OPTIMISM BIAS IN TRANSPORT PROJECT COST APPRAISAL: A REVIEW OF THE CURRENT BODY OF KNOWLEDGE

Yizi Eric Chen[1], Dominic Ahiaga-Dagbui, Muhammad Thaheem and Asheem Shrestha

School of Architecture and Built Environment, Deakin University, 1 Gheringhap Street, Geelong, Victoria, 3022, Australia

Optimism bias has been considered an important cause of cost underestimation in transport infrastructure project appraisal in recent project management literature. However, little research has critically examined the current understanding of the nature, dynamics, and impact of this cognitive bias in the context of transport cost appraisal. This systematic review provides a timely assessment of the extant journal articles in this research area. The findings of this review suggest that the presence and nature of optimism bias in the organisational setting of transport project cost appraisal are understudied. The phenomenon needs to be validated in the project planning phases. The interactions between optimism bias and other cognitive biases as well as their synergetic impacts on transport project appraisal, also require further investigations. The nuanced relationship between political pressure and optimism bias in the complex institutional environment in which transport project cost estimating is conducted should be carefully dissected.

Keywords: optimism bias; behavioural decision-making; cost underestimation

INTRODUCTION

The production of early cost estimates for major transport infrastructure projects is a challenging task. Large-scale transport infrastructure projects are often beset with many risks and uncertainties (Love *et al.,* 2021; Miller and Szimba 2015). Many of these risks arise from the time-consuming and complex organising, planning, and implementing processes of major transport projects (Cavalieri *et al.,* 2019). The risks and uncertainties derived from the lengthy and complex nature of transport infrastructure have led to frequent reports of budget overruns on transport projects around the world. Drawing from the data of completed rail, bridge, tunnel and road projects in North America, Europe, Japan and 10 developing countries, Flyvbjerg *et al.,* (2002) found that 86% of the projects experienced cost overruns. More recently, Terrill *et al.,* (2020) reported that AU$34 billion more was spent on transport infrastructure projects in Australia between 2001 and 2020 due to cost overruns. In

[1] chenyizi@deakin.edu.au

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the UK, the new London Crossrail Project was completed more than three years late and cost nearly £4 billion more than the initial forecast (Topham 2020).

The cost performance of a major transport infrastructure project can make a substantive impact on a region's economy. For instance, Allport (2008) records that in Singapore, the Philippines, and Colombia, the budgets for inter-city rail projects before any cost spike account for as much as the annual budgets for multiple central government departments. Currently, countries such as Australia are encouraging the increase of public spending on transport infrastructure provisions and the acceleration of the project schedules to relieve the national economic stress caused by the COVID-19 pandemic. These practices can increase the risks of transport project cost overrun and benefit shortfall because rushing into an expensive transport provision commitment without a robust feasibility study stating a clear scope definition and reliable preliminary cost estimation often heightens the risk of cost and schedule overruns (Love *et al.,* 2014). It is imperative to facilitate the conceptual analysis of the causality of transport infrastructure cost underestimation and provide the basis for using robust empirical methodologies to validate and expand the existing knowledge on the factors and conditions underlying misaligned project forecasts.

LITERATURE REVIEW

Extensive research effort has been devoted to unravelling the causes of transport project cost underestimation. The phenomenon has been explained by: project-specific causes such as changes in the project scope (Love *et al.,* 2014) and political-economic causes such as leadership foul plays (Wachs 1989) and project planners' strategic misrepresentation (Flyvbjerg *et al.,* 2002). A recently popularised explanation is optimism bias, the behavioural tendency to "overestimate the likelihood of positive events and underestimate the likelihood of negative events" (Sharot 2011: 941). Optimism bias is found in individuals' overly optimistic judgments about the chances of experiencing future negative events such as divorce and a heart attack (Weinstein 1980), the length of time for new curriculum developments (Kahneman 2013), the short-term future returns of the US stock market (Ben-David *et al.,* 2013) and the effectiveness of newly discovered cancer treatments (Chalmers and Matthews 2006). Transport project planners are perceived to suffer from the same bias when they underestimate the total cost and overestimate the financial and social benefits of a project under consideration (Buehler *et al.,* 1994, Du *et al.,* 2019, Flyvbjerg 2008, Kutsch *et al.,* 2011).

An initial search of the literature on behavioural decision-making in infrastructure projects reveals several papers that review the concept of optimism bias in the context of transport projects. Cavalieri *et al.,* (2019) and Denicol *et al.,* (2020) organise systematic literature reviews to summarise a large number of determinants of cost overruns and poor project performance in the delivery of transport infrastructures. These reviews acknowledge the potential influences of optimism bias on major infrastructure project cost underestimation among other behavioural, project-specific, and political-economic causes. Stingl and Geraldi (2017) systematically review the theoretical foundations and the negative impacts of a wide range of cognitive biases on general project decision-making. They show that decisions in projects, including the cost forecasts for capital works, are complex and should be explored from the lens of multiple behavioural theories. However, the consulted literature is "fragmented and draws only on a fraction of the recent, insightful, and relevant developments on behavioural decision making" (Stingl and Geraldi 2017: 121).

An elaboration of the previous reviews indicates that there is still a lack of review in the extant literature that critically examines the current body of knowledge about the nature, the dynamics, and the multifaceted impacts of optimism bias in the context of transport infrastructure project cost appraisal. Against this backdrop, this study aims to offer a timely review of what is collectively known about optimism bias in the context of transport project cost appraisal and highlight aspects of the current body of knowledge that are understudied. To achieve this aim, the study adopts a systematic approach to searching, selecting, and analysing literature pertinent to the causal relationships between optimism bias and transport infrastructure project cost underestimation. The systematic literature review enables the integration, parallel consideration and evaluation of the theoretical assumptions, methods and findings presented in the chosen literature, and "foster cross-fertilisation, new ideas and the overall development of the field" (Stingl and Geraldi 2017: 122). By using this review method, this paper contributes to deepening the academic discussions on the issue of optimism bias in the early cost management of transport infrastructure projects.

METHOD

The introductions of the political and psychological causal explanations of transport project cost underestimation open fresh opportunities for multidisciplinary researchers to explore the underlying causes of this perennial issue. What are some of the opportunities? Have the opportunities been adequately addressed in existing transport project cost underestimation research? This study will respond to these questions using a systematic literature review method detailed below.

The systematic literature review process consults the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) guidelines (Moher *et al.,* 2009) and follows the examples from Cavalieri *et al.,* (2019) and Denicol *et al.,* (2020). The systematic review process was completed on the online workflow platform Covidence. The process involved five main steps.

1. A scoping stage that lists the central research themes. The themes are summarised in three keywords: transport infrastructure project, estimate and optimism bias
2. A planning stage that develops a protocol to improve the search quality. The protocol outlines keyword identification, databases selection, synonyms brainstorms and relevant subject area categorisation to improve the search quality.
3. A searching stage that conducts on Scopus, Web of Science and ScienceDirect. The search strings were used in combination with synonyms (for example, transport* AND underestimate* AND optimism bias). The search results were limited to peer-reviewed journals published in English by April 2022.
4. A screening stage that stores the search result. Titles and abstracts which did not address optimism bias and infrastructure project management were deemed irrelevant and were removed.
5. A full-text review and data extraction stage that finalises the selection of texts for data extraction. Adapting from the Cochrane Data Extraction and Assessment Template, the lead author extracted information about the research aim, hypotheses, study design, projects concerned, theories consulted, interventions (if applicable) and outcomes.

The search returned a total of 1079 papers in the three databases. After the removal of duplications (n=65), 71 articles met the criteria for the title and abstract screening (941 papers deemed irrelevant) and were assigned to full-text reviews. The full-text review process led to the removal of an additional 50 papers. Among them, 31 studies examine optimism bias in settings other than transport infrastructure project cost appraisal, 14 studies focus on transport project cost underestimation causes other than optimism bias and 5 studies focus on the statistical characteristics of transport project demand shortfalls. In the end, 21 papers were selected for quality assessments and data extractions. The five-step process, along with the outcomes of each step, is visually summarised in Figure 1.

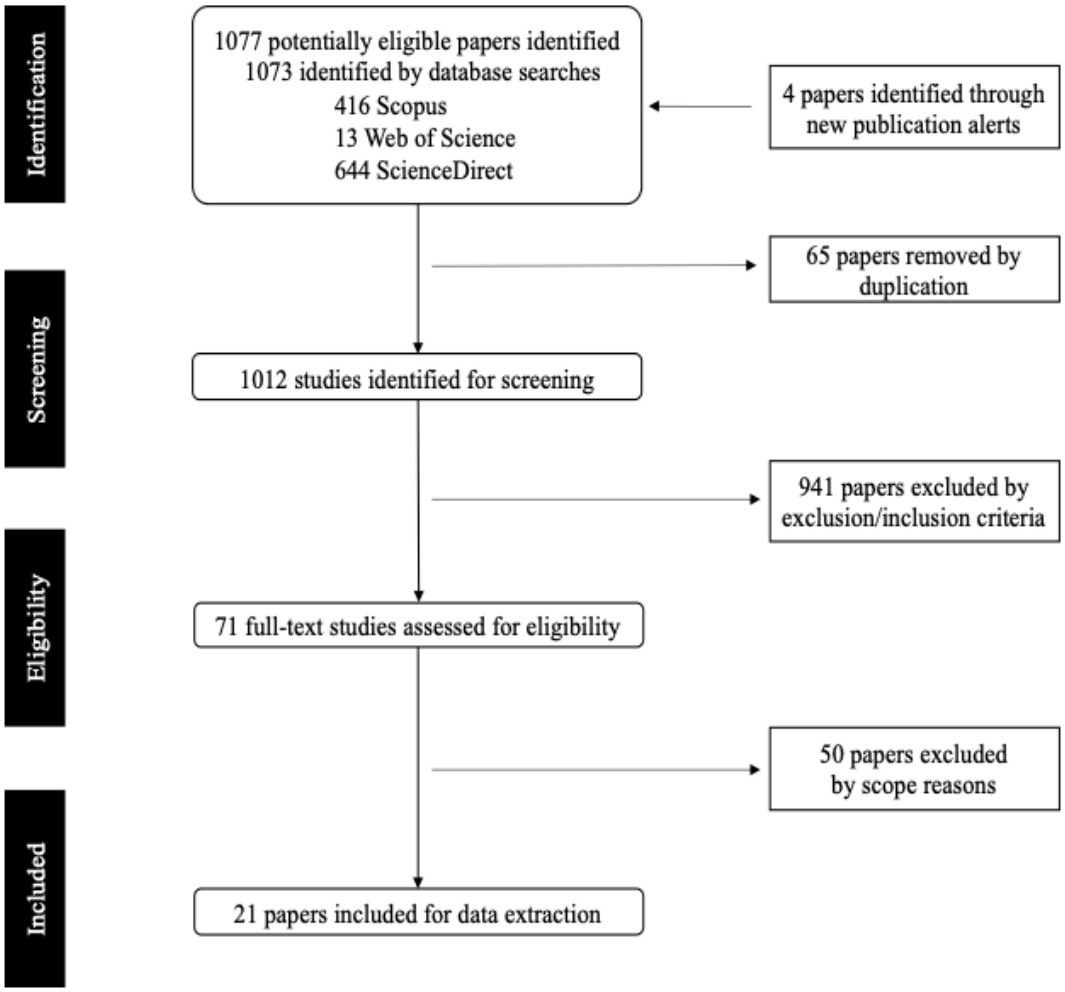

Figure 1: A summary of the systematic review process conducted on Covidence

FINDINGS

Information extracted from the selected literature facilitates the identification and synthesis of the key findings of this review. The following findings will be discussed in this section. Firstly, the presence and nature of optimism bias in the organisational setting of transport project cost appraisal are understudied. Secondly, the interactions between optimism bias and other cognitive biases and their synergetic impacts on early project appraisal in the context of transport infrastructure development requires more comprehensive investigations. Thirdly, the nuanced relationship between optimism bias and strategic misrepresentation is indicated in the literature but clear

articulations and methodological innovations are needed to uncover a deeper connection between these two cost underestimation causes.

Optimism bias in the organisational setting of transport project cost appraisal
As identified in the introduction, optimism bias has been widely cited as an important cause of transport project cost underestimation. However, Love *et al.,* (2016, 2021) and Du *et al.,* (2019) maintain that the presence of optimism bias in transport project cost appraisal is still not well supported by empirical evidence. In particular, while optimism bias is well studied at the individual level (Weinstein 1980, Ben-David *et al.,* 2013, Chalmers and Matthews 2006, Lovallo and Kahneman 2003, Seaward and Kemp 2000), evidence of its presence and impacts at the group level, which better reflects the organisational setting of transport project cost appraisal, remains scarce (Du *et al.,* 2019, Ika and Pinto 2020, Love *et al.,* 2021). Du *et al.,* (2019: 45) claim that "[t]hus far, little has been done to address the group level optimism bias in capital projects, measured as the delta between group judgement and statistically realistic judgement".

It is unclear that the findings of over-optimistic judgements about future events at an individual level are valid in the transport project planning setting. At a minimum, the cost appraisal of a major transport project involves a project control group (which consists of internal project planners and external consultants) to estimate and verify budget forecasts and a project governance team to decide upon design options and funding strategies (Berechman 2018, Du *et al.,* 2019, Love *et al.,* 2021, Siemiatycki 2009). Other research that documents the early decision-making procedures in case studies of transport infrastructure has shown that opinions from project sponsors, external consultants and professional engineers and estimators are considered, and decisions are generally made carefully in the planning phase (Farooq *et al.,* 2018, Gil and Fu 2021).

The literature reviews conducted by Stingl and Geraldi (2017), Cavalieri *et al.,* (2019), and Denicol *et al.,* (2020) did not highlight this gap in the extant research. The absence of empirical evidence of the causal relationship between optimism bias and cost underestimation has significant implications for the credibility of any policy that introduces a debiasing strategy to the early cost forecasts of transport projects (Flyvbjerg *et al.,* 2016, Allport 2011). Policies safeguarding the cost and social performance of publicly funded infrastructure projects must follow sound and accountable empirical evidence (Fridgeirsson 2016, Siemiatycki 2009, Love *et al.,* 2021).

Optimism bias and other cognitive biases in the appraisal process
Among the reviewed articles, Love *et al.,* (2021), Flyvbjerg (2021), Winch (2013), and Leleur *et al.,* (2015) explicitly acknowledge the potential impacts of cognitive biases other than optimism bias in transport project cost underestimation. Love *et al.,* (2021: 6) highlight that the influence of other cognitive biases on transport project "cost contingency (and estimate)" is not well studied. One such bias underlined by both Flyvbjerg (2021) and Winch (2013) is the escalation of commitment. This bias concerns the tendency for project sponsors to "justify increased investment in a decision, based on the cumulative prior investment, despite new evidence suggesting the decision may be wrong" (Flyvbjerg 2021: 532). Winch (2013) demonstrates through a case study of the Channel fixed link between France and the UK that committed escalation is a significant factor in the budget and schedule overruns. Leleur *et al.,* (2015) introduce overconfidence bias to the inquiry of overly optimistic

cost estimates in transport infrastructure investments. The paper suggests that "people in general (including experts) are unaware of their lack of capability to indicate a complete range of variation" (Leleur *et al.,* 2015: 368-369).

Developing upon Stingl and Geraldi's (2017: 133) call for "a more critical examination and exploration of the pluralism of theories" in behavioural decision-making research, this review specifies that future transport infrastructure research should pay more attention to the dynamic interplays between optimism bias and other cognitive biases and their synergetic impacts on project appraisals. While escalation of commitment and overconfidence bias indicate different human tendencies in project management, both suggest incentives to underestimate the costs of transport projects. Nonetheless, it should be noted that different combinations of cognitive biases could cause a very similar phenomenon. The difficulties in pointing out "which specific behavioural bias is causing outcomes in a given situation" and establishing a clear distinction between cognitive biases such as overconfidence and illusion of control are recognised in the wider behavioural decision-making literature (Thaler 2015: 295, Shore, 2008).

Understanding overly optimistic estimation in the context of strategic misrepresentation

In addition to the influences of other cognitive biases, special attention should also be given to considering the impacts of strategic misrepresentation on overly optimistic transport project cost forecasts. Based on the definition described in the review of the causal landscape, Flyvbjerg (2021) considers strategic misrepresentation a political bias. The relationship between strategic misrepresentation and optimism bias has been portrayed as a "complement" (Flyvbjerg 2008: 6). This is built on the arguments that both explanations contribute to project cost underestimation and that strategic misrepresentation is more impactful when the political and organisational pressures in project appraisal are higher (Flyvbjerg 2008, Love and Ahiaga-Dagbui 2018).

Nevertheless, a review of the pertinent literature shows that the relationship between strategic misrepresentation and optimism bias is potentially more nuanced than the proposition summarised in Flyvbjerg (2008) and Cavalieri *et al.,* (2019). For instance, Winch (2013: 730) evaluates the Channel fixed link project and states that the sustained mutual suspicion between the project's financiers and construction contractors and the strong persuasions by politicians for continued investment by the financiers are the two factors facilitating "escalation of commitment in the context of strategic misrepresentation of the original business case".

In this example the author scrutinises the chain of events that leads to project cost underestimate in a complex institutional environment. This approach can be more effective for ascertaining the presence and nature of a cognitive bias than using the deductive methods such as simple questionnaires to collect segmented and superficial responses and establish plausible evidence. An inductive inquiry that utilises contextual sensemaking and narrative analysis of the transport infrastructure decision-making process, project changes, and project risk impact on process and product has been proposed by Ahiaga-Dagbui *et al.,* (2015, 2017) to substantiate the implied interactions of optimism bias and strategic misrepresentation.

A further review of the research design of the chosen articles finds that similar in-depth investigations are used by Odeck and Kjerkreit (2019), Hayasaka *et al.,* (2018) and Love *et al.,* (2017). However, the review also observes that Chadee *et al.,* (2021) and Du *et al.,* (2019) use Likert scale questionnaires to extrapolate the exhibition of

optimism bias in project planners. Whilst current researchers are experiencing a shift from technical and engineering-managerial causal explanations to psychological and political explanations in transport cost underestimation causal investigations (Kelly *et al.,* 2015, Salling and Leleur 2017), a methodological shift towards true-experimental research designs to elicit more robust and insightful conclusions should also be encouraged (Fridgeirsson 2016, Love *et al.,* 2019).

CONCLUSIONS

A systematic literature review of the peer-reviewed journal articles pertinent to optimism bias and transport infrastructure project cost underestimation was undertaken in this paper. The review aims to take stock of the current body of knowledge about optimism bias in the cost appraisal of transport projects and identify the areas of weakness and future research opportunities. The review shows that the presence and nature of optimism bias in the organisational setting of transport project cost appraisal are largely understudied. The interactions between optimism bias and other cognitive biases and their synergetic impacts on transport project appraisal require further investigations. The relationship between political pressure and optimism bias in the complex institutional environment of the cost appraisal phase of transport projects is more nuanced than indicated in the existing research.

Building on the discussions about the causal relationships between optimism bias and transport infrastructure project cost underestimation, future research should help to test methodologies that are more capable of gathering empirical evidence for verifying optimism bias and contemplating the deep connections between political pressure and optimism bias at the organisational level in complex project planning. An option could be using inductive research methods instead of traditional deductive methods, such as standard surveys, to contextualise the complex chain of events in the project cost estimating decision process. Additionally, it is necessary to pay extra attention to the systemic and multiple root causes of cost underestimation commonly seen in major infrastructure project deliveries.

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