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An experiment evaluating the impacts of real-time transit information on bus riders in Tampa, Florida

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ABSTRACT

Public transit agencies often struggle with service reliability issues; when a bus does not arrive on time, passengers become frustrated and may be less likely to choose transit for future trips. To address reliability issues, transit authorities have begun to provide real-time information (RTI) to riders via mobile and web-enabled devices. The objective of this research is to quantify the benefits of RTI provided to bus riders. The method used is a behavioral experiment with a before–after control group design in which RTI is only provided to the experimental group. Web-based surveys are used to measure behavior, feeling, and satisfaction changes of bus riders in Tampa, Florida over a study period of approximately three months.

The results show that the primary benefits associated with providing RTI to passengers pertain to waiting at the bus stop. Analysis of "usual" wait times revealed a significantly larger decrease (nearly 2 min) for RTI users compared to the control group. Additionally, RTI users had significant decreases in levels of anxiety and frustration when waiting for the bus compared to the control group. Similarly, they had significant increases in levels of satisfaction with the time they spend waiting for the bus and how often the bus arrives at the stop on time. Taken together, these findings provide strong evidence that RTI significantly improves the passenger experience of waiting for the bus, which is notoriously one of the most disliked elements of transit trips. The frequency of bus trips and bus-to-bus transfers were also evaluated during the study period, but there were no significant differences between the experimental and control groups. This is not surprising since the majority of bus riders in Tampa are transit-dependent and lack other transportation alternatives.

The primary contribution of this research is a comprehensive evaluation of the passenger benefits of RTI conducted in a controlled environment. Moreover, this research has immediate implications for public transit agencies – particularly those serving largely transit-dependent populations – facing pressure to improve service under tight budget constraints.

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1. Introduction

Public transit plays a vital role in urban transportation systems. Transit helps to reduce carbon dioxide emissions, decrease gasoline consumption, and combat roadway congestion in metropolitan areas (Schrank et al., 2012). It is one of

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the safest modes of passenger transport, as evidenced by low passenger fatality rates (Neff and Dickens, 2013). Other benefits of transit include providing personal mobility options for those who cannot or choose not to drive (e.g., American Public Transportation Association, 2014) and positive public health impacts associated with active lifestyles (e.g. Besser and Dannenberg, 2005).

Despite its benefits, transit agencies in many American cities struggle to compete with other modes of passenger transportation, especially single-occupancy motor vehicles. To be a viable option when compared to alternatives, transit service must be fast, frequent, and reliable, among other things (Walker, 2012). Reliability can be improved in many ways, including: increasing levels of right of way, such as providing a dedicated lane; using service planning approaches, such as adding slack to scheduled running times; or implementing control strategies, such as holding vehicles that are ahead of schedule. While these supply-side strategies can be effective at improving reliability, they often come at a substantial cost.

Recently, a demand-side strategy has emerged that can improve the perception of reliability: providing real-time vehicle location and/or arrival information helps passengers adapt to unreliability of transit service (Carrel et al., 2013). Moreover, real-time information (RTI) can be provided to passengers in an increasingly cost-effective manner, particularly when agencies take an "open data" approach. "Open data" means that the transit authority makes their service information freely available to the general public in a computer-readable format (Barbeau, 2013; Wong et al., 2013). This information can be used by third-party software developers to create transit "apps," often at little-to-no additional cost to the agency. The rapid adoption of mobile devices makes this third-party information dissemination channel directly accessible to an increasing number of riders (Schweiger, 2011). This trend has occurred so rapidly in the United States that, in December of 2012, the president of the American Public Transportation Association said that "the proliferation of transit apps is one of the most exciting things to happen to this industry" (Mann, 2012). In light of this, decision-makers at the country's transit providers want to understand the impacts of RTI. This research aims to provide a comprehensive study of the benefits of providing RTI to riders via web-enabled and mobile devices. To do this, a controlled behavioral experiment, which is an established methodology in the social sciences (Campbell and Stanley, 1963), was conducted to evaluate the impact of RTI on bus riders.

This paper proceeds as follows. First, prior research about real-time transit information is reviewed and hypotheses about the benefits of RTI are presented. The next section provides detailed information about the methodology used to conduct the controlled behavioral experiment. This is followed by the results, the limitations of the study, and the conclusions.

2. Literature review

There is a growing body of research that aims to understand the rider benefits of RTI. An early segment of this research focused on the impacts of RTI displayed on signage at stops or in stations (e.g., Hickman and Wilson, 1995; Dziekan and Kottenhoff, 2007; Politis et al., 2010). Recently, the literature has expanded to include the provision of RTI through web-enabled and/or mobile devices. Many of the initial studies of RTI provided via personal devices relied heavily on stated preference and/or simulation methods to evaluate possible impacts (e.g., Caulfield and Mahony, 2009; Tang and Thakuriah, 2010). Given the recent widespread availability of RTI applications throughout the country, there is a growing subset of the literature that uses actual behavioral data to understand rider benefits, and it is the focus of this review. Based on prior behavioral studies, the following key benefits of RTI were identified: (1) decreased wait times, (2) increased satisfaction with transit service, and (3) increased ridership. It should be noted that there may be other rider benefits associated with the use of RTI (e.g. route choice to minimize travel time), but prior research has largely relied on stated preference or simulation methods (e.g., Cats et al., 2011; Fonzone and Schmöcker, 2014). Therefore, this study focuses on the benefits grounded in actual behavioral studies to provide a framework for evaluation of RTI in a controlled environment.

The following review includes discussion of each one of these impacts (decreased wait times, increased satisfaction, and increased ridership), as well as related benefits.

2.1. Decreased wait times and feelings experienced while waiting

When passengers utilize RTI, they can time their departure from their origin to minimize their wait time at stops or stations; moreover, RTI can reduce their perception of the length of wait times. In Seattle, Washington, a recent study found that bus riders with RTI had actual wait times that were almost two minutes less than those of non-users, and perceived wait times of RTI users were approximately 30% less than those who did not use RTI (Watkins et al., 2011).

Because passengers spend less time waiting at stops and stations, RTI may increase passenger perceptions of personal security when riding transit, particularly at night. A panel study conducted at the University of Maryland measured changes before and after the implementation of a RTI system on the university shuttle bus network, and the results revealed that passengers reported increased levels of perceived personal security at night attributable to RTI (Zhang et al., 2008). Two web-based surveys of RTI users conducted in Seattle, Washington provide additional evidence that RTI may increase self-reported levels of personal security. In the first survey, conducted in 2009, 18% of respondents reported feeling "somewhat safer" and another 3% felt "much safer" as result of using RTI (Ferris et al., 2010). In 2012, a follow-up web-based survey in Seattle found over 32% of RTI users had a positive shift in their perception of personal security (Gooze et al., 2013).

In addition, prior studies have aimed to assess changes in other feelings while waiting for the bus, including aggravation, anxiety and relaxation. The previously mentioned University of Maryland panel study evaluated levels of anxiety while