The Tabi Travel App Construction, results and commentary

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1 Introduction

Measuring travel and mobility behavior is a necessary but costly endeavor for governing bodies. Travel surveys are considered to provide a relatively high-quality baseline against which the models can be tested, but they lack the detail necessary for estimating location-based behavior. It is therefore of interest to researchers to begin integrating the individual travel survey with movement tracking to improve on accuracy, and to provide more granular data. Coupled with an associated cost-reduction, the resulting travel app is an easy sell.
Many apps have been developed in the preceding decade Berger and Platzer, 2015; Cottrill et al., 2013; Greaves et al., 2015; Lynch et al., 2019; Patterson and Fitzsimmons, 2016; Prelipcean, Gidófalvi, and Susilo, 2018. While some are beginning to reap the proposed benefits, others have yet to see use following initial field tests. As with any new instrument, the travel app is not without its bugs. Problems with location acquisition and accuracy arise from GNSS satellite communication Park et al., 2014. Apps must run on common mobile operating systems such as Android and iOS, whose volatility between versions makes data acquisition itself an uncertain prospect Roddis et al., 2019. Proposed time-saving methodologies for inferring travel mode and detecting stops exist, but lack the precision of traditional travel surveys Prelipcean, Gidofalvi, and Susilo, 2016; Yang et al., 2016; Zhao et al., 2015.
In 2018, Statistics Netherlands developed the Tabi Travel App on behalf of the Dutch Department of Waterways and Public Works, subsequently deploying it for a field test. The goal was investigation of a travel app's capacity to be robust enough as an instrument to be usable in official national surveys of travel behavior. We present the design of the app in brief, describe the fieldwork, and report on the response and initial results.

2 Methods

2.1 Tabi Travel app

The Tabi travel app is comprised of a front end application developed in C# in the Xamarin framework and deployed to Android and iOS, and a backend GO API and Postgres database on Statistics Netherlands servers. Full code for backend and frontend is available on gitlab. Full details on app methodology and data structure are available in McCool et al.

2.2 Field test

An invitation to participate was sent to 1902 persons, half of whom were randomly sampled from the Dutch population register, and half of whom were randomly selected from a set of recent participants in an existing Travel Diary Study, ODiN.

The sample was stratified across three incentive conditions: € 10 conditional on 7 days participation, € 20 conditional on 7 days participation, and a third condition, € 5 + € 5, € 5 conditional on downloading the app, and € 5 conditional on 7 days of participation. All letters were sent with an unconditional € 5. We denote these conditions 10, 20 and 5+5 respectively. All incentives were provided in the form of gift cards.
The letters were sent by post to addresses recorded in the Dutch population register. The invitation consisted of a brief description of the application and the purposes of the study, as well as a QR code and a URL, both of which led to the travel app landing page on Statistics Netherlands servers, from which links were available to the app store pages for both iOS and Android. The invitation also contained login information unique to the individual that allowed for register linkage.
Goals of the field test included establishing willingness and extent of participation and evaluating the quality of the sensor and survey data. To this end, response was investigated across incentive conditions and demographics. Investigation of drop-out included this stratification as well stratification over device variables. Quality of the sensor data was judged based on sparsity and divergence from expectations. Survey data were assessed for completeness.

3 Results

The study achieved an overall response rate of 35.4%. This is comparable to the 2019 response rate from the ODiN travel survey, 27.9%, although new responders have a lower response rate. Table 1 shows the response breakdown across the incentive conditions and the newly-sampled versus previous ODiN responders. Persons sampled from ODiN responders were more likely to respond (44.4%) than those who were sampled from the Dutch population at large (26.5%). The € 20 incentive condition produced the highest response rate at (39.7%), as expected. However, the 10 condition had significantly higher response (36.4%) than the € 5 + € 5 condition (30.1%), despite the latter requiring at most the same amount of work for the same monetary reward.
In addition to initial response rate, differential dropout was also considered. Figure 1 shows the days of participation across incentive conditions and sample populations. Dropout and length of participation were approximately similar across these variables.
Comparisons on some numeric measures were made between the data from the travel app and previously gathered data for the participants who had responded to the ODiN travel survey two months previously. Figure 2 shows the distribution of time spent in transit between this study and the traditional travel survey. The app recorded more time spent traveling on average than the ODiN respondents self reported. Figure 3 shows the distribution of the number of trips per day. The app recorded more total trips per day than were self-reported in the ODiN study.
Problems with data loss were identified with the app. Figure 4 shows both the time-related pattern of loss of contact with a device, in which no locations are being recorded, as well as the hour of reestablished contact, in which locations are again being sent.

4 Conclusions

Initial questions the field test intended to answer were on the topics of participation and data quality. Response rates were generally comparable to other travel surveys which only capture a single day of data. Participants who downloaded the app were asked to provide at least seven days' worth of data. Not only did the majority provide

Table 1: Device registration by condition

		Unregistered		Registered	
		n	%	n	%
Cluster	New	699	73.5	252	26.5
	ODiN	529	55.6	422	44.4
Incentive	5+5	443	69.9	191	30.1
	10	403	63.6	231	36.4
	20	382	60.3	252	39.7
Total		1228	64.6	674	35.4

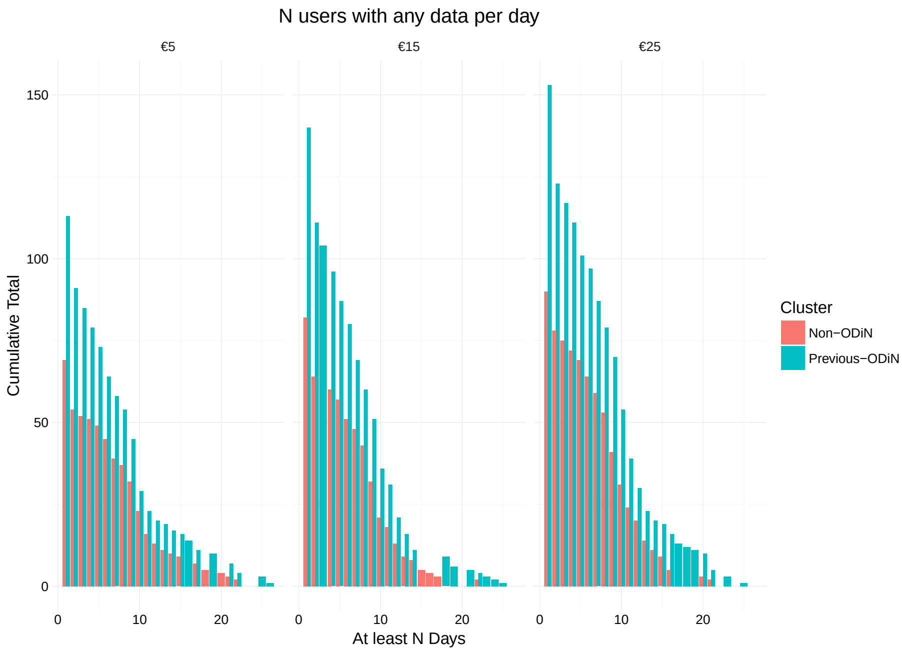

Figure 1: Cumulative days of participation by condition

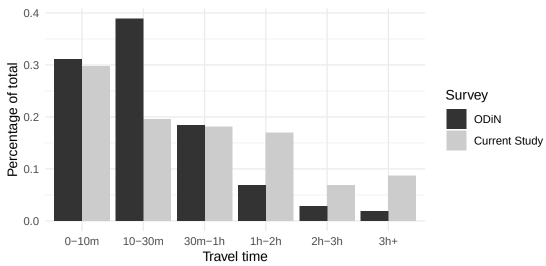

Figure 2: Daily travel time, travel survey vs travel app

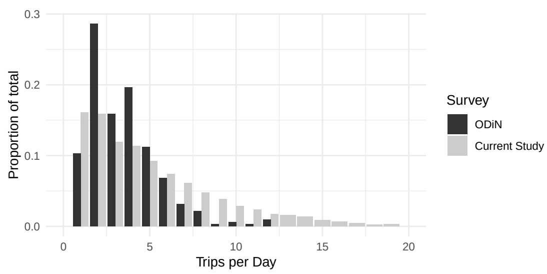

Figure 3: Daily trip count, travel survey vs travel app

this amount, many participants opted to leave the app running on their phone and continued to provide data for much longer time periods.

Comparisons made between the app data and traditional data indicate that the app may be capturing more travel behavior than people self-report. It is possible that the differences in travel time and number of trips are attributable not to genuine underreporting, but to issues arising from incorrectly identifying stops or capturing movement behavior within a stop. Future iterations of the app will allow for more user

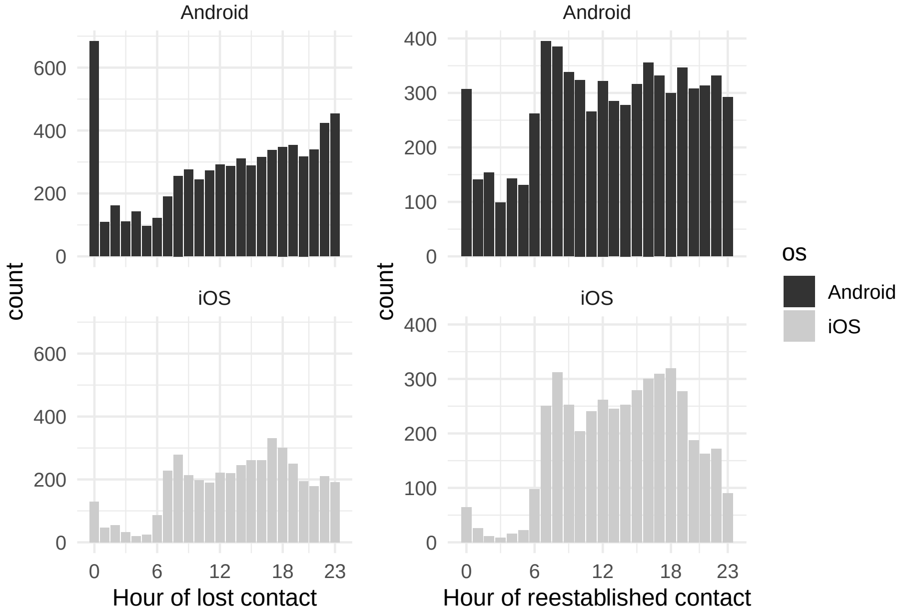

Figure 4: Hour of lost and regained contact with the device

input in removing or adding stops, which could allow for more definitive conclusions on whether the extra movement represents meaningful behavior.

Data quality remains difficult to assess. Behaviors within the device operating systems, including Android's Doze mode and both OS's app-termination policies, led to large amounts of missing data. It is likely that some amount of this missingness, such as that ocurring during the night, is largely ignorable, containing no travel information. Other missing data must be addressed with respect to time, location, device and person characteristics before the data may be used to calculate reliable aggregate measures.

Initial signs indicate that it will be possible to remove some burden from participants by suggesting likely travel modes and pre-filling motives associated with known places. Additionally, participants indicated generally favorable attitudes towards the app in follow-up evaluation surveys.

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