpretations of time, and work with different understanding of how the project should start and conclude. This finding challenges the assumptions in the existing literature on programmes that hold an absolute or objective perception of project time in a project. For example, Song *et al.* (2009) examined the influence of knowledge inputs on a single construction programme and claimed that including contractors knowledge in the design will lead to reduced project duration. This assumption differs from the findings as project groups in the three cases used different versions of the programme to develop different conception of project time and organise resources within these concepts of project time.

This finding is similar to studies that liken projects as forms of organizing with different interpretations of time. For example, Lundin and Söderholm (1995) conceptualized projects as temporary organization with new forms of organizing viewed as linear and old or repetitive forms of organizing viewed as cyclical perspectives of time that are relative to individuals. This is similar to the findings as project groups used versions of the programme to interpret and act differently based on their perception of time in the three cases. For example, the housing authority and consultants in London case worked with a linear concept of project time using the public programme. In contrast, Marble Construction worked with a cyclically concept of project time

(repetitive form of organising) and the subcontractors (Starlin and Eagle Construction) worked with a linear and cyclically concept of project time.

Evidence presented in chapter four and five demonstrated that the second way (thing) a programme functioned (did) in the three cases was that it enabled project groups to distribute task and responsibilities to each other at multiple levels in a project. This finding is consistent with the assumptions existing in literature in occupational communities that boundary objects enable a diverse group of actors to cooperate and pursue different tasks. For example Yakura (2002) studied the daily activities of three groups of people in an IT project and claimed that programmes allowed project members of different groups to coordinate work. A similar mechanism can be seen in the findings and suggest that project groups used programmes to cooperate by weaving different parts of the same work together. In the same way, Chang *et al.* (2011) studied multiple stakeholders that engaged an integrated master programme and claimed that the programme facilitated the coordination and cohesion of stakeholders. This author agrees with the findings as versions of the programme enabled cohesion of project groups that worked together.

Evidence presented in chapter four and five demonstrated that the third way (thing) that a programme functioned (did) in the three cases was that it enabled project groups to manage resources at multiple levels in a project. This finding challenges the assumptions in the existing literature that a programme is used solely or primarily to manage time. For example Hossain and Chua (2014) proposed a simulation model to overlap design and construction activities on a programme with rework and claimed that his model can shorten completion time. This assumption differs from the findings as project groups use programmes to do multiple things including avoiding financial losses. In the same way, Gledson *et al.* (2018) compared hit rates of the planned programme against the actual programme of four projects from secondary data and claimed that programming is linked to time performance. This assumption differs with the findings as versions of the programmes were used to manage three resources (money, materials, and equipment) rather than time.

Evidence presented in chapter four and five demonstrated that the fourth way (thing) that a programme functioned (did) in the three cases was that it enabled project groups to manage the expectations of the different project groups in different contexts. This finding agrees with authors that criticize the planning literature that assumes complete information in programming or planning which is very deterministic. For example Flyvbjerg (2008) stated that two types of

inaccuracy is inherent in planning (optimism bias and strategic misrepresentation) and argued that this inaccuracy should be regulated. This suggests that optimism bias and representations are aspects of expectation that need to be managed in stakeholders. This was evidenced in the three cases as the operations manager created dichotomies between 'a public programme' with longer durations for the housing authority/county and 'a construction programme' with shorter durations for (Eagle/Starlin/ Construction) involved in construction work alongside their own programmes to manage the different expectations of the project groups.

Evidence presented in chapter four and five demonstrated that the fifth way (thing) that a programme functioned (did) was to enable firms (project groups) negotiate their interest. This finding is consistent with the assumptions in the existing modern management literature that programmes can be used as a locus for negotiation. For example, Tillement and Hayes (2019) studied programme use by a group of workers involved in maintenance and production at a nuclear plant and claimed that programmes permits negotiation across social worlds. This author agrees with the findings as versions of the programme enabled project groups in the three case projects to negotiate their different interest. In the same way, Hegazy *et al.* (2011) developed a prototype to correct construction programmes to include rework and claimed that programming can be more responsive to the specific timing of events. This assumption supports the findings as project groups used versions of the programme to respond to several incidents in the project to protect their interest.

Evidence presented in chapter four demonstrated that the sixth way (thing) that a programme functioned (did) was to enable project groups capture their activities and agreements between themselves as knowledge at multiple levels. This finding is consistent with assumptions in existing modern management literature that objects in projects are used to capture knowledge. For example , Scarbrough *et al.* (2012) studied the role of a milestone programme in three groups of developers involved in a computer game development process and claimed that milestone programmes played a role in coordinating knowledge intensive work under conditions of emergence. A similar mechanism can be seen in the findings as the three versions of the programme were used weekly in the London case to formally capture agreements, activities at different moments and changes in review or revision meetings. In contrast, the evidence presented in chapter five/Southeast cases demonstrated that the three versions of the programme were not used to capture the activities and agreements between project groups as the road projects progressed. This finding differs from the study by Whyte and Nussbaum (2020)

on the role of artifact in sharing knowledge as project group adopted quick discussions to share knowledge.

Evidence presented in chapter four and five demonstrated that the seventh way (thing) that a programme functioned (did) in the two cases was enable project groups to communicate at multiple levels as the project progressed with different color codes, percentages, warning notifications, and positions of a drop line on the public or construction programme. This is consistent with the assumption in the existing modern management literature that programme can be used as a medium to communicate. For example Sapsed and Salter (2004) studied programmes used by geographically dispersed managers and engineers involved in work and claimed that when there is no face-to-face interaction, programmes become ineffective as objects for communication. A similar phenomenon can be seen in the findings as project groups in the London case often met face to face in meetings with the programme to ask questions or gain feedback rather than just exchanging programmes alone.

Evidence presented in chapter four and five demonstrated that the eighth way (thing) that a programme functioned (did) was that it enabled project groups to socially construct the meaning of a delay in an incident. This finding challenges the assumption in existing literature on programmes that delays are absolute or objectively measured. For example Nasir *et al.* (2003) proposed a programme risk model to analyse programmes and claimed that his model can provide a basis to determine likely extent of delays. This assumption differs with the findings as project groups socially constructed delays in incidents rather than objectively determine delays. In the same way , Roghanian *et al.* (2017) proposed a model of how to use programmes and argued that construction projects can be programmed to neutralise delays. This assumption is similar with the findings as project groups reconstructed or reduced delays at different moments by extending deadline or back dating start dates on the programme. Evidence presented in chapter four and five demonstrated that it is only after project members used a programme to measure/count or interpret and then label the progress of a project as delayed that they began to treat or view the project as delayed. This is important for construction professionals in practice as overruns of time in a project or part of a project does not mean it is a problem or a concern until construction professionals treat them as delays with a problem or a concern. This findings challenges the assumption in literature (Eizakshiri *et al.*, 2015), that delays are merely as a result of flawed execution .

The discussions above illustrated that the programme functioned as a boundary object at different moments in enabling the three categories of project groups to do different things in the three cases. The findings show that the three categories of project groups had different interest or priorities and adapted the programme to serve different needs in their different social worlds. As a boundary object, the programme in the three cases was plastic and adapted to local needs and the constraints of project members that used it. The findings illustrate that the programme played an active role in serving different purposes of project groups rather than a passive role as depicted in the traditional management studies on programmes.

The summary of the discussions above is that project groups used versions of the programme to do eighth things in this research and demonstrate that project groups did not use programmes primarily to manage time as the existing literature asserts but to serve different purposes at different moment as illustrated above that enabled project groups to collaborate even though they had differences on how a project should start and conclude. The implication is that the project groups used versions of the programme to protect business interest, build business relationships that were non-adversarial and encouraged interdependency on areas that each stakeholder had a strength. On the basis of the evidence presented in the three case projects, this research argues that the role or use of a programme depends largely on context as seen with the eight things of interest. The section that follows discusses the meaning of a delay for different project groups across the three case projects.

6.5 Objective 4: different meaning of a delay for project groups in a case project

The fourth objective of this research is to explore the way different project groups constructed the meaning of a delay at different incidents, and it explored variations across the cases.

Evidence presented in the three cases demonstrated that project groups used versions of the programme to socially construct delays in an incident. In the London case, project groups used versions of the programme to socially construct delays as concrete and visible by recording negative slip values on the programme, whereas project groups in the Southeast England cases treated delays informally and did not record them on the programme, thereby rendering them abstract or invisible.

Evidence presented in chapter four and five demonstrated that project groups used different versions of the programme to socially construct different meanings for the same delay in the three case projects. For example, when Marble and Starlin Construction used the construction

programme with an earlier finish date to identify or label a delay in recladding block J in London. Interestingly, the housing authority used a public programme with later finish dates for the same block and did not view the same block as delayed because the recladding was within public programme duration or dates. In the same way, Emerald and Kingsway Construction used the construction programme in the Southeast case to identify or label delays in the safety improvement work, while the county used a programme and did not identify or label the same improvement work as delayed because the project was within programme duration or dates. These differences in the way delays were conceived was because the project groups in the London and Southeast cases engaged different versions of the programme to view, label, and treat a delay in different incidents. This finding is similar to a study by Bechky (2003) on the use of engineering drawings across three groups in a manufacturing organisation that showed that the understanding of the engineering drawings changed to fit the local environments of the different groups.

Evidence presented in chapter four and five demonstrated that project groups in the three cases measured the same type of delay differently after completion. For example, the three project groups in the London case namely: the (1) housing authority, (2) Marble Construction and (3) Starlin/Eagle Construction used three versions of the programme (public, construction, and subcontractor's programme) to measure and label the same delay incident in block J differently with different slip values as delays. In this instance, when Starlin Construction recorded an overall delay on their subcontractor's programme and treated the recladding of block J as delayed, Marble Construction did not interpret or treat block J overall as delayed until 27th September 2019. At the same, when Marble Construction began to record overall slip values on the construction programme and treated the recladding of block J as delayed, the housing authority did not begin to interpret or treat block J overall as delayed until 22nd November 2019.

In the same way, the three project groups in the Southeast cases namely: the (1) the county council, (2) Kingsway Construction, (3) Emerald Construction also referenced three versions of the programme (outline programme, programme, and the construction programme) to interpret the same delay incident differently, however they did not capture them on the three versions of the programme. For example, when Emerald began to issue notifications of delays in relocating the cables in the safety improvement project, Kingsway was within construction programme duration and did not treat the incident as delayed. However, when the delay persisted and Kingsway Construction began to notice delays with reference to the construction programme,

the county council did not treat the incident as delayed because the project was within public programme duration. These findings illustrate that the way that the project groups socially constructed delays in the London case differed compared to the Southeast cases, as project groups in the London case constructed delays that were largely visible and concrete with slip values and drop lines on the programmes, whereas the project groups in Southeast cases treated delays informally, and did not capture them, thereby rendering them largely abstract or invisible.

This differences in the finding challenges the assumption in existing literature in occupational communities that delays have a singular interpretation, are absolute in value, objectively measured, or exogenous i.e., simply caused by external problems. For example, Mello *et al.* (2015) studied managers from different companies involved in shipbuilding activities to understand how the ship designers delayed activities of people in the ship yard as well as the ship for the ship owner and claimed that delays happened in activities that caused the ship production to overrun by two months. This study found something different in that delays do not happen but rather are constructed differently by project groups. In the same way, Sambasivan and Soon (2007) surveyed the perception of clients, consultants and contractors on ten related causes and six effects of delays and claimed that time overrun is caused by a factor of improper planning by a contractor. This study is further developed in the findings as delays in the three cases were not caused by factors of improper planning but rather socially constructed as project groups engaged with different versions of the programme.

Evidence presented in chapter four demonstrated that project groups mobilized three current records that were linked to the construction programme and subcontractor programme which project groups used to construct the meaning of a delay namely: (1) panel material trackers, (2) quality assurance sign off documents with a 5-scale hold -point system and (3) two- week labor forecast. For example, Starlin and Eagle Construction in the London case used these trackers alongside their own programme to trace dates when panels or panel materials they ordered from suppliers and manufacturers were ordered, delivered, and stored on site. Marble Construction used quality sign-off records or documents linked to the construction programme to monitor works that are completed to meet specified quality requirements. The team from Marble Construction assigned 20% to each hold-point such that 5 hold-point equaled a 100% completion. Marble and Starlin/ Eagle Construction linked a two-week labour forecast record to the construction programme to monitor the levels of operatives hired daily such that the team from both firms can discern when to hire more when the work is critical or delayed. These three current

records were linked to Starlin/ Eagle-programme progress and the construction programme and enabled the team from both firms to label a block or part of a block as delayed and then trace the issues tied to that delay incident. This finding is consistent with the assumptions of existing literature that artifacts can be linked to the use of programmes in a project. For example Whyte and Nussbaum (2020) studied digital and physical artifacts that were mobilized alongside a programme as a project team organization left for an operation team organization to begin, and claimed that transition involved the use of these artifacts to share knowledge and manage the disjuncture over time. A similar mechanism can be seen in the findings as three other record documents were mobilized alongside versions of the programme by project groups to capture current knowledge that were linked to operatives, quality, and delivery dates.

The implication for authors who studied a single version of the programme rather than versions of a programme, is that they always hold an objective or mechanistic view of programmes and argue that adjusting the single programme will lead to predicted changes. This may be the case in some examples, but it was not observed in the findings and is usually not the case in construction projects. The boundary object approach allows us to see the different views of a programme and different interpretations of time or delays.

The summary of the discussions above illustrate that the programme functioned as a boundary object in the London and Southeast cases as project groups adapted the initial programme into multiple versions. These versions enabled different project groups at different moments to construct different meanings of a delay. The findings in the three cases shows that programmes played an active role in constructing delays as either concrete and visible or abstract and invisible. As a boundary object, the programme in the three cases served in reconciling the different meanings of project time in the different social worlds during reviews of the progress. The findings illustrate that the programme played an active role in reconciling the meaning of delay across distinct social worlds, as each group worked with different delays based on the use of different programmes.

The paragraphs above discussed the way different project groups interpret delay incidents and across cases. On the basis of the evidence presented in the three case projects, this research argues that different project groups at different moments used different versions of the programme to construct different meanings of a delay. The section that follows discusses how different project groups interacted when responding to visible or invisible delays.

6.6 Objective 5: project groups response to delay incidents in the cases

The fifth objective of this research is to understand how different project groups interacted when responding to delay incidents, and it explored variations across cases.

Evidence presented in chapter four demonstrated that project groups in the London case responded to delay incidents by apportioning blame externally to four things namely: (1) pending design issues and unresolved information, (2) additional works not initially provided (3) lack or absence of structural engineering details (4) lengthy process of obtaining engineering approval- 2 months. In contrast, project groups in the Southeast cases responded to delay incident by apportioning blame to two individuals/firms involved: (1) the utility company in vignette 1 (2) the project manager for not properly involving the utility company. The implication is that an active use of a programme by project groups directs attention at the process, whereas an informal or passive use of a programme leads professionals to focus on people in the course of executing the projects.

Evidence presented in chapter four and five demonstrated that project groups responded differently to delay incidents when they were within the public programme duration compared to when they were outside the public programme. For example, when delay incidents were within duration of the public programme, project groups responded to visible delays in London, (vignette one and four) with a mutual accommodation of the recladding work and the construction programme. This involved the team from both firms reconciling the work to meet the construction programme and at the same time reconciling the construction programme to meet the work. For example, in vignette four, a delay incident in block F (vignette four) led the team from Eagle Construction to change orders from suppliers and increase the operatives that were working from 1 floor to 2 floors. At the same time the team from Marble Construction agreed with Eagle Construction to change the construction programme for block F as Adam made a case that he was entitled to 12 weeks due to the structural defects and lengthy approval process. In contrast, project groups in the Southeast cases responded to invisible delay incidents in vignette I by simply placing works on hold, negotiating to extend the project durations, beginning a new activity which involved informally changing the sequence and writing an early warning notification that took note of the incident. In addition, project groups treated delays differently when there were no financial implications compared to when there were financial implications.

In contrast to delay incidents within the public programme, the way project groups in London case responded to visible delays that were potentially going outside the public programme differed as the team from both firms agreed to formally extend the deadline for completion in the construction programme, moved the finish date and socially reconstructed or reduced the slip values. For example, the project groups in vignette I, II and III agreed to extend the deadline of the finish date for block J, D and G which led the team to reconstruct (reduce) slip values on the blocks on the construction programme. In the same way, project groups in Southeast cases responded to invisible delays that could potentially exceed the programme by extending the duration without any formal recording of specific delays or changes.

Evidence presented in chapter four demonstrated five different mechanisms in the way project groups responded to delays incidents: communication, negotiation, coordination, visual or knowledge capture and shared understanding.

The evidence presented in chapter four demonstrated that project groups in London case communicated in four ways when they responded to visible delays: first, through email exchanges of the construction programme (updates), through electronic or handwritten communication that involved feedbacks, through face-to-face verbal communication with printed versions of the programme in weekly meetings sessions and informal conversations. In contrast to this case, project groups in the Southeast case communicated majorly with quick verbal discussions and brief conversations on site and over the phone on issues relating to resources and solving problem.

The evidence presented in chapter four demonstrated that project groups in the London case negotiated in two ways when responding to visible delays: first, the project group in vignette four used the construction programme to avoid further financial losses and tensions with the housing authority or Marble Construction due to a breach in the contract through negotiations that involved backdating the start date. Second, the project groups in vignette one used the construction programme in a non-adversarial acknowledgement of delays with the housing authority or Marble Construction when there was a breach in the contract. These findings disagree with the mechanistic evaluation approach in the planning literature that views delays automatically as project failure. For example, Tryggestad *et al.* (2010) examined the mediating role of objects in goal adaption and claimed that adhering strictly to the project evaluation approach that references the initial project goals of time is misleading as construction projects that change their time goals would be judged as failures and construction managers as incompetent. This

suggestion is further developed in the analysis and findings by demonstrating that the three cases operated multiple versions of the programme that had initial finish dates that were changed/extended several times by project groups to actively mediate tensions at incidents of delay. This is important for construction professionals in practice as delays in a project that was planned does not imply that the planning was wrong or that the project has failed.

The implication is that if blocks J, D, G and F in the London case were evaluated strictly according to the initial finish date agreed by Starlin/Eagle/ Marble in the construction or public programme only, the recladding process of the four blocks would be deemed a failure, and the project manager or team would be deemed incompetent, because the recladding project exceeded the initial finish dates in those programmes several times. In the same vein, if the safety improvement and drainage remedial project in the Southeast cases were evaluated strictly according to the initial finish date in the construction or public programme only, the safety improvement or drainage works would be deemed a failure and the team from Kingsway/ Emerald or Diamond would be deemed incompetent, because those projects exceeded the initial finish dates.

The evidence presented in chapter four demonstrate three ways that project groups in the London case formally used programmes to visually structure work activities and depend on each other namely: (1) A housing authority-Marble Construction dependency with the aid of the public programme, (2) A contractor-subcontractor dependency with the aid of the construction programme and (3) A subcontractor-material supplier dependency with the aid of the subcontractor's programme. In contrast, project groups in the Southeast cases adopted invisible ways to structure work activities and depend on each other through quick verbal discussions or exchanges.

The evidence presented in chapter four demonstrate three resources that project groups in the London case formally used programmes to coordinate when responding to delays namely: operatives, equipment, and money at multiple levels. In contrast, project groups in Southeast case adopted quick verbal discussions and invisible sequences to coordinate the same type of resources.

The evidence presented in chapter four and five demonstrated that project groups formally and informally used multiple versions of the programme to develop a shared understanding of delays based on the different start or finish dates in the versions of the programme. For example, the team from Marble Construction use the construction programme to develop a shared understanding of delays based on the start and finish dates of the blocks in the in the London

case. In contrast to this shared understanding, the housing authority, and the consultant with the aid of the public programme shared a different understanding of delays based on a different start and finish dates for the same blocks. Marble Construction changed understanding every time they moved between the construction and public programme. At the same time Starlin/Eagle Construction changed understanding every time they moved from using their own programme to engaging with the construction programme.

The implication is that each project group's understanding of delays in the cases changed to fit different audiences in progress meetings at different moments which had some limitations. For example, when Starlin Construction in the London case started 4 new blocks in addition to block J in vignette I, this caused knock-on effects as little comparison of the construction programmes was done across the blocks that led to delays from inadequate fixer operatives. This finding is consistent with a study by Bechky (2003) on three groups involved in production that shared drawings and claimed that the understanding of individuals in a group changed across the activities in each environment, but was counterproductive when moving to different environments. This study found something similar as starting 4 blocks in addition to block J in the London case was counterproductive because efforts to conclude block J obscured the knock-on effects on other blocks and affected moving from one version of the programme to another.

The discussion above illustrated that the programme functioned as a boundary object in enabling different project groups to respond differently to visible and invisible delays at different moments. The findings show that the project groups in three cases were a diverse group with different interest and priorities and responded differently. The programme as a boundary object in the three cases represented the different interest or priorities of the project groups and played an active role in representing and reconciling diverse interests and priorities of project groups that led to tension.

In summary, the discussions above illustrated that project groups formally and informally used versions of the programme to respond to visible and invisible delays in the three cases. Also, project groups apportioned blame externally to things and people in both cases rather than attributing faults to themselves, the programme, or the way they used the programme in the course of executing the projects. The implication is that an active use of a programme by project groups directs attention at the process, whereas a passive use of a programme leads professionals to focus on people in the course of executing the projects. On the basis of the evidence presented in the three case projects, this research argues that different project groups

responded differently to visible and invisible delays at different moments. The section that follows compares the role of programmes in delay incidents.

6.7 Objective 6: role programmes play in different incidents

The sixth objective of this research is to compare the role of programmes in different delay incidents and, does this vary across cases.

Evidence presented in chapter four and five demonstrated that the programme played different roles in different delay incidents in the three cases. For example, project groups in the London case used the construction programme in three ways to visually capture delays namely: first, by halting the position of the drop line on the construction or public programme instead of moving it forward to a current date. Second, by skipping with the drop line periods that were unproductive or inactive on the construction or public programme. Third, by developing a mapping of slip values as delays at multiple levels for different zones, subzones, or areas. In contrast, project groups in the Southeast case did not use the programme visually to capture delays on the construction or public programme, but informally noted delays with early warning notifications or emails/pictures after verbally discussing them.

The implication of this difference is that the project groups in London were more conscious, actively involved in their response to the delays and more coordinated compared to the project groups in the Southeast cases, as project groups in London used the construction programme to display the delay on the programme and to the mind as something that is concrete and visible on the construction programme rather than invisible.

This finding is consistent with assumptions in the existing literature that project tools can be used to represent a project or aspects of a project and actively used to coordinate a response that involves diverse project groups. For example, Tillement and Hayes (2019) explored the role of a planned maintenance programme in interrelated activities of five worker groups and claimed that programme use allowed members of different social worlds to discuss, negotiate maintenance tasks that enabled cross department coordination. A similar mechanism can be seen in the findings reported here as the construction programme in the London case enabled the team from Marble and Starlin or Eagle Construction to discuss, negotiate task, and coordinate responses to delays from different organizations. In the same way, Scarbrough *et al.* (2012) analysed the role of milestone programmes across different developer groups in the production of computer games

and claimed that milestone programme supports coordination under conditions of emergence and coordination of the practices of the different developer groups within a time limited process. This is further developed in the findings as project groups in the three cases used versions of the programme actively under emergent conditions such as delay, to coordinate responses of different project groups.

Evidence presented in chapter four and five demonstrated that project groups responded to visible and invisible delays differently. The evidence presented in the London case demonstrated that project groups responded to visible delays with negotiations around the formal extension of deadlines, leading to a reconstruction of slip values on the public or construction programme. They also responded to delay incidents with a mutual accommodation of the work and programme. In contrast, the evidence presented in the Southeast case demonstrated that project groups responded to invisible delays with negotiations that extended the project duration, without any formal recording of specific delays.

The discussion above illustrates that the programme functioned as a boundary object that was weakly structured in collective use and enabled different project groups to discuss, negotiate, and agree to change work sequences, extend finish date, and respond differently to delay incidents in the London and Southeast cases. The findings show that the programme in both cases played an active role in coordinating the activities of diverse project groups from different social worlds at multiple levels to be able to respond to delay incidents. As a boundary object, the programme in the three cases served as a medium to respond to delay incident across different social worlds.

The summary of the paragraphs above discussed two ways that diverse project groups engaged a programme that coordinated their activities when responding to visible and invisible delays in the three cases, by formally and informally changing the sequence of activities and extending the finish date in the programme. On the basis of these findings, this research argues that the multiplication of a programme into different versions and the modes of engagement enabled different project groups in different contexts to develop realistic responses to deadlines

The six sections above have discussed the findings of the research to address the six objectives of this research. The discussions compared the findings in the three cases, explained how the findings agrees or disagrees with previous literature or studies on programmes and reflected on how boundary object theory helps us to understand what a programme does. The evidence

presented in the results compliment and extend the work by Yakura (2002) on the role of objects in coordinating work of multiple groups and demonstrated six main findings.

6.8 Theoretical contribution:

This research adopts the use of boundary object lens to understand the nature of interactions (i.e., boundary exchanges) between project groups that use programmes every day and in delay incidents within the context of ongoing construction projects. The research defined boundary objects as objects that are plastic enough to adapt to local needs or environments and the constraints of several parties employing them, yet robust enough to maintain a common identity across sites. With this lens, the research becomes useful in expanding our understanding of how programmes are created, used, adapted, and reconciled in project meetings as well as the actions or responses of individuals or project groups to specific delay incidents. This knowledge contributes to the existing literature on boundary work studies of programmes more generally or to theories of boundary work in temporary organisations or in projects and informs the concept of programmes mediating the social worlds of project firms in a construction site.

Incidents of delays in which versions of a programme are engaged or not engaged in interactions at a micro level and insights on how individuals, teams or organisations collaborate in managing time as they try to control work progress are the main contribution that this research offers to the current body of knowledge. The research findings draw attention to the important decisions, different interpretations, and negotiations that occur at a micro level between project groups that use a programme and the issue that not all boundary objects take multiple versions or forms. For example, the objects in the museum case from the original study by Star did not multiply into different versions. This differs from the research findings and draws attention to the issue that objects that do take multiple forms change the type of dynamics that take place around them. For example, the programme played different roles in mediating project firms, and their actions or activities every day and around specific delays. This stems from the fact that different versions of the programme were created and adapted at different moments, in different contexts by different groups based on how project groups agreed to relate with each other on each project. Hence, each vignette account differed in terms of how project groups engaged with or without versions of the programme during the project at different moment and in multiple contexts. Besides this, the findings highlight the differences in the formality and extent of engagement in the construction and management of delays.

Furthermore, this thesis argued that the mechanisms that characterise the way people engage with a programme every day and in the event of a delay at a micro level is underexplored within the boundary work literature of programmes. The findings in this thesis established that the different project firms in this research interacted more closely and frequently with the programme as a boundary object than the museum workers interacted with objects in the museum work in Star and Griesemer (1989). This affected the relationship between the social worlds of project firms on the projects and boundary exchanges.

Hence, this thesis contributes to the literature on occupational communities in construction that are mediated with boundary objects by presenting narratives on the issues that led to specific delay incidents and how the interacting social worlds of project firms as opposed to disparate social worlds engaged a programme to collaborate and address those specific delays, including relevant discussions on informal engagement with a programme. This suggests that when interactions are more continuous, this changes the way a boundary object functions compared to a case where there are limited group interactions.

This research compliments and extends the current knowledge on programmes as boundary objects in project groups by focussing on the treatment of delays. Taking people of diverse social worlds into account in this research on programmes has shifted the debate on delays from a positivist, technical and objective posture to one that is socially constructed. Taking people of diverse social worlds into account in this research has also challenged the assumptions in literature that there is a prescribed way of engaging with a programme when executing a project, because project groups at different moment or context adopted either a formal or an informal mode of engagement within and across cases.

Conclusion

7.1 Introduction

This research aimed at understanding how a programme that interfaces distinct project groups functions in the context of a construction project and to study variations across incidents and case projects. A boundary object approach was adopted. A case project in London in which multiple programmes are used extensively was compared with two Southeast cases with limited engagement with a programme. An ethnographic approach that involved observations of meetings onsite and virtually, interviews and analysis of document was adopted to address the six research objectives. Based on this research approach and evidence presented in the result chapters four and five, it can be concluded that the multiplication of a programme and the modes of engagement enabled different project groups in different contexts to a develop realistic responses to deadlines. The results demonstrated that different project groups engaged different versions of a programme differently in delay incidents within and across the three cases. The evidence presented in this research indicate six main findings corresponding to the six objectives that clearly demonstrates the following:

First, that project groups created and used multiple versions of the programme as a basis to relate with one another in the London and Southeast cases. For example, the project groups in the London case created and used five versions of the programme: (1) Marble Construction created/used the overall construction programme and the overall public programme. (2) Second, Marble Construction created the draft programmes as a basis to relate with subcontractors before reaching an agreement on construction programmes. (3) Marble Construction created the public programme for the housing authority, consultants and the residents, and constructed time linearly in the public programme for each block. Marble Construction used the public programme for each block as a basis to relate with the housing authority (on payments) and to organise the (start or completion of) recladding of the 11 blocks. (4) Marble Construction created the construction programme for each block for the subcontractors (Starlin and Eagle Construction) and constructed time linearly and cyclically in the construction programme. Marble Construction used the construction programme as a basis to relate with the subcontractors (Starlin and Eagle Construction) and repeatedly organised the instalment of equipment at different places in each block. (5) Starlin and Eagle Construction created the subcontractor's programme for each block for the panel manufacturers, suppliers and fixer operatives, and constructed time linearly and cyclically in their subcontractor's programme. Starlin and Eagle Construction used the

subcontractor's programme as a basis to relate with panel manufacturers or fixer operatives hired in each block and repeatedly organised the hiring of fixer operatives to replace existing cladding with newly manufactured cladding at different places in each block. Similarly, project groups in the Southeast cases created three versions of the programme: Kingsway Construction created and used the (a) outline programme and (b) the programme to relate with the county council. Kingsway Construction also created and used (c) the construction programme to relate with Diamond/Emerald Construction. These three versions of the programme had different start date and finish dates.

Second, that project groups engaged differently with a programme in each case and the modes of engagement varied across the cases. This research found that project groups in the London case engaged more formally with versions of the programme at six different types of meetings: in progress meetings, labour forecast meetings, progress review meetings, programme revision meetings, internal supplier meetings, joint inspection meetings. In the Southeast cases, in contrast, project groups engaged more informally with versions of the programme in two interactive meetings namely: (1) the first meeting at the beginning of the project to discuss the method or programme (2) informal meetings that involved quick verbal discussions to run over and catch up on progress.

Third, the research showed that project groups used versions of the programme in different contexts to do eight different things in the three cases. These uses include: to develop different interpretations of project time for projects groups, to distribute task and responsibilities at multiple levels, to manage project resources at multiple levels, to manage the expectations of project groups, to support firms negotiate their interest, to capture knowledge of activities and agreements at multiple levels, to enable project groups communicate about the progress of the project in percentages at multiple levels, and to socially construct the meaning of a delay. The way project groups used versions of a programme in delay incidents depended on the context and were responses that usually include avoiding the financial losses of placing or not placing workers, materials, or equipment to work.

Fourth, the research showed that project groups used versions of the programme to socially construct or interpret delays in an incidence in the three cases. In the London case, project groups used versions of the programme to construct delays as concrete and visible by recording negative slip values as delays on the programme, whereas project groups in the Southeast cases treated

delays informally and did not capture them on versions of the programme, thereby rendering them invisible or abstract.

Fifth, the research showed that project groups interacted differently as they responded to visible or invisible delays incidents in different context and, this varied across the three cases. This research found that project groups in the London case responded to visible delays with negotiations that involved formal extension of deadline that led to a social reconstruction of slip values on the public or construction programme. They also responded to delay incidents with a mutual accommodation of the work and versions of the programme. Whereas project groups in the Southeast cases responded to invisible delays with negotiations that extended the project duration without any formal recording of specific delays. The three cases showed that it is only after project members used a programme to measure/count or interpret and then label the progress of a project as delayed that they began to treat or view the project as delayed.

Sixth, the research showed that members in project groups engaged the programme differently when responding to visible and invisible delays in different contexts. This research found that the programme played different roles in different delay incidents in the three cases. In the London case, project groups used the construction or public programme in three ways to visually capture delays namely: first, by halting the position of the drop line on the construction or public programme instead of moving it forward to a current date. Second, by skipping with the drop line periods that were unproductive on the construction or public programme. Third, by developing a mapping of negative slip values as delays at multiple levels for different zones, subzones, or areas. In contrast, project groups in the Southeast cases used the construction or public programme to verbally discuss delays and issue warning notifications. Delay incidents led project groups to adjust initial forms of organising with a changing understanding of a programme when programmes moved between groups.

On the basis of these findings, this research argues that the multiplication of a programme into different versions and the modes of engagement enabled different project groups in different contexts to develop realistic responses to deadlines. The evidence presented in this research shows that conceptualizing programmes as boundary objects helps us understand in detail how project groups use a programme every day and when there are incidents of delay in different construction projects. These findings clearly address the overall aim and objectives of this research. This chapter concludes this research and is divided in to two main sections: the first

section discusses the contribution to knowledge with practical implications of this research. This chapter concludes with directions for further research.

7.2 Contribution to knowledge and implications

The approach adopted in this research contributes to knowledge by providing a different insight to studies on programmes by focusing on the way people respond to specific delay incidents with an empirical description on how a programme that interfaces different project groups functions in the context of a construction project. Such insight from the adoption of boundary object theory would enable people manage time and delays more effectively in projects such as construction in a dynamic manner. This contribution would help professionals to think differently and develop realistic programmes, with realistic responses rather than offer technical recommendations to delays with a mechanistic use of a programme. To date, an overriding assumption has been that delays are absolute and exogenous, however the findings in this research has demonstrated convincingly that different project groups use versions of the programmes to produce their own interpretation or meaning of delays in an incident. This stands in contrast to deterministic approaches in existing literature that supports a mechanistic or objective view or treatment of delays with programmes. Thus, rather than prescribe technical solutions, this research provides a different perspective on the subject of delays, and an active use of a programme by project groups in the context of construction projects.

This research compliments and extends the current knowledge on programmes in project groups with the adoption of a different approach on the use of tools such as programmes and the treatment of delays. Taking people of diverse social worlds into account in the research approach into programmes has changed the discussion on delays from a positivist, technical and objective posture to one that is socially constructed. Secondly, taking people of diverse social worlds into account has further developed the literature on programmes as an object that is used actively and differently at different moments. The focus of programmes as a boundary object approach has provided insights on the different interpretations and decisions of people from diverse social worlds in delay incidents that other approaches failed to consider or investigate.

Thirdly, taking people of diverse social worlds into account has challenged the literature on projects and performance i.e., project outcome of success or failure, because adhering strictly to a mechanistic evaluation of construction projects with reference to a single programme and the initial end date is misleading. This is because the findings of this research demonstrates that

projects operate with multiple interpretations of project time in different versions of the programme and the initial finish dates are changed/extended several times by project groups in the event of delays.

An implication of engaging multiple versions of the programme based on this research is that there would be different interpretations of success or failure (delays) for project groups on a project rather than a single interpretation. Therefore, not adhering strictly to the initial end date in one programme does not imply that the project has failed, or the project team are incompetent.

Another implication of the two modes of engagement with a programme observed in this research is that the formal engagement enables diverse construction professionals to be more actively involved in construction work or processes and more effective than they would be if they engaged informally with a programme. When project groups use a programme to construct delays as concrete or visible, it enables project members to be mindful when there are tensions of interest in a project. However, treating delays informally makes it (less conscious) difficult for project groups to understand when firms breach contractual agreements. Also, it may just be a convenient way of working to reduce cost overheads or conflicts. The contrast between the London and Southeast cases suggests that project groups use programmes informally when they have a history of working together. However, in situations where project groups have no prior business relationship or distrust each other, they engage more formally with a programme to penalise firms that breach contractual agreements.

7.3 Contribution to practice

The findings in this research have three important implications for practitioners and construction management research. First, the findings have contributed to our understanding of the complex nature of programme use in construction management by offering comprehensive insights on the nature of interactions that unfold i.e., boundary exchanges in interactive project meetings between project groups every day and when there are specific delay incidents. These aspects of managing time were not fully explained in previous approaches and there was the need to holistically consider (1) the use of a programme, (2) the social worlds of project firms involved in a project with the reproduction or multiplication of the initial programme as well as (3) the boundary exchanges, separating everyday actions from responses to specific delay incidents is emphasised. Second, when comparing the findings of this research with the literature on objects in occupational communities e.g.,Yakura (2002), Bechky (2003), and Chang *et al.* (2011), there is

significant emphasis in the literature on the role of programmes in coordinating the work of multiple groups that is quite superficial on the nature of interactions between groups. The literature presents a narrow empirical focus that omits the intervening points and complex boundary exchanges between the various social worlds in multiple contexts and when there are incidents of delay. Hence, not adequately addressing the complex and difficult nature of managing time with a programme when different organisation or people are involved. Taking account of the complex aspects of managing time as potential means to support interactions of diverse social worlds enriches our understanding and the effectiveness of teams in addressing tension or delays. The complimentary role of each intrinsic aspect of managing time, i.e., (1) the different social worlds with different perceptions of time, (2) the versions of the programme representing the different ways time was constructed to support group interactions, (3) the modes of engaging with a programme, (4) current artifacts or records mobilised alongside versions of the programme and (5) succession of incidents involving different project groups in multiple contexts, changes our understanding of programmes . These complex aspects and the process of managing delays were not previously understood.

The empirical issues emerging from the findings of this research has contributed in extending our understanding into the unique contribution each intrinsic aspect of managing time played in supporting the interactions of project groups in multiple contexts by revealing that each aspect is distinct in terms of how they support emergence and accomplishment of team's action in task, both the social interactions among project groups and their engagement with versions of the programme.

7.4 Limitations:

This research focused on understanding how a programme that interfaces different project groups functioned at a micro level in a building recladding project and two road network improvement projects. Nevertheless, it is possible that an entirely new or complex type of construction project such as a rail project or dam construction could inform the emergence of different mechanisms between the social worlds than those chosen in this research. For example, future research on the role of programmes with a different theoretical lens might yield more insight on the power and governance structure in projects and how project members established order or maintain clear roles and harmonious relations in the face of conflict.

The research findings are built on the access available and access to rich data was generally a challenge due to the lockdown associated with the COVID-19 Pandemic, thus limiting the amount

and richness of data needed to shed light on the phenomenon. This led to adapting the ethnographic technique employed to trace interactions between team members and with the programme. In some meetings, participants avoided discussions on financial matters because they knew their actions or activities were observed. This limited the richness of data on financial interactions and exchanges around programme use that could have provided additional light on how the different project firms engaged programme to perform their task in a heterogeneous environment such as construction.

7.5 Directions for future research

This section discusses directions of future research in construction management. There is the need to shift the current debate on programmes and delays to recognize the importance of interpretive research in the wider construction management research community. This does not imply that the current positivist approach should be entirely replaced but that future research should challenge fundamental assumptions in the way researchers in construction management develop research questions from the front-end and back end of planning. One way to achieve this as pointed out by Chan (2020) is that future research should strike a balance between theoretical rigour and practical engagement as well as positivist and interpretivist .

More research effort should be invested in investigating the way people use programmes when confronted with delays in organizations that are permanent. More specifically, the focus should be on informalities. Research on informalities has been advocated by Chan and Räisänen (2009) and Gajendran *et al.* (2011) in construction and the emphasis should be on comparing programme use in permanent organizations with temporary organizations. The long-standing dominance of the positivist approach in programme and delays in the construction management literature could be balanced by adopting more of the boundary object perspective.

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Appendix A: Ethics approval documents

Information sheet

University of Reading

Information Sheet

Oluseun Olubajo
Room 103,
Chancellors Building,
School of the Built Environment,
University of Reading,
RG6 6DF

Research Title:

How construction practitioners use project management tools

My name is Oluseun Olubajo, and I am a PhD student in the School of the Built Environment at the University of Reading. I am carrying out research on how construction practitioners manage delay in construction projects.

I am particularly interested in identifying and tracking specific delay incidents in some detail. I would like to observe practitioners at work, conduct interviews and analyse relevant project documentation.

Participation is voluntary and, at every stage, your identity will remain confidential. Your name, the location of your project and all identifying information will not be revealed to anyone other than the supervisors of the research.

With your permission, I will obtain project records as well as correspondence, attend project meetings, observe work, interview participants, and take note of activities in the workplace. The data will be kept safe and secure and deleted from computer storage once the research is completed. A copy of any transcripts that have involved you will be available on request and any changes which you ask for will be made. The data will be used only for the specific academic purposes of this PhD work and any subsequent academic publications.

If you have any questions or concerns, please contact me at o.o.olubajo@pgr.reading.ac.uk or my supervisor at w.p.hughes@reading.ac.uk. This project has been subject to ethical review, according to the procedures specified by the University Research Ethics Committee and has been given a favourable ethical opinion for conduct.
Oluseun Olubajo

Date:

Consent form

Consent Form

Oluseun Olubajo
Room 103,
Chancellors Building,
School of the Built Environment,
University of Reading,
RG6 6DF

Research Title:

How construction professional use project management tools

1. I have read and understood the Information Sheet relating to this project and all questions have been answered to my satisfaction.

2. I understand that my participation is entirely voluntary and that I have right to withdraw from the project any time and this will be without detriment.

3. I understand that my personal information will remain confidential to the researcher and his/her supervisor at the University of Reading unless my explicit consent is given.

4. I understand that my organization will not be identified either directly or indirectly without my consent.

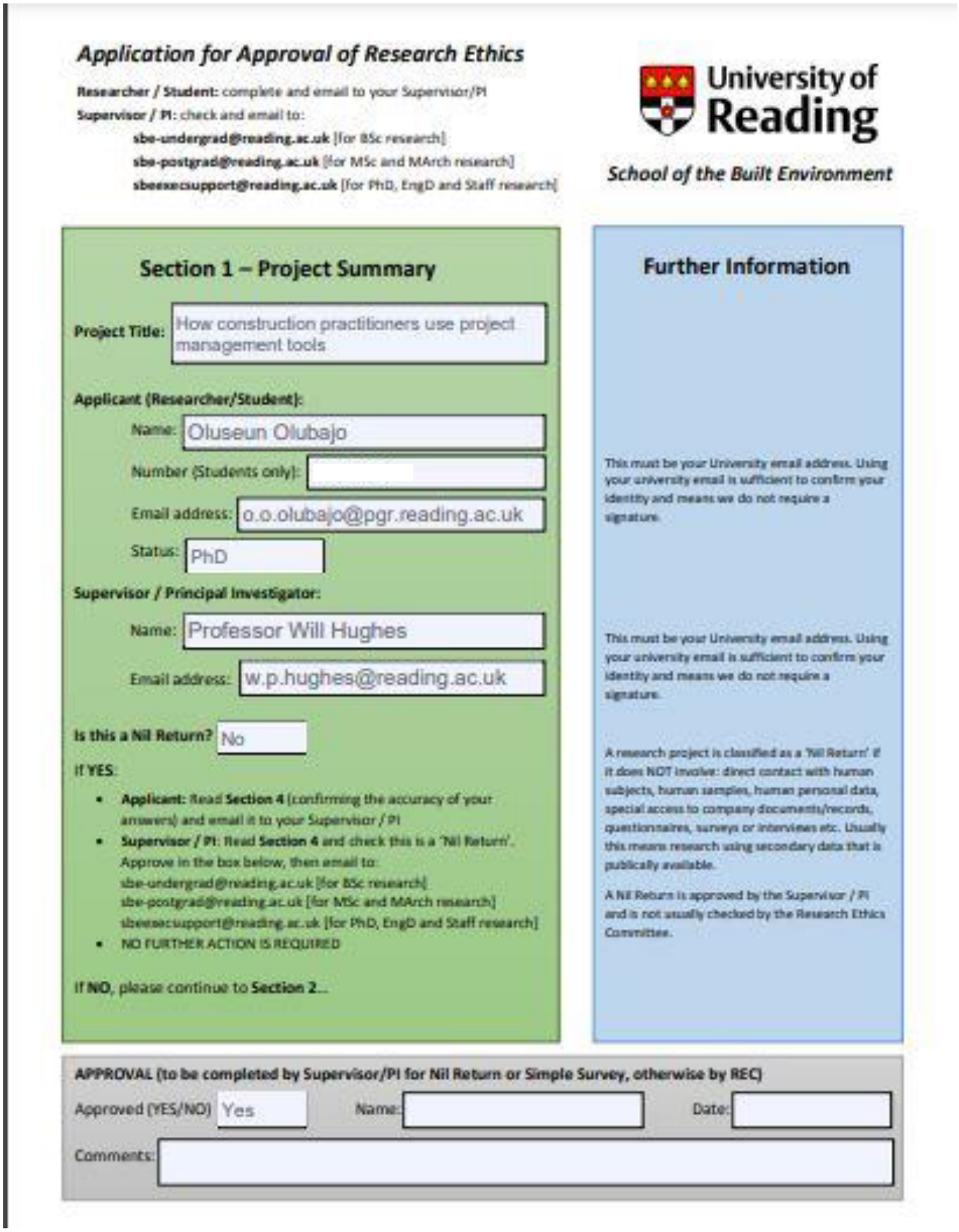
5. I agree to the arrangements described in the Information Sheet in so far as they relate to my participation.

Signed:

Name:

Date

Ethics approval application form



Application for Approval of Research Ethics

Researcher / Student: complete and email to your Supervisor/PI
Supervisor / PI: check and email to:
sbe-undergrad@reading.ac.uk [for BSc research]
sbe-postgrad@reading.ac.uk [for MSc and MArch research]
sbeexecsupport@reading.ac.uk [for PhD, EngD and Staff research]

University of Reading

School of the Built Environment

Section 1 – Project Summary

Project Title: How construction practitioners use project management tools

Applicant (Researcher/Student):

Name: Oluseun Olubajo

Number (Students only):

Email address: o.o.olubajo@pgr.reading.ac.uk

Status: PhD

Supervisor / Principal Investigator:

Name: Professor Will Hughes

Email address: w.p.hughes@reading.ac.uk

Is this a Nil Return? No

If **YES**:

- **Applicant:** Read **Section 4** (confirming the accuracy of your answers) and email it to your Supervisor / PI
- **Supervisor / PI:** Read **Section 4** and check this is a 'Nil Return'. Approve in the box below, then email to:
  sbe-undergrad@reading.ac.uk [for BSc research]
  sbe-postgrad@reading.ac.uk [for MSc and MArch research]
  sbeexecsupport@reading.ac.uk [for PhD, EngD and Staff research]
- NO FURTHER ACTION IS REQUIRED

If **NO**, please continue to **Section 2**...

Further Information

This must be your University email address. Using your university email is sufficient to confirm your identity and means we do not require a signature.

This must be your University email address. Using your university email is sufficient to confirm your identity and means we do not require a signature.

A research project is classified as a 'Nil Return' if it does NOT involve: direct contact with human subjects, human samples, human personal data, special access to company documents/records, questionnaires, surveys or interviews etc. Usually this means research using secondary data that is publically available.

A Nil Return is approved by the Supervisor / PI and is not usually checked by the Research Ethics Committee.

APPROVAL (to be completed by Supervisor/PI for Nil Return or Simple Survey, otherwise by REC)

Approved (YES/NO) Yes Name: Date:

Comments:

Section 2 – Research Methods

What is the general subject of your research?

The use of programmes and other documentation in the way that construction practitioners deal with issues around time, particularly programming and delays

Will your ONLY research method be a simple Questionnaire or Survey? No

If **YES**:

- PRODUCE A ONE PAGE DRAFT OF YOUR QUESTIONNAIRE, USING ATTACHMENT A (after Section 4).
- **Applicant:** Read **Section 4** (confirming the accuracy of your answers), then email this form including **Attachment A**, to your Supervisor / PI
- **Supervisor / PI:** Read **Section 4** and check **Attachment A** is appropriate. Approve in the box above, then email to:
- sbe-undergrad@reading.ac.uk [for BSc research]
  sbe-postgrad@reading.ac.uk [for MSc and MArch research]
  sbeexecsupport@reading.ac.uk [for PhD, EngD and staff research]
- NO FURTHER ACTION IS REQUIRED

If **NO**, please give more detail here and complete Section 3...
Describe your research methods:

The method involves identifying delay incidents in construction projects through interviews and conversations with key participants in a process to ascertain what was typical and untypical about specific events. Data will be gathered by examining project records in the contractor's office,cross-referencing and augmenting corresponding documents in the project manager's and /or client's office. Activities in the workplace around the event being studied will be observed directly, if possible.

Using 'ATTACHMENTS' (below, after Section 4), include any other information. Usually:

- **Information sheet (Example in ATTACHMENT B)**
- **Consent form (Example in ATTACHMENT C)**
- **Draft Interview Questions (Use ATTACHMENT D)**

Further Information

This should be a very short summary of a few sentences in everyday language, describing **WHAT** you are investigating (e.g. I am investigating green supply chains and how they impact on cost of construction).

A simple questionnaire or survey, with no significant ethical issues is approved by the Supervisor / PI and is not usually checked by the Research Ethics Committee. If you consider there to be ethical issues at stake, you must describe and consider these by completing the rest of the form.

All Questionnaires or Surveys MUST include an opening paragraph clarifying: voluntary participation; confidentiality; anonymity; data management; informed consent. See example in ATTACHMENT A (part of this form, after Section 4).

This should be a summary of **HOW** you intend to investigate your topic. Describe your methods (e.g. interviewing, transcription, observations, recording, photographs etc.) Include details such as: what type of data you will gather, how many participants, how they were chosen, what they will do etc. Use ATTACHMENT D (below, after Section 4) to provide examples of interview questions.

Remember this is about the practical activities you plan – tell us what you are actually going to do. This is NOT the place for you to justify your choice of method, describe theoretical underpinnings etc.

Where reasonably possible, you MUST provide every person you contact in your research with an Information Sheet, and obtain from them a signed Consent Form. If for ANY REASON you are unable to do this, you should contact your Supervisor / PI, and/or the SBE Ethics Committee.

Section 3 – Ethical Issues

Outline your ethical issues, and how you intend to deal with them:

The main issues are consent, confidentiality and safety. The research involves observational data on people at work,some preliminary interviews for familiarisation purposes, follow-up interviews for clarification purposes and documentary analysis for augmentation. To ensure consent, every data subject in a research case will be asked to sign a consent form. Only consenting participants will be used in research. For confidentiality, the location and identity of the construction projects and firms will not be revealed to anyone other than my supervisors. Technical details that identify the project will not be discussed. Only generic job titles will be used to describe participants. For safety, I shall observe all H&S policies on site and follow any guidance of those who host me. Data will be kept safe and secure and deleted from the computer storage once the research is completed.

If your research involves any of the following, your application may be raised with the University Research Ethics Committee.

- Medical procedures or samples?
- Patients or clients of the NHS?
- Psychological research using human participants?
- People unable to give informed consent?
- Educational research?
- Food research?
- The use of personal data?
- Participants who are in a 'Special Relationship' with you
- Deception

Does your research involve any of the above? No

How will you store your data (including signed Consent Forms)?

I will store electronic data in a password-protected computer that is backed up on the University server. I will store hard files like photographs and consent form in a locked drawer in the PhD room.

How long will you retain your data?

I will retain the data until 6 months after my graduation, scheduled for 2020

Further Information

Issues might include: confidentiality, privacy, anonymity, payment to participants, controversial or sensitive research topics, proprietary technical information, involvement of young or vulnerable people, existing relationships with participants (student, spouse etc.), cultural or language differences, coercion or deception, place of interaction (public place, workplace, hazardous environment etc.), revelation of criminality, uncovering health issues, exposure to pain or distress, physical contact generally, consumption of food or drink, risk to personal safety of the researcher and the participants, inconvenience or intrusion, environmental impact.

THIS LIST IS BY NO MEANS EXHAUSTIVE - YOU MUST IDENTIFY ALL ISSUES RELEVANT TO YOUR OWN PROJECT AND EXPLAIN HOW YOU WILL DEAL WITH THEM.

If an application to the University Research Ethics Committee is required, you will be contacted by the SBE Ethics Committee. If you are unsure, please contact the SBE Ethics Committee before submitting your application. People 'unable to give informed consent' are usually children or vulnerable adults. It is a legal requirement that staff and students undergo a Disclosure and Barring Service check before engaging in research when in a position of trust. 'Special Relationship' includes for example: spouse/partner; employer/employee; teacher/student etc.

All data, including signed consent forms, must be stored securely (e.g. on a password protected laptop; in a locked office etc.) All data must be removed from personal storage and returned to SBE (usually to the PI) if/when the researcher leaves SBE.

BSc / MSc dissertation data would usually be destroyed 1 year after completion. PhD / Staff research data should be retained for 3 years post-research by default. Research supported by external funders may have specific requirements (e.g. note RCUK requirements).

Attachment B - Draft Information Sheet

Use this page if you are conducting interviews or face-to-face meetings (e.g. observations, focus groups etc.) Each participant should be informed of the purpose and methods of the research, on an Information Sheet. This should be on University of Reading headed paper, and MUST include contact details for the researcher and supervisor / PI. Leave a signed copy of the Information Sheet with the participant.

Copy / Paste your draft text into the box below. You might simply edit the example text already given. Note, THIS IS ONLY AN EXAMPLE, any relevant information must be modified to suit your project, including all that text in italics (right click on text to select/remove italics). Include a representative selection of your draft questions. Do not exceed this one page.

University of Reading

School of the Built Environment
University of Reading
Whiteknights
Reading
RG6 6DF

How construction practitioners use project management tools

Information Sheet

My name is Oluseun Olubajo and I am a PhD student in the School of the Built Environment at the University of Reading. I am carrying out research on how construction practitioners manage delay in construction projects.

I am particularly interested in identifying and tracking specific delay incidents in some detail. I would like to observe practitioners at work, conduct interviews and analyse relevant project documentation.

Participation is voluntary and, at every stage, your identity will remain confidential. Your name, the location of your project and all identifying information will not be revealed to anyone other than the supervisors of the research.

With your permission, I will obtain project records as well as correspondence, audio-record project meetings, observe work, interview participants and take note of activities in the workplace. The data will be kept safe and secure and deleted from computer storage once the research is completed. A copy of any transcripts from audio recordings that have involved you will be available on request and any changes which you ask for will be made. The data will be used only for the specific academic purposes of this PhD work and any subsequent academic publications.

If you have any questions or concerns, please contact me at o.o.olubajo@pgr.reading.ac.uk or my supervisor at w.p.hughes@reading.ac.uk. This project has been subject to ethical review, according to the procedures specified by the University Research Ethics Committee and has been given a favourable ethical opinion for conduct.

Attachment C – Draft Consent Form

Use this page if you are using Information Sheets. If the participant is happy to be part of your research project, they need to confirm this by signing a Consent Form. ALL CONSENT FORMS MUST BE RETAINED ALONGSIDE THE COLLECTED DATA, AND SUBJECT TO THE SAME DATA MANAGEMENT PLAN. Make sure this is the same as you outlined in Section 3.

Copy / Paste your Draft text into the box below. You might simply edit the example text already given. Note, THIS IS ONLY AN EXAMPLE, any relevant information must be modified to suit your project, including all that text in italics (right click on text to select/remove Italics). Include a representative selection of your draft questions. Do not exceed this one page.

University of Reading

School of the Built Environment
University of Reading
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Reading
RG6 6DF

How construction professional use project management tools

Participant Consent Form - to be retained by the researcher

1. I have read and had explained to me by Oluseun Olubajo the Information Sheet relating to this project and all questions have been answered to my satisfaction.

2. I understand that my participation is entirely voluntary and that I have right to withdraw from the project any time and this will be without detriment.

3. I understand that my personal information will remain confidential to the researcher and his/her supervisor at the University of Reading, unless my explicit consent is given.

4. I understand that my organization will not be identified either directly or indirectly without my consent.

5. I agree to the arrangements described in the Information Sheet in so far as they relate to my participation.

6. I agree to the audio-recording of project meetings in so far as they relate to my participation.

Signed:

Date:

Appendix B: Interview questions

London case - Interview schedule: Recladding project

Date:.....

Interviewer: Oluseun Olubajo	
Interviewee Name	
Interviewee contact	
Designation	
Interview Location	
Interview Duration	

A. Background Questions for Interviewees:

1. What is your background in?

Answer	Additional comments

2. How long have you worked for your firm?

Answer	Additional comments

3. Could you describe your role on this recladding project and how long have you been on this project?

Answer	Additional comments

4. Could you describe what the recladding project is about generally?

Answer	Additional comments

B. Main Questions

1. How does your firm resolve delays on their projects generally?

Answer	Additional comments

2. Could you describe your experience of delay incidents working on this recladding project?

	Interviewee Experience	Answer	Additional comments
A	How did you find out about it?		
B	What was the issue?		
C	Who did you communicate to about this issue?		
D	What happened afterwards?		

3. What led to major changes in the project team at the end of 2019 that brought the second subcontractor (Eagle Construction) in the recladding project?

	Interviewee Experience	Answer	Additional comments
A	What was the issue?		
B	What happened afterwards?		

4. I observed that there were issues with lift shaft in block F in discussions at regular meetings, could you tell me what happened?

	Interviewee Experience	Answer	Additional comments
A	How did you find out about it?		
B	What was the issue?		
C	Who did you communicate to about this issue?		
D	What happened afterwards?		

5. Could you describe how your team responded to delays due to the issue at lift shaft and changes or revisions made to the programme (how was it addressed step-by-step)?

	Interviewee Experience	Answer	Additional comments
A	What did you do?		
B	Who was involved? (Who else was involved)		
C	How did you go about it? (How did you fix it)		

D	What happened afterwards or what changed?		

6. Were there issues in other blocks that led to changes to the programme, could you describe what happened?

	Interviewee Experience	Answer	Additional comments
A	How did you find out about it?		
B	What was the issue?		
C	Who did you communicate to about this issue?		
D	What happened afterwards?		

7. Could you tell me about the delays on the blocks in recladding project due to the 12 weeks lockdown, and could you tell me what happened?

	Interviewee Experience	Answer	Additional comments
A	What did you do?		
B	Who was involved? (Who else was involved)		
C	how did you go about it? (How did you fix it)		
D	What happened afterwards or what changed?		

8. Could you describe how the programme was revised due to the 12 weeks lock down to be able to meet the completion dates; and could you tell me what happened step by step to resolve this?

	Interviewee Experience	Answer	Additional comments
A	What did you do?		
B	Who was involved? (Who else was involved)		

C	how did you go about it? (How did you fix it)		
D	What happened afterwards or what changed?		

C. Sub-questions

1. How does the programme figure when making payments?
2. How does the programme figure when you receive payments?

Southeast case I - Interview schedule: Safety improvement project

Date:.....

Interviewer: Oluseun Olubajo	
Interviewee Name	
Interviewee contact	
Designation	
Interview Location	
Interview Duration	

A. Background Questions for Interviewees:

1. What is your background in?

Answer	Additional comments

2. How long have you worked for your firm?

Answer	Additional comments

3. Could you describe your role on this safety improvement project and how long have you been on this project?

Answer	Additional comments

4. Could you describe what this safety improvement project is about generally?

Answer	Additional comments

B. Main Questions

1. How does your firm resolve delays on their projects generally?

Answer	Additional comments

2. Could you describe your experience of delays incidents working on this safety improvement project?

	Interviewee Experience	Answer	Additional comments
A	How did you find out about it?		
B	What was the issue?		
C	Who did you communicate to about this issue?		
D	What happened afterwards?		

3. I observed there were issues with a utility company that led to delays in relocating fibre cables in one of my visits, could you tell me about it ?

	Interviewee Experience	Answer	Additional comments
A	How did you find out about it?		
B	What was the issue?		
C	Who did you communicate to about this issue?		
D	What happened afterwards?		

4. What was your firm's response to the utility company and how was it addressed (step-by-step)?

	Interviewee Experience	Answer	Additional comments
A	What did you do?		
B	Who was involved? (Who else was involved)		
C	how did you go about it? (How did you fix it)		
D	What happened afterwards or what changed?		

5. How did you handle delays on your projects due to the 12 weeks lockdown?

	Interviewee Experience	Answer	Additional comments
A	What did you do?		
B	Who was involved? (Who else was involved)		
C	how did you go about it? (How did you fix it)		
D	What happened afterwards or what changed?		

C. Sub-questions

6. How does the programme figure when making payments?
7. How does the programme figure when you receive payments?

Southeast case II - interview schedule: Drainage remedial project

Date:.....

Interviewer: Oluseun Olubajo	
Interviewee Name	
Interviewee contact	
Designation	
Interview Location	
Interview Duration	

A. Background Questions for Interviewees:

5. What is your background in?

Answer	Additional comments

6. How long have you worked for your firm?

Answer	Additional comments

7. Could you describe your role on this drainage remedial project and how long have you been on this project?

Answer	Additional comments

8. Could you describe what the drainage remedial project is about generally?

Answer	Additional comments

B. Main Questions

8. How does your firm resolve delays on their projects generally?

Answer	Additional comments

9. Could you describe your experience of delays incidents working on the drainage remedial project?

	Interviewee Experience	Answer	Additional comments
A	How did you find out about it?		
B	What was the issue?		
C	Who did you communicate to about this issue?		
D	What happened afterwards?		

10. I observed there were issues/delays in constructing the soakaways beside a golf course in one of my visits, could you tell me about this issue?

	Interviewee Experience	Answer	Additional comments
A	How did you find out about it?		
B	What was the issue?		
C	Who did you communicate to about this issue?		
D	What happened afterwards?		

11. What was your firm's response to the delays in locating the soakaway beside the golf course and how was it addressed (step-by-step)?

	Interviewee Experience	Answer	Additional comments
A	What did you do?		
B	Who was involved? (Who else was involved)		
C	how did you go about it? (How did you fix it)		
D	What happened afterwards or what changed?		

12. How did you handle delays on your projects generally due to the 12 weeks lockdown?

	Interviewee Experience	Answer	Additional comments
A	What did you do?		
B	Who was involved? (Who else was involved)		
C	how did you go about it? (How did you fix it)		
D	What happened afterwards or what changed?		

C. Sub-questions

13. How does the programme figure when making payments?
14. How does the programme figure when you receive payments?

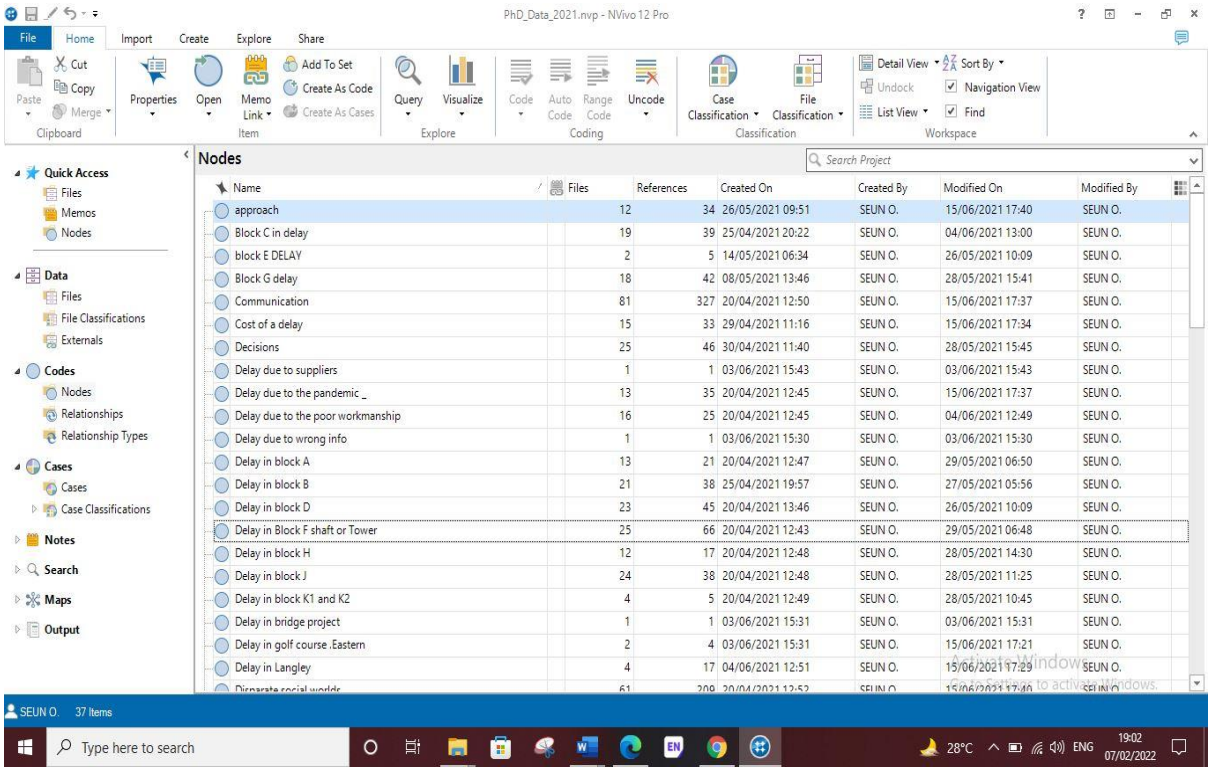
Appendix C: Coding structure (NVivo)

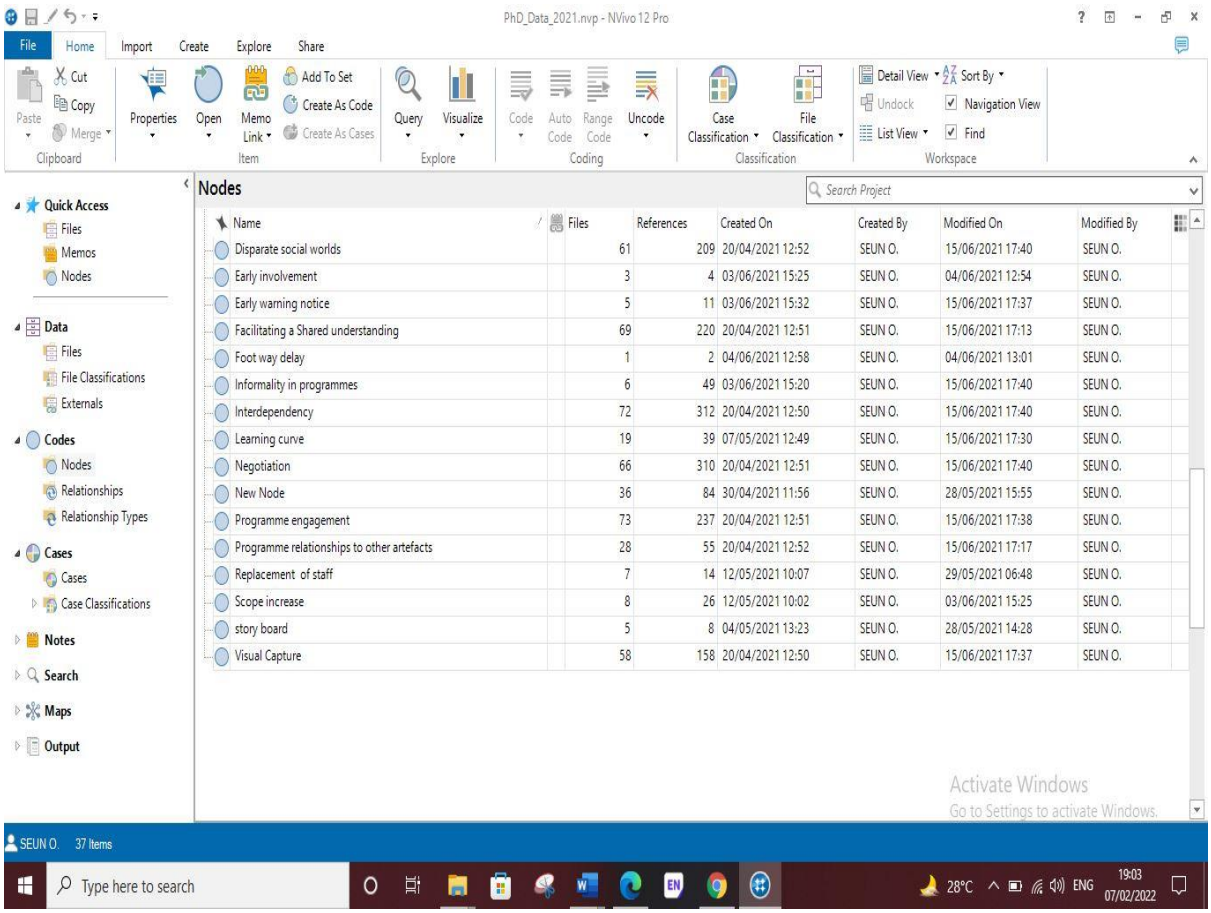
Initial coding – preliminary analysis
Themes
▪ Forecasting
▪ Trouble shooting
▪ Strategy
▪ Access
▪ Utilisation
Mechanisms
▪ Reaching agreements & negotiation
○ to agree
▪ Communication/ Dialogue
○ talking point
○ notify
▪ Capacity development: learning
○ know how
▪ Cooperation
Delay
▪ Slip
▪ Slippage
▪ Behind programme
▪ Slip value
Response

Expanded coding – analysis (NVivo)
Block C Delays
Block E Delays
Block G Delays
Block A Delays
Block B Delays
Block D Delays
Block F Delays/ Shaft or Tower
Block H Delays
Block J Delays
Block K1 and K2 Delays
Langley Delays
Eastern Delays _ Golf course
Pandemic/Lock down delays
Mechanisms
▪ Locus of negotiation
▪ Vehicle of communication
▪ Visual or knowledge capture

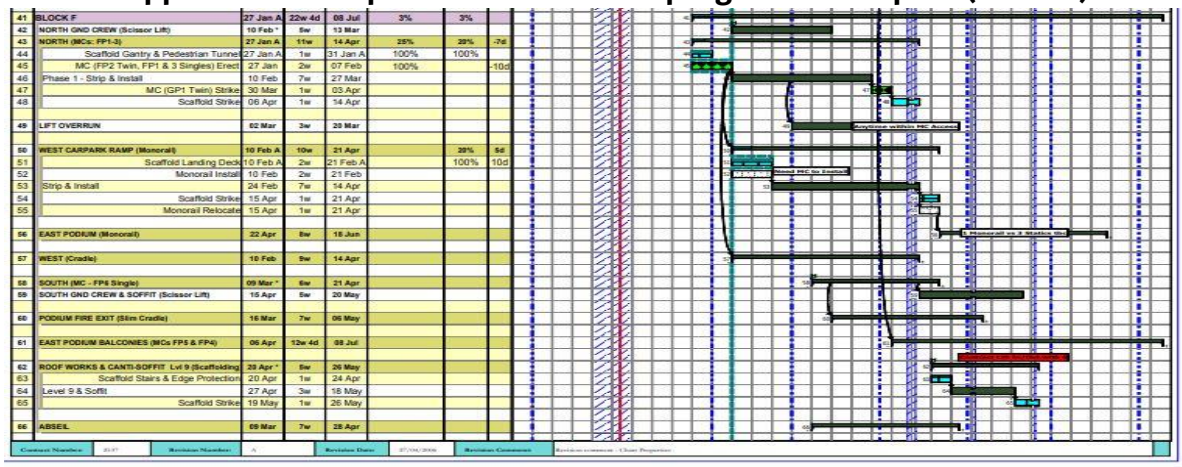
Shared understanding
Instrument for coordination
Interdependency
Early warning notices
Learning curve period
Disparate social worlds
Programme engagement/use
Programme relationship/link with other artefacts/documents
Informality in programme use
Scope increase
Story board
Replacement of staff
Early involvement
Decisions
Delay in bridge project
Footway Delay
Delay due to suppliers
Cost of a delay

Coding in NVivo



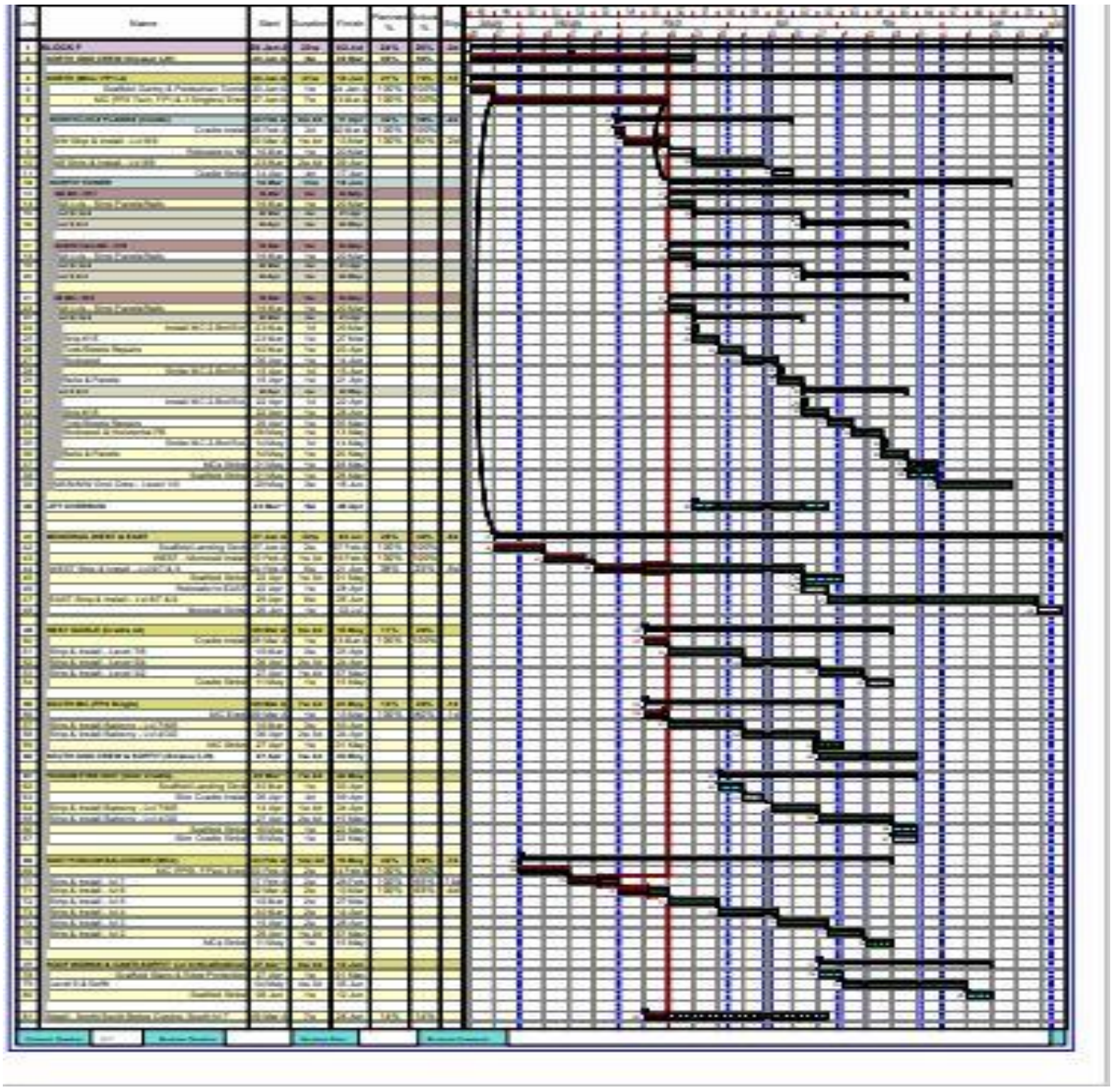


Appendix D: Sample of a construction programme adapted (Block F)



41	BLOCK F	27 Jan A	22w 4d	08 Jul	3%	3%	
42	NORTH GND CREW (Scissor Lift)	10 Feb *	5w	13 Mar			
43	NORTH (MCs: FP1-3)	27 Jan A	11w	14 Apr	25%	29%	-7d
44	Scaffold Gantry & Pedestrian Tunnel	27 Jan A	1w	31 Jan A	100%	100%	
45	MC (FP2 Twin, FP1 & 3 Singles) Erect	27 Jan	2w	07 Feb	100%		-10d
46	Phase 1 - Strip & Install	10 Feb	7w	27 Mar			
47	MC (GP1 Twin) Strike	30 Mar	1w	03 Apr			
48	Scaffold Strike	06 Apr	1w	14 Apr			
49	LIFT OVERRUN	02 Mar	3w	20 Mar			
50	WEST CARPARK RAMP (Monorail)	10 Feb A	10w	21 Apr		28%	5d
51	Scaffold Landing Deck	10 Feb A	2w	21 Feb A		100%	10d
52	Monorail Install	10 Feb	2w	21 Feb			
53	Strip & Install	24 Feb	7w	14 Apr			
54	Scaffold Strike	15 Apr	1w	21 Apr			
55	Monorail Relocate	15 Apr	1w	21 Apr			
56	EAST PODIUM (Monorail)	22 Apr	8w	18 Jun			
57	WEST (Cradle)	10 Feb	9w	14 Apr			
58	SOUTH (MC - FP6 Single)	09 Mar *	6w	21 Apr			
59	SOUTH GND CREW & SOFFIT (Scissor Lift)	15 Apr	5w	20 May			
60	PODIUM FIRE EXIT (56m Cradle)	16 Mar	7w	06 May			
61	EAST PODIUM BALCONIES (MCs FP5 & FP4)	06 Apr	12w 4d	08 Jul			
62	ROOF WORKS & CANTI-SOFFIT Lvl 9 (Scaffolding	29 Apr *	5w	26 May			
63	Scaffold Stairs & Edge Protection	20 Apr	1w	24 Apr			
64	Level 9 & Soffit	27 Apr	3w	18 May			
65	Scaffold Strike	19 May	1w	26 May			
66	ABSEIL	09 Mar	7w	28 Apr			

Block F construction programme at week 50: 6th February 2020



Block F construction programme at Week 55: 13th March 2020