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Challenges in infrastructure asset management

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Abstract: Infrastructure owners are facing a number of challenges in an increasingly difficult economic and political setting, and are seeking novel approaches to are required to meet the demands of operators, shareholders and other stakeholders. Owners are demanding greater value, for less overall cost, from their assets. New technologies enable higher performance and greater safety, but at a price. Initial purchase costs are rising, leading to longer periods in service. Maintenance requires a more highly skilled, and so more expensive, workforce. This paper summarises the outputs of two industrial workshops carried out in the UK and USA targeted at identifying the major challenges faced by infrastructure owners and operators. These challenges provide guidance to the academic community for directing research activities to address the needs of industry, thus delivering maximum impact.

Keywords: Asset management; whole-life cost, infrastructure management, maintenance, investment.

1 INTRODUCTION

Asset owners and managers face complex challenges in maintaining a state of good repair for transportation infrastructure assets. Most developed nations undertook an enormous investment in construction of infrastructure such as highway networks in the second half of the 20th century. This investment has helped catapult the countries' economic growth – but maintaining this huge infrastructure is now proving to be an enormous financial strain. In the US, 57% of total spending on infrastructure in 2014 has been towards operation and maintenance of existing infrastructure assets and this has been rising by about 6% over 2003-14 (Congress, 2014). However, there is general consensus that the level of investment is not increasing in line with the requirement, leading to worsening state of infrastructure assets. Figure 1 shows the transport infrastructure spending as a share of GDP, clearly showing a decline in most countries. In the UK, there are rising concerns about the low level of spending on infrastructure compared to its OECD peers (OECD, 2015).

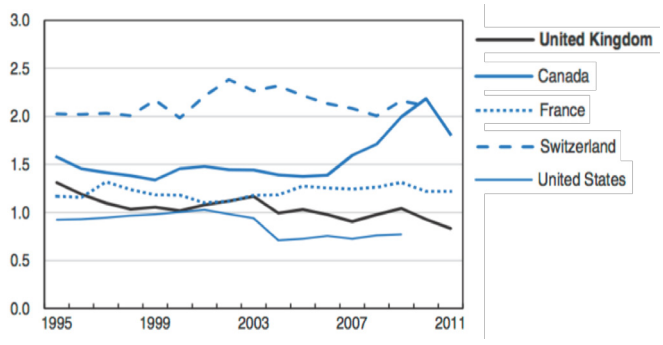

Fig. 1: Transport infrastructure spending as a percent of GDP (adapted from OECD (2015))

New regulations, such as MAP-21 (Congress, 2012) and (Congress, 2015), have created new requirements that further challenge managers in forecasting deterioration to prioritize preservation. There is impetus to develop new guidelines and innovative approaches for reducing the total cost and increasing the whole-life value of building and maintaining assets. For example, new standards such as ISO 55000 (ISO, 2014) provide guidance on how to deliver the best cradle-to-grave value, optimized for a range of stakeholders over a long period. Extracting the maximum value from an asset requires a broad range of expertise, whether that is business and financial know-how, or engineering and operations capabilities (IAM, 2008; Zuashkiani *et al.*, 2014). These skills may be required at different stages of an asset's life, when acquiring, utilising and maintaining the asset, for example. They are also needed to make decisions about how to best combine factors such as costs, risks, and performance.

On the other hand, cutting edge research in the field of asset management in the world's leading universities is delivering innovative solutions, tools and methodologies aimed at reducing the lifecycle cost and enhancing the performance of infrastructure assets and systems (e.g., CSIC (2016); CAIT, (2016)). It is essential that current and future research activities are informed by and directed at addressing the pressing challenges faced by industry to ensure that the research outcomes deliver maximum impact.

1.1 Paper objective

In order to identify the current and future challenges faced by industry, we organised two industrial workshops – one at the University of Cambridge, UK and another at Rutgers

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University, USA. The workshops brought together practitioners (asset owners, operators, designers, consultants, etc.) across different infrastructure sectors such as transportation (rail, road, air), utilities (water, energy), housing in addition to the academics with a range of related expertise. The objective of this paper is to summarise the outputs of these workshops, which can then be used as a basis for developing research roadmaps.

1.2 Paper structure

The paper is structured as follows. The next section outlines the key influencing factors that impact on the way in which infrastructure assets are managed. This section will help in understanding the relative differences between the infrastructure and manufacturing sectors. Following this, in section 3, we discuss the challenges faced by infrastructure owners and operators, as identified through the workshops. Further, in section 4, we briefly outline the solutions to the challenges as suggested by the workshop delegates. Finally, in section 5, we provide some concluding remarks.

2 FACTORS INFLUENCING INFRASTRUCTURE MANAGEMENT

A nation's infrastructure supports the development of the society as well as provides essential services necessary to sustain a vibrant economy. A number of factors influence the way in which infrastructure assets are managed in a way that they continue to provide value to its owners and to the community at large.

2.1 Financial climate

In todays economic climate, infrastructure owners and operators are coming under immense pressure to maintain an adequate (and often improved) level of service and performance within an ever-shrinking budget. Success in this climate is determined by an operator's ability to strike the right balance of expenditure without taking additional risks and adversely affecting performance over the life of the infrastructure. When developing capital investment and maintenance plans, decision-makers need to consider options that may require higher initial investment, but yield lower costs and risks, and higher performance over the life of the assets.

2.2 Regulations

Every infrastructure sector (e.g., transport, energy, water, communications) is heavily regulated in the UK. These regulators (e.g., OFGEM, OFWAT, ORR, OFCOM) increasingly demand more accountability and justification from the operators for capital and operational expenditures. The ability to generate efficient investment plans is key to satisfy the regulatory demands. Regulators (e.g., OFWAT) have now begun to emphasise more on `outcomes' rather than `outputs' by asking infrastructure owners to focus on TOTEX when submitting their investment plans.

2.3 Ageing infrastructure

UK infrastructure is ageing, and requires ever-increasing amount of investment in maintenance and upgrade in order to maintain existing performance levels. Infrastructure assets are characterised by long life and complex deterioration, and knowledge about the way these assets deteriorate over time and how the deterioration affects the costs, risks, and performance is patchy.

2.4 Network effect

Individual assets in an infrastructure network/system does not provide value on their own. It is the combination of different types of assets in the network/system that generates value. For example, a bridge on its own need not deliver value, but the bridge along with the associated road network generates value for the users and the owners. However, individual assets have the ability to affect the value generated by the network/system depending on their criticality to the service. The disparate nature of these assets (e.g., civil, electrical, mechanical at the highest level) means that effective management of an infrastructure network requires multi-disciplinary and systems-based approaches. Adding to the complexity is the sheer scale of infrastructure networks and the number of assets that need to be managed and maintained for effective service provision.

2.5 Multi-stakeholder perspective

Infrastructure assets involve multiple stakeholders ranging from the asset owners (e.g., UK Government/Public), asset operators (e.g., Highways England), asset managers (e.g., contractors), and asset users (e.g., general public). Meeting the requirements and expectations of the different stakeholders is often the biggest challenge. Furthermore, the longevity of the assets may mean that the stakeholders (e.g., the owner) or even the type of usage (e.g., power stations converted to office buildings) may change over time. This poses great challenges to the way these assets are managed over their life.

2.6 Silo mentality

There is added complexity due to the fact that infrastructure organisations are often structured in siloes along traditional disciplines. For example, maintenance of a bridge structure might be the responsibility of one department that is different to that responsible for the maintenance of the pavement on the same bridge, which is again different to that responsible for the signals/lighting on the bridge! This makes cross-asset prioritisation a challenging prospect, with each department competing for higher budgets from a shrinking pot. Effective communication, sharing of information between departments, and a clear understanding of network value is critical for effective asset management.