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What does data tell you? - insights form a carpooling dataset

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This work addresses the following topic(s) from the Call for Contributions:
(Please check at least one box)

☐ Placemaking to integrate urban spaces and mobility
☒ Promoting sustainable mobility choices in metropolitan regions
☐ Governing responsible mobility innovations
☐ Shaping the transition towards mobility justice
☒ System analysis, design, and evaluation
☐ other: _____

Extended Abstract

Problem statement

Carpooling describes private individuals sharing a ride in a private vehicle. It is an old concept that has been around for about 80 years. However, it has witnessed a decline in importance over time (Teal 1987). Nowadays, rising mobility costs and technological advances are reviving the concept. New possibilities emerge such as easier matching of participants or integration with public transit. Most current research on carpooling focuses on changes in mobility behavior as measured by surveys before and during the implementation of such systems (Gandia et al. 2021; Abrahamse and Keall 2012). Complementing this, analyses of real-world trip data provide a deeper understanding regarding the medium- to long-term effects of carpooling.

Research objectives

This paper brings new insights into the possibilities offered by real-world trip data from carpools to analyze behavioral changes over time. A key aspect is to investigate the relationship between carpooling and sustainable use of such a service and its impact on mobility behavior over time. In addition, externalities such as advertising of the service, the impact of vacations on usage and location-based information of accessibility by transport mode can be identified. The results of this work contribute to a more sustainable implementation of private carpooling and help to increase the diversity of the transport system.

Methodological approach

The basis of the analyses forms a data set of the carpooling app provider goFLUX Mobility GmbH (2023) with about 6,000 carpool trips for the use case "research center Jülich". It is located on the outskirts of the medium-sized city of Julich, about 40km west of Cologne and 25km west of Aachen. The data covers 385 employees, resulting in a total of 826 unique driver-passenger combinations in the period from November 2022 to September 2023. Initially, passengers' expenses were fully subsidized, but this was discontinued in January. In mid-January, the subsidies were increased back to 90%. For the location-based analyses, the dataset was enhanced by calculating

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distance and travel time for direct trips and carpools based on origin and destination coordinates and pick-up and drop-off locations. The car routing was based on the OSM-network, with speed data added using 2018/2019 (pre-covid) floating car data (Bundesamt für Kartographie und Geodäsie 2023). The extended dataset allows for in-depth analysis of carpool use in terms of temporal effects as well as characteristics of the transport system.

(Expected) results

The data presented provides insight into the usage patterns of carpooling trips in order to draw conclusions for a sustainable service in the long term. FIGURE 1 shows the time span between the first and last recorded trip for each reporting user, either as passenger or driver. The data is arranged chronologically based on the date of the initial trip. The carpooling app was initially launched in November 2022, resulting in a noticeable amount of active user registrations. During the Christmas holidays shortly after, there was a noticeable lack of new registrations. However, in late January, marketing efforts led to a substantial number of new registrations. The data shows a consistent flow of new users registering for the app and actively participating in ridesharing services.
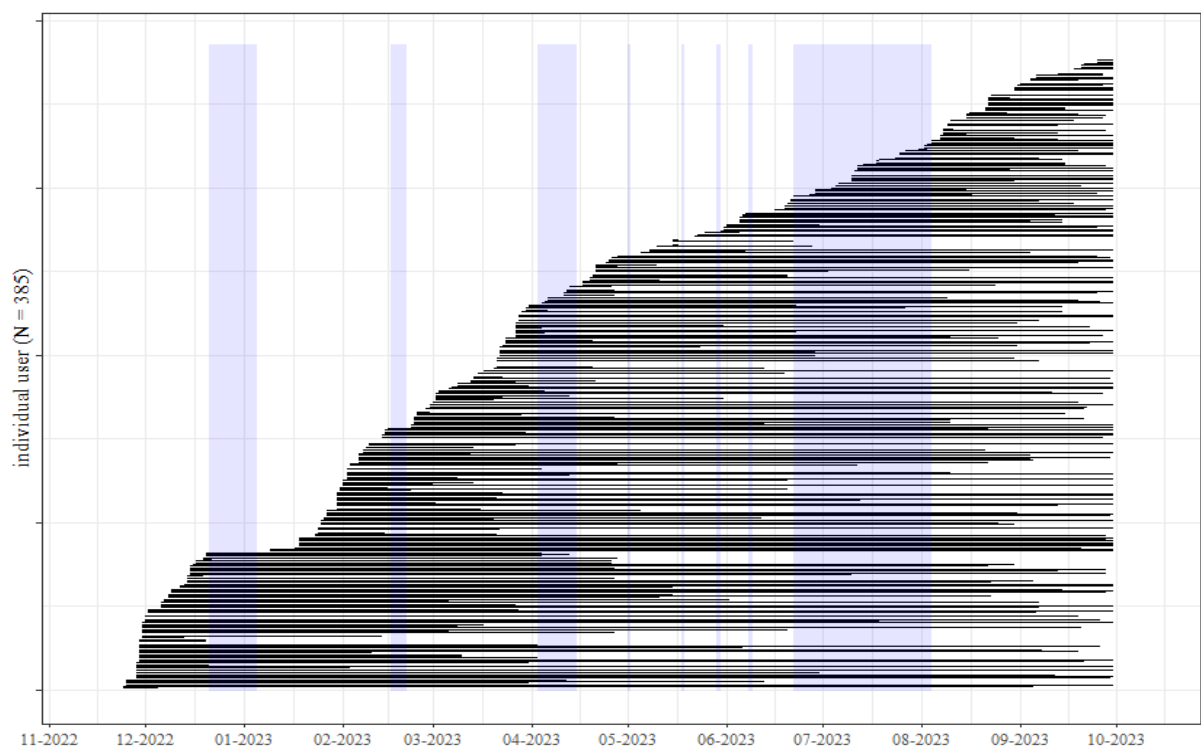

Figure 1: Time span between first and last recorded carpooling trip in the data set. Purple areas indicate public holidays, carnival, and school breaks.

Analyzing the duration of individual usage in relation to the time elapsed since the first trip, we observe two main groups. One group consists of individuals who did not record any trips beyond an initial testing phase, while the other group consists of those who continue to use the app and have an individual usage span close to the maximum possible duration.

Analyzing the frequency of carpools (TABLE 1), we see that the average number of trips per passenger per month is relatively low. After the initial uptake in the first two months, the median number of trips taken was four in the period from February 2023 to September 2023. Carpooling drivers conduct slightly more trips per month with a median range of 5 to 6. In terms of location-based analysis, most trips are typically between 30 and 50km. This corresponds to the distances to Aachen and parts of Cologne, where relatively many employees live. However, most employees live in the immediate vicinity, especially in Jülich. This suggests that this carpooling option is less attractive to those who live nearby. In the course of time, new registrations did not show any major differences and still are primarily within the mentioned distance range.

Table 1: Summary statistics for trips per active passenger (min one carpool per month) and trip distance

	Trips	**Trips per active passenger**						**Trip distance [km]**					
Month	*N*	*min*	*Q25*	*median*	*mean*	*Q75*	*max*	*min*	*Q25*	*median*	*mean*	*Q75*	*max*
Nov 22	52	1	1	2	2.2	3	6	5.1	34.5	38.3	43.6	49.5	100.9
Dec 22	219	1	2	3	4.6	6	21	4.0	34.2	37.0	39.2	41.9	100.9
Jan 23	171	1	1	3	3.1	4	9	12.1	34.6	37.8	41.1	49.0	100.9
Feb 23	520	1	2	4	5.5	7	25	4.0	34.2	37.4	39.3	48.7	69.8
Mar 23	753	1	2	4	6.3	8	35	3.4	33.3	36.5	37.4	42.2	100.9
Apr 23	602	1	2	4	5.5	7	28	4.0	32.6	36.7	36.9	42.6	69.8
May 23	594	1	2	4	6.5	10	26	4.7	32.3	35.5	36.4	42.9	69.8
Jun 23	524	1	2	4	5.6	8	22	5.4	32.8	35.6	37.2	42.9	85.2
Jul 23	560	1	2	4	6.2	9	31	4.9	32.9	35.4	37.9	40.0	69.8
Aug 23	839	1	2	4	6.7	9	43	4.8	32.8	36.1	38.4	47.4	69.8
Sep 23	696	1	2	4	6.4	9	48	4.8	32.6	35.1	38.8	47.4	136.2

Weekly aggregated data provides a more detailed analysis of the data. There were significantly fewer trips, but also active users during weeks with holidays or school vacations. There were no trips during the Christmas vacations, followed by a quiet first half of January. The number of trips increased steadily until the week before the Easter vacations. After a brief recovery in which almost all rides lost during the Easter holidays were regained, a period of declining numbers and low ridership began. During this period, ridership declined during weeks with holidays, with a much smaller recovery after Ascension Day. In contrast to the winter and Easter vacations, the number of rides unexpectedly remains relatively stable during the summer break. After the summer break, there is a steep increase to a new maximum number of trips per week. However, this level cannot be maintained at first, although the number of trips rises again in the last week of September (FIGURE 2).
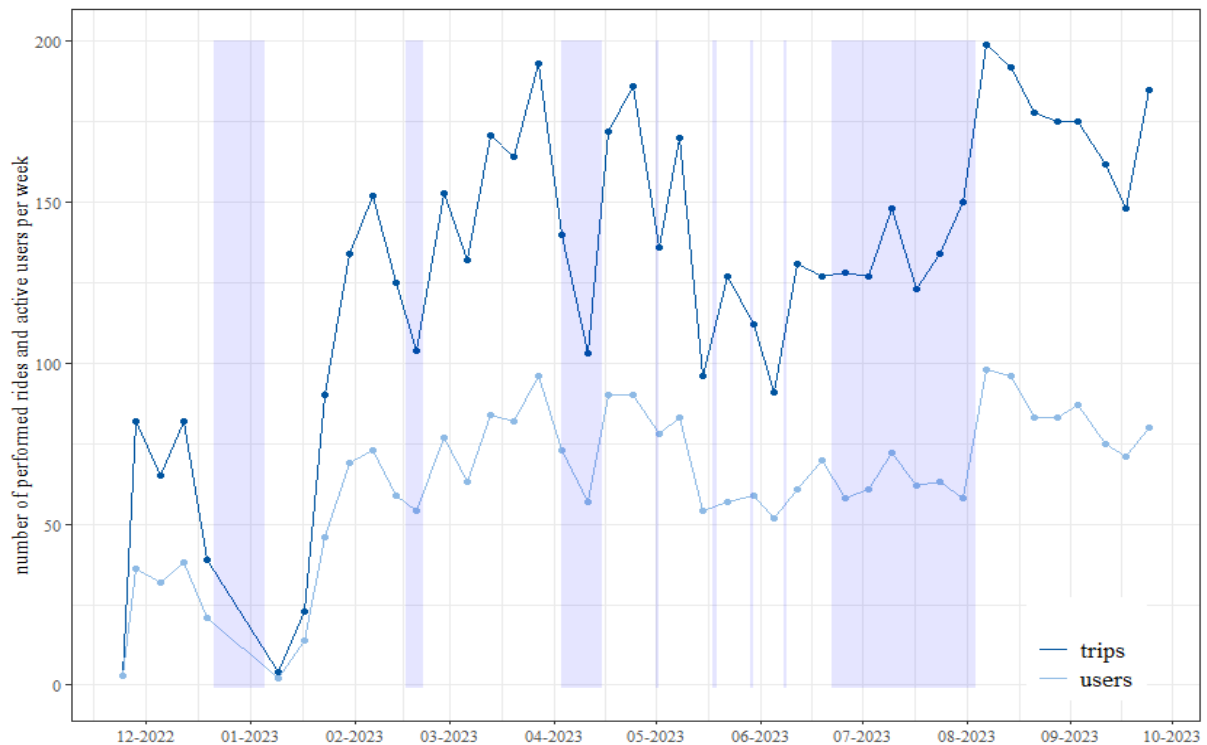

Figure 2: Weekly aggregates of trips and active users. Purple areas indicate public holidays, carnival, and school breaks.

In conclusion, a high number of users at the beginning enables the development of a stable network for a new mobility option of carpooling. Even after almost a year, the number of users increases, revealing the delayed acceptance of new services. Temporal evaluations show the strong influence of holidays on the use of carpooling. Spatially, carpooling is only attractive above the range of local mobility. These factors should be considered when introducing a new carpooling service.

Further research would improve the analysis, particularly with respect to information about users, such as prior transportation use, number of home office days, or sociodemographic characteristics. All evaluations are valid under the subsidy condition, indicating the great importance of financial support. In the future, subsidization will decrease further, which will allow more detailed evaluation of long-term effects.

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