

11th International Conference on Transport Survey Methods

The German Vehicle Mileage Survey 2014: Striking the balance between methodological innovation and continuity

Marcus Bäumer ^{a*}, Heinz Hautzinger ^a, Tobias Kuhnimhof ^b, Manfred Pfeiffer ^a

^a IVT Research GmbH, Quadrat M4,10, 68161 Mannheim

^b Institute of Transport Research, German Aerospace Center, Rutherfordstr. 2, 12489 Berlin

Abstract

Vehicle kilometers travelled (VKT) directly reflect the extent of spatial interaction within society and economy. VKT is also a key figure to quantify the use of road infrastructure. Consequently, VKT is one of the most important statistical indicators in traffic and transport. For a country with substantial cross-border transport relations such as Germany, VKT must be differentiated in national and domestic VKT: national VKT is the mileage of vehicles registered in Germany while domestic VKT is the mileage on German territory by German and foreign vehicles. This paper presents the most current German VKT survey, Fahrleistungserhebung (FLE) 2014, which comprised two elements: a motor vehicle owner survey to measure national VKT and traffic counts to measure domestic VKT. Vehicle mileage figures with deep stratification of both national and domestic VKT can only be generated through such special empirical studies. The focus of this paper is on the vehicle owner survey and national VKT.

Keywords: German Vehicle Mileage Survey, vehicle owner survey, traffic count, vehicle kilometers travelled, mixed-mode design, stratified sample, separate ratio estimation

1. Introduction

There is general agreement that comprehensive data on motor vehicle kilometers travelled (VKT) with deep stratification should preferably be generated through special empirical studies with surveys of motor vehicle owners (national VKT) and traffic counts (domestic VKT) as core elements. Owner-based national VKT surveys have a long history in Germany. In view of the associated costs, however, such studies are only conducted at long intervals and thus have the character of occasional individual studies (“vehicle mileage surveys”). The last three VKT surveys in Germany which are comparable in format and geographic scope (after the German reunification in 1990) were conducted in 1993, 2002, and 2014 (Hautzinger et al. 1996a, 1996b, 2005a, 2005b; Bäumer et al. 2016a, 2016b). All these surveys were planned, evaluated, conducted, and analyzed under the auspices of German Federal Highway Research Institute (BAST), with the organizational/ technical execution of the written/postal surveys being handled by the Federal Motor Transport Authority (KBA). This involved surveying a random sample of vehicles across the entire year (sample frame: central vehicle register (ZFZR) of the KBA) to determine the VKT through two odometer readings over a reporting period defined by the survey design.

As with many transport indicators, not only absolute levels of VKT are relevant but also the development over time. Hence, comparability of VKT survey results with results from earlier surveys is paramount. At the same time, there are various external changes that affect survey design. This ranges from survey design innovations (e.g. smartphone use) over generally declining response rates to changes in vehicle types and vehicle usage. Against this background, it is important to strike the right balance between methodological innovation and continuity when surveying VKT. In light of this objective, the paper describes the FLE 2014.

In addition to presenting the FLE vehicle owner survey methodology and selected results, the paper puts these results into context. First, the FLE national VKT figures are compared to the domestic VKT figures obtained from the FLE traffic counts which were conducted in parallel to the FLE vehicle owner survey. Second, the FLE national VKT are compared to VKT figures obtained from other surveys, in particular the German National Travel Surveys (MiD, MOP).

* Corresponding author. Tel.: +49-621-1503080; fax: +49-621-15030822.

E-mail address: baeumer@ivt-research.de

2. Methodology

2.1. Study Design

The objective of the FLE 2014 vehicle owner survey was to provide current indicators on the national VKT that are comparable in terms of content and methodology with previous studies while simultaneously taking into account changes in vehicle types and vehicle usage that have occurred in the intervening period. The study was intended not only to estimate the national VKT as a whole with the greatest possible precision, but also the VKT of particular sub-groups of German-registered vehicles as well. As classification characteristics for the delineation of these sub-groups, the study looks not only at register information (technical vehicle features and socio-economic characteristics of the vehicle owner) but also survey characteristics that describe the predominant use or type of use of the vehicle.

The 2014 vehicle owner survey to determine national VKT was largely identical to the preceding study in 2002. The survey again included all motor vehicle types, from mopeds to semi-trailers (only a few special motor vehicle sub-groups such as agricultural tractors and vehicles of the federal police and military are not recorded).

To determine the 2014 national VKT, over 6 survey waves of 151 motor vehicle strata each, a total of 162.653 vehicles were randomly selected through systematic sampling from the central vehicle register (ZFZR) of the Federal Motor Transport Authority (KBA). By surveying the respective vehicle owners with regard to the vehicle odometer readings on two key dates ten weeks apart, the study gathered data regarding the average daily mileage of the vehicles included in the study. In addition to the odometer reading on two occasions (called initial and final interview), the vehicle owner survey also collected information about some additional characteristics such as the predominant type of use of the vehicle and mileage driven outside Germany in foreign countries. These additional characteristics can not only be used to break down the total VKT, but can also be regarded as analysis variables in their own right.

2.2. Questioning Technique

With respect to the actual questionnaire, it has proven useful to retain the basic concept of the previous FLE vehicle owner surveys, i.e. focusing on the most important survey characteristics and use of a short, clearly structured and easily understandable two-page questionnaire. However, in contrast to precedent studies of this type there were additional survey mode options: respondents could not only participate by mail, but also electronically using a laptop, smartphone or like device (mixed-mode survey design, see Figure 1).

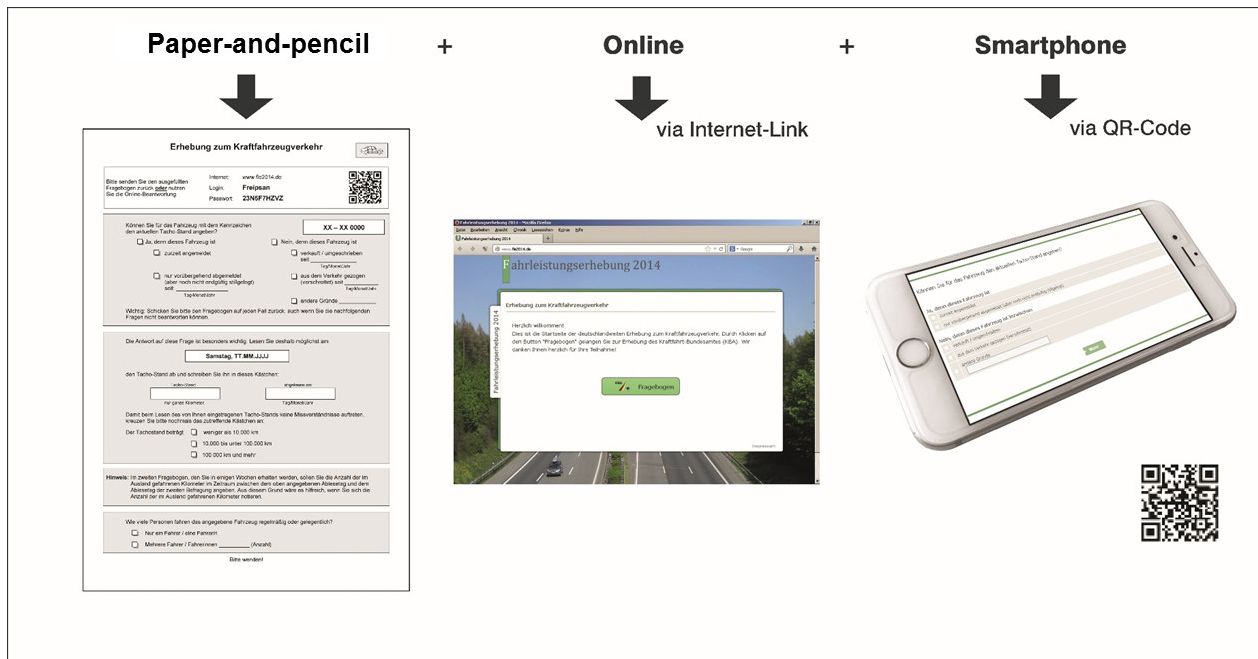


Figure 1: Response options in the FLE vehicle owner survey (mixed mode-design)

Taken together, the simple and intuitive survey design and the multiple options to participate in the survey led to a total response rate of 47 % (the response rate of the vehicle owners in the initial and final stage of the survey was 56 % and 85 %, respectively). Following the general trend, this rate was lower than in the preceding projects in 1990, 1993 and 2002, but actually somewhat above the target values defined prior to the survey. In an environment of generally declining response rates this can be seen as a good result. Thus, the owners of 76.979 vehicles took part in the initial as well as the final interview, about 87% of the corresponding data sets could be used for estimating VKT.

2.3. Data Expansion and Analysis

Based on the FLE 2014 vehicle owner survey, VKT estimates both for the complete vehicle population and for subgroups of motorized vehicles were determined empirically. Due to the large size of the sample, it was possible to derive deeply stratified indicators both regarding the current state as well as – through comparison with the FLE 2002 – the development over time of VKT by vehicles registered in Germany. For the first time, it was also possible to collect useful VKT data for vehicles with alternative drive technologies and energy sources (e.g. electric, hybrid). The same applies to vehicles used in the context of new transportation options (e.g. long-distance buses).

The results obtained are based on the statistical method of separate ratio estimation for stratified samples (auxiliary variable: number of vehicle-days registered). The starting point here is the aforementioned breakdown of the year under examination into 6 time periods and the vehicle population into 151 strata. For each time period and vehicle stratum, the VKT per vehicle and day of registration is estimated based on the sample data. Through multiplication by the population total number of motor vehicle days registered per period and vehicle stratum (calculation of this total is based on the ZFZR), estimated VKT figures for each time period and vehicle stratum can be derived. A summation over the periods yields the stratum-specific annual total VKT values, which in a final step can then be aggregated across selected individual strata (e.g. all passenger vehicle strata) or all strata of vehicles (motor vehicles altogether).

In the representation of the results, the total VKT in the study year is additionally related to the annual average number of registered vehicles. This ratio suggests itself since vehicles can fundamentally only generate VKT on days on which they are registered.

In the design-based estimation method of the FLE 2014 vehicle owner survey, the absolute and relative standard error of the estimator for the VKT can be determined with the aid of a specific estimation formula adapted to the sample selection and VKT estimation method actually applied. As such, the calculation of confidence intervals is possible at any time. The sampling error estimation can be conducted with standard statistical methods, due to the fact that neither the non-coverage nor the non-response study for the FLE vehicle owner survey indicated a need to correct for biases.

3. Results

3.1. FLE 2014 Vehicle Owner Survey

With an average motor vehicle registration stock of 53.5 million vehicles (the motor vehicle stock also includes vehicles with insurance tags), the national VKT in 2014 came to roughly 707 billion vehicle kilometers travelled. The overwhelming majority, at just under 599 billion km or 85 % of the total value of national VKT, was recorded by passenger vehicles (including motor homes). Goods transport vehicles (trucks and semi-trailers) accounted for roughly 84 billion VKT in 2014, which corresponds to approximately 12 % of the total VKT. Table 1 summarizes the main results.

Table 1: Total and mean VKT broken down by vehicle group (FLE 2014 vehicle owner survey)

Vehicle group	National vehicle kilometers travelled 2014		Average registered motor vehicle stock 2014		VKT per vehicle and year
	in billion km	in %	1,000 vehicles	in %	in km
Motorcycles	12.4	1.7	4.148	7.8	2,982
Passenger vehicles	598.7	84.7	44.126	82.5	13,568
Buses	4.0	0.6	77	0.1	51,309
Trucks	63.8	9.0	2.674	5.0	23,891
Semi-trailers	19.3	2.7	194	0.4	99,692
Other trucks	0.6	0.1	133	0.2	4,209
Other vehicles	3.6	0.5	304	0.6	11,921
Vehicles with insurance tag	4.6	0.7	1.824	3.4	2,532
Total	707.0	100.0	53.480	100.0	13,220

Relating the entire national VKT to the average registered motor vehicle stock in 2014, the result is an average VKT of 13,220 km per vehicle and year (more precisely: 13,220 km per 365 days of vehicle registration). Eliminating vehicles with insurance tags, the average value rises to 13,598 km. For passenger vehicles in 2014, an average VKT of roughly 13,600 km per passenger vehicle, while the figure for trucks was 23,900 km per truck.

According to information provided by surveyed vehicle owners, roughly 3% of the VKT for German-registered motor vehicles were driven in foreign countries (21.25 billion km). Subtracting this foreign share from the total national VKT yields the national VKT on German roads, which amounted to roughly 685.8 billion km for all vehicle groups. The highest foreign shares were found for motorcycles and semi-trailers. Across all vehicle types, roughly 400 km per vehicle and year were driven abroad; here semi-trailers and buses came in well ahead of all others (approx. 6,450 and 2,200 kilometers abroad per vehicle and year, respectively).

3.2. Comparison with other Surveys

3.2.1 Comparison with FLE 2014 Traffic Count

The tasks of the entire FLE 2014 project also included determining the "domestic VKT" (total of all motor vehicle kilometers travelled on the German road network, no matter where the vehicles are registered). The conceptual frame of the whole FLE 2014 project consisting of the vehicle owner survey and the vehicle counts is shown in Figure 2.

Registration of vehicle	Territory of VKT		Total
	Domestic	Abroad	
Domestic	vehicle owner survey vehicle count	vehicle owner survey	vehicle owner survey
Abroad	vehicle count	X	
Total	vehicle count		

Figure 2: Conceptual frame of the entire FLE 2014 project

Thus, simultaneously with the vehicle owner survey, an automatic count of motor vehicle traffic at randomly chosen locations and days was also conducted. The 24-hour vehicle counts, yielding count data broken down by vehicle type and vehicle nationality, were distributed across the entire German road network and the entire year of 2014. Consequently, this survey (FLE 2014 traffic count) also provided the option for the first time to disaggregate indicators of the VKT on the German road network by road class and location as well as by type of day and time of day.

As the nationality of a vehicle has also been recorded in the traffic count, the domestic VKT of German-registered vehicles can be estimated. The same key figure can be estimated from the vehicle owner survey by subtracting the foreign share from the total national VKT, which yields the domestic/national VKT on German roads (see figure 2). A comparison of the two estimations is given in Table 2.

Table 2: Domestic VKT of German-registered vehicles broken down by vehicle group (FLE 2014 vehicle owner survey and FLE 2014 traffic count)

Vehicle group	Domestic VKT of German-registered vehicles (billion vehicle km) according to...		Difference (billion vehicle km)
	Vehicle owner survey	Traffic count	
Powered two-wheelers	15.9	15.9	0.0
Passenger cars	577.7	579.1	-1.4
Delivery vehicles	46.8	48.8	-2.0
Buses	3.8	4.3	-0.5
Trucks>3.5t	19.4	32.5	-13.1
Tractors	18.6	17.9	0.7
Other vehicles	3.6	3.5	0.1
Total	685.8	702.0	-16.2

As Table 2 shows the two surveys yield very similar results for most of the vehicle groups. In this context it has to be mentioned that the estimate for powered two-wheelers from the traffic count has been adjusted by using the owner survey. The only vehicle group where a somewhat greater difference emerges are trucks (permissible maximum weight > 3.5t), where the traffic count results in a higher VKT value. This can, at least partially, be explained by the fact that a few special motor

vehicle sub-groups such as agricultural tractors and vehicles of the federal police and military are not recorded in the owner survey. In addition, there might be a certain amount of vehicle misclassification in the traffic count.

3.2.2 Comparison with National Household Surveys using Trip Diaries

In Germany there are two interlinked National Travel Surveys (NTS), where trip diaries are used for data collection:

The German Mobility Panel (Mobilitätspanel, MOP) is an annual panel survey on travel with a relatively small sample size (about 2.000 persons). Panel participants stay in the panel for three consecutive years before they are rotated out of the sample and replaced by new participants. In each year of participation, respondents fill in a seven-day trip diary. The annual reporting season is in fall (September to November) for the entire MOP-sample. The MOP uses a paper-and-pencil questionnaire and trip diary. In addition to the trip diary, MOP participant households with cars take part in a survey on mileage and fuel consumption (in short: Survey on Fuel Consumption). This MOP component takes place between April and June every year. Hence, the survey on fuel consumption is a vehicle based survey that samples the vehicles through sampling households. The Survey on Fuel Consumption covers annually about 1.500 cars (Vortisch et al., 2012; Weiß et. al., 2016).

The empirical study Mobility in Germany (Mobilität in Deutschland, MiD) is a cross-sectional survey with a large sample size (about 60.000 persons) which is carried out on an irregular basis. Surveys with this format were performed in 1976, 1982, 1989, 2002 and 2008 (Infas & DLR, 2010). Currently (as of August 2017) a new MiD-survey is underway. MiD participants fill in a one-day trip diary. The reporting days of the respondents are distributed equally over the entire year, i.e. they cover all seasons. There are multiple forms of communicating with the respondents and eliciting travel and other information (telephone interview, online-questionnaire, paper-and-pencil questionnaire).

Figure 3 shows the annual average mileages of passenger cars as measured by the different approaches excluding traffic counts.

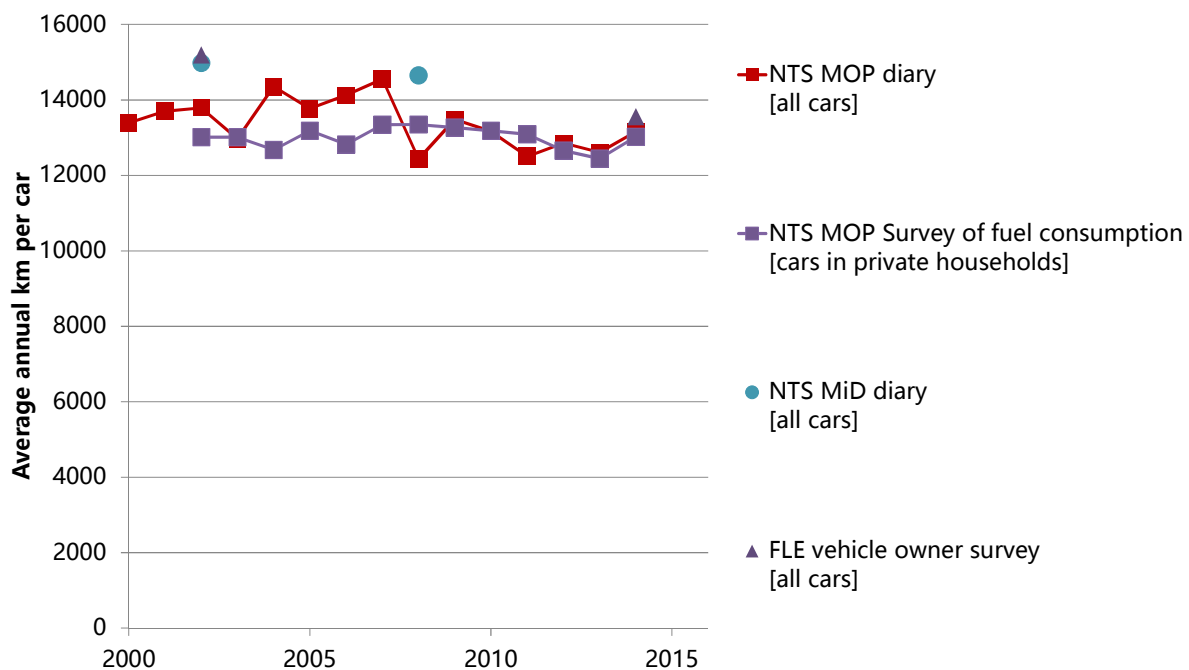


Figure 3: Annual mileages per passenger car as measured by FLE, MOP and MiD in Germany since 2000

In the travel diary car driver trips are recorded including the length (in km) of each trip. By definition these reports also include driver trips in vehicles that don't belong to the household, e.g. when driving a rented car, an ambulance or police car on the job etc. These car driver trip distances can be summed up for the entire person day. Thereafter, these daily total Km at the person-level can be extrapolated to annual car km for the entire population. Dividing this total mileage by the total number of cars results in the average number of Km per vehicle per year. However, this does not include information about distributions and differentiating by type of vehicle (e.g. by fuel) is also not possible.

Figure 3 shows that the average annual passenger car mileages derived with this method are relatively close to the result of approaches that are dedicated to establishing vehicle mileages. However, the small sample size of the MOP together with the large variance in travel diary travel information (caused by substantial intra-personal day-to-day variation) results in a strong year-to-year variability of the MOP results.

4. Conclusions and outlook

It has proven useful to retain the basic concept of the previous FLE vehicle owner surveys (focus on the most important survey characteristics and use of a short, clearly structured and easily understandable questionnaire) and extend it to include the option of participating not only via post, but also electronically using a laptop, smartphone or like device (mixed-mode design). This made it possible to take account of the changed response behavior for public and corporate surveys and counteract the downward trend in willingness to participate in such surveys, as the high response rate of 47 % demonstrates.

Looking to the future of VKT statistics, it would appear that a further methodological innovation may soon aid work in this field as it becomes possible to use odometer-reading data for motor vehicles in two successive vehicle inspections that will shortly be available to the Federal Motor Transport Authority. The estimation of VKT on the basis of process data already available offers the opportunity to make the system of mileage surveys even more efficient in the future. The addition of vehicle inspection data would reduce the scope of the still-indispensable owner survey (vehicle use data together with odometer reading data can only be obtained by vehicle owner surveys) significantly.

References

- Bäumer, M., Hautzinger, H., Pfeiffer, M., Stock, W., Lenz, B., Kuhnimhof, T. und Köhler, K. (2017a). *Fahrleistungserhebung 2014 - Inländerfahrleistung*. Berichte der Bundesanstalt für Straßenwesen, Reihe Verkehrstechnik, Heft V 290, Bergisch Gladbach.
- Bäumer, M., Hautzinger, H., Pfeiffer, M., Stock, W., Lenz, B., Kuhnimhof, T. und Köhler, K. (2017b). *Fahrleistungserhebung 2014 – Inlandsfahrleistung und Unfallrisiko*. Berichte der Bundesanstalt für Straßenwesen, Reihe Verkehrstechnik, Heft V 291, Bergisch Gladbach.
- Hautzinger, H. et al. (2005a). *Fahrleistungserhebung 2002 – Inländerfahrleistung*. Berichte der Bundesanstalt für Straßenwesen, Reihe Verkehrstechnik, Heft V 120. Bremerhaven: Wirtschaftsverlag NW.
- Hautzinger, H. et al. (2005b). *Fahrleistungserhebung 2002 - Inlandsfahrleistung und Unfallrisiko*. Berichte der BASt, Reihe Verkehrstechnik, Heft V 121. Bergisch Gladbach: Wirtschaftsverlag NW.
- Hautzinger, H. et al. (1996a). *Inländerfahrleistung 1993*. Berichte der Bundesanstalt für Straßenwesen, Reihe Mensch und Sicherheit, Heft M 61. Bremerhaven: Wirtschaftsverlag NW.
- Hautzinger, H. et al. (1996b). *Inlandsfahrleistung und Unfallrisiko 1993*. Berichte der Bundesanstalt für Straßenwesen, Reihe Mensch und Sicherheit, Heft M 68. Bremerhaven: Wirtschaftsverlag NW.
- Infas, & DLR. (2010). *Mobilität in Deutschland 2008/2009*. Ergebnisbericht. Bonn; Berlin: BMVBS (Bundesministerium für Verkehr, Bau und Stadtentwicklung).
- Vortisch, P., Chlond, B., Weiß, C., Streit, T., Wirtz, M., & Zumkeller, D. (2012). *Deutsches Mobilitätspanel (MOP) wissenschaftliche Begleitung und erste Auswertungen. Bericht 2011/2012: Alltagsmobilität und Tankbuch*. Institut für Verkehrswesen. Karlsruhe.
- Weiß, C., Chlond, B., Behren, S. v., Hilgert, T., & Vortisch, P. (2016). *Deutsches Mobilitätspanel (MOP) - wissenschaftliche Begleitung und Auswertungen. Bericht 2015/2016: Alltagsmobilität und Fahrleistung*. Institut für Verkehrswesen. Karlsruhe.