Large-Scale Transport Infrastructure Project Performance: Generating a Narrative of Context and Meaning

Peter E. D. Love, Lavagnon A. Ika, Jane Matthews, and Weili Fang

***Abstract*—In this article, we go beyond the proverbial appreciation that context matters and provide a deep exploration of how and why it can help make sense of cost deviations in large-scale transport projects (>$500 million). Using abductive inference in combination with a multiple case study approach, the criteria of planning, funding, scope, contract, challenges/issues, and benefits are used to understand and interpret the context and meaning of project cost performance. By comparing two light rail transit systems and conducting an in-depth examination of a road project, this article examines the differences between procurement approaches and worldviews and how they can introduce bias into a project's cost performance outlook. The contributions of this research are threefold as it provides an avenue for a new line of inquiry to help better understand causal inferences, thus contributing to the development of a plausible theory of project cost performance; highlights the ambiguity associated with cost performance assessment and calls for the use of standardized definitions and terminologies so that evidence-based decision surrounding risk and uncertainty can be enacted; and suggests that by engaging in a collaborative benchmarking process of project completion data, the context and meaning of a project's performance can be documented.**

***Index Terms*—Context, cost performance, estimate, meaning, policy, risk, uncertainty.**

I. Introduction

A PARADOX prevails worldwide in project management practice at a time of unprecedented investments in transport infrastructure [6], [23], [41], [43], [44], [80]. While large-scale projects remain highly sought after, they perform poorly, often experiencing increases in projects costs and falling short of expected benefits [1], [6], [15], [20], [48], [52], [55], [81], [98], [106]–[108]. More often than not, such a dismal underperformance leads to economic inefficiencies, adds to the risks associated with future infrastructure projects, and undermines their viability [51], [72], [75]. Considering this problem, research has sought to explain why transport projects repeatedly fall foul to cost underperformance, although the empirical evidence about these causes and their prevalence and magnitude remains contentious [34]–[40], [63], [66]–[73], [83], [107]. For example, while Flyvbjerg *et al*. [37, p. 282] claim that "costs are underestimated in almost nine out of ten projects," Love *et al*. [72] provide an alternative narrative as they reveal five out of ten projects come in below their budgeted estimates. Notable examples of large-scale transports completed within budget are Sydney's Metro Northwest rail line estimated to have been $500 million under budget [77] and Bangkok's Urban Transport Project Road Extension Component, which in the end was 30% below its estimated cost [11].

Two schools of thought dominate the project cost (under)performance (i.e., extent of monetary deviation from forecasted budgets and/or contract values) literature. The first is rooted in the "project management paradigm" and underscores "best practices" to deal with the technical and economic causes of cost underperformance. This longstanding school draws on inductive theories of project behavior and performance. It, thus, focuses on what "actually occurs" in practice and attributes causation to issues such as scope changes, complexity, and uncertainty [69]–[73]. Contrastingly, the second school is grounded in the "governance paradigm," which seeks to curb political and psychological factors associated with a likely increase in costs and essentially adds "bias uplifts" to a project's base estimate and contingency. In doing so, accountability for cost underperformance resides on the shoulders of decision-makers. The champions of this rather dominant school of thought proffer, armed with their deductive theories based on what "must be" [35]–[38] "that the *root* cause of cost overrun is behavioral bias in contrast to explanations in terms of scope changes, complexity, etc." [38, p. 174].

Despite such scholarly activity, the protagonists of the cost underperformance debate agree that there lacks a consensus on a definition and a means for measuring its extent [66], [69], [71], [72]. What is more, while no one would dispute "the power of context" the question remains as to how context matters, especially as the literature has focused little on how it influences project cost deviations [39], [40], [67], [84], [102]. Such a

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proverbial appreciation that context matters juxtaposed with a lack of its in-depth exploration in large-scale transport projects [69] has led to mixed if not ill-advised recommendations to curb underperformance, especially in the face of complexity and uncertainty [34], [39], [40], [51], [54], [67]–[74], [106].

Interestingly, a project's context provides the setting for cost underperformance to materialize. Numerous factors influence this setting (e.g., economic, political, legal, geographical, historical, socio-cultural, environmental, institutional, or managerial circumstances), which continually unfold and interact with one another to provide the conditions for project costs to deviate [69]. This unfolding context, along with the accrual of a project's *ex-post* benefits over its lifetime, gives a basis for the meaning or interpretation of a cost deviation to emerge [53], [54].

Much like context helps determine the meaning of the part of a text that surrounds a particular word or passage, it can also help interpret a project's cost performance. Thus, context provides the ability to weave together a narrative that may enable an understanding and help rationalize a project's cost performance [102]. The failure to account for such context is, thus, akin to remarking out of context on a subject topic [69].

For example, Gil and Fu [40] trace capital cost increases to governance adaptations during the course of transport megaprojects. They suggest that without a good grasping of the particular *context* surrounding these projects, including changing scope and end date, governance alterations, and shifting economic environment, an understanding of the real *meaning* of its cost underperformance is forgone [40]. For their part, Love and Ika [69] theorize about the context that emerge and leads to cost deviation with the fertile double metaphor of container and rope. They proffer that the *initial* context or the set of conditions that prevail before the project starts (outer container) is complemented in a continual unfolding interaction by the *emerging* context in the wake of the project (much like strands interact with the whole of a rope in a two-way relationship).

Against this theoretical backdrop, this article addresses the following research question: *How can the context of a large-scale transport project help explain the meaning of its cost performance*? This article builds and extends on the work of Love and Ika [69], whose initial exploratory work of context and meaning took a narrow view of cost performance from a contractor's viewpoint and, thus, examines differences in procurement approaches and worldviews of assessing cost performance from a broader project delivery perspective.

This article commences by examining definitions and reference points as key elements of the context and meaning used to determine the cost performance of large-scale transport projects.

Then by engaging in the process of abduction and a multiple case study approach, the research question is addressed. In doing so, the research draws and elaborates on existing "best practices" theories [69]–[73] to trigger a generation of "hunches" or the seeds of a "plausible" theory of cost performance, grounded in the idiosyncratic contexts of project delivery [101]. Next, the theoretical implications of understanding context are identified. A series of recommendations are then put forward for policymakers to consider to manage better the cost performance of their transport infrastructure projects before this article's conclusions are presented.

II. Cost Performance

This article commences by defining cost performance as it enables establishing a frame of reference to understand its context and meaning. The analogy with the context surrounding a part of a text also stands out here. Readers may know a keyword or its definition, but they still depend on the appreciation of the context in which it has been used to understand the passage of text fully. The definitions of key concepts are next defined, and then, the contextual knowledge associated with cost performance is examined.

A. Definitions

Definitions that purport to provide meaning for cost performance vary in nature [56]. Moreover, the paucity of consensus surrounding the definitions used to determine deviations in project costs has contributed to the differing perspectives and explanations of "how transport projects work" [16]–[20], [34], [36]–[38], [63], [71].

The typical definition of the term cost overrun—"actual cost minus estimated costs in percent of estimated costs"—suggests an inaccuracy if actual costs exceed those that are estimated [37, p. 281]. The term "cost overrun/underrun" refers to "beyond or below a limit". They fall short of providing context and meaning as clients may, for instance, authorize scope changes, which are additions or reductions to a project's works and original budget [69]. Thus, rather than using the terms cost overrun and underrun, it is suggested that more appropriate terms are "cost growth" and "cost reduction." Notably, scope changes are known, unknowns. If the term overrun is to be used, it should only accommodate unknowns (i.e., unexpected or unforeseeable costs) [56].

While the term overrun has been widely used in the transport literature, little thought has been given to its meaning. A cost overrun will vary with the points of reference used to determine its magnitude [56]. The points of reference used by several authors, for example, consider the estimates of construction costs (i.e., budgeted or forecasted) when the decision to build is made and the actual construction costs at a project's completion [17]–[20], [37]. Yet, there is a belief that the decision to build is an ambiguous reference point and can provide an overinflated account of a project's cost overrun [56], [69]. Odeck [83, p. 45] points out that the decision to build may arise only when cost estimates from the final stages of the detailed planning process have been undertaken. Moreover, as shown in Fig. 1, the decision to build does not necessarily occur during the formative stages of the design process, which under a gateway process, for example, can include the business case, delivery strategy, design brief, concept approval and detailed design approval. The investment decision may happen after responses to the requests for proposals in Private Participation in Infrastructure (PPI) types of procurement (e.g., public–private partnerships, PPP) or under conventional forms when a price for the construction works has been obtained.

B. Reference Points to Assess Cost Performance

As an alternative to the decision to build, several authors have examined a project's cost increase from a contract's award to the

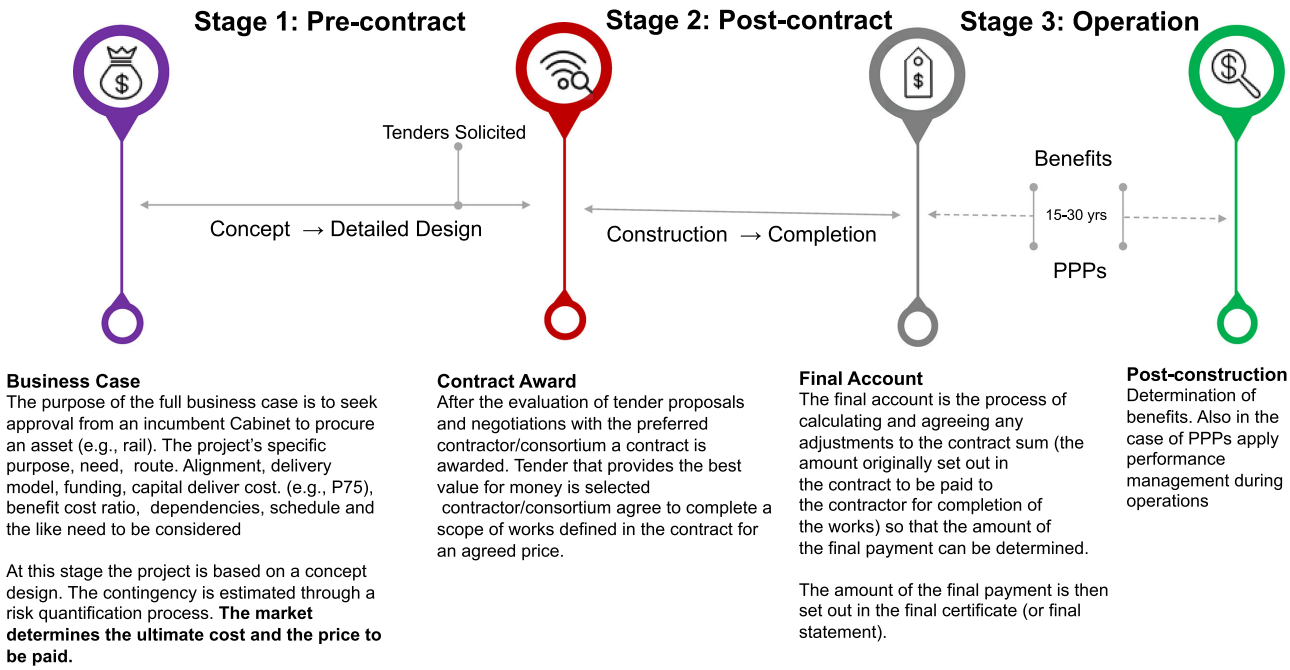

Fig. 1. Definitions: Stages to determine cost performance in transport projects.

issue of a final account [46], [70], [87], [106], [107]. However, such a reference point provides only part of the picture regarding a project's cost performance profile. It discounts the changes in scope that materialize during the design process and influence a project's approved budget. In adding clarity and providing much-needed definitions for determining the meaning of a project's cost performance and context, three reference points need to be simultaneously considered for judging a project's cost failure or success: pre-contract, post-contract, and operations (see Fig. 1).

1) Pre-Contract: The decision to build typically occurs at the business case approval. Notably, a series of estimates will be produced before the business case approval (i.e., front-end) and will invariably increase [17], [18], [108]. Still, making an allowance of the available information for each of the cases examined in this research, a focus on the approval of the business case at the decision to build is deemed an appropriate reference point to determine a project's cost performance. The period between the approval of a project's business case and the award of a contract can be lengthy and, in some cases, may take years [72]. As a matter of fact, a project's scope can change significantly during this period, mainly due to varying stakeholders' needs and demands. Also, macroeconomic factors (e.g., inflation and interest rates) can influence the approved budget, which, as a result, will accordingly require adjustment. Thus, the most significant portion of cost growth in a transport project occurs between the "Business Case to Contract Value" (BC→CA) period [72].

A series of estimates will also be undertaken during the BC→CA interval and may accommodate both scope changes and macroeconomic issues. Ultimately, the market will determine the procurement price for an asset. Knowing the likelihood of cost growth during this phase, some governments apply a series of uplifts to their estimates to account for potential optimism bias [35]–[38].

While it has been suggested that project estimates are systematically underestimated due to optimism bias [35]–[38], there is no unequivocal empirical evidence to support this claim [71]–[73]. Undoubtedly, optimism bias exists during an individual's decision-making process, but estimates for transport projects are prepared by teams of people and are often checked and verified by independent organizations.

In sum, the scientific rationale for the use of uplifts may appear questionable [34], [71]–[73]. Naturally, an estimate based on a concept design will be subject to change as information about a project's scope unfolds. Nevertheless, acquiring knowledge as to why and what changes arise during the BC→CA period provides the basis for understanding the context of their occurrence. Notably, without context, there can be no deep understanding or learning.

A project's procurement strategy will determine the level of risk allocation between a government client and their contractor/consortium. Nonetheless, there has been a tendency for many governments to place unreasonable expectations on their contractors/consortiums and have them accept significant levels of risk by providing a fixed price contract in the presence of information asymmetry [2], [79]. Knowing a project's procurement method and levels of risk allocation enable context and understanding to be established. Therefore, there is wide use of conventional procurement methods such as Construct Only, Design and Construct, Managing Contractor, Design Construct and Maintain, and variants to procure transport projects [70], [72], [75]. It is relatively straightforward to determine the cost performance of projects delivered using conventional procurement methods. However, when governments elect to use a PPP,

then this becomes a challenge for several reasons, which include the following.

1) long-term nature and the need to consider the operations phase, ranging anywhere between 15 and 30 years. Despite the significance of this phase of a PPP's life-cycle, research examining its performance has been limited [5], [16], [64], [65].
2) focus on service outcomes to business and people rather than the creation of a physical asset, "which may or may not continue to serve the needs of stakeholders and the wider community over time" [92, p. 6]. Thus, a government's objectives, requirements, and specifications tend to be developed when tenders are requested. The output/performance specification tends to be minimal to enable the private sector to provide innovative solutions for delivering the service at a low whole life cost. Typically, in the context of a PPP, a special purpose vehicle (SPV)—a subsidiary created by a parent company to guard against financial risk—assumes most of the risks associated with the design and construction of a transport asset, including the risk that it will cost more than anticipated.

As a consequence of not providing the private sector with complete output/performance specifications, deviations in the approved budget will likely occur. According to Raisbeck *et al*. [95], PPPs, for instance, in Australia during the pre-contract, post-contract, and operations phases, experience significantly less cost growth than conventional procurement methods. In addition, it is widely acknowledged that PPPs can provide governments with price certainty as all the SPV's contracts needed to design, build, operate, and maintain the asset require a signature before the government financially commits to the project [95]–[97].

2) Post-Contract: A project's cost performance is typically determined from its contract award and the agreement of its final account (CA→FA) [14], [25], [46], [59], [62]. Notwithstanding, the construction process is characteristically the shortest phase of an asset's life. Thus, its costs provide only a snapshot of the total that would be incurred throughout its life cycle. Noteworthy, policy-makers and planners tend to rely on BC→FA to determine a project's cost performance [17]–[20].

Research has repeatedly shown that the primary cause of cost deviations in transport projects during construction is attributable to "change orders" [70], [72]. Other factors contributing to increased construction costs include inclement weather, industrial action, labor shortages, and unforeseen ground conditions and utilities [25]. In addition, the uncertainties associated with geotechnical conditions (i.e., subsurface conditions and the determination of soil composition) and utilities have frequently plagued transport projects during their construction, particularly heavy and light rail. Germane examples from around the globe include Delhi's Airport Express Rail Line (India), Edinburgh's Tram System (United Kingdom), and Sydney's Light Rail (Australia).

It has been suggested that the risks associated with geotechnical conditions and utilities may be ignored or underplayed by incumbent governments to ensure a project receives approval to go ahead [37, p. 281]. Although this is somewhat possible, at the concept design stage, limited information is available. Therefore, decision-makers may not have full knowledge of the geotechnical conditions and the location of utilities. For large-scale transport projects, the estimate that forms part of the business case will contain a contingency for unknown risks. An external body will vet both the estimate and its contingency before the approval of the project's business. The geotechnical and utility risks may well be talked down to justify a business case (i.e., reducing the contingency), but they certainly will not be ignored. It would be unwise for governments to purposefully do so, as they are well aware of the negative impact on them, particularly when an election is looming. The litmus test, to reiterate, will be the market and the tender prices to deliver the project. Put simply, contractors/consortiums will increase their prices to accommodate both known and unknown risks. However, within PPP projects, debt financiers will have "skin in the game" [92], [93]. The upshot of their financial exposure often results in their requirement for technical consultants to regularly review project costs and revenues and risk mitigation strategies in place. During construction, for example, debt financiers will [92]:

1) employ an independent organization to assess the value of the work completed and the costs to complete;
2) "only allow further drawdowns of the debt facilities if the forecast cost to complete does not exceed the SPV's available funding" (p. 8).

Having the ability to veto drawdowns acts as an effective mechanism to control project costs.

Should a drawdown be required, debt financiers can resolve the situation with their equity investors, especially when a contractor is entitled to additional monies.

3) Operations: In a PPP, the cost performance of the physical asset is seldom measured postconstruction [5], [16], [64], [65]. Instead, the emphasis is placed on raising revenues (i.e., user charges or service payments) to cover the cost of operations and maintenance and capital expenditure and financing costs. PPPs are inflexible when making a change as they are based on private finance and can impact the SPV. However, there will be times when the government will require flexibility, especially if the asset forms part of a broader network. Hence, the PPP contract will need to include a mechanism to enable changes (i.e., variations) to the contract.

When changes (e.g., extensions to rail networks) are required, they can be costly. For example, in the case of a rail asset, an operator can be asked to extend and operate a line or a new operator will be appointed [93]. If the government decides to appoint a new operator, then the existing PPP contract may be terminated, which can be costly. A less expensive option for the SPV would be to terminate its existing contract with the operator and then enter into a new one with a different operator [93]. The transport literature has overlooked the costs associated with changes during the operation of PPPs. Yet, this is an issue that needs to be examined in greater detail. There are examples of projects where the private sector has suffered financial losses due to "miscalculating or mispricing" operating revenues [8, p. 16]. Such projects include the Cross-City Tunnel (Sydney), Lane Cove Tunnel (Sydney), East Link Tollway (Melbourne), Clem Jones Tunnel (Brisbane), and Adelaide-Darwin Railway in Australia [92].

While there has been a great deal of emphasis on the cost performance at the completion of construction in the transport

literature, the *ex-post* economic and social benefits that materialize from those delivered using PPPs have received little consideration [16]. In fact, it is not easy to quantitatively assess the *ex-post* benefits of projects [53]. There has been an overwhelming tendency by the media, opposition parties, and self-serving interest groups to judge the success or failure of a project based on its construction costs alone. This myopic view of success or failure has been outrightly rejected by Ika [52]. He argues that success can later be considered even when a project's construction costs exceed its budget. Cases in point include the "Rideau Canal in Canada, Sydney Opera House in Australia, the first Taurus project and the Hoosac Tunnel project" [52, p. 370]. Indeed, the accrued benefits of these projects over time largely outweigh their significant cost hikes.

In sum, context matters when examining the dynamics and performance of projects [30], [33], [39], [40], [42], [47], [52], [84], [90], [102]. Nonetheless, the context underlying the cost performance of transport projects is often overlooked and replaced by a convenient narrative that projects are repeatedly over budget. When this situation arises, and the storyline is repeated and believed, there is a danger of throwing the baby out with the bathwater and impacting risk analysis and the potential for future decision-making adversely. For example, there may be instances where a project's cost estimate is unapproved when it forms part of a debiased business case based on a series of "optimism bias" uplift indicators, even though it is based upon flawed assumptions [71], [73].

III. Research Method

To recap, the research aims to examine the following research question: *How can the context and meaning for a large-scale transport project help explain its cost performance*? As highlighted, limited research has examined the context and meaning of a transport project's cost performance. Thus, the need for generating a theory to address the problems and anomalies associated with project behavior and cost performance has never been greater considering the "rapidly changing organizational, [technological] and social contexts" within which transport assets are being delivered [101, p. 1]. Nonetheless, the inferential processes of deduction (i.e., proves something must be) and induction (i.e., shows something is operative) have been unable to derive an adequate theory of project behavior and to explain deviations in a project's cost performance [88], [89], [104]. As a result, reframing the inferential process to acquire an understanding of causal relations by focusing on the assumptions underpinning the context within which a project is delivered enables a new line of inquiry to unfold [32], [42].

By taking an abductive approach (i.e., an inference to provide a probable explanation), researchers may, through the examination and interpretation of facts, yield plausible assumptions from which a theory can begin to emerge [7]. Abduction can be viewed as the systemized use of creativity or intuition in research to develop new knowledge [60],[105]. Thus, creativity is needed to break away from the limitations of deduction and induction, "which both are delimited to establish relations between already known constructs" [61: p.136]. Contrastingly, intuition arises from unexpected observations that explain an anomaly that cannot be described using an established theory [31].

By crafting a narrative surrounding the causal inferences and interpreting meaning from the actual events that have been objectively collated, the "ideas and hunches that may explain" the cost underperformance phenomenon may emerge [101, p. 1]. Moreover, examining the context and meaning enables the "creative role of discovering the generative idea, hunch, or conjecture" to be developed into a theory by process of "logical deduction and tested through empirical induction" [101, p. 1].

A. Case Study

The interaction between a phenomenon and its context is best understood through case studies [32]. Case studies can provide a means for developing and contributing to theory by "providing insights into phenomena and their context" [31, p. 555]. The combination of abduction with a case study not only provides the ability to "confront theory with the empirical world" but to match reality with theory [31, p. 555]. This matching of reality and theory underpins the drive to develop a "plausible" explanation of cost underperformance (what maybe). The process of reconciling contradictions provides the impetus "to reframe perceptions into a new gestalt" [32, p. 546] and thus supports the use of abduction.

1) Case Selection: The "primordial task" of case selection follows a process of literal replication [100, p. 234]. Furthermore, selecting cases is a challenging task as there is a need to address sample representativeness and findings extrapolation to a broader population. The authors were conscious of the problems associated with selection bias but equally cognizant of the difficulties with randomly selecting cases [100]. Therefore, the authors choose pragmatically the cases used in this research using purposive sampling based on the following criteria:

1) accessibility to data;
2) difference of procurement methods;
3) received extensive media attention due to cost underperformance;
4) received awards for best practice.

Notably, the case selection is limited to the geographical context of Australia to ensure the homogeneity of the sample.

Two cases (e.g., Light Transit Rail, LRT) experienced cost increases yet were delivered using different procurement approaches. The third (highway) was subject to varying worldviews in the appreciation of its cost performance. By covering different selection criteria (procurement approaches and worldviews of project assessment) and types of projects (LRT and highway), the study aims to enhance the generalizability and transferability of the research findings.

2) Data Sources: In line with previous studies that have drawn upon the gray literature to examine the cost performance of transport projects [18]–[20], [37], this article also relies on such data sources to explore their context and meaning. Thus, besides differences in epistemological underpinning with other studies, specific projects and data sources are identified, allowing the veracity of the narrative presented to be corroborated.

The gray literature is defined as sources that are not formally published in books and journals but instead found in technical reports, preprints, the media, and the like [99]. Typically, the gray

TABLE I
COMPARISON BETWEEN THE G-LINK AND NEWCASTLE LRTS

	Gold Coast (G-Link)	Newcastle Light Rail
Context	***Initial Context***	***Initial Context***
	Planning: Light rail was proposed to address growing population, congestion and sustainability in the 1990s. A feasibility study was conducted in 2004. The initial projected cost was $320-$360 million. Several options were initially considered, such as diesel bus, fuel cell bus, O'Bahn, Trolley bus, monorail, CMS or Translohr and Personal Rapid Transport. Options were evaluated using rigorous multicriteria. Light rail scored the highest on all criteria. It was chosen due to its: (1) potential to meet and shape community travel and lifestyles; (2) potential to act as an economic catalyst (e.g., transit-oriented development); and (3) low impact of the natural and built environment (e.g., reduced emissions). The benefit-cost ratio for the project was estimated to be 1:7 with a net present value of $230m.	**Planning:** A heavy rail line was discontinued in 2012 as part of a program to redevelop the Newcastle Central Business District. As part of the Newcastle Urban Renewal Strategy, light rail was chosen to replace heavy rail. Consultation on the route options for the project began in February 2014. The New South Wales (NSW) State Government announced the preferred route in May 2014, and engagement with key stakeholders began in 2015. The Review of Environmental Factors (REF) for the project started in April 2016. Transport for NSW revealed the community response and stakeholder feedback on the REF in the submissions report in August 2016. In 2014 the estimated benefit-cost for the projects was between 0.47 and 0.73
	Funding: The first Public-Private Partnership (PPP) undertaken following the Global Financial Crisis (GFC) in Australia. Funded by Federal, State and Local government. Integrated with new and existing transport systems and utilizes transit-oriented development. Tender awarded to the GoldLinQ consortium in May 2011, with construction commencing in January 2012.	**Funding:** Hunter Infrastructure Investment Fund, Restart NSW, Commonwealth Government, Land Sale revenue, State Movement. Light rail was announced publicly before a business case was completed. Major construction commenced in September 2017, and it began operation in February 2019.
	Scope: Consists of a single 13 km line of 16 stations. The system uses a standard gauge with a 750 V DC overhead catenary. Daily ridership estimated to be 21,000. Almost 60% of the project's total scope took place underground, with more than 30,000km of new or existing public utilities requiring simultaneous construction, upgrade or relocation. Due to the constrained and congested nature of the corridor, vacuum excavators had to be used, with up to 28 on-site per day during peak construction, averaging a cost of $2 million per month. The project's major technical features included the state-of-the-art signalling control systems and emergency call-up protocols, real-time operational tracking, 36 km of overhead line, and. 6 traction power substations.	**Scope:** Consists of a 2.7 km line of 6 stations and stabling and maintenance facility. Utilizes a catenary-free operation, where each light rail vehicle houses an onboard energy storage system. A supercapacitor and batteries on the roof of the vehicle enable it to travel wire-free. Charging is completed through the vehicle's pantograph, contacting an elevated charge bar at each of the passenger stops.
	Contract: The GoldLinQ consortium entered into an 18-year contract with the Queensland State Government to design-build-finance-operate-maintain (DBFOM) the LRT system. A DBFOM was a Performance-based PPP that was structured, timed and delivered to stimulate the Gold Coast economy as a result of the GFC by: (1) increased government funding to reduce the amount of private debt: (2) allocation of patronage and revenue risk to the State to reduce long-term private sector risk; and (3) service payment during the concession period in accordance with key performance indicators under a performance and abatement regime.	**Contract:** Design and Construct. A managing contract was selected to deliver the light rail project in August 2017. Work included the design, construction and commissioning of the track, stations, and stabling and maintenance facility. In addition, a separate contractor was responsible for designing and constructing an interchange that formed part of the integrated transport solution.
	Emerging Context	***Emerging Context***
	Challenges and Issues: Construction on and adjacent to five major State roads, highways and motorways ensuring no disruption to traffic flow. The design documentation for upgrading and installing new public utilities required approval by authorities, but delays occurred. Uncontrolled development in the scope of the public utility upgrades due to ambiguous agreements not being enforceable under the contract. The location of utilities had not been adequately mapped, and therefore, this caused major problems during construction. Other issues that came to the fore were associated with indigenous heritage and relocating wildlife (e.g., Tusk frogs).	**Challenges and Issues:** The analysis of benefits and costs were prepared after the announcement of light rail. Project scope increased several times between 2012 and 2017, which increased the funding required for the project. The scope additions were due to a combination of community and stakeholder feedback and omissions from the original business case. The funding for the project was approved in several stages, which meant that the government did not have an overview of its total costs when making earlier funding decisions. Some of these increases related to design and scope modifications aimed to improve the urban amenity of the light rail. These were added following community and stakeholder consultations. Other changes were required to cover additional work that was not included in the original business case. For example, an extra $42 million was needed for additional road works to allow the light rail to run along Hunter Street. Delays caused by a legal challenge to the decision to close the train line increased costs by $36 million.
Meaning	**Benefits:** (1) Ridership forecasts exceeded by more than 5000 per day; (2) within two months over 1 million passengers; (3) public transport usage increased from July 2014 to January 2015 by 18%; (4) generated approximately 6500 direct and indirect jobs; (5) private development increased (e.g., for the quarter ending December 2014 by 159%; and (6) increase in retail tenancy occupations.	**Benefits:** There has been insufficient evidence that the light rail construction has made a positive economic contribution to Newcastle's urban renewal program. On average, the patronage is 3620 people per day, with over 46% connecting with bus, ferry and train as part of an integrated journey. In December 2019, the light rail celebrated its one-millionth customer.
	Cost Growth: The final delivery cost was $1.3 billion (2015): 30% higher (after allowing for inflation; Brisbane Consumer Price Index 17.8%) than the $850 million (2008) project budget at the time of Infrastructure Australia's endorsement.	**Cost Growth:** The project's scope and the total amount of funding increased from $220 million (2012) to $693 million (2017). The actual project's budget was $460m. Total cost increased by 44% since the final business case was approved.

Data sources: [8], [9], [22], [24], [79], [86], [109]

literature is the product of research by an organization, often within the realm of governance. Such sources are particularly important as a means of distributing scientific, technical, and public policy and practice information [103]. The research draws explicitly on business cases, government-initiated audit reports and inquiries, government media releases, and technical reports to acquire an account of each project's context and meaning.

The criteria of planning, funding, scope, contract form the *initial* context, and the challenges and issues provide *emerging* context (see Tables I and II). These criteria are used to describe the context (both initial and emerging) as they represent the main headings found in business cases and audit reports referred to in this article.[1] Similarly, the meaning of a project's performance is looked at in terms of its benefits accrual and cost deviation (reduction/increase). Thus, the criteria used to describe the context and meaning of a project's performance reflect actual

1The dimensions such as intrinsic complexity, multimodality, structure and shareholding on an SPV could be considered to examine the context. However, access to data to examine such dimensions is not readily available in the public domain.

TABLE II
DETAILS OF THE NEW PERTH BUNBURY HIGHWAY PROJECT

	New Perth Bunbury Highway
Context	***Initial Context*** **Planning:** The Perth–Bunbury Highway Route Development Strategy, prepared in 2001, considered the development strategy for the regional road network between Perth, Mandurah and Bunbury and was informed by the long-term strategy for the corridor. However, the initial planning of the project commenced in 1994. From 1994 to 2002, approvals for the route's alignment, environmental and planning approvals were granted. Between 2002 and 2006, the ground survey, geotechnical investigations, preliminary designs, environmental approvals and consultation with stakeholders occurred, costing $5 million. Land acquisition commenced in 2004 and was completed by 2006 at the cost of $54.5 million. Table 3 presents the benefit-cost ratio from the project, which was estimated to be 5.12. The benefit-cost ratio was based on an estimated $450 million (in 2005 $) with a two-year construction period and a discount rate of 7%. When a discount of 4% was used, then the benefit-cost ratio increased to 8.22. Thus, the project demonstrates excellent value for money. **Funding**: The Australian Government, under the AusLink Investment Programme, allocated $170 million to the project, which in 2004 accounted for 50% of the original budget. The estimated budget was revised in 2007 to $630 million. With a Federal election looming, the Federal Government agreed to increase its contribution. So, AustLink/Nation Building Program (Federal Government) contribution was $330 million and the WA State Government $375 million (include a $71 million surplus of State-owned land) **Scope:** The project commenced construction in 2006 and was completed in 2009. At the time, it was the most significant road project ever undertaken in WA. It comprised a 70.5km dual carriageway, of which 32km was of a freeway standard, 19 bridges, six interchanges, 32km shared paths, 21km of noise walls, 21km of drainage, landscaping and public art **Contract:** The project was procured using a Competitive Alliance and had a contract value of $705 million. The project's schedule was 36 months and was delivered three months ahead of schedule. The Southern Gateway Alliance was created for the project to undertake the design and construction of the project. At the peak of construction, the haulage fleet comprised 140 semi-tipper trailers - the largest trucking fleet at the time, ever assembled in Australia. The sheer size, the complexity of the project and associated risks resulted in Main Roads (i.e., State Government Department) meant that an Alliance was the most suitable procurement strategy. It was also considered that the use of Alliance would provide flexibility and achieve value for money and provide additional benefits. Alliances focus on deriving solutions, foster innovative thinking and are driven by the values that consider stakeholders and the community; these were all achieved. The project established a Technical Advisory Group, consisted of eminent and experienced designers that challenged engineering standards and established new benchmarks for the design of flexible pavements, drainage and embankments on saturated soils. ***Emerging Context*** **Challenges and Issues** Environmental: The project was granted environmental approval under the State environmental process. However, in June 2005, Main Roads referred the New Perth Bunbury Highway project to the Commonwealth Department of Environment and Heritage to decide whether the project required *consideration under the Environmental Protection and Biodiversity (EPBC) Act 1999.* The Federal Minister for the Environment and Heritage advised in July 2005 that the project was considered a "controlled action" requiring assessment and approval under the EPBC Act before the action may proceed because of the potential impact to the following matters of national significance: Threatened Species and Ecological Communities. Particular environmental challenges included restricted use of bores, Bush Forever sites, State Forests, dieback, Aboriginal heritage, Declared Rare Flora (DRF), Acid and Potential Acid Sulphate Soils (ASS & PASS), waterways and pollution management. In addition, the project did have some detrimental impacts on the environment (through the clearing of vegetation, impact on wetlands, watercourses and native fauna, and the severance of flora and fauna communities). Still, effective management by the Alliance was able to deliver acceptable outcomes to Main Roads and complied with the EPBC Act. Geotechnical: The geotechnical ground conditions varied significantly along the length of the site and in profile. Significant portions of the area were low lying and subject to seasonal inundation for extended periods, which created challenges with dealing with highly expansive soils and the risk of inundation of the pavement structures due to capillary rise. Nearly half of the bridge sites had complex soil profiles that varied significantly from pier site to abutment due to palaeo-channels that had created challenges for the foundation design. Pre-treatment of the foundations to the embankments included wick drains and preloading. Embankments that had to be constructed on weak foundations were pre-treated with wick drains and carefully preloaded under controlled conditions to prevent overstressing and failure. The foundation systems had to be tailored to suit the ground conditions and included shallow and piled foundations (including tubular steel, precast concrete and Franki piles). Three different pavement designs were adopted for various alignment sections and were selected based on a detailed whole of life assessment. Risks: A detailed risk assessment was performed to determine the probability, consequences and manageability of project risks from numerous perspectives (e.g., technical, financial, organizational, social and environmental). Examples of key projects that were identified and *shared* between the Main Roads and Alliance included: (1) impacts and costs of material supply are unacceptable/excessive; (2) managing community exceptions concerning project scope; (3) delays to selection process delay commencement of construction; (4) managing industrial relation issues; (5) lobbying by environmental groups results in major alignment changes; (6) developing a Direct Cost Target within budget'; and (7) delays to accessing land. Achievements: The project was completed without a Lost Time Injury occurring (>3.8 million person-hours). The project received a Worksafe Platinum Certificate of Achievement. The Alliance introduced a 5-day working week throughout the project and considered the need for work-life balance. This enabled high calibre staff to be retained and increase productivity. Similarly, the project did not lose any due to industrial disputes. The Alliance established individual employment contracts for its employees and provided fair and equitable wages and terms and conditions of employment. More than 230,000 person-hours were invested in developing and upskilling the workforce, including new trainees, supervision, construction leadership and women in non-traditional trades.
Meaning	**Benefits:** A wide range of benefits have occurred due to the construction of the highway, which includes: (1) Improvements in road efficiency. For example, the journey time between two locations was reduced from 72 to 34 minutes as a result of constructing the highway; (2) Improvements in road safety; (3) Social (e.g., the establishment of a growth corridor, reduction in traffic congestion and noise, and improved access to amenities); (4) Economic (e.g., improved competitiveness of exports due to decreased transport costs, and increased tourism). Also, refer to Table 3, which presents the benefit-cost analysis. **Cost Reduction:** The project increased from its approved budget due to scope changes and increasing land prices. The contract value was $705 million, and the project's final cost was $688 million.

Data sources: [1], [3], [26], [28], [91].

practice. In doing so, the research bypasses the process of artificially creating the selection criteria and shoehorning information to match them for our analysis.

IV. Research Findings

The analysis of the cases through a process of abduction relied on the researchers' intuition, experience, and knowledge to bring to the fore and craft a narrative of the issues that influence a project's cost performance. Each selected case project (two LRT projects to elucidate differences in procurement approaches and a highway to illustrate differences in worldviews) is now examined.

A. Case Study: Tale of Two Procurement Approaches

Two Australian light rail projects that experienced cost growth are presented in Table I. Scope changes have been the primary culprit for cost growth in both projects. The installation of new and upgrading public utilities was also a source of a bane for the G-Link. While a great deal of skepticism surrounds the purported benefits of the Newcastle Light Rail project, the actual economic benefits of the G-Link have been exceeding expectations. The estimated ex-ante benefit-cost ratios were vastly different for these projects. Furthermore, they were delivered using different procurement methods—a PPP *versus* a conventional approach.

While these light rail projects are vastly different in scale, purpose, and funding source, media outlets have sought to compare the Newcastle Light rail with the G-Link to justify its construction [85]. It is too early to determine the economic and social benefits of Newcastle's Light Rail. However, like the G-Link, it provided the city with much-needed economic stimulus during its construction. Due to the varying situational procurement contexts of the G-Link and Newcastle Light Rail, it would be ill-advised to compare these projects without a caveat. In the case of the G-Link, it could be compared with Canberra's Light Rail (12-km-line with 13 stations) as they were both procured using a PPP. The Canberra Light Rail contract value was $675 million, but it was delivered four months late at the cost of $643 million (i.e., 4.7% less) in 2019 [13], [48]. Even more surprisingly, the approved business case in 2014 estimated costs to be $783 million [21]. Thus, from BC→FA, a 17.8% reduction in cost occurred. While design and construction costs met their contracted value, the cost saving occurred due to the contingency being reduced from 117 to 85 million [49]. Because of this cost reduction, the original benefit-cost ratio of 1:2 was revised to 1:3 for the project [48]. Like the G-Link, Canberra's Light Rail patronage levels have been higher than forecast in the business case [58].

B. Case Study: Differences in Worldviews

All too often, explanations are sought to understand why a transport project deviates from its budgeted and contracted costs. Rarely is the nature of a project's cost reduction examined. For example, scope changes in a project may occur due to other projects within a government's transport portfolio experiencing cost growth, which influences its ability to deliver its expected benefits. Conversely, projects can be delivered ahead of time, under their contracted value, and in accordance with their specified scope [72]. So, rather than only learning from *what went wrong*, contextual knowledge can be drawn to also look at *what went right*.

Considering this milieu, the article now examines the $705 million New Perth Bunbury Highway project (also known as the Forrest Highway—Peel deviation), which was delivered three months ahead of time (see Table II). While some claim the project experienced a cost overrun of "406%" [106, p. 15], others attest it was a success [91] and was "delivered under budget" [3] at a final cost of "$688 million" [106, p. 15]. Of course, people's view of the truth varies depending on their worldview. The point here is that people with different worldviews may look at the same objective facts and will interpret them differently. While having different worldviews can explain a lot about the cost performance of transport projects, there is a potential that some observers may have succumbed to the "illusion of truth" (i.e., a person is more likely to believe a familiar statement than an unfamiliar one) [45].

As mentioned above, it has been consistently reported in the academic literature and the media that nine out of ten transport projects experience cost overruns [37], [38]. Although this claim has been challenged [71]–[73], it has not only influenced decision making within governments but has been used to question their ability to deliver transport projects. Thus, some observers [106] might have reported what the media expected to hear, that is, the New Perth Bunbury High Project experienced a massive "cost blowout" [15]. However, this project was identified as being a "best practice" and supported by both the main political parties [27], [28].

The agenda of the observers above may never be known, but they have maybe presented, in the authors' opinion, a wrong assessment of the cost performance of the New Perth Bunbury Highway project [106]. At this point, a sense of perspective and understanding of the context for a deeper appreciation of whether this project was delivered over or under budget is needed. Hence, the motivation for this article.

A summary of the contextual insights that have been gleaned from the New Perth Bunbury Highway project is presented in Table II. Planning for the project commenced in 1994 as it was recognized that with increasing population and congestion, there was a need to improve the competitiveness of exports from the region.

In December 2000,[2] the government announced that they would deliver the project to taxpayers by 2005–2006 at an estimated cost of $136 million. In a media statement, Criddle and Court said [26]:

> "Currently, this project is not in the Main Roads [the government department] WA program for the next ten years, but with traffic volumes building up rapidly in the area, we are keen to explore all of the options to see if we could build it by 2005-06."
>
> "The project is an ambitious $136 million proposal, and funding is obviously the key issue. We will explore all the options and come up with a realistic timetable for the project."

In 2004, a budget estimate was established, and the projected cost was $340 million and then revised in 2005 to be $510 million. The Minister approved the $510 million budget estimate

2.At the time of the announcement, the route for highway had not been determined. No consideration was given to the complex geotechnical and environmental conditions.

TABLE III
BENEFIT-COST RATIO

Benefit	**Discount Rate**	
	7%	**4%**
Accidental Costs	$635.5m	$925.3m
Vehicle Operating Costs	$461.5m	$747.6m
Commercial Travel Time Costs	$1380.6m	$2187.5m
Maintenance Costs	-$10.8m	-$15.7m
Total Benefits	$2466.8m	$3844.7m
Discounted Project Cost	$481.5m	$468m
Benefit-Cost Ratio	**5.12**	**8.22**

Source: [91, p. 13]

in 2006. Then, the budget estimate increased due to changes in the project's scope, increased land prices, and the rising cost of materials and labor. In addition, the WA economy was experiencing an economic boom. More specifically, the geotechnical (e.g., drainage requirements and Acid Sulphate Soils) and strict environmental conditions requiring approvals contributed to the project's changing scope [91, p. 17]. Despite the increasing costs, the benefit-cost ratio demonstrated that the project would still provide value for money (see Table III).

A competitive alliance procurement strategy was adopted due to the project's size and complexity and the ability to provide greater flexibility to achieve value for money [28]. An alliance "was also selected to manage the project risks, including community and stakeholder concerns, tight completion dates, budget, and the strategic importance of the project to Main Roads and the WA Government. It was also believed that an alliance would focus on solutions, foster innovative thinking, and be driven by the values that incorporate views of stakeholders and the community" [28, p. 89].

In 2006, the Southern Gateway Alliance was appointed to design, construct, and deliver the New Perth Bunbury Highway project in 36 months. Following additional changes in scope, the project's contract value was amended in 2007 to be $630 million and again in 2008 to be $705 million. As a result, the project was finally delivered under budget at the cost of $688 million. At the time of the project's completion in 2009, it was the most significant public road infrastructure project that had ever been undertaken in WA—an achievement in itself.

What can be learned from this project? The government should not have announced its cost without knowing its scope and a rigorous budget estimate. Premature announcements without funding commitments provide fodder for opposition political parties and the media to exaggerate the cost increases that arise when a project is completed. It has been suggested that "governments should have to table business cases in parliament when committing to projects" [106, p. 3]. In stark contrast to analyzing project cost performance "from the first funding promise" [106, p. 3], it is suggested to avoid this practice as it may produce egregious errors in cost estimation and ignore context. It is well known that such promises lack substance. Therefore, why give them credence? Governments are becoming savvy now not to prematurely announce the cost of projects due to the negative publicity that materializes from the media.

The use of an alliance contract provided a mechanism for collaboration and risk-sharing within the project team and with Main Roads. In this instance, Main Roads can manage key risks such as labor and raw materials availability. What is more, Main Roads and the Alliance jointly performed a detailed risk assessment to determine the probability, consequences, and manageability of project risks from numerous perspectives (e.g., technical, financial, organizational, social, and environmental). Design and construction engineering staff were colocated. Therefore, the construction team was involved in the design process and hence improved the project's constructability. Uniquely, the Alliance initiated a "quality of life" work package tailored to the project, which led to the retention and recruitment of high-quality personnel. In sum, the best practices emerging from this project were [28]:

1) well-informed and engaged stakeholders who were actively involved in the project's planning and development;
2) early contractor involvement ensured commitment to the project from the outset;
3) the involvement of a material supplier as a member of the Alliance rather than a traditional subcontractor. The inclusion of a material supplier meant increased certainty regarding the value and supply of raw materials.

Scope changes and cost escalations were the primary reasons behind the constant increases in the budget estimates of the proposed project. However, despite the cost increases, the project was a business case success. The economic boom experienced by WA commenced in 2005 and resulted in significant shortages in labor, increases in the cost of materials, and therefore unprecedented strains of the capacity of contractors. This contextual backdrop cannot be ignored, yet it was cast aside by the media [15] and other observers [106] when reporting the cost performance of the New Perth Bunbury Highway.

V. Discussion

The cases that have been presented explicitly demonstrate that the costs of large-scale transport projects deviate from their contracted values for several reasons (see Tables I and II). Each has its own idiosyncratic context whose complexity and uncertainty matter, yet this is often overlooked. There is a tendency to (over)simplify the causes of cost underperformance and attribute it to solely behavioral bias or narrow it down to design and scope changes from a contract's award [54]. Indeed, environmental and geotechnical risks will invariably be leitmotivs that confront projects, and practitioners should be well aware of these issues when formulating cost estimates. Despite this, the issue at hand is not so much around the formulation of an estimate and the price agreed at contract award but rather the allocation, assessment, and management of risk and uncertainty. After all, strategic and economic decisions influence how risk and uncertainty are managed in projects [72]. Such decisions are typically based on attendant risks and framed by the procurement approach, yet this is an area that has received limited exploration in the cost performance literature. It is only by examining the context and meaning and creating a narrative that which can enable in the interpretation of cost performance to be unearthed.

The LRT projects were procured using different procurement methods, respectively, a PPP and a conventional method (see Table I). Using context criteria such as planning and, in particular, benefit-cost ratio, it can be observed that the rationale for project selection was based on different needs to address population increase and traffic congestion in the case of the G-Link and stimulate economic growth and urban development for the Newcastle LRT.

While the raison d' être for the selected LRTs varies, their benefit-cost ratios, for example, can be compared to ascertain the likelihood of the asset to be future-proofed. The cost performance of transport projects procured by PPPs *versus* conventional methods (e.g., design and construct, and alliances) should not be compared or even considered in the same reference class. If compared, then it would be akin to comparing apples with oranges as the way projects are funded, their risk profiles, and their cost increase mitigation measures differ. However, when considering the risk profile of projects of a similar ilk using techniques such as reference class forecasting (RCF) [35], [36], the context associated with the procurement method may be overlooked. Simply put, RCF is an "upward adjustment on top of the standard budget including contingencies" and therefore is a contingency on a contingency [36, p. 185]. In this instance, an estimate of a project cost becomes grossly inflated through a process of (over)simplification based on the assumption of potential optimism bias. What is more, RCF cannot cater to the uncertainties that reside in large-scale transport projects [54].

The distributional information for cost and time data acquired at various decision points before agreeing on a contract price differs between conventional and PPP procurement approaches [71]. Under the auspices of RCF, for example, the LRT projects identified in Table I would be deemed comparable and, thus, form part of a reference class for forecasting uplifts for a new project of this type. It is, however, inappropriate to combine user-charge (i.e., income-producing) PPPs and variants thereof with projects wholly funded by governments into the same reference class. Nonetheless, there is a need to benchmark projects of a similar breed across their life-cycle to de-risk deviations in forecasted and expected costs.

Many governments turn to PPPs, as there is a perception that they "create fiscal space to enable accelerated implementation of infrastructure projects" [10, p. 7]. However, despite this perception, PPPs are not a substitute for government borrowing, although they can be used to create "space in the short-term in the face of deficit or debt targets" but in this instance, the value for money that can be potentially acquired is diminished when they are "transferred from one level of government to another" [10, p. 7].

In Australia, for example, State Governments adopt a "budget rule" during the planning of a potential PPP, whereby investment and procurement decisions are separated. For example, the investment decision, which seeks to ascertain if a project is worth pursuing, may comprise a benefit-cost analysis and a business case as well as a prioritization. The procurement decision fundamentally aims to determine the method that yields the best value for money. Once the decision to use a PPP has been made, a project will go through the following stages [82]:

1) project development and tendering (i.e., pre-contract stage), which involves inviting expressions of interest, approving a preferred bidder based on the request for proposal and negotiating and finalizing the contract value;
2) project implementation (i.e., post-contract and operations stages), whereby construction and operations are managed and monitored using an array of key performance indicators (KPI);
3) project termination, whereby an ex-post evaluation is undertaken (i.e., outcomes are compared to the forecasts made during the development stage).

In contrast, conventional ways of procuring transport infrastructure projects generally go through a gateway process or the equivalent before the investment decision is made (see Fig. 1). Thus, projects of similar nature (e.g., roads) can be compared. To reiterate, the criteria used to provide context and meaning rely on the details presented in business cases and public inquiries undertaken. The upshot remains the ability to provide a baseline to understand and acquire knowledge about a project's context and meaning.

Determining the reference points in time to measure a large transport project's cost performance remains a significant point of contention [38], [71], [72]. If inroads are to be made to understand better why projects deviate from their forecasted budgets or contractual values, then there is a need for policies to capture cost information using standards that are jointly agreed upon between the public and private sectors.

A. Implications for Theory

Through an abductive case study [101], this article draws and elaborates on "best practices" theories and sheds light on the key yet overlooked role that context (initial and emerging) plays in assessing a project's cost performance. As such, it extends the research presented in Love and Ika [69] and reinforces the importance of understanding the context highlighted in Gil and Fu [40], and thus provides an overarching contribution to the literature.

The theoretical explanations for project behavior and cost performance that have been put forward have been framed around deductive (e.g., behavioral bias) or inductive (e.g., best practices in project management) insights and observations. The upshot is "black" and "white" explanations, which pay lip service to various idiosyncratic contexts, thereby oversimplifying the causes of cost underperformance [79]. Moreover, the proposed theories of cost underperformance have overlooked the generative process of abductive reasoning (i.e., what "maybe") [40], [89, p. 216] and the potential to trigger the generation of "hunches" (i.e., the seeds of new theory) in idiosyncratic project contexts [69], [101, p. 1].

The theoretical context and meaning view espoused in this article epistemologically marry with the inferential process of abduction, enabling "hunches or epiphanies of serendipitous insights" that may contribute to the interpretation and evaluation of project cost performance [101, p. 3]. Hence, through an abductive case study, the research contributes toward creating a "plausible" and balanced theory of cost performance based on the idiosyncratic contexts of project delivery [7], [40], [69]. Steps toward developing a balanced theory have been promulgated by Ika *et al.*'s [54] "Fifth Hand" as it aims to reconcile differences between deductive and inductive based explanations that reside within the literature.

Until now, the cost performance of transport projects procured using different methods has not been given the credence it deserves. In the case of PPPs, they are typically 25-to-30-year projects, with their capital expenditure often only being a fraction of their operational expenditure [5]. Thus, should cost performance be determined at the end of construction or across varying stages of a project's life cycle? Previous studies that have lended support to the use of RCF do not distinguish between PPI (e.g., PPPs) assets. Instead, assets of the same ilk (e.g., rail and road) are lumped into a single reference class [35]–[37]. Yet, the approach to allocating and managing risk varies between PPIs and conventional forms of procurement and, therefore, can influence estimates and contract prices.

The project context, examined in the cases presented, does not provide straightforward answers about the risk appetite of the public sector. However, the procurement method can indicate the extent of risk aversion [78]. For example, suppose scope changes are required for a PPP project. In that case, the public sector will be required to offer a significant premium over and above the nominal cost of the change, with a potentially adverse impact on a project's cost performance. By undertaking an in-depth exploration of a project's context and meaning, profound insights about the nature of decision-making and actual practice can be garnered. More importantly, new ideas for improving the practice of transport infrastructure delivery can begin to emerge.

B. Implications for Practice

Terrill and Danks [106] have proposed a series of robust recommendations that governments can consider to ensure their transport projects are delivered cost-effectively.

1) Benchmarking to improve risk management in new proposals to ensure public accountability.
2) Governments should not be able to commit public money for transport projects unless a "rigorous, independent like-for-like evaluation and the underlying business case have been tabled in the state or federal parliament" (p.7).
3) Making available postcompletion data for projects, such as detailing scope changes and their justification, agreed and actual construction start and finish dates, actual project costs, and progress against performance indicators.

Considering the above discussion of context and meaning and Terrill and Danks's [106] recommendations, additional clarity for policy-makers about determining and evaluating a project's cost performance is needed.

1) Benchmarking Project Performance: Adding to the mix of recommendations provided by Terrill and Dank [106], there is a need for collaboration among government, industry, and academia to establish a standardized nomenclature to capture project completion data to benchmark the performance of projects project (i.e., context, process, and product). Such standardization can assure both reliability and validity in the data. Providing transparency and employing an agreed industry-wide standardized approach to capture data will enable genuine reproducibility and understanding to unfold. Project data can then be stored in a centralized repository that can be shared and drawn upon for benchmarking by the government. Commercial confidentiality issues will be a challenge, but it is pivotal to generate the insights needed to enhance knowledge.

Establishing a collaboration between public-sector agencies on a national and international basis to collate, disseminate and share best practices (i.e., about why projects were completed within budget) can be translated into "practices" guidelines that can provide a mainstay for a project's cost performance. Guidelines can be used to avoid the duplication of research and inform new avenues of exploration. Scholarly journals have a role to play in developing a balanced theory for a project's performance by adopting a similar stance to the one taken by the *Lancet.* Here authors of primary studies are required to explain the relationship between existing and new evidence by making direct reference to prevailing systematic reviews that have been conducted based on "best practices" [29]. Developing balanced explanations for a project's performance will require considerable effort, particularly if strides are made to future-proof infrastructure assets. Considering the above-mentioned discussion, the following recommendation is proposed.

Recommendation 1: Projects need to be benchmarked during the design (i.e., business case to contract award) and construction (i.e., contract award to completion process), and, in the case of PPPs, during their operation. Accountability and transparency are required when assessing a project's overall cost performance. This assessment needs to be undertaken by an independent body with access to all relevant information available and the use of standardized definitions and terminologies.

Enacting a process of benchmarking will improve decision-making and the process of determining project risks. However,

unless decision-making emerges from evidence, large-scale transport infrastructure projects will continue to be delivered over budget, eroding much of their intended benefits and public trust.

2) Recalibrate an Estimate's Detail at the Business Case: The budget estimate (i.e., baseline estimate and contingency) used to support a business case is typically based on a concept design. The objectives of such estimates are to determine baseline costs to deliver a project, compare against competing solutions, and assist with the establishment of budgets. An approved business case provides justification for a project and the allocation of funding required to procure a transport asset. The methods of first principles and unit rates are commonly used to generate a budget estimate [94]. The concept estimate, therefore, needs to take into account all available information and risk contingency assignment. Of note, Australian government agencies charged with delivering transport projects align their risk analysis with the ISO 31000. Thus, they are aware that identifying and quantifying project risks is wholly dependent on context [57]. Within a given context, consideration of uncertainties is needed, and judgment should be used to determine the likelihood of risks emerging. As there is limited available information at the concept stage, scope changes and price increases are "known unknown" risks. However, there are those risks that reside within the realm of "unknown unknowns" such as weather, industrial, labor supply, environmental, geotechnical, quality, and safety issues. Hence, the second recommendation is as follows.

Recommendation 2: There is a need for the business case to use the estimate based on a preliminary design to reduce the cost impact of scope changes and price escalation.

While additional design time and costs will be incurred, a more realistic cost and risk assessment can be made. Moreover, environmental management requirements can be considered and value management enacted. Nevertheless, basing a business case upon a preliminary design will require additional up-front costs and time. As a result, an incumbent government may be reluctant to approve a more detailed cost estimate as it may become unfeasible to deliver the project. Thus, the government could place itself in a situation where it disenfranchises voters of what may have been promised.

3) Reassessment of Contingency Production and Evaluation: Insufficient consideration is given to the contingency assessment as the amount incorporated into an estimate is typically inadequate to accommodate a project's likely cost growth [12], [27], [50]. Additionally, identifying and quantifying risks during the production of an estimate's contingency is prone to behavioral bias (e.g., anchoring, optimism, pessimism, and selection). The baseline estimate produced for the business case will generally be prepared in-house by the department responsible for delivering the transport project and then vetted by an external cost consultant, particularly in the context of a large-scale project. While the base estimate can be rigorously checked, the same amount of interest is seldom given to the contingency. A range of techniques has been used to estimate contingency (e.g., Monte Carlo simulation, factor rating, and traditional percentage). However, the accuracy of these techniques is questionable. For example, Baccarini and Love [12] have shown that a public-sector agency that had used Monte Carlo simulation to produce its contingency estimate needed to, on average, add a further 60% to accommodate the cost growth that occurred in its projects.

To better understand the nature of risks and accommodate them in the contingency developed as part of the business case and subsequent estimates, it is suggested that the public sector engages a maestro who can instigate, lead, and maintain a questioning attitude toward risk and uncertainty [69]. The maestro would have no direct involvement in producing the estimate but would evaluate the contingency's production and provide suggestions to amend the estimate accordingly. Having access to information across the government's portfolio of projects, past and present (e.g., all postcompletion data), the maestro would adopt a line of inquiry where matters such as "what situations have not been foreseen?" "what has been forgotten?" "what could go wrong," and "what went right" are considered [68]. In essence, the maestro would engage in the process of requisite imagination and, therefore, be placed in a position to "anticipate what might go wrong" in the project. Considering the risk and uncertainty associated with cost performance, it is suggested that requisite imagination can help "avert the unwanted outcomes that seem to hide beneath the surface" [4, p. 105].

At this juncture, it should be acknowledged that it is impossible to foresee all the possibilities that affect a transport project's cost performance. Traditional causality and probability analysis approaches cannot cope with unexpected disturbances that negatively impact project costs [76, p.110]. According to Wildavsky [110], having in place strategies of anticipation (i.e., predicting hazards) and resilience (i.e., resources to cope and respond) are essential to managing risk and uncertainty, especially in transport projects. Hence, the third recommendation is as follows.

Recommendation 3: Engage a maestro to undertake a rigorous review of a project's cost contingency for all estimates. In addition, the maestro would work with the selected contractor/consortium to "anticipate" risks and jointly develop a strategy for their mitigation.

To this end, the maestro would encourage their managers and employees and the project teams involved to have a "restless mind" by asking questions [110, p.217]. Noteworthy, creating a restless mindset depends on providing an environment where psychological safety can flourish.

VI. Conclusion

Context matters and meaning counts assessing the cost performance (i.e., increase/decrease) of large-scale transport projects. Yet all too often, transport projects are considered a "damp squib" based upon equivocal information drawn upon by some opposition parties, media, and even academics. As a result, differences in the determination and meaning of cost performance in the face of complexity and uncertainty have left practitioners with mixed, if not ill-advised, recommendations to curb underperformance. This situation has partly arisen due to a lack of an in-depth exploration of context and meaning. Consequently, patterns of inference that can shed light on a plausible explanatory conjecture (an abductive conclusion) of the causes of cost underperformance have gone unheeded.

In filling this void, we have used case studies to describe the context and meaning of the cost performance of large-scale transport projects by drawing on information extracted from

their business cases, audit reports, and public inquires. The context and meaning criteria we used to describe the projects align with how they were evaluated and examined in practice. This article specifically examined differences between procurement approaches (i.e., conventional and nonconventional) and worldviews about how cost performance is determined, which, it has been submitted, can provide a further understanding of the context and meaning surrounding a project's cost performance.

Musing over the observations obtained from the case studies, it is suggested that the process of abduction in conjunction with a context and meaning focus provides an avenue to understand causal inferences better and, therefore, contribute to the development of a plausible theory of project cost performance. Additionally, new ideas for improving the practice of transport infrastructure delivery were proposed. Three practical recommendations to manage the cost performance of projects were put forward: 1) benchmarking project performance; 2) recalibrating an estimate's detail to support the business case; and 3) reassessing how contingency is produced and evaluated. If progress is to be made to improve the cost performance of transport infrastructure projects, then their context and meaning need to be documented using standardized definitions and terminologies so that evidence-based decisions surrounding risk and uncertainty can be enacted.

It is acknowledged that a more profound, qualitative, and in-depth exploration of the context and meaning of the cost performance of large-scale transport projects needs to be undertaken. However, without this abductive case research highlighting the puzzles that influence the interpretation and evaluation of transport project cost performance, the foundations for its potential occurrence would not be in place. Future research is, in particular, required to create a benchmarking framework that can document the context and meaning of a project's performance. Unquestionably, this will be a challenge considering the varying worldviews about the meaning of cost performance. However, this article provides a platform for initiating a conversation about how government and industry can collaborate to develop a program of benchmarking.

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