UNIVERSITY OF CAMBRIDGE
Department of Engineering

CONSTRUCTION ENGINEERING MASTERS DISSERTATION ABSTRACT

Mapping Asset Monitoring to Failure Modes: A New Proposed Infrastructure Risk Management Framework

The provision of asset monitoring technology has become the norm in large railway infrastructure construction projects. Huge investments are currently being made in this technology as part of the project scope. Using evidence from the Crossrail project in London, this dissertation aims to map the monitoring technologies used and to illustrate its relevance in predictive maintenance strategies and risk asset management.

Crossrail is a complex London railway project, crossing the capital from east to west and increasing capacity of the network by 10%. The construction stage started in 2009 and it is anticipated to start service in 2022. The scope of infrastructure asset monitoring technology involves over 25,000 possible alarm entries in the Route Control Centre. Human factors assessments predict one alarm would be activated every 10 seconds. In addition, Crossrail has invested more than £9m in a bespoke Infrastructure Monitoring Vehicle using train-borne equipment. The project also includes the use of infrastructure monitoring equipment in three of the new Class 345 passenger trains, collecting data five times a day. However, there is a lack of analysis in regards to mapping this technology and its role in asset risk management and predictive maintenance.

The dissertation compares the Crossrail project with other railway infrastructure projects and operations in Europe and Asia, in terms of asset and risk management. The study shows that, in terms of the technology utilised, the current use of data in asset monitoring is very similar across the latest projects in Asia and Europe. It also highlights the high risk failure modes that are mitigated by manual inspections and not by the use of more effective technology. The evidence indicates that currently the infrastructure monitoring technology scope does not appear to be based in analytical risk targeting.

Mixed qualitative and quantitative methodologies have been applied, using existing infrastructure data from the Crossrail designers and Rail for London documentation. This dissertation analyses performance data from the suppliers of the project and maps the possible failure modes with the proposed monitoring techniques, considering the associated safety implications and their impact on service, on a simple, easy to read/use graph, the Seco graph. The Seco graph is a valuable tool that illustrates a snapshot of the extent of the risk coverage of the monitoring technology at any given time.

The research used a focus group, including asset management expertise from different railway companies in different continents, to challenge the graph and the basis of its calculations, hence incorporating end user feedback at an early stage.

Using the Seco Graph as a tool, infrastructure designers and asset owners could assess how effectively asset monitoring addresses potential asset failures at a given time and hence validate future investment.

Performance data collection during the operational phase of the project will determine the changes in this graph and it will provide information about the risk trend, enabling prediction of future asset monitoring requirements for optimal risk management.

Keywords: *infrastructure monitoring; railway infrastructure, risk management, asset management, predictive maintenance, asset condition.*

Maria Seco

November 2021