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Can bus really be the new tram?

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ABSTRACT

BRT appears to be less expensive to build and operate than tram systems but can it really approach the performance level of a tram system and what is the environmental performance of comparable systems?

This paper reports systematic research on these issues, particularly relating to where an urban transit system seeks to attract discretionary car users. A model has been developed to compare the implementation, operational costs and environmental impacts of a comparable tram and high quality guided BRT system. This models a UK situation, but draws upon information from elsewhere in Europe and North America. The design of the BRT system delivers equivalent performance to trams in capacity and passenger experience.

This 'equivalence' model shows that the capital costs of the high-spec BRT system are two-thirds those of tram. This is less of a cost saving than is often claimed, suggesting that, in practice, BRT is built to a lower specification that tram systems. Operational costs do not significantly differ. Using hybrid-engine BRT vehicles, CO_2 emissions are similar, BRT has lower PM_{10} emissions, but NO_x from BRT remains higher than for trams.

Although the cost differences for equivalent systems are less than is often claimed, there are substantial benefits in the flexible development of BRT, with it less vulnerable to variations from forecast ridership numbers, and development can be split into fundable stages, growing the business case for incremental upgrading. High-spec BRT can to be the new tram, but the 'value for money' case for BRT should not be at the expense of quality and transport planning impact.

1. The demise of light rail and emergence of Bus Rapid Transit

The development of new light rail systems in the U.K. has all but ceased after the construction of a handful of large city schemes. Only Edinburgh is now seeing the construction of a new tram system, and this is beset with serious programme, project overrun and overspend issues (Foster, 2011). There are some extension projects underway to existing tram systems, including Nottingham (NET), Birmingham (Midland Metro) and Manchester (Metrolink), but these are exploiting the existing investment in their initial systems.

A number of schemes have failed in the planning stages, including Liverpool, Leeds and South Hampshire. In the wake of this, a UK National Audit Office report (NAO, 2004) concluded the failings of light rail to be:

- Too costly when compared to buses
- Existing schemes financial performance is poor
- Local funding is necessary in addition to central government funding but is difficult to obtain
- The planning timescales are excessively long

These points were picked up in a recent review by Hall (2011), who compared the UK institutional and funding context to that of France, with its plethora of light rail schemes successfully implemented even in quite small urban areas.

Faced by this difficult institutional and regulatory context for new tram schemes, guided and higher-technology bus-based systems have seen growing popularity. Guided-buses were introduced in Leeds in 1995 (Bain & Tebb, 2002, pp. 51–55), and more recently in Bradford and Crawley (Fastway). In August 2011, the Cambridge guided busway opened, which is now (at nearly 26 km) the world's longest guided busway (Fig. 1).[1] In addition, segregated

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[1] There are longer busways, but not guided bus tracks (Adelaide is the next longest at 20 km and the large Essen busway system has 4.4 km of guided busway [BHLS, 2010]).

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bus running (without guidance) has been developed for the Thames Gateway (Fastrack) and the ftr Streetcar high quality bus has been used for services in Swansea, York and Luton.

In a country like the UK, BRT has been used in a different way to the high-capacity systems built in places such as South America. A major part of the policy aim is to attract car users as part of transport demand management and to reduce transport's environmental impacts. So, although in the UK BRT is advocated as a lower cost alternative to light rail, a crucial issue is whether it can be of a sufficiently high quality to attract car users and produce modal shift. For example, studies of the established Leeds guided bus service suggest that between 10% and 20% of new passengers shifted from car (Bain & Tebb, 2002); in Dublin, Rambaud and Cristóbal-Pinto (2009) note that 16% of the new trips on their Quality Bus Corridor came from car and in Stockholm 5% of the enhanced bus trunk service came from car (these two were bus priority rather than guided bus services). The desire for mode shift has led to BRT designs to attract people who might otherwise drive by car, with air conditioned buses, leather seats and in-bus features such as Wi-Fi.

Furthermore, in this transport policy context, what is the environmental performance of BRT compared to electrically-powered light rail? These questions are at the centre of the Open University project reported in this paper.

A central conceptual issue in answering these questions is how to construct an evaluation of the two systems. This paper reports on how a basis of 'Equivalence' has been developed to do this and how this framework has been applied in a validating test case study.

2. Light rail and guided-bus passenger experience equivalence

2.1. Defining equivalence

In situations where a transit system is intended to cut car use, a guided-bus system would have a better transport policy case if it could generate similar modal transfer from private vehicles as can be achieved by light rail. The attractiveness of light rail has been demonstrated whereas bus-based systems are seen as less attractive to potential passengers, who generally seem wary of public transport and have a low opinion of buses whether guided or not.

One way of generating ridership numbers for buses similar to light rail would be to make the bus look and feel like a tram; in other words provide an equivalent experience to the light rail system and vehicle. An example is the *Phileas* guided-bus system in the Dutch city of Eindhoven. This low emissions hybrid-engined powered bus operates on magnetically-guided busways, segregated from other traffic along most of its route, including some elevated sections. The vehicle is internally and externally very tram-like and operates a clearly identifiable branded service. It provides a passenger experience that is near equivalent to that of a modern LRT tram.

Fig. 1. Buses at a Cambridge busway station.

From a system perspective, the definition of equivalence has been addressed through the development of a typology to enable the classification of all forms of light rapid transit across four modes: tram-train, light rail, trolley-bus and guided-bus. The latter two represent a definition of Bus Rapid Transit (for details of this method see Hodgson & Potter, 2010). This typology method includes three tests that were derived from the system definition exercise to enable a bus-based system to be determined as being equivalent to light rail. These were that the vehicle must have:

- A capacity similar to a light rail vehicle – notionally between 100 and 300.
- The capability to run on-street to penetrate urban centres but also operate with segregated sections to ensure congestion-free running to improve reliability and speed.
- To have some capability for non-discretionary guidance, as this enforces traffic management measures which will enable prioritised running and a sufficiently enforceable segregation of routes where needed.

These tests were important as they not only define the vehicle configuration but inherently provide a specification for facets of the infrastructure that would be required. It is possible to have forms of BRT that do not meet the above criteria, but these would fall short of providing equivalence with light rail in terms of operations and passenger experience.

2.2. Measures of performance

These equivalence tests led to a specification of a BRT system to be tested against light rail. This was developed through a model to provide performance measures that could best describe environmental and cost performance and so enable a valid comparison on a like-for-like basis between the systems. A similar approach, but for costs only, was adopted by Deutsch (2009) in a German context.

For this study, the high-level reporting for the assessment of the light rail and guided-bus systems is based upon the U.K. WebTAG tool. The web-based Transport Appraisal Guidelines is an evaluation mechanism implemented by the U.K. Department for Transport (DfT) to provide a framework for the assessment of transport studies (DfT, 2009). The outputs from a transport study analysis conducted under WebTAG are summarised in the 'Appraisal Summary Table' (AST), of which there are two 'objectives' of direct concern to this study – the Economic and Environment objectives. To assess the performance of the light rail and guided-bus systems, the following measures needed to be established:

- Environment – The emissions of NO_x, PM_{10} and CO_2 with a commentary on aesthetic and noise impacts (ENVEM). Also costs would be identified to provide mitigation of environmental emissions; especially during construction (ENVEX).
- Cost – Capital expenditure (known as CAPEX) to construct the system, procure the vehicles and put into service, and also a cost per annum to operate and maintain the system (OPEX – operational expenditure).