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The 'context' of transport project cost performance: Insights from contract award to final construction costs

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ABSTRACT

Despite the plethora of studies examining the cost performance of transport projects, we still do not *fully* understand why they exceed their agreed price for construction. A lack of an in-depth exploration of context has contributed to this lack of understanding. In this paper, we seek to provide a context as to why the construction costs of transport projects experience increases from their contract award. We adopt sense-making approach, which is qualitative in nature, to examine the performance and financial reviews for eight transport projects constructed by an Australian contractor. The reviews are checkpoints undertaken during the construction of projects to monitor actual costs and forecasted profits for the contractor. The reviews are performed at the 50% and 75% milestones of a project's forecasted schedule by a team independent from the contractor's organization. We look into context states of projects such as their programme, quality, safety, design, and management. We use a context breakdown structure to uncover the 'contexts within contexts' that significantly contribute increases to construction costs. We reveal that the mean forecasted contractor margin was almost 9%, which reinforces the belief that there is a lack of competition in the marketplace. Overall, the hierarchy of contexts within contexts we unravel provides further understanding as to why transport projects experience increases in their construction costs. Considering the nature of the recurring contexts that we identify, we recommend that governments recalibrate their approaches to procuring their transport projects. We suggest that they embrace negotiated contracts, alliance contracting, leadership and resourcing strategy, and work toward establishing a generative culture in the projects they procure.

1. Introduction

1.1. *"Knowledge without understanding is useless" Thucydides*

Transport infrastructure projects are prone to significant cost deviations during their construction (e.g., Love, Sing, et al., 2019; Odeck, 2004; Turró & Penyalver, 2019). However, despite the accumulation and application of a wealth of knowledge to curb increases in construction costs from a project's contract award, cost underperformance remains a problem worldwide for the public and private sectors alike.

Australia, the geographical context of this paper, is not an exception (Terrill and Danks, 2016). For instance, let us consider some of the issues that have plagued the Sydney Light Rail Transit (LRT) system. In October 2015, when work began, the construction cost was expected to be AU$1.6 billion. Due to the unforeseen costs associated with locating and moving utilities and a contractual dispute between the New South Wales (NSW) state government and the consortium's contractor, the project cost has increased to AU$2.7 billion (Wiggins, 2018; Wiggins & Ludlow, 2018; Sas, 2019). For onlookers, this cost increase is akin to *Groundhog Day* as a similar scenario played out during the construction of the Edinburgh Tram System in the United Kingdom (UK). Local businesses in Sydney have experienced massive disruptions, losses in

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revenue and even bankruptcies like in Edinburgh to the point that they launched a class action against the NSW state government (Fellner, 2019).

There is a general belief amongst Sydneysiders that the LRT project mirrors the *folie de grandeur* that was embedded in the mindset of promoters for the Edinburgh Tram System (Miller, 2014; Voumard, 2018). A case in point, despite the expectation that the decision to build a transport asset in Australia rests on a rigorous investment and planning process,[1] "none of the 26 possible routes – including the one chosen had a cost-benefit ratio of 0.8" (O'Sullivan, 2018). In light of this low cost-benefit ratio, the project should not have gone ahead, and the construction consortium should not be the sole to bear the blame for cost increases.

The peculiar context surrounding the Sydney LRT project may help understand why it is exceeding its planned cost. Indeed, the project management literature recognizes the 'power of context' (Engwall, 2003), which whether it exists within an economic, political, legal, geographical, historical, socio-cultural, environmental, institutional or managerial environment, matters for transport project cost performance (Hertogh et al., 2008; Gil & Pinto, 2018; OMEGA, 2012). However, there has been a lack of an in-depth exploration into the multiple and interdependent layers of context and their influence on the cost performance of transport projects, not to mention research using primary data. Rather, studies tend to rely upon the use of secondary datasets to generate econometric and statistical models that notably eschew context (e.g., Catalão et al., 2019; Cavalieri et al., 2019; Moschouli et al., 2019; Turró & Penyalver, 2019). This is the gap that this research aims to fill, as the prevalence of 'appeals to context' juxtaposed with the absence of a profound 'exploration of context' may lead to a lack of understanding of what transpires in organizational settings, which may hinder policy-making.

In this paper, we define cost performance as "the extent of monetary deviation from the price agreed at contract award with a contractor and settlement of the final account (i.e., final contract sum) (Love, Sing, et al., 2019, p. 3) and thus conjecture that construction costs may result in increases or decreases. Against this backdrop, we ask: *How can we make sense of the varying and interdependent contexts that reside and interact with one another that result in construction costs increasing in transport projects?* The aim of this research is therefore to highlight the hierarchy of contexts that result in cost increases from contract award to final construction costs (i.e., at the coalface of construction) of transport projects. We focus on cost increases that arise in projects as they can negatively impact the profitability of a contractor (profit margins), a government's project portfolio (opportunity costs such as delays or cancellations of other projects) and taxpayers (value for money). We provide a context to prevailing knowledge and thus seek to make strides toward improving the cost performance of transport construction projects in a way that would benefit both the public and private sectors. In so doing, we consider the often overlooked yet important role that a government's procurement policy can play in mitigating increases in the construction costs of transport projects.

To this end, we use a case study approach to make sense of the periodic performance and financial assessment reviews undertaken by a construction organization during the delivery of their projects. In essence, the reviews are checkpoints undertaken during the construction of projects to monitor actual costs and forecasted profits for the contractor. The reviews are performed at the 50% and 75% milestones of a project's forecasted schedule by a team independent from the contractor's organization. From the insights and knowledge, we garner from our analysis, we provide a much-needed context for governments to understand and make sense as to why costs tend to increase during construction. In doing so, governments will be better positioned to recalibrate their policy initiatives and foster new procurement practices. To facilitate the process of re-calibration, we propose several policy initiatives that can be embraced by governments to improve the performance of their transport projects. We commence our paper by explaining the (understudied) need for context in cost performance research.

2. The 'context' of transport project cost performance

Examples of studies that have examined the importance of context in transport projects include the OMEGA 2 and NETLIPSE studies (Hertogh et al., 2008; OMEGA, 2012). While these studies celebrate the 'power of context', they do not explore the varying and interdependent contexts within which cost increases during construction. Unsurprisingly, the challenge of understanding context has flummoxed researchers and practitioners alike (Kovala, 2014). As Davidoff (2019) notes, "limited understanding of context therefore limits understanding of both the fundamental principles of improvement and the actions that put improvements into practice" (Davidoff, 2019, p. 1).

Research focusing on the cost performance of transport projects has considered varying contexts such as geographical location (Terrill & Danks, 2016; Welde & Odeck, 2017); project types (Odeck, 2004; Flyvbjerg, 2016); and procurement methods (Flyvbjerg, 2016; Liu et al., 2018). Moreover, different perspectives prevail in the literature: decision-makers (Flyvbjerg et al., 2018) versus contractors (e.g., Love, Sing, et al., 2019) or governance (Flyvbjerg, 2016) versus project management paradigm (Ika, 2018). These contrasting perspectives have resulted in different strategies for curbing cost increases namely 'de-biasing' estimates or project management 'best practices', which, we contend, are akin to one-size-fits-all approaches that would work for all projects, irrespective of the surrounding context (Ika, Love, & Pinto, 2021).

While there has been a prevalence of appeals to context, rarely has there been an in-depth exploration into how it can explain the occurrence of cost increases in transport projects (Dohn et al., 2018). The literature suggests that unresolved issues with the design of an asset such as head contract variations (e.g., scope changes), poor quality documentation (e.g., errors and omissions) can result in cost increases (Li & Taylor, 2014; Parvan et al., 2015; Robinson-Fayek et al., 2004). Moreover, rework constitutes a significant factor that can increase construction costs, reduce a contractor's profitability, increase quality, and jeopardize safety. For example, on average, rework can increase the construction costs of transport projects by 12% (Li & Taylor, 2014) and reduce a contractor's profit margin by as much as 30% (Love et al., 2018). While the transport literature understandably appeals to context for a better understanding of the relationship between unresolved issues in the design of an asset and rework and cost increases, without a deep exploration of context, the above insights do not tell the whole story. A closer look at the context surrounding rework however suggests there is a recursive relationship between quality and safety. Thus, construction organizations have tended to devote fewer resources to managing quality in their projects as they focus on ensuring positive safety outcomes. This situation has arisen as a result of legislative requirements and demands for safety being imposed on construction organizations (Love et al., 2018).

By understanding the context within which cost increases materialize, we may make headway to solving this "long-standing puzzle" (Gil & Pinto, 2018, p. 717). We submit that cost increases in projects

[1] In most states in Australia this process comprises: (1) strategic justification; (2) investment decision; (3) funding decision; and (4) tender evaluation. When infrastructure asset is of strategic significance to Australia, then Infrastructure Australia a statutory body will assess its financial viability and benefits to the economy and community and then make a recommendation to the Federal Government as to whether it should receive funding. Details can be found at: https://www.infrastructureaustralia.gov.au/. We need to acknowledge that business cases may contain errors and may also be 'cooked' to ensure a project stacksup. It is imperative that independent third parties review and evaluate the business case.

constitute a context-dependent phenomenon that comprises layers (e.g., demand-driven, limited competition, and adversarial procurement). Thus, we suggest without a clear understanding of these layered contexts and how they interact with one another within the broader context, our ability to provide a profound explanation for why cost increases occur will be stymied (Brown, 2010; Dohn et al., 2018). Put differently, we will not be able to acquire a deep understanding of cost increases without understanding "the hierarchy of contexts within contexts" (Bateson, 1972, p. 408).

2.1. Conceptualizing the context of cost performance

Two distinct approaches for explaining deviations in the cost performance of transport projects stand out in the literature (Love, Sing, et al., 2019). The 'project management' perspective, which suggests that the underlying cause of cost deviations in projects is attributable to errors in strategic, tactical and operational decisions made by senior or lower management. As a consequence of these managerial decisions, pathogens are created, which can lay dormant within a project until an error materializes. Mostly, decision-makers are unaware of the impact their decisions, practices and procedures can have on a project's performance. Thus, how organizations process information influences the way they manage risk (Love et al., 2016). The contrasting 'behavioural' perspective instead proffers that it is not error but bias and in particular the Planning Fallacy (i.e., optimism bias and strategic misrepresentation) that provides the 'best' explanation (Flyvbjerg, 2016; Flyvbjerg et al., 2018). In this instance, the cost of a project is almost always underestimated, revenues overestimated, environmental impacts undervalued, and development effects overvalued.

Noteworthy, the project management perspective acknowledges that optimism bias and strategic misrepresentation may be present in projects, but they are not the sole causes that contribute to increases in construction costs. The fundamental point of departure between the aforementioned approaches lays with the points of reference to determine a project's cost increase. In the case of the behavioural perspective, a project's cost overrun is determined between the decision to build and final construction costs. Conversely, the project management perspective refrains from using the term cost overrun as projects can also experience underruns. Thus, the term cost performance (increase or decrease) is used (e.g., Love, Sing, et al., 2019, 2020).

While there have been several calls to acquire an understanding of context in project management, there remains no consensus on its definition. As Dohn et al. (2018) note, the notion of context "is far from clear. Often, it is left unanalyzed and taken for granted. Sometimes, it is prefixed with an adjective such as 'historical', 'cultural', 'social' or 'national'" (pp. 1–2). We suggest this is the case in cost performance research where we often come across research that implies the role of context but does not explicate what it means.

Consider, for example, the behavioural perspective where context is, sometimes, prefixed with the adjective 'geographical' to examine cost increases in different continents (Flyvbjerg, 2016). In this instance, we are not provided with any context about the different geographical regions in terms of their governance, decision-making and project management processes, technologies, procurement methods, legal systems and environmental regulations, which all can influence a project's cost performance (Love & Ahiaga-Dagbui, 2018).

At this juncture, we would also like to point out that the "intermediary conditions and events" used to support the causal claim of behavioural bias as the root cause of cost increases suggested by Flyvbjerg (2016) and Flyvbjerg et al. (2018) have not been ascertained and, as a result, "a chronological lacuna exists between the initial event and the outcome" (Love et al., 2012, p. 569). Thus, facts are unable to be "waved, analyzed and contextualized" (Livni, 2017). Moreover, there is an absence of a narrative that reflects the actual practice associated with delivering transport projects in a specific context. Thus, a gap between knowledge and understanding of context exists, as the cause-and-effect relationship for the behavioural explanation to support cost increases in projects has not been empirically established from the decision to build to final construction costs, not to mention from contract award to final construction costs (Love et al., 2020). What is more, Flyvbjerg et al. (2018) did not consider how differing procurement approaches (Public Private Partnerships versus traditional design-bid-construct) influence the development of project costs estimates.

In this paper, we define context as 'the formal and informal setting in which a situation occurs', which includes its economic, political, legal, geographical, historical, socio-cultural, environmental, institutional or managerial circumstances and/or the continual unfolding interaction between the situation and the setting (Brown, 2010, p. 7). Indeed, the project management literature differentiates between the *existing* or *initial* context or the set of circumstances that prevail "in advance of the project" and the *emerging* or *unfolding* context or what happens "in the wake of the project" (Hirschman, 1967, p. 146; Ika & Donnelly, 2017, p. 45).

The existing context holds a 'functional feature' or a 'supplementary role' in that it is often 'brought in, or added to' the understanding of a project or in this case its cost increases. This context provides the circumstances prevailing before the start of the project or the initial 'conditions' without which it might not be possible to adequately or fully understand cost increases. Put simply, the existing context *completes* the conditions for understanding cost increases. While these conditions may be part of the context, they remain a source of considerable 'confusion' surrounding the notion of context, as authors do not explain how a cost increase 'co-determines' which of the economic, political, legal, geographical, historical, socio-cultural, environmental, institutional or managerial circumstances (or prefixes) are relevant *completing* aspects of context (Dohn et al., 2018, p. 4).

A context "is not a neutral layout of things or properties near the focal object, nor it is a set of circumstances or an indefinite "background". It is ordered and organized by its relations to the focal object. The context is determined and is determined by the object" (Dohn et al., 2018, p. 4.). Therefore, the above prefixes "remain vague precisely because they appear to overlook" yet another functional feature of context: "a context is *determined relative* to the focal object [project/cost increases]" (Dohn et al., 2018, p. 4). Put differently, the emerging context captures interactions over time. It thus represents the continual unfolding interaction between the situation (i.e., cost increases) and the context (Brown, 2010, p. 7).

Therefore, the context of a project's cost performance is both existing and emerging, initial and unfolding, or static and fluid, having significant repercussions for their comprehension. This mirrors the double metaphors of container and rope used to depict the relationships between context and the focal object. The container metaphor suggests that context is the 'out there' setting or an outer container or shell inside which the figuration of the situation (i.e., cost increases) occurs. In contrast, the rope metaphor highlights the continual unfolding interaction between the situation and the setting and speaks to the co-constitution of the becoming situation and its emerging context, much like strands are part of a rope and "become what they are through their combination and interaction" (Dohn et al., 2018, p. 5). As noted earlier, context exists or emerges within a hierarchy of settings (Brown, 2010, p. 4). Accordingly, we refer to this as a 'context breakdown structure', which includes different layers of contexts (i.e., states, substates, and features) that can be used to understand the nuances of its influences and how it is "played out" in a project (Dohn et al., 2018, p. 2) in order to explain how cost increases materialize. Cost increases, therefore, occur in a series of hierarchical contexts. The absence of which, however, has foiled governments and therefore their capacity to engage and enact a learning process (Love et al., 2016).

As we focus on the cost performance of transport projects, we turn our attention to context states such as programme, quality, safety, design, and management circumstances, which form key parts of the overarching organizational context we examine in this paper.

Noteworthy, increases in construction costs in transport projects not only adversely impact a government client but also their contractors. Thus, understanding this context is pivotal for making strides to developing robust policy decisions to ensure both clients and contractors are not subjected to unnecessary additional costs (Love, Ika, et al., 2019). In what follows, we identify, through a case study of several transport projects, the hierarchy of contexts within contexts that shed light on their cost increases at the coalface of construction.

3. Research approach

To address our research question, we utilize a case study approach that draws on the concept of *sense-making* to develop a rich understanding of the context surrounding why and how costs can increase during the construction process of transport projects. The sense-making lens is often associated with research that is interpretive, social constructionist, and phenomenological (Brown et al., 2015). While there is no single theory of sense-making, many researchers use it as a qualitative methodological approach to study how people understand (i.e., make sense of) what happens in organizational settings. We adopt Weick et al.'s (2005) view that describes this process as a way whereby people "people organize to make sense of equivocal inputs and enact that sense back into the world to make it more orderly" (p.410). Thus, actors may "extract cues and make plausible sense retrospectively, while enacting more or less into ongoing circumstances" (Weick et al., 2005, p. 409). As such, sense-making is a retrospective activity; we act upon our understanding of the present based on what has transpired in the past. Without a grasping of this particular context, we cannot learn from the cost performance related contextual issues that impede a contractor's ability to deliver projects in accord with their forecasted cost. By adopting a sense-making approach in our empirical research, we aim to turn "circumstances into a situation that is comprehended explicitly in words and that serves as a springboard into action" (Weick et al., 2005, p. 409).

3.1. Data sources

The research focuses on transport projects delivered by a 'Tier 1' Australian construction organization. 'Tier 1' construction organizations are the largest contractors that have the capability to deliver major and significant infrastructure projects. For anonymity and commercial confidentiality purposes, we are unable to present specific details about the organization and the final contract sum. We have, however, been working with the organization for several years on several related research projects. The selected projects were based on data availability, as the lead author had been examining quality-and safety related issues in these projects. The selected contexts that we present are framed in accordance with the reporting requirements of the construction organization. From the lead author's experience of working with Tier 1 contractors in Australia, the contexts used for undertaking performance and financial reviews as a project's progresses are similar, making the findings of this particular case study transferable to other organizational settings inside and outside Australia. Markedly, "most construction organizations mimic each other practices so that no competitor has an overwhelming strategic competitive advantage in the respective market places. The downside here is that established rules and norms of the organization-project dyad are, rarely, if at all questioned" (Love et al., 2018, p. 1114).

While each month's valuation of work completed is undertaken juxtaposed with a series of safety and quality reviews and the like to monitor progress, performance reviews are undertaken for the planned 25% and 50% schedule milestones to examine progress related issues, cost, and margin. Then financial assurance reviews are completed at the 75% schedule milestone to determine the costs to complete and assess the project's ability to meet their forecasted construction costs and margin. In this paper, we focus only on the 50% and 75% schedule milestones, as during the first 25% of work to be undertaken the focus tends to be on site establishment and mobilization, preparation and groundworks. Fig. 1 provides an overview of the timescales used to review a project's status, which is akin to performing a 'health check'. This timeline is crucial for unravelling the emerging context surrounding the cost performance of construction in the projects.

4. Research findings

We present a summary of the transport projects that we examined in Table 1. The sampled projects varied in their type, contract type, size, and duration. The sample comprises transport projects with significant contract values (i.e., AU$131 to AU$529.2 million). The mean forecasted margin as a proportion of the original contract value (OCV) was 8.94% for the sample of projects with a standard deviation of 8.88%. In the next sections of this paper, we provide an overview for the 50% and 75% schedule milestones and then explain with reference to the material contained in the reviews why construction costs deviated from their contracted value.

By engaging in informal discussions with the governance team and examining the reports provided, we were able to garner an understanding of the contextual issues confronting contractors at the coalface of construction. The contractor provided access to a series of performance and financial reviews for eight projects that provided us with insights about their cost performance at a specific moment in time. The reports varied in length from 24 to 56 pages, which addressed areas such as: (1) management, organization and staffing; (2) client interface; (3) planning and programming; (4) design and engineering; (5) procurement; (6) construction; (7) industrial relations; (8) environmental management; (9) financial and contract administration; (10) completion commissioning and hand-over; and (11) risk and opportunities.

4.1. The 50% schedule milestone

We examined five projects at the 50% schedule milestone. There was some leeway between dates when the reviews we performed due to staff availability as the review team was independent of the project. At the 50% milestone, four of the five projects had forecasted that their final contract sum would increase. In the case of the marine jetty, a Design and Construct (D&C) contract was required to provide a guaranteed maximum price; the contractor, therefore, bore the risk for cost increases. This project, however, along with the highway upgrade, showed signs of distress at this point. Both had only completed less than 20% of their build costs but had expanded almost to 50% of the planned programme. The forecasted margins had fallen from 10.1% to 5%, and 7.58%–5% for the marine jetty and highway upgrade projects, respectively. For the remaining three projects, the forecasted final margins had increased as a result of head contract variations that had been sanctioned by their clients (i.e., state government).

4.2. The 75% schedule milestone

All three projects examined at the 75% schedule milestone were lump sum contracts, which had experienced cost increases from the OCV due to head contract variations. The forecasted final margins increased for the rail line stations project from 8.7% to 9.8%. Contrastingly, a decrease from 8.02% to 6.08% was incurred in the highway and bridges projects. Alarmingly, however, the highway experienced a cost increase of 20% from its OCV and reported that the project would incur a significant financial loss at completion (i.e., AU$48.5). Of the 20% cost increase, 12.47% was attributable to head contract variations.

4.3. Making sense of cost performance: understanding the contexts

To better understand the nature of the cost performance for the eight projects presented in Table 1, we draw on the recurrent issues that were impacting them at their specific milestone points (Figs. 1–6). While this

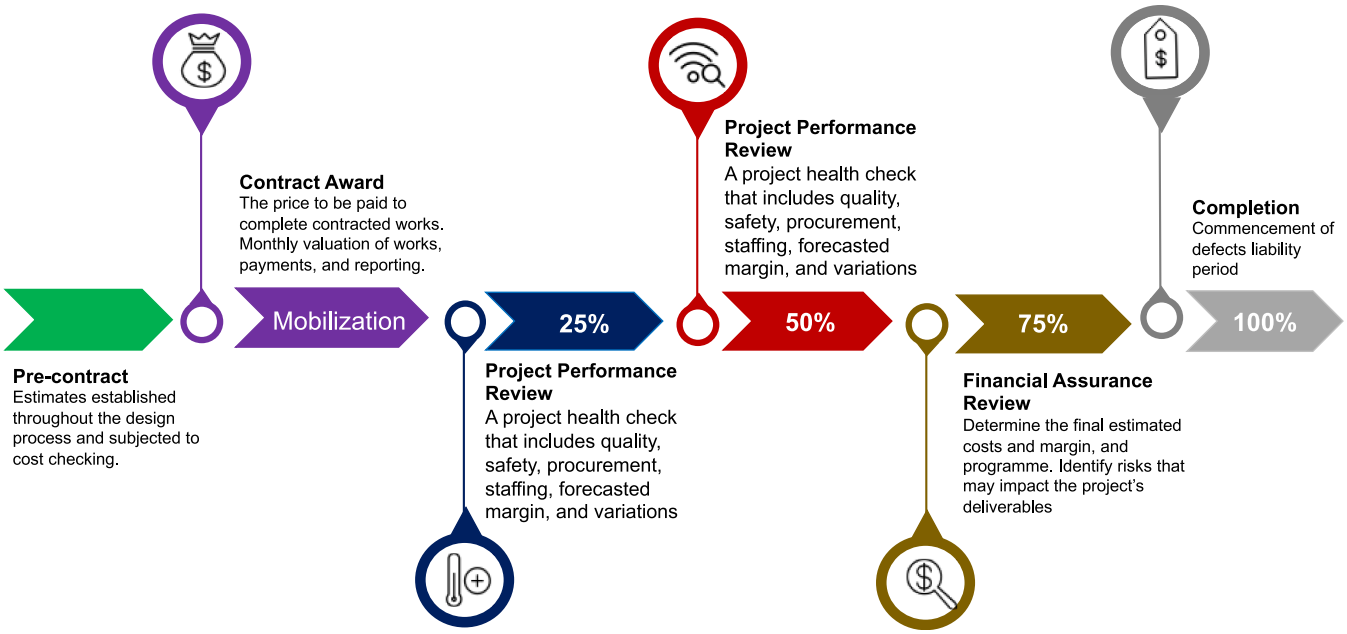

Fig. 1. Timeline of reviews in projects.

Table 1
Details of transport projects reviewed.

Project Type	Contract Type	Duration (Weeks)	Original Contract Value ($000′m)	Forecasted Final Contract Value ($000′m)	% Dif.	Original Margin ($000′m)	Forecasted Final Margin ($000′m)	% Dif.	Variations ($000′m)	% Complete by Time	% Complete by Cost
Marine Jetty for Mooring and Berthing[d]	Subcontract Design & Construct	68	99.9	99.9	–	9.8 (10.1)[c]	5.0 (5%)[c]	**−48**	–	50	17
Berthing Facilities for Ferries and Ships[d]	Engineering Procurement & Construct	60	150.5	159.9	6.24	17.9 (11.8)[c]	22 (14.61) [c]	23	9.4[a]	50	53
Highway Upgrade	Schedule of Rates (with Quantities)	90	47.2	48.3	2.3	3.58 (7.58)[c]	2.36 (5%)[c]	**−34**	0.33[a]	46	15
Railway Station and Tunnels	Lump Sum – Construct Only (with fluctuations)	216	320	365	14	26.6 (8.31)[c]	28.5 (8.90)[c]	7.1	0.9[b]	52	70
Highway	Design & Construct (with Provisional Quantities)	120	131	144	9.9	10.5 (8.01)[c]	10.65 (8.12) [c]	1.42	6.8[a]	44	27
Highway and Bridges	Lump Sum -Fixed Price	156	152.8	183.8	16	12.2 (8.02)[c]	9.3 (6.08) [c]	**−24**	19.57[a]	76	79
Rail line and stations	Design & Construct (Lump Sum)	232	529.2	636.8	20	46.3 (8.7)[c]	52.1 (9.8) [c]	12.5	66[a]	64	70
Highway	Design & Construct (Lump Sum)	158	544	564	3.6	49.5 (9.0) [c]	−48.5 (-8.9) [c]	**−99**	19.68[a]	75	74
	Total	1100	1974	2201	n/a	176.38	81.41	n/a	122.68	n/a	n/a
	Mean	137.50	246.83	275.21	9.01	22.05 (8.94)[c]	10.18 (4.12)[c]	−20.12	15.34	57	50
	Std. Deviation	64.65	195.07	221.46	7.16	17.33 (8.88)[c]	28.70 (14.71) [c]	40.24	21.98	13	27

[a] Approved variations.
[b] Unapproved variations.
[c] Margin as % of contract value.
[d] Private sector client.

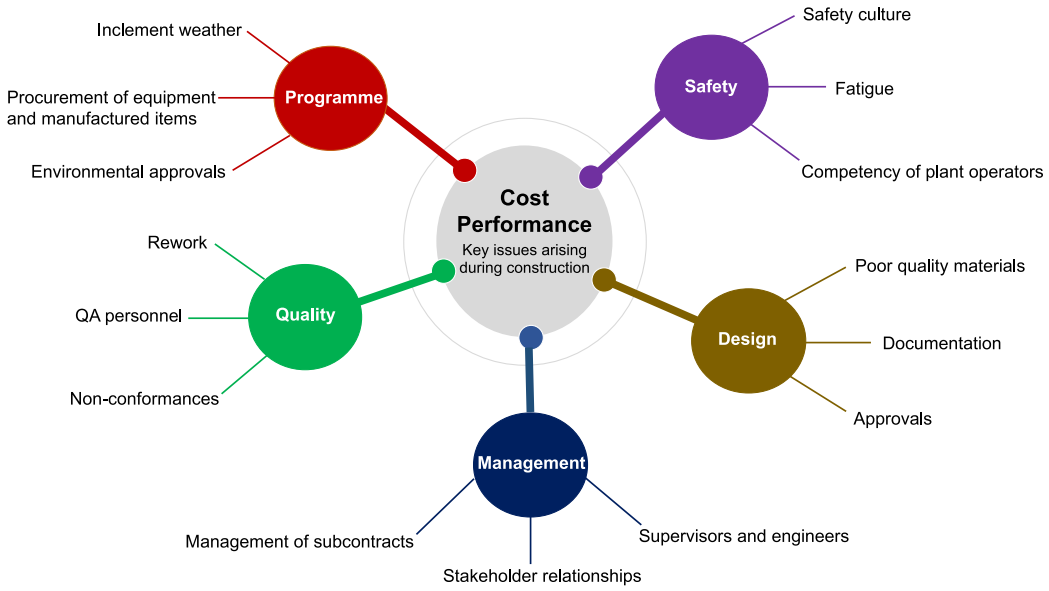

Fig. 2. Contexts within contexts impacting the cost performance of construction.

figure provides us with the knowledge, there is no context and, thus, it was not possible to enact understanding. Context is, therefore, provided as we bring to the fore the salient issues which were identified in the reports and impacted cost performance. In the Appendix Figs. 3–6 present the details for four selected projects.

4.3.1. Programme

There is often a disconnect within construction organizations between the personnel that prepares and submits a tender, and if successful, with those that are responsible for the project's construction. In general, the project team on-site will have had limited, if any input, into the preparation of a tender. However, for large transport projects, this may not be the case. In the highway upgrade project referred to in Table 1 and Fig. 3 in the Appendix, the site team had no input into the tender submission. The original tender had an allowance of 5% (i.e., a proportion of the schedule) for wet weather for the duration of the project. At the 50% schedule milestone, the site had delivered only 38% of work, and delays had been incurred. The client, however, willingly approved extensions of time, but the contractor had to bear the additional indirect costs, which adversely impacted their margin. The introduction of the report stated that:

> "The project appears to have been won at a price which has insufficient funds to it properly for the necessary duration and margin has already been written down to two-thirds of its award value".

The original programme had allowed five months for the gaining of approvals to commence works, but took seven and thus exceeded the original 'float'. As well as weather impacting the project's programme and costs, difficulties arose in sourcing materials as the local quarry could not provide the quantity of 'bridging layer rock' required for the road. This delay in obtaining the required rock was exacerbated further by the project's remote location. The project's location was identified as a concern as the staff was required one Saturday on, and two off. As a result, some staff was posing to be safety hazards as they were "driving up to 700 km one way to get home after working most of the day on a Friday and returning on a Sunday evening for Monday morning pre-starts" (see Fig. 5).

4.3.2. Quality

Non-conformances (NCR) were an on-going problem in all the projects we examined with many requiring rework at the contractor's expense, which adversely impacted the margins of their projects. In rail line and stations project (Fig. 6), for example, it was reported "out of the 54 NCRs raised to date 37 were still open, with the majority relating to concrete cracking (15). Attending to these issues will come at a significant cost". In the highway project identified in Table 1, which forecasted a loss of 48.5 million, poor quality was a significant factor contributing to their increased costs. Increased costs for the client were attributable to head contract variations. For this project, quality issues centered around pre-cast segments, which included:

1. Stressing ducts that were blocked with concrete slurry from leaks during casting;
2. Ducts cast in the wrong location;
3. Ducts or duct end boxes being located correctly but had deviated by an angle from the required duct centreline; and
4. Bony concrete.

The off-form finish on the piers, for example, had stains and surface discontinuities at the form and construction joints. As a result, this left the contractor pondering how much remedial treatment would be necessary to restore the piers effected. Despite, NCRs being a problematic issue, the quality plans were generic instead of being specific to the requirements of the project's context. For example, in the highway upgrade project, the following comment was made:

> "The project had a fairly generic quality plan. It covers all of the quality requirements for the project without being specific".

The project did not have a person experienced in quality assurance (QA), which led to a formal request for an additional resource. Contrastingly, in the case of the marine jetty, a steadfast QA manager had been deployed but had focused solely on resolving welding issues due to the sheer number of NCRs that materialized — merely focusing on the welding issues resulted in the QA manager not having the time to put in place a quality management system. As a result, this led to a request for additional QA resources, which resulted in an additional cost to the project.

In sum, the reports contained limited information about quality even though issues associated with rework had impacted their forecasted final contract values and margins. Those projects identified in Table 1 that had experienced a decrease in their forecasted margin all suffered quality issues (e.g., rework) though such costs were not able to be

quantified from the information contained within the reports.

4.3.3. Safety

In the case of the highway projects we examined, all but one had to work in proximity to live traffic (i.e., highway upgrade), all had to be in built-up areas, which resulted in safety challenges. In the case of the railway and tunnel project (Table 1), we saw from the narrative contained within the report that front-line supervisors had to reinforce safety awareness persistently. Raising such an awareness placed unrelenting pressure on the project's supervisors. During the review team's site visit, they identified several safety concerns such as poor ventilation in the tunnel, exposed electrical leads that had not been labeled, and workers were not wearing their safety harness. The upshot was a request for additional safety supervisors, which were provided and resulted in additional costs to the project. In the rail and line stations project, a culture of under-reporting safety incidents prevailed despite the extensive investment in safety training and education. At this specific milestone, a Total Recordable Injury Frequency Rate of 59 occurred in the preceding month the report was due. No cost can be placed on safety, but the financial expense of having to re-train and re-educate its workforce was a cost to the contractor had to bear.

Establishing a safety culture is a constant challenge for contractors. In the case of the highway project, this was an issue. The review team reported that the statistics were "suspect." The previous management team "had been reclassifying incidents where the injured person returned to work on alternative duties", which had the effect of artificially reducing the Lost Time Injury Frequency Rate. The review team reported that the safety culture on-site and in the precast yard was inadequate, and "several of the supervisors were resisting to improve it." The poor safety culture resulted in their dismissal and the employment of new supervisors. Several major safety incidents occurred and an investigation by Comcare[2] was in place.

4.3.4. Design

Head contract variations, late approvals (e.g., for temporary works) and errors in the contract documentation contributed to increasing construction costs. In the rail line and stations, a considerable amount of head contract variations was issued (Table 1), which under a D&C contract are costly. In the report, the following comment was made "various areas of post tender growth have occurred since the award of the contract." This tender growth impacted staff resourcing of the design team and their ability to produce the required documentation to the pre-contract team. The knock-on effect of initiating head contract variations not only increases project costs but can place additional pressure on resourcing and staff morale.

In the highway and bridges project, the design documentation contained incorrect information about the geology of the site as it was significantly different from that expected. This documentation was overlooked by the contractor when they took boreholes and pits when preparing their tender. On recognizing the problem, the contractor had to determine how to use the existing soil rather than having to discard it off-site and import alternative material; this proved to be a significant engineering challenge. A substantial quantity of material had to be lime stabilized to enable it to conform. The makeup of the base courses below the pavement and the verges had to be completely re-designed. The progress of the works slipped behind the programme as the sub-base, verge, and base course had to be re-designed, and the excavated material had to be reworked to ensure it conformed to standards.

4.3.5. Management

The relationship of the contractor with their clients was recurrently identified as being 'healthy' in all but one project. While contractors are often blamed for construction costs increasing, consultants can have a role in contributing to the occurrence. In the rail line and stations project, for example, which was being delivered using a D&C, the client made the following comment about the engineering consultant that had been employed by the contractor:

> "The [consultant] have not covered themselves in glory. Their design has been late, and their monthly inspection and certification of the work in progress were very superficial until [the contractor] insisted on a more rigorous process which included sampling ITPs and checklists. The substation design produced by the [consultant] did not conform to standards, which has meant substantial re-design needed to be undertaken. It is still not available".

All the reviews highlighted that staffing was an issue on projects, particularly supervisors and engineers. In the rail line and stations project, for example, an additional two senior engineers experienced in earthworks were required:

> "The number of unapproved design packages and material submissions is rapidly increasing on the Project. The [consulting engineer] and [client] have not approved many submissions as they were incomplete and/ or required further clarification. A shortage of engineers in the design team tasked with responding to the increasing comments has exacerbated the situation. The project has since offered positions to two engineers however it may take months before the project is on top of closing out the comments necessary for the [consulting engineer] and [client] to approve submissions".

In the highway project, which was in distress, a new management team was put in place. While this may have come at a cost to the project, there was a noticeable improvement in morale, safety, and commercial management. As the project was running behind schedule, an accelerated programme had been put in place, but there were concerns that this could adversely impact stakeholders and the community due to the disruptions that would occur. The disruption was a sensitive issue as the project had received 'bad press' due to several safety incidents that had occurred.

5. Discussion

We have sought to identify the varying and interdependent contexts that influence cost performance during the construction process of transport projects. The varying contexts adversely impacted both the client (e.g., head contract variations and delays due to weather) and contractor (e.g., rework and resourcing). By taking an overarching organizational context perspective (Brown, 2010), the context breakdown structure we proposed was able to shed light on "the hierarchy of contexts within contexts" (Bateson, 1972, p. 408) surrounding a project's cost performance. As we single out context states and analyse project performance reviews at the 50% and 75% schedule milestones, we focus on both the existing and emerging contexts (Hirschman, 1967; Ika & Donnelly, 2017). We have observed that context states may be 'brought in, or added to' understand the nature a project's cost increase. Alone, however, they are not sufficient to provide a complete and adequate understanding of their occurrence (Dohn et al., 2018). By examining a series of contexts, we reveal that several substates (e.g., head contract variations) significantly contribute to increasing costs during construction. Additionally, there will invariably be costs that will be unforeseen. As noted above, having to undertake rework is a major problem in projects but research examining its causes and costs has been limited due to a lack of access to relevant data (Love et al., 2016). Contractors have traditionally treated rework as being a *zemblanity* (i.e., unpleasant unsurprise) and often have overlooked its presence explaining it away as a one-off event. Contractors have begun to pay attention to the likelihood of rework occurring in projects and its impacts on their costs. To accommodate unforeseen costs such as rework,

[2] A statutory authority of the Australian Federal Government. Details can be found at: http://www.comcare.gov.au/.

we suggest in section 5.1.3 below that engaging in a process of anticipation can help as this issue.

Transport projects experience cost increases during construction for a wide variety of reasons, and it would be imprudent to attribute their causation to a single issue. If governments are to make headway in addressing their cost performance issues, then there is a need to understand the hierarchy of contexts within they occur. We have observed from the reviews undertaken at the 50% schedule milestone that construction costs were increasing.

Before a government client signs a contract with a construction organization to deliver a transport asset, a series of cost estimates are prepared throughout the design process. Each cost estimate will vary as a project's scope is defined, and consideration is given to environmental and stakeholder needs. When construction organizations are invited to bid for a project, those who accept present a price to undertake the works. Depending on the proposed procurement method adopted, the contractor may be required to design and/or construct the project. In the case of a Public-Private-Partnership or variant thereof, they may also be required to operate and maintain the asset for a given period (e.g., typically 25–30 years). At the award of a contract, the price for the works is agreed. After this date, variations due to the scope and design changes sanctioned by the client will increase the price to be paid.

We can see from Table 1 that all projects except for the marine jetty experienced head contract variations. The upshot being construction costs for clients increased, but the forecast margin for the contractor, correspondingly, increased in several projects. For the contractor, some projects displayed signs of distress as a result of design, quality, environmental, and related managerial issues. Could these problems have been foreknown? Some risks may well have been anticipated and prevented. For example, research has demonstrated that concrete and structural steel are the most prone to experience quality failures during construction and therefore require rework (Love et al., 2018). A lack of supervision during concrete pours and welding are significant contributors to rework (Love et al., 2018).

We observed from the reviews undertaken that there were repeated calls for additional engineers and supervisors to design and manage works, respectively. So, in a nutshell, projects were being underresourced, and the forecasted margin maximized well above the 4% and 5% levels, which is the norm within the industry (Ernst and Young, 2017; Love, Ika, et al., 2019). In the UK, for example, the construction industry has been characterized as being "fragile" with "low margins and high risks" being prominent (Hawker, 2019). Margins in the UK have been reported to be as low as 1% (Ernst and Young, 2017). Such low margin levels are not sustainable for businesses and can thwart innovation and long-term competitiveness.

Yet, we mentioned above, it is the strategic decisions taken by government that provide the conditions for projects to experience adverse cost performance. Governments tend to place unreasonable expectations on contractors by imposing a toxic cocktail of high risks and requiring fixed price contracts, particularly in the presence of information asymmetry.[3] This position creates an imbalance in power in transactions and thus results in adverse selection[4] (Kagel & Levin, 1986). This systemic failure to account for adverse selection during the tender process. As a consequence, this provides the breeding ground for bounded rationality[5] and opportunistic behavior[6] to come to the fore during the construction process and contractual disputes (Ahmed et al., 2016; Love et al., 2011).

5.1. Implications for procurement policy

The *overall* economic context has been driving the procurement of transport infrastructure, which has been fuelled by population growth and aging assets. However, there remains limited capability within the marketplace to construct much-needed transport projects. The states of NSW and Victoria, for example, are in a position where "projects are competing for contractors" (Lucas & Jacks, 2019). A marketplace with a limited competition exists for contractors for large projects tend where the tender shortlist comprises same 'Tier 1s' and an international organization (or consortium) (Productivity Commission, 2014, p. 423). Such non-competitive markets can lead to an unbalanced allocation of goods and services contracts.

Thus, we need to consider not only the *overall* context within which projects are procured but also its hierarchical layers and how they interact with one another. By taking a systemic approach to context, we can make significant strides to ensure policy-makers can deliver transport projects that are able to provide value for money. However, governments should acknowledge that traditional approaches to procurement and the management of transport projects have failed to deliver value to their citizens. To deliver the extensive pipeline of transport infrastructure that is needed to support Australia's economic and social development will require new modes of working based on the use of collaborative forms of procurement (ACA, 2017).

5.1.1. Negotiated contracts

Empirical evidence suggests that a competitive threshold for the number of bidders for infrastructure procurement is eight (Gupta, 2002). Soliciting eight bids for a large project would be a costly exercise for the contractors, especially as losing bidders tend not to receive a fee for their submission. For projects over AU$500 million, the cost to submit a bid can range from 3% to 5% of a project's value, which represents a significant cash investment for the chance of winning a project (Productivity Commission, 2014, p. 452).

Thus, preparing and submitting a bid is a costly exercise for a contractor. The unrecoverable costs are then incorporated into future bids. So, instead of engaging in a bidding process, the government should negotiate with potential contractors, and have an independent third party to review their proposed costs. The review is not a process to 'cut-costs' but to question, check, and validate the tender price. Besides, an agreed margin could be negotiated; after all, contractors need to make a profit. Having an 'open book' policy toward auditing construction costs would ensure transparency and accountability. It is not in the interest of the government to subject contractors to financial difficulty as the knock-effects can be disastrous for businesses and the community at large. After all, infrastructure is an investment that adds value to our economic and social well-being, and not merely as a monetary cost.

5.1.2. Alliance contracting

Australia has been leading the charge in the development of alliance contracting models (Walker & Rowlinson, 2019). In essence, alliances can take two forms (Love et al., 2010): (1) pure (i.e., the non-owner participants are selected on experience, capability, and attitudes without regard for price); (2) competitive (i.e., based on price). Furthermore, alliances can take three configurations (Walker & Rowlinson, 2019): (1) project; (2) design; and (3) programme.

[3] In contract theory, this relates to a situation where one party has more or better information than the other.

[4] Here the government exploits contractors, or vice versa as a result of having more knowledge/information than another part. Symmetric information which is a prerequisite for collaboration as both parties have equal knowledge/information.

[5] In this instance, decision-makers act as 'satisficers' (i.e., select an option that meets a given need), seeking a satisfactory solution rather than one that is optimal (Simon, 1979). Thus, not all potential contingencies are identifiable and can be assessed until they materialize.

[6] Its accepted definition applied to transaction costs is "self-interest seeking with guile" (Nikolova, 2008, p. 1005). It does not always occur, but the possibility of opportunistic behavior is always present. In this case, this behavior can translate in seeking monetary claims, which can result in the emergence of disputes in projects (Love et al., 2011).

Research has repeatedly demonstrated that alliances are flexible (e.g., to respond to unpredictable challenges) and provide the ability to engender innovation in project teams. The use of a joint governance framework, 'best for project' decision-making, and the establishment of a 'no-blame' culture and payments on a cost-plus basis provide a platform to ensuring project success (Walker & Rowlinson, 2019). The collaborative nature of alliances enables design and construction processes to be integrated. The creation of an integrated work environment provides the building blocks for a digital construction strategy (e.g., building information modelling and Internet of Things, and Industry 4.0) and the process of future-proofing to be enacted.

5.1.3. Leadership and staffing

We can view leadership styles on a continuum with those that are task-focused on one end (e.g., passive-avoidant or laissez-faire styles), the classical types (e.g., autocratic, democratic and situational) being in the middle and at the opposite end of the spectrum being reserved for those that are relational in nature (e.g., transactional, charismatic, and transformational). The appropriate leadership style needed to ensure project success varies with different phases of its life-cycle (Turner & Müller, 2005). All in all, effective leadership is an essential determinant of organizational and project success (Aga et al., 2016). Due to the sheer number of stakeholders and interfaces, leaders should be able to focus on not only the technical aspects of construction but also the complex social system. The requisite leadership is not only applicable within the project team but also the government client.

The role of government in delivering transport infrastructure in the modern era is phenomenally tricky, particularly in states such as NSW and Victoria, where a significant number of large projects will be constructed over the next decade. Governments, therefore, cannot be soloists in their pursuit of infrastructure but conductors of an orchestra whereby they collaborate to review, assess and work with their contractors to solve the myriad issues that can manifest during construction. We suggest that governments pay increasing attention to the leadership of contractors and their proposed staffing (e.g., experience, resourcing, and retention strategy), during the negotiation process. Governments need guarantees from their contractors that the leadership and staff that they vet during the negotiation and selection process are employed during the project's delivery.

The ACA (2017) have suggested that there is a need for contractors to focus on a "360-degree leadership style". Here, the leader guides and influences their immediate team members and becomes so respected and admired that they influence everyone in the organization. The "360-degree leadership style" *patois* is an assessment process whereby employees provide feedback (i.e., from multiple sources) and varying levels about an individual's skills, effectiveness, and influence as a leader. The evaluation is then used to harness the leader's future development.

Research, however, has found that 'authentic leadership' is needed in infrastructure projects as it centres on creating an environment of trust and engendering learning (Lloyd-Walker & Walker, 2016). In this instance, "leaders exemplify directness, openness, commitment to the success of followers, a willingness to acknowledge their limitations, transparency and a commitment to be held accountable for their actions and reward honesty and integrity" (Avolio et al., 2004, p. 10). The discord and opportunism that are bequeathed with non-collaborative procurement approaches will become unplayable when authentic leadership is enacted within an alliance-based environment.

5.1.4. Establishing a generative culture: creating a restless mindset

We suggest that both the government and the alliance that is formed to deliver a project should focus on removing the latent pathogens that result in the problems (e.g., the need for scope changes, rework, and overlooked environmental problems) materializing by engaging in the art of *requisite imagination*[7] (Adamski & Westrum, 2003). Most importantly, requisite imagination involves anticipating what might go wrong and how to check for problems that may reside in the design, planning, and delivery of a project.

Requisite imagination often indicates the direction from which trouble is likely to arrive. Thus, it can provide alliance leaders and managers, for example, with the means to anticipate and explore those factors that can affect project outcomes in future contexts. However, the failure to use requisite imagination potentially opens the door to the threat of unanticipated outcomes. The cognitive capacities of managers and their employees must be drawn upon to aid the process of requisite imagination to avert unwanted outcomes that may hide beneath the surface of a project's design and constructability. We suggest that governments and their alliances should encourage their leaders, managers, and employees to have a "restless mind" and to be encouraged to ask questions (Adamski & Westrum, 2003, p. 217). In aiding this process of inquisition, we suggest that there is a need for a 'Project Maestro' who can lead, instigate, and maintain a questioning attitude. In doing so, the Maestro would adopt a line of inquiry prior to a project's construction whereby matters such as 'what situations have not been foreseen?', 'what has been forgotten?', and 'what could go wrong' are addressed and communicated to create a collective mindfulness within the organization that is attune to requisite imagination.

By having in place a 'Maestro', and authentic leaders, the seeds for a generative culture can be established within a project's alliance (Westrum, 2004). The cultivation of a generative culture arises through a process of (Westrum, 2004): (1) *alignment*, whereby team members feel that they have a personal responsibility (i.e., buy-in) to ensure a project's forecasted construction costs are not exceeded; (2) *awareness*, which is a tool used to identify latent pathogens. Unless both the government and project's leadership and team members understand 'the big picture' context, they will be unable to recognize how anomalous conditions can increase construction costs. Providing this understanding through engaging in requisite imagination is necessary for maintaining a 'healthy' project environment. So, an awareness includes not only possessing knowledge but also an ability to assemble facts to construct scenarios about what might happen in a meaningful way; and (3) *empowerment* whereby leaders and individuals can make and carry out a decision without fear of being questioned or reprimanded. Creative thinking is encouraged to identify potential problems. By providing an ability to act, individuals are inspired to engage in reflexive thinking.

6. Conclusion

Context matters but it has only been superficially considered when explaining the cost performance of transport projects. With this in mind, we set out to provide a much-needed context that can be used to explain why construction costs increase from contract award in transport projects. In doing so, we took the perspective of a contractor, focused on context states such as programme, quality, safety, design, and management, and sought to highlight the hierarchy of contexts within contexts.

To capture emerging contexts, we examined a series of performance and financial reviews for eight transport projects performed by an independent internal review team of a contractor at the 50% and 75% schedule milestones. We were fortunate to have access to this often-confidential information and were able to observe that the mean forecasted margin of the contractor was 8.94% of the contract value. In comparison to the UK, for example, this was high and reinforced the point that there is a lack of competition in the Australian marketplace. It

[7] This is the "ability to imagine key aspects of the future we are planning" (Westrum, 1991, p. 195).

could, however, be that the UK's margins are too low. Either way, contractors' margins must be healthy, but determining an appropriate level is dependent upon the level of risk they are willing to accept.

More importantly, our analysis revealed that head contract valuations, weather, and design changes and environmental approvals appeared to be the significant contexts within the contexts affecting construction costs and schedule. By delving deeper and further analyzing the reviews, we were able to make sense of the complex hierarchy of contexts within contexts that surrounded the contractor when constructing their transport projects. This context breakdown structure may provide governments with the understanding needed to make changes to their procurement policies to enable the effective and efficient delivery of their transport projects. Accordingly, we submit a series of changes to procurement policies that governments should make as they seek to take a proactive role in their projects and work in collaboration with their contractors. Aiding this process of collaboration, we suggest that governments consider engaging in negotiated contracts, alliance contracting, leadership and resourcing strategy, and establishing a generative project culture. We do not seek to inform governments about what to do but instead provide an avenue for what they might do to mitigate the likelihood of cost increases during construction. The knowledge and context we provide in this paper can be used by governments to facilitate the understanding required to combat the issue of cost increases, which has and continue to plague the procurement of transport projects, worldwide.

CRediT authorship contribution statement

Peter E.D. Love: Conceptualization, Methodology, Data curation, Visualization, Investigation, Writing – review & editing. **Lavagnon A. Ika:** Data curation, Writing – original draft, Writing – review & editing.

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Appendix

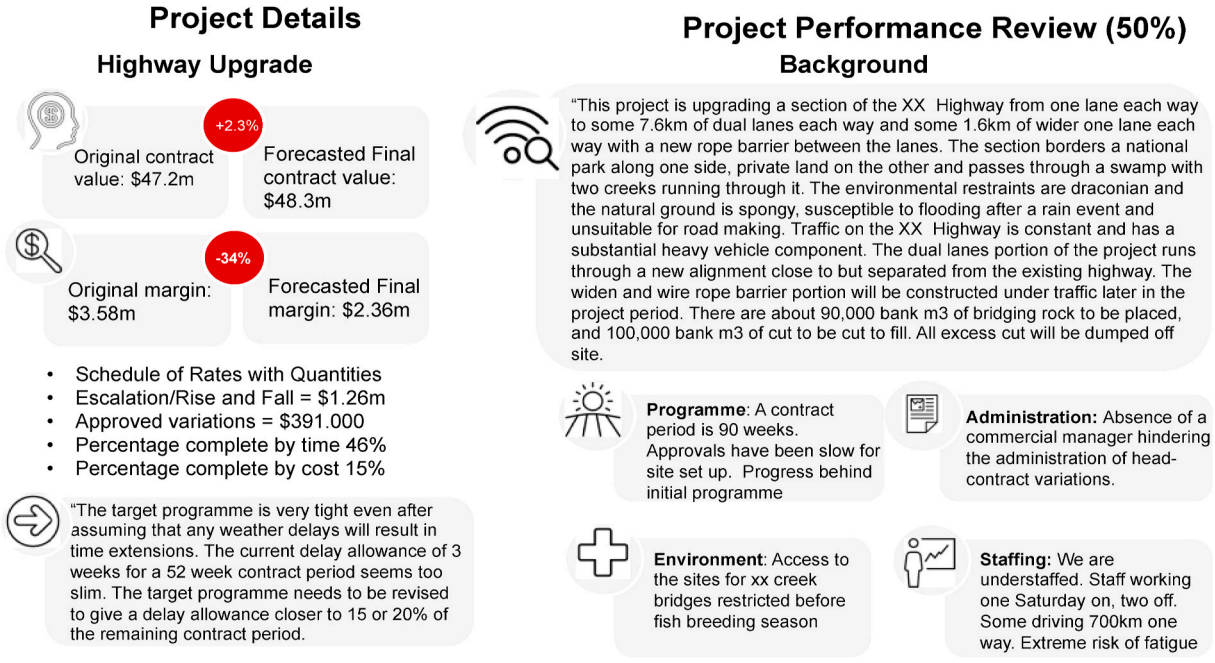

Fig. 3. Performance review report for a highway upgrade project.

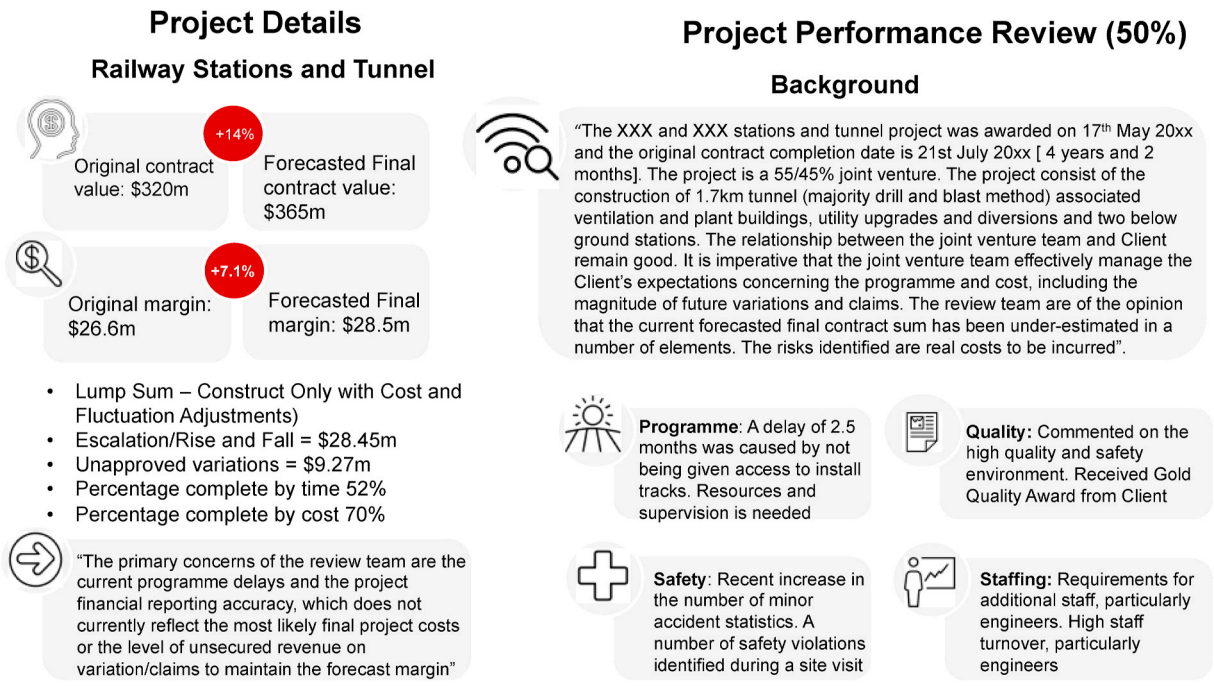

Fig. 4. Performance review for a railway stations and tunnel project.

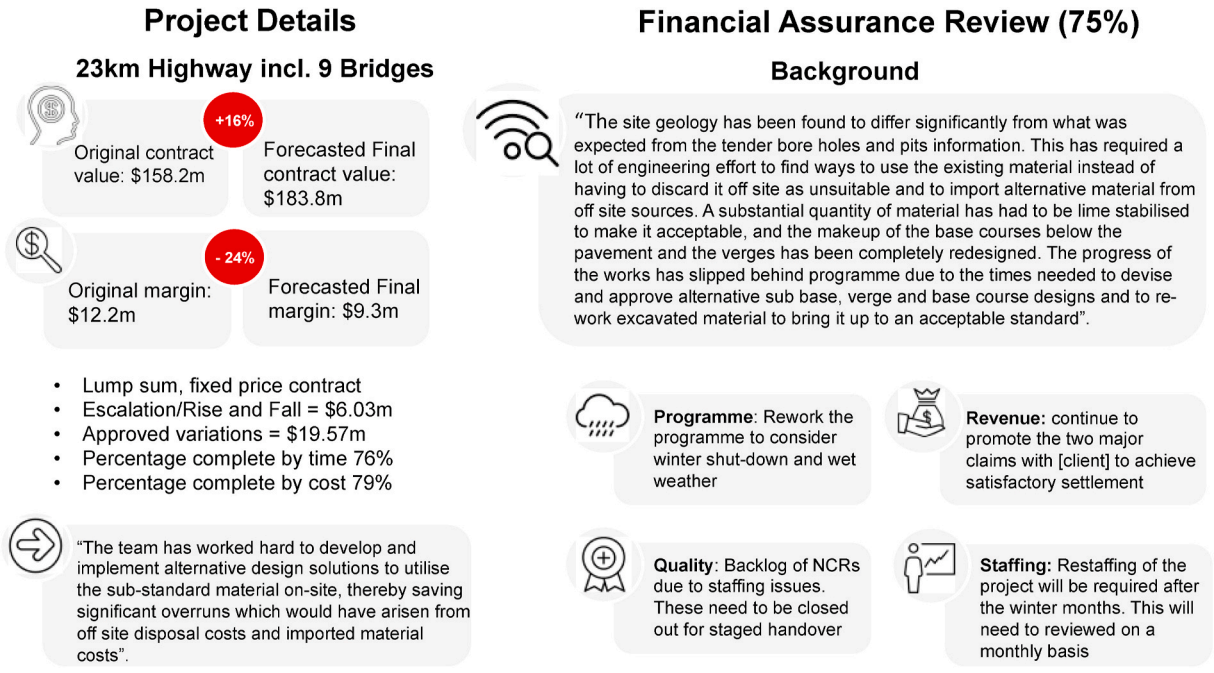

Fig. 5. Financial assurance review report for a highway and bridges project.

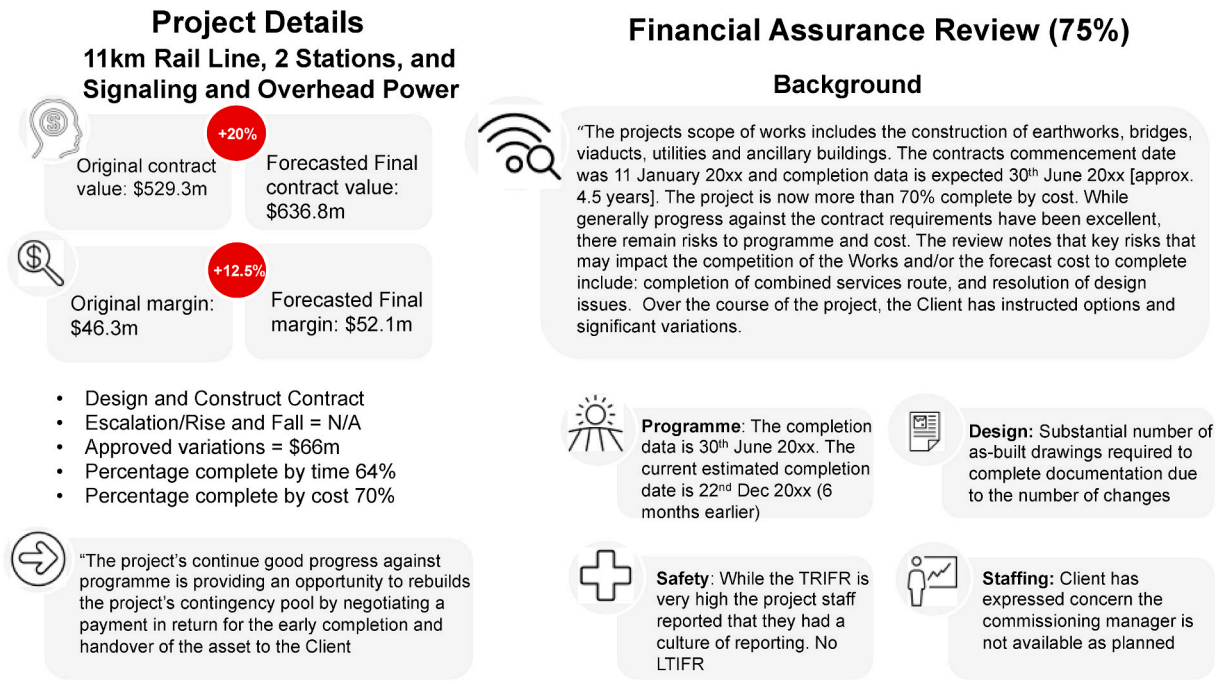

Fig. 6. Financial assurance review report for a rail project.

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