Proceedings of the 2017 Winter Simulation Conference
W. K. V. Chan, A. D'Ambrogio, G. Zacharewicz, N. Mustafee, G. Wainer, and E. Page, eds.

AGENT-BASED SIMULATION MODELING OF A BUS RAPID TRANSIT (BRT) STATION USING SMART CARD DATA

SangHyung Ahn
Samuel Richard Hislop-Lynch
Jiwon Kim
Roy Zhu

School of Civil Engineering
The University of Queensland
St Lucia, QLD 4072, AUSTRALIA

ABSTRACT

A Bus Rapid Transit (BRT) station with multiple loading zones tends to have a longer passenger-bus interface and, thus, lead to longer passenger walking times and longer bus dwell times than ordinary bus stops. As a way to reduce bus dwell times in a BRT station, this study focuses on eliminating delays in passengers' reaction to their desired bus by designing an improved passenger information system (PIS) that can increase passengers' certainty about the bus stopping location. This study develops an agent-based simulation model based on observations from a BRT station in Brisbane, Australia to reflect a real BRT operations and passenger flows. The input parameters for the simulation model are calibrated with actual data including smart card records, field measurements, and video recordings. After mapping passenger moving and waiting patterns, and allocation logic of bus loading areas, various what-if analyses can be performed to design better passenger information systems.

1 INTRODUCTION

Several studies have applied simulation approaches to model traffic conditions and operational scenarios at public transit stations. Widanapathiranage et al. (2014) used microscopic simulation to analyze the relationship between station queuing and capacity. Seriani and Fernandez (2015) experimented the effect of pedestrian traffic management in the boarding and alighting time of passengers at metro stations by using simulation modelling technique. The simulation results from this study show that pedestrian traffic management measures can have significant impacts on the passenger service time, passenger density in cars and on platforms as well as passengers' dissatisfaction in metro stations. The existing studies, however, rely mainly on field measurements and video recordings, which have a limitation in accurately identifying passenger demand for each bus route at different time-of-day periods. To overcome this limitation, this study uses smart card data to extract the detailed information on bus supply and passenger demand at a given BRT station. Using smart card transaction records collected in April 2013, the number of non-transfer/transfer passenger per route per service in 15-minute intervals during the peak hours was identified to build an origin-destination matrix for assigning boarding and alighting passengers. An example of time-dependent passenger demand used to sample boarding passengers is presented in Figure 1. Transfer passengers shown in Figure 1 are identified from alighting passengers extracted from smart card transaction records.

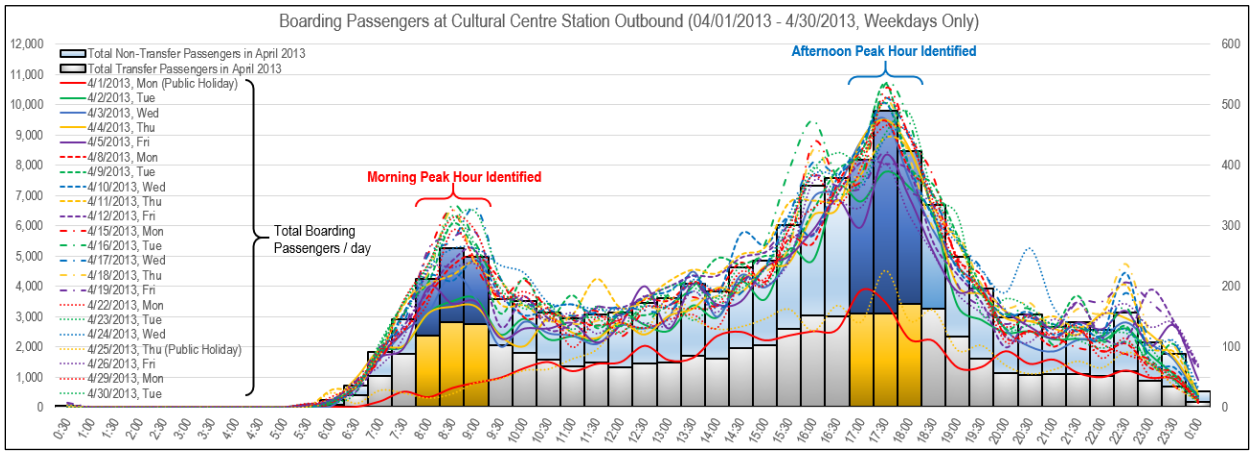

Figure 1. Boarding passengers at Cultural Centre Station, Brisbane, Australia, outbound in April, 2013.

2 CASE STUDY APPROACH AND CONTRIBUTIONS

A case study was conducted for Cultural Centre Station, one of the busiest BRT stations in Brisbane, Australia. After obtaining input parameters from the real-world data, an agent-based simulation model using AnyLogic was built to describe bus arrivals/departures and detailed passenger movement at the platform. The goal of this case study is to evaluate a real-time passenger information system (PIS), which dynamically assigns the optimal loading area to an oncoming bus and provides the assigned loading zone information to both the bus drivers and the passengers so that the passengers can proactively move toward their designated loading zone with certainty in advance. To this end, this study develops an algorithm to determine the optimal loading zone for each oncoming bus in real-time and designs a hypothetical system that provides this information to bus drivers and passengers via vehicle-to-infrastructure (V2I) communications and electronic display boards at the station. We compare the simulation results obtained from the proposed and current systems and evaluate the performance of the proposed system using different performance measures. For instance, the results show that the proposed system could reduce bus dwell time by 5%.

Main contributions of this paper entail (i) identifying key input parameters for modelling a BRT station with multiple loading areas, (ii) developing an approach to assigning boarding and alighting passengers based on historical smart card transaction records, (iii) developing an algorithm to allocate loading zones to oncoming buses in a way to minimize expected delays, (iv) developing an agent-based simulation model that implements the proposed real-time passenger information system, and (v) identifying key performance measures that are effective in assessing the feasibility and performance of the proposed system. Through a case study, this paper will demonstrate how an agent-based simulation framework can support public transport agencies and operators in evaluating new operation strategies by capturing individual agents' decision-making processes and modeling dynamic behaviors of heterogeneous passengers on a BRT station platform.

REFERENCES

Widanapathiranage, R., J. M. Bunker, and A. Bhaskar. Modeling Bus Rapid Transit Station Bus Queuing for Bus Rapid Transit Station Bus Operation Analysis. *Transportation Research Board 93rd Annual Meeting*, 2014

Seriani, S., and R. Fernandez. Pedestrian traffic management of boarding and alighting in metro stations. *Transportation Research Part C: Emerging Technologies*, Vol. 53, Apr. 2015, pp. 76–92.