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Comparing smart scheme effects for congested highways

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ABSTRACT

A high level objective for many international governments and local operators is that highways should be managed in a way that is sustainable in terms of a Low Carbon Energy future. Recent initiatives such as the Strategic Transport Technology Plan and the policy and legal framework promoted by the European Commissions' Intelligent Transport System (ITS) Directive and ITS Action Plan may assist with this objective. However, many levels of complexity are inherent within the (ITS) schemes that are now part of highway management, due to the linkage of various technological components to complex systems and services. Maintaining efficient, sustainable co-operative performance is therefore a major task, with inconsistencies between product suppliers, network managers and operators. As a result, it is of considerable interest to the highway operators and high level policy makers to be able to assess the performance of individual ITS schemes and furthermore, to be able to compare performance between ITS schemes. In this paper, an illustration is provided of a methodology that can be used to assess the performance of ITS schemes according to a set of sustainability criteria. A case study is introduced which compares the performance of anticipated Active Traffic Management (ATM) schemes for what the road network operator (Highways England) perceive to be the four most congested highways in England (in terms of annual average daily traffic flows). Appropriate action can then be taken to improve the energy and sustainable management of Information Communication Technology (ICT) and transport systems for the benefit of a smarter, sustainable and efficient future.

1. Introduction

1.1. Problem rationale

The concept of Intelligent Transport Systems (ITS) has existed for decades, spanning road, rail and air travel. Active Traffic Management schemes are currently being deployed internationally. The United Kingdom (UK) equivalent is based upon a collective term known as a 'smart highway' and formerly known as 'managed motorways'. Congestion on the highway and strategic road network in England costs an estimated £2 billion every year, with 25 per cent of this resulting from incidents. The key philosophy behind ITS is the integration of technical back-end systems augmented by Information

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Communication Technology (ICT), resulting in an increase in efficiency for a given transport mode. The performance of such systems, however, is hard to quantify due to the many systems involved. Specifically, when comparing one scheme that is geographically (region or country) or physically different to a similar service, the data must be measured objectively in order to determine the likely performance in future product (service) rollouts of transport technology. This may involve analysing different aspects of performance which may include measuring the complexity of information (Wolfson et al., 2012), how driver information is structured and where it is located, as well as identifying any significant safety critical factors such as response times and the reinforcement of policy for ITS standardisation (Highways Agency, 2010). Internationally, road network operators require new performance indicators to be developed which need to differ from those geared towards more conventional highways (Highways Agency, 2009a, 2009b). The National Cooperative Highway Research Program in the United States of America (USA) have recently published a report on the development of performance measures for sustainable transport (Zietsman et al., 2011) and also proposed how ITS can be incorporated into the current transport planning process (Bunch and Emerson, 2002). In addition (at the time of research), the ICT support infrastructure, physical transport infrastructure and the operational assessment of vehicle throughput have all been calculated in isolation. The lack of an established clear consensus on the overall emissions creates a confusing backdrop of black box 'cause and effect' chains, inconsistent emissions targets and hidden consequences. It can be argued that what is needed now is the consolidation of the various key performance areas of ITS in order to assist in quantifying accurately differences in performance between schemes as well as mapping their behavioural effects. Researchers have therefore attempted to develop evaluation frameworks which do not depend on past data by incorporating the ITS process into existing methods (Barceló et al., 2005; Gurínová, 2005; Stevens, 2004). Traditional transport appraisal methods (which are the foundational works for assessing the likely impacts of a scheme) are carried out either (1) ex-ante i.e. before implementation, (2) whilst the scheme is in operation and (3) ex-post. They are currently used to assess ITS schemes such as Active Traffic Management (ATM) (DfT, 2011; Grant-Muller et al., 2001; Mackie and Worsley, 2013). Whilst they can be used to assess traditional criteria such as road-side emissions, safety and scheme compliance, they do not cover the socio-technical aspects which includes the performance of the technology themselves.

The paper aims to firstly demonstrate the sustainability impact of the four most congested highways in England and illustrate the performance of the technology that is currently implemented to reduce traffic congestion. In addition, the paper also proposes three performance indicators in order to stimulate debate on assessing the performance of the IT systems that underpin the ITS technology.

1.2. Overview

As the international rollout of ATM continues, the UK road network operator (Highways England) is currently operating 4 schemes and aims to implement a further 16 ATM schemes on the most congested highways of England by 2015 (Highways Agency, 2013). The majority of the schemes are placed at strategic junction clusters with multiple schemes in place on the same highway. The aim of the study here is to estimate and compare the performance of ATM schemes for the four most congested highways, as if they were to be implemented today (Fig. 1).

Note that the M60 J8-17 and M62 J18-20 ATM have recently been integrated into one scheme but are shown and assessed separately for clarity. In 2013, the road network operator decided to implement permanent hard shoulder running at all times. This is a departure from temporary shoulder running, whereby the hard shoulder is operated during peak congestion periods only.

In principle this allows increased savings of vehicle emissions. Given that an assessment of the performance of the M42 ATM pilot scheme has already been undertaken (Kolosz, 2013) and the M42 gantry spacing is different to that of the other highways considered here, the M42 was not included in this comparison. According to Average Daily Traffic (ADT) flows (Fig. 2), the busiest highway in England is the M25. It is also one of the most congested in Europe. It is an orbital route around London and has been reported to reach 196,000 vehicles per day on the approaches to Heathrow airport. The road network operator has proposed two independent ATM schemes at junctions 5–7 and 23–27 respectively. Another highly congested highway is the M60 Manchester orbital. As an orbital highway, it is equivalent to London's M25 highway, however unlike the M25, the M60 forms a complete loop. In 2012, a large section of the northern M60 was England's busiest stretch of road, with an average of 181,000 vehicles per day using the stretch between junctions 8 and 17. The ATM project started as three individual schemes: M60 junctions 8 to12 (temporary hard shoulder running), M60 junctions 15–12 (lane gain scheme) and M62 junctions 18–20 (temporary hard shoulder running). The scheme has been re-assessed a number of times, resulting in a decision to treat this as a combined scheme covering the whole corridor between M60 junction 8 and M62 junction 20. The scheme covers a corridor approximately 17 miles (27 km) long. It has 11 junctions along the route with 2, 3 and 4 lane carriageways. The third highway to be assessed in the research presented here is the M62, which is a west–east trans-Pennine highway in Northern England, connecting Liverpool and Hull via Manchester and Leeds. The road is 107 miles (172 km) long and for 7 miles (11 km) shares its route with the M60 orbital highway around Manchester. The road is part of the unsigned Euro routes E20 (Shannon to Saint Petersburg) and E22 (Holyhead to Ishim). Two ATM schemes at junction's 18–20 and 25–30 are currently under construction. The final highway to be assessed is the M1 which is a north–south highway in England connecting London to Leeds, where it joins the A1(M) near Aberford. It was the first inter-urban highway to be completed in the UK.