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INTERNET-BASED TRAVEL SURVEYS: SELECTED EVIDENCE ON RESPONSE RATES, SAMPLING BIAS AND RELIABILITY

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Due to decreasing response rate to conventional mail questionnaires, transportation researchers should explore the use of alternative means of administration. Internet-surveys provide one of these alternatives. This paper reports some experiences with the use of Internet-surveys in a few studies of different complexity. Experiences suggest that sampling bias is a topic of concern. It also shows however that even quite complex stated adaptation experiments can be conducted reliably using Internet-surveys.

KEYWORDS: Internet-based surveys, sampling bias, response rates, stated adaptation, park and ride

1. INTRODUCTION

Traditionally, self-completed mail questionnaires and computer-assisted telephone interviews have been the dominant ways of data collection in transportation research. Compared to face-to-face interviews these means of data collection are relatively cheap, while response rates, albeit lower, were sufficiently high. Although these modes of administration will likely continue to play a central role in transport surveys in the near future, there is also reason for concern. Response rates for mail questionnaires show a tendency to become lower, without a large number of reminders and/or substantial financial rewards. Likewise, the rapidly increasing number of cellular phones is at least momentarily causing problems of identifying the correct sampling frame based on telephone books.

Given these developments, it is understandable that several researchers have urged to explore the potential of alternative means of data collection. For example, global positioning systems, (Draaijer et al., 2000), Murakami et al. (2000), Wolf et al. (2001), Stopher et al. (2003), tracking cellular phones (Guensler and Wolf, 1999) and virtual reality systems (Tan and Timmermans, 2004) have been suggested and examined as a means of collecting data on travel behaviour. It may be expected that such new technology will be quite useful in recording actual behaviour. However, the types of data need sometimes be completed by attitudinal or judgement data, which cannot be collected through such technologies. Internet-based surveys have therefore been suggested as a means of collecting such data (Adler et al., 2000, 2002; Lee et al., 2002; Marca, 2003).

The use of the Internet for data collection is however not without problems and offers some new challenges. Access to Internet in many countries is still much lower compared to telephone access, and in addition, typically varies between socio-economic groups. Often, finding an appropriate sampling frame may involve a lot of effort. In some countries, survey firms have started to build up a national sampling frame of email

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addresses. For national surveys, these frames can often be used, but they may be insufficient for research projects focused on a specific city. In those situations, strategies for identifying respondents with email access need to be formulated, with all the typical concerns involved. Moreover, the Internet may involve more effort from respondents. Communication can be slow at times. The amount of information that can be put on a screen is more limited, and scrolling back and forth can be a hassle. The lack of an overview may also negatively influence the reliability of the responses. Also, because respondents cannot quickly assess the length of the survey, this uncertainty may lead to higher non-response.

On the other hand, Internet-based surveys also have some potential advantages. As with computer-assisted surveys, automatic checking of responses is no problem, implying there is a better opportunity for quality control. In addition, compared to paper-and-pencil instruments, the Internet can potentially be used for interactive computer experiments to observe consumer response to changing transportation environments.

Thus, the Internet as a new medium for administering surveys has potential effects on the response rates, sampling bias and reliability, but empirical studies on this issue are still scarce (Bricka and Zmud, 2003). The purpose of this paper, therefore, is to report some recent experiences of the authors in administering Internet-based surveys. It should be mentioned from the outset that these studies were not methodological in nature in the sense that they were designed to systematically compare the performance of Internet-based surveys with other, more traditional modes of administration. Instead, the primary goal of the data collection efforts was to obtain data for a particular analysis or model. Nevertheless, the experiences of the three case studies that will be described in this paper may prove to be useful to our understanding of the pros and cons of Internet-based surveys. This is especially true because the studies differ substantially in terms of respondent burden and nature of the data collection effort.

The paper is organized as follows. Three case studies are introduced in which Internet was used for data collection. For each of the three case studies, we will describe the scope of the study and nature of the survey instrument. In addition, we will report for each case the response rate. Issues related to sampling bias and reliability of the survey instrument will be reported for specific cases.

2. CASE 1: A STATED ADAPTATION EXPERIMENT

2.1 Scope

The first case that we report concerns a data collection in the context of a study on congestion pricing (Arentze et al., 2003). The goal of this study was to analyze and model consumer response to possible congestion pricing scenarios. In addition to being a policy-relevant problem in its own sake, the study was conducted as an example of how the Albatross model (Arentze and Timmermans, 2000) can be extended to model how individuals reschedule their activities and related travel in response to transportation policies.

The questionnaire, required to collected data for that modelling effort, consisted of three parts. The first part consisted of questions about the intensity of car use and public transport use, with the aim to establish the relevance of the pricing scenarios for the respondent. A priori, four groups were distinguished: car users, train users, both car and train users and other. Assignment of respondents to a group was based on pre-defined cut-off points for amount of yearly kilometrage per car and frequency of using the train

during peak periods. The timing of travel was relevant for train and not for car since the scenarios concerned a time-of-day dependent pricing policy for train (namely an increase in tariffs only in peak periods) and a more general variabilization of travel costs in the case of car. Respondents assigned to the last group did not proceed to the subsequent parts of the questionnaire.

The second part of the questionnaire included questions about socio-economic attributes at the individual and household level and more detailed questions about the work activity, if any (work days, work hours, work hour flexibility and work location). Finally, the third part administered a stated adaptation experiment, which will be discussed in more detail below.

After describing a scenario a list of questions inquiring about changes in activity participation and travel choice the respondent would make in response to the scenario. The format of this part of the questionnaire was designed to aid respondents as much as possible in imagining what the consequences of the scenario would be in his or her case. First, an activity-based approach was used. That is to say, the same list of questions was asked related to each of a set of pre-defined activity categories. These included work, shopping, social, leisure, and some other activity. The last category was presented in the form of a list of other activities (school, business, voluntary work, club activities, etc.) in which the respondent could indicate which of them involved car or train trips (depending on the scenario) in the current situation. The system selected randomly an activity that involves the car/train mode and repeated the list of questions for this activity. By selecting an activity randomly the full range of activities will be covered at sample level provided that the sample is big enough.

Before proceeding to the questions about the respondent's response to the scenario, the respondent was asked to indicate the frequency distribution across modes and the average distance per trip by the relevant mode (car or train) in the current travel pattern for the activity category under concern. Based on this data the system calculated and presented to the respondent the total variable costs of traveling (for the activity) under both the current conditions and scenario conditions.

The questions about stated adaptation choices covered all conceivable ways of reducing the costs of traveling under the scenario conditions. Their general structure can be written as:

> "Would you, as a consequence of the scenario, choose [adaptation option] for conducting [the concerned activity]? If yes, how often would you choose [adaptation option]?"

Hereby, one adaptation option was given at a time. The options included: performing the activity less frequent, performing the activity more often at home (in case of work only), performing the activity more often at a location nearer by home (in case of shopping and leisure activities), switching to another specific mode, traveling more often together with others (in case of car), changing the route and changing the departure time. The system returned an error message if the reported frequency of a change exceeded the current frequency of travel by the mode affected by the scenario.. Finally, two last questions related to more rigorous changes, namely whether the respondent, as a consequence of the scenario, would consider to move to another location or to change work location. Note that due to the complexity of the task, respondent burden was quite high.

2.2 Response rate

Originally, the survey was administered to 2151 respondents. For 383 respondents, the survey was not relevant in the sense that these respondents did not meet the conditions relevant for completing the particular scenario. Thus, the sampling frame consisted of 1768 respondents. Of these, 701 respondents refused to participate and 593 broke off/suspended. Thus, the final response rate was 27 percent. Of course, it is difficult to judge this response rate, as it depends on a large number of factors. Based on our general experience, this response rate is higher than that typically obtained for mail-back questionnaires, but lower than for other forms of administration.

Response rates were also broken down according to a series of socio-demographic variables, such as age, gender, household composition, income level and education, and spatial variables such as part of the country and type of city. The results are shown in Table 1, which shows not only the distribution of the response and non-response, but also the distribution of the respondents who suspended or broke-off the interview session. An examination of Table 1 indicates that the non-response is slightly, but not significantly higher among females. This may suggest that women are less inclined to complete an Internet-based survey than men. On the other hand, the percentage of women breaking off the survey was slightly lower.

As for age, non-response decreased with increasing age. The percentage breaking off or suspending the survey varied among the age group. The percentage was higher for the 45-65 age group, and lowest for the respondents younger than 25 years of age. The combined effect on the conditional probability of respondents in any age group completing the survey is that this percentage is higher for respondents older than 65 years and lowest for the respondents between 45 and 65 year. The percentage of the latter age group is however hardly different from the two younger age groups.

The relationship between non-response and income is U-shaped. The highest percentages of non-response are observed for the lowest income group, followed by the two highest income groups. Interestingly, the distribution of breaking off/suspending the survey is almost the reverse. Thus, once respondents from the lowest income have decided to participate, they are more likely to complete the survey and the same effect is observed for the highest income groups. The result of these two trends is that on balance the probability of completing the survey was lowest for the lowest income group and the one but highest income group and slightly higher for the middle income groups and the highest income group.

The next socio-economic variable is household composition. Table 1 shows that the non-response is highest for students, living in student homes or with their parents. Non-response is also relatively high for singles with children. As for education, differences in non-response are small. The highest non-response rates are observed for the highest and the lowest education categories.

In addition to these socio-economic variables, non-response was broken down according to some spatial variables. First, Table 1 demonstrates that non-response was highest in strongly urbanized municipalities. This finding is consistent with typical findings for other modes of administration. The non-response in the other types of municipalities does not differ that much. The same is true for the percentage of respondents broken off or suspending the task, although it is lower for the strongly urbanized municipalities. Secondly, in terms of region, non-response is highest in the three major cities in The Netherlands and in the North. The percentage of respondents not completing the task is relatively high in the South.

TABLE 1: Response rates by socio-demographic and spatial variables

	Total	Participated completed	Participated broke off/suspended	Non-response
Gender				
Male	1109	0.271	0.341	0.388
female	659	0.263	0.326	0.411
Age				
Younger than 25	256	0.277	0.207	0.516
25 – 45	650	0.277	0.334	0.389
45 – 65	821	0.253	0.378	0.369
Older than 65	41	0.366	0.317	0.317
Income				
< Nlg 55.000	217	0.235	0.276	0.488
Nlg 55.000 - 82.5000	424	0.264	0.337	0.399
Nlg 82.500 – 110.000	415	0.267	0.371	0.361
Nlg 110.000 – 137.500	232	0.297	0.362	0.341
Nlg 137.500 – 165.000	98	0.235	0.367	0.398
> Nlg 165.000	91	0.308	0.286	0.407
missing	291	0.275	0.309	0.416
Household composition				
Single without children	321	0.330	0.271	0.399
Single with children	39	0.256	0.282	0.462
Living together/married without children	524	0.305	0.355	0.340
Living together/married with children	658	0.210	0.398	0.392
Living with parents	163	0.245	0.209	0.546
Student home	18	0.333	0.056	0.611
Other	32	0.313	0.250	0.438
Missing	13	0.308	0.308	0.385
Education				
University	260	0.312	0.281	0.408
Higher professional training	524	0.284	0.332	0.384
Higher General education	224	0.254	0.290	0.455
Middle level professional education	468	0.248	0.380	0.372
Middle level general education	137	0.255	0.365	0.380
Lower level professional education	100	0.230	0.380	0.390
Lower level general education	22	0.182	0.227	0.591
Missing	33	0.273	0.303	0.424
Type of municipality				
Strongly urbanized	571	0.247	0.254	0.499
Urban	305	0.311	0.344	0.344
Moderately urban	241	0.324	0.369	0.307
Hybrid	381	0.241	0.386	0.373
Non-urban	268	0.254	0.396	0.351
Missing	2	0.000	0.500	0.500
Region				
West, 3 major cities	412	0.216	0.269	0.515
West, other	507	0.312	0.323	0.365
North	176	0.205	0.335	0.460
East	318	0.280	0.377	0.343
South	353	0.289	0.391	0.320
Total	2151	474	593	701

2.3 Sampling bias

To examine sample bias, Table 2 represents the sample and national population distributions on some socio-economic attributes. National statistics are drawn from the Dutch Travel Survey of 1998 using case weights calculated by the Central Bureau of Statistics (CBS). We emphasize that for at least two reasons the national statistics data may have errors. First, the data relate to the population of 1998, which may deviate from the 2001 population. Second, the case weights calculated by CBS correct for over or under sampling considering only a limited number of household/person characteristics. Furthermore, we emphasize that if sample bias occurs, this cannot be attributed unambiguously to selective non-response or sample bias of the web panel. In the present survey, we selected respondents based on size of car or train transport use and this will undoubtedly also have an impact. In other words, for the reason of the selection criterion alone we would expect a difference in composition between the sample and national population. Nevertheless, the comparison in Table 2 gives some indication of the size of the difference. Due to differences in classifications between the two data sets the comparison between distributions could not be conducted on all attributes (listed in Table 1). The table shows age, household composition, education and type of municipality.

TABLE 2: Sample composition and national population composition

	Total	Participated completed	National (OVG'98)
Age			
Younger than 25	14.5	13.9	11.2
25 – 40	38.0	38.5	21.7
40 – 60	43.2	42.3	44.6
Older than 60	4.3	5.3	22.5
Household composition			
Single without children	20.8	25.6	30.6
Single with children	2.5	2.4	.3
Living together/married without children	34.0	38.6	42.3
Living together/married with children	42.7	33.4	26.8
Education			
University, Higher professional training	45.2	49.5	23.2
Higher general education, Middle level professional education	39.9	37.2	34.0
Middle level general education, Lower level professional education	13.7	12.5	33.1
Lower level general education	1.3	0.9	9.7
Type of municipality			
Strongly urbanized	32.3	29.8	20.8
Urban	17.2	20.0	24.5
Moderately urban	13.7	16.5	19.7
Hybrid	21.6	19.4	20.2
Non-urban	15.2	14.4	14.7

As can be read from the table, people of over 60 years old are underrepresented in the sample. This is probably caused by the fact that the use of PC or Internet is less widely spread in this group. As for the household composition, all the groups distinguished are represented in the sample approximately in the same proportions as in the population at large, except that 'single with children' is slightly over-represented. With concern to

education group, the figures show a shift towards higher education groups implying that the lower and middle education groups are underrepresented in the sample. At least partly, this sample bias can be explained by lower response rates under lower educated groups generally found in surveys. However, the fact that PC and Internet use is still less frequently occurring in this group may also have had an effect. Finally, the distribution across urban density types of the municipality of the home address does not show a clear bias. All urban density types are represented in the sample in approximately the same proportions as in the national population.

In summary, the sample is representative with regard to household composition and urban density and somewhat biased in terms of age group and education group in directions that could have been expected. We stress that such biases have implications for model estimations and predictions only in as far as the socio-demographic variables under concern (age group, education group) correlate with behavioral dimensions investigated here (response to pricing scenarios).

2.4 Reliability

The issue of how to measure reliability is difficult. Measures typically depend on the kind of information being collected. The present survey involved a stated adaptation experiment in which respondents were invited to indicate how they would change their activity-travel pattern in response to congestion and road pricing scenarios. This means that it is difficult to judge on the experiment alone how reliable their responses are. However, the experimental design data themselves do provide some clues. First, the intensity of the responses may be taken as an indication how involved the respondents were in the experiment. In several stated preference experiments that we conducted in the past, using a self-completed, mail-back questionnaire format, a relatively large percentage of respondents indicated that their travel behavior would not differ as a function of future policies. Secondly, this specific experiment included some specific related questions, the answers to which should be consistent. More specifically, respondents reported their total number of trips by car. This number could change as a result of implementing some congestion scenario. Respondents were asked for many dimensions of their activity-travel patterns, how many trips will be changed as a result. Logically, the sum of the changed trips should not exceed the total of the car trips in the current situation, as noted before. To be more exact, let Y be the current frequency of car trips for a given activity, X_h the indicated frequency of performing the activity more often at home, dX the decrease in activity frequency, and X_i the frequency of using alternative mode i more often. Then, the number of car trips that would remain after the indicated change can be written as $Z = Y - X_h - dX - \sum_i X_i$. This allows us to test the following increasingly strict consistency conditions:

$$Z_1 = Y - X_h \geq 0$$

$$Z_2 = Z_1 - dX \geq 0$$

$$Z_3 = Z_2 - X_1 \geq 0$$

$$Z_4 = Z_3 - X_2 \geq 0$$

$$Z_5 = Z_4 - X_3 \geq 0$$

Where Z_i is the number of car trips remaining after $i-1$ stated changes. Obviously, an activity that violates test i would automatically also violate equation $i + 1$, and so on. To

prevent double counting, Z_i is set to zero in equation $i + 1$ if equation i is violated. Thus, in these cases the subsequent frequencies should be zero and each occurrence of a positive change is counted as an inconsistency.

Table 3 presents the results of the first indicator. The table shows the frequency of making a change to an activity by dimension. The percentages in Table 3 indicate that a substantial share of the respondents said that the pricing scenarios would make them change their activity-travel pattern. The absolute value of these percentages seems plausible in the sense that less dramatic changes have a higher percentage. Thus, these results suggest that respondents were clearly involved in the stated adaptation experiment and that their responses look plausible.

TABLE 3: Response pattern to scenario by dimension of activity-travel pattern

Dimension	Scenario	Frequency of a change (%)	Total number of activities
Departure time	car	316 (31.2)	1014
	train	37 (31.9)	116
Route	car	592 (34.9)	1096
	train	-----	-----
Destination	car	250 (34.9)	716
	train	25 (33.3)	75
Frequency	car	134 (9.6)	1398
	train	16 (10.5)	152
Work at home	car	28 (9.4)	298
	train	3 (5.5)	55
Car pooling	car	170 (10.0)	1696
	train	-----	-----
More often by bike	car	328 (19.3)	1696
	train	-----	
More often by public transport	car	198 (11.7)	1696
	train	-----	-----
More often by car	car	-----	-----
	train	22 (10.1)	217

The results of the analyses regarding the consistency of their response patterns are shown in Table 4. It shows that the percentage of inconsistent responses is quite low, proving further evidence about the reliability of the responses. Note that as implied by the above equations the percentages are cumulative. The percentage of activities for which there is an inconsistency on at least one dimension equals 7.9 %.

TABLE 4: Percentage of consistent responses by dimension

Dimension	Cumulative percentage inconsistent responses
Home frequency	0.4
Frequency	1.1
Carpooling	3.4
Use of public transport	5.4
Bike	7.9

3. CASE 2: AN INTERNET PANEL

3.1 Scope

The second study that we will discuss in this paper is a study that was conducted in 2002 in the Eindhoven region. The goal of the study was to collect data on the use of greenspace. The study did not allow a detailed analysis of response rates and reliability, but is included in this paper because the Internet sample was part of a hybrid approach. Thus, particular aspects of the Internet-based sample can be compared with a traditional paper-and-pencil survey.

The questionnaire consisted of two parts. The first part was used to collect data about the experience and use of greenspace. The second part was used to collect some additional household information. The first part started with a question to get an insight into the user awareness of greenspace. Respondents had to mention up to five greenspaces they known best. Next, the respondents had to identify up to five greenspaces they used most during the last twelve months. For the greenspaces they used most, respondents were also asked to give information by season about the number of times they had visual contact with the greenspaces, the number of visits, the time of day during the week and in the weekends of the visits, the duration of the visits and the transportation mode usually used. Furthermore respondents had to report with whom they visited the greenspaces, which activities they performed, what reasons they had for the visits, how satisfied they are with the greenspaces and whether they would like to have something changed to one of the reported parks and if so, what the change would be.

The questionnaire continued with a question about the perception of safety. More specifically, respondents were asked to mention up to five greenspaces they avoided during certain hours or always and whether one of the reasons was vandalism, the presence of certain people or a feeling of insecurity. To get insight into the amount and variety of greenspace respondents were asked to give a ranking between 1 (very bad) and 7 (very good) to indicate how they assessed and how important they found the amount and variety of greenspace in the Eindhoven region. The last question of the first part related to the greenspace outside the own neighbourhood respondents had visited most during the last 12 months. For a whole list of uses and benefits of this greenspace respondents had to give a ranking between 1 and 7 to indicate how they assessed and how important they found the uses and benefits of this greenspace they visited most.

The second part of the questionnaire was used to collect some more household information. The introduction questionnaire brought already the following information: day of birth, gender, position in the household, main occupation, number of working hours, highest education and ability to drive a car or motorbike for up to six household members.

Respondents were recruited from the City of Eindhoven and 3 smaller neighboring city's Best, Son en Breugel and Waalre, located in the South of the Netherlands. The sampling frame was build up as follows. First, for the City of Eindhoven 16199 street addresses were sampled at random from their database weighted according to the number of households per neighbourhood. People received an introduction letter, explaining the goal of the research project and a small questionnaire, to collect household information and in which they were asked whether they would be willing to participate in the research. Questionnaires and diaries were sent to those who were

willing to cooperate. Among those respondents who participated fifteen coupons in a range from euro 100 to euro 1000 cash were raffled.

3.2 Response rates

Table 5 reports the response rate. In total 3240 people indicated that they were willing to participate in the research. In total 1110 people were invited to participate in the study through the Internet. 96 E-mails returned due to errors in the e-mail address. In the case that people also gave their home address questionnaires were sent by mail. In total, 529 respondents completed the questionnaire, representing a response rate of 52.2%, which is quite high. To pay for expenses respondents received a coupon of 5 euro.

TABLE 5: Selection of respondents and response rate

	People willing to cooperate	Number of respondents	Rate
By mail	2158	1124	52.1
Through the internet	1014	529	52.2

In total 2158 people were invited to participate in the study through the mail. Of these, 1124 completed the questionnaire, representing a response of 52.1%. To complete the 3240: 57 people were too young to participate. In the introduction letter we invited all household members older than 12 years of age. 11 People could not be reached through the Internet or by mail. Note that there is hardly any difference between the response rates related to the two means of contacting respondents.

Table 6 suggests some interesting differences between the two types of samples. Firstly, the share of women in the Internet-based survey is smaller than in the mail surveys, suggesting that women use the Internet less frequently. Secondly, although the shares of young people are low in both types of surveys, the percentage of 25-39 years is significantly larger in the Internet-based survey. Thirdly, the table suggests that the elderly are underrepresented in the Internet-based survey. Fourthly, the impact of household composition seems less, although household with more children are better represented in the Internet-based survey. Finally, full time workers make up a larger share of the Internet sample.

4. CASE 3: THE USE OF PARK AND RIDE FACILITIES

3.1 Scope

The purpose of the third study was to gain a better understanding of user evaluations of the attributes of park and ride facilities. Hence, the key question in this case study was whether higher-quality P&R facilities attract more car users, and how important each of these attributes is in the consumer choice process (see Bos et al., 2002, 2003). Moreover, it was critical to know which segments of the population respond most favorably.

To provide an answer to the key question, the following research design was implemented. First, a list of attributes that might influence the travelers' choice behavior was elicited. Next, in a pilot study, we determined the maximum number of attributes that could realistically be processed by respondents. The resulting list of attributes was then included in a questionnaire and respondents were asked to assign an importance weight to each of the attributes, using a Likert scale. In addition, they were asked to

group the list of attributes into clusters. Multidimensional scaling (MDS) was used to construct the cognitive maps and identify the cognitive constructs.

TABLE 6: Distribution of people willing to cooperate according to some selected characteristics

	Sample mail		Sample internet		Total	Eindhoven
	Number	Percentage	Number	Percentage	Percentage	Percentage
Gender						
male	939	43.5	570	56.2	47.6	50.1
female	1184	54.9	432	42.6	50.9	49.9
unknown	35	1.6	12	1.2	1.5	
Age						
0 -24 years	143	6.6	108	10.7	7.9	28.8
25-39 years	508	23.5	334	32.9	26.5	25.7
40-54 years	480	22.2	287	28.3	24.2	20.0
55+ years	708	32.8	162	16.0	27.4	25.4
unknown	319	14.8	123	12.1	13.9	
Household composition						
1 person with children	146	6.8	68	6.7	6.7	5.3
2 persons with children	688	31.9	326	32.1	32.0	23.2
2 persons without children	451	20.9	322	31.8	24.4	31.9
1 person without children	758	35.1	253	25.0	31.9	34.5
other	80	3.7	34	3.4	3.6	5.0
unknown	35	1.6	11	1.1	1.5	
Working hours						
no and a few hours (< 8 h)	1027	47.6	321	31.7	42.5	
part-time (>=8 & < 32 h)	388	18.0	191	18.8	18.3	
full time (>= 32 h)	743	34.4	502	49.5	39.2	

3.2 Response characteristics

To reach the target group, a link to the Internet page with the questionnaire was included in the electronic newspaper of *snelheidscontrole.com* e-mailed on 9 June and 16 June, 2001. This newspaper contains the expected speed checks in the Netherlands. The Dutch car users among the subscribers to this newspaper belong to the target group. Furthermore, a link was established in the daily electronic newspaper of *kranten.com*, e-mailed from 25 June until 28 June, 2001 (from Monday to Thursday); the link was also advertised on the site of *kranten.com* from 25 June until 1 July, 2001. This site presents the most prominent news from national leading newspapers.

2794 respondents noticed the link to the questionnaire in one of the electronic newspapers and started filling out the questionnaire. The largest share of the respondents noticed the questionnaire via 'snelheidscontroles.com'. From the 2794 respondents, 536 respondents filled out the questionnaire completely (Table 7) within a period of about 3 weeks.

Of these respondents, 76.3% were male and 23.7% female. The percentage of men having started with the questionnaire was even higher. The fact that, on average, men use the car more frequently than women (Lucassen, 1999) especially on the principal road network might explain the over-representation of men. The difference may also be caused by the fact that men are more frequent Internet users.

TABLE 7: Response of people having started and completed the questionnaire

	Started (N = 2794)	Completed (N = 536)
Way of approach respondent		
Snelheidscontroles.com	57.9	56.5
Kranten.com	42.1	43.5
Gender		
Male	79.4	76.3
Female	20.6	23.7
Age		
18-30	39.3	46.5
31-60	58.0	52.0
61-90	2.7	1.5
Education		
Lower or intermediate education	41.6	25.0
Bachelor's or master's degree	58.4	75.0
Travel purpose		
Work purposes	64.8	63.6
Recreational purposes	35.2	36.4

Looking at the age groups, 39.3% of the respondents are younger than 31, 58.0% are between 31 and 60 years of age, while 3.3% of the respondents are older than 60. The small share of respondents older than 60 can be explained by the fact the Internet is less widely available to this group. The respondents having completed the questionnaire were even younger.

Furthermore, the level of education was examined. A majority (58.4%) of the respondents had a bachelor's or master's degree, while 41.6% received lower or intermediate education. The number of highly educated respondents is explainable because people with a bachelor's degree or higher have a higher availability of the Internet and are more supportive of scientific research. Lower educated people had more difficulties filling out the rating and the grouping task.

3.3 Non-response

Because of the use of an Internet-based questionnaire, it was possible to store answers of respondents several times during the questionnaire. Given answers were stored three times in the questionnaire: after the general questions about personal characteristics, after the rating task and after the grouping task.

From the 2794 respondents who started to fill out the questionnaire, 364 never went to a city by car. These respondents did not fill out the rest of the questionnaire. 38.7% of the respondents belonging to the target group did not provide useful rating data. The largest part of the respondents gave up filling out the questionnaire after the rating task. As for the grouping task, the majority of respondents having provided useful rating data gave up filling out the questionnaire.

It can be concluded that the about 20% of the respondents having started filling out the questionnaire actually finished it. This seems to be a low percentage, however we have to consider that an Internet-questionnaire is very approachable for the target group but giving up filling out that questionnaire is also very easy when using Internet. This may be especially true because of the general announcement of the questionnaire.

It is possible to compare the main characteristics of the non-response with the response for the rating and the grouping task. Comparisons are made between the characteristics of the respondents belonging to the target group with the characteristics of the group of respondents having filled out the rating task and with the characteristics of the group of respondents having filled out the grouping task. Comparisons are made using the Chi square test (Table 8).

TABLE 8: Influence non-response on response characteristics for rating and grouping task

	Target group (n=2430)	Completed rating task (n=1489)		Completed grouping task (n=558)	
	%	%	Sign	%	Sign
Gender			0.49		0.01
Male	80.3	79.7		76.3	
Female	19.7	20.3		23.7	
Age			0.36		0.00
18-30	38.6	39.7		45.8	
31-60	58.8	58.0		52.7	
61-90	2.5	2.3		1.4	
Education			0.00		0.00
Lower / intermediate	41.9	38.4		25.5	
Bachelor's / master's	58.1	61.6		74.5	
Travel purpose			0.57		0.59
Work purposes	63.5	64.0		64.3	
Recreational purposes	36.5	36.0		35.7	
Way of approach			0.16		0.03
Snelheidscontroles	60.0	61.4		56.6	
Kranten	40.0	38.6		43.4	

Comparing the target group and the group having completed the rating task, the response characteristics only differ significantly for education. Lower educated people quitted earlier than higher educated people. Comparing the target group with the group having completed the grouping task, however, shows that more response characteristics differ significantly. More women completed the grouping task. Younger respondents were more likely to fill out the grouping task. Finally, the respondents approached via snelheidscontroles.com were more likely to fill out the grouping task. The fact that these respondents may be more concerned with accessibility problems might explain this finding.

5. CONCLUSIONS AND DISCUSSION

This paper has described some results of three studies, which used travel survey data collected through the Internet. None of these studies were designed from a methodological perspective. Hence, it should be remembered that the results obtained are indicative. Although we have Internet-based surveys in other studies as well, we choose to discuss these studies because they vary considerably in terms of the kind of questions asked. The second and third case relate to Stated preference and choice task, which by many transportation researchers are not considered the easiest tasks. Nevertheless, reliability of the data turned out to be quite good. These two studies differ

in terms of the sampling frame. While the second study relied on an existing panel, the third study had to search for respondents. The first study was even more complex in the sense that respondents were invited to respond to a set of stated adaptation questions in an interactive experiment.

The results of these studies suggest that Internet-based travels surveys offer *potential* in administering relatively complex tasks such as stated preference and adaptation experiments. Even, interactive experiments lend themselves perfectly for the Internet. The interactivity can be used either to control the input data and also to collect information about how individuals respond to new information.

These studies however also suggest some typical *pitfalls* of Internet-based surveys. First, the sampling framework is often not available. In that case, interest in the survey should be sought through various announcements Although we have been successful in attracting a sufficient number of respondents, the sample may be biased as one does not know whether the people who responded behave differently from the population of interest. Secondly, even if a sampling frame is available, it seems that some groups are underrepresented. Especially, elderly and to some extent women are underrepresented. For applications, this means that researchers are advised to oversample these groups to obtain the required sample size for these categories. It may imply that response rates for these groups are lower, but as long as the behaviour of the participants is not significantly different from the sampled groups, this is not a problem.

Caution may be in order to generalise the results of these case studies to other countries. All these case studies were conducted in the Netherlands and therefore reflect the level of Internet penetration in this country. Results may be quite different in countries with a different penetration and history of Internet. It is recommended therefore that experiences with Internet-based surveys in other countries are systematically collected and reported.

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