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Off the rails: The cost performance of infrastructure rail projects

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ABSTRACT

Governments in Australia place great emphasis on the development and expansion of their rail networks to improve productivity and service the increasing needs and demands from businesses and commuters. A case study approach is used to analyze the cost performance of 16 rail projects constructed by a contractor between 2011 and 2014, which ranged from AU$3.4 to AU$353 million. Findings indicate that scope changes during construction were the key contributors that lead to the amendment of each project's original contractual value. As a result, there is a need for public and private sector asset owners to establish a cost contingency using a probabilistic rather than a deterministic approach to accommodate the potential for scope changes during construction. To improve cost certainty during the construction of rail projects, it is suggested that use of collaborative forms of procurement juxtaposed with the use of Building Information Modelling and Systems Information Modelling are implemented. The utilization of such technological and process innovations can provide public and private sector asset owners charged with delivering and maintaining their rail networks with confidence projects can be delivered within budget and are resilient to unexpected events and adaptable to changing needs, uses or capacities.

1. Introduction

Investment in rail infrastructure is critical for improving the Australian economy's productivity and competiveness. The Federal and State Governments have placed great emphasis on the development and expansion of their urban, non-urban and freight rail networks (Infrastructure Australia, 2016); in doing so, it may require the construction of new stations and tracks, extensions to existing lines, electrification of suburban networks, amplification and line upgrades and maintenance. It is, therefore, necessary that existing rail infrastructure is maintained to the highest standards and upgrades and new projects are completed on schedule so as not to adversely impact businesses and commuters. There is however a propensity for rail projects, irrespective of their size (i.e. in terms of contract value) in Australia to experience cost overruns (Terrill and Danks, 2016). Moreover, 'large' urban rail projects (i.e. in excess of AU$500 billion) such as the Gold Coast light rail, Moreton bay rail link, Sydney light rail and the Perth-Mandurah rail line have experienced significant cost overruns; the multitude of interdependent components and interfaces that exist when integrating infrastructure amplify the likelihood of cost overruns occurring (Terrill and Danks, 2016).

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Evidence indicates that the problem of cost overruns is a worldwide phenomenon for rail infrastructure projects (e.g., Flyvbjerg et al., 2002; Leavitt et al., 1993; Cantarelli et al., 2012a,b,c). For example, in the United Kingdom (UK) the Edinburgh Tram System experienced a cost overrun in excess of 100%. In the United States (US), for example, several high profile rail projects have experienced significant overruns, namely (Grabauskas, 2015): the US$1.8 billion central link light-rail project in Seattle was 38% over budget; Phoenix's US$1.07 billion East Valley light-rail project was 31% budget; San Francisco's US $1.2 billion airport heavy-rail project, 30% over budget; and Los Angeles' US$3 billion heavy-rail red line project, 47% over budget. These cases reiterate a never ending story for taxpayers; shortfalls in construction costs result in increased debt and thus increases in taxes, which can often span generations to repay the borrowed monies of government. This situation has become clearly the case in Honolulu rail transit project that commenced in 2008, which was expected to cost US$4 billion to construct (Mangieri, 2016) and is expected to exceed US$10 billion upon completion.

A major contributor of construction cost increases that have been experienced in the Honolulu rail transit project has been the limited supply of labor and the increasing cost of materials (Prevedouros, 2016). When preparing the budget estimate for project, forecasting the supply and demand of labor and materials is an arduous task, and in some instances, may be impossible to determine, especially when estimators have to calculate construction costs months or even years in advance; in this instance 'uncertainty' prevails and 'guesstimating' occurs (Sing et al., 2012a,b). In the case of the Sydney light rail project, for example, under estimation of the cost of moving utilities such as power cables significantly contributed to increased construction costs (Saulwick, 2014); this also occurred during the Edinburgh Tram System. Importantly, 'as-built' documentation for power cables seldom exist and if they do or they are often inaccurate (Love et al., 2016a). With different cities being characteristically unique (i.e. in terms of their history, layout and structures), it is unrealistic to assume that an accurate forecast of the location of underground utilities can be undertaken. A 'provisional sum' (i.e. an allowance for undefined work), is therefore, typically provided when this situation arises (Smith et al., 2016). A design contingency (i.e. allocated for changes during design for factors such as incomplete scope definition and estimating inaccuracy) is required and subsequently reduced as more information becomes available. Prior to the commencement of construction, a contingency (i.e. where any unresolved design issues at the time of contract award are incorporated into the estimate/contract price) is also needed, though this often calculated deterministically rather using a probabilistic approach (Baccarini and Love, 2014; Love et al., 2015a; 2016b).

Research undertaken by Flyvbjerg et al. (2002) and Cantarlli et al. (2012c), for example, have provided an initial platform for understanding cost overruns in rail projects, particularly those classified as being 'mega' (i.e. in excess of $1 billion), in their size and complexity. Issues surrounding strategic misrepresentation, optimum bias and political machinations abounding have been over-emphasized in the planning and transport literature (e.g., Siemiatycki, 2009), with much of the research propagated being incorporeal (e.g., Love et al., 2012a; Osland and Strand, 2010). Explanations of this nature, however, have attracted the interest of the media and when appropriate to opposition political parties and undoubtedly served as a point of reference to begin to understand why mega rail projects experience cost overruns (Terrill and Danks, 2016).

Rather than focusing on 'large' and 'mega' projects, which have tended to be the focus of previous research studies in this area, an exploratory case study approach is used to analyze the cost performance of a combination of public and private sector rail projects constructed by a contractor between 2011 and 2014, which ranged from AU$3.4 to AU$353 million. While the public and private sector asset owners are diverse, the processes, procedures and technologies used by the contractor for rail projects were identical in nature. The research that is presented provides a much-needed context to further explain the nature of cost overruns and how to mitigate their occurrence.

2. Cost overruns and rail projects

Two schools of thought have evolved to explain the nature of cost overruns in the transportation literature, these being the 'Evolutionist' and 'Psycho Strategists' (Love et al., 2016). Each approach provides a platform to recognize the extent and issues contributing to the cost overrun problem, but they are unable to provide a robust and balanced causal explanation of this phenomena. Considering the absence of a theory of cost overrun causation, Love et al. (2016) have suggested that a pluralistic probabilistic approach is required to accommodate the interdependencies that exist between causes so as to provide public and private sector asset owners with a holistic understanding of the uncertainties and risks that may derail the delivery and increase the cost of their transportation projects.

While there have been a significant amount of studies that have examined cost overruns in road projects (e.g. Bordat et al. 2004; Odeck, 2004; Vidalis and Najafi, 2004; Liu et al., 2010; Cantarelli et al., 2012a,b,c; Love et al., 2015a; Odeck et al., 2015; Verweji et al., 2015; Terrill and Danks, 2016), the number that have focused on rail projects has been limited (e.g., Pickrell, 1990; Fourace et al., 1990; Leavitt et al., 1993; Dantata et al., 2006); more research is needed to understand the dynamics and nuances of rail projects so as to contribute to the development of a theory of cost overrun causation.

The sample size of rail projects that have been examined has been small, ranging from as low as 10 (Pickrell) to a maximum of 169 (Cantarelli et al., 2012c). According to Flyvbjerg (2007) rail tends to experience the largest cost overrun of all the types of transportation projects with a mean of 44.7%. The reported mean cost overruns, however, differs significantly between studies in various countries; ranging, for example, 50% in the US (Pickrell, 1990), 10.6% in the Netherlands (Cantarlli et al., 2012c), and 17% in Sweden (Lundberg et al., 2011). A primary reason for this observed disparity between studies is the 'point of reference' from where the cost overrun is measured (Love et al., 2015a; Love et al., 2016a). Within