**Valuing Infrastructure**

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**Running order:**

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Infrastructure systems provide a foundation that enables economic prosperity and social well-being. Whilst improving and maintaining the technical performance of individual assets remains essential, it is no longer sufficient to plan, manage, operate, regulate, govern or invest in infrastructure as a series of independent physical assets, projects or sectors. Purposeful strategic, systemic thinking with a focus on: the resources that flow along them; the services they provide; the outcomes they are intended to enable; the impact they have on people and businesses who depend on them (both positive and negative); and the whole life-cycle (from cradle to cradle) fate they display, is vital to raising awareness of the value of infrastructure systems. Systems thinking is also needed to incorporate the value of infrastructure systems more wholly into decision making process.

This themed issue is an output from the Valuing the Infrastructure of Cities, Regions and Nations Conference held in April 2017 as a join collaboration between Leeds University Business School and three research centres: iBUILD (Infrastructure BUsiness models, valuation and Innovation for Local Delivery: EP/K012398/1), ICIF (International Centre for Infrastructure Futures: EP/K012347/1) and ITRC MISTRAL (Infrastructure Transitions Research Consortium: EP/N017064/1). The two-day event brought together a UK wide community of interdisciplinary infrastructure practitioners from across academia, industry, professional bodies, infrastructure utilities, central and local government and policy makers to focus on the multi-faceted systemic challenge of valuing infrastructure systems.

This themed issue presents 9 research papers drawn from the above conference.

Drawing on detailed evidence from 16 UK case studies of Utility Strikes (accidental damage to geographically co-located infrastructure networks during excavation work to install, maintain or repair other infrastructure networks), **Makana et al.** developed an objective methodology to evaluate the 'true' cost of infrastructure disruption caused by utility strikes during groundworks in the UK. 'True' cost according to Makana et al. is the sum of three types of cost: direct costs (repair costs paid directly by the utility owner); (direct costs); indirect costs (contractual costs borne by third parties); and social

costs (those borne by wider society and the environment). Examples of each type of cost are linked to the case studies. The methodology is applied to calculate a ratio of 'true' cost: direct cost of 29:1. Thus unearthing what the authors describe as the very substantial and often neglected 'true' cost of utility strikes.

**Kabir et al.** developed a life cycle costing (LCC) model to address a universal challenge faced by infrastructure operators. Namely, how to establish practical and cost-effective programmes of renewal, repair, rehabilitation and replacement strategies, whilst constrained by the common challenges of incomplete data and scarce technical and financial resources. The model is tested and implemented on Greater Vernon Water, a medium-sized Canadian water utility.

**Hwangbo et al.** address the closely-related universal challenge of how to cost-effectively allocate constrained public budgets to the long-term planning and management of networks of interdependent infrastructure assets to simultaneously deliver multiple complementary policy objectives and preserve the value of the assets being managed. The paper presents a value-based optimisation model designed to help decision makers optimise long term return on investment in municipal assets. Using the Canadian Municipality of Kindersley as a case study, the model is evaluated against a classical condition-based optimisation approach. The authors conclude that value-based optimisation technique enables municipalities to apply a multi-asset decision-making process that balances engineering and economic approaches to delivering better value for money.

Two complementary papers from **Goodfellow-Smith et al.** focus on different aspects of sustainable infrastructure finance, in the context of projected worldwide infrastructure investment of $78 trillion in the period 2015-2025. **Goodfellow-Smith et al.** (Paper A) identify numerous macroeconomic obstacles in the finance 'Valley of Death'. They assess the short and long term impacts these will have on the feasibility of achieving the necessary rate and scale of sustainable infrastructure investment needed to enable transformational improvements to the liveablility, sustainablity and resilience of cities. The Authors conclude that radical city transformation is possible, and that the speed of transformation can be accelerated, if a new form of state entrepreneurial leadership and restorative economic theory is adopted.

**Goodfellow-Smith et al**. (Paper B) focuses on methods of finance and insurance selection to facilitate **the use of** sustainable design and construction techniques, and improve the liveability, sustainability and resilience of infrastructure and cities. They establish criteria for infrastructure financing and insurance, to enable selection of organisations providing products and services that have sustainability at the heart of their operations and by extension mandate the retention of sustainability at the core of any infrastructure programme. The Authors introduce the concept of 'restorative infrastructure' in city transformation and demonstrates that substantial savings are possible if the proposed financial and insurance selection criteria are applied.

Drawing on insight from established literature, and the observations that the scale of government investment in transport infrastructure is far easier to measure than the total social value (the sum of the total value that accrues to each individual user) enabled by that investment; and knowledge regarding the factors that determine individual behaviours and attitudes is incomplete. **Kalyviotis et al.** frame the social value of transport infrastructure as a function of safety, security, time, societal acceptance, cost, comfort and convenience; conduct a structured survey with a representative sample of the UK population; and analyse holistically the social value proposition associated of eight different modes of transport.

Bringing together the themes of how best to allocate scarce resources to maintenance strategies, the role of infrastructure in enabling sustainability outcomes, approaches to sustainable finance, understanding and exploiting cross sectoral synergies, introduces a dash of resilience and decarbonisation to the mix. **Williams et al.** explore the potential for energy capture and delocalised energy production to offset the impacts of reduced maintenance budgets by reducing the operating costs, and cross subsidising maintenance costs. Focused on the UK Highway networks, the paper explores the potential for energy to be harnessed from the forces that the network is exposed to everyday namely, solar, wind, rainwater and kinetic energy from vehicles. This work aimed to leverage additional funding to local authorities while also providing a potential solution to the trilemma of energy issues facing the UK: providing cheap, clean and renewable energy. The paper includes a set of recommendations to bring this technology from the prototype phase to mass roll-out.

Using the Chinese-funded Colombo International Financial Centre (CIFC) in Srilanka as an illustrative case study, **Thoradeniya and Tan** developed a framework for analysis of the strategic value of transnational investment in infrastructure megaprojects. They conclude, the strategic value of transnational investment in infrastructure megaprojects is comprised of more than the financial return on investment to the investing nation or the direct benefits the infrastructure asset delivers to the host nation. The diversity of interests and stakeholders involved in transnational projects makes the identification of strategic value complex. Moreover, a single infrastructure megaproject enables different types of strategic value to the investing country, the host country, and potentially positive or negative value for third party countries.

Drawing on evidence from 4 case studies, and key established literature on interdependencies, **Ersoy et al.** present compelling evidence to support the assertion that if urban infrastructure systems are to be sustainable new approaches to urban governance are required. Building on this to propose an approach to the development of cross-sectoral, locally applicable approaches to urban governance that are applicable to complex interdependent infrastructure systems and capable of supporting the sustainable realisation of societally beneficial outcomes.

In addition to the papers presented in this themed issue, a range of outputs from the conference including video of all keynote presentations, and all research presentations are available at https://conferences.leeds.ac.uk/valuing-infrastructure/programme/