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Beyond cost overruns: How cost is actually reduced in complex projects

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Abstract

In project research, most cost studies have shown how cost estimation processes can produce more realistic cost estimates and reduce cost overruns. In contrast, the knowledge of the day-to-day practices of project teams during planning to proactively reduce the actual cost of projects is limited. Utilising a project-as-practice lens, this paper aims to identify the practices of cost reduction in the planning of complex projects. We employed a single-case study of a UK major nuclear decommissioning project to find that cost reduction is practiced by setting the project up for cost reduction before developing cost reduction solutions. We show how cultures of collaboration, open communication, and opportunity management are key to realistic cost reduction. Our theoretical contribution entails an understanding of how proactive cost reduction is performed in complex projects. We recommend organisations adopt a collaborative contractual approach and place greater focus on opportunity management.

Keywords: cost reduction; practices; project-as-practice; planning; cost drivers; nuclear decommissioning projects.

1 Introduction

Cost performance is essential for publicly funded infrastructure projects to get value for money to the taxpayer (HM Treasury, 2014; Turner & Zolin, 2012). This is particularly important in the case of large, complex projects like nuclear decommissioning projects (NDPs) (OECD/NEA, 2003, 2016; Oko-Institute, 2013), since the cost – and thus impact of poor cost performance – is significant. Specifically in the UK (where NDPs are publicly funded), the programme to decommission the nuclear legacy sites is estimated to cost £105.3 billion and be completed in 2120 (NDA, 2024). Therefore, for UK NDPs, cost performance is measured not only in terms of deviation from the estimate (Love et al., 2017) but also reduction of actual cost, though this latter concept is not well-understood.

Since large projects, like NDPs, are typically delivered overbudget, researchers in the cost management realm have focused mainly on the factors that influence cost overruns (Akintoye, 2000; Cheng, 2014; Flyvbjerg et al., 2002; Invernizzi et al., 2019, 2020; Love et al., 2012; Siemiatycki, 2018). There are naturally parallels between cost overruns reduction and cost reduction, in that reducing cost overruns by definition reduces cost, e.g., by mitigating biases and misrepresentation (Flyvbjerg, 2006) or errors and inefficiencies (Love et al., 2016). The cost overruns research field focuses on avoidance of factors that make actual cost greater than budget cost, i.e., reactive, post-hoc approaches based on poor performance. What is needed to deliver greater value to the taxpayer is a focus purely on reducing the total actual cost of projects from the outset, i.e., a proactive, strategic approach to cost reduction.

The majority of studies that explicitly mention cost reduction focus on linking organisational- or project-level processes or cost estimation tools with reduced cost. For instance, building information modelling is often cited as being positively correlated with cost reduction and control in projects (Bryde et al., 2013), as is prefabricated construction (Liu et al., 2022), target costing, contractual incentives (Meng & Gallagher, 2012), and blockchain

technology (Qian & Papadonikolaki, 2021). As Olawale & Sun (2015) and Bilge & Yaman (2022) acknowledge, most studies in the realm of cost reduction examine quantitative, cost-optimisation based models, aiming to better their ease of use in practice. A necessary next step to better understand how project teams can actually implement these cost reduction methods, and thus build on this high level view of cost performance, is an understanding of the micro level, i.e., proactive cost reduction related activities employed by practitioners. Though some researchers have made efforts to advance this area (Bayraktar et al., 2011; Gharaibeh, 2014; Olawale & Sun, 2010), the focus of these studies aligns primarily with the cost overruns avoidance approach rather than explicit cost reductions. To reduce the cost of projects, Watton et al. (2023, p. 10) suggest that the planning stage of projects is a more effective stage to contextualise than that of execution, since the key areas for cost reduction opportunities – by focusing on the cost drivers (Watton et al., 2023) – are able to be exploited (upon sufficient development of the scope and subsequent baselining of the estimate (Morris, 2013)). This research therefore takes this approach of reducing actual cost in *planning* (Watton et al., 2023), specifically focusing on direct cost as we contextualise costs stemming from the project itself rather than the organisation-based indirect costs (Venkataraman & Pinto, 2008).

Additionally, whilst the mentioned cost performance studies shed light on what can reduce cost in projects, none uncover how this cost reduction is actually performed in practice. Taken alone, these cost reduction methods do not equip practitioners with a knowledge of how to implement them. Performing cost reduction requires an understanding of the day-to-day, often forgotten or overlooked activities involved in the enactment of cost reduction; this is the essence of project-as-practice research (Blomquist et al., 2010; Hällgren & Söderholm, 2012), which we utilise in this study. In addition, by examining the actuality of cost reduction (Cicmil et al., 2006), we can yield cost reduction approaches that support, complement, or even challenge existing approaches. We therefore investigate the micro level of cost reduction,

focusing on practices of practitioners to provide more actionable findings on how actual cost can be reduced in planning. These factors considered, the aim of this research is to identify the practices of actual cost reduction in the planning of complex projects. We ask the following research question: *How do project team members reduce the actual cost of complex projects with practices adopted in planning?*

The rest of the paper is structured as follows. We first outline what we mean by actual cost reduction in planning and related literature, as well as how we can use a project-as-practice lens to study projects generally and actual cost reduction in planning. The methodology outlines how we conducted our case study of an NDP to examine cost reduction practices. The results section is built around the two main stages of cost reduction: setting the project up for cost reduction and cost reduction solutions development, with a short section at the end to summarise the cost reduction solutions as a result of the previous. The discussion interprets how our findings inform future cost reduction practice, before our concluding remarks.

2 Theoretical background

2.1 Actual cost reduction in planning

The management of cost has always been an integral part of project management. Traditionally, cost is seen as a primary indicator of whether or not a project is deemed successful, i.e., project management success (Baccarini, 1999). Though the view of success in projects has shifted in recent years towards the delivery of value to stakeholders rather than the traditional cost, time, and quality metrics (Turner & Zolin, 2012), cost performance is nonetheless a vital target for project teams. Without the incentive for project teams to meet cost demands, public projects would put greater burden on the taxpayer and possibly reducing funding for other projects, including those projects that have a direct impact on the health and wellbeing of current and future generations, e.g., hospitals and schools. Private organisations involved in said projects

must reduce their costs in order to make a profit, not just for personal gain but to generate innovation, create jobs, and transfer financial risk from the public. Given that value is recognised as the ratio of benefit to cost (Laursen & Svejvig, 2016), if the cost of public projects decreases whilst the same benefits are delivered, value to the taxpayer is increased. Therefore, it is crucial not to lose sight of cost reduction in research. In the remainder of this section, we look at the key research advancements made in and around the field of cost reduction in projects.

Typically, cost in projects is examined through the perspective of cost overruns, for which there are overlaps with cost reduction. Many developments have been made in the cost overruns field, particularly in the past three decades, and has significantly extended our understanding of why actual costs of projects are greater than budgets. Cost overruns can be caused by optimism bias or strategic misrepresentation during initial estimates (Flyvbjerg, 2006, 2008; Flyvbjerg et al., 2002), which can also lead to escalation of commitment or lock-in (Cantarelli et al., 2010). Another contributor to cost overruns are scope changes, i.e., leading to rework and additional work (Love et al., 2012, 2016, 2017; Love & Li, 2000), with causes of this including inadequate front-end definition (Merrow, 2011), lacking competence (Akinci & Fischer, 1998; Larsen et al., 2016), improper contract or procurement approaches (Meng & Gallagher, 2012; Raisbeck et al., 2010; Suprapto et al., 2016), and complexity (Kaming et al., 1997; Nguyen et al., 2019). Some of these subjects also apply to cost reduction. Specifically, reducing the cost associated with scope change related causes of cost overrun by definition reduces the project's cost, though the same does not apply for the work on optimism bias and strategic misrepresentation as this is focused on reducing estimate inaccuracy rather than reducing cost. However, as we presented in our introduction, cost overruns' effects present themselves during execution; they are viewed ex-post, in the sense that cost overruns stem largely from poor planning that leads to scope changes during execution (Love et al., 2017).

To deliver more value to the taxpayer, it is important that project teams are able to proactively reduce cost *during* planning, i.e., reducing cost ex-ante. We use planning in this paper as a broad term to cover all project planning stages post-feasibility, since pre-feasibility focuses minimally on cost reduction.

It is understood that cost drivers need to be examined in order to study how practitioners can reduce actual cost reduction in planning (Watton et al., 2023). However, the understanding of what actual cost reduction in planning actually means is not as clear. In research, cost reduction in a planning context is more explicitly termed within the new product development, engineer-to-order, and manufacturing fields, i.e., to optimise the product in a way that reduces its cost. Though this is relevant to our concept of actual cost reduction in planning, studies tend towards a focus on how one particular solution is able to reduce cost, such as target costing (Ibusuki & Kaminski, 2007; Thore Olsson et al., 2018; Zimina et al., 2012), trust in partners (Bunduchi, 2013), Click or tap here to enter text.and supply chain integration (Haug, 2013), as opposed to how cost reduction solutions are devised by practitioners. This parallels the previously mentioned cost reduction articles that describe project-level processes that reduce cost (e.g., Bryde et al., 2013). Thus, to better understand the field – in a projects context – we must look to other fields of research where cost reduction is not as explicitly termed but is a core concept; specifically, the value engineering and opportunity management fields.

Value engineering (VE), part of the value management process, is about finding "*a more cost-effective way to obtain the desired result*" (Venkataraman & Pinto, 2008, p. 170), i.e., to reduce capital cost of the product or project whilst maintaining its functionality (Green, 1994; Green & Sergeeva, 2019; Laursen & Svejvig, 2016; Morris, 2013). VE researchers often use terms like cost savings or cost cutting when considering how to optimise the product or project (Ellis et al., 2005), with a focus on the cost drivers (Palmer et al., 1996). Linked to this is opportunity management, a key part of the risk management process where the goal is to

determine solutions that add value to the project, e.g., cost savings (Marsov et al., 2024). Given that VE is understood as a key enabler for opportunity management (Marsov et al., 2024), both go hand-in-hand for achieving actual cost reduction in planning. These approaches to studying cost reduction are not prevalent in research due to the more common understanding of risk management as mitigation of the negative impacts (Lehtiranta, 2014; Qazi et al., 2021; Ward & Chapman, 2003). Associated cost overruns grow faster than that of profit, therefore opportunity management can often be seen as secondary to threat management (Hillson, 2002; Lehtiranta, 2014). However, for cost reduction, it is essential (Hietajärvi et al., 2017). Opportunities identification and capture is more so the focus in the early stages of risk management during planning as "*there is scope for much more fundamental improvements in project plans*" (Ward & Chapman, 2004, p. 869), as well as for cost reduction potential (Kolltveit et al., 2004); the same holds true for VE (Ellis et al., 2005). Therefore, to avoid confusion in terminology, we hereafter use the term cost reduction to cover actions and decisions taken during planning to reduce the actual cost (during execution). In cost reduction, we include VE and opportunity management.

Some key developments have been made to better understand proactive cost reduction. For instance, Ibusuki & Kaminski (2007) and Palmer et al. (1996) identified, with a focus on VE, how different product components or project workshops (respectively) have different cost reduction potential. More recently, Hietajärvi et al. (2017) determined how opportunity management is conducted in the case of an alliance project. Additionally, the mentioned cost reduction studies whose focus is more so on cost overruns reduction (Bayraktar et al., 2011; Gharaibeh, 2014; Olawale & Sun, 2010) provide some insight into how cost reduction is performed. Their findings are based on cost control, but these are not isolated to cost overruns reduction as they are transferable to cost reduction in planning, such as (at a high level) front-end definition and good relationships and communication between parties. However, taken on

their own, many of these solutions are not easily actionable for practitioners as they neglect practical implementation detail, calling for an understanding of how cost reduction is actually performed.

2.2 Project-as-practice

Project management literature has historically been split into what Hällgren & Söderholm (2012) call a traditional stream (best practice and development of tools or models) or process stream (strategies to foster change at an organisational level). Likewise for cost reduction, most authors have examined organisation- or project-level processes that allow cost reduction (Bryde et al., 2013; Liu et al., 2022; Qian & Papadonikolaki, 2021). These studies present assumptions of practice (Hällgren & Söderholm, 2012), and as a consequence, an understanding of the situations in which these practices actually occur is absent. Thus, practice theory can be used to place the focus on the actuality of projects (Cicmil et al., 2006).

Practice-based research is explained by Feldman & Orlikowski (2011, p. 9) as a focus on the *arrows* in box-and-arrow figures, i.e., to understand how what is suggested to be done – the *boxes* – actually gets done. The field has seen significant development by management scholars generally under the banner of strategy-as-practice (Chia & Holt, 2006; Vaara & Whittington, 2012; Whittington, 1996). Following on from this, project-as-practice was conceptualised to better understand how projects get done (Blomquist et al., 2010). Project-as-practice takes a bottom-up perspective of projects, in that, unlike the process-based, top-down view of projects, it zooms in on a micro level to understand the situated doings of practitioners to implement the processes (Hällgren & Söderholm, 2012) and thus better reflect the reality of projects (Cicmil et al., 2006). Researchers have made efforts to distinguish between praxis and practice, terming praxis as the actions of practitioners to complete a particular task and practice as the "*traditions, norms, and rules or bodies of knowledge that state, explicitly or implicitly,*

how the practitioner should act in a certain situation" (Blomquist et al., 2010, pp. 8–9). However, practice-based research incorporates both praxis and practice rather than just practice in isolation, i.e., it focuses on what practitioners do *and* why they do it – as Blomquist et al. (2010) describe, project-as-practice examines the episodes or situations where praxis, practice, and practitioners meet to enact a particular process.

In the context of this research, practices can be examined in two ways as described by Feldman & Orlikowski (2011): empirically – a search for the *what*, i.e., everyday activity (praxis) of organising, both routine and improvised; and theoretically – a search for the *how*, i.e., explanations for the dynamics, generation, and operation of everyday activity. Several other concepts emerge within these approaches of studying practice theory. For instance, materiality is often used to analyse the artefacts and objects used and created when performing practices (Arnaud et al., 2016; Svabo, 2009). Also, stemming from the viewpoints of Giddens's (1984) knowledgeability and Bourdieu's (1990) habitus, Orlikowski (2002) recognises the important role of knowing in practice. This follows the theoretical approach as described previously, focusing on how practitioners use their accumulated knowledge and how consequentiality (i.e., engaging in activities to develop a practice of performing the activity and, thus, the ability to apply this practice again (Feldman & Orlikowski, 2011)) and regulative, normative, and cultural-cognitive mechanisms (Scott, 2014) operate the constitution and reconstitution of knowledge in everyday practice. We can thus use some of these key concepts to understand how practitioners do cost reduction, examining the activities they conduct to enact these practices, the materials used and created in this process, and the knowledge, experience, and institutional mechanisms guiding their doings.

2.3 The practices of cost reduction

We now critically analyse, through a practice lens, two key studies that examined cost reduction approaches with some insight into cost reduction practices (Gharaibeh, 2014; Olawale & Sun, 2010). Gharaibeh's (2014) multiple case study of two megaprojects' cost control solutions describes some situational elements, e.g., communication of budget information was performed by notifying lead engineers and project managers of staff hours. However, as this is the extent of their descriptions, the implications for practice-based research are slim. Olawale & Sun's (2010) study of cost and time control prohibitors and associated mitigating measures provides some tangible solutions; for instance, in reference to mitigating risks and uncertainties, they advise conducting a workshop with relevant parties at the beginning of projects to realise potential risks, or reviewing the risk register in progress meetings with the site team. However, aside from the fact that the vast majority of the measures are not framed in such a way, the measures are descriptive and do not examine the situations and episodes in which these practices may occur, nor the knowledge that guides how these practices actually get done. Thus, these critiqued cost reduction studies hold some value for practice-based research. Still, a deeper insight into the situations wherein practices take effect is a necessary next step as to provide practitioners with the know-how to actually *do* cost reduction in planning.

3 Methodology

3.1 Research design

In this research, we take a pragmatist philosophical position, as our focus on how project team members practice cost reduction in planning aligns with the pragmatist view of determining practical solutions based on the lived experiences of actors (Easterby-Smith et al., 2018; Saunders et al., 2019). We leveraged an inductive approach as we aim to generate an

understanding of cost reduction practices. We employed a qualitative holistic single-case study (Saunders et al., 2019; Yin, 2018). The single-case design was deemed a suitable approach since (a) it can provide rich detail into the situations and episodes within which practices occur, particularly when using multiple data collection methods to triangulate the data (Eisenhardt, 1989), and (b) more than one case in this research specifically could have placed more emphasis on comparisons between cases on how cost is being reduced, which was not our intention.

3.2 Data collection

3.2.1 The case

NDPs are large-scale, high-cost infrastructure projects that come with considerable levels of complexity and uncertainty as compared to other types of infrastructure project (Bärenbold et al., 2024; Invernizzi et al., 2020; Locatelli, 2021; Torp & Klakegg, 2016), particularly in the UK where the total cost to decommission the nuclear legacy sites is £105.3 billion (NDA, 2024). These unique project environments typically require enhanced managerial and technological innovation that goes beyond existing, off-the-shelf approaches suited to less complex projects (Flyvbjerg, 2014; Kardes et al., 2013; Merrow, 2011; Remington & Pollack, 2007). Because of these factors, an NDP serves as a valuable case of cost reduction practice. Specifically for this research, the NDP case is a UK major (i.e., greater than USD100 million) waste management facility construction project. Though this project does not involve any dismantling work – which may be perceived as an essential aspect of a decommissioning project for those not versed in this empirical context – it is an NDP since waste management is a key stage of the nuclear decommissioning lifecycle (OECD/NEA & IAEA, 2017). The unit of data collection is the project team members of said project, with our level of analysis – and

phenomenon – being the cost reduction practices (Martinsuo & Huemann, 2021). Click or tap here to enter text.

In terms of sampling to narrow down a specific project, we found that waste management projects are the more challenging part of the UK nuclear decommissioning programme than the actual dismantling projects, thus making it a more valuable case for a cost reduction study. This specific waste management case was chosen as the project was, at the time of collecting the data between January and July 2023, in the planning stage and past the feasibility stage. This was a fundamental characteristic for the selected case since our focus was on examining the planning stage practices that reduce actual cost. Our other key criterion was that the project was reducing cost from the baseline (Morris, 2013). Independent investigation revealed that the chosen project had received numerous accolades both internally to the organisation and externally regarding their baseline accuracy and cost reductions already made. Therefore, like Giezen's (2012) megaproject case study, this type of case can be termed a success case since it exemplifies a project that was successful in achieving a particular goal. Following an introductory meeting with the project manager of the case project, the data collection began.

3.2.2 Sources of evidence

We utilised both semi-structured interviews and direct observation to collect data on cost reduction practices. The purpose of utilising interviews was to specifically ask about how cost is being reduced, how the project team members perform associated activities, and the knowledge they require to do this. The observations were performed to corroborate the interviews, i.e., to provide a representation of what the team members were actually doing (Bueger, 2014).

For the interviews, these were conducted with 16 members of the lead project team from the case NDP, *lead* referring to the core group of project team members that hold decision-making positions on the project. Each team member had numerous years of experience (between 10 and 30+) in many projects and project roles, some having been in nuclear decommissioning for their entire project career. The interviews lasted on average one hour, and were conducted over Microsoft Teams. The audio was recorded (with consent) and later transcribed.

The interview protocol was structured around the controllable cost drivers of projects identified by Watton et al. (2023), as they are the key areas for cost reduction opportunity for which practice-based questions can be built around. These are project team cohesiveness, contract and procurement, rework and additional work, materials, labour, uncertainty and complexity, socio-political stakeholders, schedule, equipment and plant, and health & safety. We asked three questions per cost driver to gauge the *approaches*, *praxes*, and *knowledge* (asked in this order) of cost reduction for each. The approaches question was simple to construct (i.e., "*what has been done to reduce the cost associated with [X cost driver]?*"), but for the praxes and knowledge questions, we referred to existing practice-based research that used interviews in order to determine the most suitable phrasings. For the praxes question phrasing, we found that Mantere's (2005) phrasing of how people participate in something was most replicable, which led to our own interpretation in this research: "*How did you personally participate in these examples of cost reduction?*" For the knowledge-based question, we found that several particular articles (Arnaud et al., 2016; Nag & Gioia, 2012; van der Hoorn & Whitty, 2017) helped to construct a suitable question: "*What knowledge or experience guided these actions?*" We conducted a pilot interview and subsequently slightly amended the protocol structure. For the main interviews, we began by briefly running through each of the selected controllable cost drivers with the interviewee to ask whether or not they personally were

involved in reducing the cost associated with them, thus tailoring each interview to the specific interviewee.

We additionally used direct observation to collect data, taking an observer-as-participant role (Gold, 1958). We performed eight separate observations. These lasted between one hour and half a day; the one-hour observations were for online monthly project updates, whilst the half-day observations were in-person workshops with the lead project team and briefings with the wider project team. They were conducted over the period of December 2022 – April 2023. It was decided that only meetings were to be observed due to their more focused nature than day-to-day activities, at least in terms of cost reduction. We referred to the guidance of previous practice-based studies that observed meetings to help us to narrow down our purpose, what we were to be looking for, and how to record the data (Burger et al., 2019; Çıdık & Bowler, 2022; Jarzabkowski & Seidl, 2008; Kaplan, 2011; O'Leary & Williams, 2013). Thus, during the observations, we recorded descriptions of the surroundings, details about the atmosphere and setup of the room, the overall topic being discussed at a particular point, individual conversations had between participants, emotions, and materials (Svabo, 2009). Field notes also included our own feelings, reactions, and immediate reflections about what something meant (Patton, 2002). The field notes were reviewed and transcribed into a structured set of detailed notes within 24 hours of the observation event (Yin, 2018).

Table 1 summarises our interviews and observations. It highlights the profiles of the interview participants and contents of the observations, along with IDs for each that are referred to in the results section.

Table 1 Details of interview participants and observations

Interviews			
ID	*Role on project*	*Projects experience (years)*	*NDPs experience (years)*
P01	Construction manager	20–25	15–20

P02	Commissioning manager	20–25	20–25
P03	Project controls manager	20–25	15–20
P04	Project engineering manager	20–25	20–25
P05	Senior quality manager	20–25	0–5
P06	Construction delivery manager	25+	5–10
P07	Package manager	15–20	10–15
P08	Senior project manager	15–20	5–10
P09	Information manager	15–20	0–5
P10	Deputy engineering project manager	10–15	5–10
P11	Cost engineer	15–20	10–15
P12	Package manager	5–10	5–10
P13	Project director	20–25	20–25
P14	Commercial manager	20	5–10
P15	Package manager	15–20	5–10
P16	Package manager	15–20	15–20

Observations

ID	*Meeting description*	*Members present (no.)*	*Length of observation (hrs)*	*Format*
O1	Project brief	50–55	3	In person
O2	Monthly briefing	65–70	1.5	Online
O3	Opportunity discussion	8	<1	Online
O4	Monthly briefing	60–65	1	Online
O5	Opportunities workshop	15	5.5	In person
O6	Opportunities workshop	16	4.5	In person
O7	Tasks delegation	20–25	1	Online
O8	Project brief	50–55	3	In person

3.3 Data analysis

Thematic analysis is a standard approach to analyse interviews and observations (Attride-Stirling, 2001; Braun & Clarke, 2006). Using qualitative data analysis software NVivo, we first coded the interview transcripts. We coded text passages by distinguishing between cost reduction approaches, praxes, and knowledge, with the structure of our interview protocol making this process easier. The approaches were more general phrases, i.e., not describing a particular praxes but stating the key approach to reducing the cost associated with the cost driver. The cost reduction praxes were the specific activities relating to the cost reduction approach, often grouping multiple praxes codes to gauge situations and consequentiality

(Feldman & Orlikowski, 2011). The cost reduction knowledge was coded where the participant referred, e.g., to previous experiences or something that helped them understand how to enact the cost reduction approach or perform the cost reduction praxis.

Once all the interviews were coded, we began thematic analysis. We concluded that, this being a practice-based study, the main focus should be on the situations and episodes within which cost reduction was made possible. Codes were therefore grouped to summarise a particular practice. After this, we grouped these practices into particular stages that began to form a process of cost reduction practices, leading to three distinct areas. The first was how the project could be set up for cost reduction, i.e., initial conditions that were put in place for cost reduction to be achieved later on. The second was the development of cost reduction solutions, entailing proposal, detailed development, and implementation stages. These described how cost reduction was being actively achieved through various practices. The third was the outputted cost reduction solutions that came from the previous two stages of cost reduction, which primarily captured the approaches codes mentioned previously. We then coded the observation transcripts. This two-stage approach to the coding was performed as the interviews gave us a better idea of the breadth of themes and sub-themes, for which the valuable data from the observations would either corroborate or add to. Thus, upon coding the observation transcripts for approaches, praxes, and knowledges, we organised the codes into existing practices based on the interviews or new practices. The interviews helped in this process by giving meaning and a certain background to the observation data. In performing these activities, we could adequately triangulate the data and subsequently write up our findings. This thematic analysis process was iterative, in that themes and sub-themes were regularly restructured to suitably group the situations.

4 Results

Cost reduction is a process like all approaches to delivering value in complex projects. This process comprises many interconnected practices that may ordinarily go under the radar. Therefore, to investigate the cost reduction process in the case project, we have presented this results section as cost reduction practices in various stages. The first is setting the project up for cost reduction, followed by cost reduction solutions development, which is split into (a) proposal and initial development of solutions, (b) detailed development of solutions, and (c) implementation and maintenance of solutions. The last part briefly summarises some of the outcomes of how cost reduction is practiced, i.e., the solutions themselves – this section does not take precedence in this paper since our key focus is the practice of cost reduction to reach the point of solutions, this being the missing piece in cost reduction research. Table 2 visually represents these key stages and associated practices as discussed throughout our results.

We will use extracts from interviews and observations to create a picture of cost reduction practice. Additionally, we integrated the individual practices within the wider purpose of the practices, rather than isolating episodes without context – the latter would have limited value for other projects.

Table 2 Stages and practices of cost reduction

Stages of cost reduction	**Practices of cost reduction**
1. Setting the project up for cost reduction	
a. Collaborative contractual approach	Brainstorming to improve projects Cascading to team in meetings/workshops Interacting with partners
b. Mutual project team culture	Defining necessary competence Interviewing for behaviours Setting tone of collaboration Leading by example
c. Mutual understanding with client	Protecting team from negative behaviours

	Educating client on cost reduction/estimation
2. Cost reduction solutions development	
a. Proposal of solutions	Presenting previous effective solutions Resolving concerns on solutions Educating team members Challenging team members Discussing scope with partners Keeping stakeholders informed
b. Detailed development and assessment of solutions	Conducting opportunities workshops "Doing" activities to actively develop detail "Hands-off" activities to oversee and coordinate development Getting partner input
c. Implementation and improvement of solutions	Updating baselines Controlling spend Reviewing solutions to improve them Keeping stakeholders informed

4.1 Setting the project up for cost reduction

The ability to reduce cost in complex projects relies on specific structural and behavioural conditions, without which cost reduction is difficult. Of these conditions, the following were in place on the case project: a collaborative contractual approach, having a mutual project team culture, and having a mutual understanding with the client. Before discussing how these three key conditions came to fruition through practices, it is worth noting that the case project was in the stage of planning between the outline business case and the full business case (HM Treasury, 2018). At the outline business case gate, they built up the scope and provided a robust estimate based on what the product should achieve. As they were moving towards the full business case gate, the opportunity realisation process occurred to reduce the cost from the baseline set at the outline business case.

The collaborative contractual approach occurred at around the time the case project was being conceptualised. This was born out of a conversation and brainstorming that P14 had with

a colleague in their organisation, which ultimately led to the organisation adopting the contractual approach for their projects. The extract below highlights, in their own words, how P14 came up with the approach and their current involvement in the project:

> *"I was quite influential in setting up that model [of collaborative contracts in the organisation]… There was me and [a colleague] – we were trainees at the same time – and we literally just sat brainstorming saying, because we've always worked for main contractors, "what didn't quite work? What would be better? Should we do that? That doesn't quite feel right – if we did this, we might get that." … But it was very much driven by, on one hand, "this is what [our parent organisation is] doing, so we need to flow that down," and then the second part was, "we've both worked in this industry for 20 years. What's the stuff that used to drive certain behaviours, and can we take that out?" [Now] I interact with our team to say, "this is the stuff you can do under this contract. You can get them to do this. You can get [this partner] to schedule the rebar. You can get this person to do this."… So it's not so much how I interact with the contractors, it's how I interact with our team, which they then go and interact with the contractors, so they know what they can and can't ask them, what's possible to ask them…"*

This demonstrates the need for project practitioners to converse with one another regarding how projects can be improved at a strategic level, not just operating under traditional project delivery models. Moreover, cascading this message down to the project team is important. P14 describes how they are present in workshops and meetings with the project team and partners (particularly in the earlier stages of planning) purely to make sure the team are aware of and following the collaborative principles. They also highlight the necessity of sharing scope responsibilities with partners, even emphasising such activities as asking to sit next to a partner organisation member for a day to understand how to do certain work.

The mutual project team culture refers to building an attitude to reduce cost. This comes from appointing project team members with the necessary competence and attitude that match the organisation's values. The first part of this, before the recruitment interviews, entailed the lead project team members coming together to define the criteria for necessary competence, as P09 describes: "*We've had to basically put together our own job descriptions to then make sure that we're appealing to the most candidates that could actually support the project in the way that we want them to.*" Next were the recruitment interviews for the wider project team, where participants described how they would ask questions in the interview to draw out whether or not the interviewee liked to work closely and openly with the team and the project partners. They stated that if the applicant expressed their preference of being separate from others, they would probably not work well within the team as this was a crucial criterion for the project's collaborative approach.

Once hired, the lead project team needed to immediately set the tone of collaboration and communication, i.e., a mutual project team culture. This was performed through briefings on the culture and steering the team towards this mindset where certain members may be struggling to adapt: "*You try and realign their behaviours, try and get them working with other people who are really good at exhibiting them. The [organisation's] manifesto is a good one for behaviours. We do a lot of behaviour focused stuff on my team briefs and things about the right way to behave or good behaviours, and how to deal with challenge, and how to make challenge in the right manner*" [P04]. This being said, there were occasions where they moved members onto another project if they could not adapt to the case project's culture. Participants also recognised that it was fundamental to lead by example here, with practices including being physically present in the office to enact visible leadership, mentoring junior team members, asking seemingly stupid questions, and giving the team space to adapt to change: "*People don't like change, so you need to allow people the time and space to work with change… Don't get*

me wrong, there's a time and a place where you have to make a decision and you have to say, "this is what we're doing," but that was a fundamental shift in approach" [P08].

For P13, their role as project director was a balance act of keeping good behaviours within the project and poor behaviours out. For the former, this relied heavily on trust in the team, particularly trust in P08 who had a direct relationship with P13 and so needed to convince P13 that their team was working effectively. For the latter, this referred to dealing with responses from the client that may have had a negative impact on the project team. This – and thus the ability to reduce cost – was achieved by having a mutual understanding with the client. It required P13 and P08 to sit down with the client personnel and educate them on moving away from their more traditional method of blanket cost reduction towards opportunity management, as P13 describes:

> "*There was a point when we estimated the [outline business case] – I'll just give an example – where the client said "too much. Too much. Don't like the price. It's going to take too long. So we're going to just take 10% of your estimate." … So I didn't say, "do what you want." I actually said […], "well don't slash it. We'll create a list of things that you can do to get that 10, 15%…" And all the time, I'm working with [P08], because [P08's] got the knowledge. It's his team that are doing the work, but between myself and [P08], we offer something to the client called opportunity management that gets them what they want.*"

Alongside this, P08 contacted independent estimators (both from government departments and the project partners) to verify their baseline estimate, before meeting with the client on numerous occasions to prove to them that their estimate was robust and also how scope changes would impact the cost at different stages of planning.

4.2 Cost reduction solutions development

4.2.1 Proposal of solutions

Once the project was set up for cost reduction via the previous practices, the proposal of the cost reduction solutions could begin. Notable formats in which this was practiced included: team discussions and resolutions, challenging team members, discussion with partners, and initial workshops (though these were not part of our observation period), throughout which the client also had to be kept abreast of.

The team discussion and resolution entailed proposal and then agreement on solutions that they had either seen work on previous projects on the site or past experience generally. One key example of this is related to modularisation. P08 describes how they had seen it used on a previous project where modularised tunnel sections were installed, and thus considered it to be an invaluable tool for cost reduction. As a result, they introduced this to the team, though P04 was initially resistant to the idea. P08 stated that they "*set that challenge to the project [team], so I told them that that's what was happening, if I'm being blunt.*" Based on this, P04 stated, "*the modularisation option, which has been pushed, was something I thought, "I can't see how that's going to work, that doesn't feel right. I understand the driver but I'm not sure that's going to work.'*"" Therefore, P08 educated the team on modularisation by utilising partners' expertise, as P04 describes:

> "*The first session with [our partner] was really good, and they came back with some really good ideas, and I thought, "ah right, I can see how that works, I can see what's going to happen." … So once I was bought into it then, I then fed that down to the engineering team below me… So that's effectively [P08] from a project management side managing to influence right the way down through to your individual designers by picking your appropriate people and thinking, "if [they] can get me on board, then I can get a lot of people below on board.'*""

This practice demonstrates the need to "*allow people to get used to the change*" [P08], which is fundamental for a collaborative culture that drives cost reduction.

The act of challenging team members does not refer to disagreeing with them but to empowering them to think critically. P04 describes an example how they encouraged team members to proactively consider risks, which led to them being independent: "*I didn't identify the issue for that one [a specific risk]. It was identified by one of my leads [i.e., a lead engineer]. He said, "I'm a bit concerned about that area. […] I'd quite like to bring a bit of scope early, get a little bit of an investigation." I was like, "right, ok, yeah, seems like a good idea. Go away and do it."*" This simple interaction led to the identification of a particularly severe issue in the project regarding the route of underground cables from a substation they were going to use to power the facility. As a result, they were able to avoid a considerable amount of rework later in the design.

Reliance on the project's partners' expertise helped in the proposal stage of the cost reduction solutions. P06 describes how they had an informal discussion with a member of a partner organisation regarding a part of the scope that they were struggling to reduce cost for:

> "*It was just over a coffee after our meeting with [a partner]. I spoke to their senior PM and project director, and said, "I've got a thought of giving you [this piece of work]. Would you be interested?" … They said "yeah," they would, "why not have a look at it?"… So I got the drawings sent over to them, and they came back within a couple days and said, "yeah, that's definitely something we could do," and they then played back the same scenario to me – [they] said, "we've already identified that as a major interface with our works, we were concerned at how that would progress."… So it was a conversation. It was just a, "I've got this idea." It came to me as I was driving down to meet [our partner] for the first time. You know all your issues off of your head, and I'd probably come out of an engineering meeting when again that was raised as a*

concern, that we didn't have a supplier for it, or we had two but there'd always been issues with them at [the site]. So I had the conversation when I was there… [P08] was against it because they're not our [supplier for this particular work], so I had to give my reasons to [P08] as well to say "this is how I believe it could work.""

Upon this conversation with P08, the solution was developed with the partner in question taking primary responsibility for the work whilst the project team would continue to input to the process, thus ensuring interfaces were aligned throughout the programme. Therefore, what this extract illustrates is the way a string of simple interactions can lead to a significant saving. It also demonstrates that the previously described setup of collaborative contract principles must then be followed for cost reduction to be possible. Throughout the process, the client continues to be kept in the loop – as P15 describes, there is a healthy challenge dynamic at play in the proposal of solutions: "*They don't question my abilities or [my colleague's] abilities… but if I said something along the lines of, "we've done this because of X, Y, and Z, and this is a benefit to the project," then they would take that advice, and they might challenge it, but they wouldn't necessarily turn around [and say], "you're wrong." … I've had some client's that go, "no!"*" Without this continued interaction even in the proposal stage, there could have been considerable lost time (and thus increased costs) should the client have not approved of the solution.

4.2.2 Detailed development and assessment of solutions

Once proposed, cost reduction solutions underwent a detailed development and assessment stage. In this subsection, we will discuss this development regarding the opportunities workshops, the "doing" roles, the "hands-off" roles, and getting partner input.

The opportunities workshops were the primary subject of our observations. The purpose of these half-day sessions was to review the identified opportunities – which they had split into

six opportunity groups to categorise 21 single opportunities – and underpin them with actions or data. The sessions typically began with P08 and P13 recapping on the opportunity groups and the four-stage opportunity realisation process, before outlining the intended outcomes of the session. The atmosphere in these sessions was relaxed, with participants using humour whilst also being focused on the task at hand. It was also clear from the beginning of the sessions that the culture of openness and clarity were paramount for these sessions to be effective – the following extract from O5 is representative of their interactive, flexible nature with openness at the forefront:

> *P13 moved on by getting an A1 flipboard set up, saying they "thought of this on the way down." They noted that the flipboard's content was going to be to do with cost. They asked, "the sunk cost is, [P11]?", to which P11 replied with the figure. P13 wrote this on the board, and asked about another, larger figure, to which P11 replied. They drew these on opposite ends of the board and drew a horizontal line from one figure to the other. They switched from a blue to a red pen, and drew three horizontal lines in red, one to describe the P80 estimate, and two with P50 with a short description accompanying them to show their difference. There was a sense of confusion in the room, so P02 asked what the difference was between the lines after saying "this is probably a daft question," to which P13 swiftly replied saying, "there's no such thing as a daft question, [P13] – that's what we're here today to do."*

As P13 clarified in their interview, poor reactions during a communication can pressure an individual and lead to them hiding or missing information. Therefore, it was important for P13 to set this tone near the start of the session. After this initial section of the sessions, the format would then be to split the lead project team into two or three groups to work on particular groups of opportunities, which were assigned based on the expertise of the members in each group. For O5, there were two groups: one led by P06 and the other by P03. P06's

group worked on developing three major opportunities under a particular opportunity group, devising relevant trigger and resolution dates (as the team termed them), probabilities, and actions to adequately realise them. P03's group worked on how the four-stage opportunity realisation process would play out in practice. Both groups began the discussions whilst using an A1 flipboard to record the relevant information and attempt to come up with a structure for the related actions post-workshop. During this, P08 and P13 would be moving from one group to another to see how they were performing and offer guidance or answer questions. During O6, P08 and P13 explained the lead researcher whilst the team were working that the key purpose of the session was mainly to get the team talking to each other and to set an opportunities culture going forward, not just to review the opportunities. After the teams had completed their tasks, they presented their work to the rest of the team, again making use of interaction from the other team members for clarity. The light-hearted feel was maintained right up to the end of the sessions, as per the following extract from O5: *P13 wrapped up, asking, "everyone comfortable with what we've gone through today? Useful? Worthwhile?" People were agreeing, and P13 jokingly asked if the lunch was better than the previous in-person meeting, which they joked about saying this was better as it had chips*. Overall, the opportunities workshops demonstrated the development of cost reduction solutions as driven by a behavioural culture that effectively balanced professionalism with comfortability. These episodes were representative of this culture engrained into both the lead and wider project team.

The next key practice in the development and assessment stage were what we term *doing* activities. This refers to the tasks and roles that were directly working on particular cost reduction solutions. Rather than describing the everyday activities of participants, which could range from P15's work on creating a database of scheduling programmes to P02's selection of the specific modularisation solutions, we discuss the development of a specific cost reduction opportunity. This was an optimised crane setup involving coordination of several participants.

It began with an optioneering process, with P06 having initially asked their partner (who specialised in lifting equipment) to produce them a lifting strategy, before they agreed on the best option. They spoke to other project managers regarding any issues with cranes currently used on the site, and found that productivity was lower with the existing crane approach because they were too large and thus were being regularly "*winded off*" [P06]. Upon selecting the strategy proposed by their partner, they developed the detail behind it, including P01 and P02 scheduling the solution as well as further meetings with the partner. Upon producing verification requirements for a simulation model of the crane solution, P02 described how they utilised a storyboarding approach, having seen it work effectively on a previous project. This method allowed them to visualise how the related commissioning progressed, whilst being underpinned with a more granular breakdown of resources and documentation.

In contrast to the doing activities, the hands-off activities were conducted by almost all members of the lead project team since they were mostly in managerial positions, meaning they had their own separate team for which they would conduct these guiding and advisory activities. However, these activities were primarily conducted by P08 and P13 since they are in the senior-most positions in the team. An example we use for P08 relates to the modularisation strategy. As we looked at previously, P08 had to convince the team – particularly P04 – of the value that modularisation could bring for cost reduction. Therefore, once P08 got buy-in from all of the team, their role here transitioned from one of proposal and initial development of the solution to getting the team to conduct the detail development of the solution (i.e., the specific form(s), suppliers, amounts, etc.) and advising and challenging where necessary. For instance, P08 describes how they had a review with the members working on the solution, and they questioned why a particular approach had not been considered. This formed a discussion that revealed the team had missed something crucial and so had to revise the solution. Once this has been revised, P08 would approve the solution and conduct

facilitation-based roles such as coordinating with subcontractors for the installation of the modularised units. Similarly, P13 describes how, though they do not involve themselves in the buildup of the schedule, they make sure that they are always a part of the quality assurance: "*when the [team] presented the schedule, I test and probe and prod until I'm happy basically… I'll put the challenge in, but if it comes back with a robust answer, that's it – I don't dictate.*" Therefore, these sorts of activities may appear too detached from the cost reduction solution to be worth recognising – as P08 humorously puts it, "*the role of the project manager is everybody else takes the credit and you take all the flack!*" In fact, these activities are vital to the development of cost reduction solutions. Without them, it would be easy for the solutions to go off track and potentially have the opposite effect on the project's cost. These activities steer the team in the right direction and so are at the heart of effective cost reduction practice.

Finally, getting input from partners was particularly key in this development stage. Once again, all project team members utilised some form of partner input since it was set out under the contract and continually encouraged. By way of example, we look at a situation described by P06, in which the solution discussed is use of a rebar fabrication workshop on site to reduce material cost and installation time. They detail the development of the opportunity through having a dialogue with their partner:

> "*[It began with] engagement with [our partner], and they had delivered it previously on [the site], and they said they'd been given use of a facility to prefabricate rebar, and it worked really well for them. So there was this building that had been, not condemned, but nobody was really managing the building, weren't aware of the condition etcetera. So we looked at the site layouts, looked at the location of the building, looked at what the facility was, and took that into site establishment – package manager [P07] had asked them to include that as part of site establishment and get the service car out, and*

getting the actual building workable because I want to use it for the construction phase…"

After this, the project's partners had conversations on how interfaces would align in order for the facility to be utilised effectively. Consequently, this became a key cost reduction opportunity on the project. Therefore, for partners to input effectively, as P06 recognises, "*it's actually speaking to [our partner] and understanding what would work best for them*," not just telling them how the project will run. It demonstrates that cost reduction relies on openness and flexibility in discussions about how the project will be delivered.

4.2.3 Implementation and improvement of solutions

The last part of the cost reduction process was the implementation and improvement stage. This stage of the cost reduction development process loops back to the proposal stage, as it is not just about how, for instance, baselines were updated and controlled or digital tools were used for record keeping purposes, but how improvements were made and also how stakeholders were kept informed. To demonstrate the improvements, we look at an example about how a particular ring beam solution underwent significant development – and was even one of the opportunities being developed in one of our observed workshops – but was found to be fraught with more risk than a thin slab, as P08 describes:

"*The challenge I said to the team was, I said, "I don't want you to just focus on cost and time. I want you to focus on causational risk output, so what are the causational risks from us taking each of the choices?" And then you need to weigh up four different things, so the causational risk outputs, your cost, your time, and your conventional safety impact, whether that be positive or negative, and the team ended up on the thinner slab. Both were technically fine, but the thin slab was less risky, even though it didn't have the same savings as the others in terms of cost and time – it was marginal*

– but the risk impact from [the] ring beam solution was far greater than the total risk impact of the thinner slab."

This extract shows that it is necessary to constantly seek improvement, even upon cost reduction solutions. It shows that the focus needs to be not only on the potential saving of the solution but also the associated impacts if it goes wrong, especially for important pieces of scope like substructure. Moreover, if this was not requested by P08 and then assessed by the team, the negative impact it could have during delivery would far outweigh the additional time spent by the team on its risk analysis during planning. Therefore, the message here is to not take a cost reduction solution at face value and to instead dig into the detail.

In terms of keeping stakeholders informed in the implementation and improvement stage of cost reduction solutions development, the project team members continually liaised with stakeholders. As an example, we look at how P13, as project director, discusses the influence that key stakeholders (particularly the client) can have on the project and thus what they do to manage their influence: "*The main thing I've done in this area is sell the positives that we're trying to do as a project, that we're following industry best practice, we've learned from our mistakes from the past, the robustness of the estimate, etcetera, and give stakeholders confidence that there's no intervention required.*" They described their role previously as one of protection, i.e., maintaining the team culture by preventing poor behaviours from entering the project. This is an important practice within the cost reduction solutions development process, as it closes the loop – we highlighted in the setting up stage of the process the establishment of cultures, and this culture maintenance ensures the effort put in in the beginning is not wasted.

4.3 Cost reduction solutions in the case project

Having detailed the practices of cost reduction, we can now take a process-based approach to summarise the cost reduction solutions of the case project that the practices made possible. We have split this into to two: cost reduction enablers and cost reduction methods. The enablers for cost reduction take place prior to the methods, as these are the solutions that have to be built into the contract for the cost reductions to actually be made. They include: a collaborative contract, early engagement of partners, having a competent, professional, and cohesive project team with a collective mindset, and having a client that is open to change and has a realistic view of cost reduction. The cost reduction methods are those solutions that were able to be enacted based on the enablers. This revolved entirely around opportunity management, which led to strategies for reducing the schedule and reducing complex work. Schedule reduction methods included: modularisation, overlapping, optimising installations or materials; onsite workshops or stores (using an existing facility), to have more manufacturing-based efficiency; technology, to improve efficiency of paperwork, communication, and equipment; and optimising labour shift patterns, to offer overtime to travelling labour. Methods to reduce complexity included: requirements management and optimised installations or materials (specifically including an optimised crane setup to remove existing problems with larger cranes on the site and a slab depth reduction to remove working at height difficulties).

5 Discussion

In this work, we paint a picture of cost reduction in complex projects, bringing to light the seemingly insignificant practices that may ordinarily go under the radar (Blomquist et al., 2010; Hällgren & Söderholm, 2012) to show that cost reduction in planning is built up of practices that are enacted and created on a daily basis. We show that cost reduction is a proactive, strategic process undertaken by project team members in planning, rather than a reactive

process that occurs during execution as a result of poor planning or execution. This effort to make cost reduction possible goes deeper than current understanding. Prior research lacked the necessary depth and practice-based insights for cost reduction methods to actually be implemented, either by being too high level (Bayraktar et al., 2011; Gharaibeh, 2014) or list-like, prescriptive, and too specific without a situational understanding (Olawale & Sun, 2010). Our presentation of the practices involved in setting the project up for cost reduction, developing the cost reduction solutions, and implementing and improving the solutions was the missing piece of cost reduction research. In summary, our findings demonstrate that cost reduction in planning happens because a string of interconnected practices occur. It is not a given – something that projects *have* – but rather something project teams *do* (Whittington, 2006).

It is also important to recognise what this work means from a wider perspective. As we outlined in Section 2.1, cost reduction within a project has an impact outside the project. Our findings showed that project team members recognise how reducing the cost of their project made funding available for other projects, such as a hospital or school. The reduction of cost is therefore not just important for the project team's recognition or for project stakeholder satisfaction. Rather, the proactive, everyday practices of project team members in planning to reduce cost have an enormous impact on society and thus future generations – *this* is what makes these ordinary practices significant (Blomquist et al., 2010; Hällgren & Söderholm, 2012).

Aside from the lack of practice-based insights in previous research, it also does not signify the particular personnel who are best equipped to perform cost reduction. The only related contribution previously made was that the proposed cost reduction solutions may be particularly useful for less experienced practitioners (Olawale & Sun, 2010). In contrast, this

research shows that there are different roles involved in practicing the solutions, described as follows:

- The project manager's and director's roles primarily entailed oversight, guiding, challenging their team (regarding both proposed solutions and the accuracy of cost estimates and reductions), engaging stakeholders (owner, partners, and relevant governmental and regulatory bodies), setting an opportunities culture, and proposing solutions for the lead project team to develop.
- Package managers were required to develop the detail behind specific cost reduction solutions for each key work package, for which they held similar roles to the project manager and director in relation to their own teams.
- Other roles included a cost engineer, commercial manager, and information manager, each of which conducted to support the development of the cost reduction solutions.

Aside from the theoretical contribution this holds, cost reduction becomes more tangible for practitioners – it acts as a toolkit for the implementation of cost reduction, rather than a list of solutions with limited practical significance. In the remainder of this discussion, we zoom out of the case project to see how our findings translate in a wider sense.

To understand what our findings mean for future cost reduction practice, we can view the case at both the project and individual levels. In terms of the project level, one of the main findings was that there was a close relationship and mutual understanding between the project team and owner, as well as involvement of partners to utilise the buildability expertise of partners from the outset. This allowed the cost reduction solutions to be realised, developed, and implemented as effectively as they were, thus supporting a collaborative principal-steward approach to contracts to achieve cost reduction (Suprapto et al., 2016; Turner, 2022). Therefore, project teams should make use of this approach for complex projects. However, it is worth noting that in our case project, the owner was actively striving towards improved cost

estimation through a newer, more collaborative contract model. This is potentially unachievable for clients that are less competent, more resistant to change, or opt for traditional contract approaches (Müller & Turner, 2005).

At the individual level, the team members' effective behaviours and hence good relationships with each other were critically important. They were able to develop and maintain a culture of honesty, communication, challenging each other, and opportunities realisation. This culture was a driving force behind cost reduction, and so regular in-person interaction – as well as in opportunities workshops (Hietajärvi et al., 2017) – is essential for practitioners to educate one another, improve relationships, set a collective vision and mutual values, and, thus, create a culture (Denicol et al., 2020; Scott, 2014). A focus on opportunities has been advocated as essential for cost reduction and reduced complexity (Hietajärvi et al., 2017). Like Marsov et al.'s (2024) identified enablers for opportunity management, we found that early involvement of partners, stakeholder management, and the use of technology were also fundamental enablers for cost reduction. One aspect that played in the team's favour was its size, it being a major project with close to 100 project team members. This diverse range of experience and expertise meant cost reduction opportunities were able to be realised more thoroughly than for a smaller project (Denicol et al., 2020).

6 Conclusions

Despite the importance of cost reduction to complex projects, the knowledge of how it actually gets done in the planning stage of projects is limited. This knowledge is key to helping project teams understand the day-to-day of proactive cost reduction and, in doing so, provide value for money to the taxpayer. Thus, utilising a project-as-practice theoretical lens (Blomquist et al., 2010; Hällgren & Söderholm, 2012), we sought to identify the practices of cost reduction in

the planning of complex projects. We employed a single-case study of a UK major NDP, thematically analysing 16 semi-structured interviews and eight direct observations.

We show that cost reduction is not just an outcome, but a process built up of many practices that lead to this outcome. In an effort to understand the actuality of cost reduction (Cicmil et al., 2006), we present two key stages of cost reduction. The first describes how the project is set up for cost reduction. Practices here referred to: use of a collaborative contractual approach that benefits the project rather than individual parties, having a mutual project team culture where members have the desire to reduce cost and work as a cohesive team, and having a mutual understanding with the client to ensure they understand realistic cost reduction. The second is the development of cost reduction solutions. This is split into proposal, detailed development and assessment, and implementation and improvement of solutions. The proposal phase is about team discussions to resolve issues, challenging other team members to ensure the solution is achievable, and discussions with partners to determine who is best suited to deliver the solution. The detailed development phase refers to opportunities workshops to discuss the solutions and underpin them with relevant data, "doing" roles that actively progress the development of solutions, "hands-off" roles that ensure the doers are staying on track, and getting partner input to assess buildability of the solutions. Lastly, the implementation and improvement phase relates to how baselines and other systems were updated, how solutions were reviewed and consequently improved to better cost reduction, and how stakeholders were kept informed to prevent potential disruption. Based on our findings, our key practical recommendation for (a) organisations is to adopt a collaborative principal-steward contractual approach as to create an aligned vision and (b) project teams is to set a culture of collaborative behaviour, openness, clear communication, and opportunity management. Taken together, these can reduce the cost of delivery of complex projects. These recommendations are not solely for NDP teams since these cost reduction practices are not NDP-specific.

In terms of limitations, though our findings are transferable, the single-case study approach is naturally bounded by context and case-specific dynamics, therefore, some suggestions for future research are as follows. First, it is important to progress the understanding of practices in projects, particularly in regard to the specific cost reduction solutions identified in this paper (e.g., opportunity management, early engagement of partners, etc.) as the aim of these solutions is to actively seek value in projects. We recommend this because current practice-based research tends to be focused on understanding how things get done simply to develop the field of project practices, but it is also the researcher's duty to aim to improve the value delivered by projects, not just the practitioner's. Second, a case study of a project where the client is not as closely involved could develop knowledge of how cost reduction practice looks for less collaborative contracts. Third, a multiple-case study could allow for comparisons and benchmarking of effective cost reduction practice across projects. Another interesting avenue would be to explore how to optimally reduce indirect costs; our work focused on direct cost, and so aspects such as overheads are not factored into our findings.

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