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A Behavioural Analysis and Examination of Environmental Implications of Multimodal Transportation Choice

ESTIMATE

D. Janssens, C. Taverne, V. Wynen, A. De Witte, F. Liu

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FINAL REPORT

A BEHAVIOURAL ANALYSIS AND EXAMINATION OF ENVIRONMENTAL IMPLICATIONS OF MULTIMODAL TRANSPORTATION CHOICE

ESTIMATE

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SUMMARY

A. Context

Rising concerns over the continuous growth in car use and the increasingly intolerable externalities have generated particular interest in how transport planning policies might at least moderate the pressures in growth in personal mobility and support the principles of sustainable development. For more sustainable travel behaviour to occur, transport planning policies might rely upon other forms of motorized transport which may act as a substitute for car-travel. Public transport is then an obvious choice, but it is important to have this type of transport clearly integrated in a well coordinated multimodal transport chain. It is our goal within this project to pay attention to the three pillars of the concept of sustainability within a context of multimodal transport chains; these pillars being (i) to fulfil a social development role, (ii) to support economic growth and development and (iii) to have environmental benefits.

B. Objectives

The overall objective of this research project is to obtain insight into the activity and related travel behaviour of individuals in a multimodal transportation context.

In order to achieve this insight, a detailed and extensive data collection has been carried out. The data collection effort is based on observed and stated data. This was the first objective of this project.

The data have been collected in a context of activity-based research, which did not adequately capture the impact of multimodal transport make-up on activity and travel behaviour until this project was executed. The model building related to activity-based research (and its extension towards multimodal transport) is the second objective in this project.

The third objective in this project is to evaluate the impact of policy scenario's using the adapted activity-based transportation model as a starting basis. To this end, a feasibility analysis with respect to the different measures that can be assessed by means of an activity-based transportation model has been made. It is not our purpose in this project to evaluate all the possible identified scenarios in detail, since significant (fundamental) research with respect to the other research tasks has to be done. The list should be considered as a feasibility analysis with respect to the different measures that can be assessed though. A case study of a possible scenario will be shown for the matter of illustration.

Finally, it is a fourth objective in this project to carry out an analysis of the energy and environmental impact of multimodal passenger traffic and comparison of the different transport modes (train, car, walk, bicycle, bus, tram, etc.) on a well-to-wheel basis. Finally, we also briefly described the idea of cost-benefit analysis methodology which can be carried out to account the different cost and benefits that a multimodal transport chain brings along.

C. Conclusions

(section taken from the policy support section in this report: contains the most important conclusions of the research)

The Estimate project contained a high number of tasks which resulted in significant output that can be used for policy support. The main outcomes are listed below.

The first policy support outcome can be made with respect to data collection.

Methodological recommendations of the data collection

Paper-and-pencil versus PDA
During the Estimate project, results of an activity-travel survey which was conducted, using GPS-enabled personal digital assistants (PDA) and paper-and-pencil diaries, was presented. The data were collected in the context of the development of the Feathers model, a dynamic activity-based model of transport demand for Flanders. A custom GPS-enabled PDA-based activity-travel survey tool, PARROTS, was developed and the quality of the obtained trip and location data was investigated.

The PARROTS response rates were investigated and compared with the response rates using the paper-and-pencil tool in order to check whether a negative attitude towards the use of PDA technology exists or a higher burden is experienced in using the tool. It was found that the response rate for PARROTS was only slightly lower than for the traditional approach during the recruitment process. However, during the survey period fewer drop-outs were registered in case of the PDA survey, indicating that the burden for filling in this kind of survey is lower in comparison with the paper-and-pencil approach.

During the survey, the reported number of executed trips was more stable throughout the survey and on average more trips per person were reported for surveys using PARROTS.

The analysis of the data quality of the GPS logs in terms of the number of logged NMEA strings showed an attrition of the total number of NMEA strings logged as survey days pass. This is caused by respondents dropping out of the survey on the one hand and by a decrease of the number of logged NMEA strings per person starting from the fifth survey day on the other hand.

The analysis of the data quality of the GPS logs in terms of the fraction of NMEA strings containing location information versus the total number of logged NMEA strings showed that the data quality increases as more survey days pass. The evolution of this fraction as a function of time of day was correlated to the usage pattern of the PARROTS tool.

It was found that during slightly over half the total reported trip time no GPS logs were available. This phenomenon can be attributed to failure of the respondents to use the PARROTS tool, but also partially by errors in reporting trip start and end times.

Analysis of the PARROTS activity patterns revealed the use of PARROTS as an in the field activity and trip registration tool, although this modus operandi was on a voluntary basis.

Considering survey technology, important advantages of PARROTS over paper-and-pencil are the availability of detailed replanning and location (GPS) information, the checks on the data leading to higher data quality and the immediate electronic availability of the data.

If the results of this study are replicated in future similar research, these findings illustrate the potential advantage of using instruments such as PARROTS in order to obtain location and trip information during surveys; concepts which are of crucial importance to accurately model multimodal travel behaviour.

Internet questionnaire
Studying the specificity of the problem of multimodality was the greatest challenge of the Web survey. The lack of definition and possible interpretations of multimodality itself was a problem to construct the questionnaire. We have chosen to define the concept as broadly as possible. This choice was a good one since it was reinforced by the responses: 106 different combinations were stated by the respondents! On the connections' side, the same complexity is observed: respondents who are changing of mode with one branch in public transport (PT) have a different perception (and different estimates in the logit regression for example) than people who are changing of vehicle within the same transport company.

Observing that, we recommend to adapt some of the typologies developed in this project which deal with multimodality. For the mode typology, we recommend to add a sixth mode type resulting from the split of the Unimodal with public transport, separating the real unimodal one (unique vehicle) of those who state one (or more) connection(s). For the origin destination typology: we conducted some specific analyses on Brussels and we had developed subtypes based on the specificity of the Region and its suburbs. These adaptations should be kept in mind if you plan to focus on a specific environment.

On the stated preference exercise, we recommend to be careful with the choice of the options you let open (in our case: car and public transport) and the prior utility function.

Concerning the options, we had difficulties to select where to stop in designing the stated preference experiment: adding or not a bicycle option; splitting the public transport option in a unimodal and multimodal one? We decided not to conduct these type of analyses in the current project but it could be interesting to investigate this in detail to evaluate what the consequences of this kind of choices is.

Concerning the prior utility function, most of the interactions selected were not significant. This means that we have been a little too conservative. But the experimental design literature illustrates that a too complex design is better than a too simply one, even the best design is always the one that corresponds the most with the final model. To this end, we recommend there to keep the alternative we choose.

We can also make other methodological recommendations concerning the choice of the Internet as the unique administration mode of the stated preference survey. As we presented in section 2.1.2.1 page 26, the choice of Internet had implied restrictions on our population of interest. Even if Internet is well widespread now, unemployed, retired people and some other strata of our population stay less reachable through this media. Thus it seems really important to take this into account before choosing the administration mode. In ESTiMATE, we found a solution by centering our interest on home work trips which exclude these less reachable populations.

Furthermore it should be taken into account in research budgets that reaching people for an Internet survey is certainly not a cheaper solution. If one wishes to guarantee a predicted representativity, one should have access to a representative database from which one can make a rigorous sampling. In ESTiMATE, we found a way out by focusing on responsiveness and acceptability of subgroups, described mostly by descriptive statistics.

On the positive side of these conclusions, the Web survey is advantageous for its rapidity and the absence of coding problems. Within 7 days using the private database, we got 1383 Dutch speaking respondents (1216 were valid in fact). With the daily paper promotion and mailing, we got 1065 French speaking respondents (658 were valid) in about 40 days.

In both cases, the biggest advantages of Internet surveys are the absence of coding problems and the absence of transition time between the end of the data collection and the beginning of the analyses.

Another advantage of Internet survey (and more largely: computer based questionnaires) that we can confirm is the wide flexibility of the method: Avoiding complex question with "if-clause"; dynamic adaptation of the questions using the previous answers in order to increase the precision of the information gathered.

Scientific recommendations of the data collection

For the Web survey analyses, we defined the multimodality as the combination of modes and/or vehicles within the same origin destination trip. 27% of our sample is multimodal with a change of mode and 53% of the unimodal users of public transport are stating they have at least one connection. Then we got about 32% of multimodal users in our sample. Several findings were reported in this project. First, the multimodality is complex and cannot be resumed in a few figures. We observed 106 different combinations. Second, multimodality is more widespread within the long distance and Brussels is mostly the destination of this kind of trips. Third, all people with the same kind of combination are not acting in the same direction (see for example the differences between people who change of public transport within the same company or not). This implies that policy strategies should have a high level of adaptation or you should be aware that resistances will be different within the same groups of practice. Fourth, some multimodal type (like the combining the bicycle) are regionally marked and cannot be extended to other regions as easily.

Furthermore, we investigated in this project the perceptions and apprehensions of the connections. Connections are a loss of time; quite everyone agrees with that. On the fact that they are perceived as too long, people who do not experience them give no clear answer. Multimodal users agree the proposition and the ideal connection time is 5 minutes between two busses while it is 10 minutes as soon as one of the modes connected is the train. For non users, connections are stressful moments and the car users consider the most that they cannot do anything during the connections.

Next, we tried to investigate in this project if the services and amenities in the stations, on board of the vehicle or simply somewhere on the way could reinforce the connections acceptability. The reinforcement is not clearly demonstrated but we obtain two interesting rankings of these services: In the stations, people are expecting the most to find a parking for bicycle, then water closed, parking for cars, a ticket office open and roof and benches on the platforms. The first ranked amenity is the newsstand. More details were shown in the report. On board, the first expectation is to have a seat. The second and third expectations are to have information on board about the connections at the arrival and to have a unique ticket for all the public transport companies. Both high ranked services are fully connected to the main content of this project: multimodality. Further expectations and details are shown in the report.

Finally, we asked people to sketch their ideal transport mode. The best median transport mode for everyone is rapid, flexible (go whenever you want) and punctual. Then the security and the reduced cost are expected as well as being seated comfortably and having no connections. The interesting conclusion here is that rejecting the connection arrives only on the seventh position over ten.

Finally, within the stated preference exercise and some previous questions, we tried to model the responsiveness of people with respect to sustainable policies. Therefore we asked people what they would do with one car less in the household. Two responses should be highlighted: First, 12% stated they will combine private and public transport mode. In other words, they will become multimodal. Second, 16% stated they will go to their work by foot or by bicycle. This indicates that 16% of the respondent are living close enough to go to work by foot or bike but are using their car. This urges us to recommend reinforcing the policies in favour of the pedestrian and cyclist mode choices. We also investigated the response rate we can expect from exchanging policies (car for a season ticket). About 5% of car owners and only 2.6% of the company car owners are totally in accordance with the proposition.
The stated preference logit model is reinforcing one well known acknowledgement: the current mode is hard to change. The connections presented in the scenarios are the second most determinant variable. The others conclusions we could remind you to conclude this report is that the public transport option is always evaluated with more precaution than the car option. The effects of the concept of time illustrate it well: minimum (best) time is evaluated in the car option; maximum (worse) time is evaluated in the public transport option. And, last but not least, analyses led us to the conclusion that the best price policy seems to be the refunding one (refunding the public transport ticket at 100% by the government and/or the employer) instead of increasing the fuel taxes.

Activity-based modelling and its assessment of policy scenario's

Secondly, we can conclude that one of the major promises and reasons for existence of the activity-based modelling approach is an increased sensitivity for scenarios that are generally important in transport planning and policy making. In contrast to trip-based and tour-based models, activity-based models are sensitive to institutional changes in society in addition to land-use and transportation-system related factors. Activity-based models are sensitive to several groups of travel demand management strategies, including: population, schedule, opening-hours, land-use measures as well as travel costs and travel times scenarios. An example and simulation was tested using a novel synthetic population generation in the context of labour participation of women, but other applications are also possible. The most important recommendation is that the activity-based approach was adapted and that it can be used for the analysis of multi-modal transport decisions.

Integrated emission modelling and cost-benefit analyses

Finally, using the integrated methodology that has been developed within ESTIMATE, one is able to analyse the energy and environmental impact of multimodal passenger traffic and compare the different transport modes on a well-to-wheel basis. An example has been simulated and the total impact of such a scenario can be calculated.
Furthermore, it should be pointed that a cost-benefit analysis considers all present and future, favourable and unfavourable effects the members of society might encounter as a result from a project, plan or policy measure by expressing them in monetary values. It is based on the willingness to pay of the members of society: how much do they want to pay to receive a certain benefit or to avoid a certain downside? In case the balance of the benefits and costs is positive, then the project, plan or measure contributes to the societal prosperity. The cost-benefit analysis can be used for grounding investments in transport projects as well as for choosing the most desirable project alternative. In any ways, its support to the decision is informative. The policy maker should combine the conclusions of the cost-benefit analysis with those of other studies in order to make a balanced decision. The methodology and standard passenger km effects per mode that were shown in this report can be used to guide policy makers and help with this decision making process.

D. Contribution of the project in a context of scientific support to a sustainable development policy

The relevance of the contribution of this project is underlined by two important trends that can be observed at an international level.
First of all, there is the clear employment of activity-based transportation models to lend a support to and as an evaluation instrument for a particular pursued policy (which aims to reduce negative effects of transportation such as traffic unsafety, emissions, congestion, etc.) or to evaluate a scenario (like we did in this Estimate project). In order to effectively implement and analyze policy objectives, an increasing amount of awareness is needed with respect to the need for an improved understanding of travel behaviour. Obviously, the four-step methodologies that are adopted both in Flanders and worldwide are in nature network-models which can be used to focus on policies of infrastructure expansion.

However they embody a rather poor behavioural representation of travel behaviour mechanisms. Specifically the fact that the focus of these models is on individual transfers, neglecting the temporal and spatial relations and constraints that exist between the different trips as well as known aggregation biases, which arise due to the fact that not the individual travellers are simulated in the models (i.e. microsimulation is not used as technique), arises a lot of discussions. These arguments were not only suggested by scientists. People who use these models in practice also expressed their concerns. The Mobility Plan Flanders is one of the policy based documents expressing this point of view, mentioning explicitly that its static character and the lack of a feedback mechanism (thus the lack of temporal relations) are serious shortcomings of the traditional techniques of modelling traffic. All these scientific and more practice-oriented concerns resulted in a need for travel demand models that embody a more realistic representation and understanding of the decision-making process of individuals and that are responsive to a wider range of transport policy measures. This is where tour-based models (often adopting a microsimulation approach, thereby simulating every individual but maintaining the quite straightforward simple structure of four-step models) or more advanced models activity-based models come into play.

Secondly, and perhaps even more important, it is of crucial importance in a society that is becoming more and more subject to congestion, to have transport clearly integrated in a well coordinated multimodal chain. In fact we payed attention to the three pillars of the concept of sustainability in this project; being (i) to fulfil a social development role, (ii) to support economic growth and development and (iii) to have environmental benefits. In particular, the extensive data collection that was executed gives plenty of detail and insight to guide and support sustainable policy making.

E. Keywords

Modeling, transport, activity-based transportation modeling, environment, multimodal, Ecoscore, cost-benefit analysis

1. INTRODUCTION

1.1 Context

Urban areas, cities and metropolitan regions are the prime generators of wealth, economic growth and development in countries (Schifferes, 2002; Weissbourd and Berry, 2001). The performance of the transport system (as a means to overcome space) and the structure of the land-use system (spatial distribution) are however the most important factors that determine the quality of this potential of cities. Whereas a good transport system widens the opportunities to satisfy interaction needs, a poorly connected transport system limits economic and social development (Ortúzar and Willumsen, 2002). There seems to be an increasing realisation that current aggregate urban development trends, as manifested in *land-use patterns* (sprawl, low-density, suburban development) and *transport systems* (dominated by private, single-occupant and fossil fuel intensive vehicles) are simply not sustainable or desirable (United Nations, 2002).

Rising concerns over this seemingly inexorable growth in car use and the increasingly intolerable externalities have generated particular interest in how transport planning policies might at least moderate the pressures in growth in personal mobility and support the principles of sustainable development (Barret, 1996; Salomon et al., 1993; European Commission, 2001). For more sustainable travel behaviour to occur, transport planning policies might rely upon other forms of motorized transport which may act as a substitute for car-travel. Public transport is then an obvious choice, but it is important to have this type of transport clearly integrated in a well coordinated multimodal transport chain. Simply providing public transport does not necessarily imply that it will result in more sustainable travel behaviour patterns.

Thus for any multimodal transport chain to support the principles of sustainable development, it should (i) fulfil a social development role, it should (ii) support economic growth and development, and it should have (iii) environmental benefits (i.e. consume fewer finite resources) (United Nations, 2002). It is our goal within this project to pay as much as possible attention to these three pillars of the concept of sustainability within a context of multimodal transport.

1.2 Objectives

The overall objective of this research project is to obtain insight into the activity and related travel behaviour of individuals in a multimodal transportation context. In order to achieve this insight, a detailed and extensive data collection has been carried out. The data collection effort is based on observed and stated data. This was the first objective of this project.

The observed data are used to calibrate and build an activity-based model that is able to *predict* how individuals respond to changes in their travel environments. Specific focus will be placed in the model and in the data collection on multimodal transport, which has the specific characteristic that -amongst others- the physical make-up of multimodal public transport reduces individual's choices for activity engagement by limiting the

locations that can be reached as well as the time (and effort and convenience) it takes to reach those required activity locations. The activity diary will be used as the formalism to carry out the required data collection for the observed data.
To extend these models to new situations and contexts, we have to study how people would respond to a possible policy or change in their environment. The stated preference methods (or stated choice) are a useful toolkit for collecting stated data. A stated preference experiment typically proposes a set of scenarios to the respondent and asking him/her to choose between alternatives. These alternatives are described by the variables of interest. The latter are used to describe situations and contexts under consideration. The stated preference technique gives the opportunity to test new policies (tax, subsidiaries) but also new infrastructures such as a new public transport line. These situations cannot be evaluated on observations of the current behaviours by means of travel diaries. The stated preference methods are also indicated to identify threshold of social acceptance on price or time for example.

We will perform these research activities in a context of activity-based research, which did not adequately capture the impact of multimodal transport make-up on activity and travel behaviour until this project was executed. The model building related to activity-based research (and its extension towards multimodal transport) is the second objective in this project.
Activity-based travel analysis approaches have received attention in recent years as a potential replacement for more conventional trip-based approaches because AB approaches analyze travel from a theoretical perspective that takes into account the demand for activity participation, interrelationships among trips and interactions among household members. In the context of the activity-based framework, human activity is a result of actions which are motivated to satisfy needs and desires of the household and its members and travel is undertaken by individuals on their own behalf or as household members to fulfil their needs and desires to participate in these activities. Scientific research related to the field of activity-based modelling is motivated by the importance of improving our understanding of human behaviour on the one hand and to use this understanding to provide better predictions of the impact of societal changes and both travel and broader social policies on the future use of transport systems on the other hand. For activity-based models to have the required behavioural realism, they need to be theoretically sound, and at a sufficient resolution to explain policy impacts. The ideal activity-based model should consider activity participating along a continuous time dimension capturing time use and allocation behaviour with explicit consideration of constraints by the spatial, temporal, and social dimension, accounting for inter-dependency among individual in the households, among trips, and trip chaining. To better understand activity behaviour there is a need to analyze also the context of the activities including the why, when, with whom, and the duration and sequence of those activities. It also requires a detailed understanding of how households and individual acquire and assimilate information about their opportunities for activity participation and travel options, how this information is used to determine time allocation for activities and travel, and whether the attributes of activity episodes are determined jointly or sequentially.

The third objective in this project is to evaluate the impact of policy scenario's using the adapted activity-based transportation model as a starting basis. To this end, a feasibility analysis with respect to the different measures that can be assessed by means of an activity-based transportation model has been made. It is not our purpose in this project to evaluate all the possible identified scenarios in detail, since significant (fundamental) research with respect to the other research tasks has to be done. The list should be considered as a feasibility analysis with respect to the different measures that can be assessed though. A case study of a possible scenario will be shown for the matter of illustration.

In addition to the transportation consequences of such a scenario, it is a fourth objective in this project to carry out an analysis of the energy and environmental impact of multimodal passenger traffic and comparison of the different transport modes (train, car, walk, bicycle, bus, tram, etc.) on a well-to-wheel basis. We will propose an adapted and novel methodology about how to do this in this multimodal context. Finally, we will briefly describe the idea of cost-benefit analysis methodology which can be carried out to account the different cost and benefits that a multimodal transport chain brings along.

The remainder of the text in the main methodological chapter has been structured along these project objectives.

2. METHODOLOGY AND RESULTS

2.1 Methodology

2.1.1. Data collection of observed data

2.1.1.1 Operational content-related decisions

For the collection of observed activity-based diary data, IMOB explicitly asked respondents to report (multimodal) transport chains, both on paper-and-pencil (see section 2.1.1.3) and PDA (see section 2.1.1.4). Although this seems evident, the collection of such data requires many operational decisions from a methodological point of view.

First of all, one needs data about activities. From an operational point of view, one needs to decide whether data on activities out-of-home suffice, or whether one also needs to collect data about in-home activities. While one could also be interested in the relationship between in-home activities and out-of-home activities, we decided to only use a detailed categorization for out-of-home activities, given the significantly lower user burden and higher response rates.

Another operational decision which needs to be made is the classification of activities. We decided not to use very detailed classification information of activities at the cost of increasing the burden for the respondents significantly. Nevertheless, we still have 14 activity classes (which is more or less standard when we compare with other international data collection efforts for using an activity-based model), which include: In-home activities, sleeping, services, working, eating, daily shopping, non-daily shopping, education, social activities, leisure, bring or get persons or goods, waiting, touring and other activities.

Another facet concerns the spatial dimension or location of activities. To model this facet of activity profiles, data on where activities were conducted, are required. Several operational decisions come into play.

The third facet concerns the timing dimension. Activity-based models incorporate the timing of travel decisions. Consequently, data on start and end times, and hence duration of activities and related travel should be collected. An important consideration in this regard is that a longer time interval (for instance "before noon") will likely result in an under-reporting of short trips, and activities of short duration. We therefore decided to avoid this problem by asking respondents to report the exact start and end times of their activities.

The next facet concerns the "with whom" dimension, where one needs to collect data on who is participating in the various activities/episodes. We decided to use a rather broad categorization of travel party: other members, children and partner information. We also explicitly asked for the number of people that are participating in the travel because this has implications for vehicle occupancy rates and traffic volume.

The last facet concerns the "transport mode" dimension, and this is obviously the most important for this project. At least 11 different transport modes could be reported in the diaries: by foot, bicycle, motorcycle, motorbike, car as driver, car as passenger, train, bus, tram/metro, taxi and other. Four different trip chains (journeys) could be chained together.

Different aspects of the trips that make up each journey (e.g. which transport modes were used, duration of the trips and how many people accompanied the respondent during the trips) are questioned. We equally asked respondents to report waiting times, for instance in a context of using public transport.
The above facets concern the principal choice dimensions underlying activity-based models. Obviously, personal and household characteristics also need to be collected for segmentation and clustering purposes. We should keep in mind that within this project, it is not our primary purpose to analyze these different data facets in detail. However, the discussion is important and relevant since the purpose is to use the different facets of the activity diary in order to make them operational in an activity-based model.

2.1.1.2. Operational survey design issues
Methodological research, both in time use and transportation, is accumulating, offering a good basis to decide which format is most appropriate for a particular model. Based on this literature, we will discuss in this section the pros and cons of specific operational decisions, such as type of diary, time horizon. First, however, we will discuss the potential advantages of diaries as opposed to questionnaires.

<u>Diaries</u>
The questionnaire, asking people for their typical travel behaviour on an average day or average behaviour during some time period, has long been the dominant form of data collection in transportation research. It has been argued, however, that a questionnaire format with a focus on an average day may result in an under-reporting of trips. In particular, there is significant accumulated evidence that travel survey especially under-report off-peak, non-home based trips of short duration (e.g., Meyburg and Brög, 1981: Koppelman, 1981; Robinson, 1985; Dijst, 1993). Based on these findings, Stopher (1992) argued that an activity diary outperforms a travel survey in that short, non-home-based trips are no longer under-reported. His argument is consistent with the findings of Clarke et al. (1981), who reported that the activity resulted in a 13-16 percent higher level of trip making than the travel survey. This difference was largely accounted for by discretionary trip purposes: mandatory trip purposes did not vary significantly between the methods of data collection. Similar differences in degree of reporting have also been found in time use studies (e.g., Nieme, 1993).
Nevertheless, diaries are not perfect, as exemplified by the study conducted by Golob and Meurs (1986) for the Dutch Ministry of Transportation, and Murakami and Watterson's (1992) analysis of the Puget Sound Transportation Panel. They found a systematic under-reporting of walking trips and an underreporting of walking segments on trips involving more than one mode in diary data. People tend to overlook short, non-vehicular trips with increasing incidence during the diary period. Although this is not unique for diary data, there is also evidence of differential non-response by socio-demographic groups. For example, Roveri (1992), discussing experiences with the Italian time use study, concluded that the level of non-response for activity diaries is higher than for conventional questionnaires. Likewise, Dowling and Colman (1995) reported a higher non-response rate for lower income groups, whereas Sen et al. (1995) found people with managerial and professional education had higher response rates than blue collar workers. Moreover, they found larger households to have lower response rates single- member households. Finally, households with vehicles were more likely to respond.

However, collecting diary data is quite demanding for respondents. Such high demand may result in lower response rates and differential non-response. The literature seems to suggest that researchers should be especially aware of three sources of bias:
(i) respondents of a lower socio-economic class and lower level of education may find the diary too demanding and drop out;
(ii) respondents with a relatively low level of out-of-home activity engagement may decide not to participate because they feel their case is not relevant, and
(iii) respondents who are very busy and travel a lot cannot afford the time to fill out the diary, resulting in a differential non-response.
Regardless of these potential sources of bias, an activity-based model of transport demand requires detailed information about people's activities and related travel. It is difficult to see how such data can be collected through the use of questionnaires by asking respondents to report on the total number of trips during some time horizon. In general, the available literature seems to suggest that the diary is likely to outperform the questionnaire in terms of the validity of trip and activity data. Diaries are also a richer source of information that allows additional kinds of analysis. Diaries are thus the best choice as they represent a suitable instrument that tries to capture the relationships between activity choice, location choice, timing, travel party and transport mode in a systematic way.

Type of diary

Three types of diaries have been reported in the literature: a trip diary, a full activity diary and an out-of-home activity diary. These types do not only differ in terms of the amount of information collected, but also in terms of the format used to lead the respondents through the data collection process. In the case of a trip diary, the leading question relates to the trips made, and all other information is derived from or linked to trips. In contrast, the leading question of the other two types of diaries relate to activities, and all other collected information is associated with the activities the respondent says to been engaged in. The full activity diary records all activities, whereas the out-of-home activity diary only records out-of-home activities. Consequently, the out-of-home activity diary can be viewed as a limited case of the full activity diary. There are several methodological issues to be taken into consideration in determining the choice.
One of the most elaborate studies that compared the types of diaries in this regard was conducted by Clarke et al. (1981). They found that no respondent had any apparent difficulty in recalling yesterday's trips in the trip diary format, although some acknowledged difficulty with trips made the day before. Omissions were either of all trips in one trip purpose category, or short duration tended not to be popularly construed as trips. This finding is consistent with those reported for the Dutch and Puget Sound panel data. Many disclaimed yesterday's trips as atypical and there was some reluctance to detail 'unusual' trips and their attributes. Trips over the week were recalled in largely unordered sequences.
The results obtained for an out-of-home activity diary format suggested that this format was accepted more readily than the trip diary format. All respondents recalled and discussed patterns of shopping activities in particular detail, and patterns of social activities were quite readily described.

However, many people omitted one or more categories of activity entirely. Some respondents did not construe leisure as a distinct category, and it appeared that many non-work trip-dependent activities shared attributes of several categories, which made it difficult to identify them uniquely (e.g., shopping activities comprising shopping, social and recreational attributes). Similarly, multi-purpose travel arrangements tended to be obscured by this format.

The full activity diary format generated the initial questioning of the relevance of such information to a travel study, but nevertheless all respondents co-operated. This format demanded a longer interview time than others, and generated more discussion. It also produced more causal accounts of travel behaviour than the other formats did. Conditions at the time of the trip were reported in more detail because the adjacent activities were recalled quite fluently and in sequence. In no case did subsequent questioning reveal omitted trips.

Thus, Clarke et al. (1981) concluded that the use of a format in which participants discuss travel in the context of the day's activities seems to provide the closest correspondence with the natural storing of information and the planning of activities. Conversely, the conventional trip diary would seem the least satisfactory means of eliciting travel information. Asking respondents what trips were made during a particular period of time neither ensures that all travel is recorded nor defines the researcher's notion of trip to the respondent. Activity rather than trip diaries will substantially increase reported trip rates.

Indeed, increases of up to 13 percent have been reported (Stopher, 1992). On the other hand, Kalfs and van der Waarde (1994), comparing seven Dutch diaries, conclude that an activity diary will not necessarily result in a more accurate and more detailed reporting of trips, unless it incorporates particular features to provide high quality data.

Considering this empirical evidence, it seems that the choice between a trip diary and an activity diary is largely determined by the goals and objectives of the study. If data is to be collected for developing an activity-based model, trip diaries are sufficient. Activity diaries normally provide more detailed information, and may also provide reliable data as they imply a more natural way of storing information.

Time horizon

The concept of time horizon concerns the question whether diary data should be collected for the past or for the future. In principle, respondents may be asked to recall yesterday's trips or activities or activities longer ago, or be asked to fill out the diary for a particular day in the future. Often, the latter option is referred to as 'leave-behind' as it typically involves an interviewer leaving behind the diary for the respondent to fill out after explaining the diary. In contrast, the recall format involves asking respondents, with or without previous notifications, to report their activities performed during a given, previous day. When the interviewer meets the respondent or contacts the respondent by phone, all events of the previous day are systematically reviewed in order to elicit from the respondent's memory the whole sequence of activities and trips, while establishing also the time of the day at which the consecutive events took place, the location of the activities, the persons in whose presence they took place, etc. In our project, we will only use data for the past, and not for the future (planned) data.

Frequency

The concept of frequency is used in the time use research literature to describe how long the diary should be kept. This issue has been subject of considerable debate. One group of scholars argues that the respondent demands are so high that reliable results can only be obtained for one or two-day diaries. Others (e.g., Scheuch, 1972; Goodwin, 1978; Lawton and Pas, 1995) have argued that, while this may be true, one or two-day diaries are not very valuable in that they do not capture multi-day cycles in activity patterns. This argument is supported by referring to the typical cycles found in a large number of empirical studies (e.g., Goodwin, 1978; Hanson and Huff, 1982a, 1982b; Barnard, 1984; Harrison, 1986; Huff and Hanson, 1986, 1990; Pas and Koppelman, 1987; Mahmassani et al., 1991). In the time use research literature, the overriding opinion seems to be that one or two-days per respondent for general studies are to be preferred, while for specialized studies longer periods may be more appropriate. The choice then is between sample size and the number of days per respondent.

The choice for increasing the number of days per respondent reduces important dimensions of measurement error and marginal costs (Gershuny, 1992), and increases the usefulness of the data for analysis and model development, but also increases non-response and data quality.

On the other hand, it should be remembered that to the extent that heavy respondent demand leads to non-response, it does not necessarily imply behavioural bias. In fact, there is some evidence that non-response does not lead to serious behavioural bias (Gershuny, 1990). The problem here is that we cannot really know whether non-response has any effect on behavioural bias. To be on the save side, non-response should be reduced as much as possible, without pushing respondents too much to return their diary as they may be inclined to quickly fill out the diary, simply to avoid future reminders. For model-building purposes, multi-day diaries are required. It is clearly preferable to have a record interviewing over a number of days. In our study design, we have used a survey duration of one week.

Form of administration

Diaries can be administrated by email, personal interviews or by phone. The telephone mode of administration is likely to cause most difficulties. As diaries tend to be complex and take considerable time, it is difficult to imagine that respondents can provide such detailed information over the phone beyond simple retrieval of the information, which they have generated before. The empirical evidence in this respect is, however, far from conclusive. For example, Stopher (1992), comparing the completion rates between mail and telephone, found a rate of 23.5 percent for the mail-back retrieval and only 19 percent for the telephone. He did not find significant differences between the forms of administration in terms of person trip rates for home-based work, home-based non-work and non-home-based trips. Klevmarken (1982) found no difference in time use between personal and phone interviews in a pre-test of the Household Market and Non-Market Activities study in Sweden. Lyberg's (1989) concluded, in a study of the Swedish Time budget Survey, that the self-completed diaries provided more detailed reports than the interviewer administered recall diaries. The estimates of time spent on different activities, however, were very similar for these two modes of data collection. The interviewer-administered diaries seemed to underestimate the percentage of participants in different activities and overestimate the time spent among the participants.

Meyburg and Brög (1981) also found that face-to-face interviews yielded less valid estimates of travel time compared to mail questionnaires. Moreover, the diaries completed in the presence of the interviewer yielded 15 percent fewer trips. They argued that this finding is caused by unconscious mistakes of the interviewees, conscious mistakes of the interviewees, who are unwilling to provide certain information and the influence of the interviewer who attempts to complete the interview as quickly as possible. Libs and Lebart (1994) found in the Multi-Media Time Budget Survey that the use of a self-completed questionnaire resulted in a significantly lower number of regular readers than the use of face-to-face interviews. Thus, these findings suggest that the presence of an interviewer is likely to influence the kind and intensity of responses.

The form of administration may also impact response rates. Ampt and Richardson (1994) compared six diary instruments, which differed in terms of form of administration. One involved the telephone to establish initial contact, four established initial contact by mail and the final instrument was based on personal initial contact and a personal interview to retrieve the diary data. The findings indicated that the instrument based on personal contact resulted in a response rate 65.5 percent, whereas the lowest response rate was observed for the instrument that used the telephone to establish initial contact. The response rates for the self-completed mail diaries varied between 50.9 percent and 66.7 percent, depending upon the type of diary. In another study, Ampt (1989) compared a self-administered and a personal interview for the collection of 24-hour travel diaries in Australia. As expected, she found the personal interview to provide higher response rates.

Thus, it seems that self-completed diaries tend to result in a more detailed reporting and hence have more to offer as long as appropriate action is taken to guarantee a good response rate.

2.1.1.3 The paper-and-pencil data collection

This paper-and-pencil data collection procedure consists of presenting respondents with an integrated survey instrument in which different questionnaires probe for information about activity-travel patterns

In the household questionnaire, respondents provide information on the composition, the number of cars, the number of people with a driver's license and the income. In the personal questionnaire, similar information is acquired on modes of transportation, living and work situation, and certain activities. The paper-and-pencil questionnaire (diary) is based on a combination of the Flemish Travel Survey (OVG) and the Flemish Time Budget Survey (TBE). Earlier research has investigated the strengths and weaknesses of both surveys (Peetermans et al., 2005). The present study aims to elaborate the diary by taking into account the experiences from this previous research.

In the diary, the respondent fills out his personal activity-travel diary which includes all performed activities and journeys during one week. A questionnaire asking for information concerning planned activities and journeys is also added to this survey. The figure below shows one example of the paper-and-pencil diary of performed activities and journeys. The questionnaire contains three major sections: an activity section, a journey section and a control section. In the activity part, respondents fill out all required information concerning the activities they actually have performed. In the journey section, respondents complete questions with regard to the performed journeys and the aspects of the trips that make up each journey (e.g. which vehicles were used, duration of the trips and how many people accompanied the respondent during the trips).

IDENTIFICATIE-ID	DAGBOEK-ID-121	DAGBOEK-ID-122
1. DATUM	__ __ / __ __ / 200 __	__ __ / __ __ / 200 __
2.BESCHRIJVING Welke activiteit voerde u uit? Geef de code en uw eigen omschrijving.	BESCHRIJVING (CODE A*): A__ __ ………………………………	BESCHRIJVING (CODE A*): A__ __ ………………………………
3.BEGINUUR Hoe laat begon de activiteit?	BEGINUUR: __ __ uur __ __ min	BEGINUUR: __ __ uur __ __ min
4.DUUR Hoe lang duurde de activiteit?	DUUR: __ __ uur __ __ min	DUUR: __ __ uur __ __ min
5. PERSONEN Met hoeveel personen voerde u de activiteit uit? Met wie voerde u de activiteit uit?	PERSONEN: Aantal: □met partner □met kinderen __ __ □met anderen	PERSONEN: Aantal: □met partner □met kinderen __ __ □met anderen
6.LOCATIE Waar vond de activiteit plaats?	LOCATIE (label locatie*): ………………………………	LOCATIE (label locatie*): ………………………………
Heeft u deze activiteit op dezelfde locatie uitgevoerd als de vorige activiteit? Ja? Ga naar vraag 9. Nee? Ga naar vraag 7.		
7.VERPLAATSING Welke vervoermiddelen hebt u achtereenvolgens gebruikt om op deze locatie te geraken? Hoe lang duurde de reis met elk vervoermiddel? Met hoeveel personen hebt u deze verplaatsing samen gemaakt en met wie?	VERPLAATSING (CODE V*): 1e. Wachten __ __u __ __ min 2e. V__ __ __ __u __ __ min Aantal: □met partner □met kinderen __ __ □met anderen 3e. Wachten __ __u __ __ min 4e. V__ __ __ __u __ __ min Aantal: □met partner □met kinderen __ __ □met anderen 5e. Wachten __ __u __ __ min 6e. V__ __ __ __u __ __ min Aantal: □met partner □met kinderen __ __ □met anderen 7e. Wachten __ __u __ __ min 8e. V__ __ __ __u __ __ min Aantal: □met partner □met kinderen __ __ □met anderen	VERPLAATSING (CODE V*): 1e. Wachten __ __u __ __ min 2e. V__ __ __ __u __ __ min Aantal: □met partner □met kinderen __ __ □met anderen 3e. Wachten __ __u __ __ min 4e. V__ __ __ __u __ __ min Aantal: □met partner □met kinderen __ __ □met anderen 5e. Wachten __ __u __ __ min 6e. V__ __ __ __u __ __ min Aantal: □met partner □met kinderen __ __ □met anderen 7e. Wachten __ __u __ __ min 8e. V__ __ __ __u __ __ min Aantal: □met partner □met kinderen __ __ □met anderen
Gelieve vraag 8 in te vullen als u zich met de auto verplaatste.		
8. AUTO Welke auto werd gebruikt?	Label auto*: ……………………………	Label auto*: ……………………………
9.CONTROLE PLANNING Was deze activiteit gepland?	PLANNING: □ ja → PLANNING-ID- _ _ _ □nee → waarom niet? P__ __ (CODE P*)	PLANNING: □ ja → PLANNING-ID- _ _ _ □nee → waarom niet? P__ __ (CODE P*)

Figure 1. Diary for performed activities and journeys

The paper-and-pencil activity-travel diaries are quite comprehensive and complex. The paper-and-pencil survey has been subject to severe testing procedures and has also been used in previous projects. In order to achieve these, several individuals were involved in the testing procedures and several test and feedback loops have been executed. In addition to the diaries itself, a manual has been provided for the respondents. In these manuals an explanation of every question is provided, as well as several examples of how to fill out the diary. The manuals were also subject to severe testing, and adjustments were made based on the feedback that has been received.

2.1.1.4 The PDA data collection

The automated PDA activity-travel diary survey tool has been called PARROTS, which stands for (PDA (Personal Digital Assistant) system for Activity Registration and Recording of Travel Scheduling). PARROTS runs on a PDA and uses the Global Positioning System (GPS) to automatically record location data. The PDA was programmed such that besides automatically registering its location, respondents can provide information about their activity-travel behaviour as well. Another part of the collected data consists of data regarding replanning and execution of activities and trips that is manually input by the respondents. These data have not been used in this research project.

If the PDA is switched on, PARROTS starts automatically and the main GUI is shown (Figure 2, Left). Whenever PARROTS is active, the GPS logger is operational logging the GPS location strings at a configurable rate. Hence the respondent can automatically record route and location information using GPS by keeping the PDA switched on. The 'Vergrendelen' button provides a screen lock functionality such that the PDA can safely be stowed during the trip. The PDA is switched off using the 'Afsluiten' button.
The buttons 'Planning' (Planning) and 'Dagboekje' (Diary) are used to launch the graphical user interfaces (GUI) to input planned and executed activities and trips respectively. In the planning GUI, the registered activities and trips are grouped by day and are listed in the same order they were entered (Figure 2, Middle). In the diary GUI, the executed activities and trips are displayed in a layout that resembles an agenda (Figure 2, Right). The difference in both GUI's stems from the fact that providing an agenda layout for planned activities is reported in literature to bias the collected data due to visual feedback of the interface (Zhou and Golledge, 2007).

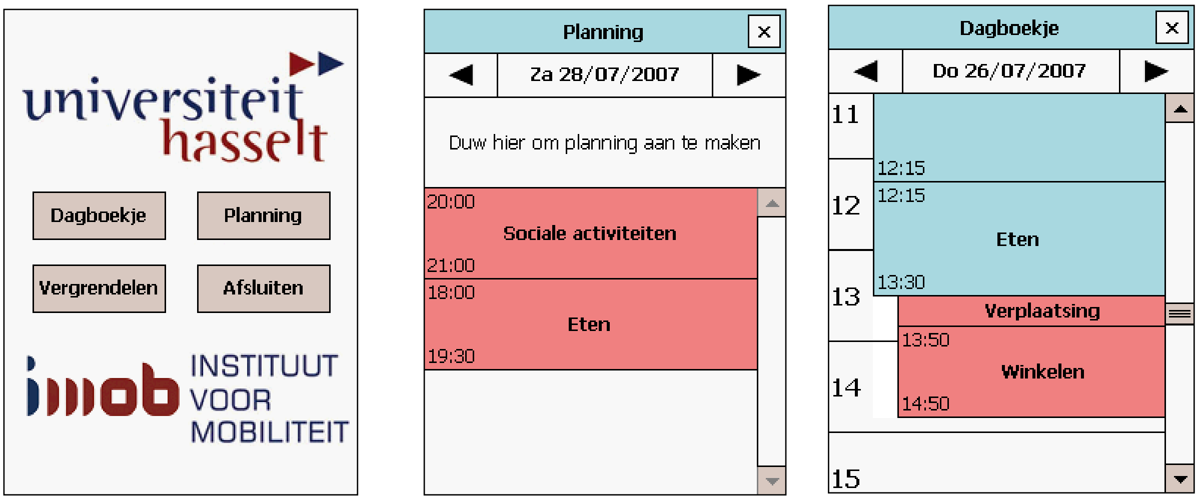


Figure 2. PARROTS main GUI (Left), planning GUI (Middle) and diary GUI (Right). In order to facilitate the distinction between planned and executed activities, planned activities are depicted in red and are wider than executed activities, which are depicted in blue.

Whenever an activity or trip is registered in PARROTS, a number of attributes for this activity or trip are collected using a customized GUI. The most important activity and trip attributes PARROTS collects are: activity type, date, start and end time, location, mode of transportation, travel time and travel party. Note that although PARROTS collects location data using GPS, the location of activities is still queried. The match between location information provided by the respondent and the location logged by GPS can be verified during postprocessing in order to validate the data.
PARROTS features several data consistency checks, the most important of which are: checks that all required data are available and feasible, checks on overlaps and/or gaps on the time axis and checks for discontinuities in location. If any of the checks fails, the user is taken to the relevant GUI and an informative error message is shown. These checks are only enforced for activities and trips that are labeled as executed.
About 900 persons have been questioned by means of the PARROTS tool, which means that this study is probably one of the largest ever using GPS in the field of activity-travel data collection and one of the few that we are aware of that uses GPS-enabled PDA's. Obviously, we were not able to collect all 900 persons in the context of the Estimate project (about 150 persons in the context of Estimate; about 750 in the context of the SBO project). For building and calibrating the model, the full data set has been used since it provides us with the necessary behavioural information and rules to build the model. More detailed analyses with respect to the collected data, like the analysis of the impact of GPS-enabled PDA technology on the user response rates, the impact of PDA technology on the quality of the collected diary data and PARROTS usage patterns, can be found in Bellemans et al. (2008). The functional design of the tool has been discussed in Kochan et al. (2006a, 2006b).

2.1.2. Data collection of stated data

The observed data are necessary for building the basic model but is not going to give us information about the willingness to change and to assess the user's perception related to the accessibility of a policy measure. To this end, a novel stated preference experiment with respect to modal choice has been fully conducted in the context of the Estimate project. The stated preference scenarios were integrated in a Web survey. The

remainder of the questionnaire was investigating the current mobility of people and their acceptance of the different components of the multimodality in their home work trips. With this data collection effort, we have sketched the contour of the multimodality in Belgium in term of practices, social acceptance and user's responsiveness to some policy scenarios related to the sustainable development.
In the next section we will describe the methodological choices that were made: first on data collection and the definition of the population studied; second on the questionnaire redaction and its treatment; third on the design and treatment of the stated preference experiment. Each choice will be justified according to scientific arguments and the specific needs of the ESTiMATE project.

2.1.2.1. Population of Interest and Data Collection

In this subsection, two interconnected methodological choices will be developed: the definition of the studied population and the data collection instrument. In order to introduce these subjects, we will first have a look the Internet surveys and their implications.

Internet Surveys

The contract of the ESTiMATE project has planned a stated preference (SP) Web study. The choice of the SP method will be discussed further. The choice of the Internet medium of data collection was motivated by the lower cost of its implementation in the one hand; and by the growing amount of similar jobs in others countries like the United States and Australia in the other hand. This initial methodological choice binds us to take into account the online survey possibilities in the definition of our studied population, and consequently to limit our analysis perspectives relatively to the reachable population.

Numerous and regular studies inform on the evolution of the Internet access in Belgium. A trend can be observed since the proliferation of the broadband Internet access: Belgians are more and more connected to the Web, mainly through home access. This development goes through most levels of society.
A recent StatBel study (SPF Economie: 2007, 1) had given some guidelines for 2006 which have been confirmed in October 2007 by new results (SPF Economie: 2007, 2) : About 62% of the Belgian population between 16 and 74 years old state that they had had access to Internet within the three months prior to the study. 94% of these people state that they use Internet at least once a week. Thus, in most cases people who access internet are regular users.
Quickly reduced we could describe the reachable population through Internet as people (men or women quite identically) between 16 and 54 years old who work. If they work in offices, they access more broadly at work than workers for example. But home access is the most widespread access place in Belgium so the difference between office and non-office workers as regards Internet access is disappearing progressively.
In fact the access differences seem to be more observable and significant between people who get a job and people who do not. This has an effect on instruction levels statistics about Internet access because of the dependent repartition between these two variables.

Symmetrically the unreachable (or more qualified: less reachable) population is older (for the 55-64 years old people the Internet access threshold goes down to 40% and fall to 14% after 65 years old); they are generally retired or unemployed. Consequently it seems more realistic to concentrate our ESTiMATE online study on the Belgian workers and students.

Definition of the Studied Population

From the Internet access point of view, unemployed and elderly persons will be less reachable than the rest of the adult population. Then, we have to put them away of our population of interest. This first step of definition is reinforced by the specific mobility of the elderly and unemployed people, probably less subjected to the same routines than workers; routines which are easier to catch through a fixed field questionnaire. Involving these categories of people will impose to broaden the questions and answers in our questionnaire and it could become impossible to administrate because of its length and complexity.

That choice imposed by context urges us to close our goals' definition in term of studied contexts in the same time: we have made the choice to concentrate our work on the home-work trips and multimodal opportunities inside them. This restriction seemed to be the most respectful of the thematic of ESTiMATE. Note that we will keep the appellation 'home-work trips' (abbreviate as 'HW trips') because the alternative notation 'commuting trips' is more restrictive by its reflected image in our national languages.

After the unemployed and elders exclusion and the HW trips choice, we also needed to exclude another part of our potential population: People who do not work at least three days per week in the same place were excluded of our population definition because of their likely specific mobility. People who are working on the road and people who have to combine multiple work locations (for example, two half time contracts) are also less subjected to routine. This has the same consequences on the questionnaire redaction as indicated previously.

So, we have finally defined our studied population as follow: All people who live in Belgium and work at least 3 days per week in the same place in Belgium.

Data Collection

The questionnaire was administrated through an internet Website available on the address: www.estimate.be. The first page is a language choice page; the second page explains in some words what is ESTiMATE; and the following ones are displaying the questionnaire in Dutch or French.

No budget was foreseen in the ESTiMATE contract to have access to the National Register or another representative database in which we could sample people to contact. Then, other sampling strategies were evaluated. In the first time, we choose to avoid some unwanted mailing that could be considered as spam by addressees. Moreover buying an access to a private email database (opinion poll companies, client fidelity programs, etc.) was too expensive. Then, we contacted each national newspaper – which are actually regional in Belgium – and offered them a partnership.

Vers l'Avenir and De Standaard from the Corelio press group accepted to deal with us. But later De Standaard cancelled the deal because of the risk of tiring their respondents and the absence of financial interest of our study for their daily paper. Urged by time, we finally chose to pay for an email database for Flanders only. This means that our samples were taken in two different manners following the language of the questionnaire.

French Speaking Questionnaire

The French speaking questionnaire was promoted by 2 ways:

- Vers l'Avenir and associative and company emailing. Vers l'Avenir promoted it via an article, a Web banner and a mailing. The article was on the back page of all their editions of the 5th of October 2007; about 100,000 copies. Their mailing list is containing about 50,000 mail addresses.
- Parallel to the Vers l'Avenir collaboration, on the 4th of October 2007 we sent over a hundred emails to journalists, mobility associations (cars, bike, and so on) and companies that have a potential link with our subject (FEBIAC, Public Administration, TEC and so on). Following these mails we got some articles in Websites (such as the users' association of the speedway E411) and mailing lists (such as Inter-Environnement Wallonie and Inter-Environnement Bruxelles).

The French speaking questionnaire was closed on Monday 12th of November 2007 after about 660 people had answered the full questionnaire.

Dutch Speaking Questionnaire

For the Dutch speaking questionnaire, we had finally concluded a contract with InSites Consulting to guarantee at least 1000 Dutch speaking respondents. The company managed the contact with its respondents (potentially 294,000 addresses of Dutch speaking Belgians) and we paid per complete response. The company regularly proposes its respondents to answer questionnaires. In exchange for answering, people can win some prizes.

The Dutch speaking questionnaire was launched the Wednesday 17th of October and closed the 23rd of October after about 1200 people had answered the full questionnaire. Since we paid per respondent, we could not let the questionnaire open as long as the French speaking one.

Weaknesses of the Data Collected

Two important remarks have to been made concerning the sample methodology: The first will concern the complexity of a data collection instrument on the Internet; the second will concern the unequal data collection according to the language the respondents speak.

Firstly, the choice to work through an Internet questionnaire bounds both the reachable population and the sample methodology. As explained previously we tried to adjust our population and our analysis goals with the reality of the Internet in Belgium.
We believe that the methodology used on the Flemish sampling method is quite good: The mailing list of InSites Consulting contains 294,000 addresses of people who live in Belgium and speak Dutch.

This database is considered as well distributed on the variables age and sex comparing to the working Flemish population. This nice quality does not implicate representativity on others sociodemographic variables for which we illustrated the correlation with Internet access in Belgium.

Secondly, the most important problem of the stated preference data gathered is the difference between the French and the Dutch speaking questionnaire. Using no sampling, the data collection in French does not allow to access prior hypotheses on the probable representativity of the sample. Statistically speaking, this implies that estimations at a national level will be less good than the ones on Flanders only.

A Qualitative Point of View

In spite of these limits, a sociological or qualitative point of view can be used to find a solution and run analysis on the data gathered. To illustrate the social acceptability and responsiveness of subgroup (defined by their behaviours) and analysing how people state they will act if such scenario became real, that is not imposing the representativity. What is important in a qualitative point of view is to observe that such a fact (the behaviour, the reaction) exists and to understand its motivations; not necessarily to count the frequency of its appearance. Of course, the better the sample is, the better the statistical estimates will be. But qualitative analyses and descriptive statistics which highlight the possible behaviours and reactions will not be as much sensible to the representativity problems as the estimation of a predictive model.

2.1.2.2.The Questionnaire

The goal of this subsection is to present the structure of the questionnaire and its themes. The structure was developed in collaboration with the needs (variables and policies estimation) of all the partners in ESTiMATE. The questionnaire follows two distinct ways to question respondents: Stated Preference (SP) scenarios and conventional questions. The SP methods will be presented and discussed in the subsection 2.1.2.3.

The second way to question people in our questionnaire is the more classical one. Through this part we have questioned both effects of current policies (such as company car tax advantages or license plate / public transport season ticket exchange) and stated effect of some hypothetic policies (such as company mobility card or parking charges around shopping malls). In most cases, we asked question about the person's responsiveness (stated actions) and the social acceptability (what they think about these policies). In other words, we will provide the first step of the policies efficiency estimation that our partners will extend with their economical and environmental perspectives.

Moreover some important interactions ought to be highlighted using the two parts of the questionnaire as the broadly sociologically illustrated weight of the mode's experience on the modal change (non-)acceptability (e.g. Kaufmann: 2000). Then, we deeply investigate the current mode use and awareness of respondents. Our questionnaire would give the opportunity to produce quantitative valuations of this sociological analysis.

Structure of the Questionnaire

The questionnaire contains 6 themes and 40 to 60 questions depending on your respondent profile. It took people about 15-25 minutes to answer.

Two draft versions of the questionnaires were tested on 6 people for the first and paper version and on 22 people for the last and Web version.

The six steps of the questionnaire follow the circuit of a multimodal Home-Work trip illustrated by the progress bar on the top of the Web page (www.estimate.be). You will find the full list of variables gathered through the Web survey in Annexe 1.

- The first step is introductive. We are questioning people about their current HW trips; the vehicle(s) they have in the household; the season ticket they have; and the refunding they eventually get from their employer for car gas and/or season ticket.
- The second step takes us from the house to the train station. We are asking about the trip from home to the public transport station. We also ask about connections (experience and feelings) in that step.
- The third step is concentrated on the services and amenities in stations and on board of the vehicles. The point here is to answer two questions: What services do people expect in a station or on board? What effect could have these services on the mode choice?
- The fourth step is the 8 stated preference scenarios on home-work (HW) trips. These are dynamically based on the current HW trips time asked at the first step. Then, the scenarios are supposed to appear as a realistic adaptation of the current mobility of the respondent.
- In the fifth step of our questionnaire the respondent answered questions about their shopping trips.
- The last step is a series of sociodemographic questions.

2.1.2.3. Stated Preference Experiment

This subsection concerns the fourth and fifth steps of our questionnaire where scenarios have been presented to the respondents. These scenarios are based on the stated preference (SP) methods (also known as stated choice or conjoint analysis; see for example Louviere: 2000).

The SP methods are used to study the choice of individuals in front of actual or projective situation. Instead of presenting a list of question with one argument at the time, scenarios are built on a set of variables (called factors). Each scenario is a particular combination of the different levels of these factors. One of the interests of this methodology is to put the respondent in front complex situation, as realistic as possible. These combinations of repeated scenarios give the opportunity to investigate the links between the variables and to obtain interesting valuation and threshold estimates.
Theoretically, the SP methods are based on the random utility theory and rational choice theory. The main idea of these can be reduced in one sentence: People who are facing a set of alternatives will choose the one that is maximizing their utility. This utility can be economical but also social or cultural. The utility will be mathematically expressed and estimated in the model.

In ESTiMATE, we developed two SP studies. The first and main one concerns the home work (HW) trips. The second and exploratory one is about shopping trips.

In both type of scenario's we offered the respondent two options: A private car only option and a public transport option which can be unimodal or multimodal (combined or not with private transport mode). In the following pages, we describe technically the first SP experiment on HW trips. The second one was quite unexploited because of its technical limits (short number of scenario to avoid boring the respondents).

The next subsections are presenting successively the choice of the factors, the prior utility function, the design of the experiment, the effective formulation of the scenario themselves, and the estimation technique of the final model presented in the section about the survey results.

The factors of interest

Jordan Louviere and his colleagues resume the key moments of an SP study in seven steps in their handbook (Louviere: 2000, p.255). In the next paragraphs, we will complete a large part of the third chapter: The development of the data collection instrument. To do so, we went through the first (defining the study objectives) and second steps (supporting qualitative study and lectures) and it was helping us to determine the factors (the variables) of interest for the SP exercise.

On the HW trips SP exercise, we choose to give attention to time, cost, connection and service present during the trip. The time parameter has been split in two kind of information: The mean time and its day-to-day variability.

- The mean time was computed by multiplying the current HW trip time of the respondent (asked in the first section of the questionnaire) by a constant. Constants were 0.7, 0.9, 1.2 and 1.5 in the car option and 0.7, 0.9, 1.1 and 1.3 in the public transport (PT) option. We avoid the constant 1 to constantly generate scenarios different of the current respondent experience as recommended in the literature. The differences in the higher constants between the car and the PT option are justified by the willingness-to-catch time thresholds (if they exist) where people accept to change from car to public transport.
- The daily variation of time parameter has 6 levels but only 4 could be selected by respondent profile. For both options, if the current time is less or equal to 30 minutes, the levels are 5, 10, 15, 20 minutes of daily variation. If the current time is in the interval 31-60 minutes, the levels are 5, 10, 20 and 30 minutes. If the current time is greater than 1 hour, the levels are 5, 15, 30 and 45 minutes. The minimum time is computed by subtracting the half of this variation level from the mean time; this computed time is rounded to the nearest multiple of 5. Then the maximum time is computed by adding the variation level to the minimum time.
- The cost parameters are also different by option. In the car option, we multiply the current gas prices by a constant: 0.8, 1.2 or 1.5. From the 4th till the 16th October 2007, the current prices are set to 0.95€/l for diesel, 1.23€/l for Eurosuper 95 and 1.35€/l for Superplus 98. Seeing the prices increase during the first decade of October, before launching the Dutch speaking questionnaire – the 16th October 2007 – we had adapted our current prices to 1.14€/l for diesel, 1.40€/l for Eurosuper 95 and 1.43€/l for Superplus 98. In the public transport option we choose to compute the cost estimation per trip with a monthly season ticket.

0We use the cost per kilometre price of the Belgian railway company (SNCB-NMBS) and a dynamically time-based estimation of home-work distance to compute a current cost. We compute the cost in the scenario by multiplying the SNCB-NMBS one by the following constants: 0, 0.5, 0.8, 1.2.

- The connection parameter appears only in the public transport option. Scenarios contained 0, 1, 2 or 3 connections per trip.
- The service parameter informs the respondent of the presence-absence of two amenities during the trip. The services are a cash delivering machine and a supermarket with bakers. A third level informs that none of these services are available during the trip without detour.

Utility Function

According to these parameters, we have built our full factorial design (FFD) which corresponds to the complete set of scenarios possible. The FFD means all the different configurations of each level of each factor. We had 4 levels of car time, 4 others for PT time, 4 daily variability in both alternatives, 3 cost levels for car, 4 cost levels for PT, 4 connection levels in the PT option and 3 service levels in each alternative. Multiplying all that, we obtained 110,592 different scenarios.
As you can imagine, it is impossible to propose all these scenarios to each respondent. It is even infeasible to ask each of them a least once to a different respondent. So we have to select a subset of the FFD. There are numerous criteria to select such a subset. We choose to combine two criterions from the optimal design theory (the S and the D optimality).

In order to do this, we had first to define a probable utility function. This should be the utility model for which we would be able to estimate its parameters at the maximum with the minimum variance (in the D optimality). This choice of a utility model prior to the data collection will determine all other building steps of the SP but also the structure of the data to be collected. By choosing it, we will decide further what information is relevant to deal with in scenarios (spread of the reality explored; key criteria of the S optimality). By formulating this particular equation, we also limit the analyses that will be possible with a high level of precision (limited variance of the estimators; key criteria of the D optimality) after the data collection. Finally, beneath these interconnected decisions, the choice of the prior utility model boils down to what Jordan Louviere calls "setting out the underlying behavioural decision framework" (Louviere, 2000, p.35).
The utility model we choose for the home-work trips scenarios was the next equation. Besides the simple formulation of the factor's parameters (Time, Variability of time, Cost, Connection and Service), we choose to introduce quadratic effects in time and daily variability of time and interaction effects between time and its daily variability, time and cost, time and connections, time and service, and connections and service. Finally, we also introduced one interaction of second order between time, connections and service in the public transport or multimodal option. We kept all the effect's hierarchies.

$$
\begin{aligned}
\textit{Mode choice} = \\
& Time_{Car} + Time_{PT} + Variability_{Car} + Variability_{PT} + Cost_{Car} + Cost_{PT} + Connection + Service_{Car} + Service_{PT} \\
& + (Time_{Car})^2 + (Time_{PT})^2 + (Variability_{Car})^2 + (Variability_{PT})^2 \\
& + Time_{Car} \times Variability_{Car} + Time_{PT} \times Variability_{PT} + Time_{Car} \times Cost_{Car} + Time_{PT} \times Cost_{PT} \\
& + Time_{PT} \times Connection + Time_{Car} \times Service_{Car} + Time_{PT} \times Service_{PT} + Connection \times Service_{PT} \\
& + Time_{PT} \times Connection \times Service_{PT}
\end{aligned}
$$

Design of the experiment

After selecting a prior utility function, the second step to design a stated preference experiment is to select the number of scenarios we want in the subset of the full factorial design (FFD). An exploratory test to compute such design without imposing a number of scenario indicated us that the best trade-off between design size and the conservation of the orthogonally repartition of scenarios (which can be seen as an independent distribution of the sample of scenarios in the whole initial space of opportunities) is a set of 113 scenarios. We wanted to submit eight scenarios per respondent so we compute a final subset of the FFD of 120 scenarios split into 15 groups. Each group should be as much orthogonal as possible inside and all groups should be as much similar as possible between them.

That selection of a subset of the FFD and its repartition in subgroups were completed via two selection methods. Firstly we used a distance based optimality criterion: the Spread optimality criterion (or S-optimality). It seeks to maximise the harmonic mean distance between each point selected and all other points of the partial factorial design. In other words, the criterion tries to spread as much as possible the selected cloud of points (set of scenarios) inside the space of nine dimensions (the nine variables). Combining this criterion with the search method Fedorov modified of Cook and Nachtsheim (Cook & Nachtsheim, 1980), the SAS OPTEX procedure computed systematically the sum of distances between a point and each points of the design. At each step, the selected point which minimise the harmonic mean is exchanged with the one outside of the sample which maximise it. The distances computed are Euclidean and the harmonic mean is computed as equation on the left; where N_D is number of points in the selected design, D is the current sample and y the point of interest. The distance is computed as equation on the right, where $y, A \subset R^p$:

$$\text{Harmonic mean distance} = \frac{N_D}{\sum_{y \in D} \frac{1}{d(y, D-y)}}$$

$$d(y, A) = \min_{x \in A} \|y - x\| = \min_{x \in A} \sqrt{(y_1 - x_1)^2 + \ldots + (y_p - x_p)^2}$$

Secondly, the subset of the FFD was improved using an information based criterion, especially useful in our case to reinforce the internal orthogonal quality of the subgroups. The second criterion is the D-optimality. It tries to maximise the information retained of the original X'X matrix which is equivalent to minimise the variance-covariance matrix of the least-squares estimates of the general linear model. That objective is attained through the minimisation of the determinant of $(X'X)^{-1}$ which is the same that maximising the determinant of X'X.

Using this succession of criteria we obtained good progressions in quality measures of the subset selected. "Because these efficiencies measure the goodness of the design relative to theoretical designs that may be far from possible in many cases, they are typically not useful as absolute measures of design goodness. Instead, efficiency measures should be used relatively, to compare one design to another for the same situation." (SAS Institute Inc., 2003,2) Seeing that and the limited number of pages of this report, we choose not to detail moreover each step's quality measures of our selection work. Nevertheless, please notice that the information based efficiency measures are scaled from 0 to 100. The final efficiency measures are the following:

Information based measure		**Distance based measure**	
General D-efficiency	80.5968	Harmonic distance	11.6225
Treatment (blocking) D-efficiency	70.7108		

The D-efficiency measures are computed as the next equation; where A = I – Z(Z'Z)$^{-1}$Z' corrects the covariate effects of blocking, with *Z* is the design matrix for the block; $C_D = \prod_{i=1}^{p} \lambda_i^{1/p}$; and $\lambda_1, \dots, \lambda_p$ are the *p* largest eigenvalues of A.

$$\text{General } D-efficiency = 100 \times \left(\frac{|X'X|^{1/p}}{N_D} \right)$$

$$\text{Treatment part (inter-blocks) } D-efficiency = 100 \times C_D^{-1} |X'AX|^{1/p} / N$$

Another measure of quality of the subset of the FFD is to compute the correlation matrix between all factors. In the FFD, there is no significant correlation, by definition. If there are significant correlations in our subset, this implicate that we could obtain significantly correlated estimates, which is clearly not good. The correlation test leaded on the variance-covariance matrix between the levels of attributes in our partial factorial design is really enthusiastic for our design quality: Except for one couple – public transport time and car daily time variation – which present a p-value of 0.0449, all the potential attributes' coupe and block-attribute couple do not reject the hypothesis that their correlation is null. According to these test results their no correlation in our partial sample.

Scenario Presentation

Before each scenario, a short text presents itself as a potential future modification of the current home-work trips of the respondent. We ask them to consider the two options as feasible even if the current network does not permit such timing for example. We ask to consider what is in the scenario all things equal otherwise. We put only one scenario per page. The options are vertically disposed and each parameter was listed in formalised sentence. The time and daily variability of time were express together via a minimum and maximum time. As you can see in the figures of the Annexe 2, other parameters were express as presented previously.

Estimation Methods

After the data collection, the utility function presented above was estimated with the logistic regression. We introduced additional information about the respondent in our model. This information was gathered through the questionnaire. In order to be coherent with other teams in ESTiMATE, we selected supplementary information that is also present in the observed datasets that was collected for calibrating the model.

The final model is the result of many estimations, selections and pruning's. To compare our models and progressing on each step of our iterative search, we combined the Wald chi-square analysis with three criteria concerning the model quality. The criteria used are the Akaike Information Criterion (AIC), an estimation of the area under the Receiver Operating Curve (ROC) curve by c statistic and the well classified rates for both car and public transport options.

The Wald chi-square statistic tests the hypothesis that a set of parameters are equal to zero, so they are not significant. If we could not reject the null hypothesis with a p-value lower than 0.05, either we try the same model with a transformation of the parameter or we drop the parameter definitively. By transforming parameters, we mean that we tested square, square root, discrete transformation or replacement by neighbouring variable.

The AIC is a weighted form of the log likelihood (a quality measure of the model) that takes into account the number of parameters entered in the model. Its formulation is the left equation and p is the number of parameters in the model and w_j, f_j and $\hat{\pi}_j$ are the weight, frequency and estimated probability values of the j^{th} observation.

$$AIC = -2\log L + 2p = -2\sum_j w_j f_j \log\left(\hat{\pi}_j\right) + 2p$$

$$c = \left(n_c + 0.5\left(t - n_c - n_d\right)\right)/t$$

The c statistic gives an estimation of the area under de Receiver Operating Curve (ROC) curve by analysing the correct pairwise ranking. It is quite similar with the Wilcoxon statistic. In the right equation, t is the number of pairs with different responses; n_c and n_d are the number of concordant and discordant pairs. "A pair of observations with different observed responses is said to be concordant if the observation with the lower ordered response value has a lower predicted mean score than the observation with the higher ordered response value" (SAS Institute Inc., 2003-1).

Models have been estimated on a training set that contains 60% of the original dataset. The well classified rates have been computed on a test set that contains the rest of the original dataset. The final model is the best compromise between the lightest model in term of parameters, the best model in term of likelihood and the best predictive one. The true final version of our model presented in the results section has been estimated on the full dataset.

2.1.2. The activity-based transportation model and its assessment of multimodal transport

Facing the difficulty and the challenge to implement a multimodal activity-based transportation model for Flanders, a modular framework to conduct research on agent- and activity-based models has been developed. The framework has been given the acronym FEATHERS which stands for Forecasting Evolutionary Activity-Travel of Households and their Environmental RepercussionS. The modularity of the FEATHERS framework is guaranteed by means of the module-based design and by the usage of the object-oriented paradigm. This design results in an agile environment that allows for easy removal, exchange and insertion of functionalities and even complete modules.

An overview of the current modular structure of the FEATHERS framework is presented in figure 3. In the remainder of this section, the functionality of the modules will be discussed. Throughout this project, the different modules were adapted and improved in order to enable us to model multimodal transportation choice.

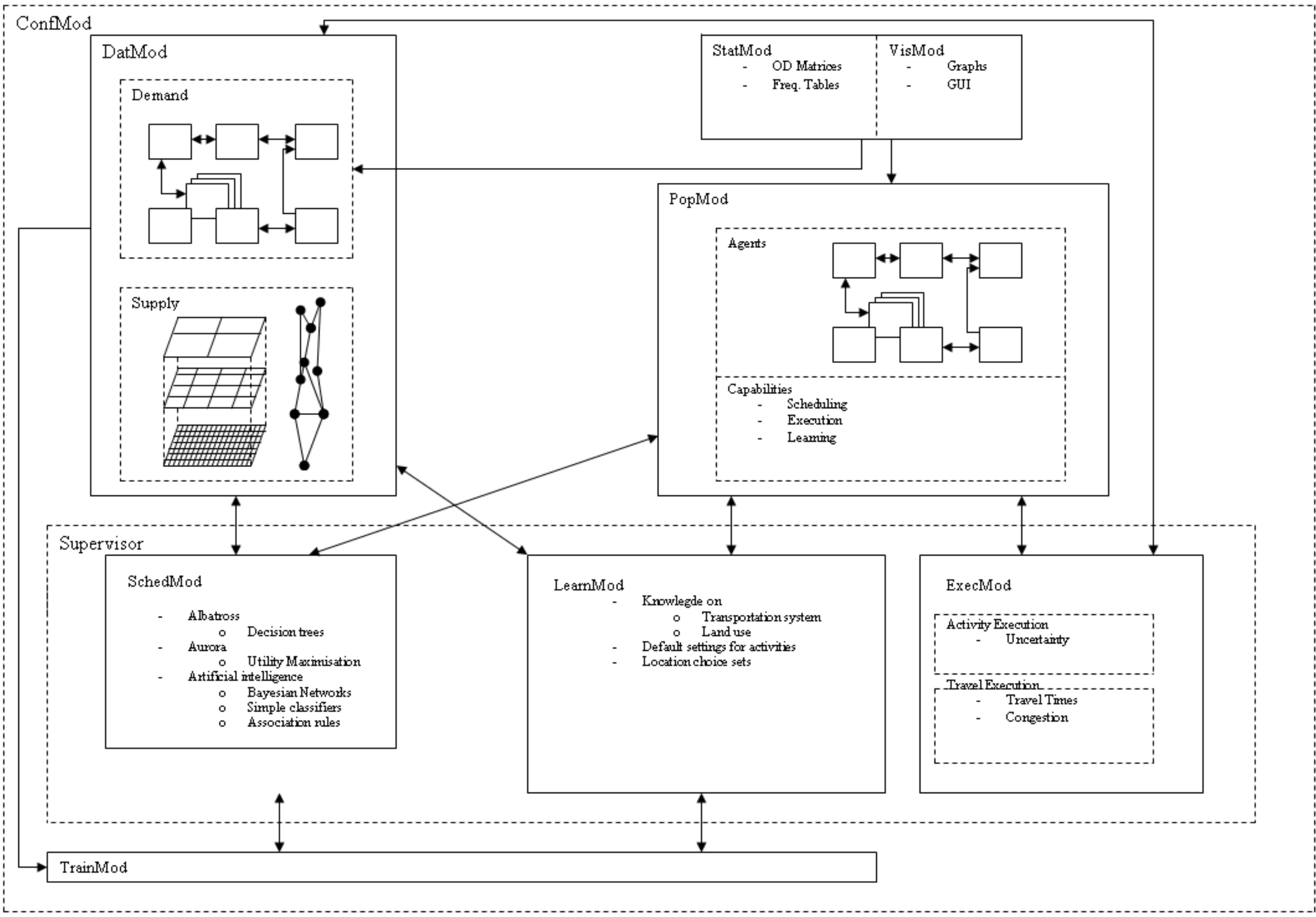


Figure 3. A schematic overview of the FEATHERS modules, their functionalities and their interactions.

Configuration module (ConfMod)

In order to be able to exploit FEATHERS' modular structure to the maximum extent, a flexible configuration functionality is required. Every module that is active in FEATHERS communicates with the configuration module in order to obtain its specific required settings (see Figure 3). This approach allows for a central configuration management, from where the relevant settings are dispatched to each of the modules. Modules can be switched (in-)active using the configuration module to facilitate the multi-stage development strategy described above. If for a module no settings are available in the configuration file, it is considered to be inactive by default. This way, users are not burdened by functionality that is provided by the framework but that is not needed for the current experiments (cfr. simultaneous development of functionalities for several stages).

In order to guarantee extensible and structured configuration settings, which are required to accommodate future and currently unknown configuration settings, the configuration module stores all the configuration settings for the FEATHERS modules in

XML format (W3C, 2006). This makes the addition of new parameter settings for a (new) module a simple matter of updating the XML configuration file.

Data module (DatMod)

One of the core modules in the system is the data module. The data module provides access to the data that needs to be accessible throughout all other modules. Two major types of data are provided by the data module: supply and demand data (see Figure 3).

The (geographic) supply data not only includes the transportation network but also includes information on geographical zones in the study area such as e.g. the attractiveness of a zone for conducting certain activities. Also information on the availability and performance of the transportation system between the zones in the study area (e.g. travel times, travel costs, bus fares) is included in the geographic supply data. In summary, the supply data consists of the data describing the 'context' in which the agents live and schedule their activity and travel episodes.

The demand data (see the upper part of the data module block in Figure 3) consists of the activity-travel diaries or schedules that describe the demand for the execution of activities at certain locations as well as the resulting demand for transportation. The collected diaries are typically accompanied by person and household data for the persons executing the diaries. The data model for the demand data in the FEATHERS data module is aware of the following entities: persons, households, (optionally) cars, activities, journeys and also lags (which are added in this ESTIMATE project) and assumes they relate as presented in Figure 3. In this definition, a lag is typically transport which is needed to access and egress the main transport mode for that trip(which enable to model multimodal transportation choice).

As FEATHERS is not only tailored towards the Flemish situation, the attributes that are available in the data files for each of the entity types are fully customisable through the configuration module.

Both the supply and the demand data managed by the data module are made available to other modules through the data module's standardised interface.

As it is imperative that the demand data can be easily accessed by (future) modules it is important to efficiently implement the relationships between the entities in the data model. These relationships are defined in the data model that is presented in Figure 4. As the number of persons and households in a survey is typically rather small (e.g. 2500 households for the survey discussed in this paper), the demand data can be loaded into memory for fast access. The relations between the entities/objects in Figure 4 are implemented as pointers between objects. They allow for efficient browsing between related entities (e.g. finding a household attribute for the household to which a person belongs).

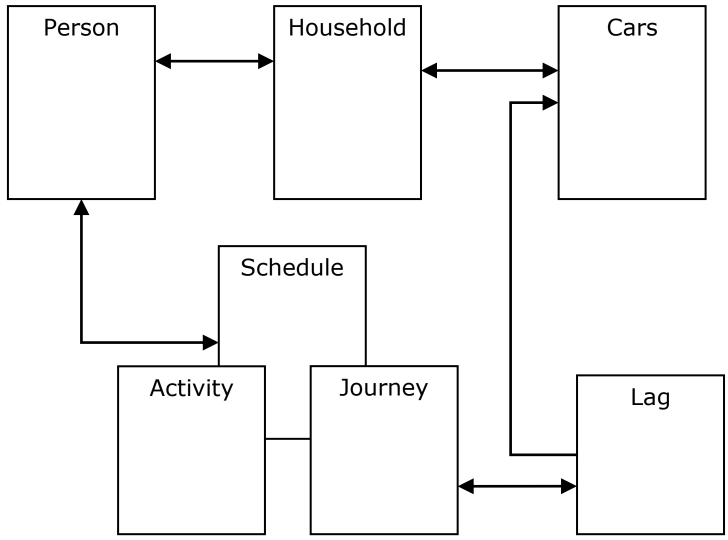


Figure 4. Schematic representation of the relations between the transportation demand data entities in the FEATHERS data module.

As not all geographic supply data is available at the same level of detail, the data module provides support for different levels of detail (currently 3, expandable if required). This support includes keeping track of the relation between the zones at the different levels of detail. In the current implementation it is assumed that each zone at the lower level (more detail) belongs to one higher level zone (less detail) only. These relations between the levels of geographic detail allow for (dis-)aggregation of simulation results to the desired geographical level of detail.

The attributes that are stored for the zones in a supply data layer are configured through the configuration module for flexibility. For the Flanders study area (total area of approximately 13 500 km^2) the levels of detail used are: statistical sector (small administrative unit, comparable to districts or quarters, 10255 zones), sub-municipalities (1145 zones), and municipalities (327 zones). As the number of zones in each of the geographical data layers is rather limited for our study area, it is perfectly feasible to load all data in memory for fast access. Although it was not required for the current research, a configuration setting allows the data module to switch over from loading all data into memory to using direct access binary data files if not sufficiently memory is available. This switch is transparent to the modules consulting the data.

As information on the transportation system (e.g. bus fares between zones) cannot be attributed to one zone only, the data module also provides attributes for pairs of zones for each of the levels of geographical detail. The attributes that are stored for each pair of zones are configured through the configuration module. However, as the required storage capacity increases with the square of the number of zones, the data module provides the choice between loading all data in memory and using direct access files. For the Flemish case study, the data on pairs of municipalities and on sub-municipalities was loaded into memory while for the statistical sectors a direct access file was used.

The supply data on the attractiveness of zones for the execution of activities that is used for the model is exceptionally rich due to the availability of the socio-economic survey, where a full population (6 million) was obligatory surveyed on several socio-demographic variables (age, gender, etc.). In addition to socio-demographic variables, the dataset also contains commuting behaviour of all persons in the study area (population level). Given this characteristic, one can derive from this data e.g. the level of employment by employment sector for each statistical sector, which can be used to calculate the availability and attractiveness of locations for different activities. Information about the transport system (road network data, congested travel times, etc.) is available from the existing four-step model that is currently used in Flanders. Also the traffic network that is used results from the existing four-step model managed by the Flemish government. Although the data module manages geographical data, it needs to be noted that it currently does not provide geographic information system (GIS) functionalities. Hence, geographical manipulations such as e.g. overlays and map matching of GPS data need to be performed in a preprocessing step and the resulting data need to be imported into the FEATHERS data module afterwards.

Population module (PopMod)

The units of investigation in an activity-based model are the persons making scheduling decisions that result in activity-travel diaries. Hence, the agents in an agent-based activity-based model are the individual persons. During scheduling, the agent's person characteristics or attributes are used as inputs for the scheduler to drive the simulated decisions of the agent. The definition of which attributes are used in the agents is realised through the configuration module. Examples of person attributes that are commonly used are marital status, age, possession of driver license, etc.

Similar to the person entities in the data module, the persons (agents) in the population module relate to households, car (optional), activity, journey and lag entities (Figure 4). In the population module, these entities are virtual entities as opposed to the real entities in the data module. Through the relations between the entities, the attributes of all entities are accessible to be used in the agent's scheduling process in addition to its person attributes.

An important difference between the person entities in the data module and the agents in the population module is the fact that the agent entities possess important additional functionalities: scheduling, schedule execution and learning (Figure 3), which are implemented in the scheduling module, the schedule (activity and travel) execution module and the learning module respectively. These functionalities are implemented in separate modules in order to make replacement and extension of agent functionalities as convenient as possible.

In order to perform a simulation of activity and travel behaviour of individuals in a population, a synthetic population consisting of persons and households (and optionally cars belonging to the household) needs to be built. The population module is responsible for the management of the different agents (persons) that are used in the synthetic population. The synthetic population therefore consists of a collection of agents where each agent is characterised by a number of attributes. As mentioned previously, the data required are available at population level in Flanders by means of the socio-economic survey.

These population data can then be updated to the current prediction year by the use of Iterative Proportion Fitting (IPF) technique. The IPF is a well established technique with the theoretical and practical considerations behind the method thoroughly explored and reported in literature (origins appear in Beckman et al. 1996). It uses the population or the larger sample margins to update the information at cell frequency level. Several applications of the technique in travel demand modeling have been reported (Arentze et al., 2007, Guo et al. 2007; Wong, 1992).

A common functionality of all agents is the scheduling functionality. Based on its personal, household related, environmental and schedule related attributes, the agent is able to predict an activity-travel schedule using functionalities provided by the scheduling module. The resulting activity and travel episodes for an agent are stored in the activity, journey and lag entities linked to that agent (Figure 4). During the simulation, the person, household and optionally car entities of the agents (corresponding to the upper part of Figure 4) are used in order to predict the schedules for the agents, which constitute an important model output and which correspond to the lower part of Figure 4.

Schedule module

The schedule module is a generic module in which different scheduling algorithms can be implemented. The configuration module determines which of the scheduling algorithms that are available is activated. The schedule module is tightly interfaced with the (agents in) the population module as it implements the scheduling algorithm that uses input data from the population module and stores the results in the schedules in the population module.

For this project, we have adapted the schedule module in order to make it suitable for the analysis of multimodal transportation chains.

▪ In our conceptualization of the problem, we relate mode choice to a chain of out-of-home activities which are connected through a tour, rather than to a single out-of-home activity. A work activity may consist of various work episodes possibly interrupted by a break or conducted at different locations. Moreover, other out-of-home activities such as for example bring/get or a shopping activity, may be conducted on the first (from home to work) or last (from work to home) commuting trip or during breaks.

To operationalize this, we have defined cases as sequences of work/school episodes that are separated in time by less than one hour. Episodes that are further apart in time are taken as separate cases, i.e. require a distinct mode choice each. Furthermore, we have assumed that mode choice is a high-level decision only for work chains that stretch out over a substantial part of the day. Three hours are used as a minimum duration. With these assumptions, we have built a mode choice model that includes known household and person attribute that might be relevant for segmentation of the sample:

- socio-economic variables such as household type, age group, child index and socio-economic class.
- Information about the activity program at a weekly basis with regard to time engaged in work at the household or person level
- Car availability at the household level.

Furthermore, there are also variables that include work time and travel time information. If travel times could not be derived from the travel-time matrices, travel times were estimated based on observed travel time and mode. In this way, one is able to derive objective travel times for every mode in every case where actual travel time and mode are known. Bike travel time was taken as an indicator of travel distances. Furthermore, travel time ratios between modes were included of the relative speed of each mode on the route between locations. Furthermore, additional descriptors at the level of the work-chain are included. First, the start time of the first work episode and end time of the last work episode of the chain determine whether travel takes place during the late morning and/or evening rush hours. Second, the number of different work locations involved serves as a measure of the amount of travel involved apart from the first and last commute. Third, activities included that are closely related in time to start of the first work episode or the end of the last work episode were recorded as a possible condition for trip-chaining during the first and last commute. Finally, the last set of variables intends to cover travel demands of the partner during the work-chain. These include the number of out-of-home activities in the schedule skeleton, maximum travel times across locations and the presence of a bring/get activity.

In addition to these adaptations, a decision tree-based scheduling algorithm is currently made operational in the schedule module in the context of ESTIMATE. This implementation currently consists of a sequence of 26 decision trees, where each decision tree is used to model decisions on specific activity-travel schedule properties (e.g. going to work or not, transport mode for a journey, start time and duration of an activity, etc.). Besides the decision trees, the scheduling mechanism contains an algorithm to make the schedules consistent. In order to be consistent, a schedule needs to comply with a number of constraints: situational constraints (one can't be in two places at the same time), institutional constraints (opening hours constrain certain activity behaviour), household constraints (bringing children to school), spatial constraints (particular activities cannot be performed at particular locations), time constraints (activities require some minimum duration) and spatial-temporal constraints (travel time depends on transport mode). The output of the scheduler in the scheduling module is the collection of activity-travel diaries for all the agents in the population module.

Learning module (LearnMod)

The learning behaviour of persons stems from the fact that they observe that their assumed knowledge about the environment in which they operate (e.g. the transportation network) does not match reality. An indication of this mismatch is given by a mismatch between scheduled and executed activities or travel. The learning process of the agents is managed by the supervisor in combination with the (re-)scheduling and the schedule execution for that agent. The supervisor takes into account that the rescheduling processes typically run on a faster time scale than the learning processes. By adaptation of the supervisor and the scheduling, schedule execution and learning modules, a wide range of experiments can be conducted.

Statistics (StatMod) and visualisation (VisMod) modules

The statistics module provides reports regarding the (synthetic) population and the activity-travel schedules to the FEATHERS user.

This includes information that can be extracted at the level of households (e.g. distribution of households according to availability of means of transportation); persons (e.g. usage of transportation modes), journeys (e.g. average number of journeys per day); lags (e.g. average number of lags per journey) and activities. Given the similarity in the person, household, car, activity, journey and lag entities and their relations in both the data module and the population module, the statistical module and the visualisation module make abstraction from the fact whether they consult the data module or the population module to extract the data to report to the user. Hence, statistics that are implemented for the survey data in the data module can readily be used to draw the corresponding statistics on simulated data from the population module. Which statistics are to be drawn by the statistical module is configured through the configuration module.

As the activity-travel diaries contain detailed travel information, the statistical module provides the functionality of skimming through all schedules and compiling an OD matrix. Given the level of detail of the data, the travel information can be aggregated in segmented OD matrices such as e.g. time sliced OD matrices, OD matrices per transportation mode, and OD matrices per activity type. This functionality enables a transition step in the evolution from four step models towards activity-based models by exporting OD matrices that are assigned to the transportation network using the traffic assignment tools from the traditional four step model as was discussed in stage 1.

The visualisation module relates strongly to the statistical module in the sense that the visualisation module will create graphical reports contrary to the numerical reports provided by the statistical module. Currently the visualization module is not operational yet and all FEATHERS reports are obtained through the statistical module. However, in order to improve user friendliness, a graphical user interface and a visualization module will be added to the FEATHERS framework in the future.

Training module (TrainMod)
All models used throughout the FEATHERS framework need to be calibrated using real-life data. This functionality is provided by the training module. The training module is configured through the configuration module and obtains the required data from the data module. The output of the training module is calibrated model parameters for the models that are used in the other modules (see Figure 3).

2.1.3. The adapted emission model and its assessment of multimodal transport

With respect to the adaptation of the emission model, we relied on the Ecoscore methodology, which is based on a well-to-wheel framework. This means that, next to the direct tailpipe (or Tank-to-Wheel) emissions, the indirect (or Well-to-Tank) emissions, due to the production and distribution of the applied fuel, are taken into account as well. Moreover, an impact calculation allows to assess the health impact related to the inventoried emissions, incorporating their impact pathway.

Direct emissions are dependent on the use of the transport mode itself. Within previous projects, the emission data of three different transport modes have been gathered: a light duty vehicle model, a heavy duty vehicle model and a two-wheelers model [i]. For the passenger vehicles the direct emissions must comply with type approval limits in g/km.
For the public buses, contrarily to passenger cars, the engines of heavy duty vehicles must comply with type approval in g/kWh. The type approval tests provide some information regarding carbon monoxide (CO), unburned hydrocarbons (HC), nitrogen oxides (NOx) and particulate matter (PM). Besides these regulated emissions, some unregulated emissions are considered as well: carbon dioxide (CO2), sulphur dioxide (SO2), nitrous oxide (N2O) and methane (CH4). In the optimal area of the efficiency map, the efficiency of a diesel engine is around 40%. At partial load, the efficiency is lower. It has been decided to define engine efficiency at 35% for diesel buses [ii].

Indirect emissions are those related to the extraction and transport of the raw materials for the fuel production, together with the emissions linked to refining and distributing the fuel. The indirect emissions are directly proportional to the fuel consumption. The indirect emissions calculations are based on the energy content and density of the different fuels. The electricity production emission data were recently updated by Electrabel.
For the electric tractions (train, metro) only rural impact factors are calculated since electricity production units are considered to be located outside cities.
For the NMBS the calculation is based on the specific average primary energy consumption for passenger travel (NMBS 2006) of 1233 kJ/pkm or 0,3425 kWh/pkm (average train). For a HST with an occupancy of 70 % decreases this value to 0,1939 kWh/pkm; for a peak train with an occupancy of 100% decreases this further to 0,0856 kWh/pkm. For the tram the calculation is based on an average substation consumption of 0,1697 kWh/pkm (STIB 2007).

a) Classification

The Ecoscore methodology encompasses three main damage categories: global warming, air quality and noise. The global warming potential (GWP) is a measure of how much a given mass of greenhouse gas is estimated to contribute to global warming. It is a relative scale which compares the effect of the greenhouse gas in question to that of the same mass of carbon dioxide. The damage category "air quality" is subdivided into: human health and effects on ecosystems.
[dB(A)] is the decibel scale with A-weighting that takes the sensitivity of human hearing into account. More information concerning the classification step is provided by Timmermans et al. (2005).

b) Characterization of the damage effect

Depending on the damage category, different impact factors were used for the characterisation of the damage due to both the indirect and direct emissions. The damage caused to human health is dependent on the location where the emissions take place. Different impact factors for indirect and direct emissions are consequently required.

The location where global warming emissions take place does not make any difference as far as the effects on climate change are concerned. One impact factor per pollutant is thus sufficient.

c) Normalisation to a reference situation

To enable the quantification of the relative severity of the evaluated damages of each damage category, a normalisation step based on a specific value is performed. An important boundary condition of the methodology is that the rating method needs to be applicable for each different passenger transportation mode: passenger car, public bus, metro, tram, motorcycle and public train. The existing Ecoscore indicator compared the impact of each vehicle with a reference vehicle corresponding to a Euro 4 emission limit and 120 g CO2/km. This was a good reference to compare vehicle technologies. For this project a specific reference situation to compare the environmental impact of passenger transportation with the different possible transport modes had to be defined.
After some literature research, it was proposed not to use the emission targets for 2010 as reference values for the Multimodal-Ecoscore model, since they often change and are not available for all pollutants.
Hence another approach was used, using the emissions values of 2005 and compare them with the total number of passenger kilometres. The indirect emissions are calculated with the emission MIMOSA model (Mensink et al., 2000; Lefebre e.a., 2003; Lewyckyj et al., 2004). The noise emission reference has been set to 70 dB(A).

The total environmental impact for each passenger transport mode can be calculated as follows:

$$q_i = \frac{Q_i}{Q_{i,ref}} = \frac{\left. \sum_j \delta_{i,j,indirect}.E_{j,indirect} + \delta_{i,j,direct}.E_{j,direct} \middle/ \text{Occupancy rate} \right.}{\left. \sum_j \delta_{i,j,indirect}.E^{\text{Reference 2005}}_{j,indirect} + \delta_{i,j,direct}.E^{\text{Reference 2005}}_{j,direct} \middle/ Travel\ demand \right.} \quad \left[\frac{g/pkm}{g/pkm}\right]$$

Where:

qi	normalised damage on category i
Qi	total damage of the assessed transport mode on category i
Qi,ref	total damage of the reference situation on category i
δ,j	impact factor of pollutant j to the category i
Ej	total contributing emissions of pollutant j to the category i

For communication purposes towards a broad public, it is important to use a score that is easy to understand. That's why the total impact (TI) is transformed into a score ranging from 0 to 100, which 0 representing an infinitely polluting vehicle and 100 indicating an emission free and silent (40 dB(A)) transport mode. The reference situation corresponds with an Ecoscore of 70. The transformation is based on an exponential function, so it can't deliver negative scores.

d) Weighting system

The final step consists in the weighting of the different damage categories, before aggregating them to obtain the total impact (TI) of the assessed transport mode:

$$\text{TI transportmode X i} = \sum_i \alpha_i . q_i \qquad (2)$$

Where:
TI total impact of the assessed transport mode
αi weighting factor of damage category i
Ecoscore indicator for multimodal transport chains

A second new indicator, the total impact TI for a specific multimodal OD-scenario (trip movement from Origin to Destination) can be calculated following equation 3.

$$TI = \sum_i \frac{Distance\,transportmode\ X\ [km] * TI\ transportmode\ X\ i}{Total\ distance\,[km]} \qquad (3)$$

For communication purposes towards a broad public, the total impact (TI) is transformed into a score ranging from 0 to 100.

The developed Multimodal EcoScore allows comparing possible modal choices for similar routes. An example of a typical transport route that can be calculated using the novel Multimodal EcoScore passenger indicator, will be shown in the results section.

2.2 Results

In analogy with the methodological section, the results for this project are structured along the objectives that were outlined in the beginning of this final report. In summary, the first objective is to collect stated and observed data in order to obtain insight into the activity and related travel behaviour of individuals in a multimodal transportation context. Second, we will report on the type of results that can be obtained by means of an activity based transportation model based on the observed data. Third, our goal is to evaluate the impact of policy scenario's using the adapted activity-based transportation model as a starting basis. A case study of a possible scenario to illustrate the methodology will be shown. Fourth, we want to show as a matter of illustration the need to carry out an analysis of the energy and environmental impact of multimodal passenger traffic and comparison of the different transport modes (train, car, walk, bicycle, bus, tram, etc.) on a well-to-wheel basis. And finally, we will briefly describe the idea of cost-benefit analysis methodology which can be carried out to account the different cost and benefits that a multimodal transport chain brings along, relying upon the outcome of an activity-based transportation model.

2.2.1. The data collection of observed data

Since the purpose of the observed data is to build a full activity-based model which is able to predict which activities will be conducted where, when, for how long, with whom, and with which (chain of) transport mode(s), it logically follows that in order to build a model that incorporates all these facets, one requires data on all these facets. Because the interdependencies between these facets are critical, one also needs detailed data about these facets for all activity episodes. That is, for each new activity, the data should reveal where it is conducted, when, for how long, etc. It was explained in the methodological chapter that both PDA and paper-and-pencil surveys were used to collect these data and to use them as input in the AB model. To this end, a large scale survey is being conducted on 2,500 households. About 500 persons (150 on PDA and 350 on paper-and-pencil) of them have been collected specifically in the context of Estimate. Although these data have not been analysed in terms of multimodality (see section 2.2.2. for this), but in order to give the reader a general idea about the difference between both technologies, descriptive analyses results have been reported in this section for the sake of illustration. In this respect, the data collected by using the traditional paper-and-pencil tool is used as a point of reference for the performance of the PARROTS survey tool. This section reports on the following analyses: the analysis of the impact of GPS-enabled PDA technology on the user response rates, the impact of PDA technology on the quality of the collected diary data and PARROTS usage patterns.

2.2.1.1 Impact of GPS-enabled PDA technology on user response rates

Households selected to participate in the survey were sent a letter stating the survey purpose and the survey method (paper-and-pencil vs. PDA). Two days later, they were contacted by telephone in order to ask for their participation. It is obvious that in order to survey 2500 households, a lot more households had to be contacted because many potential respondents were not prepared to participate in the survey. Indeed, 21% of 5537 contacted households so far was willing to take part in the survey using the paper-and-pencil procedure. In terms of percentage, this is slightly higher than for the PDA procedure (18% of 3319 households), which indicates that a number of people are reluctant to join a survey using less ubiquitous technology.

Following on these facts about participation shares, it should also be noted that quite a lot of respondents stopped participating during the survey period. However, when both survey methods are compared, it is clear that the number of drop-outs is much lower in the case of the PDA where only 38 % or 232 respondents stopped during the survey period as opposed to the paper-and-pencil survey where 62 % or 724 respondents dropped out. This substantial difference could be due to the fact that the burden for filling in the paper-and-pencil survey is much higher than in the case of the PDA where respondents are assisted when entering and editing information.

The respondents that indicated during the telephone conversation that their refusal to participate in the survey was related to being required to use a PDA were proposed to participate in the paper-and-pencil based survey. Approximately 4% of the respondents that were contacted to take part in the survey using a PDA preferred to switch to the non-PDA procedure during the telephone conversation. It can be assumed that this switch to non-PDA is induced by an aversion towards PDA technology.

During the PDA delivery, and after having the PARROTS tool explained and demonstrated to them, 3% of the respondents decided to switch to the non-PDA

procedure. From the experiences during the PDA deliveries, it was learnt that the majority of these people deem the PDA tool either too complex or too intrusive.
Since the survey spans seven days, requires keeping track of and logging of detailed activity-travel information and requires carrying a GPS-enabled PDA during each trip, the respondent burden is rather high. Some respondents stop reporting activities and trips before the survey period is over. Hence, the data returned needs to be investigated for respondent activity in order to determine respondent attrition.

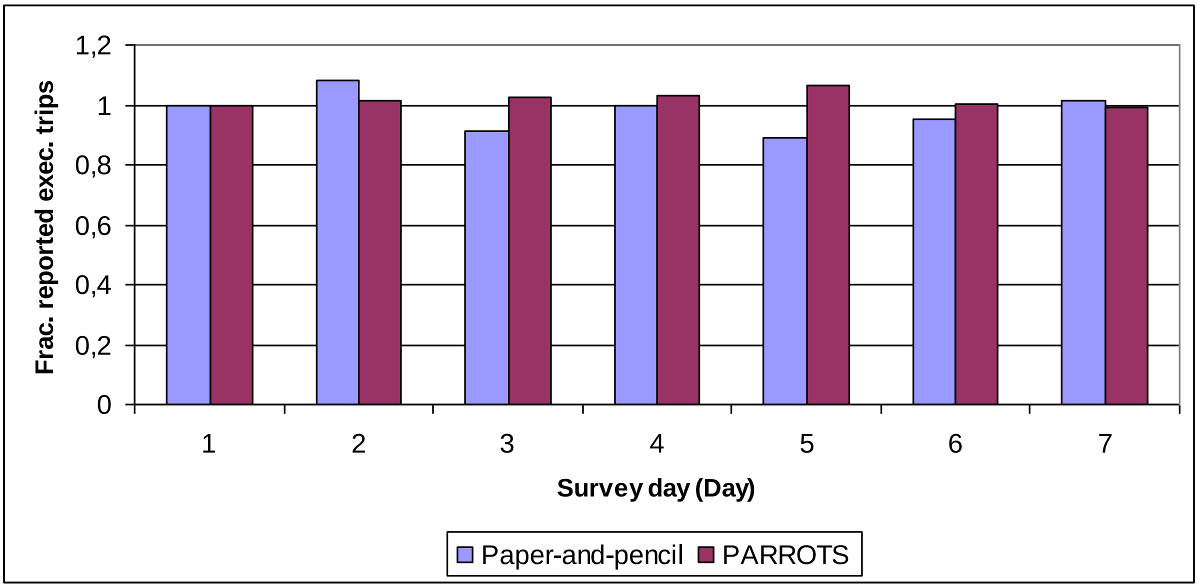


Figure 5. Overview of the average number of executed trips for the datasets collected with paper-and-pencil and with PARROTS, expressed as a fraction of the number of executed trips on the first survey day.

Figure 5 depicts for the datasets collected with paper-and-pencil and with PARROTS the average number of reported executed trips per person and per survey day as a fraction of the number of trips per person for the first survey day. The average number of reported executed trips for survey day 1 is 2.82 and 3.44 for the paper-and-pencil and the PARROTS survey tools respectively. From these averages and from Figure 5, it can be concluded that on average more trips are reported using PARROTS and that the number of reported trips using PARROTS remains more stable throughout the survey. This effect cannot be due to day of the week effects as the starting days of the surveys were randomised.
Based on the above observation, in combination with the observation that the fraction of active respondents decreases by 20% over the survey period (Bellemans et al. 2008), it can be concluded that despite respondent attrition, respondents who continue to report trips keep reporting more or less the same number of trips each day. Hence, it makes sense to run the survey for this extended period of time as there is a significant number of respondents that provides usable data throughout the whole period.
Not only registering the activities and trips in the PARROTS tool poses a burden on the respondents, but also carrying the PDA during all travel is experienced as a large burden by many respondents. In the remainder of this subsection, the response rate in terms of using the PDA as a location logger is investigated.
During the trips, PARROTS captures the location data that is provided by the GPS receiver and stores it in a file. An analysis of the quantity of GPS logs as a function of the survey day indicates the way respondents deal with the burden of carrying the PDA

around. Figure 6 shows the total number of GPS strings recorded by all respondents as a function of the survey day. The absolute values are converted to a fraction of the number of strings of the first survey day (7,205,550 strings). It is clear that the total number of registered strings decreases monotonically as the survey progresses. From Figure 6 it can also be observed that the number of logs per person stays approximately constant for the first four survey days but starts rapidly decreasing starting from the fifth survey day. Hence, the decrease in logged GPS strings as the survey period progresses results from a combination of respondents dropping out of the survey and active respondents logging less.

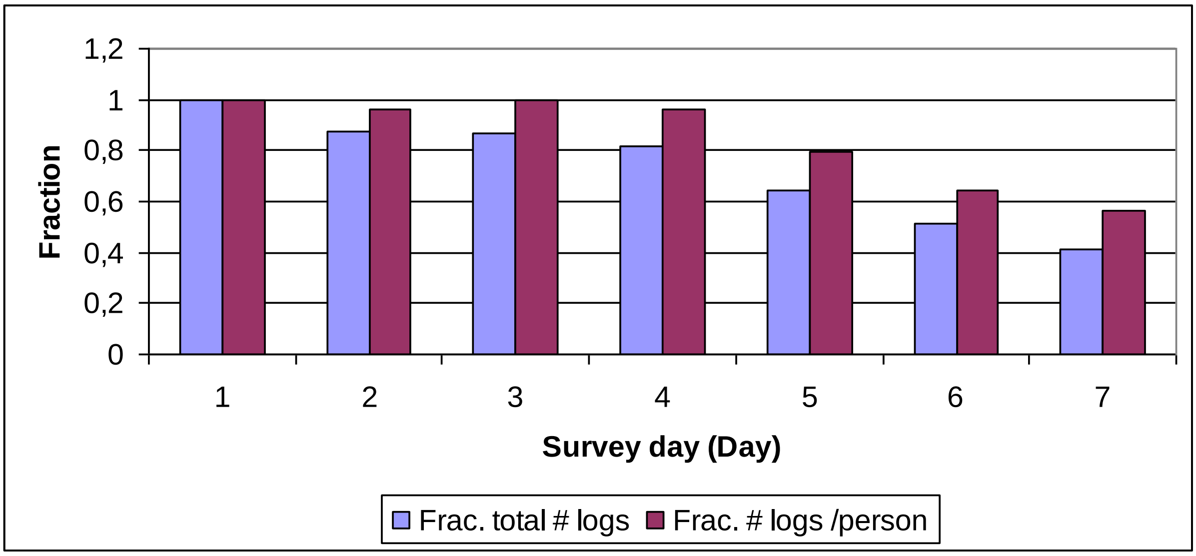


Figure 6. Evolution of the total number of GPS strings logged by all respondents and the average number of strings logged per person for each survey day, plotted per survey day, and expressed as a fraction of the corresponding value on survey day 1.

An explanation for the reduction of the average number of GPS strings logged per person, despite the continued registration of activities and trips, can be sought in the additional burden of being required to carry the PDA tool and to switch it on during trips. An additional burden is introduced by the battery of the PDA, which has an autonomy of approximately 6 hours in logging mode.

2.2.1.2 GPS-based location and travel data quality

This subsection deals with the quality of the travel and location data that is collected using the PARROTS tool. First, the quality of the GPS-based location data throughout the survey period is investigated. Next, an analysis of underreporting of trips as a function of time of day is conducted. This subsection is concluded with an investigation of the relation between time of day and the availability of valid location information in the GPS logs captured during reported trips.
The quality of the location data collected by GPS is influenced by how the respondents use the PDA tool. The data quality of the registered GPS strings can be expressed in terms of the availability of location information in the strings. PARROTS is designed to read and store all information provided by the GPS receiver. This data is provided over the (internal) serial interface according to the industrial NMEA standard (NMEA 2007). However, whenever the GPS receiver is unable to determine the location (e.g. due to

being indoors), NMEA strings are provided without any location information. These 'empty' strings are logged by PARROTS as well.

Although the respondents are made aware of the fact that not stowing the PDA too far away positively impacts the quality of the GPS data, no guidelines are provided on how the device should be carried during trips in order not to needlessly burden the respondents even more. Based on the fraction of the number of NMEA strings containing location information, relative to the total number of logged NMEA strings, an indication of the quality of the automatically collected GPS data can be obtained. In total 36,940,569 strings were logged in the current dataset and in 38% of the strings location information was present.

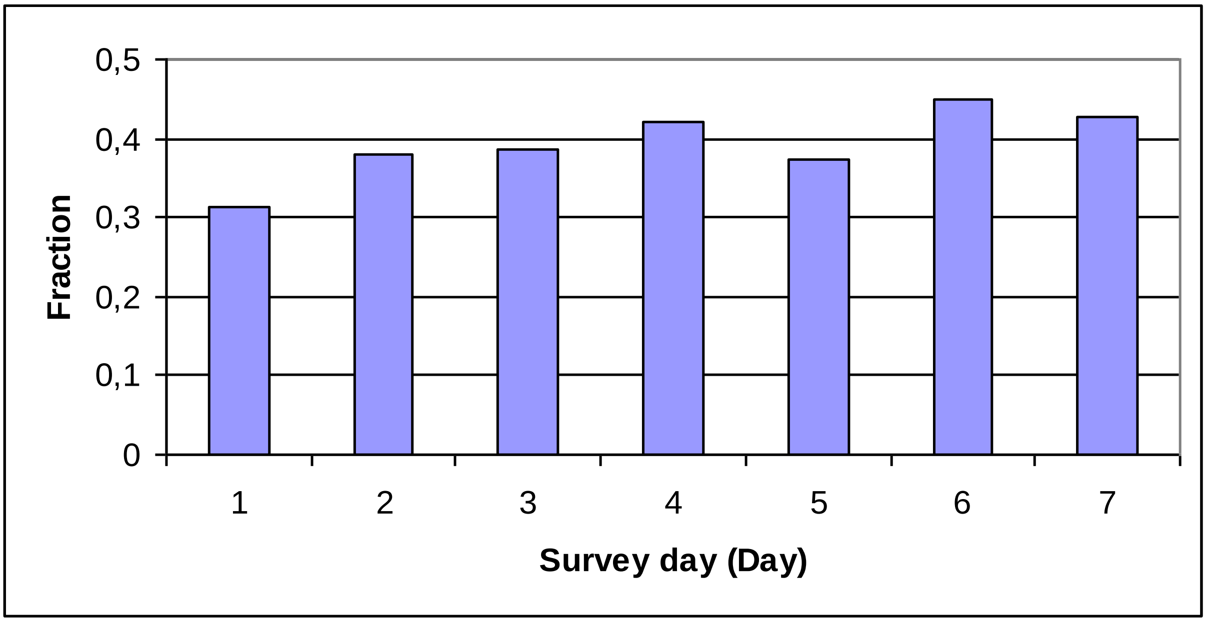


Figure 7. Fraction of the number of NMEA strings per day containing location information relative to the total number of NMEA strings logged per day.

Figure 7 depicts for every survey day the fraction of the number of NMEA strings containing location information over the total number of NMEA strings logged for that survey day. The increasing trend of the fraction towards the end of the survey could be intuitively explained as follows: near the end of the survey a higher fraction of motivated respondents remains and near the end of the survey respondents need less time inputting their data in the PDA, resulting in less NMEA strings being logged indoors during the imputation process.

In order to gain insight in the potential of the PARROTS tool as a means to collect travel information exclusively based on the GPS logs instead of relying on the respondents to explicitly input trip information, the fraction of the reported trip time that no GPS logs were available was investigated. This measure provides a crude estimate of the extent to which location and trip information would be missing if it were not surveyed but merely captured using GPS. It was found that in 52% of the reported trip time no GPS logs were present. A major contribution to this fraction was found to be respondents forgetting to take the PARROTS tool with them during a trip. Figure 8 shows the evolution of the fraction of the reported trip time that no GPS logs were available as a function of time of day. It can be observed that in the late evening and during the early morning this fraction increases dramatically, indicating poor performance of the GPS logs as a means to detect trips at night. It needs to be noted however that as can be seen from the solid line in Figure 8, the number of trips reported during these times is very low and sometimes even equal to zero. Closer examination of the data unveiled that in the majority of the trips reported between 12 am and 5 am no GPS logs were available during the whole trip. During the day time, an offset between the reported trip start and end times constitutes another contribution to the fraction of above. Further investigation of the relative contributions of both phenomena to the fraction of reported trip time without GPS logs requires a reliable trip detection algorithm and is subject to further research.

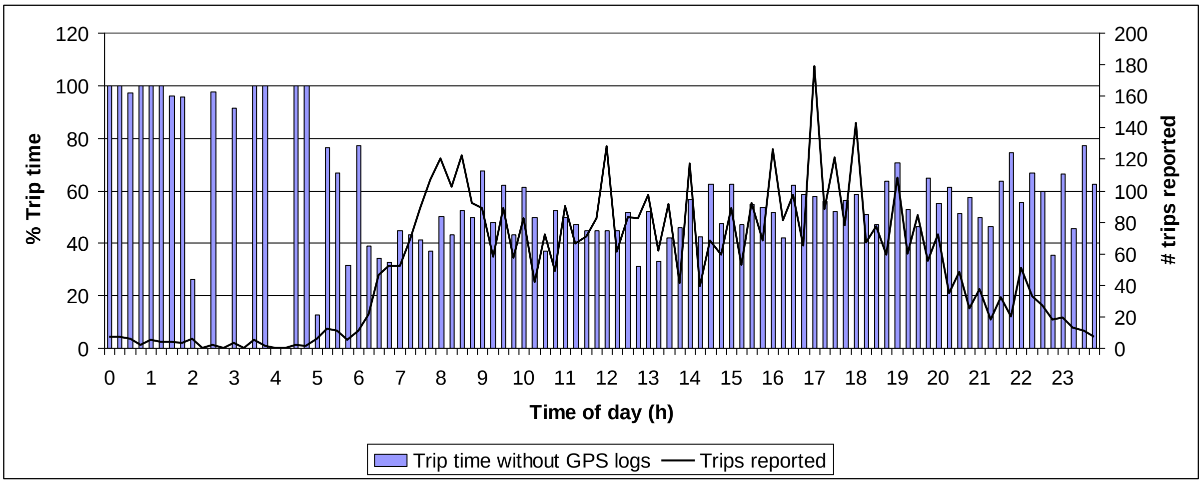


Figure 8. Plot of the number of trips reported as a function of time of day.
The trips are aggregated in 15 minute bins based on the start times.
Fraction of the reported trip time that no GPS logs were available as a function of time of day.

As a final means to assess the location logging performance of the PARROTS tool during trips the average fraction of the number of GPS strings that contain valid location information and that were logged during reported trips over the total number of GPS logged during the trips was computed. It was found that 70% of the logs during reported trips contained valid location information. Compared with the overall average fraction of 38% this indicates that people indeed tend to log their trips using PARROTS, yielding valid location information.

2.2.1.3. PARROTS usage patterns

This subsection analyses the PARROTS usage patterns based on the detailed logs generated by PARROTS.
As PARROTS is a portable tool and as it provides replanning abilities, PARROTS can be used for in the field imputation. By investigating the time stamps recorded for all data saved in PARROTS by all respondents, the usage pattern of PARROTS can be determined. In Figure 9 the total number of records *stored* in PARROTS by all respondents is plotted as a function of time of day (as opposed to the number of trips that was *reported* in Figure 8). The average number of records inputted during a 15 minute interval in Figure 9 is 420. It can be observed that during the night (1h – 6h), activity is very low and the activity increases in the morning to a level near the average activity level. There is a small dip in the activity in the afternoon (14h – 15h) and a clear activity peak during the evening (18h – 23h). The activity peak during the evening can

be explained by two phenomena; first, the respondents were explicitly asked to review their planning for the next day in the evening and second, part of the respondents will not register their activities immediately but register them in the evening as they are revising their planning for the next day. However, given the sustained level of activity on the PDA throughout the day, it can be concluded that a significant number of respondents uses PARROTS to register activities and trips in the field.

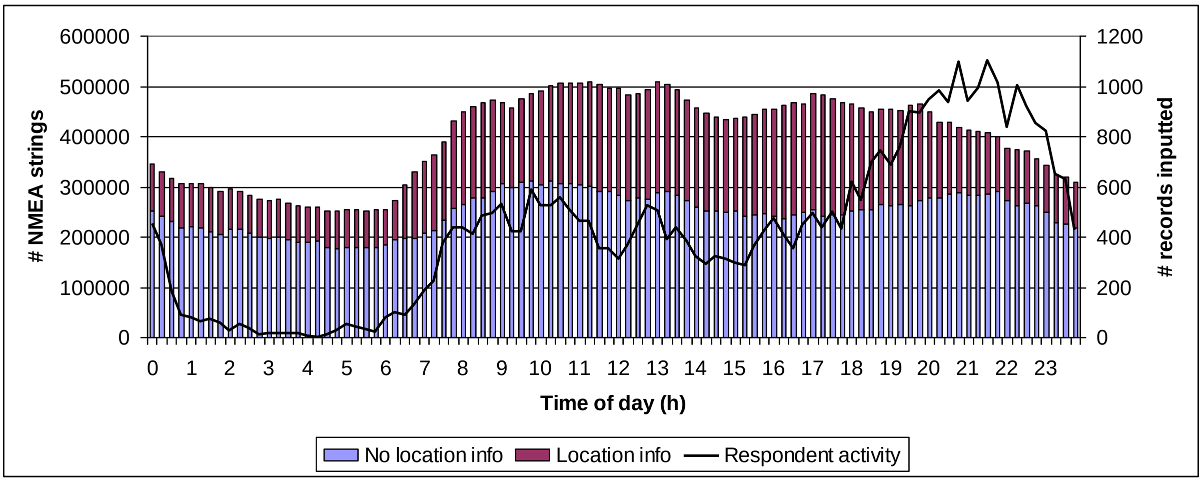


Figure 9. Plot of the number of records inputted in PARROTS by all respondents and as a function of time. The records are aggregated in 15 minute bins. Evolution of the number of NMEA strings (with and without location information) logged by all respondents and as a function of time of day.

Figure 9 also shows the total number of NMEA strings that was recorded as a function of time of day. It can be observed that conform Figure 4, the majority of registered NMEA strings does not contain location info. The fraction of the number of NMEA strings with location information, compared to the total number of NMEA strings varies with time of day. This can be interpreted as follows. Although very little activities are registered, many NMEA strings are logged during the night. This can be attributed to respondents keeping the PDA indoors (no reliable GPS signal) and switched on during charging at night. During the day, the fraction of NMEA strings containing location information increases, since more people are recording their trips during the day. During the peak of the imputation activity in the evening the fraction decreases again, which is partially caused by respondents imputing their activity-travel data while being indoors.

2.2.2. The data collection of stated data

This section contains the major analyses done on the stated data which were gathered through the Web survey and which were leaded by the ULB. We will first investigate the quality of the sample. Then, we will review some key figures of the mobility in Belgium through the specific questions we asked. Afterward we are going to deeply investigate the main orientations of politics we could recommend to deal with the multimodality in home-work trips. And finally the last subsection will be centred on the results of the Stated Preference exercise.

2.2.2.1 Sample Quality Analysis

Launched on the 4th of October 2007 in French and on the 17th of October in Dutch, the questionnaire was closed on the 23rd of October in Dutch and on the 12th of November in French. 2472 people began the questionnaire, 323 were excluded because they were not in our previously defined population, 275 respondents stopped the questionnaire before the end and 1874 people completed the full questionnaire. 64.9% (1216) of these full respondents are Dutch speaking and 35.1% (658) are French speaking.

The following paragraphs are exploring the quality of this sample. If it is not specified, all comparisons are made with the online documentation of the SPF Economy (database Ecodata) consulted in 2007.

About 58.4% of the sample lives in urban spaces according to the Luyten and Van Hecke urban typology (Luyten & Van Hecke: 2007). This proportion exceeds significatively the effective repartition by 2.83%. This means we get a slight imbalance between urban and non-urban.

Furthermore we get a good representativity on Flemish provinces (Antwerp is a little too broadly present and Limburg less). Brussels is over represented on the national level with 229 respondents but it allows us to obtain some estimates at the level of the capital's inhabitants. In Wallonia, the provinces where the variables relative to the Internet access (unemployment rate, in-office workers) are higher than others (in the sense of higher Internet access rate) are overrepresented. The Brabant Wallon and the Namur province's inhabitants are too numerous, Hainaut and Liege are underrepresented; the proportion of Luxemburg inhabitants is good.

The mean age is excellent inside each geographic subspace (country, regions and provinces) but the distribution by age levels is significantly different to the real distribution. The younger (15-24 years old) and older (55-64 years old) members of our population are underrepresented. Even if we try to adapt the questionnaire to allow students to complete it, questions stay essentially formulated in a work context so it is not surprising to observe such a lack. And as noticed previously the older people are less reachable by Internet, this could explain their low participation rate.

With 55% of women, we get an overrepresentation of women in our sample but transport studies generally do not indicate that great differences are observed between sexes in a same context, except for kids' activities management. Nevertheless it seems interesting to notice that our population definition excluded some part time workers (by the condition "work at least 3 days in the same place") which are more women than men; so the sex imbalance was expected in the other direction than observed.

The one-person households are underrepresented whereas the households with children are overrepresented. Comparatively with fiscal statistics (SPF Finances: 2005), households with an income under 1700€/month are underrepresented and household with an income between 2500 and 4100€/month are overrepresented.

Regarding the previous reminder about our population limitation on a time base, it is not surprising to observe an unbalanced repartition of working time with less part times than in the official statistics (SPF Economie: 2004).

Concerning the activity sectors, sectors which employed less people working at a computer (industry, construction, trade and so on) are less represented whereas public administration, education and international organizations are overrepresented. It is important to notice that some studies like the "Diagnostic federal Domicile Travail" (SPF Mobilité et Transport: 2005) illustrated the links between activity sector and mode choice in HW trips; thus we should keep that in mind for further analyses.

Weighting of the Sample

With all these statistics we can consider that our sample is relatively good regarding our analysis' goals. The two different ways of gathering respondents generated different sample qualities (the Dutch one is better than the French one). Nevertheless, the absence of sampling plan based on an exhaustive database (such as the National Register) on both sides prevents access to the computation of error boundaries. This is definitively limiting us to weighting techniques (Calibration, Post-Stratification) that cannot be verified. The weighting we choose and describe in the next paragraph should ensure to gain precision on the estimate but we cannot guarantee it.
In order to keep it as simple as possible and absolutely avoid the risk to supersize the behaviours of a little subgroup, we had post stratified our sample on the three Regions only. Based on their living place, the respondent received a weight before all the analyses describe in the following pages. With this weight, we obtained an exact repartition between the three Regions in the national level of analyses.
For reminder, the limits of our sample and the impossibility to check the benefit of our weights are imputable to the methodology we use to collect our database: Internet study in the first place, willingness-to-answer in the second place. The methodology motivation was mainly economics: The cost of a representative sampling has not been integrated in the ESTiMATE budget. Furthermore the research contract planned to contact people through a questionnaire on the Internet which limits the representativity capabilities whatever the methodology used.
Further than the sample correction by the weights, the qualitative point of view presented in the methodological section could be used to analyse these results without the risk to overestimate the importance of key figure. In such way of thinking, the simple presence of a fact (a reaction or a statement) is something to take care of in the elaboration of politics.

2.2.2.2. Two Typologies to Analyze the Mobility of People

Prior to the data collection, our willingness was to be able to lead most of the analyses on eight subsamples that we called segments. We define the population segments because the literature supposed that they develop specific mobility behaviours and responsiveness. We segment our population based on two metavariables, two typologies. The goal of this subsection is to present these two typologies defined a priori but largely confirmed by analyses on the data collected. These typologies are useful to decompose the subsequent analyses. We will begin with an origin destination typology. Then we will present a mode choice typology.

An Origin-Destination Typology

The first typology we have defined tried to catch the context of the home work (HW) trips and the opportunities linked to this context. The place where people are living constrain dramatically the access to some mode and/or give the advantage to such or such transport mode. The same is true at the other end of the trip, for the work place location. With this first typology we have tried to catch the main figures of these constrains.

Based on the Luyten and Van Hecke (KUL) urban typology of Belgium (Luyten, Van Hecke: 2007), we define 18 urban zones in Belgium (cf. the map in Annexe 3). The first two levels of the KUL's typology ("agglomeration" and "suburbs") were used to define what is "urban" in our case. We use the current origin-destination matrix of our respondents to define in which category they are. The four categories are defined as follow:

- Trips from an urban zone to the same urban zone are called "intra-urban" trips. In our sample, 44.72 % of the respondents were in this category. This category is largely dominant. This is particularly interesting because the work of Luyten and Van Hecke is based on urbanity information but also the density of mobility networks (route, public transports, etc.). Then, 2 persons over 5 seem to live in zone well deserved by these networks and are making relatively short HW trips.
- Trips from an urban zone to another urban zone are called "inter-urban" trips. In our sample, 12.59 % of the respondents were in this category. This is the smallest categories and these respondents are particularly multimodal with public transport (about 41% against 22.5% in general). The fact that the departure and arrival zones are well deserved by public transport (PT) network seems to generate interesting results in term of sustainable development.
- Trips from a non-urban zone to an urban zone are called "commuting" trips. In our sample, 21.9 % of the respondents were in this category. Commuters are not the major figure of HW mobility in Belgium. Again, the Luyten and Van Hecke typology conducts to a fact: the unequal service of PT network around the home end of this kind of trips comparing to the previous category is giving a comfortable advance to the private car against the public transports.
- Trips from any zone to a non-urban zone are called "extra-urban" trips. In our sample, 20.79 % of the respondents were in this category. There, the consequences of the unequal service of PT are dramatically increased. One percentage resumes well what is going on here: 70% of these trips are made with a private car without combinations.

The typology has rapidly proved to be fruitful in contextualized analyses of mode choice and current mobility behaviours. In some analyses like the one we led on the Brussels' case, it seemed to be necessary to go into the typology thoroughly. This adaptation from 4 to 9 trip-types allows us a better comprehensiveness of differences in the mobility supplies and behaviours between the 19 communes and the 43 others which compose the Brussels' urban zone. This kind of distinction between the city centre and the influence zone of it is less necessary in other cities than in Brussels (and maybe Antwerp).

A Mode Typology Specific to Study Multimodality

As expressed previously, a very important factor to analyze the mode choice and the acceptability of the multimodality is the experience of the modes that people have (see

Kaufmann 2000 for example). In order to take it into account, we develop first a couple of categories: People who currently use public transport; and those who do not. Rapidly, we observe that our typology ought to be gone into thoroughly. Regarding our analysis' points of interest (multimodality in the way of sustainable development) we have developed our typology from 2 to 5 mode aggregates. 3 aggregates are unimodal and the last 2 are multimodal. Finally, we get the following five figures (further details in the first table of Annexe 3):

We called the pedestrians and cyclists unimodal the **Unimodal Foot and Bicycle (UFB)**. It represents about 11.61% of our sample and it concerns quite exclusively people who are living in Flanders or in Brussels. The first ones are mainly Extra Urban and the second ones are Intra Urban.

- The unimodal trips by motor bicycle or car (whatever the use – alone or not – and the owner of the car – private or company) are called **Unimodal Car and Motorbike (UCB)**. This is the dominant category in our sample with 51.93%. Present in each kind of trips, they are largely over 50% in every categories of our origin destination typology where one of the end of the trip is out of an urban zone.
- The unimodal trips with public transport (or collective transport organized by companies) are called **Unimodal Public Transport (UPT)**. In our sample, 8.59 % of the respondents were in this category and they are mainly Intra urban people that do not stated the access and egress chain to the PT station. We supposed that this missing chain is probably done by foot.
- The multimodal trips without any branch of the multimodal chain in which the respondent uses public transports are called **Multimodal without Public Transport (MWPT)**. It represents 5.38% of our sample and it was one of the biggest surprises of our data collection. Even if this multimodality is residual, it highlights the fact that the multimodality might exist without public transport. Besides bike combined with car is the most repeated stated combination (9%) of the multimodal trips, with and without PT. We will discuss further the hypothesis we made on this category.
- The multimodal trips with at least one of the branch of the multimodal chain in which the respondent uses public transports are called **Multimodal with Public Transport (MPT)**. In our sample, 22.49 % of the respondents were in this category. The category is quite absent of the Extra Urban trips (only 5%) and much present in Inter Urban (41%) and Commuting trips (31%).

Trends across these Typologies

In the following table you will find more details on the repartition of each typology inside the other. The dominant mode choice in any origin destination (OD) type is the car (UCM) even if it decreases in the fully urban categories compared to the mean percentage. The other trends inside each category have already been presented in the previous paragraph.

General percentage (Row Conditioned Percentage)		Mode Typology					Total
		Unimodal Foot and Bicycle	**Unimodal Car and Motorbike**	**Unimodal Public Transport**	**Multimodal without Public Transport**	**Multimodal with Public Transport**	
Origin Destination Typology	**Intra Urban**	8.2 (18.34)	18.82 (42.08)	5.38 (12.03)	2.82 (6.31)	9.51 (21.27)	44.72
	Inter Urban	0.33 (2.62)	5.97 (47.42)	0.92 (7.31)	0.2 (1.59)	5.18 (41.14)	12.59
	Commuting	0.33 (1.51)	12.46 (56.89)	1.97 (9.00)	0.33 (1.51)	6.82 (31.14)	21.9
	Extra Urban	2.75 (13.23)	14.69 (70.66)	0.33 (1.59)	2.03 (9.76)	0.98 (4.71)	20.79
Total		11.61	51.93	8.59	5.38	22.49	100

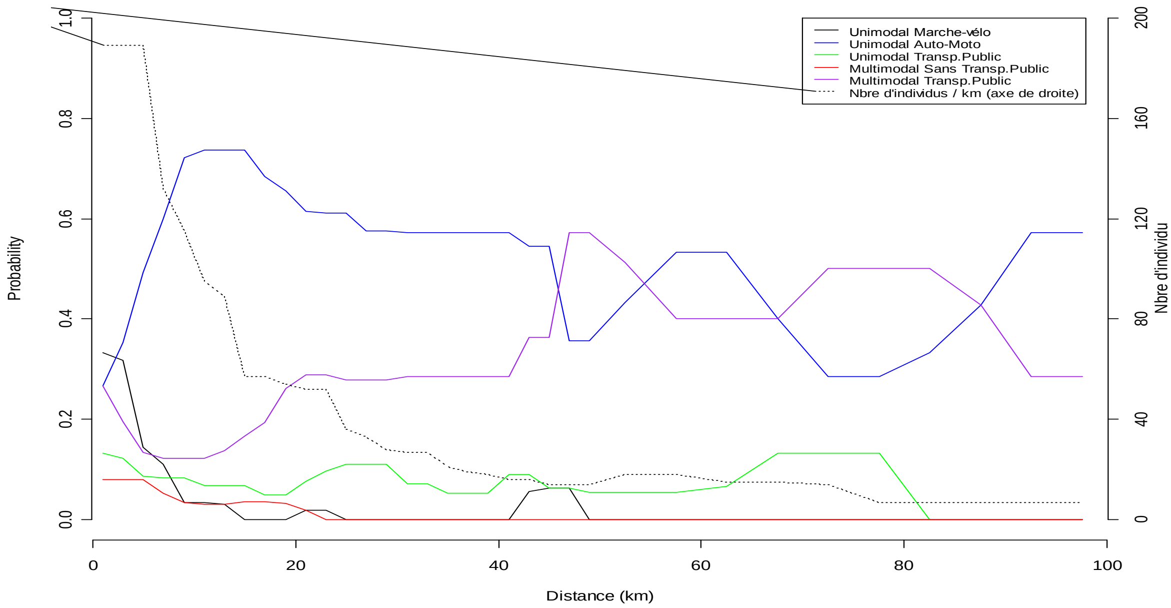
The Unimodal Foot and Bicycle is mostly present in Brussels (living and working area) and Flanders (same trend; few people enter in Brussels by bicycle but they are marginal). The Unimodal Car and Motorbike is equally widespread in Flanders and Wallonia. Even if Brussels present a small percentage here (18%), the urban zone effect are less influent. This is due to the seventeen other zones but also to the Brussels zone outside its administrative Region. The table in annexe 3 clearly shows that the Unimodal PT is quite a Brussels' thing and that the Multimodal without PT is a Flanders' thing. Concerning the Multimodal with PT, Brussels is again the leader. The difference between Wallonia and Flanders should be investigated in terms of living places.
Only one major comment has to be done on the age: the Unimodal Car (UCB) and Multimodal with Public Transport (MPT) categories' proportions are inversely proportional and both related to the age of the respondent. Older people become, less they will take a multimodal trip with PT and more and more they will take their car. On the sex, there is no major trend to note. The same can be said for the working times. Another table in annexe 3 is presenting these results more deeply.

2.2.2.3. How to Deal with the Multimodality in Home Work Trips?

This subsection is all dedicated to the multimodality. Step by step, we are going to try answering some questions: First, what could we call Multimodality? With this question we will introduce the multimodality as it is experienced by users. Second, we will make a little detour by the ideal transport mode of our respondents. Then with these pictures we will investigate the connections and the level of services.

What Could We Call Multimodality?

Let's try to define what the multimodality is. First, we could define it as a combination of transport modes within a time period (typically a day). That definition is generally used by Activity Based modellers but is not useful to study home work trips, especially with the words "Sustainable development politics' orientations" in mind. So, another definition could be better: We define the multimodality as a combination of transport mode and/or vehicle within the same origin destination (OD) trip. The combination can mix private and public modes but also be a combination of bus lines and so on.



Probability of choosing a mode type per HW distance

Through our mode typology we already investigate the major trends of the multimodality in home work trips in Belgium. In our sample, about one person over four is a multimodal one (26.7%). And one over five amongst these (21.0%) does not use any public transport in their combination. Before investigating what the combinations are, we try to understand when and where multimodality is appearing.

Again, the major trends have been presented before: The multimodal users are mostly urban (at least for the work end of their trips) if the multimodal trip includes a branch with public transport (especially if Brussels is in the OD matrix) or Flanders living if it does not include public transport.

These observations can be combined by the analysis of our mode typology against the distance of the home work (HW) trips. In the annexe 3, you will find a table with the percentiles of the estimated HW distance and the conditioned repartitions of the mode. In the first and the last deciles (the shortest 10% and the longest 10% of the trips), the multimodality with public transport is dominant over all the other mode type. It is hard to explain this trend in the first case; but the length of the trip in the second case generates a response by itself: Trips over 45 kilometres have mostly Brussels as destination (the city has the largest attractive area in Belgium) and we saw that Brussels is largely multimodal. Nevertheless the multimodality is not fully dominant: unimodal car is just behind. This double trend of fifty-fifty partition appears already from about 40 km as you can see in the previous plot. This plot is giving the approximated probability

to choose a mode type depending on the length of the OD trip (this is done by kernel smoothing – cf. further comment at the end of the next section).
The multimodal trip without public transport (MWPT) is leading us to another reality: People who state that they combine multiple private transport modes have mostly a short distance from home to work. For the half of them, they work and live in the same Commune. Combining this information with the stated combination (most repeated combination is Bike and Car) developed in the next subsection, we developed the hypothesis that they do not really combine these modes but regularly change (day to day, summer to winter) between these modes.

Which Combination?

Now that we have given some answers to the "who", "when" and "where" questions about the multimodality? We will try to describe how people are multimodal. To do so, the first question to answer is: How do they combine their mode?
Between 60 and 70% of our respondents are unimodal (cf. annexe 3). Why these percentages are different of the ones presented with our typology? The answer is that in our unimodal public transport category, they are some respondents who use only one mode but state one connection (or more). That means they are combining vehicles within the same public transport company. We can also observe that people who are combining more than two modes are less than 10% and only 1% of our sample is stating they combine 4 to 6 modes.

The next table draws a map of the major combinations stated in our questionnaire. The first was quite surprising and generated our previous remark about the way people probably are changing of mode instead of combining them. The Bike and Car combination (9% of the combinations) is mostly stated in Flanders and by people who live and work in the same area. Then the interesting combinations are coming: Walk and STIB (7%) is typically stated by people from Brussels who are working in their city. Walking is the access and egress mode and STIB is the main transport mode. The Car as driver and SNCB (4.2%) and the same combination plus walking (3.4%) are probably the same picture (where the first have a shorter walking time) and is largely present within the commuters to Brussels and the others majors cities. The SNCB, STIB and Walk (2.9%) and Car as driver, SNCB and STIB (2.6%) can be seen as a prolongation of the previous combination, more deeply linked to the capital. 35% of the respondents who are entering in Brussels by train egress to their work place by metro, bus or tram.
The last major picture concerning this table is that these eleven combinations represent less than the half of the stated combination (as well in term of number of combination – we obtain 106 different combinations – as in percentage of the occurrences). This means that multimodality is complex and that multimodal people are inventive.

Top 11 of the Most Stated Mode Combinations										
Bike and Car as driver	**Walk and STIB**	**Car as driver and SNCB**	**Car as driver, SNCB and Walk**	**Walk and SNCB**	**Bicycle and SNCB**	**SNCB, STIB and Walk**	**Car as driver, SNCB and STIB**	**Motorbike and Car as driver**	**Bicycle, SNCB and Walk**	**Car as driver and Car as passenger**
9%	7%	4.2%	3.4%	3.2%	3.1%	2.9%	2.6%	2.6%	2.5%	2.5%

The second probability plot concerns the mode taken one by one instead of our typology; this plot is on Annexe 3. Whatever the distance, about half of the trips are partially or totally made by foot. The car is broadly use in short trip and stays at the same level of importance than walking whatever the distance. This is clearly not the case concerning the train: its probability is starting from zero for short trips and progress constantly to one (100%) from 10 to 30 km. Further than 30 km, the train is present in most of the combination.

An important technical remark has to be made about these probability graphs: The probabilities are obtained by local smoothing (kernel smoothing). This means that there is no control on their sum (which should be equal to 1 in the first of the two graphs). To be interpreted properly, these probabilities should be linked to the number of people who are making trips of this length (the dashed line in the first graph, with the right axis as reference).

What Is the Reality of the Connections?
As defined before, we consider a trip as multimodal if it is combining vehicles or modes. The previous section has investigated the combination that our respondents have stated. In this section, we will have a look at the interstices between these vehicles or modes, the connections.

As multimodality, connections are suffering of a lack of definition. For us, connections are all offloading within a trip; the time between the exit of a vehicle and the entrance in another vehicle is a connection time. But this definition has a major failure for the pedestrians. They do not exit their vehicle. And, less trivially, it is difficult to define where and when pedestrians are ending to use their mode. For example, if you are going to the station by foot, how can we define a connection there? In order to avoid this problem, we proposed an adaptation of our definition which excludes pedestrian access and egress branches at the home or the work end.
Further than this limitation, results have shown that the word "connection" is mainly linked by respondent to the meaning of a mode change between two public transports. The better example of this user's definition is that 93% of the respondents who state a multimodal combination without any branch using public transport (MWPT) also state they have not any connection during their trips.

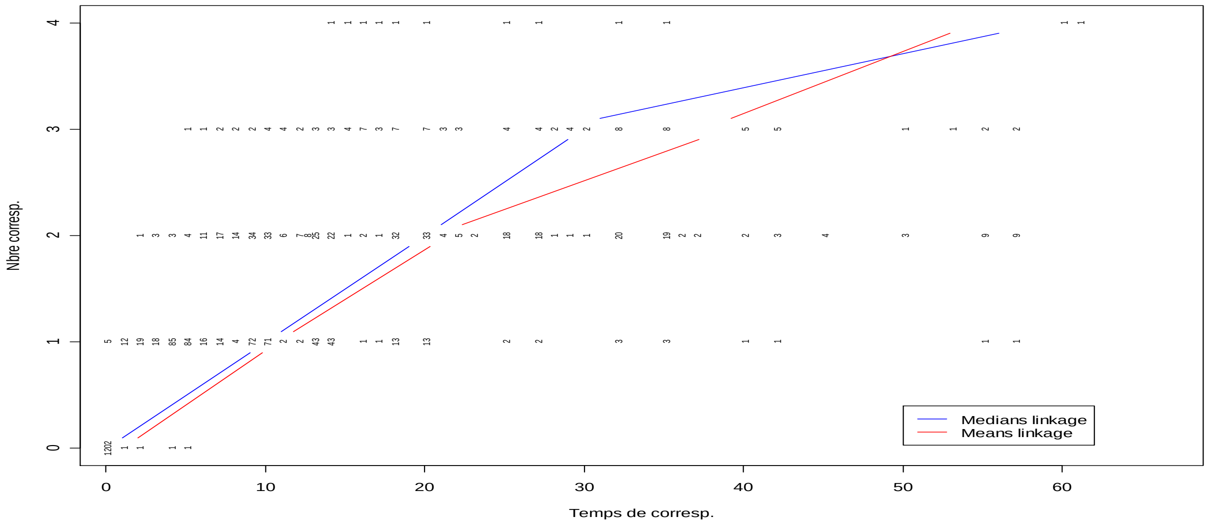
The other information of the following table is that connections are present in our unimodal category, especially within the third one: Unimodal with Public Transport. There you will find people who use only one public transport company but several vehicles of it. This represent more than an half of this category.

General percentage / Row Conditioned Percentage / Column Conditioned Percentage		Current number of connections in home work trips: No Connection	1 Connection	2 Connections	3 Connections or more	Total
Mode Typology	**Unimodal Foot and Bicycle**	9.99	0.94	0.44	0.06	11.43
		87.38	8.25	3.88	0.49	
		14.61	6.3	3.98	1.01	
	Unimodal Car and Motorbike	44.28	3.77	3.61	2.5	54.16
		81.76	6.97	6.66	4.61	
		64.77	25.19	32.34	45.45	
	Unimodal Public Transport	3.66	2.61	1.05	0.55	7.88
		46.48	33.1	13.38	7.04	
		5.36	17.41	9.45	10.1	
	Multimodal without Public Transport	5.22	0.28	0.11	0	5.6
		93.07	4.95	1.98	0	
		7.63	1.85	1	0	
	Multimodal with Public Transport	5.22	7.38	5.94	2.39	20.92
		24.93	35.28	28.38	11.41	
		7.63	49.26	53.23	43.43	
Total		68.37	14.98	11.15	5.49	100

An image in annexe 3 is illustrating the (lack of) correspondence between the number of modes and the number of connections stated. As previously mentioned, people who stated multimodal trips without public transport are stating no connection whereas some unimodal in public transport are using several vehicles of the same company. This double trend is reinforced by the fact that people are largely considering that connections only concern public transport offloadings.

Connection Time and Multimodal Speed

To end this subsection about practices, let's have a look at connections' time. The next figure is presenting the mean and median linkages of the cumulative connection time stated by the respondents. The main figure to keep in mind is that effective connection time is about 10 minutes, whatever the number of connections. That means that each time people are changing of vehicle, they add about 10 minutes to their origin destination trip time.



Mean and median connections times (cumulative time)

The image of connections will be fully developed in one of the subsections below. A part of the questionnaire was investigating the vision people have of the connections. There were two propositions about the time: "Connections are a loss of time" and "Connections are too long". In the first proposition, a large majority agree, even for people who experience the connections every day. A Pearson independence test (classically called Chi-Squared test) has shown that there is a significant difference between the responses of users and non users of connections. The second affirmation was less generally agreed. The interesting observation here is that non users do not have an opinion on the fact that connections are too long. The consequence is that people who are in accordance with the proposition are users of them. Here again there is a significant difference between answers of the two groups. The corresponding tables are in annexe 3.

Fully indicatively, we computed speed estimation based on the Lambert estimated home work distance and the stated length of that home work trip. The analysis of these speed have been put in annexe 5.

The Ideal Transport Mode

Around the middle of the questionnaire, we ask people to express their ideal transport mode. We ask them to rank some expectations they could have about their home work journey. The ranks were not exclusive and went from "Not at all important" to "Extremely important". Here are the some key figures of this ideal transport mode.

First aspect to be cited in the literature is the cost. Models are generally using it as the key argument, crossed or not with the time. Of course when we ask if the ideal transport mode should not be expensive; this expectation is largely approved but it is not the best ranked at all. Rapidity, flexibility, punctuality and security are coming before it. Public and private transport mode users do not put this expectation at the same level. Private car users (and company car users) give significantly less importance to cost than others (see table in annexe 3). A difference exists also between Walloons, Flemish's and

Brussels inhabitants, the latter give less importance to the cost. At the opposite, Walloons are the most extremely in accordance with the item.

Should we arrive rapidly at destination? The answer is clearly yes for 62% of our sample. This is the most expected proposition. As mentioned in the literature, the bike and foot users do not rank this item as important as the others. A distinction exists also between the public and private modes users. The latter are the most in accordance with the proposition (see table in annexe 3). Concerning the other variables, we could resume that people who live and/or work in Brussels are the most impatient as well as the women.

Arriving on time, without any delay is expected by everyone (see table in annexe 3), it is the third most important expectation. Some little differences exist between the current modes: multimodal users are the most in accordance with the proposition, followed by car users. Again, the Walloons are more in accordance than the Brussels inhabitants and works who are themselves more in accordance than the Flemish ones.

Connections will be deeply investigated in the next subsection. When we ask if the ideal transport mode should have no connection, the answer is not so evident. A large majority tends to think it is important but gives less importance to this factor than others. Connections have a mean rank in the 7th position over 10. This is important information about multimodality in general. The less importance to the "no connection" item is given by people who are experiencing connections every day. Again, multimodal users without public transport (MWPT) do not acting like the public transport users. But this could be related to others variables: First, here the Flemish's are the most in accordance this time (and MWPT are mostly Flemish). Second, the Extra Urban, the women and the older (see table in annexe 3) are also most in accordance with the item.

General percentage (Row Conditioned Percentage)		**No connection**							**Total**
		Not at all important (- - -)	**(- -)**	**(-)**	**0**	**(+)**	**(+ +)**	**Extremely important (+ + +)**	
Current Experience of connections in home work trips	**No experience of connections**	0.78 1.15	0.5 0.74	0.95 1.4	6.49 9.54	12.36 18.17	18.62 27.38	28.3 41.61	68.01
	Experience of connections	0.39 1.22	0.95 2.97	1.62 5.07	3.91 12.24	7.05 22.03	8.84 27.62	9.23 28.85	31.99
Total		1.17	1.45	2.57	10.4	19.41	27.46	37.53	100

In order to get the ideal transport mode, even in the multimodal way. We ask people what could be the perfect connection timing. Between two busses, the median connection time proposed is 5 minutes and the interquartile interval is extended to 10 minutes. Between a bus and a train, a median time switch to 10 minutes but the interval stays the same. For two trains, the median connection time expected is 10 minutes but the upper quartile rise up to 15 minutes. An interesting remark about this question is that a lot of respondents have proposed a multiple of 5 minutes. It is to say that these time shifts seem acting like thresholds of tolerance.

Variable	Mean	Std Dev	Lower Quartile	Median	Upper Quartile
Maximum acceptable time of connection between two busses	7.55	3.64	5	5	10
Maximum acceptable time of connection a bus and a train	9.73	4.40	5	10	10
Maximum acceptable time of connection between two trains	10.57	5.42	5	10	15

What about the flexibility? Going and coming back whenever we want could be the clue to define the ideal transport mode. The car users are really demanding on this item, followed by MWPT and unimodal with public transport (see table in annexe 3). The less importance is given by pedestrians and cyclists. On the others variables there is not much differences.

Comfort comes just after cost and before connection in the second group of most important item. Again a majority is in favour of being seated comfortably. This expectation is increasing with the age, within Flanders and within private users (see table in annexe 3). At the opposite, slow modes (bike and foot), Intra Urban users, and Brussels inhabitants and workers rank the item lower.

Security is in the fourth position in ranking. The biggest difference appears between men and women: 36% against 54% of extremely important (see table in annexe 3). The second key difference is distancing slow mode of all others. Pedestrian and cyclist do not care as much as others about feeling secure.

There are no big differences on the item "Talking with colleagues and/or friends". The item of sociability is ranked in the 8 position over 10. It is clearly not a determinant argument for the mode definition (see table in annexe 3).

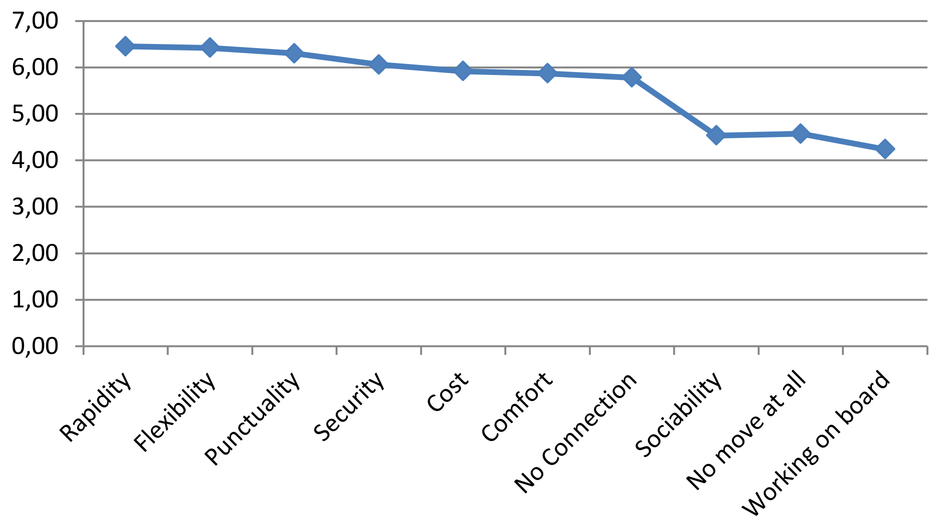
Working during the trip is an Inter Urban (see table in annexe 3) thing and it is more important for multimodal with public transport users. Working during the trip necessitate generally a sufficient trip time without driving. Considering the description of these categories, it is not surprising that the item is valorised by these groups more than others. The median rank of this item is the middle point of the scale and it is the worst mean score.

Last but not least, we ask people if an ideal transport mode (or trip) would not be to do not move at all. The proposition is positively correlated to the age of the respondent. Inter Urban and Extra Urban rank it higher too (see table in annexe 3). Finally the proposition obtains quite the same score than the working one and seems not far from the centre of the scale; which is the lower level of most of the other item's ranks.

Finally we could rank these propositions to build an ideal transport mode as presented in the following table and graph, from the most important (rapidity) to the less (working).

Variable	Mean	Std Dev	Lower Quartile	Median	Upper Quartile
Rapidity	6.45	0.87	6	7	7
Flexibility	6.42	0.96	6	7	7
Punctuality	6.30	1.06	6	7	7
Security	6.06	1.16	6	6	7
Cost	5.92	1.22	5	6	7
Comfort	5.87	1.06	5	6	7
No Connection	5.78	1.30	5	6	7
Sociability	4.53	1.63	4	5	6
No move at all	4.57	1.76	4	4	6
Working on board	4.24	1.80	3	4	6

1 = Not at all important, 2 = (- -), 3 = (-), 4 = (0), 5 = (+), 6 = (+ +), 7 = Extremely important



Perceptions and Apprehensions of the Connections

In the previous subsections we have reviewed some facts about the connections as they have been stated by our respondents. Here, we will give much attention to the perception people have about these connections in order to propose some idea's to improve their acceptability.

Let's recall some of the perception already presented. In the previous subsection, we ask people if their ideal transport mode should have no connection. A majority tends to think it is important but gives less importance to this factor than others. Previously, we have also presented the results about two propositions: "Connections are a loss of time" and "Connections are too long". In the first proposition, a large majority agree, even for people who experience the connections every day. The second affirmation was less generally agreed. The interesting observation there was that non users do not have an opinion on the fact that connections are too long.

This difference between people who currently experience connections every day and people who do not is present in quite every situation of the following items. The latter were proposed to the respondent before the stated preference experiment. The answer went from "Totally disagree" to "Totally agree" in five steps. Note that people who do not experience the connections currently are choosing more than the others the "Neither agree nor disagree". As in the "Connections are too long" item, they seems to have no opinion on these propositions. Again, the most interesting detailed tables are in the annexe 3.

The first couple of propositions are the most controversial. "Connections get me some fresh air" obtain more than 50% of disagreement, especially amongst those who experienced the connections. "Connections are relaxing moments" was even more rejected without large difference between subgroups. Both propositions were rejected most hardly by older people than the young.

Fifty percents of the respondents are considering connections as "stressful moments". The stress seems to be higher for people who do not experience it regularly. Car only users are 31% to be totally in accordance with the item. Younger people and Brussels inhabitants and workers agree less than the rest of the population.

About 60% of our respondents agree the item "I cannot do anything during connections". Concerning the response "totally agree" the difference are huge: only 15% for the pedestrians and cyclist, 25 to 28% for public transport users and multimodal without public transport, and it rise up to 38% for car users. Are these differences generating the choice of these people for their current mode? Are these perceptions based on experience? Or maybe it is the stress of the connection that prevents them to do anything else? It is difficult to answer these questions within an online questionnaire.

If connections are so badly tolerated, are people trying to avoid them? 44% of our sample totally agrees that proposition. This percentage rises up to 48% within the people who have no connections. On the other hand, people who are experiencing it do not go under 50% of agreement which means that even if they have connection(s), they do not seem to like it at all. Again, high differences can be highlighted: The "Totally agree" answer fall down to 29% within the pedestrian and cyclist and 25% within the Brussels inhabitants. The answer rise up to 52% within the others private modes and 50 to 52% for the Flanders inhabitants and workers.

General percentage Row Conditioned Percentage		**I try to avoid trips with connections**					**Total (1300 non missing)**
		Totally disagree	**Disagree**	**Neither agree nor disagree**	**Agree**	**Totally agree**	
Current experience of connections in home work trips	**No experience of connections**	2.31 4.09	2.15 3.82	13.62 24.15	11.08 19.65	27.23 48.29	56.38
	Experience of connections	3.77 8.64	3.85 8.82	7.62 17.46	11.62 26.63	16.77 38.45	43.62
Total		6.08	6.00	21.23	22.69	44.00	100

Are Services the Way to Reinforce Connections Acceptability?

A conclusion to the previous subsection could be that the best connection is the one that do not exist! Nevertheless, we showed that even if people do not like connection, they do not reject it definitively. Then, an emerging question could be: "How to reinforce connections acceptability?" A first answer has been written in the ideal transport mode subsection where the ideal connection times were exposed.
In this subsection, we will propose another answer that follows the idea that service and amenities could be a way to reinforce the connections' acceptability. Services where? We develop two set of questions: The first was about the services in stations, and the second concerned the service on board of vehicles. In the stated preference exercise presented in the next section, we also test the effect of two of these services on the stated choice.

The Nearest Train Station

Before entering in the service in station, we will make a little detour by the nearest train station. The motivation of this is simply to illustrate that the context of the following questions could be out of order for some respondents. We remind you that in the Unimodal Foot and Bicycle (UFB), Unimodal Car and Motorbike (UCM) and Multimodal without Public Transport (MWPT) categories, nobody is using the train. In the category Unimodal with Public Transport (UPT), 37% are using the train (2.94% of the full sample) and in the Multimodal with Public Transport (MPT) one, 64% are using the train (13.37% of the full sample).

For about 30% of the sample, the nearest station is the most appropriate one to go to work. For less than 10% a further station is more appropriate. And for 53% there is no appropriate train station to go to work. There exist an interesting potential in train stations regarding the fact that 40% of those who state the nearest station is the most appropriate currently use their own car.
We were also interested in the reason why another station could be chosen. For 78% of the further station chosen, the response is that they are making the trip shorter. For another 15%, a further station is simply most appropriate; maybe for shopping, kids handling and so one. And finally, only 7% are choosing another station because there are more services there. This not means that services are useless in stations but at least that they seem to have no concurrence between stations on that point of view. The table concerning this question is in the annexe 3.

Services and Amenities in Stations

In the set of questions about services and amenities in stations, we proposed eleven of them and asked people so select if they were "Superfluous", "Not important", "An advantage", "Important" or "Essential". The most interesting detailed tables are in the annexe 3.

First couple of service, the ticket office and the automatic ticket machine: Both item were largely chosen as important or essential.

The ticket office seems more essential than its automatic version. Brussels workers give less importance to the living version whereas the women prefer a ticket office to the automatic machine.
The regional trend is inversed on the automatic ticket machine: Walloons are less interested than Flemish's who are themselves less interested than the Brussels inhabitants and workers. The rank of the machine is higher by the younger people and Intra and Inter Urban.

Second couple of service, the parking for cars and bicycles: Both response trends are highly correlated with the current transport mode. In the one hand, parking for car is classified as essential by 56% of the whole sample and by 67% of the car users. In the other hand, parking for bicycles is essential for 62% of the sample (more than the car park!) and by more than 70% by pedestrian and cyclist but also by multimodal users without public transport.
The other trends of response are: The Brussels inhabitant and Intra Urban users have fewer expectations for car park; and the bicycle park seems to correspond more likely to Brussels and Flanders inhabitants and Flanders workers.

General percentage (Row Conditioned Percentage)		**Parking for cars**					**Total**
		Superfluous	**Not important**	**An advantage**	**Important**	**Essential**	
Mode Typology	**Unimodal Foot and Bicycle**	0.58 5.13	1.04 9.23	2.15 18.97	3.71 32.82	3.83 33.85	11.31
	Unimodal Car and Motorbike	0.23 0.44	0.12 0.22	3.77 7.07	13.57 25.46	35.61 66.81	53.31
	Unimodal Public Transport	0.29 3.55	0.81 9.93	1.39 17.02	2.55 31.21	3.13 38.3	8.18
	Multimodal without Public Transport	0.06 1.03	0 0	0.64 11.34	2.03 36.08	2.9 51.55	5.63
	Multimodal with Public Transport	0.46 2.15	0.99 4.57	3.19 14.78	6.67 30.91	10.27 47.58	21.58
Total		1.62	2.96	11.14	28.54	55.74	100

Third couple of service: the benches and platforms with a roof. Again both items are mostly considered as important or essential. The benches are more essential for public transport users, Brussels inhabitants and workers, and Intra Urban users. The roofs on the platform are more essential for the older.

As a transition between services and amenities, the Water-Closed are essential for 54% of the sample and important for 31%. People who do not take the train are considering it as more essential than others. Brussels inhabitant and workers are at the other end of the expectation scale.

A first couple of amenities are the newsstand or bookshop and supermarket. Comparing to all the service where the "Important" and "Essential" answer were dominant, the amenities are dominated by the response "an advantage". The newsstand is considering amongst an advantage and something important.

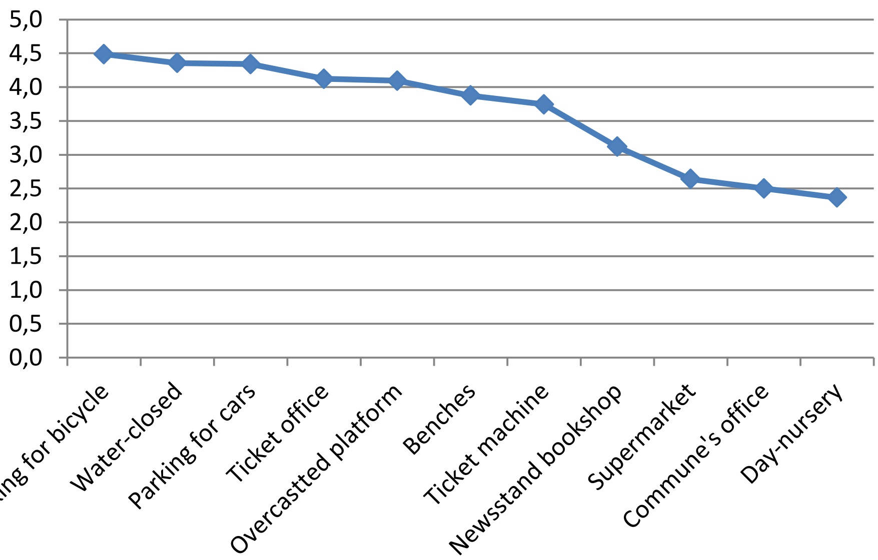
It is more demanded by Brussels inhabitants and by women. The supermarket is considered amongst not important and an advantage. The same trend about Brussels and women is true.

A second and last couple of amenities are the Commune's office and a day-nursery. The Commune's office follows the same perspective than the supermarket but is more demanded by Walloons (and women again). The day nursery is the only amenities considered amongst superfluous and an advantage. Again, the Walloons' demand is higher than others, especially comparing to Flanders that stay under the other on the four amenities.

Finally we could rank these propositions of services and amenities in the following table and graph, from the most important (the bicycle park) to less important (the nursery).

Service	**Mean**	**Std Dev**	**Lower Quartile**	**Median**	**Upper Quartile**
Parking for bicycle	4.5	0.77	4	5	5
Water-closed	4.4	0.81	4	5	5
Parking for cars	4.3	0.90	4	5	5
Ticket office	4.1	0.87	4	4	5
Overcastted platform	4.1	0.85	4	4	5
Benches	3.9	0.98	3	4	5
Ticket machine	3.7	0.99	3	4	5
Newsstand bookshop	3.1	0.93	3	3	4
Supermarket	2.6	0.90	2	3	3
Commune's office	2.5	0.93	2	3	3
Day-nursery	2.4	1.04	1	2	3

1 = Superfluous, 2 = Not Important, 3 = An Advantage, 4 = Important, 5 = Essential



Services and Amenities on Board

Let's now have a look to the services and amenities on board of vehicle. The latter can be trains, trams or busses but the first cited are probably the most considered by respondent, regarding the context of these questions. We conserved the same response scale, from "Superfluous" to "Essential" in five steps. The detailed tables are in the annexe 3.

The first proposition is an obligation at the SNCB but not at all in the other public transport companies. It is the ticket inspector. Our proposition literally mentioned both the ticket inspector and the ambiance agent. The idea is to test the willingness to have a presence of an official repetitive instead of testing the acceptance of the ticket inspector itself. The presence of an official agent is considered as important or essential by about fifty percents of the sample. Private users are more in demand for than public transport users themselves. Intra Urban and Brussels users especially think that ticket inspector is not important. The contrary is true for the older.

Related to the presence of an agent for some, the peace and quiet on board is considered as important by more than fifty percent of our sample. There is no significant differences related to the others variables and typologies.

First ranked service on board, "to have a seat" is considered as essential for 42% of the sample and as important by another 44%. The biggest difference between groups concerns the Intra Urban who are considering this service less important than others. The same diminution is observed amongst the Brussels inhabitants. Both categories are using largely urban networks and the quite "normal" congestion could explain this difference of expectation.

The presence of seats in face to face is considered as not important. It is the last but one ranked service and there is no significant differences observed across the other variables.

Wi-Fi connection on board is not considered as important at all in 2007. This is the last ranked amenity. Nevertheless differences in expectations can be observed between men and women (men think it is more important), Walloons inhabitants (more important than for the others) and Inter Urban. This last category is the easier to understand why it could be interesting to have a Wi-Fi. These people are one of the biggest users of the train and their branch with the SNCB is longer than others. So they could be more interested to check their emails and going on the Web than others.

The next amenity could be the key one to note: Information on board about the connections available at the arrival is the second ranked amenities, just after the seats. There are no big differences when we cross it with other variables. A majority consider it as important (45%) or even essential (28%) and only 3% think it is superfluous or not important.

Percentage per variable	**Superfluous**	**Not important**	**An advantage**	**Important**	**Essential**
Information on board about the connections at the arrival	0.9	1.57	24.43	45.21	27.9

Finally we ask people what they think about an old project of the public transport companies: having a unique ticket for bus, tram and train everywhere in Belgium. The item is ranked in third position, quite equal to the connections' information. As expected, the multimodals with public transport who are changing of company are considering this service much as essential than the rest of the sample (30% against 23%).

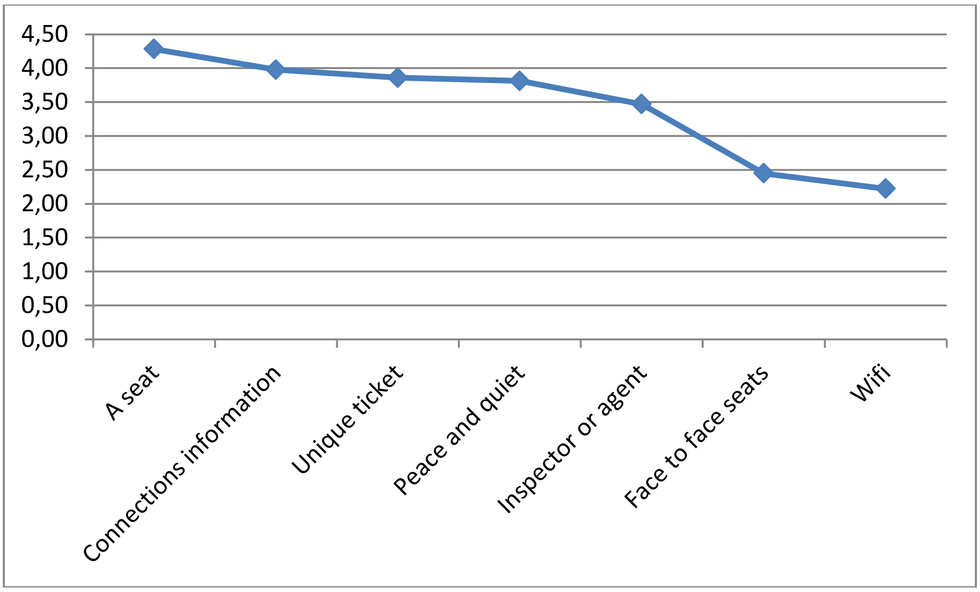
At the opposite, the multimodals without public transport (13%), the Flanders inhabitants (18% against 30 to 32% for the other regions) and the Flanders workers (17% against 30%) are considering it as less essential. Last difference about this service: the demand of the men is higher than the women (29% against 19%).

General percentage (Row Conditioned Percentage)		Having a unique ticket for bus tram and train everywhere in Belgium					Total
		Superfluous	**Not important**	**An advantage**	**Important**	**Essential**	
Mode Typology	**Unimodal Foot and Bicycle**	0.06 0.51	0.29 2.54	3.79 33.5	4.94 43.65	2.24 19.8	11.32
	Unimodal Car and Motorbike	0.23 0.43	0.98 1.83	15.05 28.23	25.27 47.41	11.77 22.09	53.3
	Unimodal Public Transport	0.17 2.11	0.23 2.82	2.24 27.46	3.85 47.18	1.67 20.42	8.16
	Multimodal without Public Transport	0.17 3	0 0	1.84 32	2.99 52	0.75 13	5.74
	Multimodal with Public Transport	0.23 1.07	0.57 2.67	7.64 35.56	6.66 31.02	6.38 29.68	21.48
Total		0.86	2.07	30.56	43.71	22.8	100

The services and amenities can be ranked: The most important one is to have a seat, considered largely as important or essential. Then come the connections' information, the unique ticket and the peace and quiet on board that people are considering from an advantage to important (and even essential for the connections). The ticket inspector or the agent is less expected and the face to face seat and Wi-Fi are considered in 2007 as not important.

Variable	**Mean**	**Std Dev**	**Lower Quartile**	**Median**	**Upper Quartile**
A seat	4.28	0.71	4	4	5
Connections information	3.98	0.82	3	4	5
Unique ticket	3.86	0.82	3	4	4
Peace and quiet	3.81	0.76	3	4	4
Inspector or agent	3.47	1.01	3	4	4
Face to face seats	2.45	0.87	2	2	3
Wi-Fi	2.22	0.99	1	2	3

1 = Superfluous, 2 = Not Important, 3 = An Advantage, 4 = Important, 5 = Essential



With the last two subsections, the importance of the train in multimodal chaining (see the part of SNCB in our MPT category) has been reinforced by the importance accorded by people to services that help multimodal behaviours: For example, the bicycle and car park are 2 of the 3 services classified in majority as "essential" (with respectively 62% and 56% of the choices) in a public transport station. Quite the same high level of importance is accorded to information on board of vehicles about connections available at the arrival (45% for "important", 28% for "essential"; second position between services on board). Having a unique public transport ticket whatever the companies used is classified in third position with 44% for "important" and 23% for "essential". Theses illustrate how much the train management and promotion policies should be oriented to allow constantly better access opportunities (private and public), in the one hand, and be coordinated with others public transport companies, in the other hand.

2.2.2.4. *Policy Scenarios: The Stated-Preference Results*

This is the last section of the Web survey results launched by the team of the ULB in October 2007. The core of this section is the results of the stated preference experiment on mode choice. But before presenting them, we will have a look to three specific scenarios we present to the respondents. First, we ask them what they would do if they are having one car less in their household. Second, we ask the same question with one car more. Third, we propose people to exchange one car for a free access to the public transport.

One Car More, One Car Less: What Consequences?

Before presenting more complex scenarios to the respondents, we had asked them what could be consequences of having a car less or a car more in their household. The responses where partially open in both case which means that people can write a fourth category of answer that corresponds better to their choice. The first three categories were "I won't change anything", "I will combine car (as driver or not) and public transport" and "I will go with public transport" for the one car less scenario. In the one car more scenario, the last item was "I will use my car".

In the one car less scenario, fifty percents of the sample will not change anything. The score of this response rise up if people have more than one car in their household. The first category of report to be chosen is the public transport one (22%), especially amongst those who have only one car (27%). This could be an effect of the possible experience people have of the public transport. They already know how to use the public transport. The multimodal answer with public transport is the less chosen (12%) whereas a large emerging category appears: the pedestrian and cyclist one. This means that for about 17% of our sample, it is possible to go to their work by bicycle or by foot.

General percentage (Row Conditioned Percentage)		**With one car less in your household, will you change of transport mode to go to work?**				**Total**
		I won't change anything	**I will combine car (as driver or not) and public transport**	**I will go with public transport**	**I will go by foot or bicycle**	
Total number of private and company motor vehicle in the household	**1**	23.24 42.94	6.34 11.72	14.69 27.15	9.84 18.18	54.11
	2 or more	25.95 56.56	5.7 12.41	7.44 16.22	6.8 14.81	45.89
Total		49.19	12.04	22.14	16.63	100

Are people willing to keep their current mode if they have one car more? For 84% of the sample the answer is yes. It is also the case (82%) for those who do not have any private or company car in their household for now. Two persons over three amongst those who state that something will change are stating they will use this car. One person over three is stating they will combine private and public transport.

General percentage (Row Conditioned Percentage)		**With one car more in your household, will you change of transport mode to go to work?**			**Total**
		I won't change anything	**I will use my car**	**I will combine car (as driver or not) and public transport**	
Total number of private and company motor vehicle in the household	**0**	10.53 82.33	1.1 8.62	1.16 9.05	12.79
	1	40.3 84.9	4.63 9.76	2.54 5.34	47.46
	2 or more	33.35 83.91	4.96 12.48	1.43 3.61	39.75
Total		84.18	10.69	5.13	100

Exchanging a Car for a Free Access to Public Transport?

After this couple of scenarios, we have checked the acceptability of exchange policies that already exist: "Could you accept to exchange (one of) your private vehicle for a free access to the public transport network?" for the car owner; "Could you accept to exchange (one of) your company car for a free access to the public transport network?" for company car users.
About 48% of the respondents had rejected totally the proposition and 24% disagreed with it. Amongst those who benefit of a company car (we have asked them specifically an exchange of this company car, not one personal car even if they have one) the proposition "totally disagree" is selected by 66% of these respondents. At the opposite, we have to highlight that 5% of the personal car owners have answered that they "totally agree" with the proposition. This gives an estimation of the potential volume of such policy. Further than potential, we can also point the profile of the respondent interested by these. In this case, two figures had retained our attention: First of all, this exchange policy is better accepted by those who have a public transport experience (respondents with an urban destination or Brussels' intra-regional for example). The experience of the mode brings out specific clusters in the population such as households with only one car; these are one of the best targets for these policy measures even if they will have no car at all after the exchange.

General percentage	**Totally disagree**	**Disagree**	**Neither agree nor disagree**	**Agree**	**Totally agree**	**Active respondents**
Could you accept to exchange (one of) your private vehicle for a free access to the public transport network?	44.18	24.81	14.75	11.27	4.99	1322
Could you accept to exchange (one of) your company car for a free access to the public transport network?	65.67	17.54	8.96	5.22	2.61	268

Stated-Preference Scenarios

The stated preference (SP) scenarios were deeply presented in the methodological section (section 2.1.2.3.). Here you will find the main results. We have written them as simply as possible in order to be sure that non statisticians can understand them easily.

Let's reminder that: We have concentrated our scenarios on the home-work trips. The choice was binary: Car was proposed in the one hand; and public transport with or without combination with private transport was proposed in the other hand. The choice did not vary according to the current mode of the respondent. That means that pedestrians or cyclists did not have their current choice as an alternative in choice. This is one of our weaknesses but it was necessary to build a questionnaire not too complicated to implement on the Web. If we had added this alternative, we should have deleted it if the trip was too long to be realistic by foot (and it was judged too complicated by our partner Stratec). And if we did not delete it, we could have obtained unreliable responses. The latter was judged worse than do not taking into account of the pedestrian and cyclist.
The SP exercise was voluntary contextualized in Home-Work (HW) trip to maximize the reduction of the imaginary aspect in answering. But this also engages us to limit (or be really careful in) our generalisation to all-purpose trips. HW trips are repeated trips (we exclude respondents who work on different places every day) that are generally stabilized enough to generate habits, to implicate the use of season ticket, and so on. Furthermore the OD matrix is fixed (in short term at least; and expressively mentioned as fixed in our scenario) which is not necessarily true in other trips (here, there is no substitution possible of the origin and destination). So if some of our results could be extend to other contexts, we would generally call for caution in such an exercise.

Relevant Variables and Model Estimates

The characteristics of the mobility expressively taken into account in SP exercises are the origin and destination (same as the current ones), the time and its variability (the scenarios' text justifies variability due to the fluctuation of the traffic flow on both option and the waiting time for public transport option), the cost (expressed in fuel prices and percentage of variation comparing the actual one for the car option; expressed in cost per trip with a season ticket and percentage of variation comparing the actual one for the public transport option), the number of connection and the services (cash machine, bakery or none of these) you can find on your way. The logistic regression we built to highlight choices in SP scenarios was extended further than these scenario's characteristic. We also tried to integrate respondent's profile information (most of this information is also collected in the AB model diary that was presented before).

After the model selection and the pruning explained in the methodological part, our final logistic regression contains the following variables from the scenarios:

- The time and its daily variation: Both variables were the minimum and maximum time of each option (more importance seems to be given by respondent to minimum time in car option and maximum time in the PT/multimodal one). The four resulting time factors were continuous.
- The number of connection was taken into account as a discrete variable.

- The fuel costs were introduced as discrete variable to ensure the stability of estimates: During the survey time, the fuel cost increased. Consequently, before launching the Dutch speaking questionnaire (13 days after the French speaking one), we adapt the current cost in computation. This means that if we use the fuel costs as literally presented in the scenarios, the variable will contain linguistic and media information (during the first decade of October 2007, fuel costs increase appeared regularly on the front page of papers; so, it is possible that answering mechanism has been trouble by this). Then, the fuel information was introduced as its levels of variation which has been also presented literally in the scenarios.
- The public transport cost has been considered in the same format than fuel cost: the degree of variation.
- The services on the way were taken into account as discrete variables.

The additional variables retained in the final model were:

- The current mode use was introduced through our mode typology.
- The origin and destination were introduced through our correspondent typology but also through the estimated distance (continuous) and two variables containing the agglomeration or Province from and to which the respondent is moving.
- A binary variable about the current experience of connections was introduced.
- Finally, the potential mobility was introduced through two possession variables: having a bicycle in the household and having a company car in the household.

Furthermore, we also introduce interactions between the price variables and the correspondent mean time of the option.

The estimates of the logistic regression in the Annexe 4 are positive if the factor or the variable is positively correlated to the choice of the car option. When the coefficient is negative, the public transport option is positively associated to this level of the factor or to the variable.

In the following subsections we will present the specific results related to each of the variables of our final model. We will present these results referring to the variation of proportion of global choice in the one hand and referring to the estimates in the other hand.

The Effect of the Prices

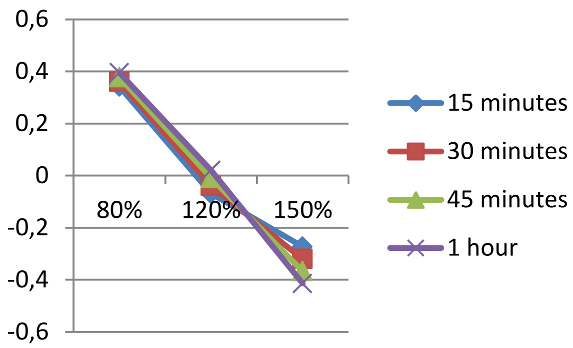
Let's begin with more popular effect: the effect of price. In our stated preference exercise we have mentioned the price as the fuel cost for the car option and as the price per trip with a monthly season ticket for the public transport option.

First, we can begin with a simple and direct question: What is the better policy to enforce sustainable development? Is there raising fuel taxes or according a free public transport ticket to workers? The next table illustrates these questions.

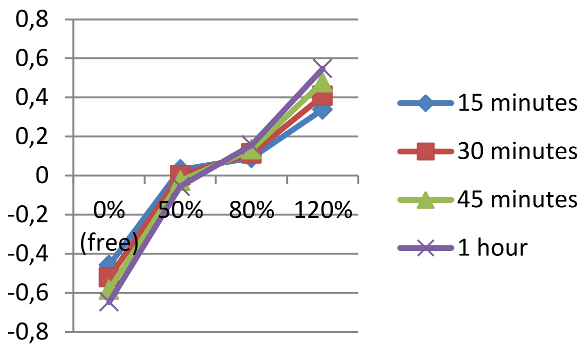
In the scenarios with maximum fuel prices (150% of the current prices), the proportion of choice for the car option decreases proportionally of 7.6% in the whole sample and of 6.5% and 8.9% amongst car current users, unimodal and multimodal.
In the scenarios with the home-work free ticket in the public transport option, the decreasing of the car option attains 17.7% (still proportionally to the initial percentage) in the whole sample, 14.2% amongst unimodal car users and 29.5% by the multimodal without public transport. These acknowledge clearly give advantage to the proactive measure of refunding public transport fees by companies and/or the State.
Nevertheless there exists one limit in this conclusion: The 150% level applied on the price of October 2007 is leading us not far from the cost of September 2008. But in September 2008 we do not observe such a change in mode choice. This could mean two things: first, that people overestimates their reaction in a stated exercise; second that the 2008 situation is not yet long enough to produce large scale changes in mode choice.

% of the subgroup (vertical) % of the initial percentage		**Mode DT**					All mode
Scenario	**Choice SP**	**Unimodal Feet Bike**	**Unimodal Car Motorbike**	**Unimodal PT**	**Multimodal without PT**	**Multimodal with PT**	
All scenarios	**Unimodal Car**	24.0	62.0	24.0	54.9	24.2	46.3
	PT/Multimodal	76.0	38.0	76.0	45.1	75.8	53.7
Scenarios with free ticket	**Unimodal Car**	15.6 -35.0%	53.2 -14.2%	18.1 -24.6%	38.7 -29.5%	18.0 -25.6%	38.1 -17.7%
	PT/Multimodal	84.4 +11.1%	46.8 +23.2%	81.9 +7.8%	61.3 +35.9%	82.0 +8.2%	61.9 +15.3%
Scenarios with highest fuel price	**Unimodal Car**	20.4 -15.0%	58.0 -6.5%	19.0 -20.8%	50.0 -8.9%	23.3 -3.7%	42.8 -7.6%
	PT/Multimodal	79.6 +4.7%	42.0 +10.5%	81.0 +6.6%	50.0 +10.9%	76.7 +1.2%	57.2 +6.5%

The previous conclusion is reinforced by the logit coefficients we obtained (plot on the left): 120% seems to be the threshold where the coefficients of the fuel prices are crossing the zero line. Over 120%, the PT option is dominant. We also see that the interaction with the time of the trip is mainly present over 120% also: People with long trip time are more sensible to the price at 150%.



Isolated coefficients of fuel prices
and their interaction with the mean time of car

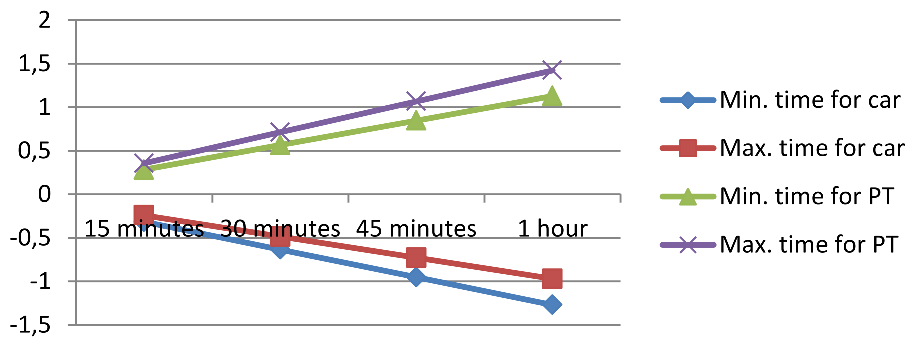


Isolated coefficients of PT prices
and their interaction with the mean time of PT

The price coefficients for the train option are less linear (plot on the right). Under 50% the train option is mainly chosen. Between 50 and 80% the price seems not determinant (see the Wald statistics in the table of coefficients) whereas the current price of public transport (around 100%) give the advantage to the car option. Again, the interaction shows that people with longer strip are more sensitive to the price than others.

The Effects of the Time

The time was studied through the length of the trip and its uncertainty due to the traffic and the waiting time. The next plot show how the time always disadvantage its mode: all coefficient of the car time are negative and all the PT ones are positive. This means that it is the comparison of both times that influences the respondent and not the time out of its context.
Another interesting observation about time is that the determinant time in PT is the maximum one whereas it is the minimum time which is considered for the car. The public transport seems to be evaluated with bigger prudence over time information than the car option.

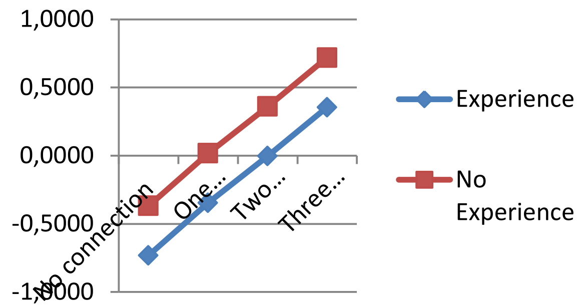


Isolated coefficients of time on a mean time based

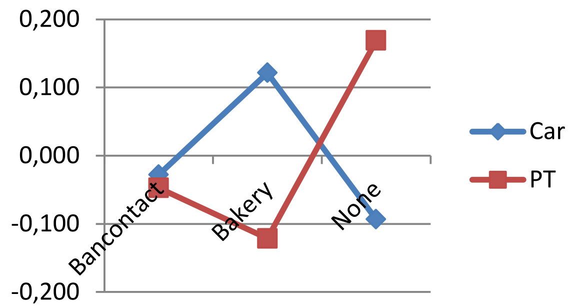
The Effect of the Connections

To investigate the connections' effect, let's go back to an analysis of the proportion of choice for each of the two options in the stated preference exercise. Despite the global bad image of the connections, some people are presenting a good "resistance" to them in our stated-preference scenarios. People who move inside the Brussels' regional space (the 19 communes for origin and destination) seem to have a larger resistance than all other groups (plot is in annexe 4). At the opposite, as soon as one connection appears in the scenario people who have their destination on a non-urban zone (Extra-urban) or in the Brussels' suburbs give their preference for the car option. The larger resistance of people who work in Brussels (whatever where they live) is pointing one of the geographic zone where the policy to encourage multimodality can be turned towards (notice however that multimodality is already more widespread there but this can be used as example for others). And at the opposite, these acknowledges engage us to recommend a quick development of sustainable mobility supplies oriented to the suburbs zones of Brussels like Zaventem, Waterloo or Lot.
Continuing with the stated preference scenarios' frequencies, the best connection with the previous illustration would be the same analysis on our mode typology (plot is in annexe 4). It shows indisputably how the current mode influence the answer mechanism in stated preference scenarios. People who currently use public transport (in a combination or not) are forming a group with pedestrians and cyclists (who have been confronted to a choice that not including their current behaviour) constantly at least 30% more favourable to public transport than people aggregated in category "multimodal without public transport" or "car only unimodal". As soon as one connection is introduced in the scenario, about 2 car-only users out of 3 choose to keep their current behaviour. At the opposite, even with 3 connections in the trip about two thirds of public transport users continue to choose the multimodal option against the car one. We cannot deny that some ideological influence has occurred in the answer mechanism even if we propose scenarios clearly favourable to the car option. Nevertheless this information argues one more time for adapted policies to the current usages instead of global policies.

The logit coefficients are indicating clearly the same direction. As you can see in the following plot (on the left), a scenario with no connection will always give the advantage to the public transport option. At one connection, the non experimented respondents begin to prefer the car option. The threshold for people who are currently experiencing the connections is at two connections. These facts urge us to recommend the reduction of the connection at one at the maximum to attract non users and at two to avoid losing the current users.



Isolated coefficients of connections and current experience of the connections



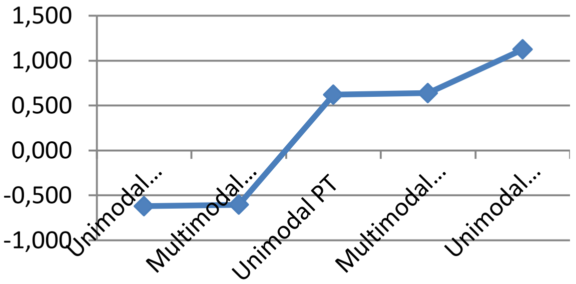
Isolated coefficients of the amenities on the way

The Effects of Amenities on the Way

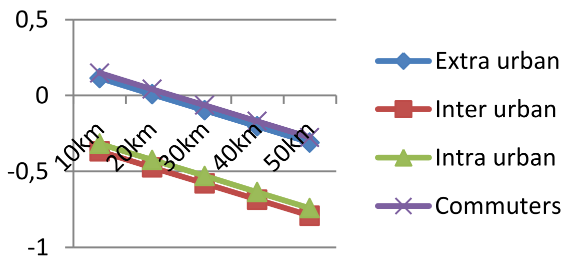
Can the presence of amenities on the way have an effect on mode choice? Regarding the logit coefficients, the answer is yes, at least for the bakery. The cash machine has no significant effect on the mode people are choosing but the bakery clearly advantages the mode where it appears; especially if it appears in the car option. Note that having no amenities on the way seems to disadvantage the PT more than having any amenities. This is not the case for the car. All these effects have been shown on the previous plot on the right.

The Effect of the Current Mode

We study the effect of the current mode through our mode typology. As illustrated above (on the left), the unimodal pedestrians and cyclists could be collapsed with the multimodal with public transport. These are the two mode types which are favouring the public transport option. Favouring at the same level the other option, the unimodal with public transport and the multimodal without public transport are composing another couple. Then, the unimodal car and motorbike are the mode type the most in favour of its own choice: the car option. Note that the effect of the current mode (through our typology) is the most significant effect in our logit regression.
The surprise here comes from the effect of people who are using the public transport without connections (UPT) which gives the advantage to the car option. It could be a side effect of the overrepresentation of the scenario with connection (3 over 4 in mean) comparing to their current use which is largely with no connection.



Isolated coefficients of the current mode



Isolated coefficients of the origin destination and the distance

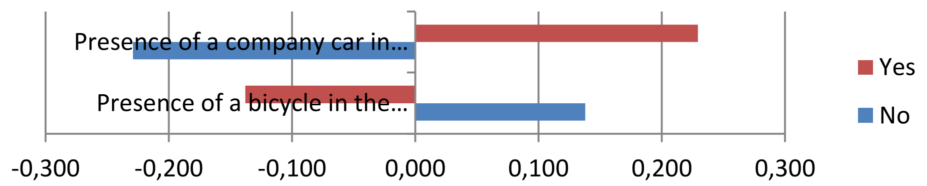
The Effect of the Origin and the Destination

The distance between the origin and destination is clearly in favour of the public transport option. This is reinforcing the facts exposed before: short trips are rarely done by public transport; a significant part of the longest trips are Inter urban in Belgium; and the latter category is clearly in favour of the public transport.
The Intra Urban are the others choice makers of the public transport option. Both categories are choosing mostly this option, whatever the length of their trip. Under 20 to 25km, the joint coefficients of the distance and the Extra Urban and Commuters are in favour of the car option as you can see on the previous graph (on the right).

In the annexe 4, a plot is illustrating the origin and destination (OD) coefficients according to a finest typology. There we have separated the urban area from their province based on the work of Luyten and Van Hecke (Luyten, Van Hecke: 2007). We can easily see that almost all the provinces out of their urban areas are favouring public transport option which is quite unexpected because of their extra urban character. Amongst the cities, it is difficult to highlight a trend. Nevertheless we kept this variable in the model because of its important effect on the likelihood; we can consider it as random slope effect which takes into account the specificities of the OD areas.

The Effect of the Bicycle and Company Car

Last but not least we suspected an effect of the presence of some vehicles in the household. It was significant for both of them: the bicycle and the company car. Not surprisingly, the presence of a company car is largely favouring the car option. Less clear a priori, the presence of a bicycle in the household is favouring the public transport one, maybe for a multimodal use.



Isolated coefficients of the presence of company car and bicycle in the household

Hierarchy of the Effects

The following table present two relative hierarchies of the effects we just present. Both have their own legitimacy and it is not possible to give only one order. Then, the interest is to compare and observe the redundancies.
The first one is based on the global Wald statistic that is testing the hypothesis that a variable have no effect at all. The first variable in that hierarchy is the one that reject the most this hypothesis and so on.
The second hierarchy is based on the Stepwise algorithm largely used in the literature to make a selection between the variables of interest. The algorithm begins with an empty model and adds or deletes successively variables step by step.

To enter in the model, a variable should inform on something that is not already explained by another variable which is in. Then, the second hierarchy informs on the key variables to keep in order to conserving the largest view of what is going on.

Rank	1	2	3	4	5	6	7	8	9	10
Wald Chi-Square based hierarchy	Mode typology	Connection in the scenario	Maximum time for PT	Minimum time for car	Presence of company car	Minimum time for PT	Experience of connections	Maximum time for car	Origin destination distance	Presence of bicycle
Stepwise algorithm based hierarchy	Mode typology	Connection in the scenario	% of varia. of PT cost	Home city or Province	Minimum time for car	Minimum time for PT	% of varia. of fuel cost	Presence of company car	Experience of connections	Work city or Province

Rank	11	12	13	14	15	16	17	18	19
Wald Chi-Square based hierarchy	% of varia. of car cost	% of varia. of PT cost	Amenities PT	Amenities car	Interaction time and PT cost	Home city or Province	Work city or Province	Origin destination typology	Interaction time and car cost
Stepwise algorithm based hierarchy	Maximum time for PT	Maximum time for car	Origin destination distance	Amenities PT	Presence of bicycle	Interaction time and PT cost	Amenities car	Origin destination typology	Interaction time and car cost

2.2.3. Policy scenario's of the activity-based transportation model

2.2.3.1. Feasibility analysis

In the context of this project, a detailed feasibility analysis with respect to the different policy measures that can be assessed by means of an activity-based transportation model has been carried out (see section 2.1.2 for the methodological discussion of this model). We found that the detailed measures that can be found in different policy plans and that can be evaluated by means of an AB model can be structured along 5 broad categories:

- Changes in socio-economic and demographic characteristics
- Changes in institutional constraints
- Changes in spatial characteristics
- Changes in multimodal transport network characteristics
- Travel costs and travel times

Changes in socio-economic and demographic characteristics

Socio-economic and demographic variables constitute key input variables in activity-based travel demand models. Therefore, these models should be sensitive to changes in economic factors and to population developments. Factors that are typically subject to changes include:

- Composition of the labour force, e.g. increase in the number of women in the labour force.
- Household composition, e.g. increase in the number of one-adult households, decrease in the average household size or decrease of the share of households with children.
- Household income, e.g. increase in the household income due to economic growth.
- Composition of the population, e.g. ageing of the population.
- Car ownership, e.g. increase in the average number of cars per household.
- Population and employment totals.
- Employment distribution.
- Employment status.

Changes in institutional constraints
Institutional variables, such as opening hours of shops and public services, determine time windows within which these activities need to be executed, and thus influence the structure of activity-travel patterns. Changes in institutional constraints contain changes in:

- Opening hours of shops, e.g. change in the law fixing the allowed number of opening hours of shops per week. Possible scenarios include both widening and shortening of opening hours.
- Schedule-skeletons, e.g. changes in work times by altering the structure of the workweek from 5 days of 8 hours to 4 days of 10 hours or by delaying or advancing the start of the working activity.

Changes in spatial characteristics
Spatial variables also play an important role in determining travel based on individual activity patterns. In particular, changes in land use characteristics and spatial distribution of facilities cause changes in activity-travel behaviour. Spatial scenarios include changes in:

- Spatial distribution, e.g. increasing spatial separation of locations for residence, work and other facilities.
- Household distribution per zone, e.g. de-urbanisation.
- Employment distribution per zone.
- Person distribution per zone
- Land use development.

Changes in multimodal transport network characteristics
It is not unrealistic to assume that individuals' activity-travel sequences are susceptible to changes in transport network characteristics, as they directly influence the individual perception with respect to different travel modes. Various changes can be recorded in activity-based travel demand models:

- Costs, e.g. parking pricing in the form of incremental parking surcharge at work place, congestion pricing during peak periods along commute routes or increases in fuel costs, tolls, taxes, employer reimbursement schemes or other car-related costs.
- Service levels, e.g. improved bicycle/pedestrian facilities, including well-marked and well-lit bicycle paths and sidewalks and secure place to park a bike, or new transit routes or transit stops, or improved public transportation facilities (e.g. increased public transport speed) or rideshare programmes (e.g. High Occupancy Vehicle [HOV] or High Occupancy Toll [HOT] lanes).
- Transit fare policy.
- Travel time, e.g. increase or decrease in (car) travel times.

Travel costs and travel times
With respect to travel costs and travel times, one could for instance evaluate the impact of a fuel price increase; congestion pricing schemes and the like. It is also possible to evaluate the impact of an increase in service of a better public transport system, for instance by means of the shortening of travel times.

Of course, it is not possible and it was also not our purpose in this project to evaluate all the possible identified scenarios in detail, since significant (fundamental) research with respect to the other research tasks had to be done in order to make the model operational (see methodological section). The above list should therefore be considered as a feasibility analysis with respect to the different measures that can be assessed though. A case study of a possible scenario that can be carried out will be briefly shown for the matter of illustration. Other detailed scenario's can be easily computed now that the methodology is stable by the end of the project.

For the matter of illustration we will show the application of the model for a scenario which belongs to the first category that was outlined above: i.e. Changes in socio-economic and demographic characteristics. It is important to note however in the section below that model results/outcomes should never be interpreted exactly, but should rather be used for trend/indication evaluations.

2.2.3.2. Case study

In terms of population developments, there are several trends going on in several western countries. In 2000 compared to 1995, for example, a number of changes related to attributes on household and person level took place and is still ongoing. These include for instance the labor participation of women. In this scenario we assumed that the size of the work population in the age category of 15 – 64 increased with 10% (for men) and 22% (for women). Compared to 1975 the female labor participation almost doubled (Arentze, 2004).

For this scenario we assumed the following (based on small literature review):
-in 1995 approximately 2.2 million of the women has paid work.
-approximately 50% of these women has a part time job.
-an increase of working women from 2.2 to 3.8 million (i.e., an increase of 54%) -a decrease of the fraction of part time workers from 50 to 25%.

The scenario was implemented by changing the demographic data in the population synthesis model. That means that the above-mentioned changes were implemented for each of the zones in the model. It is worth noting that the fitting procedure is constrained only by work status and age group of individuals meaning that distributions of children, car possession and socio-economic class may change in the synthesized population simultaneously, as an indirect effect of the scenario.

Detailed results of this case study (see also Arentze, 2004) are shown in the tables below to give the reader a good overview of the output variables that are generated.

As expected, the biggest change concerns the work-status distribution. The number of full time workers increased with more than 30% and the number of part time workers decreased with approximately 20%.

Total		Number	Number
Person	no	117361	-15.58
work status	part time	22543	-18.97
	full time	70262	31.32
	MISSING	0	
	Total	210166	-0.27

At household level, the number of single-adult, single-worker households increased with approximately 30% and the number of double-worker households increased with more than 40%. The total number of households has not changed.

Total		Number	Number
Househld	si,0-w	24746	-26.17
compos.	si,1-w	24174	29.13
	do,0-w	30295	-11.22
	do,1-w	32025	-15.65
	do,2-w	18303	42.88
	MISSING	0	
	Total	129543	0.00

In addition to these direct effects of the scenario there are also some indirect effects. Whereas the age distribution has stayed approximately the same, the number of households without children has increased with more than 4%. In particular, the number of households with young children (younger than 6 years of age) has declined. Also, economic consequences are noteworthy. Car possession increases, as the number of households without a car increased with approximately 6% and the number of households with two cars or more increased with approximately the same proportion. Finally, we see a decline of the number of households in the low socio-economic group of almost 20%. All these direct and indirect effects seem realistic for the scenario considered. Again, it is important to recall that since we are interested in sensitivities rather than actual predictions (exact values), the actual sizes of the changes assumed are not always realistic but give an indication. A model output should never be interpreted as an absolute exact change, rather than a trend/indication (e.g. positive versus negative trend).

Total		Number	Number
Househld	No child	92179	4.21
childr.	< 6 yr	18417	-16.15
	6-12 yr	10561	-7.74
	> 12 yr	8386	-1.03
	MISSING	0	
	Total	129543	0.00

Total		Number	Number
N cars	no car	32843	-5.80
	one car	79517	1.12
	2 or more	17183	5.92
	MISSING	0	
	Total	129543	0.00

Total		Number	Number
Househld	Min	20282	-18.06
SEC	Low	14291	0.77
	Medium	51771	8.04
	High	43199	-1.41
	MISSING	0	
	Total	129543	0.00

The predicted consequences of these changes on system performance are represented in the table below. These are also the main outcomes of the transportation model. As it appears, the total distance traveled has increased with 7.4%. The shares of different transport modes in the total distance traveled changed only slightly. The share of car and slow mode has reduced (with 1% and 3%) and the share of public transport has increased. The number of trips virtually has not changed. A modest increase in the ratio between number of trips and number of tours, however, indicates a slight increase in trip chaining. The increase in travel distance combined with a constant number of trips means that the average trip length increased while the number of activities has stayed the same. The explanation for this finding can be found in the distribution across activities that is also represented in the table below. The distribution reveals an increase in work trips of 16%, which is a direct consequence of the increase in number or workers. At the same time, the total number of activities has virtually stayed the same meaning that the frequency of non-work activities has decreased. The main contributors to this decrease are school, bring/get, non-leisure (i.e., voluntary work) and shopping and service-related activities. In sum, the increase in work activities entails a decline in non-work activities with as a result that the total number of out-of-home activities stays approximately the same. Since work trips tend to be long trips, the substitution causes an increase in average trip length.

Total(Total)		Value	Value
Total travel time		13520408	6.06
Total car travel time		6226319	3.46
Travel time ratio car-public		1.536	-7.60
Travel time ratio car-slow		1.922	-0.16
Travel time ratio car driv.-pass.		6.606	6.81
Number of tours		361512	-1.12
Number of trips		897969	-0.50
Ratio trips-tours		2.484	0.63
Ratio single stop tours - all tours		0.686	-0.97
Nof unknown trav. time trips		5509	13.07
Total travel distance		10437553	7.39
Distance ratio car driv.-total		0.613	-1.08
Distance ratio car pass.-total		0.089	-8.05
Distance ratio slow-total		0.056	-2.95
Distance ratio public-total		0.242	6.36
Distance car (driver)		6397328	6.24
Total		Number	Number
Act. type	Workout	84928	16.04
	Schoolout	8382	-8.71
	BrngGet	87621	-5.95
	Non-Ls	17543	-7.80
	Grocery	88265	-2.11
	Service	17405	-2.92
	Non-groc	34557	-5.64
	Social	76659	0.52
	Leisure	85483	-0.97
	Other	35614	-5.60
	Total	536457	-0.08

Related to his, there are several changes in other choice facets. With regard to time of day, we see an increase in early morning and evening activities, which may induce an increase in travel during peak hours. A modest decrease in the number of single trips is consistent with the slight increase of the trip/tour ratio that we saw earlier. With regard to mode choice we see an increase of car (1.7%) and a stronger increase of public transport (almost 10%). As these modes are typically long-distance modes, the increase in average trip length can explain this change.

Total		Share	Share
Act.	< = 10 am	0.239	5.02
begin time	10-12 am	0.166	-4.22
	12-2 pm	0.155	-3.87
	2-4 pm	0.15	-4.67
	4-6 pm	0.115	0.00
	> 6 pm	0.174	5.17
	Total	536457	-0.08

Total		Share	Share
Act.	Single	0.463	-2.16
trip pattrn	After	0.211	1.42
	Before	0.211	1.42
	Between	0.115	4.35
	Total	536457	-0.08

Total		Share	Share
First	Car	0.422	1.66
tour mode	Slow	0.44	-2.73
	Public	0.061	9.84
	CarPass	0.07	-2.86
	Unknown	0.007	14.29
	Total	361512	-1.12

One can conclude that, in the predictions, the increase in work activity frequency results in a less than proportional increase in the volume of traffic generated. Partly, this is due to the fact that work reduces the time available for other activities and for another part the absence of children in an increasing number of households means a reduction in activity generation. Because car possession increases, the new work trips within households can be conducted by car. In a scenario where car possession is kept constant, an increase in work activity would lead to a reduction in the proportion of distance traveled by car and probably to a smaller increase in total distance traveled.

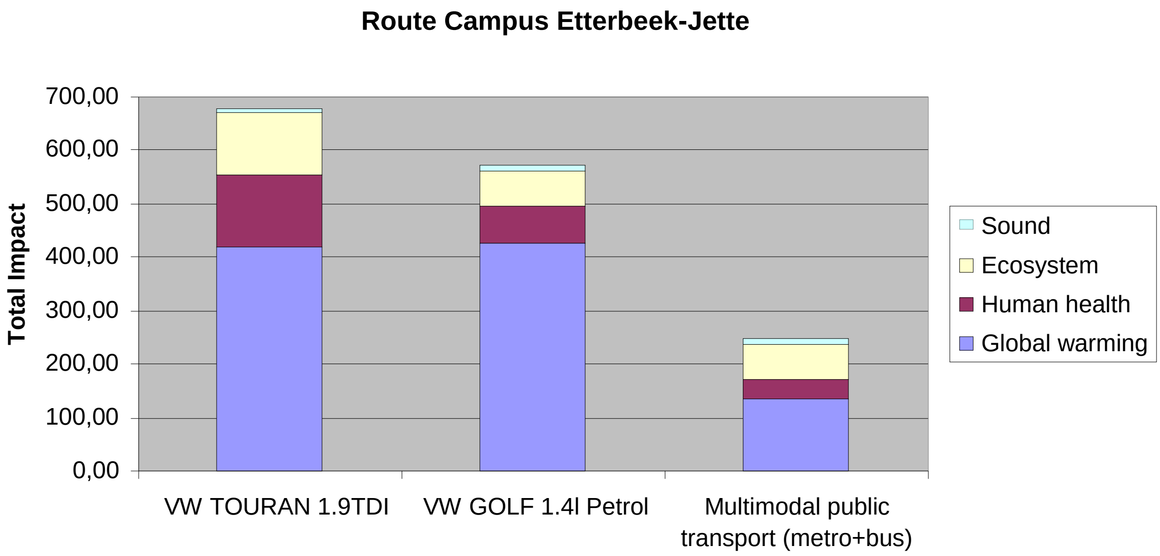
Obviously, those results are only shown as a case study (Arentze, 2004) to show and illustrate the possibilities of an activity-based model. Other additional policy measures as identified in section 2.2.2.1 of this report can also be calculated.

2.2.4. Application of the adapted emission model and its assessment of multimodal transport. Illustration of methodology about of costs and benefits.

In section 2.1.3. the adapted EcoScore indicator and the total impact (TI) per passenger transport mode were illustrated.

As an example of an application of this novel indicator the environmental impact of travelling from our University in Etterbeek to the other Campus in Jette is simulated. This route is possible by mains of different public transport modes or by a private car. The multimodal public transport mode goes from Etterbeek to Simonis by Metro, from Simonis to Etterbeek by public bus. This route is also simulated with a small diesel and petrol private passenger car. The results of the Total Impact (TI) are shown in the next Figure.

Figure : Environmental assessment of OD-relation Campus Etterbeek-Jette



In addition to the environmental assessment, a first general scheme for assessing possible costs and benefits was prepared. During the process the general scheme was adapted using feedback from the user committee. The final list is divided into three main types of effects: direct effects, indirect effects and external effects. Depending on the value of the effects (negative or positive) they will influence the net result differently. This allows for more flexibility and a better representation of the effects, offering a better view and understanding of the whole. Below an overview is presented of the effects in this main structure:

- Direct effects
  - *Investment costs (vehicles, materials, roads …)*
  - *Exploitation costs (maintenance, drivers…)*
  - *Consumer surplus (includes service level, public acceptability)*
  - *Producer surplus (for instance more ticket revenue)*
  - *Taxes*

- Indirect effects
  - *Included in direct and external effects*

– External effects
  - *Pollution (PM10 and Climate Change)*
  - *Noise emissions*
  - *Accidents (road accidents, traffic safety, operating accidents)*
  - *Space availability, separation, nature and landscape*
  - *Congestion (opportunity cost)*
  - *Up- and downstream processes (for instance nuclear power risk for electricity for electric trains, or energy losses during transport)*

In order to perform a social-cost benefit analysis, all effects are to be measured and calculated using a monetary value. Key figures are used to calculate and monetarize the effects of the indicators. For the collection of these key figures, we used the data from the INFRAS research and their updates (Schreyer et al., 2004), also key figures from the UNITE research (Henry and Godard, 2002; Bickel et al. 2003) were used. We also took a look at the study for Flanders about internalisation of external costs made for MIRA (De Ceuster, 2004) to compare our calculated values from the key figures, they show a similar magnitude. All those monetary values are also brought back to one certain start point using a deflator form the National Bank of Belgium. This replaces nominal prices with real prices. Below an overview is given of the key figures that can be used to perform an actual social-cost benefit analysis:

Passenger km effects per mode in 2005 € value

Costs (-) / Benefits (+)	*Unit*	*Unit cost in prices in 2005 €*
Infrastructure		
Infrastructure costs road	€/pkm	0,017291
Infrastructure costs rail	€/pkm	0,194112
Infrastructure costs bus, tram	€/pkm	0,078408
Exploitation		
Exploitation cost rail, supplier variable operating cost	€/pkm	0,314665
Exploitation cost bus and tram, supplier variable	€/pkm	0,381501
Exploitation cost car	€/pkm	0,198735
Taxes and charges, revenues		
Revenues car	€/pkm	0,074671
Revenues rail	€/pkm	0,212671
Revenues bus and tram	€/pkm	0,152168
Subsidy		
subsidies rail	€/pkm	0,248462
subsidies bus and tram	€/pkm	0,107246

External effects		
Marginal pollution costs car (all techniques, total)	€/pkm	0,042477
emission factor PM10	€/pkm	0,024073
climate change €20 / t CO_2	€/pkm	0,003119
nature and landscape	€/pkm	0,001170
space availability	€/pkm	0,001192
separation	€/pkm	0,010694
up- and downstream processes	€/pkm	0,002228
Marginal pollution costs urban bus (all techniques,	€/pkm	0,026792
emission factor PM10	€/pkm	0,019762
climate change €20 / t CO2	€/pkm	0,001560
nature and landscape	€/pkm	0,000000
space availability	€/pkm	0,000123
separation	€/pkm	0,002451
up- and downstream processes	€/pkm	0,002896
Marginal pollution costs rail (all techniques total)	€/pkm	0,010438
emission factor PM10	€/pkm	0,005681
climate change €20 / t CO2	€/pkm	0,001003
nature and landscape	€/pkm	0,001337
space availability	€/pkm	0,001192
separation	€/pkm	0,000000
up- and downstream processes	€/pkm	0,001225
noise costs car (all techniques)*	€/pkm	0,005793
noise costs bus (all techniques)*	€/pkm	0,001448
noise costs rail (all techniques)*	€/pkm	0,002005
Traffic safety		
Marginal accident cost car (medium traffic flows mean)	€/pkm	0,082013
Marginal accident cost bus (medium traffic flows	€/pkm	0,002674
Marginal accident cost rail	€/pkm	0,000412
Congestion cost		
Marginal congestion cost car	€/pkm	0,088580
Marginal congestion cost bus	€/pkm	0,012610
Delay cost train	€/pkm	0,000407

3. POLICY SUPPORT

The Estimate project contained a high number of tasks which resulted in significant output that can be used for policy support. The main outcomes are listed below.

The first policy support outcome can be made with respect to data collection.

Methodological recommendations of the data collection

Paper-and-pencil versus PDA

During the Estimate project, results of an activity-travel survey which was conducted, using GPS-enabled personal digital assistants (PDA) and paper-and-pencil diaries, was presented. The data were collected in the context of the development of the Feathers model, a dynamic activity-based model of transport demand for Flanders. A custom GPS-enabled PDA-based activity-travel survey tool, PARROTS, was developed and the quality of the obtained trip and location data was investigated.

The PARROTS response rates were investigated and compared with the response rates using the paper-and-pencil tool in order to check whether a negative attitude towards the use of PDA technology exists or a higher burden is experienced in using the tool. It was found that the response rate for PARROTS was only slightly lower than for the traditional approach during the recruitment process. However, during the survey period fewer drop-outs were registered in case of the PDA survey, indicating that the burden for filling in this kind of survey is lower in comparison with the paper-and-pencil approach.

During the survey, the reported number of executed trips was more stable throughout the survey and on average more trips per person were reported for surveys using PARROTS.

The analysis of the data quality of the GPS logs in terms of the number of logged NMEA strings showed an attrition of the total number of NMEA strings logged as survey days pass. This is caused by respondents dropping out of the survey on the one hand and by a decrease of the number of logged NMEA strings per person starting from the fifth survey day on the other hand.

The analysis of the data quality of the GPS logs in terms of the fraction of NMEA strings containing location information versus the total number of logged NMEA strings showed that the data quality increases as more survey days pass. The evolution of this fraction as a function of time of day was correlated to the usage pattern of the PARROTS tool.

It was found that during slightly over half the total reported trip time no GPS logs were available. This phenomenon can be attributed to failure of the respondents to use the PARROTS tool, but also partially by errors in reporting trip start and end times.

Analysis of the PARROTS activity patterns revealed the use of PARROTS as an in the field activity and trip registration tool, although this modus operandi was on a voluntary basis.

Considering survey technology, important advantages of PARROTS over paper-and-pencil are the availability of detailed replanning and location (GPS) information, the checks on the data leading to higher data quality and the immediate electronic availability of the data.

If the results of this study are replicated in future similar research, these findings illustrate the potential advantage of using instruments such as PARROTS in order to obtain location and trip information during surveys; concepts which are of crucial importance to accurately model multimodal travel behaviour.

Internet questionnaire

Studying the specificity of the problem of multimodality was the greatest challenge of the Web survey. The lack of definition and possible interpretations of multimodality itself was a problem to construct the questionnaire. We have chosen to define the concept as broadly as possible. This choice was a good one since it was reinforced by the responses: 106 different combinations were stated by the respondents! On the connections' side, the same complexity is observed: respondents who are changing of mode with one branch in public transport (PT) have a different perception (and different estimates in the logit regression for example) than people who are changing of vehicle within the same transport company.

Observing that, we recommend to adapt some of the typologies developed in this project which deal with multimodality. For the mode typology, we recommend to add a sixth mode type resulting from the split of the Unimodal with public transport, separating the real unimodal one (unique vehicle) of those who state one (or more) connection(s). For the origin destination typology: we conducted some specific analyses on Brussels and we had developed subtypes based on the specificity of the Region and its suburbs. These adaptations should be kept in mind if you plan to focus on a specific environment.

On the stated preference exercise, we recommend to be careful with the choice of the options you let open (in our case: car and public transport) and the prior utility function.

Concerning the options, we had difficulties to select where to stop in designing the stated preference experiment: adding or not a bicycle option; splitting the public transport option in a unimodal and multimodal one? We decided not to conduct these type of analyses in the current project but it could be interesting to investigate this in detail to evaluate what the consequences of this kind of choices is.

Concerning the prior utility function, most of the interactions selected were not significant. This means that we have been a little too conservative. But the experimental design literature illustrates that a too complex design is better than a too simply one, even the best design is always the one that corresponds the most with the final model. To this end, we recommend there to keep the alternative we choose.

We can also make other methodological recommendations concerning the choice of the Internet as the unique administration mode of the stated preference survey. As we presented in section 2.1.2.1., the choice of Internet had implied restrictions on our population of interest.

Even if Internet is well widespread now, unemployed, retired people and some other strata of our population stay less reachable through this media. Thus it seems really important to take this into account before choosing the administration mode. In ESTiMATE, we found a solution by centering our interest on home work trips which exclude these less reachable populations.

Furthermore it should be taken into account in research budgets that reaching people for an Internet survey is certainly not a cheaper solution. If one wishes to guarantee a predicted representativity, one should have access to a representative database from which one can make a rigorous sampling. In ESTiMATE, we found a way out by focusing on responsiveness and acceptability of subgroups, described mostly by descriptive statistics.

On the positive side of these conclusions, the Web survey is advantageous for its rapidity and the absence of coding problems. Within 7 days using the private database, we got 1383 Dutch speaking respondents (1216 were valid in fact). With the daily paper promotion and mailing, we got 1065 French speaking respondents (658 were valid) in about 40 days.

In both cases, the biggest advantages of Internet surveys are the absence of coding problems and the absence of transition time between the end of the data collection and the beginning of the analyses.

Another advantage of Internet survey (and more largely: computer based questionnaires) that we can confirm is the wide flexibility of the method: Avoiding complex question with "if-clause"; dynamic adaptation of the questions using the previous answers in order to increase the precision of the information gathered.

Scientific recommendations of the data collection

For the Web survey analyses, we defined the multimodality as the combination of modes and/or vehicles within the same origin destination trip. 27% of our sample is multimodal with a change of mode and 53% of the unimodal users of public transport are stating they have at least one connection. Then we got about 32% of multimodal users in our sample. Several findings were reported in this project. First, the multimodality is complex and cannot be resumed in a few figures. We observed 106 different combinations. Second, multimodality is more widespread within the long distance and Brussels is mostly the destination of this kind of trips. Third, all people with the same kind of combination are not acting in the same direction (see for example the differences between people who change of public transport within the same company or not). This implies that policy strategies should have a high level of adaptation or you should be aware that resistances will be different within the same groups of practice. Fourth, some multimodal type (like the combining the bicycle) are regionally marked and cannot be extended to other regions as easily.

Furthermore, we investigated in this project the perceptions and apprehensions of the connections. Connections are a loss of time; quite everyone agrees with that. On the fact that they are perceived as too long, people who do not experience them give no clear answer.

Multimodal users agree the proposition and the ideal connection time is 5 minutes between two busses while it is 10 minutes as soon as one of the modes connected is the train. For non users, connections are stressful moments and the car users consider the most that they cannot do anything during the connections.

Next, we tried to investigate in this project if the services and amenities in the stations, on board of the vehicle or simply somewhere on the way could reinforce the connections acceptability. The reinforcement is not clearly demonstrated but we obtain two interesting rankings of these services: In the stations, people are expecting the most to find a parking for bicycle, then water closed, parking for cars, a ticket office open and roof and benches on the platforms. The first ranked amenity is the newsstand. More details were shown in the report. On board, the first expectation is to have a seat. The second and third expectations are to have information on board about the connections at the arrival and to have a unique ticket for all the public transport companies. Both high ranked services are fully connected to the main content of this project: multimodality. Further expectations and details are shown in the report.

Finally, we asked people to sketch their ideal transport mode. The best median transport mode for everyone is rapid, flexible (go whenever you want) and punctual. Then the security and the reduced cost are expected as well as being seated comfortably and having no connections. The interesting conclusion here is that rejecting the connection arrives only on the seventh position over ten.

Finally, within the stated preference exercise and some previous questions, we tried to model the responsiveness of people with respect to sustainable policies. Therefore we asked people what they would do with one car less in the household. Two responses should be highlighted: First, 12% stated they will combine private and public transport mode. In other words, they will become multimodal. Second, 16% stated they will go to their work by foot or by bicycle. This indicates that 16% of the respondent are living close enough to go to work by foot or bike but are using their car. This urges us to recommend reinforcing the policies in favour of the pedestrian and cyclist mode choices. We also investigated the response rate we can expect from exchanging policies (car for a season ticket). About 5% of car owners and only 2.6% of the company car owners are totally in accordance with the proposition.
The stated preference logit model is reinforcing one well known acknowledgement: the current mode is hard to change. The connections presented in the scenarios are the second most determinant variable. The others conclusions we could remind you to conclude this report is that the public transport option is always evaluated with more precaution than the car option. The effects of the concept of time illustrate it well: minimum (best) time is evaluated in the car option; maximum (worse) time is evaluated in the public transport option. And, last but not least, analyses led us to the conclusion that the best price policy seems to be the refunding one (refunding the public transport ticket at 100% by the government and/or the employer) instead of increasing the fuel taxes.

Activity-based modelling and its assessment of policy scenario's

Secondly, we can conclude that one of the major promises and reasons for existence of the activity-based modelling approach is an increased sensitivity for scenarios that are generally important in transport planning and policy making. In contrast to trip-based and tour-based models, activity-based models are sensitive to institutional changes in society in addition to land-use and transportation-system related factors. Activity-based models are sensitive to several groups of travel demand management strategies, including: population, schedule, opening-hours, land-use measures as well as travel costs and travel times scenarios. An example and simulation was tested using a novel synthetic population generation in the context of labour participation of women, but other applications are also possible. The most important recommendation is that the activity-based approach was adapted and that it can be used for the analysis of multi-modal transport decisions.

Integrated emission modelling and cost-benefit analyses

Finally, using the integrated methodology that has been developed within ESTIMATE, one is able to analyse the energy and environmental impact of multimodal passenger traffic and compare the different transport modes on a well-to-wheel basis. An example has been simulated and the total impact of such a scenario can be calculated.
Furthermore, it should be pointed that a cost-benefit analysis considers all present and future, favourable and unfavourable effects the members of society might encounter as a result from a project, plan or policy measure by expressing them in monetary values. It is based on the willingness to pay of the members of society: how much do they want to pay to receive a certain benefit or to avoid a certain downside? In case the balance of the benefits and costs is positive, then the project, plan or measure contributes to the societal prosperity. The SCBA can be used for grounding investments in transport projects as well as for choosing the most desirable project alternative. In any ways, its support to the decision is informative. The policy maker should combine the conclusions of the SCBA with those of other studies in order to make a balanced decision. The methodology and standard passenger km effects per mode that were shown in this report can be used to guide policy makers and help with this decision making process.

4. DISSEMINATION AND VALORISATION

The relevance of the contribution of this project is underlined by an important trend that can be observed at an international level, namely the employment of activity-based transportation models to lend a support to and as an evaluation instrument for a particular pursued policy (which aims to reduce negative effects of transportation such as traffic unsafety, emissions, congestion, etc.) or to evaluate a scenario (like we did in the Estimate project). In order to effectively implement and analyze policy objectives, an increasing amount of awareness is needed with respect to the need for an improved understanding of travel behaviour. Obviously, the four-step methodologies that are adopted both in Flanders and worldwide are in nature network-models which can be used to focus on policies of infrastructure expansion. However they embody a rather poor behavioural representation of travel behaviour mechanisms. Specifically the fact that the focus of these models is on individual transfers, neglecting the temporal and spatial relations and constraints that exist between the different trips as well as known aggregation biases, which arise due to the fact that not the individual travellers are simulated in the models (i.e. microsimulation is not used as technique), arises a lot of discussions. These arguments were not only suggested by scientists. People who use these models in practice also expressed their concerns. The Mobility Plan Flanders is one of the policy based documents expressing this point of view, mentioning explicitly that its static character and the lack of a feedback mechanism (thus the lack of temporal relations) are serious shortcomings of the traditional techniques of modelling traffic (see also the original project description for a discussion of current pitfalls and identified problems).

All these scientific and more practice-oriented concerns resulted in a need for travel demand models that embody a more realistic representation and understanding of the decision-making process of individuals and that are responsive to a wider range of transport policy measures. This is where tour-based models (often adopting a microsimulation approach, thereby simulating every individual but maintaining the quite straightforward simple structure of four-step models) or more advanced models activity-based models come into play.

In the United States, the use of transportation models to back up transportation policies even became required by law. But also in Europe, a similar trend can be observed. In the Netherlands, the directorate-general of the Ministry of Transport and Public Works supports fundamental research for activity-based models. Comparable initiatives have been set up in Switzerland, Sweden and Denmark. Other countries are likely to follow rapidly, witnessing the steady increase of interest in the community in large transport conferences all over the world.

A useful reference in this respect is the online TDM encyclopaedia (http://www.vtpi.org/tdm/) where an enormous list of policy measures has been identified. While not all measures listed there can be easily calculated by means of an activity-based model, the application area is still huge, as can be seen from the following list of policy measures with a possible application area of an activity-based model.

The application within an AB model has been structured along 5 broad categories: (1) Changes in socio-economic and demographic characteristics; (2) Changes in institutional constraints; (3) Changes in spatial characteristics; (4) Changes in multimodal transport network characteristics; (5) Travel costs and travel times. Those application areas were also identified in the Estimate project.

IMOB is coordinator of two IWT-SBO projects: "An activity-Based Approach for Surveying and Modelling Travel Behaviour"; and "A Model-Based Approach for Evaluating the Safety and Environmental Effects of Traffic Policy Measures". The principal objective of the latter project is still being executed at this moment, and it concerns the development of a framework for the evaluation of traffic policy measures on road safety, the environment and human health.This framework will develop and integrate different sub-models, e.g. an activity-based transportation model, an agent-based traffic assignment model, and an emission, dispersion and exposure model (with emphasis on the latter two models as requested by the end users), into one overall model framework. To this end, the emission models, will be extended to exposure models in order to calculate the real health impacts of a particular policy measure. Indeed, not only with respect to the emission model, it is possible to achieve a higher degree of accuracy, but probably also in terms of the dispersion of emissions (which lead to a health impact), it is likely that a higher degree of precision can be obtained due to the use of the developed AB model. For instance, not only outdoor but also in-home concentrations can be accounted for. Also the occupancy rate for the car can be computed, as well as the exact time and location of the particular trip, enabling a more precise calculation of the level of personal exposure. Also, the platform will be used to evaluate different policy measures and the link with traffic safety. With respect to the traffic safety model, traffic safety effects can be calculated based on interactions between movements of different vehicles (time-to-collision approach). To this end, it is important to have accurate information about route choice and driving behaviour, related with the particular purpose of the trip. We will use the results of the Estimate project in the SBO project to account for multimodality of those effects.

IMOB also is coordinating a grant with VITO, where an activity-based model is coupled with an emission model, and where an other alternative approach is followed when compared to ESTIMATE. We will organize valorization activities between researchers of the VITO and the ESTIMATE project to discuss about differentiations in results, methods and techniques.

IMOB is currenly also preparing in a larger consortium the new Mobility Plan for Flanders (funded by the Flemish Government). By acquiring this project, IMOB is given the opportunity to help shape transportation policy in Flanders. The goal of this project is to prepare the new Mobility Plan Flanders. To this end, future scenarios will be identified in this project for the period 2020-2050. While some of the scenarios will be examined in a qualitative manner, the project also involves a quantitative evaluation based on an agent-based microsimulation model, similar to the one used in the activity-based model that was used in the Estimate project. In addition to this, attempts are made to benchmark the results of the agent-based microsimulation model that is used in this project with the current aggregated four-step methodologies. Therefore, also this project will help to facilitate the transition towards more micro-simulation of travel demand. Based on its experiences in the Estimate project, IMOB played a role in helping to make the end users of the Flemish Mobility Plan project aware of the important advantages of the adopted methodology.

Finally, we have dessiminated the results of this project in the European KITE project where the attempt is to build a knowledge base for intermodal passenger travel in Europe. Also, several scientific papers have been published.

The "Centre de Recherche Urbaine" has disseminated the results of its internet survey. One article concentred on the Brussels' case is published in next edition of the mobility specialised revue "Le Moniteur de la Mobilité / De Mobiliteitsgids". Two conferences during which we have presented the first key results took place in April and May; one of those during the "Séminaire du GRT" in Namur (FUNDP), the other to some managers of Infrabel (the infrastructure manager company of the Belgian public train consortium SNCB-NMBS).

5. PUBLICATIONS

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Janssens, D., Bellemans, T., Wets, G., Timmermans, H.J.P. and Arentze, T.A. (2009) Implementation Framework and Development Trajectory of the Feathers Activity-Based Simulation Platform. Paper submitted Journal of the transportation research record. Paper conditionally accepted.

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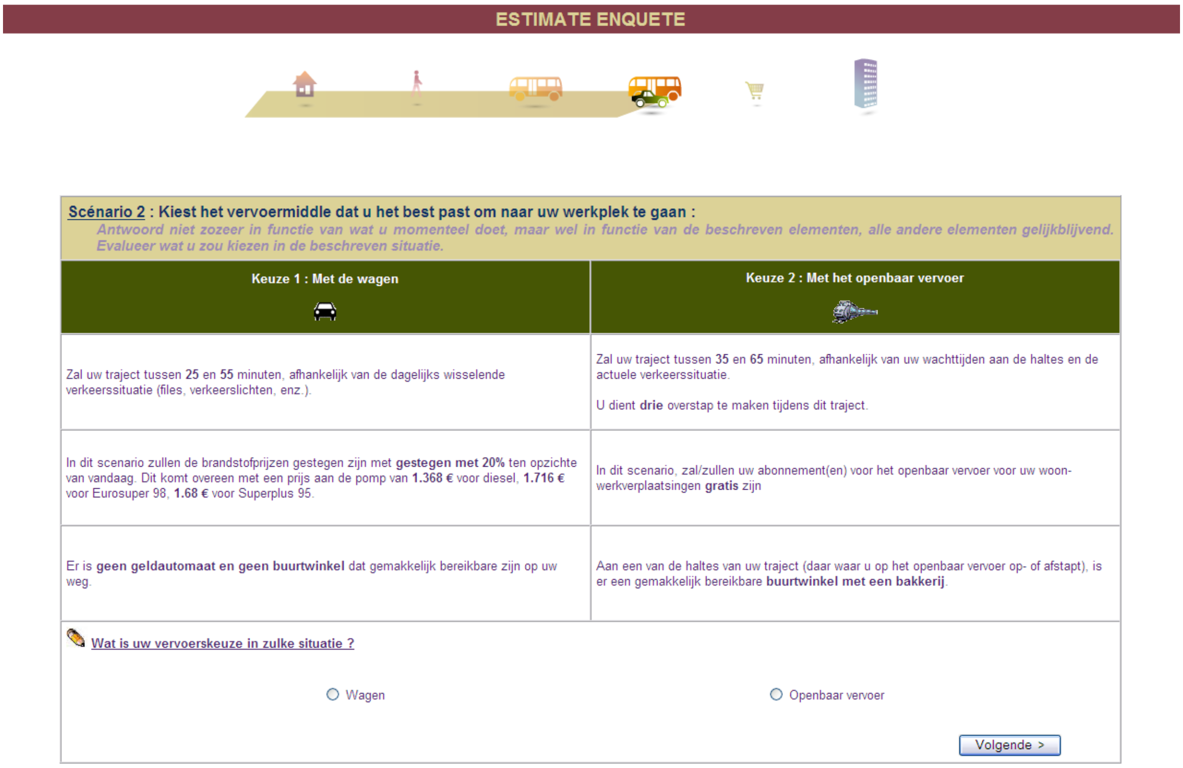
7. ANNEXES

Annexe 1: List of the Variables in the Web Survey

	information gathered	Scale / Unit
Step 1: Current mobility	Living place, Working place	Postcode
	Current mode choice in Home-Work trips	List of
	Current time needed between Home and Work places	Minutes
	Public transport season ticket possession?	List of
	→ Benefit from preferential fare?	Which
	Driving license possession?	Y/N
	Household vehicle possession (bicycle, motorcycle, car, company car)	Number of
	Home-Work trips refund by employer?	In which way
	Is there sometimes other mode choice than the previous ones	List of
Step 2: Between home and the train station	Distances between home and train station, and bus stop	Knowing, meters
	Mode choice to go to the train station	List of
	Bus line between home and the train station	Knowing, current use, stated use
	→ Justification register if no use even if that line exist	Justification register
	Connections	Current experience
	→ How long do they take? How do you feel the connections?	Minutes, Likert scales
	Connection acceptability (in function of different modes)	Minutes, little SP ex.
Step 3: In the station, on board, change scenarios	Services in/around a train station (waiting and knowing)	Likert scales, satisfaction scales
	→ Stated influence on train use	Likert scale
	What is your dreamed (but realistic) transport mode to go to the work	Classification ex.
	Home-Work trips qualitative description	Likert scales
	Services on board of vehicle	Likert scales
	→ Stated influence on public transport use	Likert scale
	One vehicle more in the household scenario: H-W mode choice, public transport season ticket possession	Stated change
	One vehicle less in the household scenario: H-W mode choice, public transport season ticket possession	Stated change
	Do you agree to renounce to one car/company car in exchange for a free public transport season ticket	Likert scales
Step 4: Stated preference scenarios on H-W trips	8 stated preference scenarios on Home-Work trips with variation on:	Mode choice
	→ Time, variability of time	Minutes
	→ Cost (petroleum and fare)	Euros
	→ Connection	number of
	→ Services available on the route	Which
	+ Justification register if people always choose the same mode	Justification register

	information gathered	Scale / Unit
Step 5: Shopping trips	Are people sometimes in charge of the shopping for the household or drive they members of the household to the shopping place	Time scales
	Current mode choice in shopping trips	List of
	Current time needed between home and shopping places	Minutes
	Combination between H-W trips and shopping?	Y/N
	→In which branch (access, egress, …)	Descriptive list
	3 stated preference scenarios on shopping trips with variation on:	Mode choice
	Time, waiting time for public transport	Minutes
	Parking costs	Situations
	Connection	Number of
Step 6: Sociodemographic questions	Date of birth, Sex	Year, F/M
	Profession, activity sector	List of
	→If people are working in the transport sector, in which society?	List of
	Working times	Length
	People in the household (adults/children)	Number of
	Household incomes	Euros
	Are you eventually interested in being interviewed on your mobility	Y/N

Annexe 2: Additional Details about the Methodological Choices of the Web Survey



ESTIMATE ENQUETE

Scénario 2 : Kiest het vervoermiddle dat u het best past om naar uw werkplek te gaan :
Antwoord niet zozeer in functie van wat u momenteel doet, maar wel in functie van de beschreven elementen, alle andere elementen gelijkblijvend. Evalueer wat u zou kiezen in de beschreven situatie.

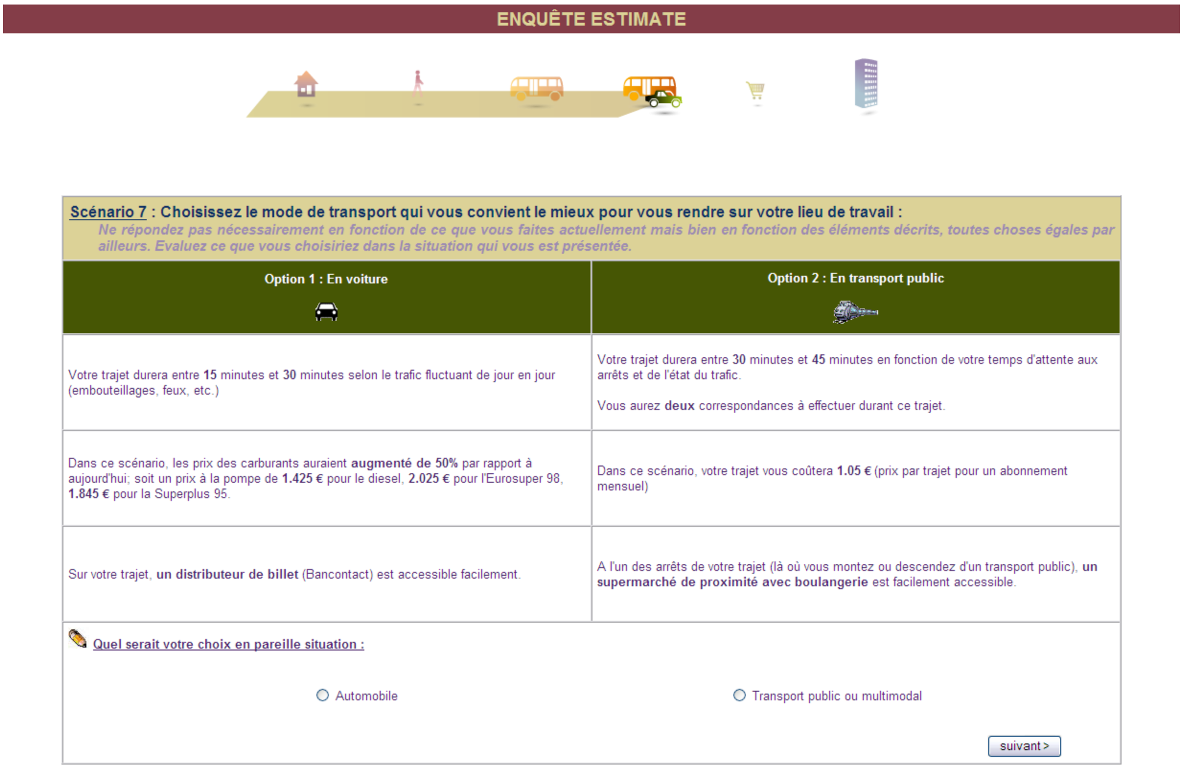
Keuze 1 : Met de wagen	Keuze 2 : Met het openbaar vervoer
Zal uw traject tussen **25** en **55** minuten, afhankelijk van de dagelijks wisselende verkeerssituatie (files, verkeerslichten, enz.).	Zal uw traject tussen **35** en **65** minuten, afhankelijk van uw wachttijden aan de haltes en de actuele verkeerssituatie. U dient **drie** overstap te maken tijdens dit traject.
In dit scenario zullen de brandstofprijzen gestegen zijn met **gestegen met 20%** ten opzichte van vandaag. Dit komt overeen met een prijs aan de pomp van **1.368 €** voor diesel, **1.716 €** voor Eurosuper 98, **1.68 €** voor Superplus 95.	In dit scenario, zal/zullen uw abonnement(en) voor het openbaar vervoer voor uw woon-werkverplaatsingen **gratis** zijn
Er is **geen geldautomaat en geen buurtwinkel** dat gemakkelijk bereikbare zijn op uw weg.	Aan een van de haltes van uw traject (daar waar u op het openbaar vervoer op- of afstapt), is er een gemakkelijk bereikbare **buurtwinkel met een bakkerij**.

Wat is uw vervoerskeuze in zulke situatie ?

○ Wagen ○ Openbaar vervoer

Volgende >

Example of Dutch speaking scenario



ENQUÊTE ESTIMATE

Scénario 7 : Choisissez le mode de transport qui vous convient le mieux pour vous rendre sur votre lieu de travail :
Ne répondez pas nécessairement en fonction de ce que vous faites actuellement mais bien en fonction des éléments décrits, toutes choses égales par ailleurs. Evaluez ce que vous choisiriez dans la situation qui vous est présentée.

Option 1 : En voiture	Option 2 : En transport public
Votre trajet durera entre **15** minutes et **30** minutes selon le trafic fluctuant de jour en jour (embouteillages, feux, etc.)	Votre trajet durera entre **30** minutes et **45** minutes en fonction de votre temps d'attente aux arrêts et de l'état du trafic. Vous aurez **deux** correspondances à effectuer durant ce trajet.
Dans ce scénario, les prix des carburants auraient **augmenté de 50%** par rapport à aujourd'hui; soit un prix à la pompe de **1.425 €** pour le diesel, **2.025 €** pour l'Eurosuper 98, **1.845 €** pour la Superplus 95.	Dans ce scénario, votre trajet vous coûtera **1.05 €** (prix par trajet pour un abonnement mensuel)
Sur votre trajet, **un distributeur de billet** (Bancontact) est accessible facilement.	A l'un des arrêts de votre trajet (là où vous montez ou descendez d'un transport public), **un supermarché de proximité avec boulangerie** est facilement accessible.

Quel serait votre choix en pareille situation :

○ Automobile ○ Transport public ou multimodal

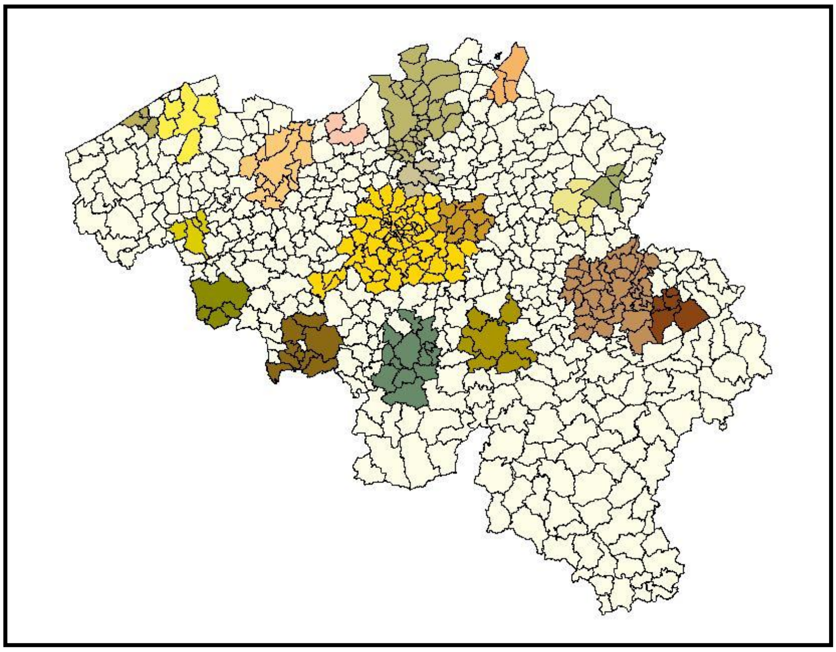
suivant >

Example of French speaking scenario

Annexe 3: Additional Details about the Web Survey Results (except SP experiment)

Annexes to the section 2.2.2.2.

The map illustrates the 18 **urban zones** defined from the work of Luyten and Van Hecke (Luyten and Van Hecke: 2007)



The table resume all the cases of our **mode typology** based on the information gathered in the questionnaire.

Unimodal			Multimodal	
Foot and Bicycle	**Car and Motorbike**	**Public Transport**	**Without Public Transport**	**With Public Transport**
(UFB)	**(UCB)**	**(UPT)**	**(MWPT)**	**(MPT)**
By foot	Motorbike	TEC	Without any branch with	With at least one branch with
By bicycle	Personal car as driver	De Lijn	TEC	TEC
	Company car as driver	STIB	De Lijn	De Lijn
	Car as passenger	SNCB	STIB	STIB
	Car Sharing as driver		SNCB	SNCB
		Company collective transport	Company collective transport	Company collective transport

The table illustrates the **mode typology** across the **origin and destination**

General percentage (Column Conditioned Percentage)		Living Region			Working Region			Urbanity of the living place		Total
		Brussels	Wallonia	Flanders	Brussels	Wallonia	Flanders	No	Yes	
Mode Typology	Unimodal Foot and Bicycle	3.2 (25.2)	1.5 (6.6)	6.7 (10.4)	3.4 (13.2)	1.5 (8.4)	6.5 (11.5)	3.0 (7.6)	8.4 (13.9)	11.4
	Unimodal Car and Motorbike	2.3 (18.1)	13.2 (57.8)	38.7 (59.8)	6.6 (25.8)	11.4 (64.2)	36.2 (63.7)	25.5 (63.9)	28.6 (47.7)	54.1
	Unimodal Public Transport	2.5 (19.9)	1.8 (8.0)	3.5 (5.5)	4.3 (16.9)	1.3 (7.5)	2.2 (3.9)	2.2 (5.4)	5.7 (9.5)	7.9
	Multimodal without Public Transport	0.1 (0.9)	0.4 (1.7)	5.1 (7.9)	0.2 (0.9)	0.4 (2.2)	5.0 (8.8)	2.2 (5.4)	3.4 (5.7)	5.6
	Multimodal with Public Transport	4.5 (35.8)	5.9 (26.0)	10.7 (16.5)	11.0 (43.2)	3.2 (17.8)	6.9 (12.2)	7.1 (17.7)	14.0 (23.3)	21.1
Total		12.5	22.8	64.7	25.5	17.7	56.8	39.9	60.1	100

The table illustrates the **mode typology** across some **sociodemographic** variables.

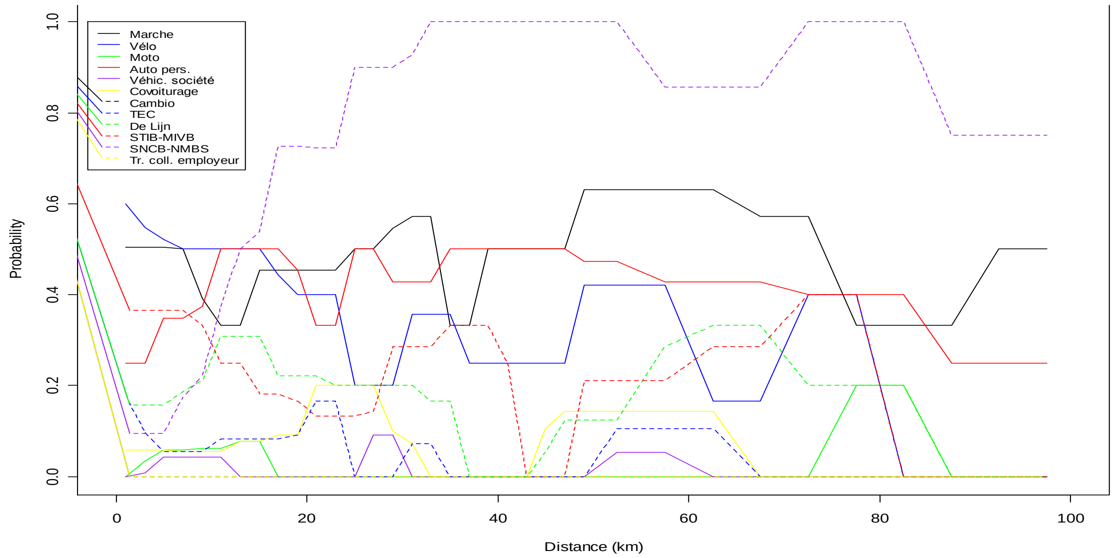
General percentage (Column Conditioned Percentage)		Age					Sex		Working Times		Total
		15-24	25-34	35-44	45-54	55-64	Woman	Man	Partial Time	Full Time	
Mode Typology	Unimodal Foot and Bicycle	0.4 (7.0)	3.9 (13.1)	2.8 (10.9)	3.1 (11.5)	1.0 (9.7)	6.1 (11.1)	5.5 (12.2)	3.2 (12.9)	8.2 (10.9)	11.4
	Unimodal Car and Motorbike	2.1 (32.2)	14.9 (49.5)	16.4 (63.3)	14.3 (52.9)	6.3 (61.6)	30.1 (54.9)	22.6 (50.1)	13.5 (54.3)	40.6 (54.0)	54.1
	Unimodal Public Transport	0.8 (13.0)	2.8 (9.2)	1.1 (4.3)	2.3 (8.6)	0.8 (7.6)	4.8 (8.8)	3.4 (7.5)	1.8 (7.1)	6.1 (8.1)	7.9
	Multimodal without Public Transport	0.2 (2.6)	1.5 (5.0)	1.8 (6.8)	1.7 (6.4)	0.4 (4.3)	3.2 (5.9)	2.1 (4.7)	1.6 (6.5)	4.0 (5.3)	5.6
	Multimodal with Public Transport	2.9 (45.2)	7.1 (23.4)	3.8 (14.7)	5.6 (20.7)	1.7 (16.8)	10.6 (19.4)	11.5 (25.5)	4.8 (19.2)	16.3 (21.7)	21.1
Total		6.4	30.2	26.0	27.1	10.3	54.9	45.2	24.8	75.2	100

Annexes to the section 2.2.2.3

The table illustrates the **mode typology** across the **home work distance**.

General percentage (Column Conditioned Percentage)		Estimated Distance from Home to Work										Total
		P 10	P 20	P 30	P 40	P 50	P 60	P 70	P 80	P 90	P 100	
		< 2.6]	Same Commune	]2.6 ; 4.8]	]4.8 ;7.0]	]7.0 ; 10.0]	]10.0 ; 13.9]	]13.9 ; 19.6]	]19.6 ; 27.6]	]27.6 ; 44.7]	]44.7 >	
Mode Typology	Unimodal Foot and Bicycle	0.5 (18.75)	6.14 (34.58)	1.99 (19.78)	1.22 (12.22)	0.61 (6.15)	0.39 (3.89)	0.06 (0.56)	0.11 (1.11)	0.11 (1.11)	0.28 (2.78)	11.4
	Unimodal Car and Motorbike	0.77 (29.17)	6.80 (38.32)	4.04 (40.11)	5.03 (50.56)	6.97 (70.39)	7.41 (74.44)	7.02 (70.95)	5.97 (60.00)	5.8 (58.33)	4.31 (43.33)	54.1
	Unimodal Public Transport	0.39 (14.58)	0.55 (3.12)	1.38 (13.74)	1.16 (11.67)	0.77 (7.82)	0.66 (6.67)	0.44 (4.47)	0.94 (9.44)	0.83 (8.33)	0.72 (7.22)	7.9
	Multimodal without Public Transport	0.11 (4.17)	2.71 (15.26)	0.88 (8.79)	0.55 (5.56)	0.44 (4.47)	0.28 (2.78)	0.33 (3.35)	0.06 (0.56)	0.06 (0.56)	0.17 (1.67)	5.6
	Multimodal with Public Transport	0.88 (33.33)	1.55 (8.72)	1.77 (17.58)	1.99 (20.00)	1.11 (11.17)	1.22 (12.22)	2.05 (20.67)	2.87 (28.89)	3.15 (31.67)	4.48 (45.00)	21.1
Total		2.65	17.74	10.06	9.95	9.89	9.95	9.89	9.95	9.95	9.95	100

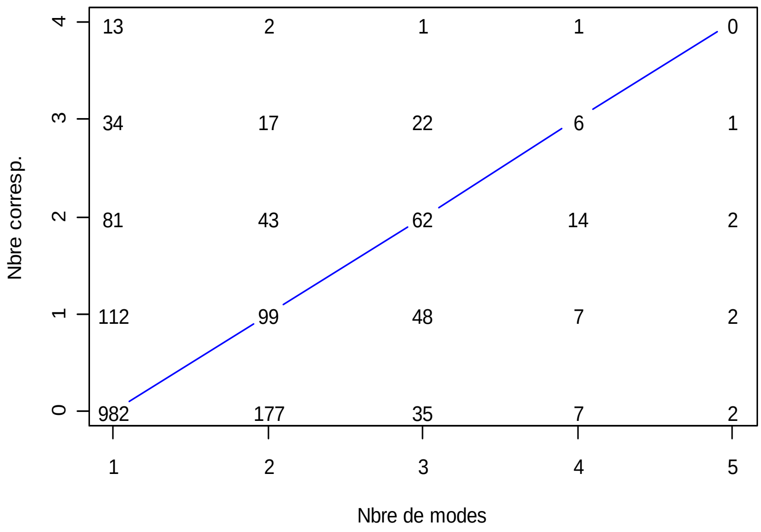
The plot is illustrating the **probability of choosing a mode per home work distance**



The table illustrates the percentiles of the stated **mode combinations**.

Percentiles in the global sample	Size of the Stated Modal Combinations											
	P 10	P 20	P 30	P 40	P 50	P 60	P 70	P 80	P 90	P 95	P 99	Max
Number of mode(s) combined	1	1	1	1	1	1	2	2	3	3	4	6

The picture illustrates the lack of correspondence between the **number of modes** and the **number of connections**



The following tables illustrate the key analysis concerning the **ideal transport mode**

General percentage (Row Conditioned Percentage)		Should not be expensive							Total
		Not at all important (- - -)	**(- -)**	**(-)**	**0**	**(+)**	**(+ +)**	**Extremely important (+ + +)**	
Mode Typology	**Unimodal Foot and Bicycle**	0.06 0.51	0.11 1.03	0.28 2.56	1.03 9.23	1.77 15.9	3.13 28.21	4.73 42.56	11.1
	Unimodal Car and Motorbike	0.63 1.16	0.46 0.85	1.42 2.65	7.92 14.71	8.66 16.08	13.55 25.19	21.18 39.37	53.82
	Unimodal Public Transport	0 0	0 0	0.06 0.7	0.46 5.63	1.42 17.61	2.51 30.99	3.64 45.07	8.09
	Multimodal without Public Transport	0 0	0 0	0 0	0.74 13	0.57 10	1.48 26	2.9 51	5.69
	Multimodal with Public Transport	0 0	0.17 0.8	0.17 0.8	1.25 5.88	3.13 14.71	7.12 33.42	9.45 44.39	21.3
Total		0.68	0.74	1.94	11.39	15.55	27.79	41.91	100

General percentage (Row Conditioned Percentage)		Arrive rapidly at destination							Total
		Not at all important (- - -)	**(- -)**	**(-)**	**0**	**(+)**	**(+ +)**	**Extremely important (+ + +)**	
Mode Typology	**Unimodal Foot and Bicycle**	0.06 0.52	0.06 0.52	0 0	0.51 4.64	1.31 11.86	4.11 37.11	5.02 45.36	11.07
	Unimodal Car and Motorbike	0.23 0.42	0.06 0.11	0.29 0.53	1.65 3.07	2.85 5.3	12.84 23.83	35.94 66.74	53.85
	Unimodal Public Transport	0 0	0 0	0.06 0.7	0.34 4.23	0.86 10.56	1.94 23.94	4.91 60.56	8.1
	Multimodal without Public Transport	0 0	0 0	0 0	0.46 8	0.34 6	1.2 21	3.71 65	5.7
	Multimodal with Public Transport	0 0	0 0	0 0	0.34 1.61	2.05 9.65	6.33 29.76	12.55 58.98	21.28
Total		0.29	0.11	0.34	3.31	7.42	26.41	62.12	100

Percentage	Arriving on time, no delay						
	Not at all important (- - -)	**(- -)**	**(-)**	**0**	**(+)**	**(+ +)**	**Extremely important (+ + +)**
Total	0.56	0.45	1.34	5.14	9.72	24.25	58.55

General percentage (Row Conditioned Percentage)		No connection							Total
		Not at all important (- - -)	**(- -)**	**(-)**	**0**	**(+)**	**(+ +)**	**Extremely important (+ + +)**	
Age	**15-24 years**	0.06 0.85	0.22 3.42	0.39 5.98	0.67 10.26	2.02 30.77	1.29 19.66	1.91 29.06	6.57
	25-34 years	0.34 1.11	0.79 2.58	0.73 2.4	3.7 12.18	6.57 21.59	8.42 27.68	9.88 32.47	30.42
	35-44 years	0.28 1.08	0.17 0.65	0.51 1.94	2.75 10.56	5.11 19.61	7.18 27.59	10.04 38.58	26.04
	45-54 years	0.39 1.46	0.22 0.83	0.95 3.53	2.53 9.36	4.26 15.8	8.14 30.15	10.49 38.88	26.99
	55-64 years	0.11 1.12	0.06 0.56	0 0	0.67 6.74	1.46 14.61	2.53 25.28	5.16 51.69	9.99
Total		1.18	1.46	2.58	10.33	19.42	27.55	37.49	100

General percentage (Row Conditioned Percentage)		Going and coming back whenever I want							**Total**
		Not at all important (- - -)	**(- -)**	**(-)**	**0**	**(+)**	**(+ +)**	**Extremely important (+ + +)**	
Mode Typology	**Unimodal Foot and Bicycle**	0.06 0.52	0.11 1.04	0 0	0.57 5.18	1.82 16.58	3.13 28.5	5.29 48.19	10.97
	Unimodal Car and Motorbike	0.34 0.63	0.11 0.21	0.4 0.74	1.53 2.84	2.84 5.26	9.84 18.21	38.94 72.11	54.01
	Unimodal Public Transport	0 0	0 0	0.11 1.41	0.45 5.63	0.97 11.97	1.65 20.42	4.89 60.56	8.07
	Multimodal without Public Transport	0 0	0 0	0.11 2	0.23 4	0.4 7	1.65 29	3.3 58	5.69
	Multimodal with Public Transport	0.06 0.27	0.06 0.27	0.11 0.53	0.8 3.74	2.27 10.7	7.16 33.69	10.8 50.8	21.26
Total		0.45	0.28	0.74	3.58	8.3	23.42	63.22	100

General percentage (Row Conditioned Percentage)		Be seated comfortably							**Total**
		Not at all important (- - -)	**(- -)**	**(-)**	**0**	**(+)**	**(+ +)**	**Extremely important (+ + +)**	
Mode Typology	**Unimodal Foot and Bicycle**	0.11 1.04	0.17 1.55	0.29 2.59	1.31 11.92	3.48 31.61	3.48 31.61	2.17 19.69	11
	Unimodal Car and Motorbike	0.34 0.63	0.11 0.21	0.23 0.42	3.48 6.45	10.66 19.77	20.13 37.32	18.99 35.2	53.93
	Unimodal Public Transport	0.06 0.7	0.06 0.7	0.06 0.7	0.63 7.75	2.45 30.28	2.34 28.87	2.51 30.99	8.1
	Multimodal without Public Transport	0 0	0 0	0 0	0.4 7.07	0.97 17.17	2.28 40.4	2 35.35	5.64
	Multimodal with Public Transport	0.06 0.27	0.06 0.27	0.68 3.21	0.97 4.55	4.9 22.99	8.89 41.71	5.76 27.01	21.32
Total		0.57	0.4	1.25	6.78	22.46	37.12	31.41	100

General percentage (Row Conditioned Percentage)		Feeling secure							Total
		Not at all important (- - -)	**(- -)**	**(-)**	**0**	**(+)**	**(+ +)**	**Extremely important (+ + +)**	
Sex	**Women**	0.56 1.02	0.06 0.11	0.31 0.57	3.3 6.03	5.29 9.67	15.49 28.33	29.68 54.27	54.7
	Men	0.56 1.24	0.31 0.69	0.62 1.37	4.98 10.99	8.77 19.37	13.88 30.63	16.18 35.71	45.3
Total		1.12	0.37	0.93	8.28	14.06	29.37	45.86	100

Percentage	**Not at all important (- - -)**	**(- -)**	**(-)**	**0**	**(+)**	**(+ +)**	**Extremely important (+ + +)**
Talking with colleagues and/or friends	9.02	4.09	5.88	25.71	25.66	20.17	9.47

General percentage (Row Conditioned Percentage)		I can work during the trip							Total
		Not at all important (- - -)	(- -)	(-)	0	(+)	(+ +)	Extremely important (+ + +)	
Origin Destination Typology	**Intra Urban**	5.48 12.69	2.46 5.7	3.24 7.51	12.02 27.85	9 20.85	7.15 16.58	3.8 8.81	43.15
	Inter Urban	1.29 11.06	0.39 3.37	0.78 6.73	2.29 19.71	2.46 21.15	2.24 19.23	2.18 18.75	11.63
	Commuting	3.3 15.09	0.95 4.35	1.57 7.16	6.37 29.16	4.25 19.44	3.35 15.35	2.07 9.46	21.86
	Extra Urban	4.3 18.42	0.78 3.35	1.01 4.31	6.99 29.9	5.25 22.49	2.96 12.68	2.07 8.85	23.37
Total		14.37	4.58	6.6	27.67	20.96	15.71	10.12	100

General percentage (Row Conditioned Percentage)		I won't move at all							Total
		Not at all important (- - -)	**(- -)**	**(-)**	**0**	**(+)**	**(+ +)**	**Extremely important (+ + +)**	
Origin Destination Typology	**Intra Urban**	5.1 11.89	2.84 6.61	2.44 5.68	15.71 36.59	5.28 12.29	4.2 9.78	7.37 17.17	42.94
	Inter Urban	0.85 7.32	0.4 3.41	0.51 4.39	3.23 27.8	1.25 10.73	2.33 20	3.06 26.34	11.63
	Commuting	1.53 6.94	0.74 3.34	1.13 5.14	8.22 37.28	3.29 14.91	2.78 12.6	4.37 19.79	22.06
	Extra Urban	1.3 5.58	0.45 1.94	0.68 2.91	9.53 40.78	3.29 14.08	3.35 14.32	4.76 20.39	23.37
Total		8.79	4.42	4.76	36.7	13.1	12.65	19.57	100

The following tables illustrate the **perception of the connection time** according to the **current experience** of it

General percentage Row Conditioned Percentage		Connections are a loss of time					Total (1290 non missing)
		Totally disagree	**Disagree**	**Neither agree nor disagree**	**Agree**	**Totally agree**	
Current experience of connections in home work trips	**No experience of connections**	1.86	2.17	11.71	16.05	23.8	55.58
		3.35	3.91	21.06	28.87	42.82	
	Experience of connections	3.02	3.95	6.9	13.88	16.67	44.42
		6.81	8.9	15.53	31.24	37.52	
Total		4.88	6.12	18.6	29.92	40.47	100

General percentage Row Conditioned Percentage		Connections are too long					Total (1270 non missing)
		Totally disagree	**Disagree**	**Neither agree nor disagree**	**Agree**	**Totally agree**	
Current experience of connections in home work trips	**No experience of connections**	3.23	1.65	30.08	9.13	11.1	55.2
		5.85	3.00	54.49	16.55	20.11	
	Experience of connections	5.12	7.17	12.05	11.5	8.98	44.8
		11.42	15.99	26.89	25.66	20.04	
Total		8.35	8.82	42.13	20.63	20.08	100

General percentage Row Conditioned Percentage		Connections get me some fresh air					Total (1282 non missing)
		Totally disagree	**Disagree**	**Neither agree nor disagree**	**Agree**	**Totally agree**	
Current experience of connections in home work trips	**No experience of connections**	19.81	7.96	17.00	6.63	3.98	55.38
		35.77	14.37	30.7	11.97	7.18	
	Experience of connections	17.00	6.94	10.3	7.80	2.57	44.62
		38.11	15.56	23.08	17.48	5.77	
Total		36.82	14.90	27.30	14.43	6.55	100

General percentage Row Conditioned Percentage		Connections are relaxing moments					Total (1273 non missing)
		Totally disagree	**Disagree**	**Neither agree nor disagree**	**Agree**	**Totally agree**	
Current experience of connections in home work trips	**No experience of connections**	23.49	12.33	15.48	3.22	0.94	55.46
		42.35	22.24	27.9	5.81	1.7	
	Experience of connections	19.48	11.08	8.8	4.16	1.02	44.54
		43.74	24.87	19.75	9.35	2.29	
Total		42.97	23.41	24.27	7.38	1.96	100

General percentage Row Conditioned Percentage		Connections are stressful moments					Total (1278 non missing)
		Totally disagree	Disagree	Neither agree nor disagree	Agree	Totally agree	
Current experience of connections in home work trips	No experience of connections	2.27 4.08	4.85 8.73	17.06 30.7	17.06 30.7	14.32 25.77	55.56
	Experience of connections	4.3 9.68	6.65 14.96	10.09 22.71	14.71 33.1	8.69 19.54	44.44
Total		6.57	11.5	27.15	31.77	23.00	100

General percentage Row Conditioned Percentage		I cannot do anything during connections					Total (1273 non missing)
		Totally disagree	Disagree	Neither agree nor disagree	Agree	Totally agree	
Current experience of connections in home work trips	No experience of connections	1.49 2.68	5.03 9.03	15.48 27.79	16.03 28.77	17.67 31.73	55.7
	Experience of connections	3.46 7.8	7.38 16.67	6.36 14.36	13.75 31.03	13.35 30.14	44.3
Total		4.95	12.41	21.84	29.77	31.03	100

The table illustrates the question about the **most appropriate train station**

General percentage (Column Conditioned Percentage)		Is the nearest train station to your home the most appropriate to go to your working place?						Total
		Yes	No, a further station is most appropriate	No, a further station makes the trip shorter	No, a further station offers most services	There is no appropriate station to go to work	Do not know	
Mode Typology	Unimodal Foot and Bicycle	1.7 (5.8)	0.1 (4.0)	0.2 (2.3)	0.0 (0.0)	7.8 (14.7)	1.5 (17.7)	11.2
	Unimodal Car and Motorbike	12.1 (40.6)	0.7 (48.0)	3.4 (46.2)	0.3 (41.7)	32.6 (61.9)	5.1 (62.6)	54.2
	Unimodal Public Transport	3.6 (12.0)	0.2 (12.0)	0.5 (6.9)	0.0 (0.0)	3.1 (5.9)	0.5 (6.1)	7.9
	Multimodal without Public Transport	0.9 (3.0)	0.0 (0.0)	0.2 (3.1)	0.1 (16.7)	3.9 (7.3)	0.5 (6.1)	5.6
	Multimodal with Public Transport	11.5 (38.6)	0.5 (36.0)	3.0 (41.5)	0.3 (41.7)	5.4 (10.2)	0.6 (7.5)	21.3
Total		29.8	1.4	7.3	0.7	52.7	8.2	100.0

The following tables illustrate the expectations about **services and amenities in PT stations**

Percentage per variable	Superfluous	Not important	An advantage	Important	Essential
Ticket Office	0.92	2.97	17.96	39.19	38.96
Automatic Ticket Machine	2.07	5.99	34.47	30.32	27.15
Parking for bicycles	0.46	1.89	8.69	26.63	62.34
Platforms with a roof	0.52	2.14	22	38.28	37.07
Water-Closed	0.52	1.67	13.18	30.86	53.77
Newsstand Bookshop	5.28	15.1	49.31	23.13	7.18
Supermarket	14.17	20.37	54.56	9.12	1.78
Commune's Office	16.3	29.45	44.37	7.83	2.06
Day-Nursery	25.56	26.83	35.92	8.98	2.71

General percentage (Row Conditioned Percentage)		Benches					Total
		Superfluous	Not important	An advantage	Important	Essential	
Mode Typology	**Unimodal Foot and Bicycle**	0.12 1.03	0.52 4.64	2.39 21.13	4.25 37.63	4.02 35.57	11.3
	Unimodal Car and Motorbike	1.51 2.84	3.38 6.33	16.13 30.24	18.23 34.17	14.09 26.42	53.35
	Unimodal Public Transport	0.12 1.41	0.29 3.52	1.05 12.68	3.15 38.03	3.67 44.37	8.27
	Multimodal without Public Transport	0.06 1.08	0.41 7.53	1.81 33.33	1.92 35.48	1.22 22.58	5.42
	Multimodal with Public Transport	0.41 1.88	0.52 2.42	5.42 25	7.4 34.14	7.92 36.56	21.67
Total		2.21	5.13	26.79	34.94	30.93	100

The following tables illustrate the expectations about **services and amenities on board of vehicle**

General percentage (Row Conditioned Percentage)		Ticket inspector or ambiance agent					Total
		Superfluous	Not important	An advantage	Important	Essential	
Origin Destination Typology	**Intra Urban**	1.91 4.4	6.4 14.77	16.34 37.69	13.48 31.09	5.22 12.05	43.35
	Inter Urban	0.39 3.38	1.68 14.49	3.65 31.4	3.76 32.37	2.13 18.36	11.62
	Commuting	0.79 3.64	2.36 10.91	6.74 31.17	7.8 36.1	3.93 18.18	21.62
	Extra Urban	0.34 1.44	1.97 8.39	7.13 30.46	9.49 40.53	4.49 19.18	23.41
Total		3.43	12.41	33.86	34.53	15.78	100

Percentage per variable	Superfluous	Not important	An advantage	Important	Essential
Peace and quiet on board	0.39	3.43	27.29	52.45	16.43
Face to face seats	9.36	50.62	27.73	10.37	1.92

General percentage (Row Conditioned Percentage)		A seat					Total
		Superfluous	Not important	An advantage	Important	Essential	
Origin Destination Typology	Intra Urban	0.06 0.13	0.56 1.29	7.73 17.85	20.83 48.12	14.11 32.6	43.28
	Inter Urban	0 0	0.06 0.48	0.78 6.73	4.09 35.1	6.72 57.69	11.65
	Commuting	0 0	0.17 0.78	1.29 5.94	9.35 43.15	10.86 50.13	21.67
	Extra Urban	0 0	0.11 0.48	2.46 10.53	10.13 43.3	10.69 45.69	23.4
Total		0.06	0.9	12.26	44.4	42.39	100

General percentage (Row Conditioned Percentage)		Wifi connection on board					Total
		Superfluous	Not important	An advantage	Important	Essential	
Origin Destination Typology	Intra Urban	15.05 34.77	10.88 25.13	14.49 33.46	2.59 5.99	0.28 0.65	43.29
	Inter Urban	2.31 19.9	2.09 17.96	5.69 49.03	1.07 9.22	0.45 3.88	11.61
	Commuting	6.65 30.65	5.02 23.12	8.79 40.52	1.01 4.68	0.23 1.04	21.7
	Extra Urban	6.6 28.19	7.16 30.6	8.17 34.94	1.13 4.82	0.34 1.45	23.39
Total		30.61	25.14	37.15	5.81	1.3	100

Annexe 4: Additional Details about the Stated Preference (SP) experiment

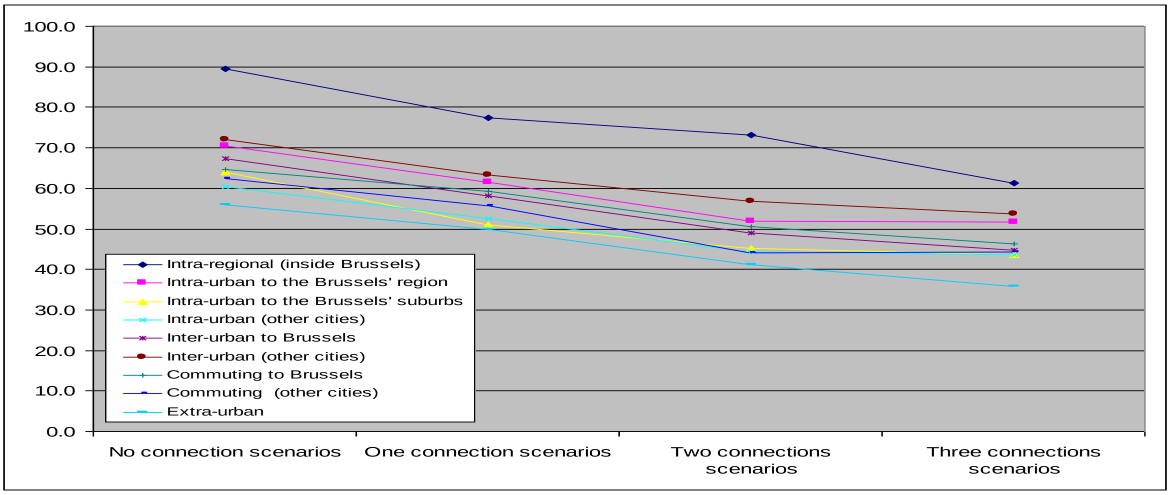
The tables present the estimates of the logistic regression. These are positive if the factor or the variable is positively correlated to the choice of the car option. When the coefficient is negative, the public transport option is positively associated to this level of the factor or to the variable.

Variables	Levels of the Factor Variables	Local Estimate (LE)	Standard Error of the LE	Degrees of Freedom of the LE	Wald Chi-Square of the LE	P-Value of the LE	Global Degrees of Freedom	Global Wald Chi-Square	Global P-Value
Intercept		-0.484	0.082	1	34.54	<.0001			
Minimum time for car option		-0.021	0.002	1	74.22	<.0001	1	74.22	<.0001
Maximum time for car option		-0.016	0.002	1	43.64	<.0001	1	43.64	<.0001
Minimum time for PT option		0.019	0.003	1	56.48	<.0001	1	56.48	<.0001
Maximum time for PT option		0.024	0.003	1	83.60	<.0001	1	83.60	<.0001
Percentage of variation of fuel cost	80%	0.324	0.045	1	51.24	<.0001	2	52.80	<.0001
	120%	-0.099	0.044	1	4.95	0.0262			
	150%	-0.226	.	.	.	.			
Interaction: Percentage of variation of fuel cost * Mean time for the car option	80%	0.001	0.001	1	1.50	0.2207	2	9.51	0.0086
	120%	0.002	0.001	1	4.32	0.0376			
	150%	-0.003	.	0	.	.			
Percentage of variation of season ticket cost	0% (free)	-0.396	0.053	1	55.17	<.0001	3	61.62	<.0001
	50%	0.059	0.054	1	1.17	0.2788			
	80%	0.069	0.056	1	1.50	0.2203			
	120%	0.268	.	0	.	.			
Interaction: Percentage of variation of season ticket cost * Mean time for the PT option	0% (free)	-0.004	0.001	1	11.85	0.0006	3	20.93	0.0001
	50%	-0.002	0.001	1	2.47	0.1158			
	80%	0.001	0.001	1	1.26	0.2618			
	120%	0.005	.	0	.	.			
Number of Connections	0	-0.550	0.036	1	227.84	<.0001	3	371.62	<.0001
	1	-0.165	0.035	1	21.74	<.0001			
	2	0.179	0.035	1	26.52	<.0001			
	3	0.536	.	0	.	.			
Amenities on the way of the car option	Bancontact	-0.028	0.029	1	0.91	0.3407	2	18.94	<.0001
	None	-0.094	0.030	1	10.09	0.0015			
	Bakery	0.121	.	0	.	.			
Amenities on the way of the PT option	Bancontact	-0.047	0.028	1	2.78	0.0953	2	35.73	<.0001
	None	0.169	0.029	1	34.05	<.0001			
	Bakery	-0.122	.	0	.	.			
Mode Typology	Multimodal with PT	-0.605	0.054	1	125.87	<.0001	4	1132.73	<.0001
	Multimodal without PT	0.639	0.058	1	122.62	<.0001			
	Unimodal Car Motorbike	1.124	0.038	1	888.56	<.0001			
	Unimodal Feet Bicycle	-0.621	0.060	1	108.62	<.0001			
	Unimodal PT	-0.538	.	0	.	.			
Origin Destination Typology	Extra urban	0.220	0.207	1	1.13	0.2871	3	14.45	0.0024
	Inter urban	-0.262	0.104	1	6.39	0.0115			
	Intra urban	-0.212	0.100	1	4.52	0.0336			
	Commuters	0.254	.	0	.	.			

Variables	Levels of the Factor Variables	Local Estimate (LE)	Standard Error of the LE	Degrees of Freedom of the LE	Wald Chi-Square of the LE	P-Value of the LE	Global Degrees of Freedom	Global Wald Chi-Square	Global P-Value
Current experience of connections	Experience	-0.182	0.027	1	45.31	<.0001	1	45.31	<.0001
	No Experience	0.182	.	0	.	.			
Distance from home to work		-0.011	0.002	1	28.48	<.0001	1	28.48	<.0001
Presence of a bicycle in the household	No	0.138	0.027	1	26.88	<.0001	1	28.48	<.0001
	Yes	-0.138	.	0	.	.			
Presence of a company car in the household	No	-0.229	0.030	1	60.29	<.0001	1	60.29	<.0001
	Yes	0.229	.	0	.	.			
Origin: City or Province	Agglo. Antwerpen	0.030	0.111	1	0.07	0.7893	27	146.56	<.0001
	Agglo. Brugge	0.230	0.190	1	1.48	0.2246			
	Agglo. Bruxelles	-0.482	0.102	1	22.47	<.0001			
	Agglo. Charleroi	0.704	0.271	1	6.73	0.0095			
	Agglo. Genk	0.335	0.289	1	1.35	0.2455			
	Agglo. Gent	-0.348	0.136	1	6.54	0.0106			
	Agglo. Hasselt	-0.318	0.240	1	1.76	0.1842			
	Agglo. Kortrijk	1.021	0.208	1	24.02	<.0001			
	Agglo. Leuven	0.350	0.150	1	5.47	0.0194			
	Agglo. Liege	0.337	0.207	1	2.65	0.1035			
	Agglo. Mechelen	0.442	0.171	1	6.69	0.0097			
	Agglo. Mons	0.209	0.284	1	0.54	0.4625			
	Agglo. Namur	-0.126	0.152	1	0.68	0.4092			
	Agglo. Oostende	1.034	0.238	1	18.82	<.0001			
	Agglo. Sint-Niklaas	-0.190	0.232	1	0.67	0.4132			
	Agglo. Tournai	-0.442	0.263	1	2.84	0.0922			
	Agglo. Turnhout	-0.237	0.284	1	0.70	0.4033			
	Agglo. Verviers	0.237	0.382	1	0.39	0.534			
	Prov. Antwerpen	-0.376	0.137	1	7.54	0.006			
	Prov. Brabant Wallon	-0.523	0.176	1	8.87	0.0029			
	Prov. Hainaut	-0.726	0.162	1	20.08	<.0001			
	Prov. Liege	-0.346	0.217	1	2.53	0.1117			
	Prov. Limburg	-0.461	0.169	1	7.48	0.0062			
	Prov. Luxembourg	-0.234	0.367	1	0.41	0.5241			
	Prov. Namur	-0.054	0.160	1	0.11	0.7361			
	Prov. Oost-Vlaanderen	-0.284	0.118	1	5.79	0.0161			
	Prov. Vlaams Brabant	-0.097	0.142	1	0.47	0.4923			
	Prov. West-Vlaanderen	0.314	.	0	.	.			

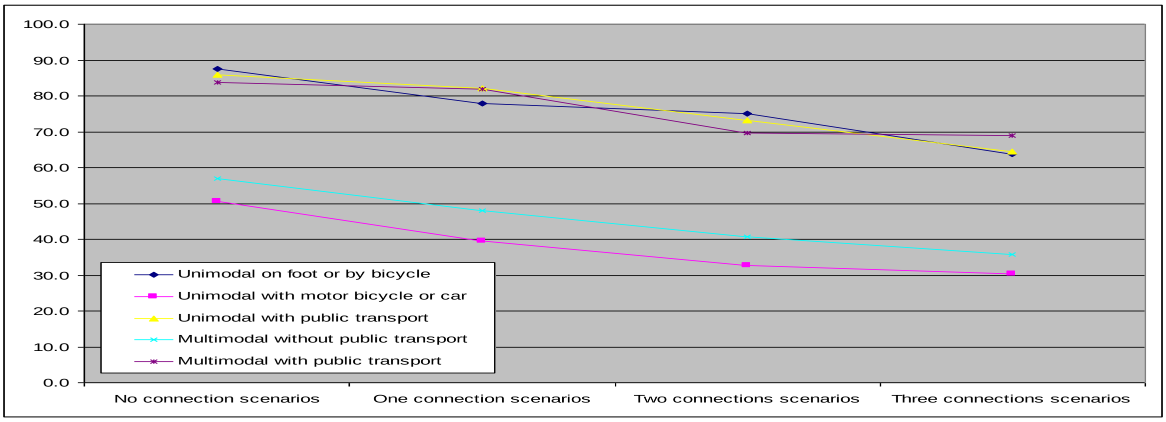
Variables	Levels of the Factor Variables	Local Estimate (LE)	Standard Error of the LE	Degrees of Freedom of the LE	Wald Chi-Square of the LE	P-Value of the LE	Global Degrees of Freedom	Global Wald Chi-Square	Global P-Value
Destination: City or Province	Agglo. Antwerpen	0.459	0.154	1	8.83	0.003	26	127.38	<.0001
	Agglo. Brugge	-0.041	0.197	1	0.04	0.8349			
	Agglo. Bruxelles	0.503	0.134	1	14.03	0.0002			
	Agglo. Charleroi	-0.082	0.225	1	0.13	0.7153			
	Agglo. Genk	-0.417	0.287	1	2.11	0.1462			
	Agglo. Gent	0.425	0.154	1	7.61	0.0058			
	Agglo. Hasselt	0.201	0.223	1	0.81	0.3682			
	Agglo. Kortrijk	-0.377	0.235	1	2.58	0.108			
	Agglo. Leuven	0.340	0.183	1	3.46	0.0629			
	Agglo. Liege	-0.403	0.224	1	3.22	0.0726			
	Agglo. Mechelen	-0.231	0.210	1	1.22	0.2703			
	Agglo. Mons	0.007	0.281	1	0.00	0.9806			
	Agglo. Namur	-0.147	0.167	1	0.78	0.3774			
	Agglo. Oostende	-0.582	0.283	1	4.23	0.0396			
	Agglo. Sint-Niklaas	0.238	0.278	1	0.73	0.3919			
	Agglo. Tournai	1.116	0.312	1	12.76	0.0004			
	Agglo. Turnhout	0.569	0.266	1	4.57	0.0325			
	Agglo. Verviers	0.236	0.454	1	0.27	0.6026			
	Prov. Antwerpen	0.571	0.204	1	7.83	0.0051			
	Prov. Brabant Wallon	-0.658	0.363	1	3.28	0.0699			
	Prov. Hainaut	-0.378	0.269	1	1.97	0.1604			
	Prov. Liege	-0.467	0.348	1	1.81	0.1791			
	Prov. Limburg	0.542	0.232	1	5.44	0.0197			
	Prov. Luxembourg	-0.560	0.449	1	1.56	0.2123			
	Prov. Namur	-0.505	0.286	1	3.13	0.0767			
	Prov. Oost-Vlaanderen	0.063	0.210	1	0.09	0.7656			
	Prov. Vlaams Brabant	0.000	.	0	.	.			
	Prov. West-Vlaanderen	-0.421	.	0	.	.			

The plot illustrates the influence of the **origin and destination** on the **connections acceptance**



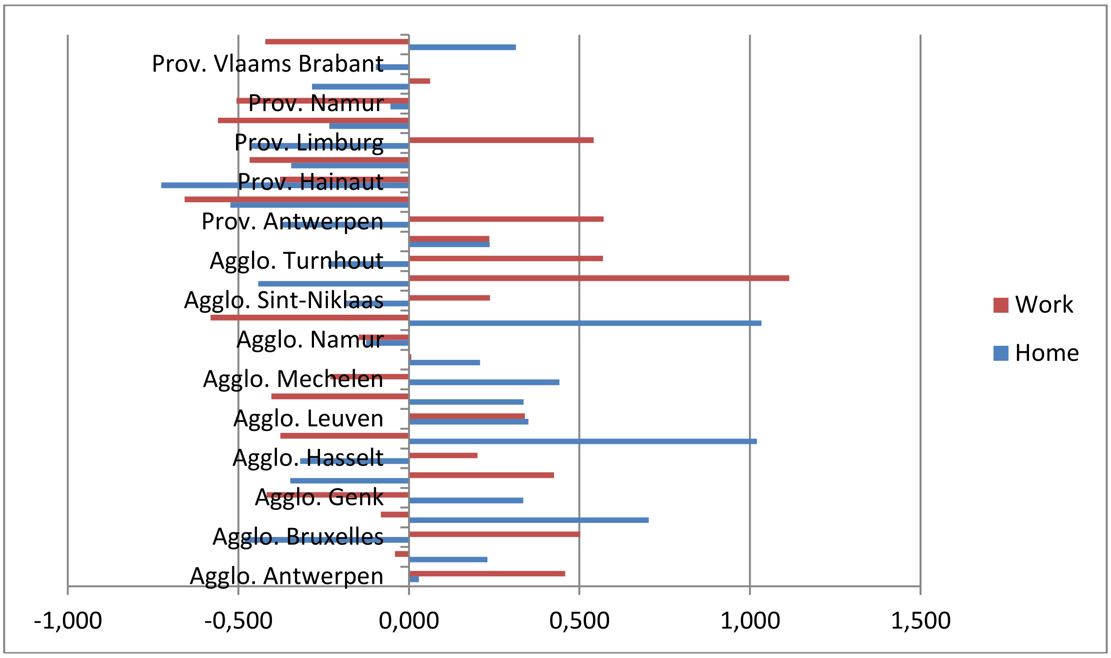
Influence of the connections on the mode choice by origin destination

The plot illustrates the influence of the **current mode** on the **connections acceptance**



Influence of the connections on the mode choice by mode type

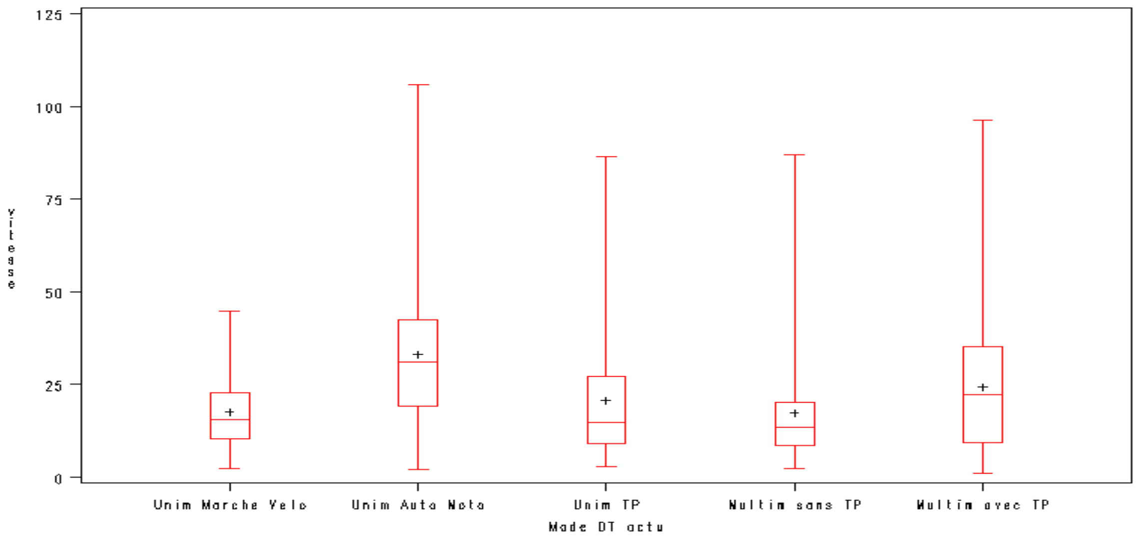
The plot illustrates the **isolated coefficients of the origin destination**


Prov. Vlaams Brabant
Prov. Namur
Prov. Limburg
Prov. Hainaut
Prov. Antwerpen
Agglo. Turnhout
Agglo. Sint-Niklaas
Agglo. Namur
Agglo. Mechelen
Agglo. Leuven
Agglo. Hasselt
Agglo. Genk
Agglo. Bruxelles
Agglo. Antwerpen
-1,000
-0,500
0,000
0,500
1,000
1,500
Work
Home

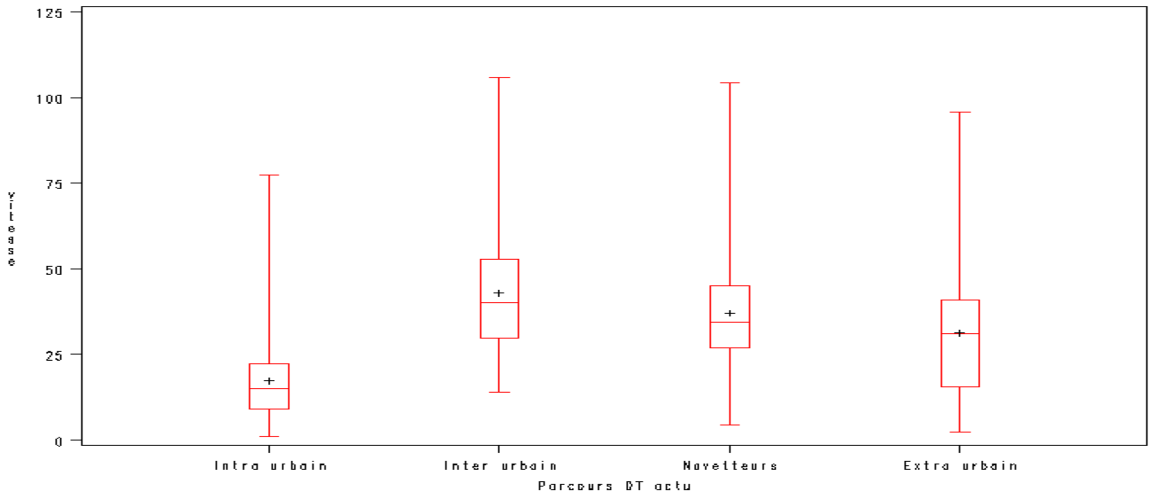
Annexe 5: Analysis of the Speeds

Fully indicatively, we computed speed estimation based on the Lambert estimated home work distance and the stated length of that home work trip. The distance estimation is based on the coordinate of the geographical centre of each commune. This estimation probably underestimates the distance so the speed could also be underestimated. But, the interest here is to compare our five mode category and our four origin destination category.

The boxplots concerning the mode typology show without any surprise that unimodals by foot and bicycle are slower than every other mode. Then the multimodals without public transport are coming. This is not surprising yet: This mode category is dominated by the combination Bicycle and Car which we suppose it is an alternative choice and not a real combination. After these slow modes, public transports (PT) arrive with a unexpected higher speed for multimodal. This is probably due to SNCB users that are more present in this category (64% in MPT against 37% in UPT). Note that the median speed of the unimodal in PT is not far from the slow mode which is problematic to promote the public transport. Winner of the speed contest, unimodals car and motorbike are largely the faster.
In the origin destination typology, the winner is the Inter Urban category. It is composed by people who come from a city area and go to another city area. About fifty percents of these people are using the public transport with a long branch with the SNCB. Then Commuters and Extra Urban are slower with an extended interquartile range for Extra Urban. These are largely non users of Public Transport but users of the slower modes. Finally, Intra Urban origin destination trips are the slower trips we estimate.



Speed distribution in the mode typology



Speed distribution in the origin destination typology

Annexe 6: report of the user meetings

Meetings of the follow-up committee were organized. The follow-up committee has posed some informative questions with respect to the reported intermediary results. These are reported below.

The first question deals with the application of the activity-based model in terms of level of detail (granularity of the model).

- It is explained that given the available dataset, and taken the statistical representativeness into account, the model is only appropriate to calculate origin/destination information between zones (like for instance between communities or cities).
- At this moment and given the available data (designed to be respresentative between communities) it is not possible for the model to analyze micro-level information at a very low detail or within a particular city. Conceptually, there is no problem and it can be done since the model does not require major adaptations (although the level of work to achieve this goal (including collecting statistically representative data at the level of one city or community, calibrating the model, etc.) may be significant).

The second question which is raised, deals with the authority of policy makers at different levels. It is questioned whether it is perhaps possible to give final policy recommendations both at the federal and regional level. Within this context it is important to take into account that the final influence on decision making is highly influenced by the fact whether a policy maker operates either at regional or at federal level (given different authorities at different levels).

- It is stated that at this moment the scientific teams did not yet take the level of policy making into account in the formulation and choice of policy scenarios. It may however be possible to do this, because policy measures for transportation are not solely limited to the "Mobility" policy domain. Giving tax incentives to companies to encourage flexible work hours for instance, may have a significant impact on transportation (can be calculated by the model) but it is certainly not only applicable to the policy domain of transportation. Several other examples can be thought of as well.

Third, a question is posed towards the users which policy measures seem to be preferential from their point of view.

- Most users prefer cost scenarios (like congestion pricing or increased fuel costs) as a case study. Also specific measures which address the service level of public transport (like new transit routes or transit stops) are preferable. With respect to service measures, it is argued that some of these measures incorporate infrastructure information, which is not specifically addressed in the model at this moment. It is concluded that several policy measures are useful and that one should concentrate on the integrated approach of the project (economic, ecological and acceptability) which is an unique opportunity and which facilitates awareness and the degree of acceptability by policy makers.

Finally, some detailed questions were related to the emission and cost results that were reported so far. First, an explanation was asked for the fact that train and tram had less environmental impact than buses. It was reported that this finding is related to the occupancy rate of the vehicles. The reported findings are findings per passenger at the moment, not per vehicle. Also, the remark was made that the socio-psychological cost of the implementation of a sequence of activities (willingness to organize different activities in daily life), was not accounted for. One should also care for the opportunity cost of driving your own car, which is eg. related to the cost of time and congestion. Finally, the personal cost of using public transport should be accounted for. It was answered that these costs were accounted for to some extent, but that in further analyses and work we will try to better detail the mentioned cost categories. However, one should be careful for double-counting. Also some of the mentioned categories are difficult to measure and implement. Especially one should also care for the time cost of using different transport modes. (delay costs, etc). Related to this, it is said that the sensitivity analyses can be calculated in more detail. Finally, it is mentioned that it is important to relate the findings of the SCBA with the findings of the Ecoscore model, for benchmarking purposes but also in order to come up with more detailed cost estimates (g/km; g/passengerkm)