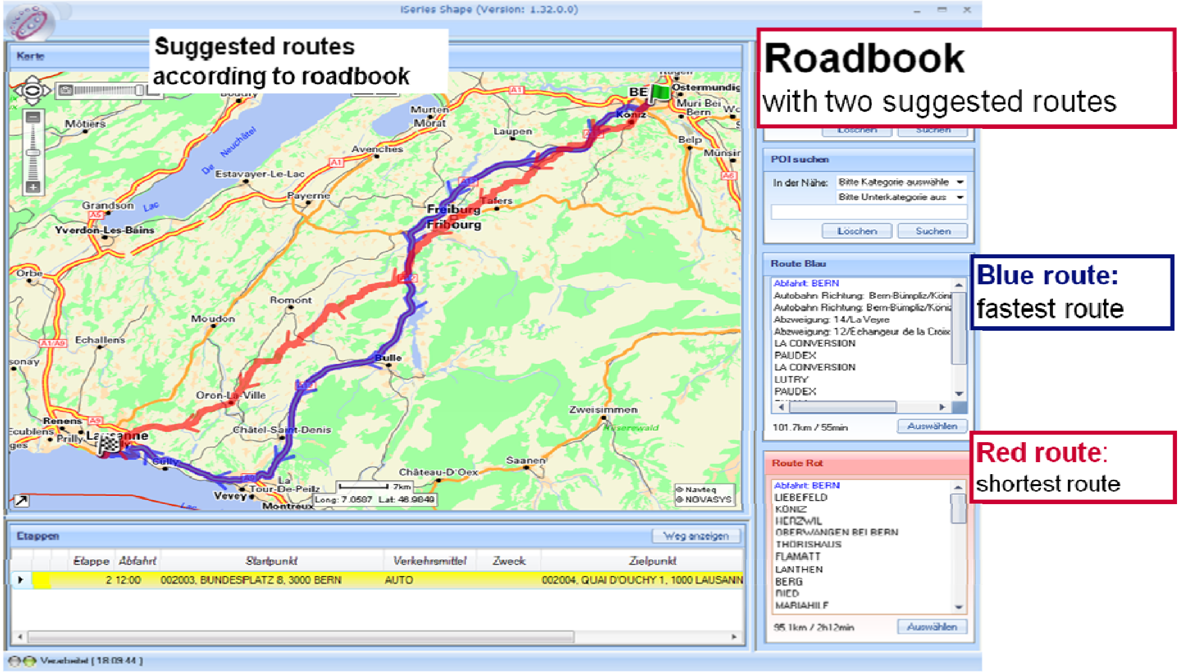

Swiss Microcensus on Mobility and Transport 2010

Introduction of the routing-tool and adjusting estimated distances in previous Swiss Microcensuses on Mobility and Transport

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Abstract

The Swiss Microcensus on Mobility and Transport (MCMT) – conducted every five years since 1974 – featured an all-time high in 2010 in regards of people interviewed and data collected: The 2010 microcensus was able to acquire comprehensive data on household and personal information as well as, for the first time in the history of the MCMT, GIS-based (Geographical Information System) recording of personal travel routes of the 62’868 surveyed individuals. The MCMT 2010 explored the possibilities of CATI (*Computer Assisted Telephone Interview*) interviews and in this paper the methodological advances for this survey will be discussed in detail.

Route-recording is a key new feature of the MCMT 2010. Whereas in previous microcensuses information on distances was based on respondents' estimates, the MCMT 2010 for the first time supplements these estimates with the effective distances determined by means of routing. Given the far greater accuracy of routed distance data compared to subjective estimates, the routed distances were applied for all distance-related analyses.

To ensure that the MCMT 2010 remains comparable with previous surveys despite the methodological changes, the distance data for private motorized transport (PMT), public transport (PT) and "other" modes of transport in the 1994, 2000 and 2005 microcensuses were recalculated. The journey stage distances in these surveys were adjusted through the application of correction factors derived from a comparison of the estimated and routed distances in the 2010 survey.

Keywords

Mobility, travel, survey, microcensus, methodology, CATI, GIS

1. Swiss Microcensus on Mobility and Transport – status report and aim of this article

Ever since 1974, the travel behaviour of the Swiss residential population has been surveyed every five years. The degree of detail contained in the questions, and the methodology of the survey, have continued to develop throughout this period. The latest survey – the 2010 Microcensus on Mobility and Transport (MCMT 2010) – was conducted for the reference year of 2010 by the Federal Statistical Office (FSO) and the Federal Office for Spatial Planning (ARE) as part of a comprehensive CATI survey (*Computer Assisted Telephone Interview*). LINK, which has offices in Lucerne, Lausanne and Lugano, was the market research company responsible for the programme and for conducting the survey itself.

The 2010 survey was held in connection with Switzerland's redesigned census for the first time. Taking into account the increases in sample size in the individual cantons, 62’868 individuals were asked about their travel habits. In addition to the detailed recording of daily mobility (number of trips and stages, travelling time, distances, purpose of trip and use of different modes of transport), the MCMT 2010 also gathered basic data on the ownership of vehicles, driving licences and season tickets for public transport. Furthermore, in a series of additional modules, the MCMT 2010 was devoted to the themes of one day journeys, journeys with overnight stays, non-motorized transport, and attitudes to transport policy in Switzerland.

Taken together, the data that was collected present a detailed picture of the travel behaviour of the population in Switzerland. These key national data serve not only as a statistical basis for preparing political action and monitoring its success, but also as inputs to more in-depth analyses of travel trends, spatial planning, environmental conservation and the Federal Government's energy strategy.

For the first time, the actual routes traveled are recorded using GIS (Geographical Information System) software and, thus, provide information on the routes selected and distances covered within the methodological framework of the MCMT 2010. The enhancement of the traditional CATI survey environment with a GIS client enabled the interviewers to comfortably route and record the stages travelled during the interview in real-time. This technique of enhancing CATI frameworks with GIS software is ground-breaking on both the national and international level. This method allows to make precise statements regarding distance, types of road and train classes used, calculation of route selection models to assess complex decision-making processes and offers a great basis of data for further in-depth analysis.

Although the geocoded routes of the surveyed individuals allow to calculate the distance travelled, the interviewees were also asked to give an estimate of the distance travelled, as had been the practice in previous surveys. Thus, an adjustment factor can be calculated to ensure comparability back to 1994 (a difference in the methodological conception prior to 1994, the change from an trip-based to an stage-based interview, makes comparisons to surveys conducted earlier than 1994 unreliable).

The objective of this article is to present these methodological changes in and experience from the empirical MCMT 2010 survey regarding the route-recording technique. Furthermore, it outlines the method adopted for adjusting the distances in the 1994-2005 microcensuses. Drawing on the findings of this examination of the latest microcensus, it concludes by formulating opportunities for improvement and enhancement.

2. Methodological changes – recording choice of route and route distances

2.1 Ground-breaking route-recording in the MCMT 2010

With its routing facility, the MCMT 2010 set new standards for telephone surveys. This new approach explores anew the methodological, technical and practical boundaries of a telephone interview (cf. Ohnmacht et al. 2011).

Computer-aided telephone surveys have been conducted in Switzerland for over 25 years now. At first, the use of computers during the interview was seen as revolutionary, but the CATI method has now become an integral part of telephone surveys. The options for CATI use, and the demands that the approach must satisfy, have risen markedly in recent years. With the right open interfaces with the CATI software, it is now possible to incorporate not only data files, audio media and databases into a CATI survey, but also entire programme applications.

With this in mind, the MCMT 2010 is a prime example of the new possibilities offered by telephone surveys. Integrating routing software seamlessly into the classic CATI survey environment makes it possible to perform georouting by telephone, and thus during the interview itself.

2.1.1 Stage as the smallest unit in travel recording

Key date mobility covers the reference day about which the respondent is later interviewed by phone about their mobility. In this system, a stage is the smallest unit of key date mobility that is recorded. It constitutes a portion of a trip completed with the same mode of transport, which includes walking. Anyone riding their bike to the railway station, then taking the train and walking from the destination station to their workplace thus completes three stages in their trip.

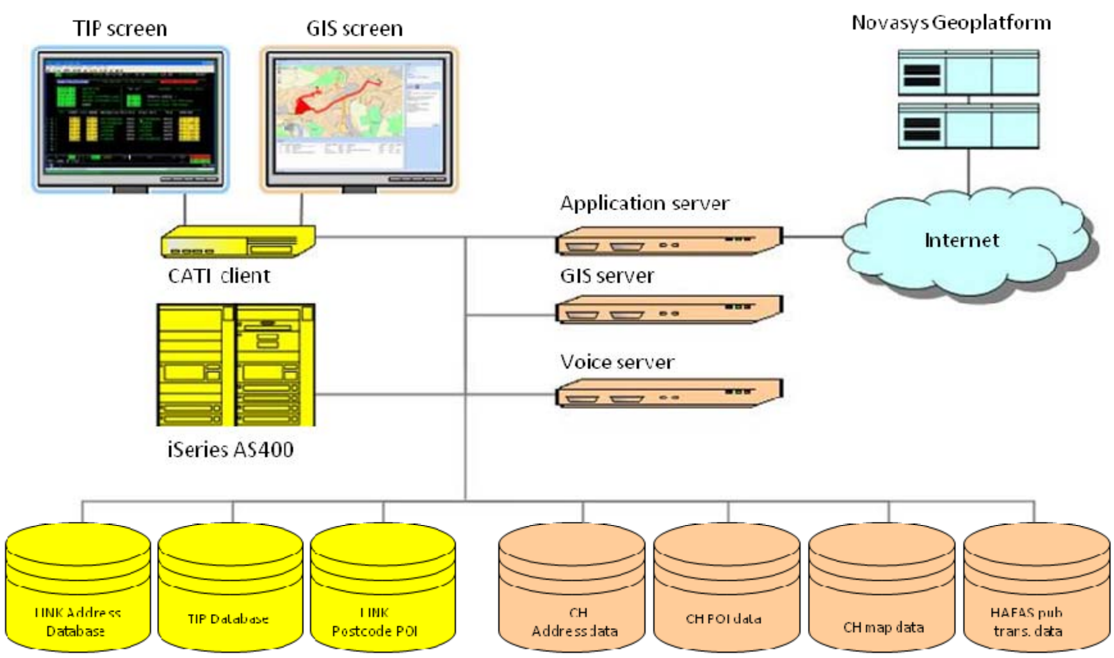
When capturing key date mobility, the survey records all of the stages completed by the respondent. The questions about these stages cover choice of mode of transport, the start and end points of the journey, the distance travelled and the times of departure and arrival. Previous MCMT surveys, however, have not been able to capture the actual route travelled between the start and end points of the stage, i.e. the choice of route.

As in earlier surveys, respondents estimated the distances covered in the individual stages travelled on the key date. In this latest survey, however, specific stage data attributes were recorded which showed the routes actually travelled by MCMT 2010 respondents. These attributes were then used to calculate the distances covered.

2.1.2 GIS application incorporated into CATI

A proprietary GIS (geographical information system) application was developed for the MCMT 2010 to ensure the best possible geocoding of start and end points, as well as for actual routing calculations. The complete integration of the GIS client in the CATI system guarantees that geographical information can be processed efficiently as part of regular CATI surveys. Data are available synchronously on both systems at all times, and are visible to interviewers on the same screen in two different windows. Users can switch easily from one system to the other (See Figure 1).

Fig. 1 Hardware and software concept for the MCMT 2010



Searches are conducted primarily using the CATI client, but the GIS client is used to set approach points and verify routes. This allows the rapid online database functions of the telephone interview environment to be used to save time. Since the CATI client controls the GIS client in real time when mobility data is being entered, the routes are visualised in parallel, without the interviewers having to switch program or do anything else. In the overall MCMT concept, all of the necessary hardware and software components are installed locally, which avoids slow access via the internet and eliminates external factors that cannot be controlled.

2.1.3 Several databases – one search system

Using several databases within a single system optimally supports searches for each stage start and end points. The MCMT 2010 worked with the following databases:

- Buildings and dwelling register (*Gebäude- und Wohnregister GWR*)
- Business and enterprise register (*Betriebs- und Unternehmensregister BUR*)
- The Swiss Federal Railways' HAFAS station and journey register
- The Navteq POI (Points Of Interest) file.

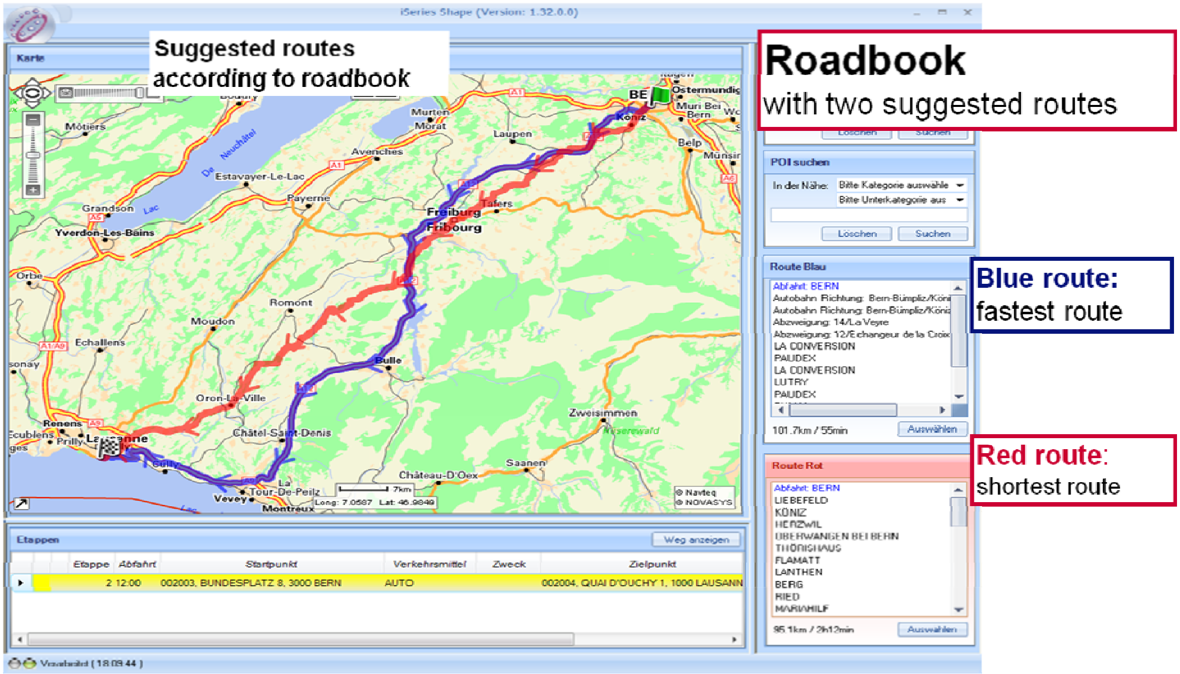
Furthermore, interviewers can also call up and copy points that have already been entered. This applies not only to stage points entered in connection with key date mobility, but also special points such as residential addresses or places of work or training which had already been recorded in the first part of the survey.

2.1.4 Route-recording for private motorized transport: route verification during the interview

The interviewer asks the respondent to describe briefly the route they chose to take between the start and end points of their stages. On the basis of the information they receive, the interviewer then decides on one of the two routes calculated and shown by the GIS client (either the fastest or the shortest route).

To aid their decision, the interviewer can consult not only the route options shown on the map, but also the points along the route that are listed in what is known as a "roadbook" (See Figure 2).

Fig. 2 GIS client – route selection for private motorized transport

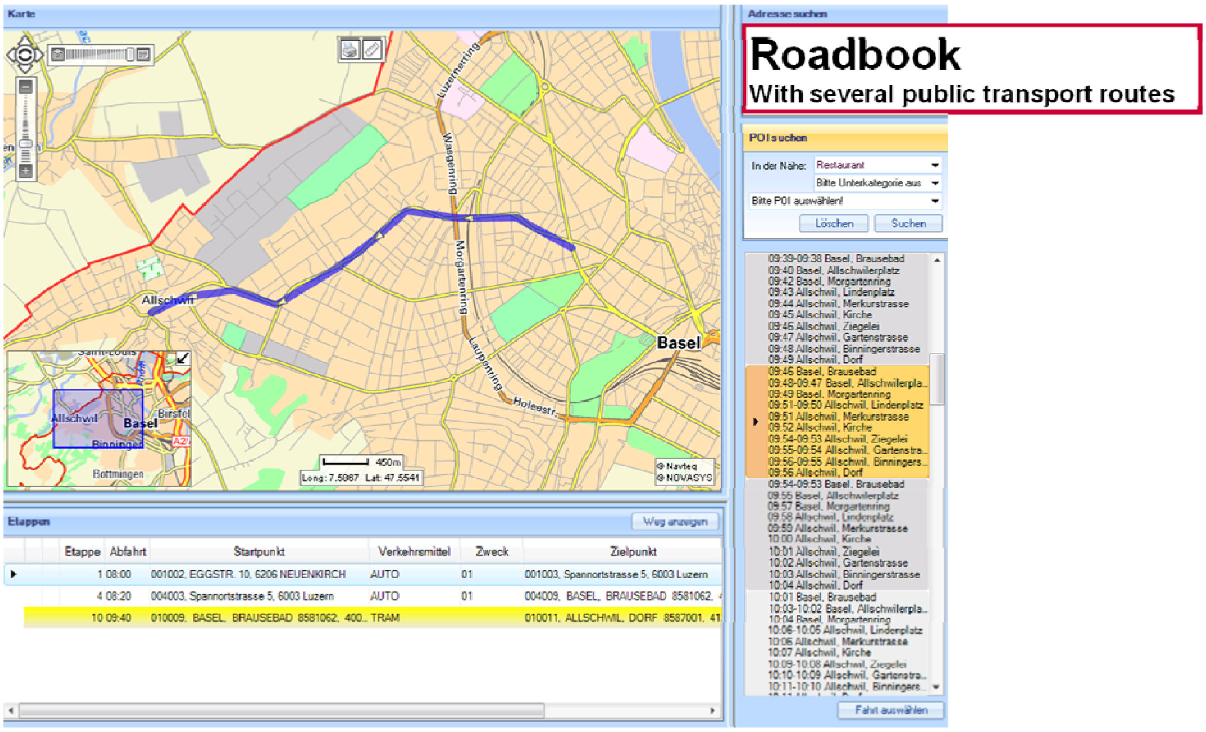


Having chosen a route, the interviewer confirms two of the given verification points either directly on the map or in the roadbook. If the route points that are given are not found along the route that is shown, or listed in the roadbook, the proposed route or the verification point can be moved using the drag and drop function. Information from the roadbook is particularly helpful in the case of longer journeys, as it often matches the details provided by the respondent, such as motorway junctions, interchanges and local transit routes, etc. However, in many cases the information that respondents give with respect to shorter local journeys cannot be shown using conventional urban and road network data. In such cases, the comprehensive point of interest (POI) database can offer additional landmarks and points of reference, whether shops, local attractions, restaurants, or public transport stops, etc. (See Figure 2). Moreover, in addition to the traditional map view, interviewers can always access an aerial photograph, which is helpful when the respondent mentions a prominent feature such as a church or park. Voice recording is used to register searches in the GIS client. If a point cannot be determined, or not determined fully, then automatic voice recording during the search process is used for subsequent encoding. This increases the accuracy of later encoding work, and shortens the interview considerably.

2.1.5 Route-recording for public transport: choosing the right connection

Based on the given departure and arrival times, the GIS client uses timetable data to calculate all the possible connections within the defined time window. As shown in Figure 3 using the rail example, the various timetable options are shown both graphically (as a polyline between stations/stops) and in the roadbook. Once the correct connection has been selected, the actual route will be displayed or – in the case of road-based public transport – calculated between the stops visited using the shortest possible route algorithm.

Fig. 3 GIS client – route selection for public transport



2.1.6 Route overview and opportunities for correction during the interview

When recording a route, checking and/or modifying the chosen route is at least as important as the technical support offered by the GIS client. Interviewers can therefore check the recorded route again at any time, either using the log book which lists chronologically all of the stages that have been entered, or with the aid of the entire daily route profile that is shown on the map.

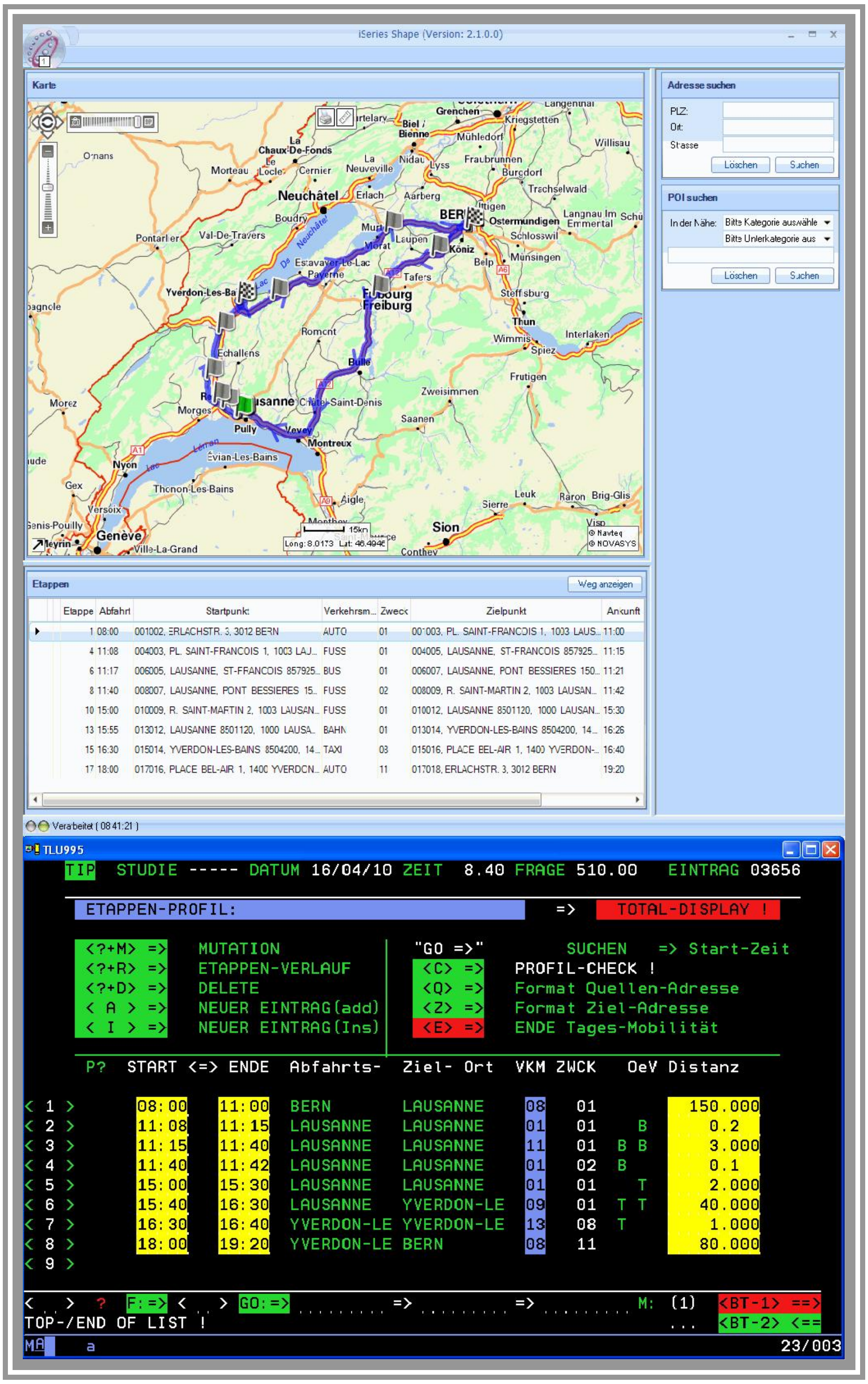
As can be seen in Figure 4, the log book contains the start and end points, departure and arrival times, the activity at the stage's end point, the mode of transport used, the purpose for the trip as a whole, and the estimated distance for each stage of the respondent's trip. This gives the interviewer a rapid overview of the stages that have already been recorded. This information can be corrected or amended at any time. Stages can be changed, deleted, added at the end or inserted at an earlier stage in the trip. In addition to the automatic map display of the entire daily route profile, each stage may be shown separately. Once changes have been made, the interview may be resumed as usual, or the interviewer may continue to enter information on daily mobility.

2.1.7 Ensuring the full capture of daily mobility and a complete chain of journey stages

To ensure that a complete chain of stages has been recorded, when the user leaves the mobility section the CATI program conducts a profile check on all log book entries. Gaps in the chain of stages are flagged up so that the interviewer can address these gaps specifically. The interviewer can also actively trigger a profile check at any point during the interview. The program does not permit time overlaps. Should they occur nonetheless, they must be corrected when the stages are entered, or where appropriate via the change menu.

In addition, at the end of the mobility section the system compares the activities recorded in the course of the day with the daily activities on which specific questions were asked at the beginning of the interview. Any discrepancies must be clarified and completed or corrected in the daily profile.

Fig. 4 Interview screen for the MCMT 2010 survey showing the CATI and GIS clients – overview and change menu



2.1.8 Ground-breaking route-recording in the MCMT 2010

The method of recording routes described above and used for the first time within a CATI framework in the MCMT 2010, is ground-breaking at both the national and international levels. A comparison between Belgium, Denmark, Finland, France, Germany, the Netherlands, Spain, Sweden, the USA and Switzerland shows that the MCMT 2010 was the first time that choices of route had been recorded (according to Cenicciaro and Roux 2009, Armoogum 2007, Kunert et al. 2002).

Recording an individual's route offers the following advantages compared with earlier MCMT surveys:

- The distance actually travelled is recorded, rather than the often-imprecise estimates given by respondents
- Traffic volumes can be broken down into different types of road and train class
- It permits route selection models to be calculated; these may reflect the complex decision-making patterns exhibited by road users, for example, according to the reason for their journey
- Route attributes (such as the number of roundabouts, traffic lights or billboards to be negotiated) can be used for more in-depth analyses.

3. Route recording: Method for Adjusting Estimated Distances in Previous Microcensuses

Route-recording is a key new feature of the MCMT 2010. Whereas in previous microcensuses information on distances was based on respondents' estimates, the MCMT 2010 for the first time supplements these estimates with the effective distances determined by means of routing. Given the far greater accuracy of routed distance data compared to subjective estimates, the routed distances were applied for all distance-related analyses.

To ensure that the MCMT 2010 remains comparable with previous surveys despite the methodological changes, the distance data for private motorized transport (PMT), public transport (PT) and "other" modes of transport in the 1994, 2000 and 2005 microcensuses were recalculated. The stage distances in these surveys were adjusted through the application of correction factors derived from a comparison of the estimated and routed distances in the 2010 survey.

3.1 Plausibilisation

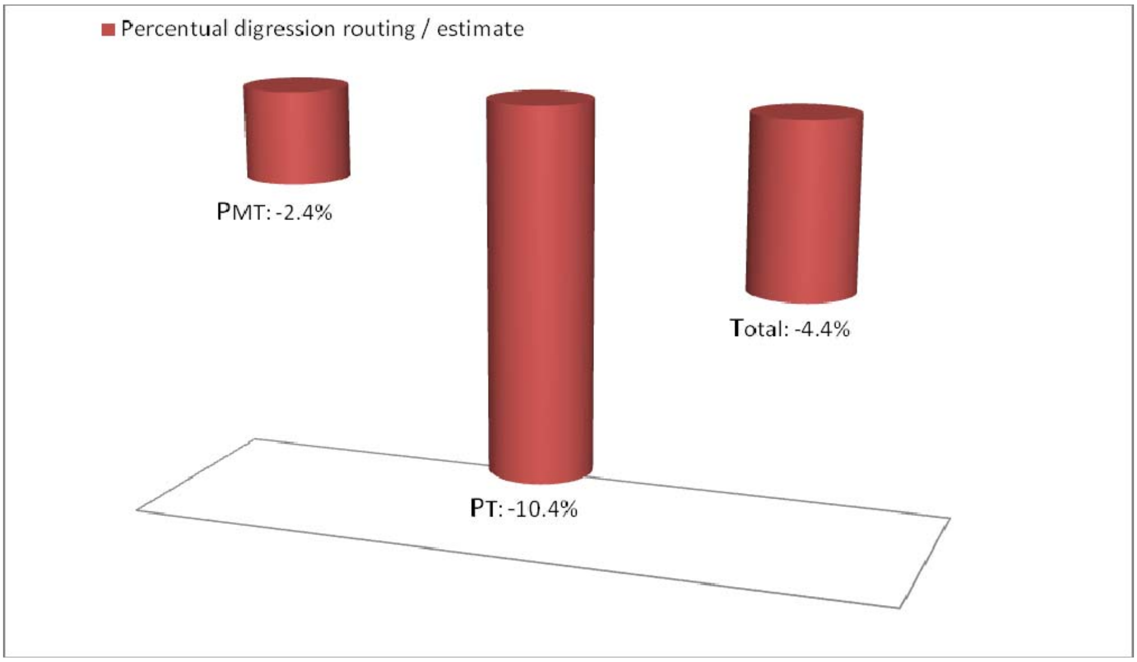
High-quality geocoding is essential for successful routing. In the MCMT 2010, 93% of the stage points and 97% of residential addresses could be geocoded down to the precise address. This excellent basis of data ensured that the launch of routing within the MCMT 2010 survey was a success. All in all, 87% of the stages could be routed successfully (81% of stages by public transport, and 96% of the stages travelled by private motorized transport).

After the data had been gathered, the route distances were compared with the distances between the start and end points of the stage. This involved taking the distance as the crow flies and multiplying it by a correction factor of 1.3. For stages travelled by private motorized transport or public transport that could not be routed successfully (e.g. stages travelled abroad, stages in which the start and end points could not be determined with sufficient certainty), the routed distance was imputed using a corrected estimated distance. Correction factors for these estimated differences were calculated using the gap between estimated and routed distances from the MCMT 2010. Where private motorized transport and public transport are concerned, the routed distances are fed into official traffic and travel statistics. Extensive analyses of non-motorized transport have revealed that digital representations of walking and cycle routes are not sufficiently precise for routing also to be applied to these modes of transport. For example, paths that are chosen as short cuts, or narrower paths across squares or areas of land, are frequently ignored by digitized representations of transport networks. Automated routing for non-motorized traffic also often neglects the fact that stages travelled for leisure (e.g. on walks or cycle rides) often do not take the most direct route.

3.2 Differences between estimated and routed distances

The accuracy of reported distances is a centre-stage question in travel behaviour research (Stigell and Schantz (2011), Witlox (2007)). It is also researched in the field of cognitive psychology (Thorndyke (1981)). The relationship between routed and estimated differences, and comparability of the MCMT 2010 with previous studies, is of particular interest (see Chalasani et al. (2005) for a study comparing various measures for Switzerland). It can be seen from Figure 5 that, based on the daily distance travelled within Switzerland by the Swiss resident population, routed distances are an average of 4 percent lower than estimated distances. Concerning PMT, it can be assumed that the information on kilometres travelled that is given on signposts, the vehicle dashboard and in navigation aids enables respondents to make valid estimates of physical distances. In the case of public transport, routed distances are some 10 percent lower than estimated distances (Figure 5).

Fig. 5 Differences between estimated and routed distances, based on daily distance travelled within Switzerland using primary modes of transport



Source: FOS/ARE, 2012, own evaluations (62,868 respondents)

Since the latest survey uses routed distances rather than estimated distances, it can be compared with earlier microcensuses only if correction factors are applied. In this way, the estimated distances from previous surveys can be adjusted in line with the MCMT 2010. Routed distances cannot be compared with the surveys prior to 1994, however, because the corrections are stage-based, and the stage concept was not introduced until that year.

Different correction factors are calculated for aggregated modes of transport (non-motorized transport, private motorized transport, public transport, and other) and distance classes. A significance test, in the form of a *t*-test, is performed on the basis of the difference between the estimated and routed distances. The correction factor is then calculated according to the following formula:

$$Corr = Median\left(\frac{dRouted\ 2010}{dEstimate\ 2010}\right)$$

The median is used to limit the impact of outliers. The correction factors are calculated for earlier surveys for all modes of transport except non-motorized transport. This calculation excludes stages for which no routed distance exists and stages whose start and end points cannot be determined at least as accurately as the roads concerned, and which are less than 5 m apart as the crow flies.

3.3 Adjustment of distances in 1994, 2000 and 2005 microcensuses

For time series analyses, the distance data for the private motorized transport, public transport and "other" categories in the 1994, 2000 and 2005 microcensuses were adjusted using correction factors derived from a comparison of the estimated and routed distances in the 2010 survey. The correction factors were applied at stage level. The applied correction factors varied according to transport category and distance class (stage length). The individual correction factors are presented below by transport category .

3.3.1 Private motorized transport

For private motorized transport (moped, scooter, motorcycle as driver, motorcycle as passenger, car as driver, car as passenger), the following correction factors were applied depending on the journey stage distance:

Distance class	**Correction factors**
0 - <1 km	1.008
1 - <3 km	0.915
3 - <10 km	0.870
10 - <20 km	0.893
>= 20 km	0.981

3.3.2 Public transport

For public transport (rail, Postbus, bus, tram), the following correction factors were applied depending on the journey stage distance:

Distance class	**Correction factors**
0 - <1 km	0.973
1 - <3 km	0.940
3 - <5 km	0.880
5 - <10 km	0.797
>= 10 km	0.936

3.3.3 Other

For the "other" transport category (taxi, coach, truck, boat, plane, rack railway, funicular, cable car, chair lift, ski lift, vehicle-like devices, miscellaneous), the following correction factors were applied depending on the journey stage distance:

Distance class	**Correction factors**
0 - <1 km	0.936
1 - <3 km	0.874
3 - <10 km	0.746
>= 10 km	0.891

3.3.4 Non-motorized traffic

As the 2010 Mobility and Travel Microcensus continued to use distance estimates for non-motorized (i.e. pedestrian, cycle) traffic, no adjustment of previous survey data is needed. Comprehensive analyses have shown the digital representations of walking and cycle routes to be not yet sufficiently precise to allow the application of routing to these modes of transport. Nor does automated routing for non-motorized traffic allow for the fact that the most direct route is frequently not selected for stages travelled during leisure time (e.g. when walking or cycling). For these reasons, the application of distance estimates was retained for non-motorized traffic.

3.3.5 Application example

The application of the correction factors described above is illustrated by the following example, which uses fictitious data.

Household no.	**Respondent no.**	**Journey stage no.**	**Mode of transport**	**Estimated distance**	**Adjusted estimated distance**
1234	1	1	On foot	0.300	0.300
1234	1	2	Car as driver	5.000	5.000*0.870 = 4.350
1234	1	3	Car as driver	2.000	2.000*0.915 = 1.830
1234	1	4	Bus	4.000	4.000*0.880 = 3.52

4. Outlook: opportunities for improvement and enhancement

As the MCMT 2010 shows, the right interfaces in the CATI system offer a wide range of new opportunities. Integrating a routing application into CATI software for the first time was a ground-breaking move not only in the recording of mobility, but also in telephone interviewing research *per se*. The steady integration of specific program applications into the regular CATI survey environment opens up new and pioneering opportunities for telephone interviewing, the capacities of which we are only just beginning to explore.

The MCMT 2010 has demonstrated that routing is possible during a telephone interview. Possible changes in the light of the survey include:

- Improvements to routing for non-motorized transport (possibly with verification)
- Improvements to routing for road-based public transport
- VFR (VISITING FRIENDS AND RELATIVES) geocoding using a name search in a telephone database in the field (e.g. tel.search.)

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