



**UNITED NATIONS**

**ECONOMIC COMMISSION FOR EUROPE**

Transport Division

WP.6

Task force on Road Traffic

# **HANDBOOK ON STATISTICS ON ROAD TRAFFIC**

Methodology and experience

Geneva, 2007

12 June 2007

## PREFACE AND INTRODUCTION

The need and demand for statistical information (comparable at international level) for monitoring trends in the volume of road traffic, to support the general transport, as well as road safety policies on national and international level is well and widely recognised. The increased use of individual means of transport, especially of private cars, gives rise to demands for reliable statistics on the volume of traffic by vehicles. Such statistics are presently compiled on the basis of different methodologies, depending on the data available and resources devoted to that purpose.

To meet the intensified demand for data about the volume of road traffic, the Working Party on Transport Statistics (WP.6), at its fifty-sixth session (8-10 June 2005), accepted the offer of the Government of Denmark to host a workshop on Statistics on the volume of road traffic (vehicle-kilometres).<sup>1</sup> The goal of the workshop, which took place in Copenhagen on 1-2 December 2005, was primarily to examine the situation regarding collection and calculation methods applied in the UNECE member countries. The purpose was to explore the issue and to identify or suggest best practices. This would give an impetus to the improvement of national collection and calculation methods, as well as statistical coverage of this important area of transport statistics. The workshop in Copenhagen created a voluntary task force that should draft a methodological handbook.

The work of the task force has always been open to all interested parties. The work was also fully transparent and interested national parties had an open invitation to communicate their suggestions, observations, recommendations, national experiences and comparisons, as well as other types of input directly to the focal point of the relevant chapter of the future handbook. The task force has had four meetings:

- 1-2 March 2006 in Geneva
- 22-23 May 2006 in Heerlen, the Netherlands
- 21-22 September 2006 in Bratislava, Slovakia
- 30 November - 1 December 2006 in Maastricht, the Netherlands

In addition, an advanced version of the Handbook was presented for information and comments at the annual session of the Eurostat's Coordinating Committee on Transport Statistics on 11-12 December 2006 in Luxembourg. The final draft version of the Handbook was presented at a workshop in Belgrade on 6-7 March 2007 and is expected to be approved by UNECE Working Party on Transport Statistics (WP.6) at its fifty-eight session on 6-8 June 2007.

The entire work on the Handbook was chaired and coordinated by Erik Grib (Denmark). Erik Grib was the lead author of the chapter on the scope of the Handbook (chapter 1). Marly Odekerken-Smeets (The Netherlands) was the lead author of chapter 2 on user needs. In chapter 3, Lars Klit Reiff (Denmark) was the lead person behind the part on odometer readings; Erik Grib did the same job for household surveys; Olga Kastlova (Czech Republic) was in charge of traffic counts; while Sylvie Mabile (France) led work on fuel consumption methods. Peter

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<sup>1</sup> All information relating the work on the Handbook on Statistics on Road Traffic may be obtained at this web address: <http://www.unece.org/trans/main/wp6/transstatac5agenda.html>

Smeets (The Netherlands) wrote chapter 4 on inland and foreign traffic and Erik Grib wrote the synthesis (chapter 5). Chapter leaders were assisted in their work by all members of the task force, as well as by many national contributors who sent their comments, observations, national experiences and other type of input. All chapters of the Handbook were meticulously put together in this final form by the Secretariat of the UNECE Working Party on Transport Statistics, led by Miroslav Jovanovic, which organised meetings, elaborated the reports and gave invaluable assistance to the task force.

The task force hopes that this Handbook will contribute to an improved and wider data collection on road traffic.

# HANDBOOK ON STATISTICS ON ROAD TRAFFIC

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## CHAPTER 1

### SCOPE OF THE HANDBOOK

There is a need for statistical information - comparable at international level – monitoring trends in the volume of road traffic, to support the actual transport policies of the European countries.

The increased use of individual transport, especially of private cars, gives rise to demands for reliable statistics on the volume of traffic performed by private cars. Such statistics are presently compiled on the basis of different methodologies, depending on the data available. To meet the intensified demand for data about the volume of road traffic, the Working Party on Transport Statistics, at its fifty-sixth session (8-10 June 2005), accepted the offer of the Government of Denmark to host a workshop on Statistics on the volume of road traffic (vehicle-kilometres).

The aim of the workshop was primarily to examine calculation methods applied in the European countries for the purpose of finding best practices, and thus give impetus to the improvement of national calculation methods.

The Workshop addressed the important issue of the statistical coverage of road traffic measured in vehicle-kilometres, an issue that is highly important because of a multiplicity of reasons which include: transport policy; fuel consumption; pollution; spatial planning; planning of public transport; planning of intermodal transport; taxation; investment in infrastructure; risk exposure (accidents); and international comparisons.

The Workshop also considered issues that include availability of data; their usefulness; comparability and accuracy (errors), and underlined the need to collect, estimate and supply data on road traffic measured in vehicle-kilometres and well as information about transport performance and fuel consumption in road traffic.

Four general types of methodologies for compiling of statistics on road traffic were identified: The road traffic could be estimated based on the:

- **Vehicle**  
Such statistics are based on odometer readings. They will cover only vehicles registered in the country. Additional surveys would therefore be required to obtain statistics for the national territory.
- **Driver**  
Here household surveys or surveys among owners or users of vehicles are applied to obtain statistics on the road traffic. The surveys will cover only resident persons so additional surveys would be required to obtain statistics for the national territory.
- **Road**  
Statistics are based on manual and /or automatic traffic count on selected road segments. Such sample surveys include traffic by national as well as foreign vehicles on the national territory.

- **Fuel consumption**

Volume of road traffic is estimated from information about fuel supply and fuel consumption as derived from estimates of kilometres driven per fuel litre for typical types of vehicles.

The Copenhagen Workshop revealed that there is a demand and necessity for more reliable data on the volume of road traffic by types of vehicles for analysis, international comparisons and policymaking. Even though there are certain similarities among countries in their statistical methods and practices in this area, there are important differences and gaps in coverage. Hence, there is a need for recommendations concerning methodologies that may be applied, and pros and cons relating to the chosen methodology.

Accordingly the Copenhagen Workshop requested the UNECE secretariat of WP.6 to invite countries to form a task force that during 2006 should **draft a handbook**:

- Describing the **users' needs** for statistics in the domain of statistics about road traffic
- Presenting the above mentioned **four types of methodologies** for compilation of road traffic statistic
- Giving an overview of the **methodologies applied in the various UNECE countries**
- Presenting recommendations for **international definitions** relating to the subject.

The draft handbook should be presented to the Workshop in 2007 and submitted to WP.6 for adoption at its Session in June 2007.

The task force was established in March 2006. The task force decided that the content of the handbook should describe the various uses of road traffic statistics and the four above-mentioned general methodologies for compilation of road traffic statistics, their benefits and limitations, and examples from practices in the member states. A fifth methodology based on data obtained from border controls was discussed in the task force but in the end excluded from the handbook as it was found less general.

The task force sees the **scope of the handbook** as a means to assist countries improving their existing statistics on road traffic or helping them setting up new statistics on road traffic. The handbook should point to advantages and problems linked to the various methodologies, touch upon possible ways to overcome specific problems relating to an applied methodology and inform of inspiring concrete examples in the UNECE Member States. Finally, the handbook should address the needs for internationally comparable statistics about road traffic, recommending regular submission of a limited set of harmonised tables to UNECE, ECMT and EUROSTAT.

Transparency in the work of the task force has been ensured by free access to the preliminary drafts via the homepage of WP.6 and by encouraging all interesting statisticians and users of the road traffic statistics to participate in the meetings of the task force or to supply comments to the draft chapters or supplementary information to the task force.

## CHAPTER 2

### USERS' NEEDS FOR STATISTICS ON ROAD TRAFFIC

#### General

There is a growing need for figures about the most diverse topics in the world. This also applies to the field of traffic and transport. While markets are being liberalised the volume of transport and traffic is still growing at both national and international levels. Congestion, accidents and pollution are negative factors directly related to traffic volume. However, there is considerable demand to maintain economic growth by sustainable and safe mobility and transport with fewer negative effects.

Policy-makers therefore have to deal with many challenges. For each of these aspects different figures should be collected or obtained from the available information sources. The information should be brought up to international level and be exchanged with other countries to improve quality and increase its scope and the use made of it. More and more countries are becoming aware of the value of exchangeable information and methods to collect information on traffic and transport. Insight into each other's methods can be very helpful and refreshing and lead to internationally comparable information.

Information about road traffic can relate to many aspects. The information depends very much on the goal for which it is collected. Different users need different figures, although always in relation to the unit "vehicle-kilometres". Widespread use is made of this information. Users can be found, for example, in the following areas:

- policy-making at national and international level;
- infrastructure management and planning;
- traffic and transport management;
- spatial planning;
- accidents;
- environmental issues (including safety and scrap).

A more detailed list of known users can be found in Annex 1 to this Chapter.

Nevertheless, that still leaves the problem of collection of the necessary information. Because national and international legal acts on statistics are mostly restricted to transport of goods and passengers, there is no common practice for collecting information about traffic movements. Methods differ and depend frequently on the available and usable data sources. However, there is a growing need for comparable and harmonised information. For example, information on the safety and environmental impact of traffic in relation to urbanisation should be based, among other things, on common practice for calculating road traffic.

The greatest demand is for figures concerning road traffic movements. Since this mode of transport is still growing in many countries, continuous monitoring is of great importance. The sections which follow will therefore focus mainly on the needs for figures on road traffic movements.



## 2.1 Data on road traffic movements

The demand for information about road traffic movements depends very much on the use made of the figures. The main variable is the distance travelled by the vehicle. If possible the route used from origin to destination should be clear. Information on the loaded weight (and axles) of the vehicle is useful for calculation of the road wear and variables like for example total weight and age of the vehicle would be valuable for the estimation of emission from road transport.

Depending on customers' needs, several variables should be collected or used in connection with the distance travelled. This improves the quality of the data in many ways. The following additional variables should be considered:

a. Variables related to the vehicle:

- type of vehicle (passenger car, van, lorry, road tractor, bus, motorbike, others);
- age;
- fuel type (petrol, diesel, LPG);
- gross vehicle weight (unladen vehicle weight plus loading capacity);
- engine power;
- fuel consumption/fuel efficiency;
- nationality of the owner and of the vehicle.

*If the vehicle is known this information is probably available from the national vehicle register. The problem here is with foreign traffic.*

b. Variables related to use of the vehicle:

- reasons for use (private or business/own account or hire and reward);
- actual fuel consumption.

*For national vehicles this information could be available from the vehicle register (name of user: private or business, lease identity, economic sector).*

c. Variables related to the user (or passenger) of the vehicle:

- age;
- gender;
- driving experience;
- provisional or full driving licence;
- driving licence by vehicle type;
- income group.

*This information will be available only in the case of mobility surveys.*

d. Variables related to infrastructure:

- type of road (motorway, main roads, other roads).

*In most countries, information on the main road network (length, volume of traffic, etc.) is available from network databases. However, information on minor/local roads will often be sparse.*

- e. Variables related to the location:
  - inside or outside built-up areas/urban or rural;
  - NUTS<sup>2</sup> 0, 1 or 2.

*This information could also be available from network information. Sometimes there is even information about the maximum speed limits for vehicles in some areas. If not, a classification of roads as urban or rural could be used.*

It is very difficult to collect all this information from a single survey. In most cases the available information has to be combined from different sources. However, some countries could combine all the variables in a table.

The above-mentioned variables could be extended by adding the *time* dimension. For some users it would be necessary to split up information on traffic movements depending on the time of day or type of day (working day, weekday or weekend). On the other hand, variables such as *level of urbanisation* or availability of *business centres* in an area would be of interest when splitting up the number of vehicle-kilometres.

## **2.2 Basic demand for information from regular users**

This section describes some basic tables for traffic movements (not transport measurements). If possible this information should be available to regular users.

The needs should be classified in some way based on users' priorities. However, this depends very largely on the use made of the data by the category of users concerned. Primarily we can distinguish between national and international user needs. In general, a higher priority is given to the national data requirements than to the international requests. National data requirements often determine the data spectrum available to users on the international level. Consequently, a clear classification of priorities that single users have with regard to transportation statistics, turns out to be a non-trivial exercise. Consequently, this is not an easy exercise. Nevertheless, data should at least be available on the vehicle-kilometres driven on national territory and by national vehicles. If possible, this data should be supplemented with information about foreign vehicles on national territory. Furthermore, for national vehicles the total kilometres driven during a certain period would be of great interest. Of course, the above-mentioned data become even more interesting if they can be broken down by other relevant variables, for example age class of the vehicle, vehicle type or the category of roads on which the kilometres were clocked up. Another important information regarding data configuration is the periodical frequency at which particular data is made available to interested users. In general annual data, updates are the common standard. Nevertheless, this can differ significantly depending on the data generation procedure used and therefore on the costs of the data production.

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<sup>2</sup> NUTS: Nomenclature of territorial units for statistics consisting of several levels. Mostly level 2 or 3 are used.

Table 1 set out below gives an overview of the basic needs classified by category of users. However, this table needs further elaboration.

<b>Basic needs for regular users</b>		unit	Policy making (national and international)	Infrastructure management and planning	Transport management	Traffic management	Spatial planning	Accidents	Environmental issues	Environmental issues	Scrap policy
table 1	Road traffic on national territory by vehicle type and road type.	vkm	•	•	•			•	•		
table 2	Road traffic on national territory by vehicle type and age class	vkm	•	•	•			•	•		
table 3	Road traffic on national territory by vehicle type and fuel type.	vkm	•	•	•			•	•		
table 4	Road traffic on national territory by vehicle type and weight class.	vkm	•	•	•			•	•		
table 5	Road traffic on national territory by origin and destination.	vkm	•	•	•			•	•		
table 6	Road traffic on national territory by nationality of the vehicle.	vkm	•	•	•			•	•		
table 7	Road traffic on national territory by built-up and non-built-up area.	vkm	•	•	•			•	•		
table 8	Border crossing Road traffic by vehicle type and nationality.	vkm	•	•	•			•	•		
table 9	Border crossing Road traffic by origin and destination.	vkm	•	•	•			•	•		
table 10	Road traffic by national vehicles by vehicle type on national and foreign territory.	vkm	•			•	•			•	•
table 11	Road traffic by national vehicles by age class.	vkm	•			•	•			•	•
table 12	Road traffic by national vehicles by fuel type.	vkm	•			•	•			•	•
table 13	Road traffic by national vehicles by origin and destination regions (NUTS 0 (country) 1, 2 or 3).	vkm	•			•	•			•	•

(vkm = vehicle kilometres)

In order to improve quality, attempts should be made to cross as far as possible the relevant variables within the above-mentioned tables for each category.

### 2.3 Data on transport measurement

Measurement of goods and passenger transport provides information about the use made of the vehicle. Units such as tonne-kilometres and passenger-kilometres are used to compare different vehicle types and so are widely used for monitoring the modal split and modal shift. Measuring information on transport is not directly within the scope of this handbook. However, it is closely linked to information about traffic movements. In some (EU) countries the survey on goods transport by road also produces information about the total vehicle-kilometres by origin and destination. In some cases even the border crossing points are asked, from which information on the kilometres driven on national territory can be calculated for these types of vehicle.

## Annex 1

### **List of known data users**

- Ministries
- Statistical offices' internal users (environmental statistics, energy accounts, etc.)
- Regional and local authorities
- Road authorities
- International organisations (EC, UNECE, ECMT, EEA)
- Research institutes (public or private institutes, universities, etc.)
- Vehicle industry
- Car companies
- Insurance companies
- Road construction industry
- Safety organisations
- Freight transport associations
- Private transport associations



## C H A P T E R 3 a)

### **ODOMETER READINGS AT ROADWORTHINESS TESTS**

#### **3.1 General description of the method**

The total volume of traffic generated by national road vehicles can be calculated from odometer readings taken at roadworthiness tests. The basic calculations are very simple: the average distance travelled by the vehicles inspected is determined and then multiplied by the number of road vehicles.

Since official vehicle data are essential for the calculations it is possible to break the data down by vehicle characteristics to a very detailed level. Furthermore, if all data from the mandatory roadworthiness tests are used, in principle all vehicle-kilometres are included in the calculations, which suggests a high level of accuracy. But results from odometer readings give no geographical information. Hence, it is not possible to attribute the kilometres driven to specific roads, regions or even countries. This will be discussed later.

There are two essential data sources for calculating the total vehicle-kilometres from odometer readings:

- regular odometer readings from roadworthiness tests;
- the number of vehicles in the fleet at a given time.

Calculations can be based on odometer readings from the total vehicle fleet or from a sample.

##### **3.1.1. Background**

Under EU Directive 96/96, periodical roadworthiness tests are mandatory in all Member States. This has been in force since 1998 for personal cars. Vehicle inspections are also mandatory in many non-EU countries.

In some countries an odometer reading is part of the test, and the readings are often kept in a database for various statistical purposes. These are the key data for the calculations.

##### **3.1.2. Basic calculations**

The main features of the calculations are as follows:

For each vehicle the kilometres driven in a specific period are calculated and this figure is then converted into kilometres driven per day. If possible, the period between two tests is used; otherwise the age of the vehicle is used. The average kilometres per day for all vehicles in question are calculated, and this figure is multiplied by the number of registered vehicles of the same type. This gives the daily traffic volume (vehicle-kilometres per day) which is easily converted to yearly traffic volume by multiplying by the number of days in the year.

In Switzerland, until 2006, no records were kept of odometer readings. Kilometres per day were therefore calculated as the total distance travelled divided by the number of days since the first day of use.

In Denmark, the distance travelled between two successive roadworthiness tests is used (except for the first test). To calculate the driving period, the number of "inactive days" is subtracted from the number of days between the two tests. "Inactive days" means periods when a vehicle is deregistered, e.g. periods when the vehicle is put up for sale second hand.

### 3.1.3. Coverage – which traffic is included and which excluded

Calculations from odometer readings obtained at roadworthiness tests cover:

All traffic by national vehicles due for a periodical test

Hence:

- Kilometres driven in other countries are included.
- Foreign traffic is excluded.
- Vehicles that are not due for a roadworthiness test are not included.
- Off road traffic is included

Figure 1 illustrates the coverage of traffic with respect to vehicle nationality and the territory where the traffic takes place.

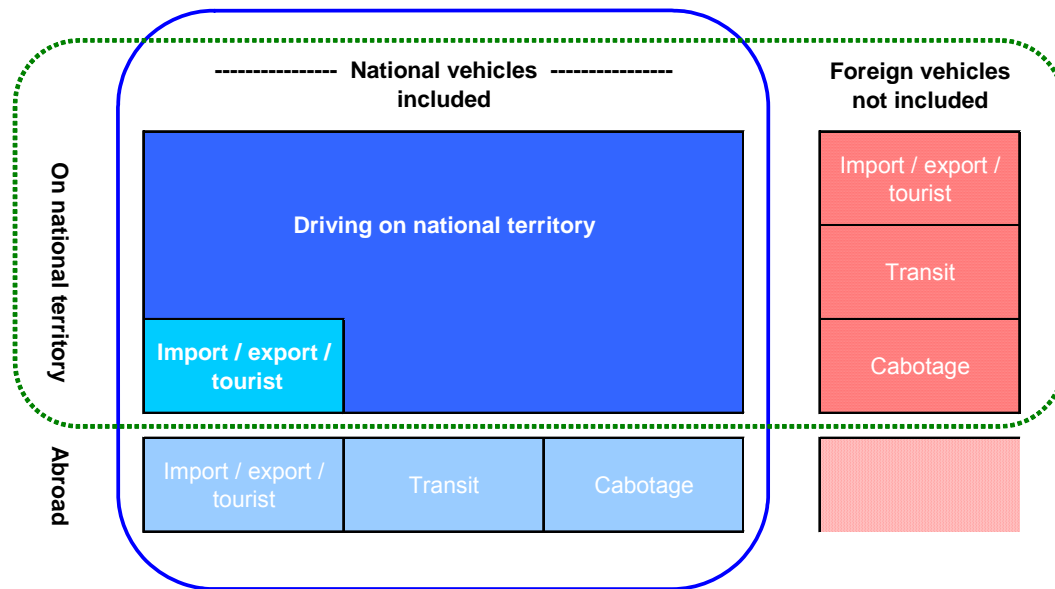


Figure 1: Coverage of traffic

Figure 1 indicates traffic in national vehicles in blue and enclosed in the full line. Traffic in other vehicles are in red. The total traffic on national territory is enclosed within the dotted line.

It can be seen that adjustments must be made if foreign vehicles travelling on national roads are to be included, or if national vehicles travelling outside the country are to be excluded. These adjustments must be based on other sources.

The EU Directive on periodical roadworthiness tests covers only four-wheeled vehicles intended for on-road use. Some countries include other types of vehicle (e.g. motorcycles, agricultural tractors and mopeds) in their mandatory inspections. Only some countries record odometer readings at the test and keep them in a database. This is not one of the requirements in the EU Directive.

Data on road traffic generated by vehicles that are not due for inspection must be drawn from other sources. Figures on traffic due to vehicles without odometers (e.g. trailers, semi-trailers and bicycles) must also be obtained from other sources.

On the other hand, off-road traffic by vehicles subject to roadworthiness tests is included. In principle the volume of off-road traffic should be estimated from other sources and subtracted from the total. However, in most countries the figure will be negligible.

## **3.2 Details of the method**

This section describes the method in more detail, along with necessary or possible adjustments and improvements.

### **3.2.1. Vehicle-kilometres for a specific period**

The number of vehicle-kilometres must be attributed to a specific period – normally to a specific year – if it is to be useful or even meaningful. However, odometer readings are obtained continuously and it is not possible to tie down the kilometres recorded to a given calendar year. The longer the period covered by the distance recorded, the bigger the problem becomes. This is why it is preferable to use odometer readings from successive tests. But even in this case consideration must be given to the problem.

This is illustrated in Figure 2 for a vehicle due for a test every second year. In this example a significant part of the period between the two tests lies beyond 2005 which is the year for which the information is actually wanted.



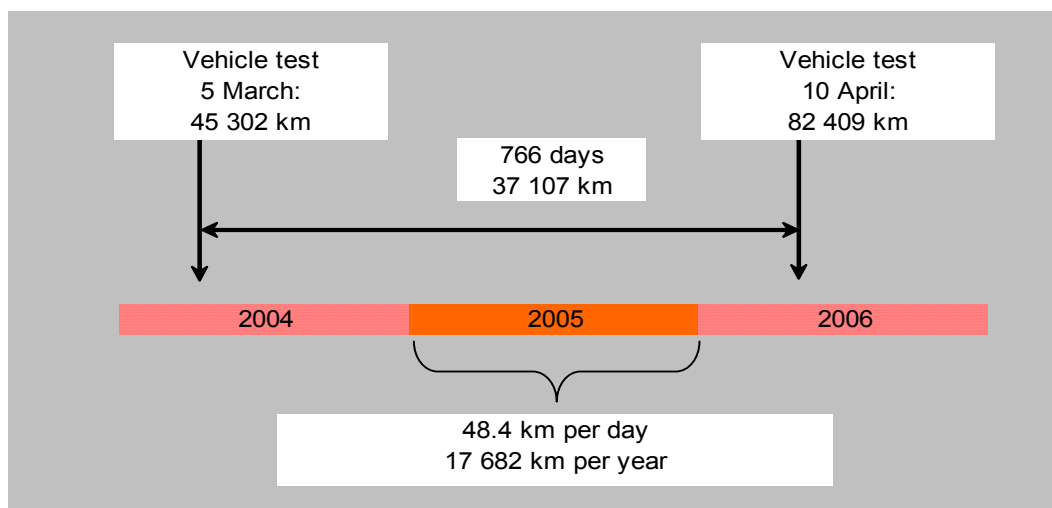


Figure 2: Calculation of kilometres driven in 2005 by a single vehicle

### 3.2.2. Changes over time in yearly kilometres per vehicle

If the yearly traffic per vehicle is stable over the years, the calculation shown in Figure 2 gives a correct estimate. If, on the other hand, there is a change in the yearly traffic per vehicle the traffic estimate for a specific year can be improved by taking this change into account in the calculation. Yearly traffic over the years can be estimated either directly from test data or from other sources.

In Denmark for passenger cars and vans the kilometres driven between two roadworthiness tests are distributed between each month in accordance with the ratio between the official "road traffic index" (based on road traffic counts) and the total number of passenger cars and vans in the fleet.

### 3.2.3. Distribution of kilometres driven up to the first roadworthiness test

In line with the minimum requirements in the EU Directive, passenger cars and vans are due for their first roadworthiness test after four years. The minimum requirements are applied in many countries. This means that the kilometres driven during the first four years of vehicle life cannot be distributed directly to specific years. It is a well-established fact that new vehicles are driven more than older vehicles (see *figure 3*).

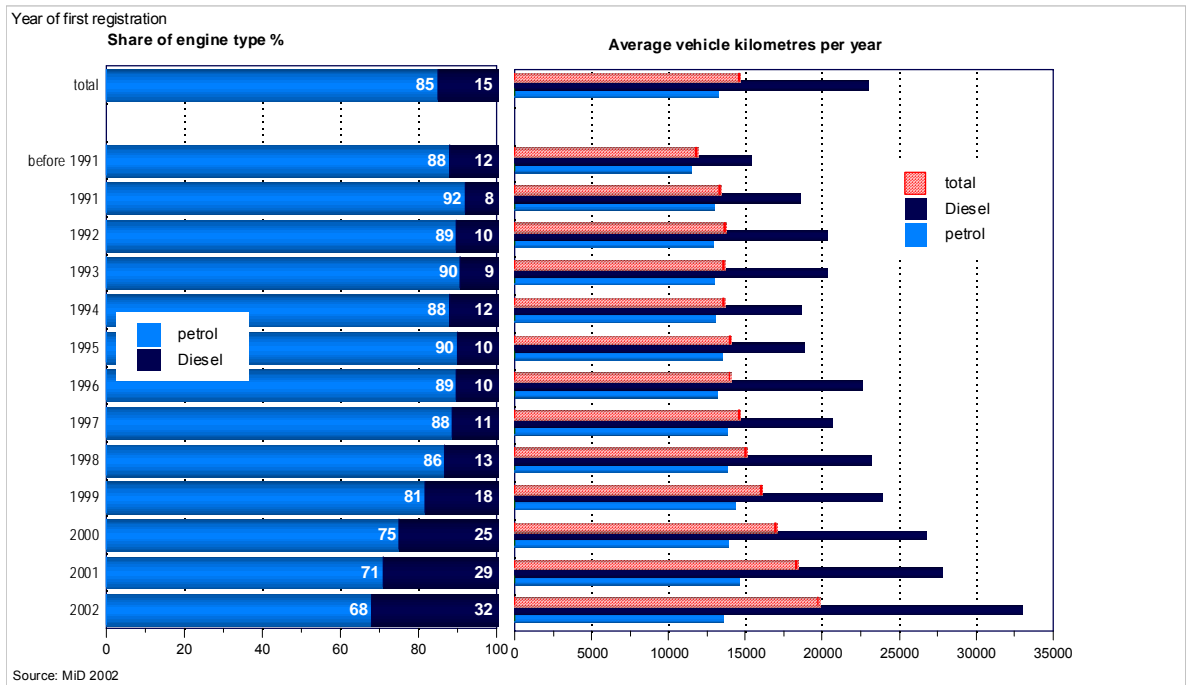


Figure 3: Average vehicle kilometres per year of German passenger cars by year of first registration and engine type (Source: *Mobilität in Deutschland, Ergebnisbericht*. Bonn, Berlin 2004. page 38).

If the average trend in yearly kilometres from new to older vehicles is known from other sources the kilometres driven during the first four years should be distributed to each calendar year accordingly. Otherwise, the kilometres can be distributed in accordance with findings from other countries or even attributed to each of the years without any adjustments.

### 3.2.4 Matching odometer data with vehicle fleet – which period to use

The basic calculation in this method is the multiplication of the number of vehicles by the average yearly distance travelled. Therefore it is essential to have matching periods for the two datasets:

**Vehicle fleet:** The average number of vehicles in the fleet for a specific year is calculated.

The most precise calculation is a yearly average of the vehicle fleet on each day:

$$\text{Average vehicle fleet} = \frac{1}{365} \times \sum_{d=1}^{365} N_d$$

Where  $d$  is the number of the day in the year,  $N$  is the number of vehicles registered on that day and 365 is the number of days in the year. The result of this calculation will be the most precise estimate of the average fleet for the year in question. But it requires access to very detailed information from the vehicle register.

The average fleet can more easily be calculated as:

$$\text{Average vehicle fleet} = (\text{Fleet on a specific date in year } T + \text{fleet on the same date in year } T+1)/2$$

If the vehicle fleet displays seasonal fluctuations (e.g. because special vehicles are deregistered during the off-season) or is undergoing substantial changes for other reasons, the choice of date for counting the fleet is critical to the result.

If it is of any significance to the calculations, account should also be taken of whether vehicles can remain on the register even when they are no longer in use.

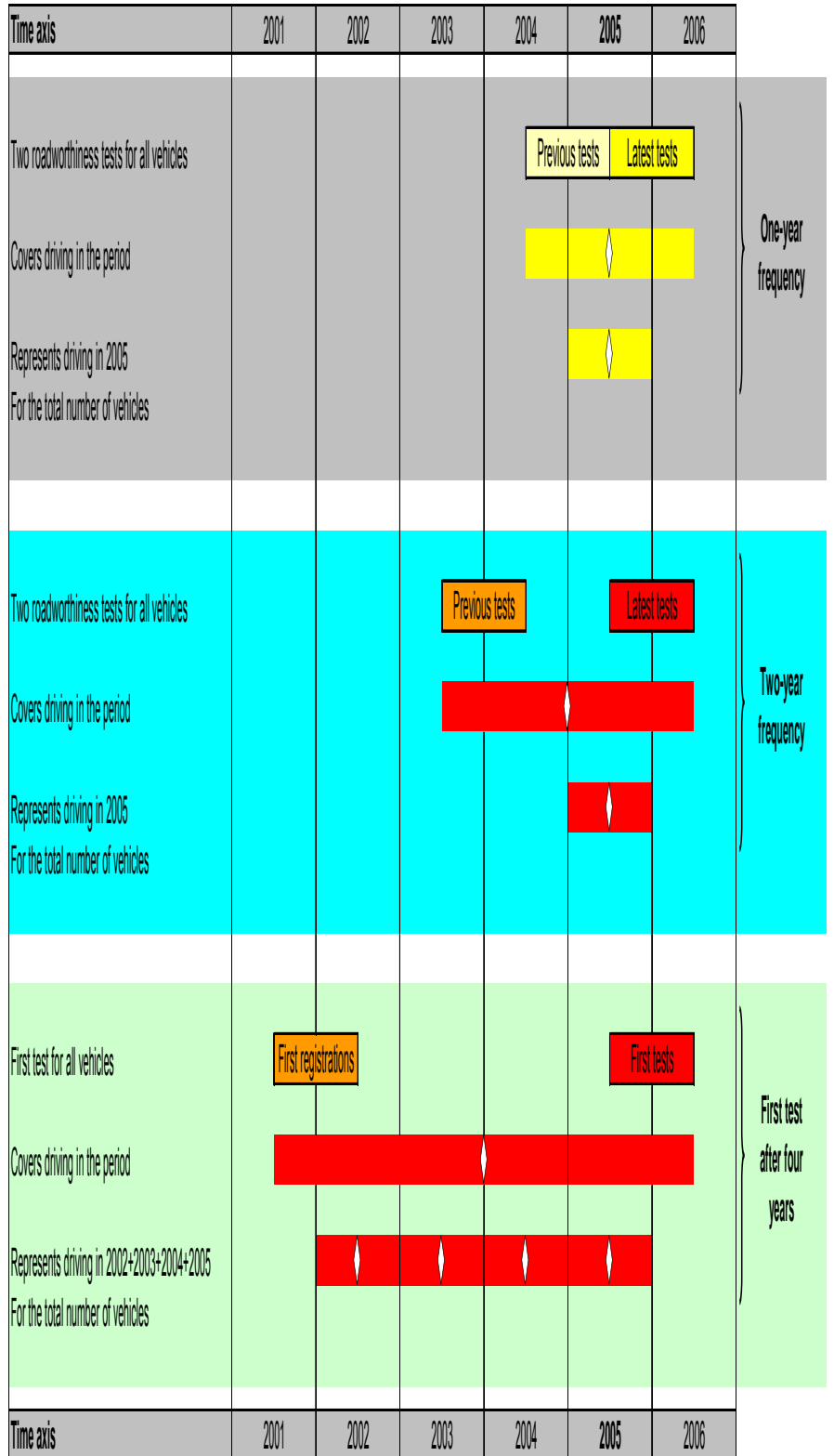
**Odometer readings:** As odometer readings are taken continuously, a decision must be taken on which time period to use for the first and second readings.

Figure 4 shows an example of calculating the total distance travelled in 2005 considering which odometer reading periods (tests) to use in the calculations. Which period to use depends on the test frequency for the vehicles in question.

For vehicles subject to yearly inspection the first odometer reading used in the calculations for 2005 is from 1 July 2004 and the last reading is from 30 June 2006. As can be seen, the “centre” of the driving period recorded lies in mid-2005, which is the year in focus. This gives the best possible estimate of the distance travelled in 2005 (see also Figure 2).

For vehicles with a two-year test frequency the first odometer reading used in this example is from 1 July 2003 and the last is from 30 June 2006. The centre of the driving period assessed is then New Year 2005 and not mid-2005. If, instead, the “odometer period” covers all of 2004 for the first reading and the whole of 2006 for the last, the centre would be mid-2005, as preferred. But if these periods are used, it will not be possible to estimate vehicle-kilometres driven in 2005 before the beginning of 2007. Choosing periods as shown in Figure 3 can be a reasonable compromise between accurate estimates and reasonable delays in data production.

For vehicles that are due for their first roadworthiness test after four years the first odometer reading is used to estimate vehicle use over a period of four years. It is most likely that the driving over the four years is not evenly distributed between each year. This was discussed in further detail earlier.



◇ Indicates the centre of the specified period

The figure illustrates that since roadworthiness tests are spread over all dates it is not possible to make a precise calculation for vehicle kilometres a specific year.  
 For vehicles with yearly tests the estimation in this example is good, since the middle of the calculated driving period is mid 2005. For vehicles with 2 years between tests the calculations are less precise, since the middle of the driving period is New Year 2005. Calculations can be improved by including tests from all of 2006, but then statistics will be delayed.  
 For vehicles having their first test after four years special considerations must be given. If driven kilometres per year are changing during the first four years calculations are imprecise, and adjustments must be made.

Figure 4: Periods for odometer readings, calculating distance travelled in 2005

When estimating vehicle-kilometres for the latest year information is missing on the newest vehicles, i.e. vehicles that have not yet passed their first test. It is necessary to make an estimate for them. This can be based on the distances clocked up by the newest vehicles that have been tested. This figure could possibly be adjusted to allow for the fact that new vehicles are driven more than older vehicles.

From the remarks set out above it can be seen that the estimate of vehicle-kilometres for a specific year can be made more precise as time goes on, as more and more “new” cars have their first test and (for vehicles with two-yearly inspection frequency) odometer data are obtained for one whole year after the year for which the estimates were made. However, in most situations it is desirable to have an estimate of vehicle-kilometres for a specific year within a relatively short time after New Year. This means that the data are not as accurate as they could be.

In Denmark it has been decided to produce provisional data to gain a reasonably up-to-date picture. The first calculations for a given year are made when odometer data for the following half-year are available. The first revision can be carried out after one year, at the same time as the figures for the next year are calculated for the first time. But since private cars and vans have their first mandatory test after four years it will not be possible to finalise the annual road traffic volume until almost five years after the end of the year concerned. In the mean time it is possible to make the estimate more and more accurate each year.

### **3.2.5. Subdividing data**

With these two main data sources – vehicle fleet and odometer readings – it is possible to split up data according to specifications such as type of vehicle, year of first registration, gross vehicle weight or unladen vehicle weight, type of fuel and, in some cases, use of the vehicle. If calculations are made on a big sample, or even on the whole fleet, it is possible to make them at a very detailed level. This opens up the possibility of subsequently adjusting the subgroups, depending on the use to be made of the results (aggregation on different parameters and different levels).

Subdivisions are typically based on the following parameters:

- 1 Type of vehicle: passenger cars, vans, lorries, road tractors, buses and special vehicles
- 2 Age classes (most detailed for newer vehicles)
- 3 Weight classes (gross vehicle weight or, for private cars, unladen vehicle weight)
- 4 Fuel type: petrol, diesel, LPG and others
- 5 Vehicle use: private or business

Table 1 proposes a minimum subdivision. Following this table ensures that data are comparable between countries. The table is a proposal for a subdivision of data as they are published. Thus, the table reflects the user needs.

	Total fleet	Km per vehicle per year	Total vehicle-kilometres
<b>Passenger car</b>			
<i><b>Petrol</b></i>			
Unladen v. w. <= 1 300 kg			
Unladen v. w. > 1 300 kg			
<i><b>Diesel and others</b></i>			
Unladen v. w. <= 1 300 kg			
Unladen v. w. > 1 300 kg			
<b>Taxi's</b>			
<i><b>Petrol</b></i>			
<i><b>Diesel and others</b></i>			
<b>Buses</b>			
<i><b>Scheduled service</b></i>			
Gross v. w. <= 5 000 kg			
Gross v. w. > 5 000 kg			
<i><b>Other</b></i>			
Gross v. w. <= 5 000 kg			
Gross v. w. > 5 000 kg			
<b>Vans (&lt;= 3 500 kg GVW)</b>			
<i><b>Petrol</b></i>			
Gross v. w. <= 3 000 kg			
Gross v. w. 3 001-3 500 kg			
<i><b>Diesel</b></i>			
Gross v. w. <= 3 000 kg			
Gross v. w. 3 001-3 500 kg			
<b>Lorries (&gt; 3 500 kg GVW)</b>			
Gross v. w. <= 6 000 kg			
Gross v. w. 6001-18000 kg			
Gross v. w. > 18 000 kg			
<b>Road tractor</b>			
Gross v. w. <= 18 000 kg			
Gross v. w. > 18 000 kg			
<b>Powered two wheelers</b>			
Motorcycles			
Mopeds			
<b>Other</b>			

Table 1: Minimum subdivision of results from odometer readings when published

Due to the nature of this method, it is not possible to perform separate calculations for road trains or articulated vehicles but only for the power-driven units.

When using odometer data it is not possible to allocate the kilometres driven to different road types or specific areas.

In some cases it will be possible to subdivide data by the area in which the vehicles are registered but this will not necessarily be the area where the vehicle is used.

### 3.3 Data sources

There are two main and essential data sources, namely:

- Odometer readings from periodical roadworthiness tests; and
- Information on the vehicle fleet, preferably from the national vehicle register.

If possible a vehicle-to-vehicle link between the two registers should be established.

In Germany, no legislative regulation exists so far to make the odometer data submission obligatory. But for a pilot-study funded by the German Federal Ministry of Transport, Building and Urban Affairs (Bundesministerium für Verkehr, Bau und Stadtentwicklung) vehicle data covering at least 13 % of the overall annual volume of all roadworthiness tests in Germany will be available. These data will be provided on a voluntary basis by several different inspection organisations. Odometer and vehicle data reported by the inspection organisations participating in the project will be merged based on a specific vehicle-type-manufacture-key-combination with detailed technical vehicle attributes available from the German Federal Bureau of Motor Vehicles and Drivers. Based on these technical characteristics and annual counts of the overall vehicle fleet registered in Germany adequate extrapolation factors and strata weights will be calculated for the odometer survey data in order to allow for representative estimation results of annual vehicle kilometres travelled by German vehicles. Due to strict data privacy protection regulations applied in Germany, it will not be possible to merge the vehicle data with any individual driver or holder characteristics. Especially the information of previous inspections of the vehicle cannot be combined with the actual odometer reading, so just the total vehicle kilometres travelled since the first registration are available.

The main challenge of the study lies in finding and implementing a procedure for the odometer data collection, and developing a method of extrapolation of these data to calculate annual average vehicle mileage differentiated by type of vehicle, mode of drive and additional attributes.

So 2007 will be the first year in Germany when data on odometer readings together with additional vehicle data and data on fuel consumption can be applied for a better estimation of annual vehicle kilometres travelled.

If odometer readings are not available for all vehicles, traffic volume can be based on a sample from the vehicle register. This is done in the Netherlands and Germany. However, if this is the case a correct sampling and weighting method should be applied. The best way to take a sample is to stratify it on the basis of several vehicle characteristics, for example vehicle type, year of first registration, weight class and fuel type. For each stratum the average yearly kilometres could be calculated and then multiplied by the average vehicle fleet in the relevant stratum.

Other data sources will be needed for adjustments and corrections:

#### 3.3.1. National vehicles travelling abroad

Calculations based on odometer readings give the total number of kilometres travelled both on national territory and abroad (see Figure 1). Often it is of significance to draw a distinction, in which case additional data sources must be used.

***For passenger traffic:***

- Tourism statistics on national travellers;
- Information from other countries about foreigners in their country;
- Information from national travel surveys (mostly only on own territory). This should be subtracted from the total volume to calculate the kilometres travelled abroad.

***For goods traffic***

The distribution between national and international traffic for lorries, road tractors and special vehicles can be based on journey log studies or, for EU countries, on information supplied under Regulation 1172/98.

For other vehicles special surveys are needed.

**3.3.2. Foreign vehicles travelling on national territory**

If kilometres travelled on national territory by foreign vehicles have to be estimated other data sources must be used.

***For passenger traffic:***

- Tourism statistics about foreign travellers;
- Information from other countries about travelling abroad.

***For goods traffic:***

The information about foreign lorries, road tractors and special vehicles can be based on journey log studies or, for EU countries, on information supplied under Regulation 1172/98 from the EUROSTAT exchange programme.

**3.3.3. Kilometres travelled up to the first inspection**

In some countries the first roadworthiness test takes place after four years for private cars and vans. This means that there is no information for this period. It is therefore necessary to estimate the yearly distance travelled for new cars. The distribution of the kilometres driven during the first years of a car's lifetime also has to be estimated.

It is preferable to conduct special surveys covering use of new cars. If no such surveys are available, estimates can be based on driving patterns known for older cars. Also, the trend in yearly distance travelled can be taken into account when deciding the distribution of vehicle-kilometres between two inspections covering a time span of two or more years.

In the Netherlands odometer readings are also available from servicing and from repairs after accidents. Consequently, sometimes information is available before the first mandatory test. This additional information can be used to calculate traffic more accurately over the first few years. However, this extra information mostly applies to cars averaging a high number of kilometres per year and should therefore be treated with care.



### 3.4 Error sources

**Reading of the odometer:** Procedures for reading odometers will probably differ between countries or even within each country. Odometer reading is likely to be a low priority in written instructions and in daily work. This can lead to inaccuracy in the readings and will mostly produce random errors. However, if, for instance, all figures are rounded down to the nearest thousand, it will lead to systematic error. Errors due to misreading the odometer can, to some extent, be excluded by setting criteria for accepted intervals of kilometres driven per year. Such criteria should be specific to different groups of vehicle.

In Denmark the following criteria are used for non-acceptance of odometer readings:

- Negative distance travelled between two tests
- Private car: More than 100 000 km/year
- Taxi: More than 200 000 km/year
- Bus: More than 200 000 km/year
- Van, petrol: More than 100 000 km/year
- Van, diesel: More than 150 000 km/year
- Lorries, 3.5 – 6 t: More than 200 000 km/year
- Lorries, > 6 t: More than 250 000 km/year
- Road tractors: More than 500 000 km/year

**Five-digit odometers:** When a five-digit odometer crosses 99999 the mileage between two tests will be shown as negative. Five-digit odometers are mostly found in older vehicles, and it is possible to identify most of this kind of errors in the dataset. Hence it is possible to make an adjustment and calculate the correct number of kilometres driven.

**Cheating with odometers:** Odometers can be adjusted. Sometimes, when vehicles are sold second hand, the odometer is tampered with to reduce the number of kilometres on the clock. This is a systematic error leading to underestimation of the yearly distance travelled. There is no easy way to overcome these kinds of errors or to estimate their significance. However, a requirement can be imposed that a minimum number of kilometres must be driven during a period before a reading can be accepted.

**Changes in use of vehicles between two inspections:** A vehicle can shift from one stratum to another in the period between two tests – or even before its first test. For instance, a taxi can be changed into a private car. If it is impossible to detect this kind of change in the dataset and to remove the vehicles from the calculations, this can result in errors in the estimated distance travelled by some groups of vehicle.

**Data quality:** The central vehicle register will normally be an official register used for data on owners, administration of number plates, taxation, etc. Therefore, the register is not necessarily very suitable for the purpose of calculating vehicle-kilometres.

## CHAPTER 3 b

### HOUSEHOLD SURVEYS

For the purposes of this Handbook, “household surveys” means surveys of households, persons or vehicle-owners, the sole purpose or one of the purposes of which is to obtain information about vehicle use, measured in vehicle-kilometres.

#### 1. Sampling methods

The population to be sampled is the aggregate from which the sample is drawn. The population might be:

- the residents in the country or, as the purpose is to collect data about vehicle use, the adult population, as children are not usually vehicle-owners;
- the fleet of vehicles or selected types of vehicle.

The population is subdivided into sampling units in such a way that every component in the population belongs to one and only one unit. The units may be persons, families, households, enterprises, etc. The list of sampling units is called the sampling frame. The construction of the sampling frame is one of the major problems with this type of survey.

Possible sampling frames and their overlaps are shown in Figure 1.

*Figure 1. Sampling frames*

Resident natural persons	Resident legal persons (companies)
Resident vehicle-owners	Resident company vehicle-owners

Some countries may not have access to an up-to-date population register, either because access is restricted or because the population censuses are not carried out every year. Such countries may base the survey on lists of households, of addresses or of telephone numbers instead.

Alternatively the territory may be split up into small districts, e.g. postal districts or streets, and either all persons or households in the sampling units may be surveyed (cluster sampling) or a sub-sample of the persons or households in the sampling unit (two-stage sampling).

The survey costs depend on the set-up costs and the direct unit costs. In order to reduce survey costs, multi-purpose surveys might be considered. In such surveys only part of the questionnaire will deal with the target data, in this case vehicle use, and part of the sampling

units will be of no interest for statistics about vehicle traffic, e.g. persons or households without vehicles. Those respondents can be filtered out easily via a filter question. But the lower the frequency of vehicle ownership by residents or households the higher will be the sampling costs to obtain the desired degree of precision.

An existing general panel survey might be used for establishing the sub-sample. In this way the set-up costs can be reduced as the sampling frame is already established and the background data on the panel will be available for the estimation. A filter question about car ownership is added to the panel survey and subsequently a sample survey is conducted among the vehicle-owners in the panel to collect the information about vehicle use (cf. Box 1).

***Fact Box No. 1***

In France since 1983 the SOFRES panel has been taken as the basis for an annual sample survey among households with one or more cars. The questionnaire is sent to 10 000 households at the end of each year, and results are available five months later. Information is requested on vehicles (including light commercial vehicles since 1994), car purchases, the number of kilometres driven by each vehicle during the whole year and unit consumption.

In France's continuous SECODIP panel every two weeks 3,300 car owners return a questionnaire reporting the odometer readings and volume of fuel for each purchase made during the period.

In both surveys detailed information on the type of car is available plus some information on the driver.

These are examples of multi-purpose surveys for energy and environment agencies and transport authorities, but also for oil companies, car manufacturers or insurance companies.

*Source: TRANS/WP.6/AC.5/2005/7. Estimation of the annual balance of road traffic and fuel consumption on French national territory*

## **2. Survey methods**

The respondents can be contacted in several ways:

- Postal survey;
- Telephone survey;
- Face-to-face interview.

### **Postal survey**

In a postal survey the data collection costs will be about the same for all sampling units. But the number of useful replies will depend, among other things, on the frequency of vehicle ownership in the population. Therefore, if possible, it is preferable to sample vehicle-owners directly, using the national or regional vehicle registers as the sampling frame or using other lists of vehicle-owners, e.g. customer registers of petrol stations, car dealers or garages, in order to reduce the number of units of no interest to the survey.

### ***Fact Box No. 2***

In 1992, a Danish ad hoc survey on the use of light motor vehicles 3 000 passenger cars (0.2% of the vehicle fleet) and 2 500 vans and lorries of less than 6 tonnes gross weight (1% of the vehicle fleet) from the Central Motor Vehicle Register were sampled. Questionnaires were sent by post to the owners/users of the vehicles. Information about the mileage of the vehicles over the past 12 months in Denmark and abroad was collected. The response rate was about 75%.

*Source: Statistiske Efterretninger, serien Samfærdsel og turisme 1993:24 (in Danish only). Statistics Denmark, Copenhagen 1993*

Postal surveys are a very useful method for simple short questionnaires where respondents can fill in the requested information easily without having to read long explanatory notes about what to do and how to interpret the questions. It is best if the questions are self-explanatory. Reminders should be sent in order to increase the response rate and prevent biases in the statistics because of lower response rates from some segments of the sample.

### ***Fact Box No. 3***

At irregular intervals the German Federal Highway Research Institute (BAST) conducts its vehicle mileage survey. The last such survey, carried out in 2002, covered approximately 127 000 vehicle-owners from the master file held by the Federal Motor Transport Authority (Kraftfahrt-Bundesamt) using a method based on random sample theory. The overall response rate was approximately 70%. This survey gathered information on vehicle mileage on all German roads and by vehicles registered in Germany.

*Source: Volume of road traffic based on data collection of the Federal Highway Research Institute (BAST) - an informal document presented at the UNECE workshop in Copenhagen on 1 and 2 December 2005.*

If the questionnaire used is very detailed and takes a long time to fill in there is a risk that the respondents will skip some of the questions, omit parts of the questionnaire or not respond at all. It is therefore a good idea to make sure to motivate the respondents. This could take the form of a fee for participation or of telephone calls, e.g. to motivate respondents to keep a trip diary for a short period.

An older Estonian survey based on diaries obtained useful responses on 60% of the vehicles sampled even though the owners were asked to report for a relatively long period.

### ***Fact Box No. 4***

An Estonian diary survey from 1967 examined the use of cars and motorcycles belonging to residents of Tallinn over a three-month period. Odometer readings were reported for the first day of each month and for each crossing of the city border (date + km + direction). Further information on daily use was gathered (not used; used only inside Tallinn; used both inside and outside Tallinn; used only outside Tallinn).

*Source: Ilmar Pihlak, Tallinn University of Technology.*

## Telephone surveys

Telephone surveys can be kept short for units that possess no motor vehicle at all. In this case the interview can be restricted to information used for the estimation process, e.g. size of household, age of household members, etc. plus, in multi-purpose surveys, a filter question about car ownership.

### *Fact Box No. 5*

The Canadian Vehicle Survey is a part-postal, part-telephone survey. It has been conducted quarterly since 1999.

The survey provides annual and quarterly estimates of road use by vehicles registered in Canada. Motorcycles, off-road vehicles (e.g. snowmobiles, dune buggies and amphibious vehicles), buses and special equipment (e.g. cranes, street cleaners, snowploughs and backhoes) are outside the scope of the survey. The estimates are provided by type of vehicle, by vehicle characteristics (e.g. fuel type, body type and age), by driver characteristics (e.g. age and gender) and by journey characteristics (e.g. purpose of trip, season, day of the week, time of day, road type and speed limit).

In the ten provinces registered, owners of a sample of 20,000 vehicles were telephoned, interviewed to obtain background data and asked to complete a seven-day trip log. If respondents agreed a logbook was mailed to them. If respondents could not be contacted by telephone a trip log plus a short additional questionnaire was mailed out. There are three types of log, depending on the type of vehicle: a light log (for passenger vehicles), a bus log and a truck log for vehicles weighing more than 4 500 kg. To increase the number of responses, respondents were contacted a second time either by telephone or by mail. On the first or second day of the log, attempts were made to telephone each vehicle-owner to answer any questions the respondents might have. Later an attempt was made to contact by telephone or by mail everyone who did not return a log.

In the three northern territories registered owners of 11 000 selected vehicles were sent postcards asking them to provide two odometer readings, one at the beginning of the quarter and another at the beginning of the next quarter, plus information about the vehicle status (owned, sold or scrapped).

*Source: Canadian Vehicle Survey 2006, Statistics Canada, Ottawa 2006.*

Over the telephone it is possible to explain the purpose of the survey to the respondents and to motivate them to participate. Further guidance can be given about how to interpret the questions.

Telephone interviews should not be too long or else respondents might refuse to complete the interview or might seek to find answers that will quickly bring the interview to an end. If the costs of establishing the sampling frame are relatively low, it could be preferable to limit the survey to one topic instead of conducting multi-purpose telephone interviews.

### **Fact Box No. 6**

The Swiss Microcensus on Travel Behaviour is conducted every five years. This survey is primarily intended to measure the distances travelled by the permanent resident population aged 6 and over. Roughly 28,000 households (about 30,000 individuals) were contacted by telephone throughout the year 2000. Telephone interviews began by asking respondents to provide socio-demographic data and information about their cars and motorcycles (age of vehicle, total distance travelled since the vehicle was acquired and total distance travelled in 2000 in Switzerland and abroad). One or two members of the household (aged 6 and over) were then chosen for the rest of the interview. These respondents were asked to describe very precisely where they went on a specific "travel day" chosen at random for each household but generally the day before the interview. Respondents were asked to indicate each segment of their trips (e.g. a person going to work cycles to the railway station for the first segment of the trip, takes the train for the second segment and then walks the rest of the way for the third segment), points of departure and arrival, departure and arrival times, means of transport used (e.g. walked, cycled, drove the car, rode as a car passenger, etc.) and the distance travelled for each segment. Based on random samples of households, respondents and travel days, with the help of the Swiss Annual Population Statistics it is possible to estimate the volume of passenger car traffic for the entire Swiss population for 2000.

*Source: TRANS/WP.6/AC.5/2005/13 Swiss calculation methods.*

### **Face-to-face interviews**

Face-to-face interviews may be used to collect data. This type of survey is normally used for longer and more complicated interviews, where the benefits of direct personal contact can outweigh the relatively high costs of travel. In this case, cluster sampling could reduce interviewers' travel costs.

### **3. Coverage of statistics**

#### **All motor vehicles or selected types**

The statistics can cover all motor vehicles or selected types, e.g. passenger cars or commercial goods vehicles. The Canadian Vehicle Survey (cf. Box 5) covers all types of motor vehicle except motorcycles, while the Danish ad hoc surveys in 1992 and 1993 covered only passenger cars and light goods vehicles. The EU sample survey of goods transport by road relates only to goods vehicles with a permissible gross weight of over 6 tonnes (cf. Box 7).

### **Fact Box No. 7**

EU countries (plus Norway and Liechtenstein) carry out sample surveys of goods transport by road, as required by Council Regulation 98/1172/EC. This survey gathers information about the mileage of a sample of vehicles with a gross weight of over 6 tonnes used for goods transport in the survey period. Some countries include vehicles with a gross weight of over 3.5 tonnes. Journeys can be split up into national and international trips.

*Source: Council Regulation (EC) No 1172/98 of 25 May 1998 on statistical returns in respect of the carriage of goods by road. Official Journal of the European Communities L 163, p. 1.*

## Passenger mobility surveys by mode of transport

Daily passenger mobility surveys are carried out in many European countries. These focus on the movements of resident persons. Typically information is collected about each journey travelled during a set period, e.g. the day before, by a selected member of the household. Journeys can be broken down into trips between activities (work, school, shopping, leisure, etc.) and the individual trips can be split into stages depending on the mode of transport used (cf. Box 8).

### *Fact Box No. 8*

An up-to-date inventory of national passenger mobility surveys reports that at least one third of EU, applicant and EFTA countries are running regular surveys; five countries have conducted a survey recently but not indicated the frequency. Another three countries reported surveys specifically on travel by car, bus, coach, etc. Most were postal surveys or combined postal and telephone surveys.

*Sources: D1.1\_D2.1 Up-to-date inventory of national surveys on passenger and car passenger mobility, AGILIS (August 2006) and D1.3\_D2.2 Up-to-date inventory of national surveys on passenger and car passenger mobility, AGILIS (August 2006).*

Estimates of road vehicle movements can be deduced from the estimates of passenger movements. For car occupants, however, the mode of transport “car” would have to be split up into “car driver” and “car passenger”. A few countries apply such a breakdown of car occupants. Passengers are also carried by other modes of road transport (motorcycles, mopeds and bicycles), but in these cases it can be assumed that the number of occupants including the driver is, on average, close to one.

Often passenger mobility surveys cover only non-business transport in detail. Business transport, e.g. by agents, is sometimes reported as aggregates. The same applies to movements of taxi drivers, lorry drivers and bus conductors which are not considered passenger transport.

#### **4. Coverage errors**

Coverage errors sometimes arise when the survey population does not fully correspond to the target population. This could occur if:

- The classification of vehicles differs from the scope of the survey. The EU road goods vehicle survey does not include special goods vehicles (e.g. vehicles whose authorised weight or dimensions exceed the limits normally permitted in the Member States concerned), lorries not used for transport (e.g. for snow-clearing) and goods vehicles used off road in closed areas (e.g. building sites or forests). The vehicle-kilometres will therefore not correspond to the traffic of all road vehicles classified as goods vehicles.
- The sampling frame is not up-to-date. If the list of vehicles used is based on the vehicles registered months before the reference period, some of the target vehicles, especially newly registered vehicles, cannot be included in the sample. As the vehicle-kilometre figures tend to be higher for younger vehicles than for older vehicles this could lead to underestimation.

- The sampling frame may include vehicles that have been scrapped or exported. This could cause overestimation.
- The sample is drawn from a register of households or resident persons. In this case the survey can cover only vehicles belonging to those units. Consequently, information about vehicles owned by enterprises will not usually be reported - unless the vehicles are permanently used by one and only one employee and therefore can be regarded as belonging to that person. If the sampling frame is a vehicle register instead, commercial vehicles can and normally will be included.
- The sample is drawn from telephone directories. In this case part of the target population cannot be sampled, namely units without a telephone and persons not in the telephone directory either because the directory is not fully up-to-date or because their number is confidential. This could lead to biases in the estimates. Increased use of mobile telephones instead of fixed net telephones could have an impact on access to up-to-date telephone directories, as mobile telephone holders are not always in the directories.
- The purpose of the survey is to gain knowledge about the volume of road traffic on national territory but the sampling frames of household surveys cover only vehicles registered in the country concerned.
- The traffic figures for the vehicles surveyed include operations abroad.

To some extent the estimation procedure may be able to correct for biases and for over- and under-coverage.

### **Vehicles registered abroad**

If the target population is vehicles on the roads in the country and the information requested is the vehicle-kilometres clocked up on national territory, then neither surveys based on resident households nor on vehicles in the national register will fully meet the target, partly because the vehicles surveyed will be used for both national and foreign operations and partly because traffic generated by foreign vehicles will be excluded.

For lack of information about foreign road traffic, it has often been assumed that the volume corresponds to the volume of operations by national vehicles abroad. This assumption does not always reflect the realities. Cross-border traffic may be influenced by differences in level of income, prices, production and tourism between countries. Solid information is therefore needed about traffic by foreign vehicles on national territory.

### **Traffic abroad with national vehicles**

Passenger mobility surveys collect trip data. If the origin and destination of the trip are reported it will be possible to obtain data on cross-border trips. The distance travelled abroad on a trip can be calculated from the border-crossing point indicated in the survey or estimated from route planners for the shortest distance between the two places. For multi-destination journeys abroad calculation of the volume of traffic is more problematic. Either information will have to be requested on each single trip on the journey, which will place an enormous burden on the respondent, or the respondent can be asked to report the total journey length or the distance driven abroad, which could then be more or less accurate.



### **Fact Box No. 9**

DATELINE, a European long-distance mobility sample survey carried out in the EU-15 Member States in 2001/2002 collected data from households on each journey of more than 100 km travelled during the past calendar month. Supplementary data about the household and the vehicle fleet were collected too. The journeys were described trip by trip, giving details of the origin/destination, time of departure and arrival, means of transport (type of road vehicle, owned or hired), major stops en route, etc. The data collected would allow calculation of the distances travelled in the countries visited.

*Source: Dateline Consortium (2002) Deliverable 5: Final report on data collection, Project Report, Brussels: European Commission.*

Long-distance mobility surveys like DATELINE will not include journeys shorter than the threshold, e.g. 100 km. Daily mobility surveys focusing on the trips performed on a selected day, typically the day before the interview, will not include longer holiday journeys.

But mobility surveys could include background questions about the overall use made of the vehicles belonging to the household in the past year. These might seek information about the technical data on the vehicles (age, type, size and fuel type), about the mileage travelled nationally and abroad, and about fuel consumption.

#### **5. Other types of errors**

The following types of error can also influence the quality of statistics:

- Sampling errors;
- Recall errors;
- Measurement errors;
- Underreporting.

#### **Sampling errors**

Sampling errors are caused by the fact that the statistics are based on a sample of units instead of all units in the population. The size of the sampling error depends on the sample size, stratification and estimation procedures.

In general the target is to obtain information about vehicle mileage in a calendar year. The units surveyed could be asked to report:

- the mileage clocked up in a calendar year or a 12-month period close to the calendar year;
- the mileage clocked up over a shorter period;
- the odometer reading at the start and at the end of a chosen period, e.g. a fortnight.

The shorter the reference period, the smaller the real sample size. If 10 out of 100 vehicles are sampled and the reference period is one week the sampling rate is one out of 5 200 vehicle-weeks, i.e. 0.2%, but if the reference period were the full year instead the sampling rate would be 10%. But the gains made by extending the reference period could be wiped out because of the recall effect.

## Recall errors

Very few people keep records of the daily use made of their vehicle. Trip data for a short period may be obtained (cf. the Canadian survey described in Box 4). But the more trips carried out the bigger the risk of underreporting.

Alternatively the desired information may be reported as an estimate of the volume of traffic over a longer period, e.g. a calendar year. The respondent may calculate the vehicle-kilometres from:

- normal weekly use of the vehicle;
- average annual use, based on the age of the vehicle and the odometer reading;
- visits to a garage for regular services, oil changes, engine check-ups, etc. for every 15 000, 20 000 or 30 000 km driven.

In all these cases the estimate calculated could diverge from the actual use made of the vehicle and is very likely to be affected by the respondent's assumptions concerning normal use of the vehicle.

## New, sold or scrapped vehicles

One special variant of "recall error" is the case where the vehicle has been in the possession of the owner for only part of the reference period and the owner cannot normally supply information covering the full period. This situation is especially relevant if the reference period is long. If a sampled vehicle is bought brand new or second hand during the reference period the owner can instead be asked to report either the expected annual use of the car or the use made of the vehicle in the part of the reference period when it was in his possession.

### *Fact Box No. 10*

In the Danish ad hoc surveys in 1992 and 1993, owners of vehicles acquired in the reference period were asked to report the mileage driven only in the period under their ownership. The annual mileage for the vehicle was then estimated on the basis of the information held in the Central Vehicle Register about the date of acquisition of the vehicle.

*Source: Statistiske Efterretninger, serien Samfærdsel og turisme 1993:24 (in Danish only). Statistics Denmark, Copenhagen, 1993.*

## Measurement errors

To avoid errors stemming from estimates of the mileage travelled by the vehicle in a given period the owner could instead be asked to report the actual odometer reading on the morning of the first day of the reporting period and again in the evening of the last day of the reporting period either in a single questionnaire or in two consecutive questionnaires.

### ***Fact Box No. 11***

In the German BAST survey, vehicle-owners were asked, during six different periods over the year, to report the readings of their odometers between the beginning and the end of the period.

*Source: Volume of road traffic based on data collection of the Federal Highway Research Institute (BAST) - an informal document presented at the UNECE workshop in Copenhagen on 1 and 2 December 2005.*

But here too measurement errors can occur, e.g. because of misreading of the odometer. The respondent might mistakenly:

- round the vehicle-kilometres to the nearest thousand, 5 thousand or 10 thousand;
- include decimals if the odometer shows the kilometres plus decimals;
- report the wrong vehicle if the household or enterprise surveyed owns more than one vehicle;
- change procedure between the first and second reading.

Measurement errors can also occur in other variables.

### **Non-response and underreporting**

Non-response and underreporting could occur if the burden on the respondent is felt to be too heavy, whether in the form of a lengthy interview or of a questionnaire requesting many data.

To avoid biases stemming from non-response, measures can be taken to reduce the level of non-response, e.g. by accompanying the questionnaires with information about the use to be made of the statistics and by using reminders – whether by post or by telephone.

Underreporting occurs if a respondent declares only some of the journeys in the vehicle. Underreporting is not easily detected from a single respondent but will become clear in the final statistics if comparable data are available from other sources.

### ***Fact Box No. 12***

In the Danish road freight survey carried out as part of the EU survey of transport of goods by road (cf. Box 7) a significant gap between the vehicle-kilometres estimated from the sample survey data and the vehicle-kilometres calculated from the odometer readings at the mandatory roadworthiness tests was observed. The reason is presumably the detailed journey data demanded in the transport survey. Presumably, some enterprises omit part of the journeys made or falsely report that the sampled vehicle was not used for national operations in the reporting period.

Similar observations have been made in other countries.

*Source: Declarations of content: Transport of goods by road by Danish vehicles in national traffic. Statistics Denmark.*

## 6. Data collected

The types of data that might be collected in surveys of owners or users of vehicles fall into four general categories:

- Vehicle characteristics;
- Driver characteristics;
- Journey characteristics;
- Road characteristics.

Detailed technical data about the vehicles surveyed can easily be obtained if the sampling frame is the vehicle register of the country. If the sampling population instead consists of households or of individuals, details of the characteristics of the vehicles belonging to (owned or leased by) the household might be obtained either indirectly from the vehicle register using the plate number reported by the household or directly via the sample questionnaire. In the latter case some data might be expected to be missing, as the person surveyed might not know all the technical data on the vehicle immediately.

Driver characteristics and journey characteristics can be obtained from diary surveys. If access to population registers is feasible then it is easier to obtain driver data.

Diary surveys can also be used to collect traffic data by type of road. Differentiation of the distance travelled by class of road, speed limit or level of urbanisation may, however, pose certain difficulties for respondents. In general many non-responses can therefore be expected for questions about the type of road. If points of departure and destination are reported in the diary, route planners might be used to calculate the likely route travelled, and the distances travelled on different types of road, e.g. motorways, main roads or minor roads, can be worked out from this.

Accordingly, most of the data of interest for compilation of road traffic statistics can be collected from household surveys, i.e. surveys that address the owner or user of vehicles. Such surveys are, however, typically sample surveys and, for that reason, their statistical reliability depends on the sample size and the level of detail requested. Another aspect of household surveys is that the sampling frame inherently includes only persons residing and vehicles registered in the reporting country. Statistics about the total road traffic in a country – including traffic by foreign vehicles – must draw on auxiliary data sources.

## C H A P T E R 3 c)

### TRAFFIC COUNTS

#### General description of method

Nation-wide traffic censuses are one of the basic inputs for calculating vehicle-kilometres, and should be conducted regularly, following the same method, on the same set dates and with procedures as harmonised as possible, the objective being to acquire information on road traffic intensity.

In the majority of States such regular censuses are being conducted in compliance with the UNECE recommendation every five years. The range, organisation and evaluation of the censuses carried out in individual years should follow the same pattern in order to ensure that the results are comparable with those from the preceding census in terms of both the methodology of the census and the evaluation of the results.

This chapter presents a proposed method for road traffic censuses and for subsequent calculation of vehicle-kilometres.

#### **1. Range of the census**

Range of the census means *where* on the road network and *when* in time counting should take place. The relevant roads (i.e. where the count is to be conducted) are expected to be further divided into “counting sections”.

Section is defined as a stretch of road, usually between two consecutive intersections or based on the administrative division of the network, where a counting point (manual or automatic) is located.

Road traffic intensity means in this chapter Annual Average Daily Traffic (AADT), that is the average over a year of the number of vehicles passing a point in a given counting section each day (24 hours).

#### ***Types of road***

Each country describes its road network in a different way. It is very difficult to reach agreement on the terminology and it seems that only “motorway” is clearly understood. It would be very useful if some general description or definition could be developed at international level – if this is possible at all. Nevertheless, for the purpose of this chapter a national network is considered to consist of motorways, E-roads, main roads and other (regional) roads. Main roads are further subdivided into two more categories - class I and class II roads. Local roads, i.e. roads in an urban area (not roads of the above mentioned types – i.e. motorways, etc. - passing through an urban area), are not included in the method presented. This does not, of course, mean that no counts should be conducted on local roads in urban areas, but just that they require a different approach.

In order to obtain full information on road traffic intensity, it is recommended to perform the traffic count on:

- a) all homogeneous motorway sections;
- b) E-roads;
- c) main roads;
- d) selected sections of other (regional) roads.

***Fact Box No. 1***

Roads in the Czech Republic are classified as motorways, class I, class II and class III roads. A five-yearly census is conducted on all sections of motorways, class I and class II roads and on selected sections of class III roads. Approximately 10 to 15% of all counting sections on class III roads are covered. The same classification is used in the Slovak Republic.

Great care must be taken with selection of counting sections on regional roads (or other types of road if the count does not cover their entire length), so that the information on the road traffic intensity will cover the maximum proportion of this part of the road network. This means that the combined total of all the sections on regional roads on which counts take place should add up to at least 10 to 20% of the total length of this part of the road network in the country concerned.

***Fact Box No. 2***

In Germany, the Federal Highway Research Institute (BAST) as a research institute in the responsibilities of the Federal Ministry for Transport, Building and Housing has established a system of automatic counting stations. About 600 are placed on motorways and about 700 on other federal roads.

In addition the manual road traffic count (Straßenverkehrszählung – SVZ) on motorways and other federal roads consists of about 10,000 counting stations and is conducted every 5 years. The last one took place in 2005.

In principle, the German motorway toll system invented and designed for heavy trucks could provide reliable information of the total volume of traffic. However, the political accreditation of the system was tied to the adoption of strong data use restrictions on the licence, the Toll collect GmbH. So, the available data in Germany further on result only from road count stations for statistical purposes.

The results of manual counts are usually made more accurate and completed by the results from automatic counters which monitor the traffic on the most loaded sections all year round offering the added possibility of distinguishing between different vehicle types. No manual count is necessary at points where the traffic intensity is monitored by automatic counting equipment.

***Fact Box No. 3***

In Great Britain, all links on category A, B and C roads – otherwise known as “major roads” - are (manually) counted, at least once every eight years, depending on traffic volume and variability. The busiest roads, with the most variable flows, are counted every year. Counts are conducted on a sample of other roads (“minor roads”), to take coverage up to around 10 to 15% of the total road network.

The nature of the road network and traffic in London makes it unsuitable to use the same automatic counting equipment as in the rest of GB. Consequently, the London automatic counters only draw a distinction between short and long vehicles. Breakdowns by vehicle type are provided by supplementary manual counts. In the rest of GB, the automatic counting equipment recognises 22 different types of vehicle; these are then combined to provide estimates for eleven vehicle types.

### *Time range*

Obviously it would be desirable to carry out censuses over the longest period possible. This, of course, applies to manual counting only because automatic counts are conducted continuously and provide data all year round. On the one hand, the bigger the statistical sample in terms of time covered, the more reliable the data received from manual counts will be. On the other, however, economic and personnel requirements also have to be taken into account.

When performing manual counts it is therefore recommendable to choose counting days that would make it possible to obtain information on the volume of traffic on a given section in the spring, summer and autumn (lower traffic volume is expected in the winter). During each period a typical average working day should be selected. Usually it is best to choose Tuesday or Thursday and to count in morning or afternoon peak hours. It is also useful to include peak hours on Friday and Sunday (or a holiday) afternoon. The count should last 3 to 5 hours in any one day. Peak hours will probably differ from one country to another and could be determined from the results from automatic counters or from other analyses. On working days they are usually between 7.00 and 11.00 and between 13.00 and 17.00 hours while recreational traffic peaks (on Fridays, Sundays and holidays) are approximately between 14.00 and 18.00 hours. In each period (i.e. spring, summer and autumn) counts should be carried out on at least one working day and on one Friday or Sunday, i.e. a total of  $3 \times 2 = 6$  counting days, and for at least 3 hours on each day. This gives a traffic sample of 18 hours, i.e. 0.2% of a whole year's traffic. In this case, however, any statistical error could be quite significant. It is therefore better to extend this counting period if possible. The optimum seems to be to count on 10 days a year, 4 days in spring, 3 days in summer and 3 days in autumn - for 4 hours each day. This gives a sample of  $10 \times 4 = 40$  hours, i.e. 0.45% of a whole year's traffic which gives much better results than the earlier example. In order to assess the volume of night traffic, it is recommended to carry out counts on a small sample of selected counting sections (approximately 1% of the total length of all the counting sections) for 16 to 24 hours.

Because manual counts are quite costly, counting hours could be reduced, e.g. by counting for 10 days on sections with high traffic intensity (5 000 vehicles per day) and for just 6 days on others. This depends on the situation and capacity in each country.

It is therefore generally recommended to carry out the traffic census in the given year on each selected counting section on at least 10 counting days and for 4 hours on each of those days. The count should be conducted from April to October on 7 working days plus 3 holidays for a 4 hour period on each day. The annual average intensities per 24 hours will be calculated by applying conversion coefficients derived from the results from automatic counters.

The four-hour sampling should be applied in the same months, on the same days of the week and at the same times as in the preceding census, thereby ensuring maximum comparability of results with the preceding count.

For instance, the schedule for the count could look like this:

Day	Month	Day of the week	Length of the counts	
			4 hours	8 hours at night
5	April	Tuesday	7-11	
5	May	Thursday	13-17	21-5
3	June	Friday	14-18	
12	June	Sunday	16-20	
12	July	Tuesday	7-11	21-5
17	July	Sunday	16-20	
4	August	Thursday	13-17	
7	August	Sunday	16-20	
9	September	Friday	14-18	
4	October	Tuesday	7-11	

**Fact Box No. 4**

In the United Kingdom the vast majority of counts are conducted between March and October, spread evenly across the whole period (apart from public or school holidays) to secure a representative sample. For each road link covered, counts are conducted on a single day, over a 12-hour period between 7 a.m. and 7 p.m.

**Fact Box No. 5**

Volume of road traffic in the Republic of Croatia, estimated for the total road network, is based on the data collected by automatic traffic counters installed on the network of national roads and motorways. Traffic counters are stationary and portable, i.e. for permanent and temporary traffic counting, respectively.

Stationary counters for permanent automatic traffic counting have been installed on sites across the national road network. Over the years, the number of counters has increased, while many outdated counters were replaced by new devices in the year 2006. This enabled equal classification of vehicles by all permanent counters installed and also resulted in improved analysis of traffic composition.

Permanent counting is a continuous, daily counting at a selected road section site, which is carried all year round and covers traffic in both directions, in 60-minute sampling intervals.

Temporary counting is implemented on those sections which are not covered by permanent counters. For this purpose portable devices are used in scheduled periods (dates) to obtain representative sample as a basis for estimates. Each year one third of total temporary counting sites are included in counting. Based on data collected, traffic volume estimates are made for road sections in the vicinity of stationary counter sites.

Special systems of traffic counting are employed on tolled facilities (managed by motorway authorities Hrvatske autoceste, Autoceste Rijeka-Zagreb, Autocesta Zagreb – Macelj and BINA Istra) and local ferry boat liner authorities (Jadrolinija and Rapska plovidba). Data collected are processed and included in analysis where they are compared with data obtained from automatic traffic counters of Hrvatske ceste.

The national road network has 148 stationary automatic counters for continuous traffic counting, including 64 new devices. Temporary traffic counting is carried out by 94 portable counters. Motorway traffic is covered by 92 count sites, while traffic data are taken also on 25 ferry boat lines.



## 2. Organisation

### *Counting sections*

Calculating vehicle-kilometres from traffic counts is basically very simple: the AADT from every single road section is multiplied by the length of the section concerned. The grand total is the total number of vehicle-kilometres on the road network:

$$\text{Total Vehicle Kilometres} = 365 \times \sum_{s=1}^n \text{AADT}_s \times L_s,$$

Where n is the total number of road sections, s is the actual section, L is the length of the section and 365 is the number of days in a year.

Vehicle-kilometres based on traffic counts will include both national and foreign traffic since it will not normally be possible for counts to separate vehicles by nationality.

Traffic counts can be conducted manually or by different kinds of automatic counter. In many countries a combination is used. The possibility of breaking down data by vehicle types depends on the counting method (manual or automatic) and, when automatic counters are used, on the equipment. Manual counts will always be conducted over a short period, and the AADT is then calculated based on knowledge of traffic distribution over time. Automatic counts can be conducted continuously, providing figures for every hour of the year. If movable equipment is used, counts can be made for shorter periods.

It is never possible to conduct counts on every single road section in a country. Counting sites must therefore be chosen as a statistical sample, taking into account the road and traffic characteristics for each section.

As a rule, in the manual method counting points should be equipped with two counters, each monitoring traffic in a single direction. Certain less loaded sections may be equipped with only a single counter monitoring both directions, either separately or together.

Separate counts for traffic in each direction should be carried out on motorways, international links, sections where the preceding count recorded an intensity exceeding 3,500 vehicles per 24 hours, selected road sections to obtain background data to assess the capacity of a road and on all counting sections with a 16-hour counting period.

Sunday counts may be limited to sections with absolutely or relatively high Sunday traffic, for instance where the preceding count recorded Sunday traffic intensity of over 2,000 vehicles per 24 hours.

To determine the coefficients for converting 4-hour to 16-hour figures, it is recommended to carry out the 16-hour count between 5.00 and 21.00 hours on selected key counting sections equivalent to approximately 3% of the total number of sections. The counting periods should be identical to a 4-hour count.

On selected international road sections the count should also be carried out during the night (from 21.00 to 5.00 hours) in order to meet the requirements set by the UNECE method for counts on international (E) roads if these are not covered by automatic equipment.

## ***Vehicle types***

Individual road vehicle types have a different impact on carriageway wear and influence the requirements for the transverse layout and design of the carrying capacity of the carriageway. They show different trends. Therefore, the census should treat different vehicle types separately. In compliance with the UNECE recommendation, all vehicles in the following categories should be counted.

Category A: Motor vehicles with not more than 3 wheels (motorcycles with or without sidecars, including motor scooters and motor tricycles);

Category B: Passenger and light goods vehicles (vehicles, including station wagons, with not more than nine seats, including the driver's seat, and light vans with a permissible maximum weight of not more than 3.5 tonnes). Passenger and light goods vehicles are recorded as such, irrespective of whether they are with or without trailers, including caravans and recreational vehicles;

Category C: Goods road vehicles (lorries with a permissible maximum weight of more than 3.5 tonnes, lorries with one or more trailers, tractors with semi-trailers, tractors with one or more trailers and tractors without trailers or semi-trailers) and special vehicles (agricultural tractors, self-propelled rollers, bulldozers, mobile cranes, army tanks and other road motor vehicles not specified elsewhere);

Category D: Buses, coaches and trolleybuses.

### ***Fact Box No. 6***

In order to obtain more complete information about the traffic flow structure, the following vehicle breakdown, from which also the values as required by international agreements for international road counts may be calculated, is used in the Czech Republic

- |   |  |
|---|--|
| B | 1. N1 – light goods vehicles (permissible maximum weight up to 3.5 t)  |
| C | 2. N2 – medium-sized goods vehicle (permissible maximum weight 3.5 - 10 t)   |
| C | 3. PN2 – trailers of medium-sized goods vehicles   |
| C | 4. N3 – heavy goods vehicles (permissible maximum weight of more than 10 t) including road tractors of semi-trailers |
| C | 5. PN3 – trailers of heavy goods vehicles  |
| C | 6. NS – semi-trailers  |
| D | 7. A - buses   |
| D | 8. PA – trailers of buses  |
| C | 9. TR – agriculture tractors   |
| C | 10. PTR – trailers of agriculture tractors   |
| B | 11. O – passenger cars and vans, minibuses, motor cycles with a side-car   |
| A | 12. M – motor cycles   |
|   | 13. C – cyclists   |

The first column indicates the corresponding UNECE categories.

*Note: Category 11 in this breakdown includes motorcycles with sidecars, so it does not correspond exactly to category B. The number of sidecars is negligible, however. The same breakdown is used in the Slovak Republic.*

### 3. Calculation methods

#### *Volume of road traffic (vehicle-kilometres)*

The volume of road traffic, expressed in vehicle-kilometres, on main roads can be calculated either for a whole country or for established regions, if necessary for administrative reasons. The method described below can be used, provided the average intensities determined on counting sections are applicable to the entire road network in the given country or region. However, as mentioned earlier, it is recommendable to carry out traffic counts on all or at least most motorways and main roads.

Other (regional) roads require a different approach because the count is usually performed on roughly 10 to 20% of the total length of such roads. Accordingly, the vehicle-kilometre calculation is based on the results of the same calculation in the previous census (usually up to 5 years ago) and on the traffic growth coefficient estimated by region and vehicle type (heavy, passenger, motorcycle) representing the increase in traffic in the period from the last census up to the year when the next census was performed. The resulting value for each region will then be calculated by multiplying the number of vehicle-kilometres from the preceding census by a growth coefficient, including the impact of any change in the length of road (see equation 6).

In most countries motorways are either equipped with automatic counters or counts are conducted on all of them. Consequently, the volume of road traffic in vehicle-kilometres on motorways is simply calculated as the sum of all vehicle-kilometres calculated for each counting section.

For other main roads (considering the further breakdown mentioned earlier into class I and class II roads), where the traffic count is expected to cover nearly the full length of the roads, vehicle-kilometres can be calculated in a similar way as for motorways. First the sum of all vehicle-kilometres calculated for each counting section is determined and then the result is multiplied by the quotient of the real length of the road and the overall length (sum) of the counting section.

The calculation can be described as follows:

$$D = D_1 + D_2 \quad (1)$$

$$D_1 = \bar{D}_1 \cdot \frac{d_1}{d_1} \quad (2)$$

$$D_2 = \bar{D}_2 \cdot \frac{d_2}{d_2} \quad (3)$$

$$\bar{D}_1 = \sum_1^{n_1} I_n \cdot d_n \quad (4)$$

$$\bar{D}_2 = \sum_1^{n_2} I_n \cdot d_n \quad (5)$$

where:

$D$	is the total average volume of traffic in vehicle-kilometres per 24 hours in the country or region
$D_1, D_2$	is the total average volume of traffic in vehicle-kilometres per 24 hours in the country or region on main (class I and class II) roads
$\bar{D}_1, \bar{D}_2$	is the total average volume of traffic in vehicle-kilometres per 24 hours in the country or region on the part of the main roads where the count takes place
$d_1, d_2$	is the length of main roads in the country or region
$\bar{d}_1, \bar{d}_2$	is the length of the part of main roads in the country or region included in the count
$I_n$	is the average road traffic intensity/24 hours on section n included in the count
$d_n$	is the length of counting section n

The calculation for other (regional) roads for a country (or a region) is as follows:

$$D_3^C = \frac{D_3^R \cdot k_3^{R-C} \cdot d_3^C}{d_3^R} \quad (6)$$

where:

$D_3^C$	is the number of vehicle-kilometres on other (regional) roads in the country or region in the year monitored
$D_3^R$	is the number of vehicle-kilometres on other (regional) roads in the country or region in the preceding census
$k_3^{R-C}$	is the coefficient of traffic growth used for other (regional) roads in a country or region in the period R – C, i.e. the year of the last census and the year of the current census; the coefficient is calculated from the results from automatic counters and using the results from the sections where manual counts were conducted in the last census as well as in the current census
$d_3^C$	is the length of other (regional) roads in the country or region in the year monitored
$d_3^R$	is the length of other (regional) roads in the country or region in the year of the last census

This is only an approximate calculation which assumes that the trend on all roads (meaning regional roads) in a country or a region is the same as on sections where the census was carried out, which, of course, is not necessarily true. However, the calculation described could be sufficiently precise within the reliability of vehicle-kilometre calculations in general, which, in fact, always represent an expert estimate only.

The above-mentioned information may be used for assessing the estimate mileage of road vehicles, with the number of vehicles being used as follows:

$$D^t = D_t + D_o + D_m \quad (7)$$

$$D_t = T \cdot p_t \quad (8)$$

$$D_o = O \cdot p_o \quad (9)$$

$$D_m = M \cdot p_m \quad (10)$$

where:

$T, O, M$	is the number of registered heavy vehicles (lorries, special vehicles and buses), passenger vehicles (cars and vans) and motorcycles
$D^t$	is total number of vehicle-kilometres per year
$D_t, D_o, D_m$	is the vehicle-kilometres performed by heavy vehicles, passenger cars, motorcycles, etc.
$p_t, p_o, p_m$	is the yearly mileage of heavy vehicles, passenger cars and motorcycles

### ***Vehicle mileage***

The mileage of vehicles is one of the basic variables in developing models to forecast road network load capacity. Another method of calculating, or rather estimating, vehicle mileage is presented below. The relationships between some variables related to road traffic volume are described before showing how those equations can be used to calculate one variable, knowing or choosing a value for the other.

For this method only the number of vehicles registered in a given country is used. It is also assumed that the number of kilometres driven abroad by the vehicles registered in a given country is approximately “equal” to the number of kilometres driven by foreign vehicles in that country.

For a closed area the following relationship could be applied:

$$D^t = I \cdot d = V \cdot p \quad (11)$$

where:

$D^t$	is the total number of vehicle-kilometres on the road network
$I$	is the average traffic intensity on the road network
$d$	is the length of the road network
$V$	is the number of motor vehicles
$p$	is the mileage of motor vehicles

With certain simplification, the relationship set out above may be applied to a road network in any country. Variables  $V$  and  $d$  are well-known, whereas the mileage and average intensity are unknown or difficult to identify. In analysing the nationwide census, certain variables which determine or could be determined with only a small error are used to estimate the mileage. Such variables include traffic flow structure, traffic intensity growth, vehicle fleet structure, and increase in the number of vehicles. The mileage differs substantially between basic vehicle types – heavy vehicles, passenger cars and motorcycles.

For calculation, or rather estimation, of the mileage the following two methods may be applied:

1. The first is based on the relationships:

$$D_t = T \cdot p_t, D_o = O \cdot p_o, D_m = M \cdot p_m \quad (12)$$

where:

$D_t, D_o, D_m$  is the total number of vehicle-kilometres of heavy vehicles, passenger cars and motorcycles  
 $T, O, M$  is the relevant numbers of vehicles  
 $p_t, p_o, p_m$  is the mileage of heavy vehicles, passenger cars and motorcycles  
as well as:

$$p_t : p_o = \frac{D_t}{T} : \frac{D_o}{O} \quad p_t : p_m = \frac{D_t}{T} : \frac{D_m}{M} \quad p_o : p_m = \frac{D_o}{O} : \frac{D_m}{M} \quad (13)$$

and, following a simple adjustment:

$$p_t : p_o = \frac{t_d}{t_v} : \frac{o_d}{o_v} \quad p_t : p_m = \frac{t_d}{t_v} : \frac{m_d}{m_v} \quad p_o : p_m = \frac{o_d}{o_v} : \frac{m_d}{m_v} \quad (14)$$

where:

$t_d, o_d, m_d$  is the share of heavy vehicles, passenger cars and motorcycles in the traffic flow and in the volume of traffic,  
 $t_v, o_v, m_v$  is the share of heavy vehicles, passenger cars and motorcycles in the vehicle fleet.

The values referred to above are well-known. Hence, if one of the mileage values is selected the other can be calculated.

2. The second method draws on the knowledge of the growth coefficients calculated on the basis of previous census results.

If:

$p_1$  is the mileage of vehicles in the year of the nationwide traffic census (year 1)  
 $p_2$  is the mileage of vehicles in the year of the next nationwide traffic census (year 2)  
and, by analogy:

$D_1, D_2$  is the corresponding number of vehicle-kilometres

$V_1, V_2$  is the corresponding numbers of vehicles

$$\pi = \frac{p_2}{p_1} \quad (15)$$

is the coefficient representing the change in the mileage from year 1 to year 2.

The relationship between the values of  $D_1$  and  $D_2$ , and  $V_1$  and  $V_2$  is as follows:

$$D_2 = D_1 \cdot K_d, \quad (16)$$

$$V_2 = V_1 \cdot K_v \quad (17)$$

where:

$K_d$  and  $K_v$  are traffic performance (traffic intensity) growth coefficients and growth coefficients for the number of vehicles from year 1 to year 2.

It is easy to derive that the growth coefficient is

$$\frac{p_2}{p_1} = \frac{K_d}{K_v} = \pi \quad \text{from which it follows that } p_2 = \pi \cdot p_1 \quad (18)$$

and consequently:

$$p_{2t} = \pi_t \cdot p_{1t}, \quad (19)$$

$$p_{2o} = \pi_o \cdot p_{1o}, \quad (20)$$

$$p_{2m} = \pi_m \cdot p_{1m}, \quad (21)$$

where:

$p_{2t}, p_{2o}, p_{2m}$  is the mileage of heavy vehicles, passenger cars and motorcycles in year 2  
 $\pi_t, \pi_o, \pi_m$  are the corresponding coefficients of the change in mileage  
 $p_{1t}, p_{1o}, p_{1m}$  is mileage of heavy vehicles, passenger cars and motorcycles in year 1

Knowing or having selected the mileage in year 1, the mileage in year 2 can be calculated.

Both methods of calculation could be used simultaneously for analysing the results of the nationwide census, using the results from the preceding census. The calculated estimates of the mileage should be tested against the volume of traffic, expressed in vehicle-kilometres, calculated by the methods described above.

In connection with new technology development better information on traffic volume will be available. For example, it is expected that Electronic Fee Collection (EFC) systems will become a source of very precise data and in a much more extensive way than current data collection is. It will also be possible to get information on vehicle nationality from the EFC source which would then enable the separation of nations and foreign traffic.

# CHAPTER 3 d)

## FUEL CONSUMPTION

### 1. General description of method

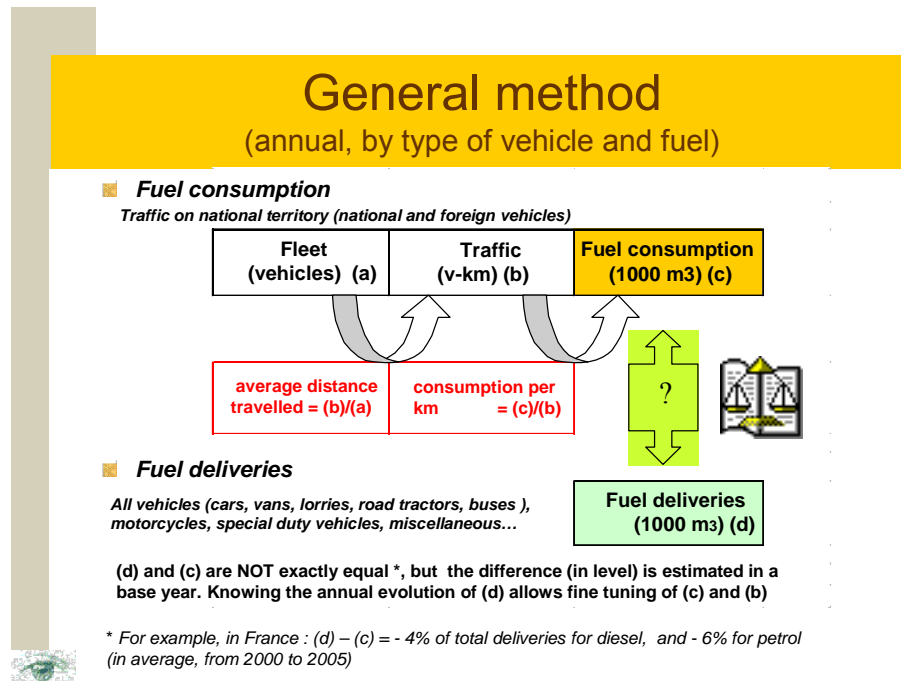
The main idea is to take into account multiple data sources to estimate, in an iterative process, both traffic and fuel consumption. The aim is to have *one coherent set of (annual) figures* providing:

- on the one hand, physical data on the volume of national traffic, consumption per kilometre and total fuel consumption;
- on the other, official data on fuel deliveries (proxy for fuel sales).

With multiple sources of information, the data could be over-identified in some domains, while coverage could be incomplete in others. *But this method applies where total fuel deliveries are considered the best known among all the variables.* Other related variables might have to be adjusted, by an iterative process, to make them consistent with deliveries.

The general coverage of the method is all traffic on national territory as well as all traffic by national vehicles. However, not only cross border traffic has to be taken into account, but cross border use of fuel is also important (see chapter 3d.3.3).

The general method is illustrated below:



Variables (c) - fuel consumption, derived from traffic - and (d) - fuel deliveries - are not exactly the same, but the difference (d) - (c) = SA (statistical adjustment) is explained by:



- miscellaneous uses: duty-free fuel sales (fishing boats) or special-purpose vehicles, construction site equipment, lawnmowers, etc.;
- “cross-border trade” (“grey” imports/exports): fuel bought abroad and, conversely, traffic abroad with fuel bought on national territory.

An initial estimate of total fuel consumption (c) is calculated, independently of data on fuel deliveries, by combining the:

- fleet data (a);
- estimated total distance traveled by the vehicle fleet (b) (derived from surveys, official data or other sources);
- and estimated consumption per kilometre (c/b).

Traffic and fuel consumption by foreign vehicles on national territory are also estimated. The result (c) is then compared with total fuel deliveries (d). If the gap between the two variables cannot be explained, the first assumptions are revisited, until convergence towards a coherent set of estimates is obtained (in France, this is agreed by a group of experts).

There are already different international inventories for fuel consumption, with various scope or methods. This analysis focuses on fuel consumption and traffic on national territory, for all types of road vehicle. ***The consistency with data used for international inventories should be considered.***

*Notes:*

1) The complete set of figures (a), (b) and (c), plus the two ratios (b/a) and (c/b) - from fleet to fuel consumption - can be estimated only for the *national fleet*.

2) *For foreign vehicles, (b), (c) and ratio (c/b) are estimated:* the fleet variable is not relevant for vehicles not permanently operating in the country.

3) Generally, the traffic index, when available, is measured on the national (or main) road network. The index includes *all types* of vehicle of *all nationalities*. This information may be used to break down the estimate of total traffic on national territory by *type of road* (the traffic on the road network not covered being obtained as the difference). The result is also taken into consideration for the overall assessment of the data set.

4) *European consolidation*

The following variables are additive:

- (a) fleet (number of vehicles);
- (b) traffic (vehicle-km);
- (c) fuel consumption (litres or m<sup>3</sup>);
- (d) fuel deliveries (litres or m<sup>3</sup>).

They may be aggregated at European level, if the definition is the same in all countries (“cross-border trade” is nearly zero at this level of consolidation), with a minimum common breakdown to allow accurate analysis of ratios (b/a) and (c/b).

*In practice, the structural effects (changes in fleet structure over time) are very important and make a significant contribution to the overall traffic and fuel consumption trends (see, for example, the impact of the increasing share of diesel cars or of road tractors).*

*In summary, the method generally does not replace direct sources of information to estimate traffic, but using **fuel deliveries (or sales)** as a control variable is a way of obtaining a more consistent set of traffic data and to minimise errors.*

In some cases (Germany, for example), an extra variable is explicitly added to the set: the **CO<sub>2</sub> emissions** related to the petrol and diesel consumption.

## **2. Classification of variables**

### **2.1 Fuel deliveries and consumption**

The consistency between consumption and deliveries is analysed *for each type of fuel*.

In general, two categories are considered (see example in table 1):

- petrol, and
- diesel.

In some countries LPG - liquefied petroleum gas - is added (this type of fuel is negligible in France, where it powers less than 0.5% of the passenger car fleet).

*Biofuels and alternative energy sources:*

Alternative energy sources, used for suitably adapted vehicles, should be included as new classifications if their shares become significant (compressed natural gas, ethanol with fuel-flexible technology, electricity, etc.).

When liquid biofuels, biodiesel (FAME/FAEE<sup>3</sup>) and ethanol-based fuels (like ETBE<sup>4</sup>) are used, blended in *low proportions* with diesel or petrol, the total volume of fuel deliveries (d) must include them to ensure the consistency of “fuel consumption – fuel deliveries (or sales)”.

But in Germany, for example, biodiesel is increasing and about one third of the total volume of fuel is delivered as *pure* biodiesel at public fuelling stations. In this case, this volume (d') must be added to the total diesel deliveries (d) in the balance:

(d) + (d') is compared with (c).

#### **Fact Box No. 1**

##### Alternative energy sources

Large-scale deployment of biofuels can be expected by 2020 to 2030. Three main phases are to be considered:

*Phase I short term* (until 2010): 1st generation

Improvements to existing technologies for EtOH, ETBE and FAME/FAEE.

*Phase II medium term* (2010-2020): deployment of 2nd generation biofuels production:

<sup>3</sup> FAME/FAEE: fatty acid methyl/ethyl esters (made from vegetable oils).

<sup>4</sup> ETBE: ethyl tertiary butyl ether (made by mixing ethanol - EtOH - and isobutene).

EtOH, Syn Diesel, DME<sup>5</sup> from lignocellulosic biomass and SNG<sup>6</sup>.

*Phase III (beyond 2020):* large-scale deployment of 2nd generation biofuels: deployment of integrated biorefining complexes.

*Source: Biofuels in the European Union, A vision for 2030 and beyond, EUR 22066.*

*Final report of the Biofuels Research Advisory Council.* Promotion of use of biofuels or other renewable fuels for transport is the goal of *Directive 2003/30/EC of 8 May 2003*. National indicative targets are to be set by Member States. The reference values are 2% of LCV in 2005 and 5.75% of LCV in 2010 for all petrol and diesel placed on Member States' markets for transport purposes. In France the targets are 7% in 2010 and 10% in 2015.

## 2.2 Vehicle categories

The basic stratification (before aggregation at country level) is performed, for each type of fuel, by “nationality plus type of vehicle”, as follows (example for petrol and diesel):

*Nationality:*

National

Foreign

*Type of vehicle:*

Light vehicles:

Passenger cars - petrol

Passenger cars - diesel

Vans (light-duty vehicles, LDV) - petrol

Vans (light-duty vehicles, LDV) - diesel

Motorcycles and mopeds (petrol)

Heavy vehicles:

Lorries and road tractors (diesel)

Buses and coaches (mainly diesel)

### **Fact Box No. 2**

Private and company cars are considered separately in Germany, since the average distance traveled and average consumption per kilometre differ substantially.

In France this distinction has been drawn for the last base year (2000), but no survey is available for monitoring either traffic or consumption by company cars.

*Notes:*

1) For traffic by foreign vehicles on national territory the classification may be less detailed if information is missing (there is no permanent European survey to estimate annually all kinds of traffic – passenger cars in particular - by country and by nationality of vehicle).

Moreover, a detailed breakdown will not generally add much information to the overall traffic and fuel consumption of the country (in France, for example, traffic and consumption by all foreign light vehicles are estimated jointly, broken down only by type of fuel).

<sup>5</sup> DME: dimethyl ether (clean burning synthetic fuel that can be used as a substitute for conventional diesel or liquefied petroleum gas (LPG), or be reformed into hydrogen for fuel cells).

<sup>6</sup> SNG: substitute natural gas (made from LPG, naphtha and COG (coke-oven gas)).

2) In the Tremove (or Artemis) model a further breakdown by technology is produced for passenger cars, split into :

small cars (engine size < 1.4 litres);

big/medium-sized cars:

medium-sized: engine size 1.4 - < 2.0 litres;

big: engine size  $\geq$  2.0 litres.

For petrol vehicles, a distinction is drawn between:

- conventional;
- CNG (compressed natural gas);
- hybrid (petrol engine + electric motor);
- LPG (liquefied petroleum gas).

For diesel vehicles, a distinction is drawn between:

- conventional;
- hybrid.

### **2.3 Road categories**

Traffic may be broken down by road categories *as a second step*, if traffic counts are available. If the traffic index covers only the main road network, the traffic on local roads may be estimated from the difference (and, depending on the results, this breakdown may trigger revisiting of the initial traffic estimates).

*Note:*

To estimate the emission values, the COPERT calculator requires a breakdown by type of road considering three types of traffic:

- urban,
- rural,
- motorways.

(In France traffic data by type of vehicle are available only for motorways, at national level, and only for two categories of vehicle. The consumer panel survey on fuel consumption asks about the split of traffic between three types of road, for two-week periods, but the answers are not very precise and are not based on proper measurements.)

Table 1

**Traffic and fuel consumption on national territory**

(example for 2 types of fuel)

i = type of vehicle

j = type of fuel (usually, j = 1 (petrol) or 2 (diesel); cf. Classification of variables 3d.2.1)

	Fleet ( <i>a<sub>ij</sub></i> )	Average distance travelled ( <i>b<sub>ij/a<sub>ij</sub></sub></i> )	Vehicle-kilometres ( <i>b<sub>ij</sub></i> )	Consumption per km ( <i>c<sub>ij/b<sub>ij</sub></sub></i> )	Total Consumption ( <i>c<sub>ij</sub></i> )
<b>National vehicles</b>					
Passenger cars					
<i>Petrol</i>					
<i>Diesel</i>					
Buses and coaches					
<i>Diesel</i>					
Vans					
<i>Petrol</i>					
<i>Diesel</i>					
Lorries and road tractors					
<i>Diesel</i>					
<b>Other</b>					
Moped and motorcycles					
<i>Petrol</i>					
Other motor road vehicles (if any)					
<i>Petrol</i>					
<i>Diesel</i>					
<b>Total (national)</b>					
<i>Petrol</i>					
<i>Diesel</i>					
<b>Foreign vehicles</b>					
Passenger cars & Vans					
<i>Petrol</i>					
<i>Diesel</i>					
Buses and coaches					
<i>Diesel</i>					
Lorries and road tractors					
<i>Diesel</i>					
<b>Total (foreign)</b>					
<i>Petrol</i>					
<i>Diesel</i>					
<b>Miscellaneous consumptions</b>					
<i>Petrol</i>					
<i>Diesel</i>					
<b>TOTAL CONSUMPTION (<i>c<sub>.j</sub></i>)</b>					
<i>Petrol</i>					
<i>Diesel</i>					

### 3. Data sources

#### 3.1 *Traffic estimates (b)*

There are many sources of traffic data, and the estimates are derived from a mix of sample surveys and official data (see previous sections). Annual data are available only for heavy goods vehicles. Like national counts, the levels for most other vehicle categories are established for *a base year* and are adjusted annually. For passenger cars or other light vehicles, detailed surveys are not generally implemented every year, but every five (or ten) years, if at all.

Some surveys may be best designed to estimate mainly the average distance travelled per vehicle (b/a), others to estimate total traffic (b).

##### **Fact Box No. 3**

###### Surveys

In France, for example, an annual household survey produces an estimate of trends in the average distance travelled (b/a) by national passenger cars.

Total traffic is calculated as:

$$(b) = (a) * (b/a).$$

The trend in (b/a) for foreign vehicles is estimated from a compilation of different sources of information (tourism data, etc.).

For heavy goods vehicles, by contrast, the output from the French survey under Council Regulation (EC) 1172/98 gives a direct estimate of total traffic (b) (only the domestic part of traffic is considered in this case).

The average distance travelled by goods vehicles is calculated afterwards, based on the registered fleet:

$$(b/a) = (b)/(a).$$

The results for foreign vehicles are not available in time, and provisional estimates are necessary (not yet annually revised).

##### **Fact Box No. 4**

In Germany, the average annual distance travelled (b/a) by passenger cars is taken from surveys conducted in 1993 and 2002 and adjusted by model calculations to allow for the ageing of the fleet and obtain estimates for new models in the fleet. Inputs to the model include ownership (private or company), type of drive (diesel or petrol), size, engine capacity and vehicle age. The results are adjusted by taking into account additional data from the household panel survey.

#### 3.2 *Fuel consumption estimates*

Some sample surveys are best designed to measure fuel consumption per kilometre (c/b), *by type of vehicle*.

If this information is missing, estimates are made, using auxiliary variables (such as extrapolation to foreign vehicles of measurements on domestic vehicles).

Notes:

1) Structural effects, such as the fast development of diesel passenger cars and increasing comfort of vehicles (weight, air conditioning, etc.), strongly contribute to the overall trends in average consumption per kilometre (c/b) and total consumption (c).

2) In Germany, the norm consumption values and the values published in test reports on new cars are the baseline data for estimating the “real” average consumption per kilometre of passenger cars, needed as (c/b) in the model calculations. Data from the German household panel survey give additional information.

**Fact Box No. 5**

The German household panel survey (mobility panel, MOP) not only collects data on everyday mobility behaviour in a travel diary, covering one week in autumn each year, it also surveys the distance driven in private vehicles in Germany and their fuel consumption.

For six weeks in spring every year, the distance driven and fuelling are reported for every car in the selected households. The latest results (for 2005) show an average consumption of 7.1 litres per 100 km for diesel-fuelled cars, and 8.2 litres per 100 km for petrol-driven cars. However, since the sample is small, changes in consumption from one year to the next give some hints about the trend, but are not statistically significant generally.

Source: [http://mobilitaetspanel.ifv.uni-karlsruhe.de/ENGLISH/MOP\\_Frameset.htm](http://mobilitaetspanel.ifv.uni-karlsruhe.de/ENGLISH/MOP_Frameset.htm) (as of Dec. 2006)

**Fact Box No. 6**

According to the European survey, the share of road tractors in total goods traffic in France increased from 48% in 1988 to 65% in 2001 (stable from 2001 to 2005). Over the same period, the share of lorries under 11 tonnes decreased from 14% to 3%. Although the average consumption of road tractors decreased from 39.4 l per 100 km in 1988 to 37.5 l per 100 km in 2005, the average consumption of all goods vehicles (over 3.5 tonnes) increased from 1988 to 1998, then nearly stabilised from 1998 to 2005 (at around 35.6 l per 100 km). The effects of technological progress are counter-balanced by the structural effects, as goods vehicles become heavier and heavier, on average.

**3.3 Data on fuel deliveries**

The annual data on deliveries (d) are considered (in France) to be precise and a good proxy for the “total volume of fuel sales” on national territory<sup>7</sup>. They include blended biofuels: all biofuels are sold blended in low proportions with traditional fuels.

Today in Germany, for example, regenerative fuels are gaining importance, for both diesel and petrol vehicles. The volumes of biodiesel and ethanol mixed in mineral fuels are included in (c). But deliveries of *pure alternative fuels* (d') are not included in the delivery data (d): they have to be added to the balance. For example, biodiesel took 7% of total diesel consumption in 2005.

In addition, before comparison with the first-step estimate of vehicle consumption, some **statistical adjustments** (SA) have to be considered, to take into account the scope of the data:

$$(d) + (d') = (c) + SA, \text{ or}$$

<sup>7</sup> For France the overseas departments are not included in data issued by the CPDP (Professional Committee for Petroleum).

**(d) + (d') – SA = (c)**, total fuel consumption on national territory,

where **SA = SA1 + SA2 + SA3** and

- SA1 = duty-free fuel sales (mainly for fishing boats),
- SA2 = fuel consumption for miscellaneous uses, generally not related to road traffic (special-purpose vehicles, construction site equipment, lawnmowers, etc.),
- SA3 = “cross-border balance” or “grey” exports minus “grey” imports: consumption by vehicles travelling abroad with fuel bought on national territory minus consumption by vehicles travelling on national territory with fuel bought abroad (national or foreign vehicles).

*Notes:*

1) The “cross-border balance” (SA3) may be significant. Models have been developed to explain this variable, but in practice the following parameters should be considered for an empirical diagnosis of its annual trend: the fuel price differentials between geographically close countries, data on tourism, data on external trade, etc.

In Germany, SA3 is estimated as 2.4 billion litres of diesel, that is 10% of diesel deliveries, and 2.7 billion litres of petrol or 9% of petrol deliveries.

2) Within Europe (countries = k)  $\sum_k SA3_k$  is nearly = 0.

## **4. Coverage**

### **4.1 Cross-border trade**

The annual balance concerns the volume of fuel consumed *on national territory (c)*.

The volume of fuel deliveries must be adjusted before being compared with total consumption (see statistical adjustment SA3 above).

### **4.2 Off-road consumption**

See statistical adjustments SA1 and SA2 above.

## **5. Need for supplementary statistics**

### **5.1 Types of vehicle not covered**

For some categories of vehicle (light-duty vehicles, special-purpose vehicles, company cars, motorcycles, etc.) many countries have no annual source of information. Estimates have to be made more carefully for base years.

The share of some types of vehicle in total traffic may become significant (increasing share of motorcycles in urban areas).

### **5.2 Counts of nationality for traffic abroad and “grey” imports/exports (cross-border balance)**

Total traffic (b) covers:



$(b) = (b)_n + (b)_f$  (**national** vehicle + **foreign** vehicle traffic).

To estimate  $(b)_f$ , i.e. the foreign vehicle traffic crossing the border (transit, international trade or tourism), the European survey can be used for goods vehicles (with a one-year delay), but there is no such annual survey for cars nor for light-duty vehicles.

The basic information “which vehicle operates in which country” (by nationality of vehicle) is therefore needed for consistent consolidation of traffic (b) and fuel consumption (c) at the European level. As far as possible, traffic should be counted in the same year (base year).

In addition, to estimate the fuel imported/exported in fuel tanks (see SA3 above), the differences in fuel prices between countries must be taken into consideration.

**Fact Box No. 7**

In some countries (Germany, for example) “grey” imports are increasing:  
*“In addition, with the accession of the Czech Republic and Poland to the European Union on 1 May 2004, the import restriction of 20 litres at the borders of these countries was no longer applicable”*  
(see TRANSP/WP.6/AC.5/2005/15).

**Fact Box No. 8**

In France most motorways are toll roads operated by private companies. A comparison of manually counted light vehicles exiting at toll stations (by vehicle nationality) and estimates from credit card records of payments (by bank nationality), show that automatically collected data may be an efficient way to identify foreign visitors on the French territory by nationality. Odit France - a public agency involved in tourism engineering - has created a method to estimate the probability of paying by credit card, according to the amount of toll, for each of the 17 most significant European nationalities. Specific probability laws are adjusted for Germany, Belgium, Netherlands, United Kingdom, Denmark, Switzerland, Italy and Spain, and other laws are derived from these, based on geo-cultural proximity (for example, Luxembourg and Belgium). In 2003, around 45% of payments over €5 were made by credit card, for all nationalities. Estimates of traffic by nationality for passenger cars are then calculated annually on each motorway network cooperating in the data collection. The results are not yet consolidated at national level, but the coverage is being extended.  
*Source: Odit France.*

Besides this project, large surveys based on manual counts are done periodically on the national network (roads and motorways). The last surveys were implemented in 1990; 1996-1997, and 2004-2005. These surveys are the only homogeneous sources of information available to measure traffic with its seasonal factors by type of vehicle and origin (or nationality for foreign vehicle), on different types of roads. The sample is stratified by regions, type of roads and time periods. For example, in the 2004-2005 survey, a sample of 297 spots was selected for manual counts, including 65 spots on the toll motorways network. Most of the manual spots are supplied by automatic stations for the determination of the type of vehicle: SIREDO ‘silhouettes’ stations can automatically identify 14 categories of vehicles, and toll stations 5 categories. Sampled spots are generally located between two important nodes of the road network, one spot by segment (every 50 km on average, or every 120 km in the toll motorways network). Time sampling is stratified, depending on the type of day and hours within a day (12 one-hour periods has been defined for each spot, both ways, or 27 periods for ‘all manual’ spots). Data collection took place from June 2004 to June 2005 (or from September 2004 to September 2005 on the toll motorways network).

*Source: Ministry of transports (SETRA: The Technical Department for Transport, Roads and Bridges Engineering and Road Safety).*

### 5.3 Consumption per kilometre

As the structure (age, weight, etc.) of the fleet is changing, and fuel efficiency of cars is improving, there is a need to measure *empirical-based* consumption per kilometre, by category (to estimate the average consumption, weighted by the share of vehicle-km taken by the category).

But the experience gained in some countries may be used to make estimates in others (by default), if the climate conditions are not too different.

#### **Fact Box No. 9**

In France, until 2005, the question of consumption per kilometre was not asked in the European goods transport survey every year (but every three to four years). Now it is a permanent question. For passenger cars, a panel is designed to measure actual consumption per kilometre (permanently monitoring odometers and fuel purchases, by two-week periods: odometer readings are reported at the beginning of the period, end of the period and whenever fuel is purchased). The Ministry of Transport has access to the results of the panel survey only at a more aggregated level. In Germany, a detailed model is implemented: *“For each year, separate estimates for company and private, gasoline and diesel cars are made to determine the average distance travelled by car types. The updated model is based on the number of cars owned privately and by companies differentiated by about 5 000 models and types. The results of a log linear regression analysis of the survey data were used to estimate the average distance travelled by each car type.”*

## 6. Error sources

The global consistency of the data system is a way to minimise the error in the traffic variable.

### 6.1 Traffic

(b) is estimated (for each type of vehicle) by:

(b) = (b)<sub>n</sub> + (b)<sub>f</sub> (national vehicle + foreign vehicle traffic),

where (b)<sub>n</sub> = (a)<sub>n</sub> \* (b/a)<sub>n</sub>,

(a)<sub>n</sub> is estimated from national registers, and

(b/a)<sub>n</sub> is estimated from odometer readings or sample surveys,

and

(b)<sub>f</sub> is directly estimated, using multiple sources of information or expertise

(usually, this term is not very precise, but in many countries (b)<sub>f</sub> is largely lower than (b)<sub>n</sub>).

For the precision of “first step” estimates of traffic (b), see the previous sections.

### 6.2 Fuel deliveries (d) and consumption (c)

These are reported/calculated independently: the error in (c) is less than or equal to the sum of errors in each term:

(c) = (d) + (d') - SA (usually SA is largely lower than (d), in absolute value)

where (d') = pure alternative fuels deliveries (if any),  
 SA (statistical adjustment) = SA1 + SA2 + SA3,  
 SA1 = duty-free fuel sales,  
 SA2 = miscellaneous,  
 (special-purpose vehicles, construction site equipment, lawnmowers, etc.),  
 SA3 = "cross-border balance" (see above),

and

$$(c) = (c)_n + (c)_f$$

$$(c) = (b)_n * (c/b)_n + (b)_f * (c/b)_f,$$

where (c)<sub>n</sub> = consumption by national vehicles on national territory,

and (c)<sub>f</sub> = consumption by foreign vehicles on national territory.

*Note:*

(c/b)<sub>n</sub>, average consumption per kilometre of national vehicles, is estimated (in France) from sample surveys: the precision of this variable, based on the trends, is quite good, if the types of vehicle are sufficiently homogeneous.

Assuming that, based on the trends, the error in the statistical adjustment SA is inferior to the error in total traffic, then *the precision of known deliveries (d) + (d') will improve the precision on total traffic (b) = (b)<sub>n</sub> + (b)<sub>f</sub>.*

Annex

**List of countries using fuel consumption as a main or supplementary source (or for research) (*draft - to be updated*)**

<b>Country</b>	<b>Body</b>	<b>Fuel (x=main source)</b>
<b>Austria</b>	Kuratorium für Verkehrssicherheit	<input checked="" type="checkbox"/>
<b>Belgium</b>	IBSR	
<b>Finland</b>	Finnish Road Administration	
<b>France</b>	Ministry of Transport (SESP)	<input checked="" type="checkbox"/>
<b>Germany*</b>	German Federal Highway Research Institute (BAST)	
<b>Latvia</b>	Latvian Road Safety Directorate	
<b>Norway</b>	- Norwegian Public Roads Administration - Statens vegvesen Vegdirektoratet - Statistics Norway	
<b>Portugal</b>	Direcção Geral Viação (DGV)/ National Laboratory of Civil Engineering	<input checked="" type="checkbox"/>
<b>Slovenia</b>	Statistical Office of the Republic of Slovenia	

*Notes:*

\* Germany has estimates of diesel and petrol consumption by national vehicles (in Germany and abroad) and by foreign vehicles driven in Germany. Traffic estimates for foreign vehicles in Germany are also available by nationality (from 1998 and 2003 surveys).

## CHAPTER 4

### FOREIGN TRAFFIC ON NATIONAL TERRITORY

#### 1. General

One of the most difficult aspects of traffic movements measurement on a given territory is the question of foreign vehicles. Chapter 3 describes some methods to cover all traffic regardless of the nationality of the vehicle. This chapter presents some specific solutions to cover the volume of road traffic (in vehicle-kilometres, vkm) due to foreign vehicles on national territory.

Passenger car movements can be obtained from tourism statistics, toll collection information, border counts, etc.

For freight transport a good option is to take the results based on Regulation 1172/98. This Council Regulation and the later specific Commission Regulation 6/2003 give Member States the opportunity to use selected data for traffic calculation. In 2004, a total of 23 countries participated in the data exchange programme and in 2005, 25 countries.

#### 2. Examples

The boxes set out below give specific examples.

##### *Fact Box No. 1*

The Dutch method of calculating traffic movements (vkm) on national territory is based on two sources. The first is the national road freight survey. This contains the extra variable "border-crossing point".

For freight vehicles it is possible to calculate the distance travelled on national territory for both national and international traffic. The hauliers indicate the place of loading, place of unloading and, in the case of a cross-border journey, also the border-crossing point. These three elements make it possible to calculate the total distance travelled and the distance on national territory.

After aggregation to NUTS3-NUTS3 pairs the average distance per origin-destination pair (OD pair) can be calculated. The foreign NUTS regions are also further aggregated to NUTS2, NUTS1 and even NUTS0 (country) level. The result of this calculation is an OD distance table (distance on national territory).

**Fact Box No. 1 (end)**

The second source is the Eurostat exchange programme. Almost all EU countries and some EFTA countries (a total of 25 countries in 2005) participate in the exchange programme. The D tables described in Regulation 2003/6 give detailed regional information on the freight traffic between countries. In 2004 the majority of the countries were using the most detailed level of the NUTS classification (NUTS3).

From this data all journeys that begin and/or end on national territory, in this case in the Netherlands, are selected. The country's own data in the exchange programme are ignored. Only the distance driven by foreign vehicles on Dutch territory is selected. D3 (laden) and D4 (empty) journeys are included in this selection.

These tables contain the geographical details.

In order to be able to combine the two sources it is assumed that national and foreign vehicles use the same routes. Only type 1 journeys (single basic transport operation) are considered in this model.

From the D tables the OD pairs at the most detailed NUTS level are used. For some countries the NUTS classification abroad is at level 3, for others at level 0 (country). A total of 47 500 journeys involving the Netherlands are selected. Of these, 51% are a NUTS3-NUTS3 route. Complementary OD pairs (NL region - non-NL region and non-NL region – NL region) are treated the same.

The OD pairs are compared with the OD distance table from step 1 and the distance travelled on national territory is deduced. If the OD distance table does not contain the specific route at NUTS3 level, the foreign level is reduced to NUTS2, etc.

In this way, the level of detail on national territory, in this case in the Netherlands, is kept as high as possible and the other regions in the OD-pair are gradually scaled up from NUTS3 to NUTS0. This adds another 25% of journeys for which the distance could be deduced.

In the next step the Dutch level is gradually decreased from N33 (NUTS3 – NUTS3) to N32, N31, N30, N23, N22, N21, etc. At the end of this exercise 90% of the total journeys by foreign freight vehicles included a stretch on NL territory. An additional 8.5% were cabotage operations, and 1.5% had to be corrected or were allocated the overall average distance of 90 km (2005).

The rest is transit traffic. Exchange table D5 shows the countries that are transited. This table is more difficult to use because of the lack of detail. It indicates the reporting country and the transited country and the number of laden and empty journeys. This table is not used in the method described and the transit traffic is not calculated.

Traffic movements by freight vehicles<sup>1)</sup> in the Netherlands, 2005

	Total	National traffic <sup>2)</sup>	International traffic
	mln vehicle km		
Total	6608	5300	1308
National vehicles	6140	5251	888
Foreign vehicles	468	48	420

1) Gross vehicle weight of 3.5 tonnes or more.

2) Including cabotage on national territory by foreign vehicles.

Source: Peter Smeets, Statistics Netherlands

**Fact Box No. 2**

Calculation of foreign vehicle-kilometres

**ROMANIA**

# Vehicle-km = Odometer\_reading\_at\_exit\_border\_point -  
Odometer\_reading\_at\_entry\_border\_point

Source: odometer readings or database search.

**Fact Box No. 3**

**Estimation of cross-border traffic in Germany**

Estimates of the volume of road traffic in **Germany** are based on assumptions about the average mileage of vehicles registered in Germany. The annual amount of fuel distributed to cars and trucks and their consumption are the main sources of data for calibration of the total mileage. Consequently, the results cover the mileage of the national fleet, not the mileage on German roads. To calculate the mileage on German roads, the mileage of national vehicles driven abroad and the mileage of foreign vehicles in Germany have to be estimated, along with the fuel consumption and the quantities of gasoline and diesel purchased while travelling abroad.

Unfortunately, there is a lack of empirical data for these calculations. For many years the comfortable assumption was used that both figures are the same and cancel each other out, in terms of both mileage and of the amount of fuel consumed. However, in 2002 an extensive survey on cross-border travel showed an "export" surplus of car-kilometres but an "import" surplus of truck-kilometres. Lower fuel sales along the German border as well as large-scale upgrading of cross-border trucks with additional tanks had become familiar phenomena. With the introduction of the "eco-tax" - a surcharge on top of the fuel excise tax in Germany - the fuel price differential between Germany and many neighbouring countries increased to such an extent that cross-border fuelling and "fuel tourism" had to be taken into account.

The above-mentioned 2002 survey consisted of:

- counting vehicles crossing the border, and
- interviewing drivers at German motorway service stations, mainly to ask them about the length of their journey.

These data were combined and adjusted with data from several other sources (see table 1 below).

To estimate the volume of fuel purchased abroad, long-distance journeys which require refuelling anyway were separated from other cross-border traffic. One data source used for this was the number of long holiday trips made by Germans by car. The volumes of fuel unavoidably consumed on these trips were then added to the total fuel volume, assuming fuelling took place near the border, depending on fuel prices in Germany and the relevant neighbouring country.

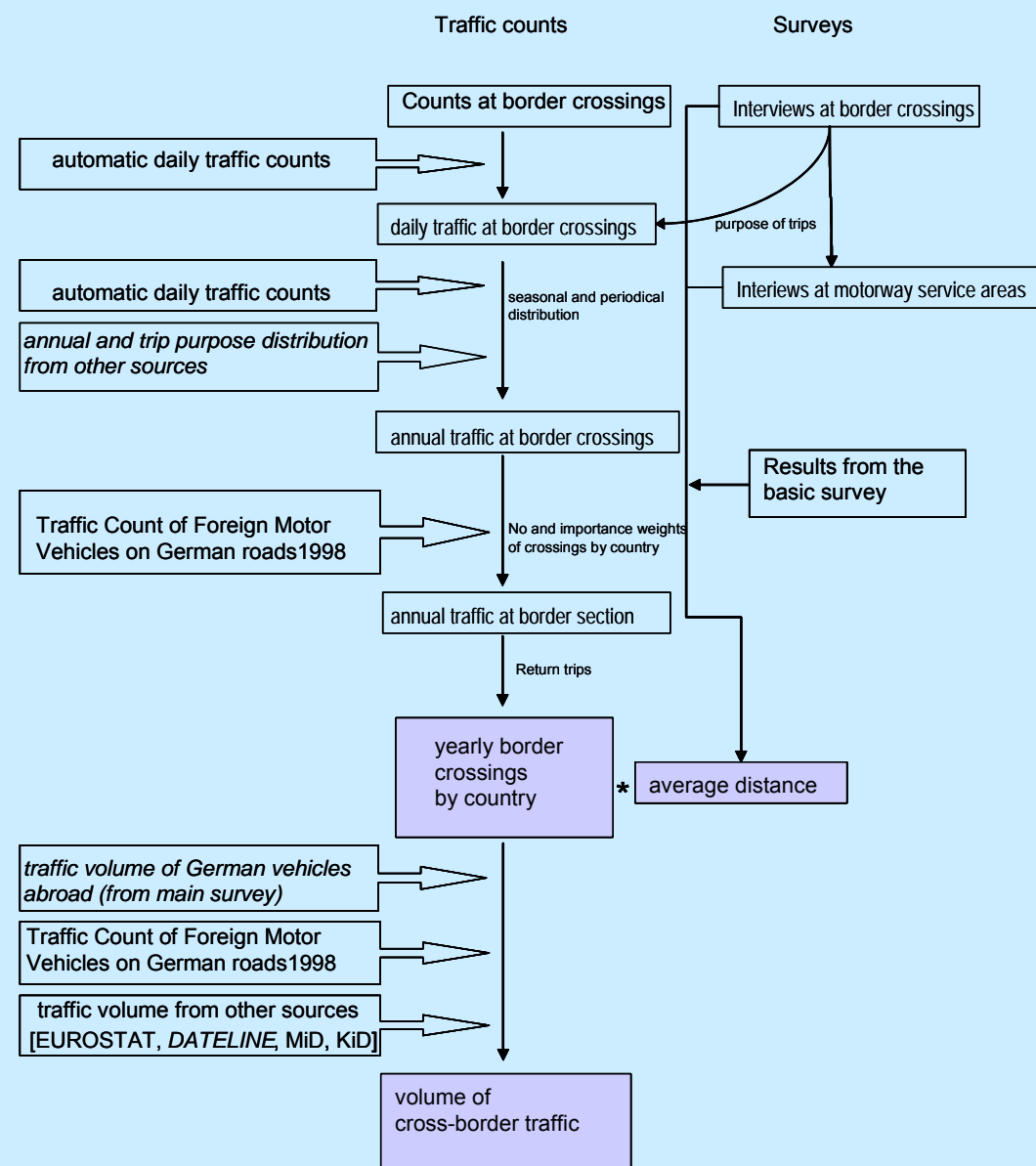
Table 1 - Cross-border traffic, 2002

	freight vehicles	passenger vehicles <sup>1)</sup>	all vehicles
<b>Kilometres 2002</b> billion vkm			
by foreign vehicles in Germany	8.2	19.2	27.4
by German vehicles abroad	3.7	23.4	27.1
compared with all German vehicles	84.2	603.1	687.3
<b>Gasoline fuelled</b> billion litres			
by foreign vehicles in Germany		0.425	0.425
by German vehicles abroad		2.500	2.500
compared with total consumption of German vehicles	0.602	37.250	37.852
<b>Diesel fuelled</b> billion litres			
by foreign vehicles in Germany			
by German vehicles abroad	0.800	0.057	0.857
compared with total consumption of German vehicles	2.300	0.700	3.000
	19.122	11.626	30.748
<sup>1)</sup> Motorcycles, cars and buses			

The periodic updates necessary to calculate annual vehicle mileages for 2003 and later are based mainly on the automatic traffic counts on stretches of road near the border. However, this method does not allow a distinction to be drawn between national and foreign vehicles. For freight transport, data collected under EU Regulation 1172/98 will be used in the future.

**Fact Box No. 3 (end)**

Method used to estimate the amount of cross-border traffic in Germany in 2002, based on data on traffic volume (from traffic counts) and on traffic flows (from surveys).



Source: IVV Aachen, 2003.  
Hartmut Kuhfeld, Deutsches Institut für Wirtschaftsforschung



#### **Fact Box No. 4**

##### **Calculating the volume of road traffic in Austria**

In general, **Austria** uses three sources to calculate the volume of road traffic:

- fuel consumption data;
- data from road counts (only on major roads);
- the "Verkehrsmodell Österreich" ("VMOe", Austrian National Transport Model) of the Ministry of Transport, BMVIT.

The data on fuel consumption and road counts are available as time series, the calculations from the transport model only for a reference year.

The main inputs for calculations of time series on total road vehicle performance in Austria are fuel consumption data, as only these give a full picture of the traffic volume in Austria. Total fuel consumption (based on the energy statistics of the Austrian Statistical Office) is allocated between the various modes of transport via the "GLOBEMI model" of the Technical University of Graz. Additional data available on specific modes such as road freight also enter into the calculations.

The output from this model is also used to calculate emissions from transport. Two versions are made available. One is based exclusively on the amount of fuel sold in Austria. The follow-up to the Kyoto Protocol requires information on the level of CO<sub>2</sub> emissions based on fuel sales in the country concerned. The second version relates to the traffic volume within Austria. By contrast to the first, it takes into account the effects of "fuel tourism".

Due mainly to lower excise duties, fuel is currently somewhat less expensive in Austria than in some neighbouring countries. Many foreigners therefore cross the border just to buy petrol or diesel at the closest fuel station in Austria. They contribute far less to the traffic volume in Austria than they do to Austria's fuel sales figures.

The method of calculating the amount of fuel tourism is as follows:

For a reference year, the traffic volume within Austria is calculated from the VMOe, which itself is consistent with the data from the road counts.

VMOe is a network-based, multi-modal transport model covering passenger and freight transport. It is used mainly for transport forecasts and infrastructure assessment. In principle, it covers traffic movements between "transport zones" (the Austrian communities). Estimates of traffic generated by movements within the zones can also be added. In this way the total traffic within Austria from both Austrian and foreign vehicles is covered. The results are used to calculate the total fuel consumption (and emissions) of traffic within Austria.

The difference between the fuel consumption calculated in this way for traffic within Austria and total fuel sales in Austria is put down to fuel tourism (fuel sold in Austria but consumed abroad).

For the purposes of calculating time series and for validation, Austria has developed another model which estimates the fuel tourism effect. It is based on fuel price differentials between Austria and neighbouring countries and has been calibrated with the help of driver surveys, amongst other sources.

The traffic volumes are calculated jointly by the Austrian Umweltbundesamt (the Austrian government authority for environmental protection and environmental control) and the Technical University of Graz.

*Source: Thomas Spiegel, Bundesministerium für Verkehr, Innovation und Technologie (BMVIT)  
Günther Lichtblau, Umweltbundesamt (UBA)*

### **Fact Box No. 5**

Compilation of tourism statistics at Eurostat is based on Council Directive 95/57/EC on tourism statistics and the Commission Decision on the procedures for implementing Council Directive 95/57/EC. For transport issues the following data collected might be useful.

Firstly, occupancy in collective accommodation establishments. Monthly and annual data on arrivals, nights spent and occupancy of bed places in hotels and other collective accommodation establishments at national or regional (NUTS2) levels.

From these data arrivals of residents and non-residents (broken down by nationality) and nights spent by residents and non-residents can be found.

Secondly, the information on tourism demand, which shows trips of which the main purpose is holidays or business and which involve spending at least one or more consecutive nights away from the usual place of residence.

From this the main destination of the trip (country) is obtained. In addition, data on the principal mode of transport used can be found but only for trips including four or more nights away. Quarterly and annual data are collected.

*Source: Eurostat*

### **Fact Box No. 6**

In **France** most motorways are toll roads operated by private companies.

A comparison of manual counts of traffic of light vehicles exiting at toll stations (by vehicle nationality) and estimates from credit card records of payments (by bank nationality) show that the automatically collected data may be an efficient way to identify foreign visitors on the French territory by nationality. ODIT France - a public agency involved in tourism engineering - has built a method to estimate the probability to pay by credit card, according to the amount of the toll, for each of the 17 most significant European nationalities. Specific probability laws are adjusted for Germany, Belgium, Netherlands, United Kingdom, Denmark, Switzerland, Italy and Spain, and other laws are derived from these, based on geo-cultural proximity (for example, Luxembourg and Belgium). In 2003, around 45% of payments over €5 were made with a credit card, for all nationalities. Estimates of traffic by nationality for passenger cars are then calculated annually on each motorway network cooperating in the data collection. The results are not yet consolidated at national level, but the coverage is being extended.

*Source: Odit France.*

Besides this project, large surveys based on manual counts are done periodically on the national network (roads and motorways). Last surveys were implemented in 1990; 1996-1997, and 2004-2005. These surveys are the only homogeneous source of information available to measure traffic with its seasonal factors by type of vehicle and origin (or nationality for foreign vehicle), on different types of roads. The sample is stratified by regions, type of roads and time periods. For example, in the 2004-2005 survey, a sample of 297 spots was selected for manual counts, including 65 spots on the toll motorways network. Most of manual spots are supplied by automatic stations for the determination of the type of vehicle: SIREDO 'silhouettes' stations can automatically identify 14 categories of vehicles, and toll stations 5 categories. Sampled spots are generally located between two important nodes of the road network, one spot by segment (every 50 km on average, or every 120 km in the toll motorways network). Time sampling is stratified, depending on the type of day and hours within day (12 one-hour periods has been defined for each spot, both ways, or 27 periods for 'all manual' spots). Data collection took place from June 2004 to June 2005 (or from September 2004 to September 2005 on the toll motorways network).

*Source: Ministry of transports (SETRA: The Technical Department for Transport, Roads and Bridges Engineering and Road Safety)*

**Fact Box No.7**

**ABRIDGED VERSION OF THE METHODOLOGY OF STATISTICAL RESEARCH ON GOODS FLOWS IN INTERNATIONAL ROAD TRAFFIC**

The Statistical Office of the **Republic Serbia** has been conducting a number of statistical researches on the basis of which the public is informed about goods flows performed by every mode of transport. However, until 1996, research on goods flows were not realized which presented a significant limitation in the system because the users were not provided with the information about transport as a whole. The main limitation in the implementation of the statistical research in road transport was not of methodological nature, but above all it was due to the lack of financial means needed for the realization of this research.

As an exception, in the period from 1986 to 1990, with the aim to provide foreign financial support for building and reconstruction of the main transit roads across the SFRY, two ad hoc statistical researches on goods flows in road transport were carried out, with the financial support of EUROSTAT.

The research that was carried out in 1986 included only the flows of goods in transit across the territory of SFRY, and that carried out in 1990 included goods flows by all modes of international transport.

Experience gained from the realization of these researches, as well as the participation of transport statisticians in the preparations for the implementation of the new documents (Single Administrative Document) in customs supervision and customs clearance on the territory of Yugoslavia, has provided conditions for provision of data on goods flows in road transport from the documentation from Federal Customs Administration.

Expert from the statistical office, in collaboration with the Federal Customs Administration, added some specific attributes, which are important for the statistics of transport, to the Single Administrative Document in the part which is used in the customs supervision. With the beginning of the realization of customs procedures of supervision and clearance using Single Administrative Document, transport statistics started providing data for users regarding goods flows by road in international transport.

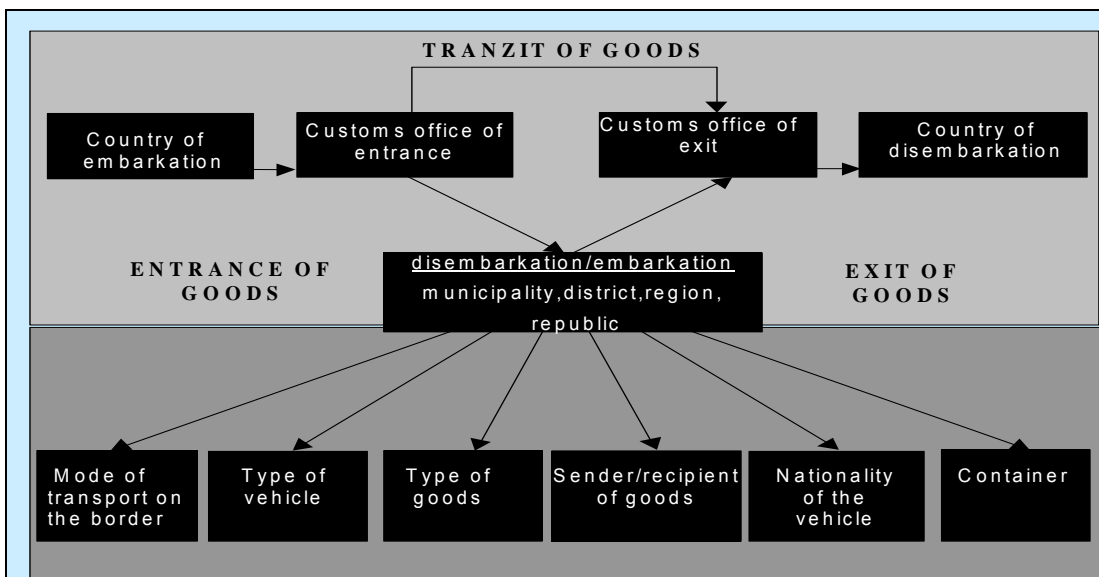
Changes in the customs supervision and customs clearance procedures led to certain reductions in the volume of information which could be obtained by processing data. The most significant change is the impossibility to get information about the type of goods carried in transit through the territory of the Republic Serbia. Certain changes were made regarding the types of vehicles used in goods transport, especially in the classification of transport means in inland waterway transport. In road transport, however, the classification of vehicles remained the same, with certain improvements referring to multimodal transport.

**Goal and object of the research**

The goal of this research is to provide data on volume and directions of goods transport- by places of embarkation and disembarkation, in import, export and transit of goods over the territory of the Republic Serbia, by national and foreign vehicles.

This research provides data on the number of road freight vehicles entering or leaving the country, and vehicles in transit over the border crossings of the Republic Serbia (statistical indicators), and those on flows of vehicles and goods between foreign countries of embarkation and disembarkation and places of embarkation and disembarkation within our country (dynamic indicators).

**Fact Box No.7 (continued)**



Besides these basic information the data on traffic by countries of registration of vehicles and by customs offices of entrance/exit of the vehicle and data on the amount and type of carried goods-by type of transport vehicle are available.

By calculating the distances travelled on the road network of the Republic Serbia the data on kilometres of freight vehicles performed and realized tonne kilometres on the territory of the Republic Serbia are obtained.

The data obtained through this research, together with the data on the goods flows realized in other modes of transport, are used for the analysis of dynamics and structure of goods flows in international transport, as well as for the analysis of the share of domestic vehicles in transport and bilateral trade with individual countries.

These data are showing an objective picture of: pressures on individual border crossings, division between different modes of transport in overall international freight transport, dynamics and structure- by types of goods and countries of loading and unloading and participation of our transport companies in bilateral exchange. The data obtained are very important for financing construction and reconstruction of the main roads. They can serve for the realistic distribution of revenue from the charged road taxes, according to the actual transport demand on the particular international traffic flows. These data are an important base used in issuing licenses for road transport in bilateral negotiations conducted by the Ministry of Capital Investments.

**Fact Box No. 7 (end)**

**Unit of observation and reporting unit**

The Unit of observation is a commercial freight vehicle with goods (ship, wagon, vehicle, etc.), which is crossing state borders of the Republic Serbia on some of the official border crossings and deals with the documentation which is stated to be used in the customs supervision. Reporting unit is the border customs office. Customs administration delivers basic data on the movements of vehicles with goods on the basis of records from the customs supervision. The data are delivered in DB-2 form.

**Data processing**

Besides classical data processing-through predefined processing tables, a relational database of aggregated data was formed with the aim to respond to users ad hoc requests easier and faster.

Time frame for which the data is processed is defined according to the date of entrance, i.e. exit of vehicle through border customs. Data given by months before the final yearly processing are liable to changes. However, monthly data are more accurate as the data processing is further away from the month for which this data is given.

For that reason, processing is done in May for the previous year, so that problematic customs declarations that were late in processing could be included.

Data on quantities of goods gathered in the statistics of international foreign relations and transport statistics, although taken from the same customs documents, vary significantly.

In transport statistics the time frame is defined according to the date of entrance, i.e. exit of the vehicle through border crossing, and the quantity of goods is measured for that period, regardless of when the customs procedure is done.

In statistics of international foreign relations the time frame is defined according to the date of customs clearance of the goods, regardless of the time period between the entrance and exit of the goods.

*Source: Jelena Kovijanic, Statistical Office of the Republic Serbia*

**3. Conclusion**

There are a wide range of solutions to calculate traffic in terms of vehicle-kilometres clocked up by foreign vehicles on national territory and by national vehicles abroad. Most of the solutions use traffic counts and (border) surveys (e.g. odometer readings) combined with fuel sales and consumption. Data collected under European regulations (on road freight transport and tourism statistics) are also used.

# CHAPTER 5

## SYNTHESIS

### 1. Four general methods

Four survey methods can be used to obtain estimates of the volume of road traffic measured in vehicle-kilometres, namely surveys focusing on the:

- vehicle (odometer readings);
- vehicle user (household surveys);
- road (traffic counts); and
- fuel consumption.

### 2. Coverage differs

The five methods differ in terms of the territory covered and of the nationality of the vehicles surveyed (cf. Table 1).

**Table 1. Coverage of surveys by method applied**

	Road traffic by				
	national vehicles on national territory (1)	foreign vehicles on national territory (2)	total vehicles on national territory (3) = (1) + (2)	national vehicles on foreign territory (4)	national vehicles TOTAL (5) = (1) + (4)
<b>Method:</b>					
Odometer readings					+
Household surveys	(+)			(+)	+
Traffic counts	(+)	(+)	+		
Fuel consumption	+	(+)	(+)		

If the coverage indication is in brackets the information may be obtained by extending the questionnaire accordingly or by using manual or optical traffic counts.

Users' needs mostly concern estimates of the volume of road traffic (in vehicle-kilometres) on national territory. This information can be obtained directly from traffic counts on roads. Countries that use a primary method other than traffic counts to estimate road traffic will need to include supplementary surveys in order to estimate national road traffic. If, for example, odometer readings are applied as the basic method, estimates of road traffic by foreign vehicles in the reporting country (column 2) and by national vehicles abroad (column 3) will be needed.

Estimates reported to international organisations (UNECE, EUROSTAT, ECMT, etc.) should be accompanied by information about the coverage. This might be obtained by using a table containing the same five columns as Table 1. If the national road traffic (column 3) cannot

be estimated directly, the reporting country should be urged to supply estimates or guesstimates for i.e., road traffic by foreign vehicles (column 2) or road traffic by national vehicles abroad (column 3). Appropriate notes and footnotes should inform users about the nature of the estimates, e.g. “basic survey”, “supplementary survey” or “guesstimate”.

### 3. Variables surveyed depend on the method

The type of variables that can be examined in a road traffic survey could be limited by the choice of method. If statistics are based on traffic counts, it will clearly be impossible to obtain information about the journey or about the driver, and vehicle data will be rather limited. On the other hand, household surveys can supply detailed data on vehicles, journeys and drivers, but the information will to some extent depend on the survey population sampled (vehicles or persons).

**Table 2. Types of variable possible by method applied**

	Type of variable			
	Vehicle data	Driver characteristics	Road characteristics	Journey characteristics
<b>Method</b>				
Odometer	+			
Household	+	+	+	+
Road	(+)		+	
Fuel	+			

Users of road traffic statistics would, of course, like to have the vehicle-kilometres on the territory of each reporting country presented by type of vehicle, by type of road, by driver characteristics and by journey characteristics and, if possible, as multi-dimensional tables. But, as can be seen from Table 2, there are limitations. Values for some variables will inevitably be missing as a consequence of the survey method chosen. Use of supplementary surveys may further reduce the level of detail for estimates of national road traffic.

### 4. Proposed table with common set of variables

Accordingly, it is proposed that road traffic statistics collected by international organisations should be limited to a set of variables that can be supplied by the majority of countries (compiling road traffic statistics). The statistics should be reported in a tabular form that can present the details obtained from the basic method applied as well as estimates of road traffic on national territory, as derived from supplementary surveys, etc.

In order to make the survey methods applied transparent, the proposal is to use the columns in Table 1 in a standard reporting table. A draft is presented in Table 3 – Table 6. Estimates of road traffic on national territory have the highest priority. It might not be possible for a country to make estimates for all variables at that level. Even more detailed breakdowns may be available and supplied for other columns in the table. But data may also be missing for countries that delimit the scope of their road traffic surveys to only some of their roads, some of the vehicles or some of the journeys, etc. Table 3 – Table 5 are considered of highest priority. Table 6 is useful for describing risk exposure but will require information from household surveys.

**PROPOSED Tables**

to be reported to UNECE/EUROSTAT/ECMT (via the common questionnaire)

**PROPOSED Table 3**

**Road traffic by type of vehicle**

	Road traffic by				
	national vehicles on national territory	foreign vehicles on national territory	total vehicles on national territory	national vehicles on foreign territory	national vehicles
	(1)	(2)	(3) = (1) + (2)	(4)	TOTAL (5) = (1) + (4)
<b>TOTAL</b>	- vehicle-kilometres -				
<b>Type of vehicle:</b>					
Passenger car					
- petrol					
- diesel					
- other fuel					
Bus or coach					
Motorcycle					
Moped					
Bicycle					
Goods vehicle <= 3.5 tonnes					
- petrol					
- diesel					
- other fuel					
Goods vehicle > 3.5 tonnes					
- petrol					
- diesel					
- other fuel					
Of which >3.5 -6 tonnes					
- petrol					
- diesel					
- other fuel					
Of which > 6 tonnes					
- Lorry (total)					
-- Lorry (alone)					
-- Road train					
- Road tractor (total)					
-- Road tractor (alone)					
- Articulated vehicle					



**PROPOSED Table 4.**

**Road traffic on national territory by type of vehicle, type of road and type of area**

	Road traffic by					TOTAL =(1) + (2) + (3) =(4) + (5)
	Type of road			Type of area		
	Motorways (1)	Other main roads (2)	Minor roads (3)	Built-up areas (4)	Non built-up areas (5)	
<b>TOTAL</b>	- vehicle-kilometres -					
<b>Type of vehicle:</b>						
Passenger car						
- petrol						
- diesel						
- other fuel						
Bus or coach						
Motorcycle						
Moped						
Bicycle						
Goods vehicle <= 3.5 tonnes						
- petrol						
- diesel						
- other fuel						
Goods vehicle > 3.5 tonnes						
- petrol						
- diesel						
- other fuel						
Of which >3.5 -6 tonnes						
- petrol						
- diesel						
- other fuel						
Of which > 6 tonnes						
- Lorry (total)						
-- Lorry (alone)						
-- Road train						
- Road tractor (total)						
-- Road tractor (alone)						
-- Articulated vehicle						

**PROPOSED Table 5**

**Road traffic on national territory by type of vehicle and age of vehicle**

	Road traffic by					TOTAL
	Type of vehicle					
	Passenger car (1)	Bus or coach (2)	Goods vehicle <= 6 tonnes (3)	Goods vehicle > 6 tonnes (4)	Motor cycle (5)	
<b>TOTAL</b>	- vehicle-kilometres -					
<b>Age of vehicle:</b>						
0 year						
1 year						
2 years						
3 years						
4 - 5 years						
6 - 7 years						
8 - 9 years						
10 - 11 years						
12 years or more						

**PROPOSED Table 6.**

**Road traffic on national territory by type of vehicle and age of driver**

	Road traffic by					TOTAL
	Age of driver					
	< 18 years (1)	18 - 24 years (2)	25 - 34 years (3)	35 - 64 years (4)	65 + years (5)	
<b>TOTAL</b>	- vehicle-kilometres -					
<b>Type of vehicle:</b>						
Passenger car						
Bus or coach						
Motorcycle						
Moped						
Bicycle						
Goods vehicle <= 3.5 tonnes						
Goods vehicle > 3.5 tonnes						
of which >3.5 -6 tonnes						
of which > 6 tonnes						

## **5. Road traffic and fuel consumption**

A few European countries use compilation of fuel consumption of road vehicles as basic input for the estimation of the volume of road traffic. Apart from data about fuel supply and fuel consumption account is taken of estimates of unit consumption of fuel per vehicle (litre per kilometre) and average annual kilometres travelled per type of vehicle.

The various, often conflicting, estimates are conciliated on basis of views from an expert board and the outcome is a set of coherent data relating to road traffic, vehicle stock, fuel consumption, unit consumption of fuel (litre per km) and average annual kilometres driven per type of vehicle. An example is presented in Chapter 3d, Table 1.

It is recommended that countries take account of alternative data sources and that they attempt to explain and as far as possible also to bridge the gaps between conflicting estimates.

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