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Determination of a Representative Travel Speed for Road Facility Performance Evaluation Using Floating Car Data

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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
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Extended Abstract

Problem statement

The accuracy of any analysis regarding the Level of Service of road facilities is dependent on the used input values. Usually, operational and design analysis focuses on the peak-hour traffic since this represents the most critical period for the service for any infrastructure element. However, the peak-hour traffic is not constant from day to day, so there is usually a specific value defined as the analysis hour in regulation. For example, the American 'Highway Capacity Manual' (HCM) (National Academies of Sciences, Engineering, and Medicine, 2022) defines the analysis hour as the most frequently occurring peak traffic volume, and the 'German Highway Capacity Manual' (HBS) (FGSV, 2015) defines it as the hour with the 50th-highest traffic volume in a year. Based on the obtained traffic volume in the analysis hour, other values, such as average speeds, are estimated through methods included in the regulation.

With newer detection technologies such as Floating Car Data (FCD) becoming increasingly relevant for traffic analysis, information about travel speed distribution on road facilities can be directly obtained. Utilizing this data for roadway performance evaluation could simultaneously be more cost-efficient and improve the current methodologies in both the temporal and spatial domains. However, to use travel speed information for analyses that align with the current regulatory guidelines, it is necessary to extract a value from the distribution representing the traffic state in the analysis hour. In current regulation, such a representative travel speed is usually estimated using the traffic volume in the chosen analysis hour.

Research objectives

To determine a representative travel speed, it is necessary to investigate whether this value can be approximated exclusively using FCD. Therefore, this paper aims to explore multiple methods for obtaining a representative travel speed and evaluate their feasibility. For this evaluation, all methods are applied to several study sections and compared to values estimated based on the current regulatory methodology.

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Methodological approach

In the following section, the investigated methodologies for the extraction of a representative travel speed from an FCD dataset are presented. Afterward, these methods are applied to several test sections and compared to travel speed values estimated according to the current regulation.

The first approach is to utilize a value from the distribution of average travel speeds along the road facility, which can be obtained from the individual trajectories of all detected floating cars. This involves identifying a value that is representative of the road performance in the analysis hour. A frequently applied approach for short-term analysis of traffic state is the use of the average travel speed (for example, see Axer and Friedrich, 2014 or He *et al.*, 2016). However, this value should not be applied for road performance evaluation since long-term travel speed distributions tend to be left skewed. The median value can instead be used to obtain the midpoint of the distribution.

The second approach adapts the established methodology for determining the analysis hour traffic volume from hourly traffic volumes. This involves sorting the traffic volumes recorded in all hours of the year and then using the value of the predefined analysis hour as the representative value. In the German HBS, the analysis hour is defined by the 50th-highest traffic volume in the yearly distribution. In order to transfer this approach to determine a representative travel speed using FCD, the space-mean speed of all vehicles traveling through the respective road facility at every hour of the year is calculated. The methodology for determining the space mean speed is based on (Mori et al., 2015). Afterward, the representative travel speed is selected as the hour with the 50th lowest space-mean travel speed within the year.

The third approach is based on the methodology for determining the design traffic volume from short-term counts, which is included in the German HBS (FGSV, 2015). For this methodology, all Tuesdays, Wednesdays, and Thursdays in the summer months outside of school vacations are defined as typical working days. Based on this, we apply a method to determine the representative travel speed from FCD on these typical working days. We aggregate the trajectories detected on all typical working days throughout the year into two datasets for the morning and afternoon periods. For both datasets, we then determine a space-mean speed for each 15-minute interval. The four consecutive 15-minute intervals with the lowest travel speed are then determined. These four intervals result in an average peak hour for the morning and afternoon on typical working days. From all trajectories within the respective peak hours, the representative speed for both aggregated periods is calculated, with the lower value being chosen as the representative travel speed.

The presented approaches are subsequently applied to a historical dataset of FCD for a study section in the German city of Remscheid. The utilized FCD includes trajectories for an entire year from July 2018 to June 2019. In addition, a reference travel speed is calculated through a microscopic traffic simulation using the traffic volumes in the analysis hour of the study section.

Preliminary results

The resulting travel speed values for the three FCD-based methodologies and the analysis hour reference value are shown in Table 1. It is evident that there are significant differences between the calculated values of the FCD-based methodologies. Among the investigated methodologies, the average peak hour travel speed replicates the reference travel speed best. In further research, we aim to apply these methods to additional study sections and investigate whether the results are similar. Additionally, we will investigate to what extent traffic-flow-independent influences (e.g., coordination of intersections) influence how representative the different travel speed values are of the value in the analysis hour.

Table 1: Comparison of Travel Speed Values for the Study Section

	Travel Speed [km/h] *Direction North → South*	*Travel Speed [km/h]* *Direction South → North*
Reference Travel Speed	**33,7**	**35,0**
Method 1: Median Individual Travel Speed	43,8	43,1
Method 2: 50th Hourly Travel Speed	18,7	19,0
Method 3: Average Peak Hour Travel Speed	38,7	36,9

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