Transportation Research Part A 92 (2016) 184–194

Contents lists available at ScienceDirect

Transportation Research Part A

journal homepage: www.elsevier.com/locate/tra

Cost overruns in transportation infrastructure projects: Sowing the seeds for a probabilistic theory of causation

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ARTICLE INFO

Article history:
Received 3 December 2015
Received in revised form 26 July 2016
Accepted 3 August 2016
Available online 18 August 2016

Keywords:
Infrastructure
Cost overrun
Causal reasoning
Probabilistic causation
Mechanisms
Dependencies

ABSTRACT

Understanding the cause of cost overruns in transportation infrastructure projects has been a topic that has received considerable attention from academics and the popular press. Despite studies providing the essential building blocks and frameworks for cost overrun mitigation and containment, the problem still remains a pervasive issue for Governments worldwide. The interdependency that exists between 'causes' that lead to cost overruns materialising have largely been ignored when considering the likelihood and impact of their occurrence. The vast majority of the cost overrun literature has tended to adopt a deterministic approach in examining the occurrence of the phenomenon; in this paper a shift towards the adoption of pluralistic probabilistic approach to cost overrun causation is proposed. The establishment of probabilistic theory incorporates the ability to consider the interdependencies of causes so to provide Governments with a holistic understanding of the uncertainties and risks that may derail the delivery and increase the cost of transportation infrastructure projects. This will further assist in the design of effective mitigation and containment strategies that will ensure future transportation infrastructure projects meet their expected costs as well as the need of taxpayers.

1. Introduction

Investment in transport infrastructure (e.g., roads, bridges, ports, railways) is required to meet the growing needs of an increasing population, as well as to sustain a competitive advantage in the global marketplace. For an economy to position itself to capitalize on growth and increased investment due to a burgeoning population and increasing international demand for goods and services, greater investment in transportation infrastructure is needed. In Australia, for example, it has been forecasted that over the next two decades the number of trucks on its roads will increase by 50%, rail freight by two-thirds and shipping containers through ports will double; international and domestic travel through capital city airports will double; and technology will play a significant role in meeting the needs of transport, while also improving safety (Australian Federal Government, 2014a,b). Yet history indicates that the capital expenditure (CAPEX) of transportation infrastructure projects routinely overrun their initial cost estimates leaving asset owners, financiers, contractors and the public dissatisfied (Flyvbjerg et al., 2005; Flyvbjerg, 2007; Love et al., 2015a). This is not an unusual situation for infrastructure projects, as it has been observed that on average, 48% of them fail to meet their baseline time, cost and quality objectives

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http://dx.doi.org/10.1016/j.tra.2016.08.007
0965-8564/

(Caravel Group, 2013). Well-known Australian projects that have attracted the attention of the popular press due to cost overruns include the Melbourne's Southern Cross Railway Station, Sydney Cross City Tunnel, Brisbane's RiverCity Motorway and the M7 Clem Jones Tunnel (Regan et al., 2015).

If the CAPEX of a project overruns, then the scope of works in others being considered or undertaken by Government's may be reduced to accommodate the increased expenditure. Moreover, contractors could face cash flow issues, liquidity and damage to their business image while the public has to pay more when the taxpayer funds projects. This may also have a knock-on effect on the funds available for maintaining and operating the asset. For Governments, managing the cost performance of their portfolio of transportation infrastructure projects is essential for ensuring the economic competitiveness and wealth for its constituents; it is a critical metric, as it quantifies the cost efficiency of the work completed. Cost performance is generally defined as the value of the work completed compared to the actual cost or progress made on the project (Baccarini and Love, 2014). The ability to reliably estimate the final cost of construction is vital for maintaining the planning and resourcing in other projects or those in the pipeline.

A cost overrun has been defined as the ratio of the actual final costs of the project to the estimate made at full funds authorization measured in escalation-adjusted terms (Merrow, 2011). In this instance, a cost overrun is treated as the margin between the authorized initial project cost and the real final costs incurred after adjusting for expenditures due to escalation terms. Despite the considerable amount of research that has been undertaken, cost overruns are a pervasive problem (e.g., Flyvbjerg et al., 2002; Bordat et al., 2004; Odeck, 2004; Vidalis and Najafi, 2004; Cantarelli et al., 2012a,b,c; Odeck et al., 2015; Love et al., 2013, 2015a,b; Verweij et al., 2015). If cost overruns are to be mitigated, then there is a need to be able to determine whether a set of events or propositions can be validated and their causal relationships can be accepted as being true; at present, neither can be corroborated. This paper briefly reviews the normative literature and proposes that there is a need to develop a probabilistic theory of cost overrun causation so that effective strategies can be developed to ensure transportation projects can be successfully delivered.

2. Cost overruns: Points of conjecture

Reported cost overruns have been found to vary significantly between studies in various countries; ranging, for example, from −11 to 106% (Pickrell, 1990), −59% to 183% (Odeck, 2004), and −12% to 70% (Love et al., 2014). A primary reason for the disparity between studies is the 'point of reference' from where the cost overrun is measured. Within the planning fraternity, cost overruns have been generally determined as the difference between initial forecasted budget and actual construction costs (Cantarelli et al., 2012a). Between the initial forecasted budget of construction costs and the commencement of construction, several estimates will be prepared and refined before being lodged for approval. Odeck (2004) has however, suggested that the reference point for determining a cost overrun should be at the detailed planning stage where design, specification and final cost are determined. The use of the aforementioned different reference points provides varying results, in the case of road projects for example, Flyvbjerg et al. (2002) provides a mean cost overrun of 20% whereas Odeck (2004) revealed a more modest mean cost overrun of 7.9%.

Most large publicly funded projects tend to go through a long definition period after project inception during which many changes to scope and accompanying costs occur (Allen Consulting and the University of Melbourne, 2007). It would seem misleading in some cases to make direct comparisons between the initial estimate at the 'time of decision-to-build' and that at project completion, particularly if the estimate at the 'time of decision-to-build' is only based only on a conceptual design (Love et al., 2015b). As suggested by Ahiaga-Dagbui and Smith (2014b), a more valid explanation of a cost overrun would need to factor-in process and product, as well as changes to scope and specification. With changes in scope, the fees of consultants may increase as well. Consequently, this may lead to the pre-construction phase incurring significant cost increase (Ahiaga-Dagbui and Smith, 2014b). A point to also consider is the tendency for Governments to anchor themselves to the initial budget estimate and subsequently inform the public of the estimated cost of a project without providing any form of *proviso*. The time between the establishment of the initial budget and the letting of contracts for construction may be lengthy; prices of materials and labor can increase. Moreover, as more information becomes readily available during the design process scope may change, which can also lead to increases in cost.

2.1. Schools of thought on cost overrun causation

Two predominant schools–of-thought have emerged from the on-going discourse regarding the sources of cost overruns (Ahiaga-Dagbui and Smith, 2014a). These are the 'Evolution Theorists' who suggest that overruns are the result of changes in scope and definition between the inception stage and eventual project completion (e.g., Odeyinka et al., 2012). Sometimes scope changes may account for up to 90% of what are traditionally called 'overruns' (Auditor General of Western Australia, 2012). The other school-of-thought, is the 'Psycho Strategists' (i.e., which is a combination of psychological contributors and business strategy) attribute overruns to deception, planning fallacy and unjustifiable optimism in the setting of initial cost targets (e.g., Flyvbjerg et al., 2002; Siemiatycki, 2009). Fig. 1 combines these two approaches to provide an overview of the complexity associated with the nature of cost overrun causation (Fig. 1).

There has been a widespread campaign by the 'Psycho Strategists' that *optimism bias* (i.e. the underestimation of risks and overestimation of benefits) and *strategic misrepresentation* (i.e. deception) can adequately explain why transportation