# LONG-TERM TRAVEL SURVEYS: HOW CAN THE BURDEN REMAIN BEARABLE ?

Steven Broekx, VITO, steven.broekx@vito.be

Tobias Denys, VITO, tobias.denys@vito.be

Luc Int Panis, VITO, luc.intpanis@vito.be

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## Contents

**Summary/Samenvatting**


*Onderzoek verplaatsingsgedrag op lange termijn, hoe blijft de last voor de respondent draaglijk?*

Het project “An Activity-Based Approach for Surveying and Modelling Travel Behaviour” heeft als doel om bestaande onderzoeksmethodes voor verplaatsingsgedrag verder te verbeteren. Hiervoor wordt gebruik gemaakt van technologische ontwikkelingen zoals GPS en internet-gebaseerde vragenlijsten. Doelstelling van deze technieken is om o.a. de last voor de respondent tot een minimum te herleiden zodat bevragingen op lange termijn mogelijk worden.

Voor een bevraging van 30 respondenten gedurende een periode van een jaar gaat VITO gebruik maken van een dataregistratiesysteem dat ingebouwd wordt in de wagen. Dit registratiesysteem registreert enerzijds gegevens via GPS en via het ‘Controller Area Network’ (CAN) van het voertuig elektrische signalen zoals snelheid, toerental en brandstofverbruik. Data worden opgeslagen en dagelijks via een GPRS-verbinding doorgestuurd naar een centrale server. Respondenten kunnen geregistreerde gegevens na verwerking raadplegen op een website. Op deze website kan de respondent tripgegevens toevoegen over het doel en het aantal passagiers tijdens de verplaatsing.

In vergelijking met klassieke bevragingsmethodes op papier betekent dit dat de respondent niet langer het begin- en einduur en de afstand van de verplaatsing moet opgeven. Bovendien kunnen vaak bezochte locaties gedefinieerd worden. Op basis van gegevens uit het verleden worden op de website voor routinetrips tussen twee gedefinieerde locaties voorstellen gegenereerd voor het doel van de trip en het aantal passagiers. Respondenten moeten dan nog enkel deze suggesties accepteren.

De verzamelde gegevens zullen voor meerdere doelstellingen gebruikt worden. Op de eerste plaats dienen zij als input om de dynamiek in verplaatsingsgedrag o.a. ten gevolge van gebeurtenissen als feestdagen of verjaardagen beter te simuleren in een activity-based transportmodel. Daarnaast zullen gegevens gebruikt worden als input voor het emissiemodel VeTeSS. Dit model is in staat om op basis van ogenblikkelijke snelheden brandstofverbruik en emissies in te schatten. Dit betekent een nieuwe dimensie op vlak van emissiemodellering. Emissies kunnen in dit geval niet enkel toegewezen worden aan voertuigtypes en wegtypes, maar een onderscheid kan gemaakt worden tussen karakteristieken van bestuurders zoals leeftijdsgroep, geslacht en het motief van de verplaatsing zoals woon-werkverkeer of recreatie.

## 1 Introduction

Travel surveys are an important source of information for transportation planning and decision making. Classical surveys are performed on paper. Respondents are asked to fill out the survey and to return it by mail. These classical data collection methods, also referred to as paper-and-pencil interviews, have several disadvantages. Researchers were faced with omission of trips or trip elements, illegible hand-writing, entry errors and other difficulties (Wolf, 2000). During the past decade, methods to conduct these surveys have undergone tremendous changes. The development of the Internet and other Multimedia methods provided more possibilities to exchange information between respondents and researchers. With the use of technologies such as global positioning systems (GPS) and GSM much more detailed and accurate positional information can be collected. This resulted in the enhancement of data quality on the one hand and reduction of the burden for the respondent on the other hand. These aspects allow for a whole new range of possibilities in the field of travel surveys. Whereas with the paper-and-pencil techniques surveys were restricted to periods between two days and one week, travel surveys can now be performed over much longer time periods. This can provide whole new insights on how personal and household lifestyle can influence daily travel behaviour.

This paper will describe the methodology that will be used to perform a survey with a duration of one year. By means of a vehicle-based logging device and a website, data is collected on trips and trip purposes. Due to the long duration of the survey, special attention will be given to minimizing the respondents burden as much as possible. This survey will contribute to the development of a new activity-based travel model in the Flanders Region of Belgium (Janssens et al., 2005) and better methods for emission estimation (Beckx et al., 2006)

## 2 Technological improvements in data collection for travel surveys

Several technological improvements have taken place in the past decades in collecting data for travel surveys. A first technological enhancement was the use of computer assisted telephone interviews (CATI), computer-assisted personal interviews (CAPI) and computer-assisted self interviews (CASI). In these techniques computer-based questionnaires are used to provide more accurate data and to avoid the tedious process of transferring data from paper to a database. These significant advantages were among others indicated by CHASE (Doherty and Miller, 2000), iCHASE (Lee et al., 1999) and REACT! (Lee and McNally, 2001).

With the introduction of Global Positioning System (GPS) technologies, a whole new range of possibilities occurred. These technologies allowed to log second-by-second position data and time data. Potential advantages according to Wolf, 2000 are 1) the automatic collection of trip origin, destination and route data which reduces the burden for the respondent, 2) recording routes for all trips, allowing for recovery of unreported or misreported trips, 3) accurate logging of trip start and end times and 4) possible verification of self-reported data with GPS-data. The first known study using GPS was vehicle-based and conducted in Austin in 1997 (Casas and Arce, 1999). A device that could be carried outside a car and thereby logging all travel modes was first tested in the Netherlands (Draijer, 1999). These first devices were heavy and there was a resistance to use this equipment during walks, bicycle drives and public transport. However, recent devices are much smaller and lighter (Kracht, 2004) and many of the current GPS-studies use some kind of user interface like a PDA attached to the GPS-device to collect further information about the trip. This technology is also applied to perform a short-term data collection within the Flemish research program “An activity-based approach for surveying and modeling travel behaviour”. Within this short-term survey 2500 respondents are asked to carry and use the PDA-device during two days. Some disadvantages exist with this technology. Power supply is a major difficulty. Batteries have to be recharged regularly, which is an extra burden (Kochan et al., 2005, Beckx et al., 2006). The duration of the data collection is subject to the storage capacity of the device. Performance of the system is also less than in-vehicle systems. (Wolf, 2004) These kind of devices are not really suited for long-term usage. The burden of carrying it around and providing power is too heavy for periods longer than one week. Until now, long-term surveys are limited to in-vehicle systems. An ultimate goal is the elimination of the travel diary. Ideally the travel mode and the trip purpose can be determined by comparing GPS-logged data with GIS databases. This would significantly reduce the burden. Research performed in this field on data loggings from a Swedish ISA-trial indicate however that this is very difficult to handle. Especially in multipleuse environments in urban cores it is impossible to link a specific destination with a unique trip purpose. (Axhausen et al., 2003)

Some research projects use GSM tracking technology to track respondents. By using existing cell phones to pinpoint a respondents position, the burden of carrying a supplementary device would be avoided. However, compared with GPS-technology, accuracy levels are much lower. Highest accuracy levels are approximately 100 meter in dense areas. (Kracht, 2004) Costs charged by network companies to provide positional information, are also significant and requesting data on a second-by-second basis or for longer time periods requires very large budgets. That is why data-logging within this project does not built on this kind of technology.

## 3 The added value of long-term data collection within the development of an activity-based model

Most known travel surveys are restricted to periods between one day and one week. The amount of studies which study longer time-periods is very limited due to cost reasons and a high non-response rate after time. However, during the last decade growing efforts of transport research are directed toward the dynamic processes in travel behaviour. Some studies have already shown that day-to-day variability in travel behaviour exists and is substantial (Pendyala and Pas, 2000). This dynamic behaviour can only be captured by long-term data collection.

The survey described in this paper makes part of the Flemish research program “An activity-based approach for surveying and modeling travel behaviour”. Long-term data will be used to provide the required framework to improve the modeling of the dynamics of travel behaviour. Based on these data analyses can be made on routine behaviour and the impact of key events as holidays or birthdays on travel behaviour. (Cools et al., 2006)

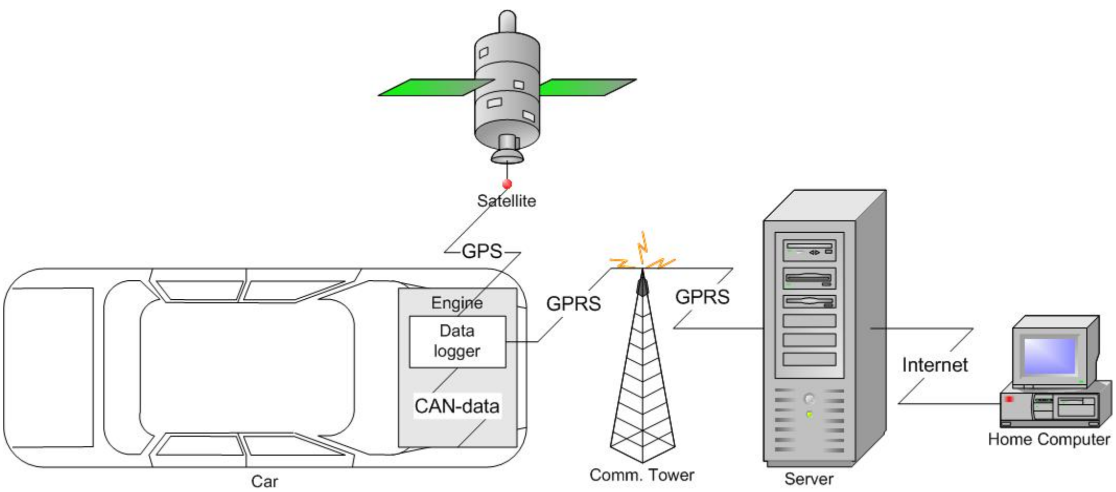
# 4 Applied methodology for the long-term data collection

## *4.1 General set up*

The methodology that is being developed for the long-term survey is a combination of an on-board data logging device and a computer-based questionnaire. The on-board logger receives data from 2 information sources. On the one hand, position data and speed data are collected with a GPS tracking system. On the other hand, electronic engine data are collected by installing the device in parallel with the Controller Area Network (CAN) of the vehicle.

These data are stored on the internal memory card of the on-board logger and transmitted daily to a central server on a GPRS-network. On this central server all data are translated and stored in a database. A web-based application uses a selection of these data (time and position) to provide information to the respondent. Each respondent has a personal login to have a look at the collected data and add information on the driver of the vehicle, the number of passengers and the trip purpose. This information is also stored by the central server.

**Figure 1: General set-up of long-term travel survey**



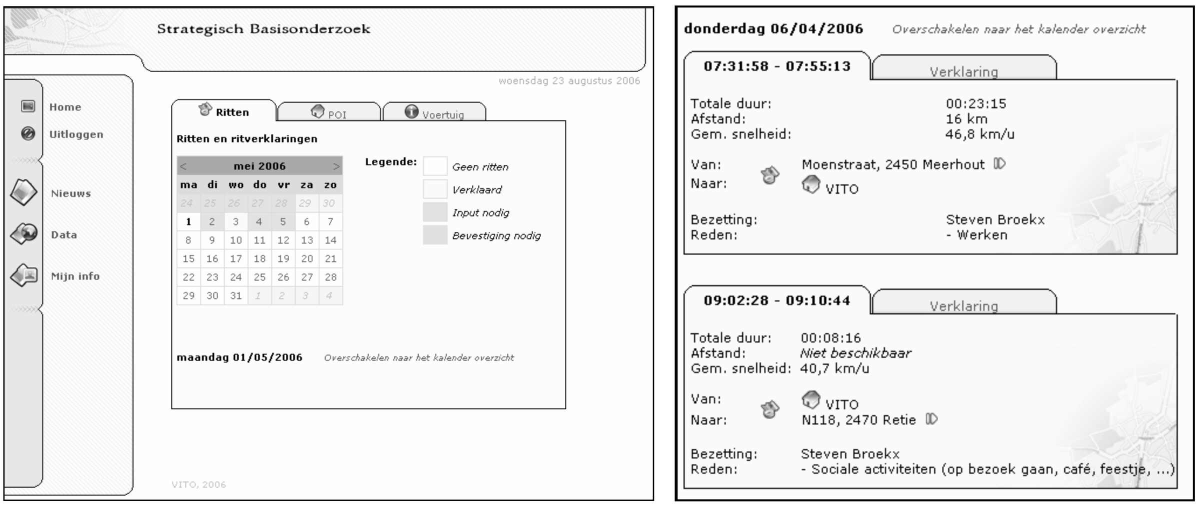

## *4.2 The on-board data logging device*

To perform the travel survey for the long-term data collection, VITO makes use of an on-board data logger. This vehicle monitoring technology consists of a device which is installed in parallel on the 'Controller Area Network' (CAN) of the vehicle. This configuration allows to monitor virtually every electrical signal that passes through the CAN. This includes obvious behavioural parameters as travel distance and speed, but also other less frequently sampled parameters as fuel consumption, number of revolutions, engine temperature and outside temperature. The logging device is also equipped with a GPS-based element. This allows to gather data not only on the behaviour related parameters but also on location of the vehicle. Logged data are transmitted to a central data collection point by means of a GPRS-network. This transmission can be performed on a real time basis or all at once, for example during the night when mobile communication activity and costs are low. Due to the long duration of the trial period, data are only transmitted at night. The logging device is small (approximately 10 by 5 cm) and is installed close to the engine, out of sight of the driver.

### *4.3 The web-based questionnaire*

A web-based questionnaire is used to allow respondents to add information on the number of passengers and the trip purpose. Each respondent has a personal login address. When logging the respondent gets an overview of the present month. Depending on the tasks to be performed the color of a specific day changes. These colors point out whether no drives took place on that day, trip purposes on that day are already explained or still have to be explained. A last option indicates that only confirmation is needed. This means that drives took place between points of interest previously defined. The purpose of the trip and the number of passengers will automatically be suggested and the respondent only has to confirm or alter this suggestion.

**Figure 2: Website and display of activities**



The definition of points of interest is possible each time the respondent visited a new location. After definition all stops taking place within a distance of 100m of that point are recognized as being this point. To encourage drivers to fill in the necessary information, some features are added to the website. Drive data can be consulted. Besides start and end times, distances driven and average speed are given. Driven trajectories can be displayed on maps to strengthen the interest in the survey.

## 5 Further valorization of data collected

Besides travel behaviour a whole other range of possibilities exists to further use the collected data. A first important application is the collection of more accurate data on driving speed. A parameter that is important in the evaluation of many policies on road safety and the environment. At the moment average speeds are derived from speed control data. These data are not representative for all traffic conditions. In Flanders not much is known about the effects of time (daytime versus nighttime, winter versus summer), weather conditions (rainy versus dry weather) or traffic conditions (peak versus off-peak) on actual driving speeds. By analyzing the collected data and linking them to GIS-maps a more complete picture can be drawn on driving behaviour.

Another foreseen valorization step is using driving data for studying impacts on exhaust emissions. Logged speed data will be fed into VeTeSS, a microscopic emission model. This model was developed by MIRA and VITO in the European DECADE project and is able to calculate instantaneous fuel consumption and emissions based on instantaneous speed (Pelkmans et al., 2004). This will allow a new dimension in the field of emission modeling. Not only can emissions be attributed to specific vehicle types or road types, but distinction can be made between driver characteristics as age group or gender and travel motive as work, shopping or recreational activities (Beckx et al., 2006). To study potential impacts on driving behaviour, a teaching course on economical driving after six months. By looking into driving data on speed, fuel consumption, engine velocity and gear selection before and after this course, a detailed analysis can be made on the effectiveness of these courses and on the potential of how a changing driving style can influence total fuel consumption and emissions.

Driving style differences have been shown to have significant impacts on emissions (De Vlieger et al., 2000) and policies that try to reduce emissions (Int Panis et al., 2006).

## 6 Discussion

To study the effects of dynamic travel behaviour, long-term travel surveys are needed. Due to technological advancements made in the field of tracking systems and computerized questionnaires, the burden to collect travel data can greatly be reduced. In the methodology described above, following data given by the respondent in classic paper-and-pencil surveys are now generated automatically:

- time of departure
- origin and destination
- trip duration
- trip purpose of routine trips

Avoiding these tasks should enable to perform a continuous survey over one year without being faced with a large number of respondents dropping out. Only a small sub sample of 30 people will be surveyed. This means that representativeness cannot be attained and that no real conclusions for the whole of Flanders can be drawn. However this first test will provide new insights on the long-term reliability of the technology and on how eager respondents remain to cooperate. A question that certainly can be answered at the end of the trial is: “Has the burden been reduced enough to perform surveys during one year?”

The applied on-board technology does not allow for the collection of non-vehicle displacements. This is a large drawback of this kind of technology. Possibilities of using personal trackers in combination with the on-board logging device will be examined during the project. Objective is to integrate data from both data sources on the web-based questionnaire. The usage of a personal tracker will not be tested during the complete duration of the survey but during the occurrence of key events.

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