For the most part, public transit agencies have relied on manual surveys to collect demographic and travel diary information in order to understand the travel behavior of their customers. Recently, many agencies have taken advantage of automatically collected data to obtain a richer understanding of travel behavior. Specifically, automated fare collection (AFC) have allowed agencies to observe complete trip history on an individual basis and thus obtain a richer understanding of how, when, and where customers are using the public transit system. With the recent proliferation of smartphone usage, transit agencies now have the potential to use new sources of automated mobile data. Specifically, mobile activity tracking apps are an emerging class of applications for smartphones that use GPS and smartphone sensors to create an automated travel diary. This research uses TfL as a case study to examine how and to what extent mobile activity tracking data can be used in transit agency setting to gain an increased understanding of travel behavior. The research can be considered in three stages: 1) application review and data collection 2) processing the data and fusing with other sources 3) analyzing the data for travel insight.

There are a wide variety of mobile activity apps, both in terms of intended use and resulting data. After reviewing apps on the basis of 1) modes captured 2) accuracy of data 3) battery drain 4) privacy concerns 5) accessibility of data and 6) privacy, this research focused on Moves - a free application for both iOS and Android developed by ProtoGeo (1). Moves creates an automatic trip diary that includes information on trip mode (walking, cycling, running, transport), route information, and start and end location and time. This data provides a much more detailed, granular depiction of travel behavior. And most importantly, it provides information on modes beyond public transit. Furthermore, since the app is running in the background, it is easy to collect many days of data with low effort, in contrast with a manual survey which often only includes one or two days. Therefore, automatic activity tracking data provides the potential to obtain a detailed picture of individual travel behavior over time in a way that AFC and survey cannot. In collaboration with MIT, Transport for London recruited over 140 students to participate in the study.
users to collect mobile activity tracking data for two weeks between August 2015 and April 2016. This resulted in over 6,000 person-days of data. Furthermore, a household survey with trip diary and AFC records for the same individuals were provided by Transport for London.

Moves does not differentiate car, bus, subway, or train trips. Instead, it categorizes all motorized trips as 'transport'. However, the distinction between these modes is critical for public transit agencies. Therefore, one major methodological problem of this research is to infer a more precise trip mode - car, subway, train, or bus. This problem is approached in two ways. First, by matching each 'transport' trip in Moves with corresponding AFC records, the public transit trips can easily identified. Second, by adapting a method of 'network-matching' (2), public transit trips can be identified by matching trajectories of GPS trackpoints to the physical layout of the public transit network. Furthermore, since mobile activity tracking data is a new source of data, this research will also focus on developing methods and heuristics to remove and correct outliers, such as incorrect trip modes and trip duration. In order to develop as complete a trip diary from the automated data, the home and work locations are also inferred.

Using the processed trip diary, the research summarizes the spatial and temporal patterns of different mode use. For a transit agency, understanding when and where individuals use non-public transit modes, especially car or taxi, is particularly important. Similarly, the research also aims to analyze how walking, cycling, and car modes interact with public transit. Specifically, using this new source of data, it is now possible to observe the mode, route, and variation in how individuals access their originating public transit station. Furthermore, by combining with AFC data, the granularity of the mobile activity tracking data can also have the potential to provide new transit measurements - such as time from entering station to boarding train. Although outside of the scope of the current research, the incorporation of automatic vehicle location data could also provide invaluable insight into denied boarding and waiting times at stations.

Since there are only 140 individuals in the sample, the results are not intended to be representative. Instead the research aims to demonstrate the data's potential to provide insight individual travel behavior and make the case that with a larger sample of data it could provide valuable insights into aggregate travel behavior as well. The research argues that mobile activity tracking has value as a survey tool. To support this claim, the resulting trip diary from the mobile activity tracking data is compared to the manual trip diary and survey questions on travel behavior.
REFERENCES
