Passenger Segmentation Using Smart Card Data

Le Minh Kieu, Ashish Bhaskar, and Edward Chung

Abstract—Transit passenger market segmentation enables transit operators to target different classes of transit users for targeted surveys and various operational and strategic planning improvements. However, the existing market segmentation studies in the literature have been generally done using passenger surveys, which have various limitations. The smart card (SC) data from an automated fare collection system facilitate the understanding of the multiday travel pattern of transit passengers and can be used to segment them into identifiable types of similar behaviors and needs. This paper proposes a comprehensive methodology for passenger segmentation solely using SC data. After reconstructing the travel itineraries from SC transactions, this paper adopts the density-based spatial clustering of application with noise (DBSCAN) algorithm to mine the travel pattern of each SC user. An *a priori* market segmentation approach then segments transit passengers into four identifiable types. The methodology proposed in this paper assists transit operators to understand their passengers and provides them oriented information and services.

Index Terms—Automated fare collection (AFC) system, market segmentation, public transport, smart cards (SCs), transit passenger.

I. INTRODUCTION

BETTER understanding of passengers is essential for transit authorities to satisfy customer needs and preferences. The Transportation Research Board has published a handbook on using market segmentation to increase patronage [1]. Most transit operators have defined classes of customers but not market segments. For instance, operators in South East Queensland (SEQ), Australia, classify passengers into six types (adult, senior, child, pension, secondary school student, and student) according to age and occupation. Although this classification is still useful for fare collection, whether these types differently respond to alternative services and whether new policies benefit them is unknown.

Despite the high exposure to transit passengers, transit providers have limited knowledge about their customers due to reasons such as the anonymity of passengers, the stochasticity of their behaviors, and the complexity in analyzing the disaggregated information of a massive population. Future impacts of the proposed initiatives to existing and latent passengers are obscure due to the lack of knowledge on their mobility requirements and travel behaviors. Existing service improvement projects are limited to the impacts on generic transit customers, neglecting the differences between the types or segments of passengers with different needs and behaviors. Paradoxically, the majority of studies in public transport solely focus on improving a vehicle's performance, such as the travel time or schedule adherence, without a profound understanding of passenger segments and behaviors, notwithstanding the fact that different segments of passengers would behave differently in a transit system. For instance, an irregular transit passenger would be more concerned with the service coverage, i.e., if s/he would be able to travel by public transport to the desired destination, whereas a commuter transit rider user would be more concerned with the on-time performance and the easiness of transfers.

One of the dominant factors that dictate the level of passenger characterization is the availability of data. Traditional studies on passenger travel patterns and passenger segmentation solely focus on the use of transit user surveys [1]–[3]. These surveys are generally expensive to perform, are limited in sample size, and are only valid within the study period. Transit agencies are at a critical transition in data collection technology from manual data collection toward automated data collection systems (ADCSs). Manual data collection systems with a low capital cost but a high marginal cost, small sample sizes, and sometimes unreliable accuracy are being replaced by a low marginal cost, large sample sizes, and disaggregated ADCSs. ADCSs such as automatic vehicle location, automatic passenger counter, automatic vehicle identification, and, particularly, smart card (SC) automated fare collection (AFC) systems have only recently become widely popular for collection and analysis. The proliferation of these modern technologies provides a tremendous opportunity to analyze the existing condition of transit quality of service and facilitates agencies to enhance the service quality. Public transport agencies that are able to take advantage of this massive amount of data to anticipate and actively react to the changes in the transport environment and passenger behaviors would earn an utmost advantage to attract customers. The Brisbane City Council Transport Plan for Brisbane, Australia [4], emphasizes the use of data to ensure that the strategies are effective to augment the transit experience and provides a demand-responsive transit system.

This paper augments the transit passenger characterization by passenger segmentation using the dynamic SC data. The segmentation aims to group passengers of similar travel pattern, i.e., with the same level of transit journeys at regular times and places. The market segmentation of transit passengers brings various benefits to transit authorities to better cater to their customers. A targeted survey could aim for the passengers of

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