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Understanding bus rapid transit route ridership drivers: An empirical study of Australian BRT systems

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ABSTRACT

Bus Rapid Transit (BRT) systems are an increasingly popular public transport option internationally. They provide rail-like quality for bus services for a fraction of the cost of fixed rail. Many claims of high and increasing ridership have resulted from BRT system development; however, it is unclear exactly which aspects of BRT system design drive this. This paper explores whether BRT design features, among other influences, significantly increase ridership above and beyond the impact of service levels. It does so using a series of regression models undertaken on 77 BRT and non-BRT bus routes in Australia which is known for its diversity in BRT route design. Explanatory variables used included service level, frequency, speed, stop spacing, share of segregated right of way, vehicle accessibility, employment and residential density, car ownership levels and BRT infrastructure quality. Five models explored the role of these variables. Two models found that service level dominates predictions of boardings per route km although they suffer from endogeneity. Further models control for this influence by modelling boardings per vehicle km. Overall results suggest that some BRT infrastructure treatments such as right of way have a significant impact on ridership but the influence of infrastructure is within the context of high service levels. The role of accessible vehicles has also been highlighted in this research, although more research is needed to clarify this influence. The paper concludes with a discussion of the various influences on ridership and recommendations for existing policy and future research.

1. Introduction

Bus Rapid Transit (BRT) systems are being embraced worldwide as an increasingly popular public transport development option. They apply rail-like infrastructure and operations to bus systems with offerings that can include high service levels, segregated right of way, station-like platforms, high quality amenities and intelligent transport systems. Australian BRT systems have been noted as being particularly diverse in design (Currie, 2006) with systems now operating in Sydney, Brisbane, Adelaide and to a lesser extent Melbourne (Currie and Delbosc, 2010).

As more cities adopt and expand BRT infrastructure, a critical question which must be addressed is the relative value provided by the alternative design treatments which BRT infrastructure can provide. In theory BRT technologies improve service design compared to conventional bus services hence they should act to increase ridership. Improvements which can increase ridership are said to include:

- higher frequency services with longer operating hours;
- priority systems (including segregated right of way) which are known to reduce journey times and improve service reliability; and
- better-defined network/corridors, branding and provision of new technology information systems to improve the ease of understanding the system.

A key research question concerns the relative impact of each of these factors and the extent to which BRT design components compare with the service design elements of conventional bus routes. Past research on bus and light rail ridership suggests that service frequency is one of the most important influences on ridership. Therefore the hypothesis tested in the research is whether BRT design features contribute to higher ridership above and beyond any increase in service frequency compared to conventional bus routes.

The theoretical framework of the paper is to explore this hypothesis by measuring the links between service and infrastructure design aspects of conventional and BRT routes and how these relate to ridership. An empirical methodology is adopted

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using multiple regression analysis. The analysis considers traditional measures of supply such as service frequency. It also examines the impact of BRT design/infrastructure above and beyond the influence of conventional supply measures. These influences are explored on 77 BRT and non-BRT bus routes in the Australian cities of Melbourne, Sydney, Adelaide and Brisbane.

The paper is structured as follows. The paper starts with a summary of previous research in this field. This includes an assessment of relevant research on route level influences of patronage on public transport, an assessment of research concerning BRT technologies and infrastructure and their impacts on ridership. This is followed by a discussion of the research approach and methodology adopted for the empirical analysis. The results of the analysis are then presented followed by a summary and discussion of the findings. Future areas for research are also discussed.

2. Research context

A range of research has examined the influences on route level ridership on public transport systems. High service levels, measured in terms of frequency and span of hours covered, has often been cited as the most important influence on route level ridership. One of the first analyses of bus route level ridership (Stopher, 1992) found that service quantity, measured as the number of buses per hour, was the single most significant factor in an empirical analysis of US bus routes. FitzRoy and Smith (1998) in their study of the European Freiburg public transport system state that high service levels are important for achieving high patronage levels. In a review of factors driving ridership growth on bus services, Currie and Wallis (2008) found that service quantity was the single most effective influence. A number of studies have also found that service levels were the principal influence on ridership in US light rail research (e.g. Kain and Liu, 1999).

The density of urban development has long been identified as a major influence on ridership although it is rarely cited as a primary influence (Seskin and Cervero, 1996; Johnson, 2003). Stopher (1992) found employment density was a significant factor influencing bus ridership but this was not as important as service levels. Kain and Liu (1999) examined the factors determining the high ridership of light rail routes in Houston and San Diego. While stating that factors like urban density and employment levels play a role in determining patronage levels, they concluded that the most important factors to drive patronage are high service levels (measured in vehicle kilometres on a route) and low fares.

Several researchers have suggested that high car ownership can act to reduce route level ridership (e.g. Babalik-Sutcliffe, 2002; Mackett and Babalik-Sutcliffe, 2003). Although these influences are large between countries of widely differing car ownership levels, they are unlikely to be significant in explaining the large differences in ridership for routes across Australia where car ownership is consistently high.

Low fares have been cited as a factor affecting rail ridership (FitzRoy and Smith, 1998; Kain and Liu, 1999). However Currie and Wallis (2008) note that elasticities of bus demand to fares are low (typically −.3) and hence very large fare differences are required to show substantive differences in ridership between bus routes. It is unlikely this would be a significant influence on the Australian bus routes examined since fare levels do not significantly vary between Australian cities. Integrated ticketing has been linked to higher ridership in several bus systems. Streeting and Barlow (2007) suggested that integration effects of fares and better marketing and planning explained up to 30% of the 11.6% growth in ridership in Queensland between 2004 and 2006.

Overall previous research suggests a wide range of factors might influence route level ridership but service levels are generally identified as a principal influence.

2.1. BRT technologies and ridership effects

> "Bus Rapid Transit (BRT) is a high-quality bus based transit system that delivers fast, comfortable, and cost-effective urban mobility through the provision of segregated right-of-way infrastructure, rapid and frequent operations, and excellence in marketing and customer service. BRT essentially emulates the performance and amenity characteristics of a modern rail-based transit system but at a fraction of the cost."
> (Wright and Hook, 2007, p. 1)

As the above definition states, Bus Rapid Transit (BRT) aims to deliver rail-like service quality using higher quality provision of bus based services. The key features of BRT systems which define this quality are articulated by Levinson et al. (2003) as:

A. Running Ways—including mixed traffic lanes, curb bus lanes, and median busways on city streets; reserved lanes on freeways; and bus-only roads, tunnels, and bridges. These may act to increase ridership through increases in travel speeds and greater reliability.
B. Stations—providing higher quality infrastructure than simple bus stops. This can include platforms, more significant forms of shelter, quality information systems and other amenities. Quality stops may increase ridership through greater comfort and faster boarding times due to factors such as level boarding platforms.
C. Vehicles—BRT vehicles can include conventional standard and articulated diesel buses however there is also a trend toward innovations in vehicle design. These include: (1) 'clean' vehicles; (2) dual-mode (diesel-electric) operations through tunnels; (3) low-floor buses; (4) more doors and wider doors; and (5) use of distinctive, dedicated BRT vehicles for image and branding. As with stations, quality vehicles may increase ridership through greater comfort and faster boarding times using multiple doors or level access to vehicles.
D. Intelligent Transport Systems—use of technologies including automatic vehicle location systems; passenger information systems; transit preferential treatment systems at signalised intersections, controlled tunnel or bridge approaches, toll plazas and freeway ramps. These technologies may increase ridership through increased travel speeds, greater reliability and better passenger information.
E. Service Patterns—usually with high service levels and can include a mix of express and stopping patterns. Significantly, most networks operate beyond the running ways and onto local streets which can reduce the need to transfer at stations. High service levels are likely to be a strong influence on ridership.

Much research on BRT system performance has focussed on the relative cost effectiveness of their design relative to light and heavy rail infrastructure (e.g. Brown and Thompson, 2009). However, little research has considered whether BRT provides significant benefits over traditional bus systems. Little work has been undertaken on the relative patronage performance of BRT system features (Currie, 2005).

Hensher and Golob (2008) undertook one of the few comparative assessments of system-wide data from 44 BRT systems from around the world to examine a range of performance features