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Managing rail infrastructure for a digital future: Future-proofing of asset information

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A B S T R A C T

Rail infrastructure that operates at its optimum will be economical and sustainable and thus positively contribute to the productivity and competitiveness of an economy. The health of rail infrastructure, however, needs to be monitored, measured and maintained, which falls within the remit of asset managers who are often charged with balancing costs, opportunities and risks against the desired performance of the assets and their respective systems at varying levels. Having appropriate and reliable information about an asset is pivotal for enabling asset management to support decision-making, planning and execution of activities and tasks of assets, particularly during operations and maintenance. But, having access to the right information at the right time, has been and remains a pervasive problem, hinders an asset owner's ability to ensure their rail infrastructure performance is being optimized. A new approach to facilitate the acquisition and integration of information to support digital asset management (DAM) for rail infrastructure is presented. The research uses a case study to empirically assess the quality of 'as-built' documentation for electrical systems of Bayswater railway station that forms an integral part of the Forrestfield Airport Linkage project, in Perth Western Australia. Errors, omissions and information redundancy contained within the existing 'as-built' documentation is quantified. Then, a case for the adoption of a Systems Information Model is put forward as the rail industry moves toward a digital future and seeks to future-proof their assets and networks.

1. Introduction

"The best way to predict the future is to create it"

(Peter Drucker)

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Rail forms a critical part of the transport infrastructure cadre that is needed to service and improve the productivity and performance on an economy (ARA, 2015). The construction of resilient rail assets and networks that are able to withstand or recover swiftly from demanding conditions and unexpected events is essential for ensuring their future-proofing. In response to climate change and the need to obtain economic efficiencies throughout an asset's life, many governments worldwide have begun to embark on a process of future-proofing. But, the design, construction and maintenance of resilient rail assets and networks that are able to

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cope with foreseeable risks are a challenge. Presenting an even greater challenge are those risks that are difficult or even impossible to foresee. Such risks arise from low-probability, but potentially have severe consequences materialising from complex inter-dependent processes with wicked uncertainties (Blockley, 2015).

Wicked problems are difficult or impossible to solve because of incomplete, contradictory and changing requirements that are often difficult to recognise. Climate change has been identified as a wicked problem for Australian governments (Verweij et al., 2006; NCCARF, 2013). The traditional approach to policy development (i.e. an orderly and linear process, working from problem to solution) is therefore inadequate to deal with such problems, particularly the future proofing process (APSC, 2012). For governments, the climate change problem has many interdependencies that are often multi-causal (NCCARF, 2013). Thus, to address this wicked policy problem, particularly in the context of future proofing rail infrastructure, there is a need for a coordinated and interrelated response, given its multi-causal nature. The Australian public sector has acknowledged that to address issues surrounding climate change and ensure assets are future proofed there is a need to stimulate and nurture innovation (APSC, 2012).

Recognising the increasing complexity and the role that the private sector can play in providing innovative solutions to future proof rail infrastructure, particularly during the design process, governments have embraced non-traditional procurement strategies to deliver their assets (Love et al., 2017a). For example, an alliance with a contract value of AU$600 million was used to deliver the works between Southern Cross Station and Hopkins Street, Footscray, as part of the State government's strategy to provide improve links between Melbourne and Maribyrnong River in regional Victoria. Juxtaposed with the use of non-traditional procurement strategies, governments have also turned to adopting technological innovations enabled by digitisation such as Building Information Modelling (BIM), to generate, build and manage rail infrastructure data throughout their lifecycle. For instance, the New South Wales Government mandated the use of BIM on AU$8.3 billion Sydney's Northwest Metro project to reduce construction and maintenance costs. Similarly, London's £14.8 billion Crossrail project in the United Kingdom (UK) is relying on the use of BIM to create a field verifiable 'as-built' models that can be used to effectively and efficiently manage assets and the network during its operations and maintenance.

While many governments worldwide are actively addressing the future-proofing process, there is a paucity of empirical evidence to indicate that the use of non-traditional project delivery mechanisms and digitization can provide cost efficiencies and value for money throughout an asset's lifecycle, especially for rail infrastructure (Love et al., 2017a,b). Indeed, a complex network of issues need to be considered when addressing the wickedness associated with future proofing of rail infrastructure, but unless fundamental problems are addressed, then attempts to redress them by governments will remain futile unless policy is challenged and amended to accommodate future practice.

In concordance with the recommendations provided in numerous Australian government initiated reports (e.g., Productivity Commission, 2014) and drawing on the authors phenomenological research (Lui et al., 2016, 2017), non-traditional procurement methods are well positioned to drive innovation and the change needed to develop resilient and adaptable rail infrastructure. While headway is being made in developing policy to ensure the resilience of rail infrastructure, the approach being adopted remains somewhat linear in nature, particularly the way in which the information needed to effectively manage, operate and maintain assets is acquired. The upshot is rail infrastructure vulnerability, which can have physical, social and economic consequences, especially when electrical systems are defective, malfunction or are damaged. Simply put, without a power supply rail networks are unable to operate, which will reverberate adverse economic and social corollaries throughout an economy.

Against this contextual backdrop, the research presented in this paper makes a contribution to the future proofing of rail infrastructure by empirically demonstrating that the prevailing approach to documenting and managing information for electrical systems is ineffective and can result in a quagmire whereby the asset's integrity is jeopardised. This is undertaken using a case study of the existing Bayswater railway station that forms an integral part of the Forrestfield Airport Link (FAL) project. Rather than simply propagating a solution that the Public Transport Authority (PTA) in Western Australia (WA) should adopt in the future to tackle the issues surround the management of information, an innovative way to document and manage electrical information that is enabled by digitization using a Systems Information Modelling (SIM) is presented. The potential productivity and information management benefits enabled by using SIM were acknowledged by the PTA. A decision was taken to embrace SIM, which has provided the PTA with a catalyst to enact changes to their work practices.

2. Toward digital asset management

Large-scale capital intensive rail infrastructure projects are susceptible to experiencing increases in their capital expenditure[1] (CAPEX) (Love et al., 2017b). In Australia, for example, the Gold Coast light rail has been reported to run approximately AU$350 million over budgeted CAPEX (Coulton, 2016) and the Perth to Mandurah rail project an increase well in-excess of $250 million (Spagnolo, 2007). Research undertaken by Love et al. (2017b) revealed that CAPEX increases from the award of construction contracts were predominately due to change orders. Equally, it has been revealed by Crossrail (UK) that an increase of £1 billion to the tier 1 contracts will be incurred due to design changes and low initial bids were received during low levels of construction activity within the marketplace (Prior, 2017).

[1] Terrill and Danks (2016) examination of 836 transport projects between 2001 and 2015 revealed large cost overruns are uncommon, but when they do occur they can be expensive. That is, 90% of the total of cost overrun that was experienced for the sample, in dollar terms, was attributable to only 17% of projects.