"Transport Statistics"

WORKING GROUP ON “PASSENGER MOBILITY STATISTICS”

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Jean Monnet Building, Room M5

Beginning 10:00 am

Data Weighting and Projection

*Item 5.4 of the agenda*
Design and Application of a Travel Survey for European Long-distance Trips
Based on an International Network of Expertise

- 5th Framework Programme
Competitive and Sustainable Growth

- European Commission – DG TREN

Data Weighting and Projection

- University for Bodenkultur –
Institute for Transport Studies
AUSTRIA
1 INTRODUCTION
The goal of the weighting procedure is to avoid any bias of the target characteristics of the DATELINE survey. Whenever bias is found, known or presumed to exist in the raw data set of a survey, weighting is necessary. This is necessary for instance if the response rate is less than 100%. Generally, assessment of bias is done by comparing certain key variables of the sample with recent data of the population and other possible sources of benchmarking. In addition to the weighting procedure mentioned above grossing up steps are conducted with respect to the specific survey design of DATELINE.

2 DEFINITION OF USABLE RETURNS
For the DATELINE project, the minimum amount of information required to qualify as a usable return is defined as follows:

- Age
- Gender
- Destination of journeys
- Duration of journeys
- Purpose of journeys

This means, only interviews yielding at least this information were counted. In a second contact, survey organisations explored for any missing items that may have been forgotten to be collected or reported. All returns included in the final database contain the defined minimum information, all others were skipped and deemed not usable.

3 REFERENCE DATA
In order to provide an anchor point for weighting, a set of population reference data for each of the involved countries was needed. For DATELINE, type, aggregation level and reference date of the data have been defined to achieve a homogeneous basis for the weighting procedure. The following socio-demographic information was used on NUTS1 level:

- Gross distribution of gender (male – female) and age (2 x 5 classes)
- Distribution of household size
- Distribution of employment status (8 classes)
- Cars per household
4 VALIDATION SURVEYS
Two special surveys were developed to examine the influence of unit and item non-response. Both surveys delivered information directly used in the correction process and the weighting of data.

For the unit non-response, a number of key questions were posed to 10% of the non-respondents of the main survey. This enabled an evaluation of their long-distance travel behaviour. The outcome was compared with that of all the regular respondents of the main survey.

In the exploration survey, 5% of all respondents were asked for journeys they might have accidentally omitted or forgotten to report in the main survey. In addition, all journeys previously reported were validated via reiteration and double-checking. The weighting procedure considers in its analysis the influence of this item non-response for given journey variables.

5 THE CONCEPT OF WEIGHTING AND GROSSING UP

5.1 General Information
The weighting procedure was split into the following steps (Figure 5-1):

1. Weighting of the non-response bias
In particular the response speed related to the key parameters of the unit non-response survey was analysed (response speed analysis). The target characteristics of the travel behaviour resulting from the main survey and the non-response survey were compared.

2. Weighting on household and person level using national data of the population
In this step the data were weighted using socio-demographic characteristics such as household size, age, gender and employment status. Furthermore, the influence of existing differences in the selection probability, the car ownership of the household and the seasonal distribution of the response was analysed and corrected.

3. Grossing up on journey level, Phase I
Since the questionnaires were designed for the detailed reporting of only 3 holiday journeys, 6 other private journeys and 6 business journeys, the number of given additional journeys had to be taken into account by calculating grossing-up factors for each journey purpose.
Also, the reporting period of 3 months for private and business journeys had to be projected to one year.

(4) Grossing up on journey level, Phase II
A grossing up was done for non-response in the second phase and the applied selection procedure.

(5) Correction on journey level using the output of the validation surveys
In this step the influence of non-reported journeys (exploration survey) was analysed.

(6) Grossing up to the total population
In order to derive mobility parameters applicable to the total population, results from the weighting and grossing up procedure were multiplied to fit the population in each zone (households or persons).
Figure 5-1: The Weighting Procedure – household survey

6 UNIT NON RESPONSE

One issue associated with surveys is that the response rate is usually less than 100%. Thus, only the travel behaviour of respondents is known, while that of the non-respondents remains concealed. In order to be able to make calculations for the whole population, the long-distance travel behaviour of non-respondents has to be analysed.
6.1 The Response Speed Analysis

The analysis of the target variables of respondents compared with the response speed shows the relation between response behaviour and travel behaviour. The aim is to find a suitable mathematical function in order to be able to extrapolate the cumulative figures of the respective values investigated for a response rate of 100%. A polynomial function of the 2nd order was found as best befitting the number of journeys per households and year. Figure 6-1 for example, shows the response speed for Austria (household survey).

Figure 6-1: Response speed analysis, cumulative, Austria (postal household survey)

6.2 The Non-Response Survey

The socio-demographic characteristics and the travel variables of reported journeys of both respondents and non-respondents were analysed. Since the sample size of the non-response survey was too small in many countries, no significant differences between the group of respondents from the main survey and those of the non-response survey were found. However, the results from the response speed analysis described above were tested for plausibility against trends apparent in the non-response survey.

Only for the number of journeys, not for the distance or duration of journeys, a significant non-response effect was found. The calculation of appropriate weighting factors for this non-response effect was based on the mean value of the number of journeys per household or person. The response speed analysis showed, that the group of non-respondents in postal
household surveys is less mobile, as far as long-distance travel is concerned, than the group of respondents. For telephone person surveys, the opposite effect was observed.

7 SEASONAL DISTRIBUTION OF RESPONSES

The survey month has an influence on response rates. The response behaviour is supposed to be different, for instance, during the summer holiday season. In calculating general figures over the whole year, this seasonal bias effect had to be taken into consideration. A calculation on a monthly basis was not possible due to the small monthly sample size; thus, the weighting for seasonal distribution was conducted on a quarterly basis.

Figure 7-1: Quarterly distribution of returns for NUTS 901 (zone of Italy)

8 INFLUENCE OF THE SAMPLING FRAME

One major problem is the difference of a probability for a survey unit to be selected. In principle, three different types of registers exist:

- Person register
- Household register
- Mixed register (person and household)

Related to the sample of respondents, the distribution of household sizes was analysed and compared with that of the total population. Then a respective weighting carried out.
9 CAR OWNERSHIP
The socio-demographic characteristic “car ownership” also has an influence on long-distance travel behaviour. Relevant population data is available in two different forms:

- Number of households by “car ownership class”
- Average number of cars per 1.000 inhabitants

The distribution of car ownership related to the sample of respondents was analysed with reference to the total population. For this step, car ownership was classed in the following way:

- Household without car
- Household with 1 car
- Household with 2 cars
- Household with more than 2 cars

In cases where the number of cars per 1.000 inhabitants was available, the average number of cars per 1.000 inhabitants was calculated for the sample and compared with the figures given for the total population. For the weighting procedure the group of respondents was divided into three classes:

- People or households without car
- People or households with 1 car
- People or households with at least 2 cars

Weighting factors for the first and the third class were calculated from the distribution based on calculated numbers per class.

10 SOCIO-DEMOGRAPHIC BIAS
Other socio-demographic characteristics such as age, gender and employment status, too, have an influence on long-distance travel behaviour. If the sample of respondents showed a distribution different from that in the total population, weighting on person level was done to reduce bias. For this purpose, the socio-demographic characteristics were classed in the following way:
• Age classes:
  < 15 years / 15-24 years / 25-44 years / 45-64 years / > 64 years
• Gender:
  male / female
• Employment status:
  full time employed / part time employed / at school, university / retired / home duties / looking for work / not yet in school / others

11 GROSSING UP THE JOURNEYS TO 12 MONTHS
The DATELINE questionnaire asked respondents to report their journeys in the following way:

• Holiday journey: 3 journeys reported in detail + number of additional journeys in the reporting period
• Business journey: 6 journeys reported in detail + number of additional journeys in the reporting period
• Other private journey: 6 journeys reported in detail + number of additional journeys in the reporting period

In rare cases, some reported journeys had to be excluded from the data set, because they were below the 100 km “crow-fly” distance. When this occurred, the assumption was made that the proportion of journeys below 100 km would be similar in the group of additional journeys, so that the following analysis was carried out:

• Analysing the number of additional journeys reported by the respondents
• Analysing the number of the excluded journeys
• Investigating the respective reason for these exclusions

Prior to the inclusion of additional journeys in the total number of journeys, a recalculation was necessary using a factor that takes account of the proportion of excluded journeys.

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1 In some cases, classes had to be aggregated into new classes, because data had not been available for the aggregation level needed.
12 GROSSING UP PHASE 2 TO PHASE 1

Having used a predefined selection procedure for journeys relevant to Phase 2, it was necessary to gross up this information. The two main reasons were (see Figure 12-1):

- Not all journeys relevant to Phase 2 were included
- The response rate of Phase 2 was sometimes below 100%

![Figure 12-1: Grossing up scheme for Phase 2 journeys](image)

The number of journeys by purpose selected for Phase 2 was compared with the respective number of journeys relevant for Phase 2. The grossing up of Phase 2 journeys to all those relevant in Phase 1 was carried out considering three levels used in the selection procedure:

- Distribution of the different journey types (holiday, business, other private)
- Journey distance (below and above 500km)
- Journey duration (below and above 7 days for holiday, below and above 1 day for business and other private journeys)

13 THE RECALL EFFECT – FORGOTTEN JOURNEYS

Long-distance journeys do not happen very often. In order to capture journeys with precision and success in a survey carried out retrospectively, the reporting period has to be extended. However, the longer the reporting period, the more difficult it is to remember travel details.
Journeys made at the beginning of a reporting period tend to be forgotten more often than journeys made only recently. Moreover, distance and duration of journeys may also play their part in the “recall effect”. One possibility points to the fact that people tend to forget shorter journeys more easily than longer journeys with distant destinations. Two types of analysis are possible:

- Analysis of the exploration survey; is there an overrepresentation of longer journeys? Analysis of explored journeys has to focus on a possible difference in the number, duration and distance of journeys relative to the target variables.
- Analysis of the target variables in relation to the time passed between the undertaking of a journey and its reporting (“journey-age-analysis”). It has to be analysed whether there is a statistically significant difference in the target variables’ number, duration and distance of journeys within defined classes. The analysis of the number of journeys is not possible for the DATELINE project due to the date of additional journeys not being known. The classes for duration and distance of journeys are defined as:
  
  a) For holiday journeys: 0-100 days / 101-200 days / 201-300 days / > 300 days
  b) For business and other private journeys: 0-40 days / 41-70 days / > 70 days

Having analysed the recall-effect for DATELINE, it came out very clearly that an effect was only present in the number of journeys, not the distance or duration of journeys. The effect was balanced by the calculation of correction factors for the number of forgotten journeys.

14 RESULTS FROM WEIGHTING AND GROSSING UP

In most NUTS1 zones the weights follow approximately a Gaussian normal distribution. As an example the distribution of the weights on person level is shown for NUTS 101 (zone of Austria (Figure 14-1)) and for NUTS 1401 (zone of Sweden, Figure 14-2).
To see the influence of the several weighting steps, the effect of the whole procedure was split into four parts:

- Raw data
- Raw data + re-calculation for the “additional journeys”
- Raw data + re-calculation for the “additional journeys” + re-calculation for the recall effect
(forgotten journeys)

- Final weighted data = Raw data + recalculation for the “additional journeys” + weighting for the recall effect + socio-demographic weighting

As an example, the following figures shows these effects for three parameters for Austria and France:

- **Number** of long-distance journeys (holiday, business and other private) per person and year
- **Average distance** of a long-distance journey (holiday, business and other private)
- **Average duration** of a long-distance journey (holiday, business and other private)

![Figure 14-3: Effects of weighting steps – Austria](image-url)
Figure 14-4: Effects of weighting steps – France