**TRAVEL SURVEY DESIGN AND DESCRIPTION OF MULTIMODAL TRIPS**

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# INTRODUCTION

Persons use for a majority of the trips just one transport mode. This is mostly the car, walking, or –in some countries– the bicycle. For a small proportion of the trips, generally a few percent, two or more modes are used. In the Netherlands, the estimated proportion of multimodal trips is about 3% (Van Nes, 2002). The small proportion doesn’t alter the fact that multimodality is a promising concept for solving a number of transport problems. Combining different modes “offers opportunities to capitalise on the strengths of the various systems while avoiding their weaknesses” (Van Nes, 2002, p.1). Travelling from a village in the countryside to a larger city, using the car for the first part of the trip and the train or another public transport mode for the second part, can be efficient. Generally, the car performs well in rural areas and collective public transport in densely populated areas. A drawback of multimodal travelling is the need to make interchanges between modes. This can be minimised by providing good and convenient transfer conditions.

Multimodal trips include particularly trips where a collective mode is the main mode (e.g. bus, train, airplane, company car) and a reasonable distance has to be bridged. In travel segments with high shares of collective public transport, like trips to/from central urban areas, and with rather long trip distances, the proportion of multimodal trips is generally substantial and can exceed 50%. Combes and Van Nes (2012) observe a share of 53% in the Paris region for trips between the Grande Couronne (outer ring) and the core city.

The added value of multimodality to the transport system can be a reason for promoting or facilitating multimodal travelling. Then knowledge about this kind of travelling is desirable in order to monitor the effect of policy measures. Knowledge on volume and characteristics of multimodal trips can have more applications. One is the assessment of the quality of public transport services. An important quality aspect is the number of interchanges that travellers have to make; making interchanges is inherent to multimodal travelling. Penalties for interchanges are estimated to range from 15-40 minutes (Balcombe *et al*, 2004). Knowledge on multimodal travelling is also useful for the planning and design of facilities at train stations and other nodes where people make interchanges, and for simulating multimodal travelling in transport models.

Information on the use of transport modes, including multimodal use, is generally asked for in the national and regional travel surveys. Multimodal trips are relatively complex, and reporting on such trips is more troublesome and may be less accurate than reporting on unimodal trips. As a consequence, multimodal trips demand for more effort to achieve accurate information. Consecutively, the quality of the registration of multimodal trips could be relatively low and depend on the set-up of the survey.

The paper discusses the association between travel survey design and the quality of the registration of multimodal trips. The discussion regards the traditional national travel surveys, that are surveys that use questionnaires as the only source for trip information and that cover a large area (country).

The quality of the registration of interchanges is an important topic in the paper. The analysis is not restricted to multimodal interchanges (between vehicles of different modes), but includes unimodal interchanges as well (between vehicles of the same mode, e.g. bus-bus transfers). Therefore, we assume a wide definition of multimodal trips. We define them as trips where at least two vehicles are used, even if these vehicles are of the same mode and the trip is strictly speaking unimodal. In other words, a multimodal trip is defined as a trip consisting of at least two legs other than walking.

This definition prevents the need to define modes. Whether two vehicles belong to the same mode can be debatable, for instance when the vehicles are technically similar but not identical (which can be the case for different light-rail systems) or identical vehicles have different functions (e.g. urban bus versus interurban bus). Still, in the paper a distinction will be made between intermodal and intramodal interchanges. The first are interchanges between vehicles of different modes, the second between vehicles of the same mode. Then modal definitions are still necessary. We adopt the modal definitions in the reviewed surveys. These regard the modes that are listed on the enquiry form and stored in the data. Because the definition can differ for different surveys, there is no unique definition of modes in the paper. For instance, tram and metro are sometimes defined as one mode, sometimes as two different modes.

Assessing the impacts of survey design on the registration of multimodal trips should preferably be done under the condition that the other factors that affect the registration do not or hardly change. The most important other factors are the actual travel behaviour and the willingness to respond. These two factors usually are stable in the short term for a given population. One of the best examples of a population (country) with a long tradition in surveying mobility behaviour and where some significant changes in the survey design were carried out is the Netherlands. We selected the survey and design changes in this country for the analyses. The paper makes also a reference to the Flemish survey which design differs to one interesting aspect from the Dutch designs. This decreases somewhat the disadvantage of the limitation to one country, viz. that promising designs used elsewhere will not be examined.

The condition of absence of notable changes in actual travel behaviour is not fully satisfied in the Netherlands. In the reviewed period (1978-2015) one event caused a break in the mobility trend. At the beginning of 1991 a student pass was introduced that allowed free travelling with PT. As a result, PT patronage increased considerably and this event is likely to have affected multimodal travelling. The provision of the student pass continues up to today though the conditions changed and restricted the validity since 1994. The introduction of the pass did not coincide with a design change and will not affect the analysis of the impacts of the separate changes.

Section 2 describes the Dutch national travel survey, including the several designs that have been applied in the history of the survey. Section 3 shows the registration of multimodal trips according to the different designs and discusses the association between design and accuracy of registration. Some general conclusions about this association and the sensitiveness of different aspects of multimodal registration to design changes are drawn in Section 4.

# DESIGN OF THE DUTCH NATIONAL TRAVEL SURVEY

The survey started in 1978 and has been conducted since continuously. Both design and sample changed a few times considerably. Also the naming changed a few times. Table 1 gives an overview of naming, design, and annual sample size. We added sometimes a number (or number and letter) to the names in the case a significant design change happened without a name change. The designs are so identified by name + number (+ letter). The sample size is expressed in trip numbers. The displayed types of leg data collection are explained later.

Table 1: Naming, designs and samples of the Dutch NTS

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Name | Period | Addressed entity | Age of traveller | Survey period | Leg data collection | Sample size (avg # of trips per annum) |
| Oud OVG 1 | 1978-1984 | Household | >= 12 | 2-3 days | Type 1 | 125,000 |
| Oud OVG 2a | 1985-1993 | Household | >= 12 | 1 day | Type 1 | 77,000 |
| Oud OVG 2b | 1994-1998 | Household | All | 1 day | Type 1 | 550,0001) |
| Nieuw OVG | 1999-2003 | Household | All | 1 day | Type 2 | 370,000 |
| MON 1 | 2004-20052) | Household | All | 1 day | Type 2\* | 200,000 |
| MON 2 | 2006-2009 | Household | All | 1 day | Type 2 | 140,000 |
| OViN 1 | 2010-2014 | Person | All | 1 day | Type 3 | 120,000 |
| OViN 2 | 2015- | Person | All | 1 day | Type 4 | 100,000 |

1. In 1994 300,000, including 100,000 for expanding the sample in two urban regions.
2. Type 2\* was during the second half of 2005 replaced by Type 2. The MON 1 period is in the paper defined as 2004 and the first six months of 2005.

The initial name of the survey was OVG (Onderzoek VerplaatsingsGedrag). This was conducted by the Dutch Central Bureau of Statistics (CBS). After introduction of a new design, the name changed into Nieuw OVG (New OVG), and the old survey was renamed as Oud OVG (Old OVG). When the data collection was commissioned to another company in 2004 (Socialdata), a new name was introduced: MON (MobiliteitsOnderzoek Nederland). In 2010 the commission returned to the CBS and the name changed again. The renewed and current name is OViN (Onderzoek Verplaatsingen in Nederland).

In OVG and MON households were addressed and all persons of the households (or all persons aged at least 12 in Oud OVG 1 and 2a) were asked about their trips. Trip information was reported by filling in diaries. In OViN persons are addressed and trips of the other household members are not registered. Trip reporting is via internet. If there is no response, persons are addressed by telephone or, if no telephone number is available, face to face.

In all designs information on the levels of household, person, trip and leg is collected. Leg information is essential for the registration of multimodal trips. In the Dutch NTS four different types of leg data collection can be considered. These are explained in Table 2.

Table 2: Types of collection of leg data in the Dutch NTS

|  |  |
| --- | --- |
| Type indication | Description |
| Type 1 (Oud OVG) | For all registered trips information about legs is registered for a maximum of 4 legs. The information includes the leg modes, the order of the legs, and the leg distance. |
| Type 2 and 2\* (Nieuw OVG and MON) | In the trip questionnaire is only asked which modes are used. In the case of usage of a public transport mode (Type 2) or two different public transport modes (Type 2\*), respondents are asked in a second wave by telephone to report detailed information about all legs, including mode, order, distance, and departure/arrival times. |
| Type 3 (OViN 1) | In the trip questionnaire is asked which modes are used, and in the case two different modes are reported that include a public transport mode, the respondent is asked directly to report detailed information on all legs. He/she is also asked about the number of intramodal interchanges for each reported public transport mode. |
| Type 4 (OViN 2) | In the trip questionnaire is asked which modes are used, and in the case two different modes are reported, the respondent is asked directly to report detailed information on all legs. This extends the questionnaire to trips without a public transport mode. The question about intramodal interchanges (OViN 1) has been dropped. |

The second wave in the type 2 and 2\* designs had no full response. The response rates were 45% in Nieuw OVG and 60-65% in MON. Moreover, the response did not fully represent the population. Generally the response rate was higher for groups of respondents that had a relatively high response in the main enquiry. We developed expansion+correction factors to overcome this problem. The type 3 and type 4 designs, that include a second dedicated questionnaire for multimodal trips as well, may give somewhat more accurate information in this respect, because they address (nearly) 100% of the trips that are selected for additional questioning.

One may hypothesise that Nieuw OVG, MON, and OViN, that have a dedicated questionnaire on PT trips (or multimodal trips in OViN 2), provide the best information on multimodal trips when a public transport (PT) mode is used. The maximum of 4 legs in Oud OVG limits the multimodal registration. However, for multimodal trips where no PT mode is used, the limitation to 4 legs will seldom be a bottleneck and Oud OVG may give the most accurate information, together with OViN 2.

The design changes include changes in the definition of modes. The definition is relevant for indicating whether an interchange is inter- or intramodal. Regarding the collective public transport modes, three different definitions have been used, as indicated in Table 3. In Oud OVG 1 rather different modes like bus and tram are considered as one mode. OViN has the most detailed classification. The definition of the train is unchanged in the whole period.

Table 3: Definitions of collective public travel modes in the Dutch NTS

|  |  |
| --- | --- |
| Survey | Modal definition |
| Oud OVG 1 | * Train * Bus, tram, metro |
| Oud OVG 2, Nieuw OVG, MON | * Train * Tram, metro * Bus |
| OViN | * Train * Metro * Tram * Bus |

The definition of the individual and private modes are similar regarding the most common modes. All surveys distinguish walking, bicycle, car as a driver, car as a passenger, and taxi. The definition of the remaining, less commonly used modes, is most detailed in Nieuw OVG, MON, and OViN. These surveys specify 13 to 14 other modes, compared to 5 to 7 in the older surveys.

# REGISTERED MULTIMODALITY

The association between survey design and the registration of multimodality is examined by comparing the registration in the different designs of the Dutch NTS, with a reference to the Flemish NTS at the end of the section. The analysis is restricted to persons >= 12 years old. This makes the outcomes from Oud OVG 2b and later surveys comparable with those from the oldest surveys.

## Examining Dutch survey designs

The 8 different designs shown in Table 1 are compared for a number of indicators. These regard the number of multimodal trips and interchanges. Distinctions are made between PT trips and non-PT trips, or between PT modes and non-PT modes. PT trips are trips for which at least one of the most common collective PT modes is used, either as the main mode or as an access/egress mode; these are bus, tram, metro, and train. For these trips special leg information is collected in Nieuw OVG and later surveys. Regarding the interchanges, a second distinction is made between intermodal and intramodal. For the interchanges to/from a PT mode separate figures for the train are produced. The train is the only PT mode with an unchanged definition, making the figures comparable in all designs.

The period of Oud OVG 2a will be split up into two periods, because during this period the student pass was introduced that affected a break in the trend. The period before the introduction (1985-1990) will be indicated as Oud OVG 2a1, the period after the introduction (1991-1993) as Oud OVG 2a2.

Table 4 gives the trip and interchange numbers, expressed in numbers per capita per year (for persons aged 12 and older). The change in travel behaviour is marked by a duplicate vertical line, the major changes in the collection of leg data, that directly affect the registration of multimodality, are marked by bold lines.

Table 4: Multimodal trips and interchanges per capita per year for different designs of the Dutch NTS

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Indicator | Oud OVG 1 | Oud OVG 2a1 | Oud OVG 2a2 | Oud OVG 2b | Nieuw OVG | MON 1 | MON 2 | OViN 1 | OViN 2 |
| Multimodal trips   * PT * non-PT | 18.5  5.6 | 24.1  5.1 | 32.6  4.3 | 30.8  4.7 | 34.6  2.3 | 31.5  2.2 | 34.1  1.9 | 33.2  3.9 | 28.9  2.9 |
| Interchanges to/from PT mode   * intermodal * between train and other PT * between other PT * between PT and non-PT * intramodal * train * other PT | 20.5  *7.1*  *-*  *13.4*  3.1  *0.1*  *3.0* | 29.8  *9.8*  *4.9*  *15.1*  1.0  *0.2*  *0.9* | 41.5  *16.2*  *5.3*  *20.0*  1.8  *0.4*  *1.4* | 39.3  *14.5*  *3.7*  *21.1*  0.9  *0.2*  *0.7* | 38.9  *13.4*  *3.5*  *22.0*  11.8  *5.4*  *6.4* | 37.2  *13.3*  *2.6*  *21.3*  4.2  *2.0*  *2.2* | 39.9  *13.7*  *2.8*  *23.4*  10.5  *5.9*  *4.6* | 36.7  *12.0*  *3.6*  *21.1*  15.2  *8.2*  *6.9* | 37.4  *12.2*  *3.8*  *21.4*  2.6  *0.9*  *1.7* |
| Interchanges between non-PT modes   * intermodal * intramodal | 5.0  0.8 | 4.5  0.2 | 4.2  0.1 | 4.9  0.2 | 2.5  0.1 | 2.2  0.1 | 2.1  0.1 | 4.1  0.1 | 3.0  0.8 |

The figures are averages for the whole period of validity of a certain design, sometimes with the exception of the starting year. In Oud OVG 1 and OViN 1 the results for the starting year are rather deviant and therefore excluded from the averages. Probably some problems were encountered when conducting the survey, leading to adaptations after the first year. In one case (Oud OVG 2a1), the observations of the separate years display a trend, viz. an increase in PT patronage. The number of multimodal PT-trips increased from about 22 to about 26, the number of interchanges between PT and non-PT modes from about 13 to about 17. In all other cases, no clear trends are visible. The deviations of the annual numbers from the average are generally small, <5% for the averages that value >20, <10% for averages >5, <20% for averages >1, and <40% for averages >0.1.

The table shows that the **break in the mobility trend** that was caused by the introduction of the student pass affected also multimodal travel behaviour. The number of multimodal PT trips and transfers to and from PT modes increased significantly between Oud OVG 2a1 and Oud OVG 2a2. This observed increase has no relation with the survey design and will be left out of consideration in the next discussion. A smaller break in the trend might happened in 1994 (Oud OVG 2b) when the conditions of validity of the student pass were restricted. The pass became either only valid on weekdays or on weekend days (up to the student). This might explain the observed decrease in the reported number of interchanges between PT modes, both the intermodal and intramodal interchanges. Still in 1994 some other changes could have had minor influences on registered travel behaviour. Young children were included in the survey which increased the response burden for the parents somewhat, and the sample increased largely which may have affected the organisation of the survey.

The **definition of modes** has necessarily impacts on intramodal and intermodal interchanges. In Oud OVG 1, that defines just two PT modes, intermodal interchanges between other PT modes (other than the train) cannot exist. Interchanges between other PT modes are then always intramodal. This explains both the zero number of intermodal interchanges between other PT modes in Oud OVG 1, and the fall of intramodal interchanges between other PT modes between Oud OVG 1 and Oud OVG 2a1. An additional increase in intermodal and decrease in intramodal interchanges between other PT modes will have taken place between MON 2 and OViN 1 because the definition of the PT modes became more refined again. Nevertheless, for both intermodal and intramodal interchanges a significant *increase* can be observed. Another change in the survey design, to be discussed next, induced an increase of the intramodal interchanges that exceeds the decrease resulting from the more refined definition of modes.

One can hypothesise that **shortening of the survey period** will have a (small) positive impact on reported trips because the burden for the respondent is relieved. This impact is indeed observed for all trips of Dutch residents. The number of registered trips per person per day increased from 3.2 to 3.5 between Oud OVG 1 and Oud OVG 2a1. Table 4 shows a similar increase for the multimodal PT trips and interchanges to/from a PT mode. Remarkably, the multimodal non-PT trips and intermodal interchanges between non-PT modes decreased somewhat. Possibly this kind of information continues to be reported accurately when the survey period becomes longer.

A striking change between Oud OVG 1 and Oud OVG 2a is a fall in the number of intramodal interchanges between non-PT modes. The shortening of the survey period is unlikely to explain this (fully). It seems that such interchanges either are overregistered in Oud OVG 1 or underregistered in Oud OVG 2a and later surveys. Observing that in OViN 2, that has the best design for registering multimodal non-PT trips, the number raises again to the Oud OVG 1 level, one can assume that the registration in Oud OVG 1 is rather accurate and that in OVG 2a is incomplete. The reason is unclear. Looking at the modes that are object of most of the intramodal interchanges, no difference between Oud OVG 1 and later years is found. In both cases most interchanges are between cars as a driver, between cars as a passenger, and between bicycles.

The impact of change of the **addressed entity** from household to person (between MON 2 and OViN 1) is difficult to assess. The change went together with changes in the leg data collection and mode definition that are likely to have significant impacts. As will be discussed next, most observed differences can be explained by the change in the leg data collection. Only the large increase in multimodal non-PT trips and intermodal interchanges between non-PT modes remains unexplained. However, it is not likely that this was the result of the changed addressed entity. The higher values in OViN 1 are comparable to those in Oud OVG when households were addressed.

The largest impacts on the registration of multimodal travel behaviour might be expected from the changes in the **collection of leg data**. The moments of change are marked by the bold lines in Table 4. Next impacts can be observed:

1. **Releasing the maximum of four legs per trip for PT-trips** (in Nieuw OVG) induced a huge increase in the reported number of intramodal interchanges between vehicles of a PT mode. The increase is more than a factor 10 and for the train even more than a factor 20. The figures suggest a small increase in the number of multimodal PT-trips as well, which will be the direct consequence of the increase of interchanges.
2. **Limitation to trips with two different modes** when trips are selected for a dedicated questionnaire (in MON 2 and OViN 2 compared to Nieuw OVG, MON 1, and OViN 1) reduces the number of intramodal interchanges between PT vehicles significantly. A related impact is a small decrease of the reported number of multimodal PT-trips.
3. **Inclusion of a special question on intramodal PT interchanges** (OViN 1) raises the number of these interchanges. The increase is somewhat larger than suggested in Table 4, because the refined definition of modes has an opposite effect.
4. **Limiting collection of leg information to PT-trips** (Nieuw OVG, MON, OViN 1) reduces the registered numbers of multimodal non-PT trips and interchanges between non-PT modes, both the intermodal and intramodal interchanges. However, this impact is not visible for OViN 1 regarding the multimodal non-PT trips and intermodal interchanges between non-PT modes. These figures are in OViN 1 even higher than in OViN 2 where the collection of leg information is extended to all trips with two or more different modes. We have no explanation for this finding. Still, the OViN 2 figures are higher than those for Nieuw OVG and MON, and that could be expected.

Next conclusions about the design can be drawn from the Dutch case:

1. A dedicated questionnaire about PT trips renders much more reported intramodal interchanges between PT vehicles than a general trip questionnaire that enables to report a limited number of legs (4 in the Dutch case).
2. A specific question about the number of intramodal interchanges for each reported PT mode raises the number of reported intramodal interchanges.
3. Asking for information about a limited number of legs in the trip questionnaire gives better information about multimodality in non-PT trips than just asking for the modes that are used in the trip. A dedicated questionnaire for all multimodal trips seems to have no added value in this respect.
4. A general conclusion is that the accuracy of registered intramodal interchanges is stronger associated with the survey design than that of registered intermodal interchanges or multimodal trips. Some surveys might even not register the order of magnitude of the intramodal interchanges correctly.

Which design reflects reality best? We hypothesize that the reported trip and interchange numbers tend to underestimate the actual numbers because respondents generally will a) not report trips that they did not make or legs/interchanges that were no part of their trip, and b) may omit reporting actually made trips, legs or interchanges. A possible reason for the latter is that respondents do not recall all trips or the exact multimodal configuration of some trips. Another reason for omitting legs and interchanges is a limitation imposed by the questionnaire, like the maximum of 4 legs in the Oud OVG. According to this hypothesis, the design that produces the largest number of interchanges is the best one. In the history of the Dutch NTS, OViN 1 would then have the best design for registering multimodal PT trips, and Oud OVG and OViN 2 have the best design for registering multimodal non-PT trips.

## Comparing with Flemish survey

The very low number of intramodal interchanges between PT vehicles in Oud OVG demonstrates that the maximum of 4 legs is highly pinching and leads predominantly to putting together successive legs of the same mode by the respondent. The Flemish NTS gives an idea about to which extent this will be relieved if the number of legs is raised to 5. Some editions of the incidentally conducted Flemish NTS (called also OVG) collects leg information in the same way as the Dutch Oud OVG (Type 1 in Table 2), with the difference that the maximum number of reported legs is 5.

If Flemish and Dutch figures are compared, one has to assume that multimodal travel behaviour of Flemish residents is not very deviant from that of the Dutch residents. The two countries are comparable regarding a number of factors that may influence multimodal travelling, like population density, flatness, and public transport supply (Van Goeverden and De Boer, 2013). Moreover, both countries have a bicycle culture, though this is more pronounced in the Netherlands than in Flanders. A relevant difference between the two countries is the higher spatial concentration of buildings in the Netherlands.

Table 5 shows some indicators from the Flemish OVG in 2007/2008 and compares them with those from the Dutch Oud OVG 2b. Both surveys are identical regarding survey period and definition of PT modes, but differ regarding addressed entity; this is a person in the Flemish OVG and a household in the Dutch OVG. The collection of leg information is identical, except for the maximum number of legs per trip.

Table 5: Multimodal registration in the Flemish OVG and the Dutch Oud OVG, numbers per capita per year

|  |  |  |
| --- | --- | --- |
|  | Flemish OVG 2007/08 | Dutch Oud OVG 2b |
| Multimodal trips   * PT * non-PT | 32.0  *28.9*  *3.1* | 35.4  *30.8*  *4.7* |
| Intermodal interchanges   * PT * non-PT | 37.1  *33.9*  *3.2* | 44.2  *39.3*  *4.9* |
| Intramodal interchanges   * train * other PT * non-PT modes | 4.9  *1.0*  *3.2*  *0.7* | 1.1  *0.2*  *0.7*  *0.2* |

The differences between the registered numbers of multimodal trips and between the intermodal interchanges are just small. This supports the assumption that multimodal travel behaviour by the Flemish residents is not very deviant. Nevertheless, the differences in reported *intramodal* interchanges are large, and these apply for all modes. Considering that the Flemish residents seem to make no more multimodal trips than the Dutch residents, the number of actually made intramodal interchanges is likely to be not (much) higher, and the large difference in the table should largely be attributed to the design difference (5 versus 4 legs).

Comparing the Flemish figures with those from the Dutch surveys with a special PT questionnaire learns that the number of registered intramodal interchanges between PT modes is still much lower in the Flemish survey. This finding suggests that such interchanges are still underregistered when the number of legs per trip is limited to 5.

# CONCLUSION

Three kinds of conclusion can be drawn from the analysis. The *first* regards which kinds of survey design changes affect the multimodal registration significantly. The outcome is that the method for collecting leg data is by far the most important in this context. Other kinds of changes like changes in the addressed entity or the number of reporting days have no or relatively small impacts.

The *second* kind of conclusion regards which aspects of multimodal travelling are highly sensitive to the survey design and which are not. The conclusion is that particularly the registration of intramodal interchanges is extremely sensitive. The registration of the volume of multimodal trips or of intermodal interchanges is rather independent from the survey design. If survey outcomes are used for designing transfer nodes, the appropriateness of the survey design for reproducing intramodal interchanges should be examined.

The *third* kind of conclusion is which kind of design produces the most accurate description of reality. Given the former conclusion, this regards predominantly the description of intramodal interchanges. Analysing the Dutch survey designs, we come to the next recommendations for a good design:

* Ask a respondent which modes he/she used for a trip.
* Ask about the number of intramodal interchanges for each reported collective PT mode, both the common PT modes and the less common modes (airplane and ferry).
* Ask questions that invite respondents to report intramodal interchanges between cars and between bicycles. Start with an analysis of the nature of these interchanges in order to find an efficient way for questioning. Possibly the definition of the modes should be refined, for instance based on ownership of the vehicle (private, acquaintance, company, public). In the case of the bicycle normal bicycles and tandem bicycles could be distinguished.
* If different modes or one or more interchanges are reported, ask information about all legs, including the order of modes used and distance or duration.

A limitation to the conclusions is that only designs that were applied in the Netherlands have been examined. This limitation seems particularly valid for the first and third conclusions. It is possible that certain design changes that not directly affect the collection of leg data and that are not applied in the Netherlands influence the registration of multimodality significantly (conclusion 1). Additionally there might exist other very promising designs that are applied in other countries (conclusion 3). The second conclusion is likely to have a general value.

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