Can Synergies between Micro-mobility and Public Transport lead to increased Public Transport ridership?

Executive Summary

- Shared micro-mobility services (e.g., shared e-scooters, bikes, and e-bikes) have rapidly gained popularity in major cities around the world.
- Multilevel integration (physical, digital and commercial) between different transport service operators can significantly benefit mobility in modern cities and can contribute towards the Mobility-as-a-Service (MaaS) vision.
- Voi, S-Bahn Stuttgart and Mobimeo executed a joint pilot project in this direction, in late 2020, in an effort to obtain some additional insights into the potential synergies of micro-mobility and public transport.
- The campaign had a positive impact on the number of S-Bahn Stuttgart tickets purchased by Voi users terminating at the Bad Cannstatt station, in which the pilot was focussed; at least a 35% increase, compared to the rest of the city of Stuttgart, was observed during this pilot.
- The number of last-mile Voi trips was increased by more than 250% in the Bad Cannstatt station, after parking racks were installed, compared to a cross-sectional increase of less than 30% for the entire city of Stuttgart.
- During the campaign, the number of S-Bahn Stuttgart users that planned a route with an e-scooter in the Mobility Stuttgart app by S-Bahn Stuttgart increased threefold. The number of users who then decided to follow the link and be transferred to the Voi app (or the respective app store to download the app) increased by more than threefold.
- The number of searches from/to Bad Cannstatt in the Mobility Stuttgart app also increased considerably for the period of the campaign (for example, the number of searches to Bad Cannstatt increased by almost 90% in September 2020, while the number of searches from Bad Cannstatt increased by more than 110% in October 2020).
- This project is a very promising step in the direction of tighter, mutually beneficial integration between micro-mobility and public transport providers.
- It is crucial that researchers, operators and policy makers collaborate in understanding the potential impact of shared e-scooters and MaaS platforms in shaping urban mobility.

Background

Shared micro-mobility services (e.g. shared e-scooters, shared bikes, shared e-bikes) have rapidly gained popularity in major cities around the world. According to NACTO (2020), 136 million rides took place in 2019 in the US alone – a 62% increase from 2018, mostly due to the rise of shared e-scooters (Reck and Axhausen, 2021).

Within the emerging paradigm shift towards electric and shared modes, shared e-scooters have emerged as a new mode of transport within cities. While initially approached as a

temporary fad by many, shared e-scooters have managed to become a persistent part of the urban mobility landscape, pretty much wherever they have been introduced. In fact, a number of service providers are often operating in parallel in each city. Users seem to be more enthusiastic about e-scooters, compared to other urban mobility modes: in a survey of Swiss users, Reck and Axhausen (2021) find that “shared micro-mobility adoption rate is highest for e-scooters (28%)”.

One big question pertains to the impact that micro-mobility, in general, and shared e-scooters, in particular, could have on urban mobility. Questions of interest include: (i) which modes do shared e-scooters replace, and (ii) which modes do they complement? These questions are important, as they can help determine how the introduction of shared e-scooters really affects the urban traffic situation. (Remember, for example, the recent ban on new ride-sourcing and ride-sharing licenses in New York City, while their impact on traffic congestion was being investigated).

This white paper comprises a review of pertinent literature, as well as empirical evidence from a collaboration between S-Bahn Stuttgart, a subsidiary of Deutsche Bahn, Voi and Mobimeo, a MaaS platform provider founded by Deutsche Bahn, as the technological partner, with the aim of exploring the potential synergies between micro-mobility and public transport.

Mobimeo develops a Mobility-as-a-Service (MaaS) platform to deal with the specific challenges that result from the digitization of public transport. As a partner of transport companies, transport associations and other mobility providers, Mobimeo connects existing public transport systems, sharing and on-demand options.

The multimodal Mobility Stuttgart app is based on the Mobimeo MaaS platform. Mobimeo supported the joint project e.g. by integrating the location of the Voi parking racks and providing the technical solutions for offering vouchers for Voi users in the app.

Evidence of synergies between micro-mobility and public transport

S-Bahn Stuttgart is an important provider of public transport in the Stuttgart region with almost 133 million passengers per year. To increase accessibility and improve the comfort of public transport, S-Bahn Stuttgart is continuously testing innovations. Focussing on increasing the share of public transport within the modal split, S-Bahn Stuttgart is strengthening collaborations and the integration with mobility partners, such as shared bikes and e-scooters.

Voi is a global player in the shared e-scooter space and has shown a keen interest to use data to understand and improve its services’ uptake by integrating with local public transport operators. An example of this attitude is the collaboration with S-Bahn Stuttgart in coordinating e-scooter and S-Bahn services, at the following three **levels of integration**:

(i) **Physical** level, e.g. placing shared e-scooter parking racks at S-Bahn stations;
(ii) **Digital** level, e.g. providing incentives for Voi users leaving their e-scooters at the parking racks at the S-Bahn stations, as well as integrating their services with the Mobility Stuttgart app, allowing for users to perform route searches and be transferred from one app to the other; but also
(iii) **Commercial** level, e.g. integrating vouchers for use of the Voi e-scooters in the Mobility Stuttgart app, as this integration can result in higher ticket sales.

Initial evidence from data collected in the second half of 2020 from these initiatives in Stuttgart suggests that there is a positive correlation between rail (as the main commute mode) and e-scooters (as the last-mile mode). For example, the number of Voi trips increased by more than 250% in the Bad Cannstatt station, after parking racks were installed

(compared to a cross-sectional increase of 29% for the entire city of Stuttgart). Besides the direct effect on the number of trips, this intervention of adding parking stations also had a distinct qualitative effect on the parking characteristics, resulting in much more organised spatial parking patterns. Overall, these findings suggest that **local public transport accessibility is improved** with the Voi initiatives.

These findings are consistent with Reck et al. (2021), who find that “Docked modes are preferred for commuting. Hence, docking infrastructure for currently dockless modes could be vital for bolstering micro-mobility as an attractive alternative to private cars to tackle urban congestion during rush hours.”

Voi has also already engaged in a number of initiatives to understand the profile of its users. For example, based on a Voi survey, 42% of users combine their e-scooter trip with public transport, and only 11% with private cars. This suggests that **e-scooters may contribute to the reduction of Vehicle Kilometers Traveled (VKT),** meaning that they could contribute to a reduction of congestion and associated adverse environmental impacts.

Another point of synergy between PT and micro-mobility is that, while the public transport operator knows the starting and ending stop of the passengers, Voi has actual origin and/or destination information (for the subset of PT riders that use it for first and/or last mile) that is not available to public transport providers.

Evidence of increased public transport ridership due to micro-mobility

One important question is whether (and how) increased micro-mobility use can lead to increased public transport ridership. The **contribution of micro-mobility to an increase in public transport ridership** can have at least two effects:

- More people use Voi e-scooters to reach the public transport station, due to the physical integration, and
- More of these people convert to a public transport ticket, due to the digital and commercial integration.

Voi, S-Bahn Stuttgart and Mobimeo executed a joint pilot project in late 2020 in an effort to obtain some additional insights into these synergies. Preliminary analysis of the obtained results suggests that, indeed, e-scooter sharing systems can benefit public transport ridership. To demonstrate this, we use two types of data:

- The number of Voi scooter trips terminating at the Bad Cannstatt train station, and
- The conversion rate of these trips to public transport tickets.

Figure 1 summarizes the impact of the two aforementioned effects, by showing a composite measure, i.e. the product of the number of trips terminating at the Bad Cannstatt station multiplied by the conversion rate of these trips to public transport tickets[1]. To make the presentation simpler, August 2020 (the month before the pilot project started) is used as a reference point and the following months’ figures are normalized based on this. The following curves are presented:

- Bad Cannstatt: the product of the number of trips terminating in Bad Cannstatt, in which Voi is used as last mile, multiplied by the conversion rate is shown;
- Hauptbahnhof: the same information is presented for the Stuttgart Hauptbahnhof (main station), as a reference;
- All excl. Bad Cannstatt: the same information is provided for all other stations (incl. Hauptbahnhof), but excluding Bad Cannstatt, again as a reference. This is done in

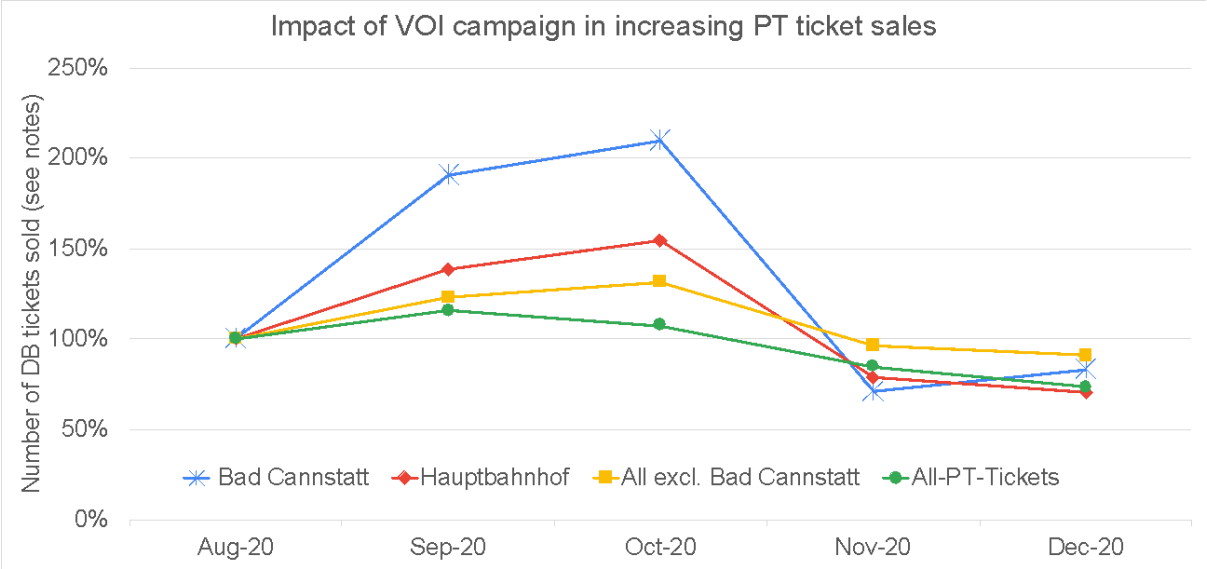
[1] It is noted that the “unit” of this measure is still “public transport tickets”, as the first term unit is “Voi trips” and the second is “share/number of public transport tickets bought per Voi trip”

this way, and not by presenting each individual station separately, for two reasons: (i) the number of trips for several stations is relatively small, resulting to noisy data, and (ii) to simplify the figure;

- All-PT-Tickets: the evolution of S-Bahn Stuttgart ticket sales for the entire Stuttgart area, for the same time (see Appendix A for a discussion of these data, including on annual seasonality and the impact of COVID-19).

From Figure 1, one can observe that all stations (except for Bad Cannstatt, where the pilot project between Voi, S-Bahn Stuttgart and Mobimeo took place) follow a similar pattern as the total S-Bahn Stuttgart ticket sales during the same period. However, Bad Cannstatt shows a marked increase, compared to these. Even if we assume the most conservative reference point (Hauptbahnhof), this translates to an increase of more than 35% for the months of September and October 2020, while still being normalized to the same data point (August 2020). It is also noted that all lines return to the same level after the pilot (i.e. during November and December 2020).

Naturally, these numbers cannot be expected to hold directly if a larger campaign or deployment is performed, e.g. in an entire city. For example, micro-mobility users have a specific demographic profile (e.g. Liao and Correia, 2020, find that current users of e-mobility services, including e-scooter sharing, “are mostly male, middle-aged people with relatively high income and education”), so the effect might not be so strong in the general population. Furthermore, the scalability constraints of micro-mobility supply might lead to a saturation (e.g. how many e-scooters can be deployed). However, it is evident that the campaign had a positive impact on the number of S-Bahn Stuttgart tickets purchased by the Voi users terminating at the Bad Cannstatt station.



Notes:
1. y-axis: for the first three data series, this corresponds to the product of the number of trips terminating at the station multiplied by the conversion rate to S-Bahn Stuttgart tickets, which translates to S-Bahn Stuttgart ticket sales resulting from these trips. For the last data series (All-PT-Tickets), this corresponds to the number of tickets sold in the Stuttgart Area.
2. All numbers normalized to August 2020 (prior to campaign start)
3. Duration of campaign: September-October 2020

Figure 1: The potential impact of the Voi campaign on the increase of ticket sales in the Mobility Stuttgart app

The digital integration between the Mobility Stuttgart and Voi apps also increases the use of micromobilty in the last mile, which **may translate into a reduction of car trips for the last mile**. During the campaign, the number of S-Bahn Stuttgart users that plan a route with an e-scooter in the Mobility Stuttgart app increased threefold. Similarly, the number of

users who then decided to follow the link and be transferred to the Voi app (or the respective app store to download the app) increased by more than threefold. These numbers were consistent for iOS and Android users. The number of searches from/to Bad Cannstatt in the Mobility Stuttgart app also increased considerably for the period of the campaign (for example, the number of searches to Bad Cannstatt increased by almost 90% in September, while the number of searches from Bad Cannstatt increased by more than 110% in October 2020).

Discussion

The current collaboration between S-Bahn Stuttgart, Voi and Mobimeo has demonstrated, in a relatively small scale, the potential for **bidirectional synergies between micro-mobility and public transport services**. The multilevel integration (physical, digital and commercial) between different transport service operators can greatly benefit the general mobility landscape in modern cities and is an essential prerequisite for really moving towards the Mobility-as-a-Service (MaaS) vision. The success of this project demonstrates the “cultural” agreement between the project partners and is a very promising step in the direction of tighter, mutually beneficial integration between micro-mobility and public transport.

While there is, in general, adequate research on bike-sharing, **research on shared e-scooter users is very scarce** (e.g., Sanders et al., 2020). Shaheen and Cohen (2019, p. 11) in one of the earliest reports on shared micro-mobility user characteristics concluded by stating: “more research is needed to understand the user demographics of dockless bike-sharing and scooter sharing.” While in the last couple of years there has been an increase in studies regarding e-scooter sharing, there is still a clear need to understand better the potential impact of this new mode.

For example, in a recent study by Abouelela et al. (2021), combining a stated-preference survey with car-sharing use data, it was estimated that about 23% of carsharing demand of young users in Munich could be shifted to e-scooter-sharing. Naturally, such preliminary findings need to be considered carefully, and validated with further studies.

One of the big limitations in obtaining insights about this topic is the lack of data. Therefore, most of the research that is currently being performed on the topic is based on stated-preference surveys, or surveys of the general population. It is expected that analyses of the attitudes and patterns of the users of the system can provide much deeper insights (similar to the depth of the results that has been obtained e.g. by Tirachini et al., 2020, who analysed a survey of thousands of users of a ride-sharing system, along with data on the usage patterns of these users.)

Even with the deep level of access that was possible in this collaboration of TUM researchers with the company Jetty, providing the mobility service, enabled by a level of trust and well-designed privacy-preserving processes, the results obtained from this analysis are not extremely strong and unambiguous. This is, unfortunately, a common occurrence in mobility analyses, especially when dealing with the non-core modes (i.e. not car or public transport), partly due to the smaller penetration of such modes.

Therefore, **it is crucial that researchers, operators and policy makers collaborate** in understanding the potential impact of shared e-scooters and -perhaps more importantly- the factors that may influence the behavior of the travelers using potentially integrated transport systems of cities. In this way, suitable services and incentives/campaigns can be designed, in order to optimize the transport system as a whole, offering benefits for all operators. The successful completion of such a process can be very beneficial for all involved parties, and the public at large, as it can improve accessibility.

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Appendix A

During the period of the Voi campaign, the COVID pandemic was developing; in fact, the second wave developed in parallel. To put the above information in context, Figure A.1. shows the seasonality trend and impact of COVID on the total ticket sales of S-Bahn Stuttgart in the Stuttgart area. The seasonality pattern is very clearly seen in all years. In particular ticket sales in 2018 and 2019 show a correlation of 93.7%. A similar seasonal pattern is shown in ticket sales during 2020, with a sharp decrease, due to COVID. This decrease is sharper for the first wave (March/April 2020) and at the beginning of the second wave, towards the end of the year (November/December 2020).

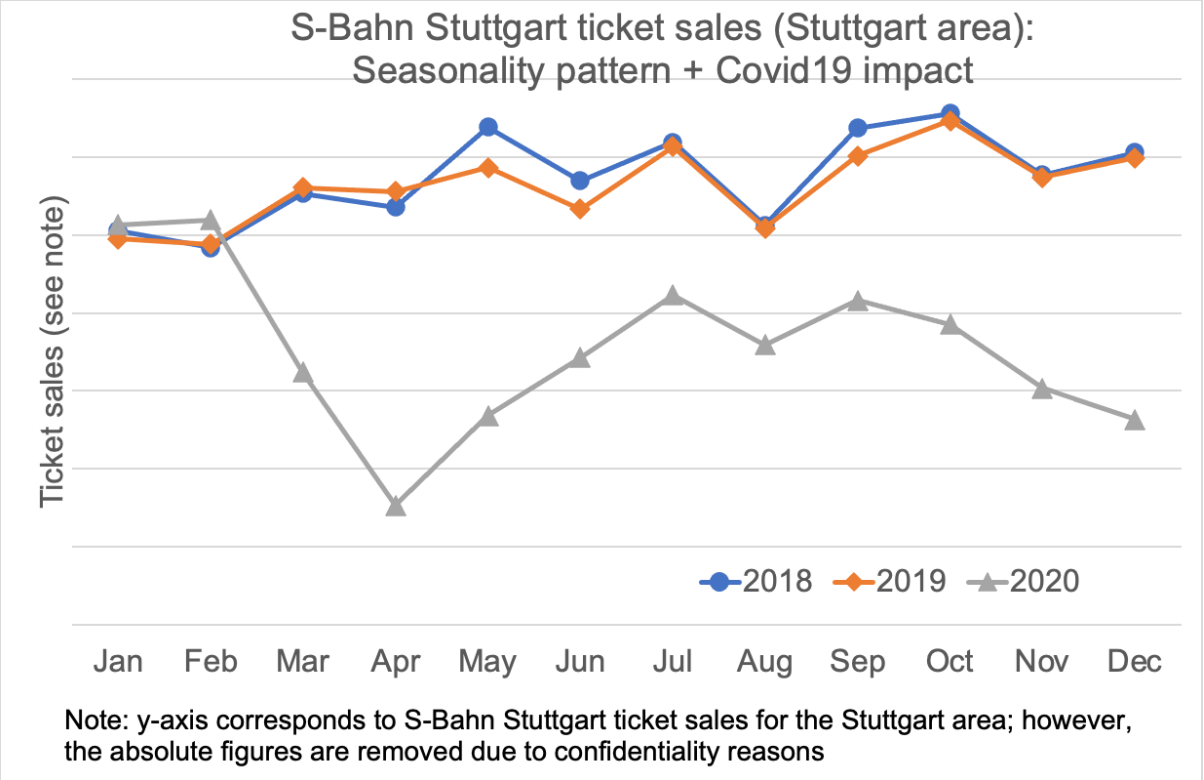

Figure A.1. S-Bahn Stuttgart Ticket Sales in Stuttgart for 2018, 2019 and 2020, indicating regular seasonality patterns (2018 and 2019), as well as the impact of COVID-19 (2020). (Source: Deutsche Bahn)