

# Is Servicing Commuters the Goal of the Public Transport System?

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## Abstract

Public Transit (PT) networks – lines, stops and even timetables remain stable for many years. Behavioral changes of travelers', in contrast, follow dynamics of urban land-uses in space and in time, habits and introduction of new modes, e.g. ride-hailing or bike sharing and e-scooters. Travelers without access to private cars become "captives" of PT, while the rest use the car almost exclusively. This is the essence of the "*PT is for commuters*" hypothesis. We analyze Israeli PT smartcard boarding records collected in November 2017 and November 2018 with 4 sequential weeks each month and reveal that only half of the Israeli PT users are commuters or frequent users. The other half use PT infrequently and seem flexible in their mode choice. We discuss possible consequences of this phenomenon on the way to Mobility as a Service of the future.

**Keywords:** Smartcard, Public Transport, Mobility-as-a-Service, Commuting

## 1. Public Transport for Commuters Paradigm

Public Transit (PT) networks usually remain stable for years. Changes in infrastructure based PT (rail-based and some BRT's) are limited to time table variation while potentially flexible bus networks remain steady for long periods of time interrupted by infrequent but intensive updates ("bus reforms"). These phenomena can be considered as an outcome of a rather cumbersome assumption of transport planning that urban inhabitants adopt habitual activities and their travel patterns remain thus stable over time.

In fact, the behavior of residents and businesses in modern cities changes constantly both over space and in time, inducing patterns that are difficult to serve by the existing PT network. This discrepancy can result in a practical bifurcation of travelers' mode choice. Travelers who have no access to private cars become captives of PT, no matter what the level of the PT service is, while the rest use the car almost exclusively, ignoring the outdated PT-based mobility. This is the essence of the "*PT is for commuters*" hypothesis that is followed by the majority of transportation planning agencies and suggests that PT travelers are mainly captives and their three major groups have characteristic travel behavior: working commuters (morning and evening peaks), students and pupils (morning peak and noon or afternoon peak) and senior citizens (mostly travel off peak). Smartcard research has largely followed this assumption focusing on the frequent travelers and origin-destination (OD) matrix identification for buses or metro (Wang et al. 2011) (Gordon et al. 2013) (Alfred Chu & Chapleau 2008), but recently started to reveal high flexibility of PT users (Huang et al, 2018).

## 2. Smartcard Data Demonstrate High Flexibility of PT Users

Our analysis of the Israeli smartcard data suggests refuting “*PT is for commuters*” hypothesis. Several weighty facts bring us to assert that Israeli PT users are quite flexible in their mode choice and, thus, may easily accept new PT modes with higher than the existing Level-of-Service (LOS).

### 2.1. Israeli Smartcard Database

The smartcard system in Israel reached its mature state by September 2017 and this paper discusses boarding records collected over 4 weeks in October and early November 2017 and similar data for 4 weeks of November 2018 (both periods without holidays), for the entire country and show very similar phenomena. In 2017, the weekly number of boardings with the smartcard is 14M (15.5M in 2018) including 3M (2.5M in 2018) paper tickets; the number of unique smartcard-users per week is 1.7M (1.9M in 2018). The number of the unique smartcard-users per month is 2.0M in 2017 (2.3 in 2018). The analysis below focuses on the transaction of ticket validation when boarding a PT vehicle – bus (boarding only) or train (also alighting) - for the purpose of traveling. In this paper we do not account for the knowledge on train ticket validation at alighting stations and on possible bus alighting stops that were recognized by applying the (Trépanier et al. 2007) algorithm.

Each record includes: *SmartCard\_ID*, *User\_Profile*, *Operator* (train or one of the bus operators) and *BoardingTime* in 100% of records, *Line\_ID* in 90% and *Boarding\_Stop* in ~60%. About 0.1% of the smartcard users boarded more than 12 times a day were excluded from the analysis (understood as a collaborative use of the same anonymous smartcard by several people, team leaders who paid for groups, of bus/train employees, etc.). Smartcard data are a part of wider database that covers the entire territory of Israel and includes freely available GTFS data and the data on administrative partition and population. This made possible recognition of the intra- and inter-city bus lines. Trains in Israel are used mainly for inter-city trips.

### 2.2. Analysis of the Smartcard Database

In what follows we present the results of analysis at the level of the country as a whole. These results, qualitatively, repeat when the data are analyzed at the level of the metropolitan area (four metropolitan areas in Israel – Tel Aviv, Beer Sheba, Haifa, Jerusalem), groups of users (Adult, Senior, Pupil, Student) and for large PT operators.

Overall, more than a quarter of smartcard owners board once a day only. Table 1 presents this phenomenon for November 2018: Total number of the PT users with the smartcard in November 2018 workday is ~1,1M, from which one third (0.4M, 36%) use their monthly/weekly/daily pass, while the rest two thirds (0.7M, 64%) pay by trips. The share of once a day travelers among them is above 30%. The owners of the monthly and weekly tickets that planned to ride frequently are, evidently, more steady in their trips, but yet more than 10% of them boarded once a day (Table 1). We assert that these shares cannot be explained by possible irregularities of PT users’ behavior, such as purchasing paper ticket for some of the rides, walking on one of the travel legs, or erroneous work of the decoding device in a bus/train station.

Number of boardings	Total share	Monthly and Weekly pass owners	The rest of the travelers
1	27%	10.65%	31.34%
2	35%	34.24%	35.73%
3 – 4	27%	35.40%	23.80%
5 – 6	8%	13.93%	6.76%
7 – 12	3%	5.77%	2.36%

Table 1. Number of boardings per day for November 2017 and 2018

The total share of users who use PT 1 or 2 days a week is 44% (Figure 2) and reaches 60% for the users who pay by trips (64% of all users). This outcome is basically different from the expectation of the “PT is for commuters” hypothesis. The share of users who travel one day a week only is ~27%, while the share of users who would comply with the “PT is for commuters” hypothesis and use PT 3 - 5 days is only 41%.

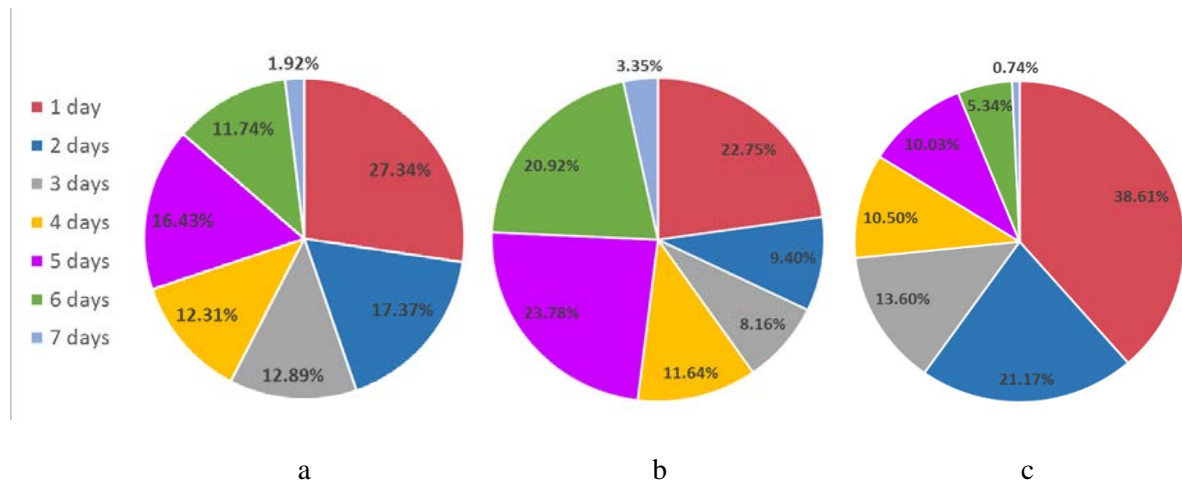


Figure 2. Number of days of weekly PT use for all users (a) for the holders of monthly/weekly/daily pass (b) and for the users who pay for each trip (c)

Monthly use of PT follows the tendency revealed in the shorter-term analysis: half of the PT users board less than 15 times during 20 working days in 2017 and this 50% percentile decrease to 13 boardings per 20 working days in 2018. For Adult and Senior user profiles 50% percentile of the number of boarding is like for all travelers, while for the Pupils the median is even lower, 12 boardings in 2017 and 10 in 2018.

Spatial activities of the PT users consist of both steady and varying components. The essential share of trips starts at the same stops defined as travelers’ key activity centers, while the majority of stops are visited infrequently. Figure 3 presents the number of stops most frequently used for 50 and 75% of the weekday boardings in November 2017. As shown in Figure 3b, the overall number of visited stops grows almost linearly to 20-22 stops, while the number of frequently visited stops stabilizes very quickly – 50% of boardings are done at 2-3 stops, and 75% at 4-5 stops. The fraction of infrequently visited stops increases from about half to two thirds of all stops visited during a month.

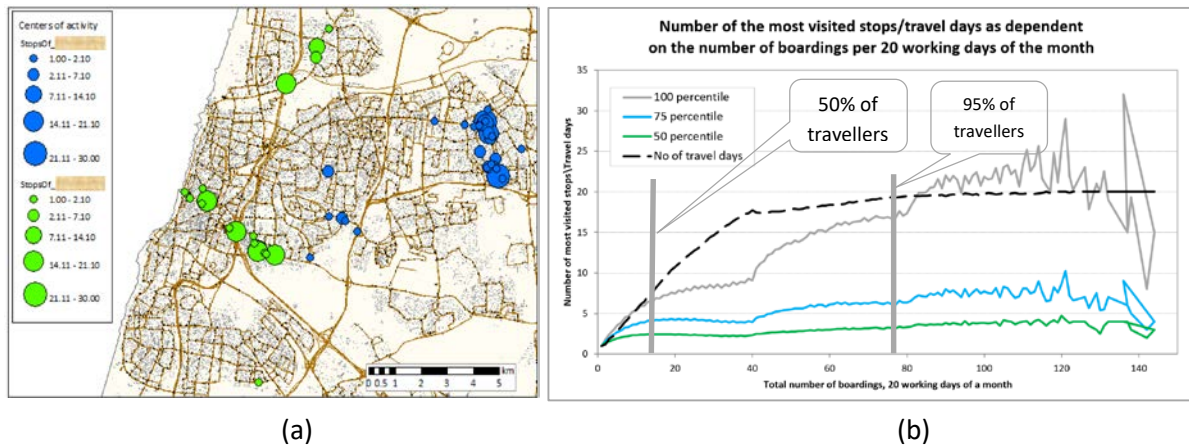


Figure 3. (a) Example of activity centers for two frequent users of the PT (80 boardings, 97<sup>th</sup> percentile) (b) Number of visited stops for 50% and 75% of the most frequently visited stops and for all stops, as dependent on the total number of boardings, all for 20 working days of the month.

### 3. Conclusions

Concluding the above, a well-known fact is that the LOS of Israeli PT is well below the standard of European counterparts (OECD, 2015). The average velocity in major metropolitan areas is ~15kph vs ~30 kph in the EU, while the priority bus lane length per capita is 14m compared to 300m. We assert that these dire-straits are a possible reason of the highly adaptive behavior of the Israeli PT users that may plan each trip anew and that for many of them public transport is a complementary mode, when a private car is unavailable for a certain trip. This travelers' behavioral adaptation can work both ways: On the one hand, adaptive PT users can quickly shift to new travel modes, such as ridesharing or two-wheelers (e-bikes and e-scooters that have become increasingly popular in Israel in recent years). On the other, improvement in the PT's LOS can possibly attract those 25+% of users for whom PT is a marginal mode with positive influence on mitigating the metropolitan traffic conditions.

### 4. Acknowledgements

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