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**Thorpe, N. and Namdeo, A. (2016) Innovations in technologies for sustainable transport.
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1. Introduction

The aim of this special issue is to focus on recent and current innovations in technologies for sustainable transport. Since the mid-1980s there has been an ever-increasing surge in interest, investment, research and application of technology which now pervades all the main modes of transportation. The emphasis is focused in particular on developing and applying new technologies to address the issues of congestion, environmental degradation and social inclusion in pursuit of more sustainable transport and travel practices. Our reliance on technology is likely to increase in the future due to the development of fast and reliable communication systems. This will make travellers and the environment in which they operate more inter-connected than they have ever been – this has potentially significant impacts in a wide range of areas including passenger information; smart ticketing and payment methods; smart mobility and digital interventions; alternative fuel technology (e.g. electric and hybrid vehicles; bio-fuels); air quality information for vulnerable travellers; smart driving assistance (e.g. automated driving navigation; driving style; parking; apps); tools for managing traffic in extreme conditions (e.g. flooding; earthquakes; terrorist attacks); and traveller safety. The call attracted papers on several of these (and other) issues and those selected for publication are discussed below.

2. Electric Vehicles

There is little surprise that several submissions were made in answer to the call in relation to the uptake of electric vehicles. Three papers appear in this Special Issue dealing with commercial electric vehicles (Margaritis *et al.*, 2016), the total cost of ownership (Hagman *et al.*, 2016) and consumer preference towards electric vehicles (Morton *et al.*, 2016). Although much of the attention on electric vehicles has focussed on the private-car market due to the large volume of sales that could be generated and the impact on emissions, the commercial vehicle sector is responsible for a significant amount of mileage on the road network. Margaritis *et al.* (2016) suggest that many organisations are now considering the procurement of electric vehicles for their vehicle fleets to join the push for and promote sustainable development across the EU. The paper presents an informative critique of the technical specifications of vehicles that could serve the fleet market (from mini-vans to heavy trucks and including battery types and vehicle range parameters) and the various operating conditions that can impact on these vehicles' effectiveness at fulfilling a useful role in the commercial vehicle market. Range anxiety is often cited as a current barrier to the uptake of electric vehicles and Margaritis *et al.* (2016) consider that the same anxiety exists for commercial electric vehicles and will be a critical issue in the future although developments in battery technology are expected to alleviate this operating restriction over time. Battery recharging is also seen as an important challenge to be overcome – one of the main problems cited here being the lack of standardization of recharging plugs restricting when and where batteries can be recharged. A package of measures for energy management is proposed that includes user-centred measures such as eco-driving initiatives for commercial electric vehicle drivers to more technological solutions such as energy

harvesting. There is also a clear role identified for information such as real-time traffic data and customer requirements that are needed to help inform 'smart' fleet management strategies that have electric vehicle fleets as a key component.

Morton *et al.* (2016) consider the other significant sector of the electric vehicle market – the private electric vehicle market – and the important issue of consumer preferences in an attempt to understand future consumer demand which will be pivotal in achieving a smooth and successful transition to a low carbon future. Using data from two surveys in the UK, the paper suggests that EV adoption is a complex issue with early adopters falling into a number of different and clearly distinguishable segments which can assist the design of effective marketing strategies that promote the uptake of EVs. In a related vein, Wikström *et al.* (2016) also consider the potential for plug-in electric vehicles but this time with a primary focus on their uptake by public organisations rather than private individuals and communities, using Sweden as a case-study, and focusing specifically on the role of key individuals in these organisations (identified as policy entrepreneurs) in facilitating and encouraging the uptake of new technologies. The paper reveals how the policy entrepreneur's role is evident throughout the process from raising the knowledge and awareness levels of key decision-makers with the objective of getting the issue on to the political agenda of a particular organisation. Thereafter, the entrepreneurs are usually retained for the deployment phase with a role of managing the deployment strategy to promote user acceptance and hopefully increasing the levels of use of the electric vehicles. A successful deployment can then breed further uptake by the policy entrepreneur forming partnerships with new organisations.

The final paper in relation to alternatively powered vehicles concerns the slow diffusion of electric vehicles (Hagman *et al.*, 2016). Using a novel Total Cost of Ownership approach, the authors suggest that uncertainties about available relevant data can make purchasers' choices very difficult when comparing conventionally and alternatively fuelled vehicles. From the vehicle sample tested, the research suggests that battery electric vehicles outperform conventional internal combustion engine vehicles and hybrid electric vehicles – however, if this is not appreciated or understood by potential consumers then this could hamper the diffusion of this type of vehicle into the mass market. The authors therefore make a clear link between the findings from their modelling work and the design of awareness raising tools to accelerate the diffusion of battery electric vehicles and thus realise the resulting economic and environmental benefits.

3. Traveller Information

In a rather different direction, Heiskala *et al.* (2016) address the business potential for exploiting data from smartphone technology to develop crowd sensing applications for services that enable smoother and sustainable travel. However, user participation is critical to the success of such services in terms of contributing relevant data to the system and the authors consider different types of incentives that could be deployed to encourage participation. A number of current crowd sensing and travel service applications are reviewed (e.g. Waze and Moovit) in terms of their use of incentives and business model approach before concluding that to achieve sustainability targets, data should be readily

available to all users and not be constrained by competing providers resulting in a fragmented service.

4. Public Transport

Hess and Bitterman (2016) highlight that branding, marketing and advertising play important roles in influencing travel behaviour and shaping public opinion about public transit. Their study examines best practices and short term outcomes of advertising in response to situations external to a public transit agency from which transit managers can objectively evaluate future efforts. This outcome is based on a close examination of the value-oriented advertising messages, environmental brand designs, and vehicle livery, and specifically the planning and administration of branding efforts. A critical analysis of advertising messages across a select number of North American public transit markets yields a typology that uncovers contemporary advertising practices.

Moving to the other end of the public transport system, Papangelis *et al.* (2016) study the importance of providing real time passenger information (RTPI) for individuals in rural areas who often have little or no information regarding public transport disruptions. This paper illustrates and categorises travel disruptions and identifies requirements for RTPI for rural public transport users for each type and stage of disruption through interviews and focus groups. Patterns of passenger behaviour during travel and transport disruptions are also classified. Papangelis *et al.* (2016) also describe the development and evaluation of a conceptual model of the recovery phases of disruption to map the RTPI requirements for each recovery phase of disruption. This paper also discusses and suggests the necessary advances in digital technologies for RTPI systems to support public transport users during disruptions to minimise the number of trips abandoned.

Personal rapid transport (PRT) is gaining momentum in terms of improving people movement. There is a strong need for development and evaluation of PRT. Mascia *et al.* (2016) present a holistic approach for performance assessment of PRT. In recent years, PRT has received increased attention due to technological innovation and the need for safer, more efficient, and more sustainable transport systems in dense urban areas. There is still a lack of comprehensive assessment of PRT's performance from the perspectives of both operators and users. Mascia *et al.* (2016) address this gap by proposing a set of PRT-specific key performance indicators (KPI) relevant to its operational characteristics (e.g. pod utilisation, total distance travelled) and user experience (e.g. average waiting time, delay). The proposed KPIs are demonstrated through a simulation study. The findings of this paper constitute the first step towards comprehensive benchmarking for PRT systems, and facilitate comparative analyses of different PRT systems to help operators identify and implement best practise.

5. Fuel and Energy

An important part of promoting the use of alternative fuels is understanding the policy, infrastructure and other barriers. Pfoser *et al.* (2016) describe a critical analysis in this area through a case study in Austria investigating the implementation of LNG (liquefied natural gas) as an alternative fuel technology in landlocked Europe. The paper reviews several

barriers which impede the application of LNG in the landlocked areas of Europe, the most important being the infrastructure which could stimulate the spacious application of LNG. Pfoser *et al.* (2016) first examine the potential demand for LNG to see if the construction of LNG infrastructure is viable in this region and then identify the stakeholders which have to be taken into account to successfully accomplish this process. Their paper carries out a demand analysis by interviewing 15 potential Austrian pioneer users and identifies and categorises their requirements towards LNG application using Maslow's hierarchy of needs. The paper uses a stakeholder matrix to evaluate crucial stakeholders and gives an indication of how to deal with them appropriately. The results reveal the interest and potential for LNG in landlocked Europe.

Improving energy efficiency of passenger vehicles, and their eco-effectiveness, is a primary societal need to reduce both energy demand and CO₂ emissions of passenger vehicles. There are new opportunities in vehicle design and development to comply with this need. Carvalho *et al.* (2016) present qualitative analysis of vehicle needs and perceptions towards the adoption of reconfigurable vehicles. Their paper explores to what extent the notion of a reconfigurable vehicle, presented as an innovation, is an anticipated need given the current patterns of vehicle occupancy. Within the context of designing vehicles to comply with European regulations on CO₂ emissions, the results reveal latent needs in human dimensions of the product. The notion of a reconfigurable vehicle has been identified as a latent need for different target markets. The authors also investigate the stated barriers for the adoption of this particular vehicle and test whether they fully overlap with what individuals ponder when they consider buying a vehicle.

6. Conclusion

This special issue attracted a variety of responses in terms of recent and on-going research ranging from electric vehicles, alternatively fuelled vehicles, public transport and traveller information. It is probably not that surprising that papers concerning various aspects of electric vehicles dominated the submissions given the current impetus from both the public and private sectors (e.g. vehicle manufacturers) to address the issues of environmental pollution and reliance on a more secure fuel supply. The hoped-for rise in electric vehicle ownership could potentially be a warning sign for public transport, especially if households adopt these vehicles as second cars and the perceived cost of travel at the point-of-use falls relative to public transport due to cheaper energy costs. One aspect of emerging technology that was surprising not reflected significantly in the submissions was that of automated vehicles. This emerging technology could provide a new lease of life for public transport in the coming decades, with the boundaries between public and private transport potentially becoming more blurred as new business models of vehicle ownership and use emerge potentially with users subscribing to, rather than owning, their own vehicle in the future. Automation also creates the possibility for new modes of shared transport creating new challenges for the management and operation of public transport. It is expected therefore that this issue of automation will focus much more heavily in the transport and business management literature in the future.

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