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Public transport user's perception and decision assessment using tactic-based guidelines

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ABSTRACT

An important step in the development of an integrated system is for policy-makers and public transport (PT) operators to remove the uncertainty of PT service performance in real-time. Implementing proper control actions, such as tactics, leads to reducing passenger waiting time and preventing missed transfers. These two undesirable features are major contributors to PT's negative image. However, there has been no specific investigation of the effect of implementing tactics on passengers' perceptions and decisions (demand side). This paper presents the results of a qualitative and quantitative study of PT users to obtain a deeper understanding of travelers' attitudes toward transport uncertainty and to explore perceptions of real-time operational tactics on PT service quality. The study is undertaken in two-parts: (a) assessment of the effects of delay on PT users' perception and decision to change route or mode; (b) evaluation of users' decision based on various real-time operational tactics. To investigate users' perception and decisions related to various operational tactics, a user-preference survey was conducted at a major terminal in Auckland, New Zealand, and Lyon, France. The survey data was modeled following a Multinomial Logistic Regression and a decision-tree-based method. The statistical analysis emphasized that, in various situations (e.g., waiting at a stop for more than 10 min), more than 60% of the travelers will change their decision and adapt travel behaviors based on a decision-support tool. The findings provide policy makers with an understanding of the behavioral aspect of real-time operational tactics.

1. Introduction

The need to attract people from personal automobiles to public transport (PT) is paramount for achieving a sustainable transport system (Hanaoka and Qadir, 2009). PT agencies have adopted a common tactic of developing an integrated, effective multi-modal transport system in order to provide travelers with a reliable alternative to private cars. Improving PT service reliability is one of the most important tasks in PT planning and operations. Unreliable PT services have been found to be one of the main reasons for the considerable reduction in PT service attractiveness (Ceder, 2007, 2016). As a result, continued unreliable PT service will not only frustrate existing passengers, but will also cause the loss of potential new users. Ceder (2007, 2016) showed that attractive, advanced PT was a system that operated reliably and relatively rapidly, with smooth (ease of) synchronized transfers and constituted part of the door-to-door passenger chain. Levinson (2005) demonstrates that reliable transit service is essential to attracting and retaining riders, principally in modern societies, where many transportation options are available.

Balcombe et al. (2004), in a practical UK transit guide, reported that in passengers' perception, the reliability of local bus services is considered twice as important as the element of frequency. Because of some uncertain and unexpected factors, such as traffic disturbances and disruptions, inaccurate PT-driver behavior and actions, and random passenger demands, a pre-planned, scheduled PT service does not always materialize, especially synchronized-transfer service. Eboli and Mazzulla (2010) introduced a methodology to evaluate user behavior and perception based on comfort attributes and overall PT service quality; this study uses rating and choice options. Iseki and Taylor (2009) argued that PT users' perceived waiting time has been shown to be more onerous than the actual waiting time and is dependent on waiting conditions, such as personal safety, connection reliability, and comfort. An empirical study by Psarros et al. (2011) indicated that what passengers perceive as waiting time is relatively different from their actual waiting time at a bus stop. Vincent (2008) showed that transit passengers perceive unexpected waiting time to be 3–5 times more burdensome relative to in-vehicle time. A recent study by Ceder et al. (2013a) investigated the effects of uncertainty in out-of-vehicle times during transfers on PT users' willingness to use transfer routes. Their findings show that increasing consistency in out-of-vehicle times will increase the attractiveness of

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transfer routes, thus enabling a more efficient, integrated network of PT routes to result in the enlargement of ridership. One efficient approach to alleviate the uncertainty of the simultaneous arrival of vehicles at a transfer point and to correct schedule deviations is to use selected operational tactics, such as holding, skip-stop, and short-turn. Suh et al. (2002) showed that skip-stop can be considered as an alternative strategy to the express subway service. Studies (Ceder et al., 2013b; Hadas and Ceder, 2010; Nesheli and Ceder, 2014) show that applying certain operational tactics can significantly increase the number of direct (simultaneous) transfers and reduce total passenger travel time.

Hanaoka and Qadir (2009) investigated bus passengers' behavior and perceptions of the use of potential features of an automatic vehicle-location (AVL) system in bus transit. The study involved an attitudinal on-board survey to understand respondents' behaviors in Bangkok. The work focused on measuring the effects of a bus-holding strategy using AVL technology in bus operation utilizing a simulation model. Concerning passengers' information systems, Eboli and Mazzulla (2012) argued that a high-quality information system was an essential factor in retaining existing riders and attracting potential users and thus increase ridership. Studies (Bachok, 2007; Grotenhuis et al., 2007; Molin, 2009) have shown that integrated information systems are required to facilitate transfers between urban and inter-urban multimodal PT networks.

A recent study by the authors (Nesheli and Ceder, 2014) investigated how selected operational tactics should be used in PT networks to increase the actual occurrence of scheduled transfers. Their model determined the impact of instructing vehicles either to hold at or to skip certain stops/segments on total passenger travel time and the number of simultaneous transfers. Although extensive research has been conducted to analyze PT movements at control points, there has been no specific analytical study dealing with passengers' perceptions and decisions related to real-time control actions. There is need, then, to assess the effect of applying real-time tactics in a proper study of demand side perceptions and decisions as complementary to the agent side. The expected contribution of the present study is to provide PT agencies with a perception of demand control. The research is undertaken in two-stages: (1) an assessment of the effects of delay on PT users' perception and decision to change route or mode; (2) an evaluation of users' decisions based on various real-time operational tactics.

The objective is to develop a guideline for both policy-makers and passengers in terms of using possible real-time operational tactics in order for users to make the best possible decision in any uncertain event. The PT agents can provide PT users with different possible options, including operational tactics, with real-time information. Passengers can thus make a decision based on the available options. The method enables agents to control demand, redirecting and allocating passenger flows.

The primary aim of this study is to collect and analyze information on PT passengers' behaviors and their perceptions related to the use of potential features of a decision-support tool in the existing PT system. A secondary aim is to determine the potential benefits of a control strategy using selected operational tactics to reduce the uncertainty of passengers' travel-times by increasing PT service reliability. The specific objectives to achieve the study's aims are as follows:

- To assess PT passengers' perceptions and expectations of the potential features of a decision-support tool.
- To determine and compare passengers' decisions modeled in different scenarios.
- To determine the effect of implementing selected operational tactics on passengers' decisions.
- To assess the importance of PT service factors in passengers' preferences.

To the authors' knowledge, the present study provides, for the first time in the literature, a description of two commonly used models: Multinomial Logistic Regression (MLR) and a Decision Tree (DT)-based method for passengers' decisions, CHAID. Section 2 of this work presents the research methodology, Section 3 describes the two modeling procedures and results, Section 4 provides a tolerated time model and a discussion of the use of the application and operational tactics, and Section 5 presents the conclusions and recommendations for future study.

2. Stage 1: methodology and findings of users' perception of the service factor

Because of the complexity of travel behavior, a deeper understanding of people's perceptions, attitudes, and behavior is required (Beirão and Sarsfield Cabral, 2007). Qualitative and quantitative methods can be used to explore this complexity. Quantitative approaches have the advantage of measuring the reactions of many subjects by a limited set of questions, thus allowing the comparison and statistical aggregation of the data. Qualitative methods produce a wealth of detailed information on a small number of individuals (Patton, 2002). In this study, an attitudinal survey was designed to compare PT users' perceptions and attitudes toward various events; the respondents included regular and occasional users. The questionnaire consisted of four parts: socio-economic and trip information, users' preferences and expectations as criteria for selecting PT over car, users' attitude and decision toward different waiting times, and lastly their attitudes toward and decisions about some selected real-time operational tactics.

2.1. Design of questionnaire

Attaining the study's objectives is done by the use of a questionnaire. All the considered factors, of this questionnaire, are in line with a solid theoretical base to support it (Nesheli and Ceder, 2014; Nesheli and Ceder, 2015). The questionnaire is five-fold. The first part contains general questions and a demographic survey. The second part refers to the use of smartphone application. The third part is used as a decision support tool using stated preference type of questions. That is, given a certain real-time information displayed on the smartphone, there are four travel scenarios (solutions) to select from under three main categories: (1) given that the bus is delayed by different times, (2) given that the use of operational tactics can make the PT better than the car in terms of travel time and comfort, and (3) given that the use of operational tactics can save travel time. The operational tactics in this study consist of "Holding", "Skip-stops", and "Boarding limit". To ensure that the respondents fully comprehend the real-time operational tactics and their features, a clear definition of each tactic was presented to them prior to the beginning of the survey. For a tolerated time model it is asked "How many extra minutes are you willing to bear because of implementing the introduced real time tactics to make the PT service more reliable? " The fourth part was designed to investigate user's perception of value of time perceived for the four travel scenarios when implementing an operational tactic. The fifth part is a proportional evaluation of four criteria: travel time, PT reliability, comfort, and energy; Likert score from 1 (not important) to 5 (very important) was used for this evaluation of knowing when the PT service is preferred over the car. In addition the questionnaire was designed to evaluate the risk-perception level of the respondents concerning their decisions. In travel behavior studies, it has been a common practice to assume that travelers have a perfect knowledge about their choices and make rational decisions based on utility maximization (Xu et al., 2011).