Transportation Research Part C 107 (2019) 510–524

Contents lists available at ScienceDirect

Transportation Research Part C

journal homepage: www.elsevier.com/locate/trc

Diffusion behavior in a docked bike-sharing system

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ARTICLE INFO

Keywords:
Bike sharing
Diffusion behavior
Bike trip distance
Rebalancing action
Isolated communities

ABSTRACT

This paper examines bike diffusion behavior in a docked bike-sharing system in Chicago. The analysis is based on an analogy between the movement of shared bikes and the transmission of certain information on internet or the spreading of epidemics among humans. By mining a bike trip data set collected in the city, we find that (1) the distribution of bike trip distance peaks between 0.8 and 2 km, and beyond 6.3 km, it follows a strong power law; (2) the diffusion intensity of a community is affected positively by the number of incoming bike trips and rebalancing actions, and negatively by the percentage of inner-community trips. The effect of the rebalancing actions is roughly twice as strong as that of the incoming bike trips; (3) both the diffusion range of a bike and the number of rebalancing actions it receives are strong predictors of its use. Reaching one more community will produce about 14 more trips and an additional rebalancing action contributes about 8.6; and (4) even the most active bikes could only reach about 75% of all communities in Chicago. The last finding helps identify a cluster of communities poorly connected with the rest of the city by bike travel. Interestingly, these isolated communities are strongly correlated with the areas of the city that have high concentration of African American population, low-income households and homicide crimes.

1. Introduction

Thousands of cities around the world now operate some forms of bike-sharing systems (Meddin, 2018). Bike sharing helps transit users solve their first- and last-mile problem (Liu et al., 2012). It also offers others, including residents and visitors of large metropolitan areas, a low-cost mode to make relatively short trips. While bike-sharing systems are expensive to operate in general (Shaheen et al., 2010), they are quite popular among travelers. A recent survey found that over 90 percent of bike sharing users in Beijing, China were satisfied with the experience (Wang, 2017). Bike-sharing systems may or may not be operated with fixed docks. Dockless bike-sharing systems allow users to pick and return bikes pretty much anywhere, a crucial feature that has quickly attracted myriads of users and stimulated their dramatic expansion, especially in China (e.g. Mobike and ofo). Yet, they are often frowned upon by city managers, who see the bikes littering the streets and sidewalks a threat to their city's ecosystem (Liu et al., 2017; Jiang, 2018). Docked systems, such as Capital Bikshare in Washington D.C. and Divvy Bike in Chicago, are less intrusive, but they are generally viewed as less flexible and more expensive.

Although large-scale bike sharing is a relatively new concept, it has attracted great interest from the research community in recent years, see (Fishman, 2016) for a review. Researchers have attempted to examine the characteristics of bike-sharing systems using

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https://doi.org/10.1016/j.trc.2019.08.018
Received 2 October 2018; Received in revised form 3 May 2019; Accepted 20 August 2019
Available online 12 September 2019
0968-090X/