Available online at www.sciencedirect.com

ScienceDirect

Procedia CIRP 38 (2015) 245 – 249

www.elsevier.com/locate/procedia

The Fourth International Conference on Through-life Engineering Services

Uncertainty of Net Present Value calculations and the impact on applying integrated maintenance approaches to the UK rail industry

L. Kirkwood[a]*, E. Shehab[a], P. Baguley[a], A. Starr[a]

[a]*Department of Manufacturing, School of Aerospace, Transport and Manufacturing, Cranfield University, Cranfield, UK*

* Corresponding author. *E-mail address:* l.kirkwood@cranfield.ac.uk

Abstract

The Public performance indicator (PPI) is an important Key Performance Indicator for Network Rail and monitored carefully by the organisation and their external stakeholders. Condition monitoring is of increasing interest within network rail as a suitable method for increasing asset reliability and improving the PPI metric. As condition monitoring methods are identified each will need assessment to establish the cost and benefit. Benefit can be measured in cost savings as poor PPI performance results in fines. Within many industries Net Present Value (NPV) calculations are used to determine how quickly investments will break-even. Cost-risk is a term that is used to describe the financial impact of an unexpected event (a risk). This paper outlines a more detailed approach to calculating NPV which considers the cost-risk effect of changes of the denial of service charging rate. NPV prediction is of importance when assessing when to deploy different fault detection strategies to maintenance issues, and therefore the cost-risk of the NPV calculation should be used to support asset management decisions.

Keywords: Cost engineering; through-life cost; cost-benefit; KPI; NPV; rail industry

1. Introduction

Cost engineering methods have seen a diversification of interest over recent years: where the traditional challenges of accurately determining and reducing cost of producing a product have expanded to include the challenge of considering the whole life cost (WLC) of the product. This mirrors the shift within the manufacturing industry towards seeing the product as a component of a delivered service. This servitization concept is gaining interest in many industrial sectors [1]. Rolls Royce, for example, are moving away from selling engines and move towards supplying “power by the hour” [2]. This shifting focus has meant that cost engineering, with its interests in cost estimation and cost control, has had to increasingly consider the WLC of a product or service and in particular the cost of maintenance has become a topical issue. As maintenance has increased in interest to cost engineering research, the traditional focus on manufacturing has become too specific and organisations with asset-management challenges have become more relevant.

One of the challenges cost engineers in industry and academia often face is to advise on the possible risk mitigation choices and predict cost consequences [3]. NASA has a strong interest in estimates being prepared with cost-risk factored into the estimate. Cost-risk assessment involves identification of risk and a translation of those risks into cost impact [3]. Within this paper changes in denial of service charging rates is considered a risk, the financial consequences of which constitute the cost-risk.

In maintenance condition based monitoring might be considered industry best practice, but this approach brings with it costs that need examining if a data-driven decision on the choice of maintenance strategy is to be made. A consideration of the issues surrounding cost of condition

doi:10.1016/j.procir.2015.07.056

monitoring data has been previously presented [4], in which the cost relevant issues related to data gathering and data storage were given focus.

This paper will seek to examine the specifics of the situation at Network Rail by outlining cost-risk caused by Office of Rail Regulation decisions that potentially endanger installation of condition monitoring projects. This is done by showing a development of an existing case study with further cost-risk details being applied to the Net Present Value (NPV) calculation.

2. Background

Determining the cost of asset ownership is a challenge faced in many industries and organisations: NATO [5] and the defence industry have well defined terminology but continue to struggle to accurately calculate life-cycle cost, whole-life cycle cost and total ownership cost. Within the oil & gas industry methods like Markov-chain to predict the cost of maintenance [6] or Real Options (RO) are used to make cost-efficient decisions over the life-cycle [7].

Often the first stage of a WLC assessment is the Net-present value (NPV) calculation, which is used to indicate the return achieved from an investment. Commonly used in the oil and gas industry and financial sector as well as less obvious sectors such as the PV solar energy [8], NPV predictions are an important part of the decision process when considering the feasibility of a given project [9].

One of the methods that better technologies can benefit NR is to reduce the costs associated with denial of service. The framework for payments between train operating companies (TOC's) is referred to as "schedule 8" within the rail industry. Schedule 8 is overseen by the Office of Rail Regulation (ORR) and was updated at the start of the latest control period (CP5). The stated intention is for the schedule 8 targets and rates to be cost-neutral between TOC's and NR. A change in the rate of schedule 8 by the ORR is a risk that significantly influences the NPV calculation for a condition monitoring project.

The PPI is a key performance indicator within Network Rail and of significance for several reasons:

• PPI results are made available to the public. Therefore poor performance results in damage to the organisations brand and sufficient public and/or media attention can result in political intervention

• PPI and denial of service are related. A financial penalty is paid to a train operating company (TOC) when denial of service is caused by Network Rail.

The work of Marquez et al. [10] use expected values of the schedule 8 costs to calculate the "penalty saving". Penalty saving and reduction of maintenance costs are the two cost components that could be responsible for eventually making an investment in condition monitoring systems "break-even" (producing a positive NPV). Within the calculations presented by Marquez [9] the quickest that the point actuator condition monitoring system "pays" for itself is less than 8 years. As this is longer than a rail industry CP, it is worth noting that the Office of Rail Regulation is therefore very likely to reset both the target quantity of permitted delay minutes and the payment rate between NR and the TOC's. This adds a significant risk to the calculation and therefore it is a much more complex issue to calculate the "break-even point" than previously thought.

Looking at the recent trend for the penalty minute rate to rise we might draw the conclusion that this is a good thing that will likely make better equipment, technology or methods more cost effective, (in addition to the original intention of providing a strong incentive to achieve a punctual train service). The schedule 8 fees are only part of the discussion.

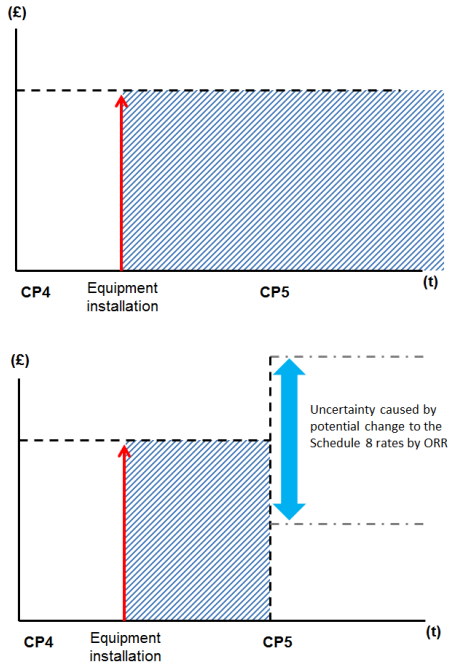

Fig. 1: Illustrative comparison between the assumed and real situation

The seemingly good news from raising schedule 8 rates is strongly mitigated by the Office of Rail Regulation setting the target for delay minute totals across the network. If NR reduces the delays across the network then the Office of Rail Regulation will eventually make the targets more difficult to achieve. The minutes saved no longer are working towards over-achieving the targets set by the Office of Rail Regulation, but are required to achieve expected performance. In effect, a change in targets will lower the number of "saved" delay minutes.

Figure 1 shows the schedule 8 related return on investment rate in schematic form, where denial of service related cash