Technological Forecasting & Social Change 82 (2014) 149–166

Contents lists available at ScienceDirect

Technological Forecasting & Social Change

Intelligent Transport Systems: The propensity for environmental and economic benefits

Susan Grant-Muller [a,*], Mark Usher [b]

[a] Institute for Transport Studies, University of Leeds, 34-40 University Road, Leeds, LS2 9JT, UK
[b] Department of Geography, School of Environment and Development, University of Manchester, Oxford Road, Manchester, M13 9PL, UK

ARTICLE INFO

Article history:
Received 10 February 2012
Received in revised form 6 October 2012
Accepted 20 June 2013
Available online 21 July 2013

Keywords:
Intelligent transport
Propensity model
Transport policy
Environmental impacts
Economic impacts
Sustainability

ABSTRACT

Whilst the economic and efficiency benefits of Intelligent Transport Systems (ITS) are well established, the goal of this research is to demonstrate the simultaneous propensity for low carbon benefits through the deployment of ITS. The foundation of this paper is therefore that the deployment of these technology measures contributes to the positive-sum game of both economic and environmental sustainability. Two research questions are addressed: firstly whether the evidence supports the notion that ITS systems can be implemented and operated in such a way to generate environmental benefits; and secondly whether policy priorities amongst national and international stakeholders reflect a propensity for ITS deployment in order to yield those benefits. The first question is addressed using a rationale based upon both underlying drivers and a synthesis of the empirical evidence. The second is addressed by the development of novel propensity models using primary research on international stakeholders' perceptions of ITS as a priority solution to deliver climate and environmental goals. The research shows that Vehicle Density and High Technology exports were found to be significant variables in determining the propensity for ITS to feature as a high priority policy tool in future transport strategies. The research holds further value in positioning ITS as a policy tool able to deliver both economic and sustainability gains. It holds relevance for both policy analysts and transport strategists at international, national and regional tiers.

1. Introduction and background

Transport has become fundamental to the everyday functioning of society and the economy. Yet the reliance on motorised transport as an everyday function is a substantive contributor to global climate change [1]. Without significant policy or technological advances, the likelihood of decoupling transport growth from emissions growth would appear slim given that 95% of transport energy is derived from fossil fuels [2].

As there are a number of possible pathways for reducing the carbon intensity of transport, it is understandable that there has been lack of agreement on a definitive approach. Principal carbon reduction pathways include supporting low carbon technological innovation and deployment; encouraging modal shift from private car use to less polluting options such as walking, cycling and public transport; advocating more efficient forms of traffic management and driving behaviour; and employing strategies that seek to reduce the need to travel altogether (e.g. spatial planning). The main areas for debate appear to be between behavioural and technological innovation, and between reform and radical change. Whilst discouraging private car use through comprehensive behavioural measures would assure significant cuts in emissions from transport, a technological reformist approach could be seen to be more politically and socially expedient. In fact, as scholars working within the "socio-technical systems" school of thought maintain ([3–9]), a transition to a lower carbon society will almost certainly necessitate changes in and across both dimensions simultaneously: behavioural and technological, reformist and radical. Drawing upon the socio-technical perspective, [10]

* Corresponding author. Tel.: +44 113 3436618; fax: +44 113 3435334.
E-mail address: s.m.grant-muller@its.leeds.ac.uk (S. Grant-Muller).

0040-1625/$ – see front matter © 2013 Elsevier Inc. All rights reserved.
http://dx.doi.org/10.1016/j.techfore.2013.06.010

examine the car system as 'being made up of humans (drivers, passengers, pedestrians), machines, materials, fuel, roads, buildings and cultures', and therefore all the different elements – actors, artefacts and institutions – have to be aligned in a particular order for a sustainable transition to a lower carbon alternative to emerge. However, there has historically been difficulty in achieving a coherent behaviourally-orientated demand management strategy for private car usage, and because transport is a particularly difficult sector to decarbonise, much emphasis has been put on piecemeal technological innovation for providing more sustainable transport solutions ([1,11,12]). Intelligent technologies are therefore playing an increasingly important role in the drive for green innovation; however socio-behavioural barriers may still need to be addressed if comprehensive deployment of these technologies is to occur.

Given the potential for technology enabled low carbon futures, in Section 1.1 the ability for ICT to support this through two alternative but potentially overlapping routes is described. Firstly by Information Communication Technology (ICT) working to link the transport sector with complementary sectors and facilities, and secondly through ICT being embedded within the transport system and connecting different types of technologies and functions. These ICT connected technologies and functions within the transport sector are collectively referred to as Intelligent Transport Systems (ITS). As a 'system of systems' it is difficult to precisely define ITS, however a taxonomy of some common types is provided in Section 1.1 with their main drivers towards delivering carbon benefits. In Section 1.2 a summary of the evidence base on the likely size of impacts is discussed based on both synthesised and measured observations. Many ITS systems are focused towards enabling behavioural change. An introduction to the historical difficulties in following a coherent behaviourally orientated transport demand management strategy (and how technology solutions have emerged alongside) therefore follows in Section 1.3. This past experience forms the backdrop to understanding future propensity to prioritise ITS systems.

1.1. Overview of ITS systems in the low carbon context

ICT acts as a cross-sectoral enabler that exists in two contexts to engender a low carbon future. Either in systems which either sit alongside the transport sector (for example in sectors such as health, education, business or linked non-transport facilities) or being fully integrated into aspects of the transport system (for example as components of the vehicle, road infrastructure or management system). In practice these two contexts can be overlapping rather than mutually exclusive. Here a summary is given of ICT acting in both contexts and how each reflects either technological advance or supports behavioural change — an important precursor to establishing the case for ITS as a sustainable solution.

Much has already been written about the rise of advanced ICT, the associated information networks and flows, and the implications of pervasive computing for society and the environment ([13–15]). There is a growing literature exploring the existing and predicted implications of the ICT revolution for transport ([16–21]) and ICT-enhanced transport on spatial planning [22]. Significantly, for [23] this boom in ICT should be directed towards low carbon industries where the comprehensive deployment of intelligent technologies can be advantageous for the economy whilst simultaneously prompting the shift towards environmental sustainability.

Where ICT operates in the context of being complementary to the transport system it enables individuals to make choices that impact on both the overall demand for transport and for different modes, for example in facilitating home working or encouraging mode switch. Where ICT is intrinsically embedded in the transport system it serves to optimise the use of the system infrastructure in some way — either towards efficiency, safety, enhanced traveller experience or potentially towards a more sustainable mode of operation. In Table A1 (Annex A) a classification of the different ICT solutions is given according to the system and the extent to which they are in the context of being complementary to, or integrated within, the system.

Where ICT operates to connect complementary sectors and services to transport it can reduce carbon intensive physical transport movement. This occurs when remote communication via digital connection acts as a substitute for the physical negotiation of geographical space. In this context ICT can therefore reduce the need to travel for social and business purposes. Avoiding unnecessary travel through digital connection and planning unavoidable journeys using real-time traffic information (RTTI) prior to entering the transport network is certainly in line with the 'smarter choices' agenda ([24,25]). Smarter choices are 'soft' techniques that positively influence travellers and encourage more sustainable voluntary behaviour in the school, workplace or at the home through the production and implementation of travel plans. Although evidence is far from conclusive, it would appear that workplaces are beginning to acknowledge the necessity of including environmental issues in their travel plans to bolster their corporate social responsibility and to attract potential employees to the organisation [26]. According to [24] the smarter choices agenda could potentially reduce traffic levels by 10–15% as a national average if complemented by 'hard' measures, and could therefore substantially reduce carbon emissions from the transport sector. However, although the Smarter Choices agenda has had some success in reducing private car usage and carbon emissions, it has failed to carve major inroads into transport policy [11].

When ICT becomes integrated within the transport system it is generally referred to as an ITS. ITS infrastructure can be *fixed* so that they function at one particular location, for example variable-message signs and electronic tolling stations. ITS infrastructure can also be *mobile* in that they can be located on board vehicles or on persons (for example satellite navigation systems, advanced traveller information systems and adaptive cruise control). 'Cooperative' systems, are an advanced form of ITS operating by means of vehicle to vehicle communication (V2V), vehicle to infrastructure communication (V2I) and infrastructure to vehicle communication (I2V) to develop better traffic management systems and to enhance road safety and efficiency.

Using dynamic and ubiquitous connectivity, integrated ITS applications aim to *sense* transport movement, *process* this incoming information, and then *communicate* information in real-time to private or public transport users and/or traffic