Professional mindsets regarding mobility behaviour

Do we fully understand mobility behaviour? What do the decisionmakers think and what is their professional mindset?

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Introduction

In Deliverable 2.1 of the MIND-sets project (*Understanding the role of mobility in the changing lifestyles of Europeans: coordinating what we know*), we have brought together what we know about the role of mobility in the changing life-styles of Europeans, taking an explicitly multidisciplinary perspective. This knowledge is based on decades of research, mainly by academics and consultants. Throughout the years, this scientific knowledge has been used to develop a wide range of decision support tools, ranging from mathematical models of transport networks to sophisticated approaches to participatory planning processes.

In this report, we take the perspective of the practitioners, and ask the following questions:

- Are practitioners aware of the tools that are available, and do they use them? If not, why?
- Have these tools proved useful in daily practice?
- What would be needed to improve the performance and the relevance of these tools, and what does this imply in terms of future research needs?

In order to tackle these questions, we have held a series of semi-structured phone interviews with transport planning professionals from a very wide range of backgrounds. Despite the diversity in our sample, some clear storylines have emerged.

The report is structured as follows. First, we explain the approach we have taken for our survey, including a verbatim representation of the questionnaire. In a second step, we review the main story lines that have emerged from the interviews. As the interviews were semi-structured, some issues have been raised that had not been anticipated when the questionnaires were drafted. Moreover, some topics have received more weight in the discussion than we would have thought. Therefore, our review does not follow the structure of the questions that have been asked initially, but has been structured around the main themes that have emerged in the process:

- Who uses decision support tools when planning transport policies or projects, and how important are formal quantitative tools in this process?
- How easy is to communicate the potential and the limitations of the tools to policy makers and the broader public?
- Where formal tools are used, what explains the continuing prominence of the Four Step Model, while most practitioners acknowledge that, at least in theory, Activity Based Models contain more relevant information?
- How satisfied are the users with the tools they have at hand? To the tools still fit the policy questions that need to be answered?
- How realistic are the underlying behavioural assumptions?
- What kind of data are used in transport models? What are the most important gaps, biases and limitations in current data collection methods? How significant is the potential of new data gathering techniques based on new communication technologies?

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- How will emerging vehicle and communication technologies affect the validity of current modelling approaches? µ
- How well are models equipped to deal with regional differences across regions?
- What are, according to the practitioners, the most pressing needs for further research in the field of mobility behaviour?

We also discuss briefly some miscellaneous other topics that have been raised during the interviews. We conclude this paper with the key conclusions that we have drawn from these interviews.

Approach used

In order to conduct in depth interviews, it was necessary to limit ourselves to a small sample of interviewees from a diverse background. In total we have interviewed 16 professionals.

They include:

- Officials supporting strategic decision making at the level of national ministries of transport; officials involved in transport modelling (at the national level or at the city level); planners for public transport operators; transport authorities at the city level (ranging from small municipalities up to large metropolitan areas). Several of these officials have in the past also worked as academics or consultants. Some have worked both for municipal and national authorities.
- Geographically, we have covered most regions of the European Union (northern countries, Western Europe, Mediterranean region, Central and Eastern Europe) and one metropolitan area from the MENA region. Our sample also included two islands with a large touristic industry.
- An important share of the respondents come from an engineering, mathematics or physical science background, but our sample also includes professionals with a background in policy sciences, economics, urban and regional planning, and marketing.

All professionals who have been contacted have been asked to respond on a voluntary basis and have been asked to choose whether they wanted to be further involved in the MIND-sets activities, namely in WP3 and in the Knowledge Center created in WP5. A disclaimer has been included in the questionnaire stating that all information would be used for the purposes of the project only. Before entering the questionnaire, participants have been asked to sign a 'informed consent form', where the purposes of the research and what use will be made of the information they provide are clearly stated, in accordance with EU ethical guidelines. It has been emphasized that the project report would follow "Chatham house rules", i.e. would not attribute specific statements to individual respondents. Moreover, the report does not refer to the brand names of the actual tools that have been discussed. All respondents have been given the opportunity to review the draft deliverable.

The MIND-sets team would like to explicitly thank all participants for the time and the effort they have invested in answering our questions.

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Questionnaire

The following questions have been submitted in the written questionnaire. This questionnaire has been used to structure the phone interviews, but the respondents have been given the opportunity to raise any issue they thought was relevant for the subject. Each interview has taken around one hour.

- What tools and types of data do you use in your current planning process and/or policy cycle?
- Do these tools include quantitative models?
- Would it be possible to succinctly describe the main characteristics of these tools (note that you only need to discuss model you have actual practical experience with):
    - ☐ four-step model,
    - ☐ activity based models,
    - ☐ aggregate forecasting models,
    - ☐ microsimulation
    - ☐ others (explain)
- If you have considered using different tools, can you describe why you have chosen the specific tool(s) you use now?
- How would you describe the assumptions regarding human behaviour that underlies these models?
- How would you describe your general experience with these tools?
- To what extent have the forecasts of these tools (total transport demand, modal shares, distribution of the flows over the transport network, impacts of specific measures on traffic safety or local bottlenecks) proved to be reliable?
- Have these tools helped you in developing a better understanding of the transport problem under analysis?
- Do you think that these models are well equipped to integrate other motives than the money and the time cost of travel. For instance:
    - ☐ Comfort and convenience could be important considerations in mode choice. People may travel by High Speed Rail rather than airplane just because they can work better; or may select a longer flight combination when travelling within Europe to avoid the hassle of a connection in one of the largest European hubs.
- What would need to change in existing tools in order to improve their practical performance and relevance?
- If past forecasts have proved to be inaccurate, would you attribute this to (non-limitative list):
    - ☐ The underlying behavioural assumptions of the model?
    - ☐ Inaccurate or insufficiently detailed representations of the underlying transport network?
    - ☐ Inaccurate forecasts of the exogenous variables of the model (economic activity, demographics)?
    - ☐ Inaccurate representation of new transportation technologies (ITS, smart cards enabling shorter alighting times in public transport, web based services for

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intermediation between supply and demand) or specific transport modes (e.g. electric bicycles)?

- Do you think existing tools are well equipped to integrate some expected technological and societal changes (greying of the population or other demographic tendencies, autonomous vehicles, social media, e-shopping, teleworking or other aspect of the organisation of work that could affect transport demand, changes in land use, a possibly growing share of people wishing to travel by "green" modes)? If not, how do you think they would need to be modified?
- Do you have recommendations, suggestions or wishes for mobility research in the mid-term future (horizon : 2020) as part of the overall changing lifestyles of different population groups (ages, generations, social classes, different sexes ...) across Europe?"!

Discussion of the results

Use of formal tools

The use of formal tools varies widely. Two elements appear to be important in whether they are adopted or not: 1) the resources available for the adoption of the tools, which is linked to the geographical scope of the policy analysis on the one hand and the average income levels in this area on the other hand; 2) the type of policy question that is being addressed.

1) All other things being equal, the larger the area covered, the more policy is guided by formal tools. Thus, national transport authorities tend to use sophisticated formal models, underpinned by vast and detailed data sets. The same holds for larger cities. Although our sample was too small to give a clear threshold, we would submit that only cities with more than 100,000 inhabitants find it worthwhile to invest in dedicated models. Public transport operators serving a wide area also tend to use formal planning tools. However, operators do not necessarily develop these tools in house, but can also use the models used by the public authorities.

The traditional Four Step model remains the most widely used tool (see further for more details) and can be used as input in social cost benefit analysis. However, larger agglomerations also use microscopic simulation models (for instance, for optimizing signalisation and changes in the geometry of junctions).

Below the threshold of 100,000 inhabitants, it appears to be difficult to convince policy makers of the usefulness of formal tools, particularly in the light of the development *and* maintenance cost (data collection, coding of the model, etc.) of such tools. At this level, authorities tend to rely on coarser sources of information, such as traffic counts at crucial intersections (which can help to identify major problems in the network) or interviews with stakeholders (in the case of infrastructure projects). Nevertheless, one of our respondents has pointed out that, in his experience, meso-level models can

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be useful in discussions about infrastructure projects in small municipalities: in the discussion with stakeholders, such models can help to illustrate and visualize the concrete implications of the options that are being considered.

In one of the cities covered by this study, formal tools are used extensively for the day-to-day management of the transport system (maintenance, traffic sign signalling, the introduction of car free zone, changes in the public transport supply), but no need is felt for formal tools in long term planning. However, this situation seems to be rather unusual.

As pointed out above, other factors than the size of a city also play a role in the adoption of sophisticated tools. The resources available for model development do not depend only on the size of the city, but also on the average income levels. Some less affluent metropolitan areas have only recently moved from traffic counts to actual trip modelling.

2) The second important criterion in the use of formal models is the subject of the policy analysis. Several respondents are mainly involved in projects that aim to *change* mobility behaviour in the direction of more sustainable choices. Their toolkit tends to be less formal, and includes recommendations on how to create 'nudges'[1] (see the discussion on Behavioural Economics in D2.1), social marketing, stakeholder consultations,...

It should be noted, though, that the use of consultation and participatory processes can be complementary to the use of formal models. For instance, one of the respondents described the following process for the construction of long term scenarios :

- In a first step, consultation with experts (not limited to academics) to identify the parameters that are relevant for the model or long-term scenarios, and to define a plausible range of values for these parameters
- Second, with the support of a consultant specialised in participatory processes, consultation of a sample of citizens. Although the objective is to have a representative sample of the population, participation is voluntary.
- Third, based on the two first steps, the definition of 4 possible visions (qualitative scenarios) of the future.
- Fourth, submission of these scenarios to a panel from industry. The main objective of this step is to correct for factual mistakes, and to have up to date assessments of technological developments.
- As a final step, quantifying qualitative scenarios by translating these inputs in model parameters.

[1] One example is the attribution of symbolic awards (such as in the 'climate heroes' campaign in school campaigns).

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Communication with policy makers

Most transport planners and modellers report that the use of models tends to be widely accepted by policy makers, although not all reported experiences were positive . There are still instances where decision makers do not understand the models and would mainly like to use them to confirm their own prejudices. Another problem is that some decision makers take the model results as 'facts' rather than as indicative figures. Communicating the results with broader audiences is even more challenging.

In contrast, transport planners see these tools more as instruments to explore possible future scenarios than as accurate predictors. At least one respondent thinks that models are useful precisely because they trigger the debate with respect to the policy issues at hand. One respondent suggests that, instead of running a large number of scenarios, it would be better to run a limited number of scenarios, and then to invest a lot of time in a detailed analysis and explanation of the results.

Also, some policy makers think that the results of formal traffic models are either trivial or not credible, and do not feel comfortable with the "black box" aspect – this is especially problematic in the case of smaller jurisdictions.

Interestingly, a specific advantage of microscopic simulation (compared to large scale models) is their graphical interface (animation), which makes it easier to articulate results to a non-technical audience and to decision makers.

Four Step models versus activity based models

Despite all its shortcomings, the Four Step model remains the working horse of traffic modelling, especially at the national level and in large metropolitan areas. It is not just being used for predictive purposes, but also to underpin social cost benefit analysis.

The persistent use of Four Step models is not due to a lack awareness of the existence and the potential of activity based models (ABM). The slow adoption of ABM in planning practice is mainly due to four elements:

- The use of Four Step models reflects fundamental choices that have been made in the past, before ABM were available. Once an authority has invested in such a model, switching to a completely different approach may be very costly.
- The use of ABM requires detailed data. Planning authorities typically do not have the resources to collect these data (let alone to maintain the model).
- Full-fledged ABM still require important computational resources, and can therefore be very slow to run. In order to tackle policy issues, it is sometimes better to have a less realistic model that runs quickly than a very sophisticated model that takes a week to finalise.
- ABM are more sophisticated models and therefore require more investment in training personnel and communicating to policy makers.

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Nevertheless, several respondents acknowledge that only ABM are well equipped to model adequately the interaction between transport and land use, the emergence of new social trends and technologies and "new" types of transport policies (such as: regulating parking, implementing ITS, Bus Rapid Transit, public transport pricing, promoting the rescheduling of trips and of distance work). In some cities, chain trips are relatively more important than in others, and Four Step models cannot capture this – this can lead to an important misrepresentation of reality.

To some extent, Four Step model can capture the effect of some technological or societal changes. For instance, once we have a better understanding of the impact of autonomous vehicles on road capacity use, this could be included in a Four Step model. Similarly, changes in spatial structures can be imposed as constraints on Four Steps model. However, dealing with the impacts of for instance teleworking would be much more challenging: teleworking does not only lead to a change in the number of trips, but also in how they are spread over the day.

Moreover, pragmatic approaches can deal with the drawbacks of each modelling approach. For instance, activity-based models can be used to cross-check trip based models, and maybe enable adjustment factors to be applied to the latter.

Intermediate solutions are also emerging. For instance, in one country, some regions are in the process of developing *tour* based models - although some of them claim to be activity based models, none of them really qualifies as such (see the D2.1 for a more detailed discussion of this specific issue).

In general, the theoretical potential for ABM seems to be recognized, but there are important barriers to implementation in practice. Practitioners often face limited resources, and most seem to think that the priorities for improvement lie elsewhere.

Four step models: what's in a name?

Although Four Step models are multi-modal by nature, this does not mean that they consider *all* modes. For instance, a Four Step model used by an organising authority may take the shares of walking and car as exogenous, and only consider the competition between (for instance) surface lines and the metro system as endogenous. Such a model can also limit itself to the study of the impact of public transport investments.

In other cases, the bias goes the other way: some models focus on the car (for instance, because public transport users are considered to be captive), and have a very rudimentary representation of modal choice for bicycle and public transport. Such models however lack the flexibility that is needed to understand a modal shift to public transport, which is an increasingly important policy issue.

The main reason why some authorities use a simplified modal choice module probably is the need to save resources (such as for instance conducting travel surveys that would allow to estimate all possible substitution patterns between modes). One of our respondents has shared her experience with

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integrating several standalone models into a fully integrated multimodal model, and has made clear that such an integration requires a major effort.

Satisfaction with the tools

In general, practitioners who do use formal tools seems to be satisfied with them, despite all the identified needs for further improvement. Of course, 'satisfaction' is a relative term: one of the respondents deemed that predictions with margins of errors of about 25% were very good. Still, this level of accuracy was considered good enough to tackle issues such as the dimensions of the railway platforms, or the width of the corridors or the stairs in the stations that would accommodate the projected traffic flows. Another respondent reported that, although prediction were reasonably reliable at a global level, on a link per link basis, the difference with measured flows could reach 40 to 50%. In his view, such models can be used to support strategic analysis, not to obtain accurate estimates of future traffic flows for project development.

In the experience of one of the respondents, while the total transport demand forecast is generally reliable, in most of the cases, modal shares are not. If a single transport mode, i.e. road/cars, is considered, the flows *distribution* over the network is pretty good. The respondent suggested that this may be due to an underestimation of psychological factors (such as the need for comfort, safety, prestige) associated with private car use. Another respondent has pointed out that the costs of overestimating the flows in public transport are not symmetric with the costs of underestimating them (think of the capacity of the exits of a station). Other respondents have not raised this specific issue.

One of our respondents takes a completely different view on this issue, and argues that, at the level of cities, so many parameters are changing simultaneously, that it is not really possible to evaluate the reliability of model predictions (except for schemes with purely local impacts). In the case of highways, the Highways Agency in his country systematically assesses past traffic , and finds no clear bias in the direction of over- or underestimation. In the case of rail forecasts, however, future demand tends be overestimated.

Another respondent pointed out that the biggest problem is not the lack of precision as such, but rather the risk that policy makers will accept the results as facts, rather than as (imprecise) forecasts. It has also been pointed out that inaccurate forecasts are sometimes used by third parties to discredit the models as such.

While several respondents acknowledged that existing tools and data are not well equipped to deal with major societal and technological trends, they do not see an obvious way forward to deal with this, and would rather see an improvement of existing tools and better data. One respondent argued that, at least in the medium term, errors in socio-economic projections are much more crucial than changes in values and technology.

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Tools in the light of evolving policy objectives

The usefulness of data and tools also depends to a large extent to the question that is being addressed.

As discussed elsewhere, their main application is to plan for transport infrastructure capacity, although transport models can also be used for environmental evaluations.

However, transport data can also underpin operational changes with immediate effects. For instance, in one touristic area, a careful identification of the tourists' needs through targeted interviews has led to the construction of bus shelters, to targeted information concerning the different transport options in the area[2] and to the addition of new bus stops. These actions have resulted in a marked increase in the use of busses by this target group. In this case, no sophisticated modelling was needed to achieve significant policy results.

Another respondent pointed to the wider and more fundamental issue of the changing objectives of transport policies (and hence appraisal). 40-50 years ago, the main objective of these models was to evaluate projects that would provide for private cars. Now, the objectives are moving towards promoting liveable cities. It is however not clear how one could evaluate an objective such as the "regeneration of an area" with existing evaluations tools, especially if the "regeneration" objective conflicts with other objectives, such as improving traffic flows, which are easier to quantify. Some policy needs are thus running ahead of appraisal capacity.

Underlying behavioural assumptions

Several respondents who use Four Step models appear to be comfortable with the underlying behavioural assumptions. Two broad categories of arguments in favour of this approach have been punt forward:

- Some acknowledge that people may exhibit some irrational behaviour, but claim that this can adequately be captured by the constant term and the error term in discrete choice models, as long as this irrational behaviour remains stable. However, if this behaviour changes, new model estimates are needed – as discussed elsewhere, collecting the necessary data can be rather resource intensive.

- Others argue that these behavioural assumptions are simple approximations, but that they suffice to understand aggregate mobility patterns, and to better understand the consequences and the effects of public decisions. One planning authority has argued that, with an increasing

[2] Including multimodal information, information on how to access the local transport system and information on the different payment options.

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use of real time information, the importance of irrational behaviour will decrease with time anyway.

This is however not an opinion that was shared by all, and one respondent even sees unrealistic behavioural assumptions as the main sources for prediction errors in the models. Another described the underlying behavioural assumptions as 'very poorly developed', and thinks that the formal models need to be integrated with qualitative information, based on expert knowledge.

Other respondents are convinced that getting a better grip on mobility behaviour is actually the most fundamental challenge. They point to concrete examples in planning practice where predictive models failed to anticipate determinants of travel behaviour, such as the aesthetic pleasure derived from a route.

There are hugely diverging opinions on the capacity of formal models to capture other motives than the money and time cost of travel. Some respondents are very sceptical on this subject.

In line with the recent developments in the field of behavioural economics (see MIND-sets D2.1, Chap 'The economic approach to mobility behaviour'), one single respondent took the more radical position that some essential behavioural assumptions are simply missing in current models. Furthermore, the models are often inappropriate for assessing the effects of behavioural measures, as there is often a gap between the model input parameters and the behavioural measures.

Data sources

The data inputs come from diverse sources such as national or regional travel surveys[3], traffic counts at key points in the network, surveys held at park-and-ride sites, dedicated interviews, smartcards in the case of public transport, surveys organized by public transport operators or their organizing authorities, census data, public transport timetables and schedules, police data (mainly as a by-product of the enforcement of traffic regulation), expert panels, macroeconomic forecasts, stakeholder consultations, data from planning and development agencies…

Next to the structural sources of information, data are sometimes collected for very specific needs. For instance:

- In order to optimize the transport supply for the tourist sector, the authorities in one Mediterranean island have also collected data from the Airport Express services, the bike sharing company and from surveys held at the tourist resorts.

[3] It is noteworthy that some countries do not hold systematic national travel surveys, and that any surveys that are available are based on ad hoc work by external consultants.

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- Next to the recurring large scale surveys, some cities also hold surveys during large scale events such as annual fairs, which attract a lot of people from outside the city.

Besides data on transport demand, models also need to be fed with data on transport supply. In less affluent countries, the representation of the underlying transport network can be very coarse, and this also affects the quality of the model outputs.

Integrating different sources of information

At all levels, transport policy makers and planners are thus confronted with a plethora of different data sources. It is then crucial to decide whether the information that is obtained from outside sources meets their needs, or whether additional information needs to be collected.

Especially in the case of larger geographic areas, the transport system is sometimes covered by different surveys. For instance, in a city, both the organizing authority and the public transport operators may conduct surveys, but with a different focus: individual operators will focus on the journey between stops on their network, while the organizing authority is more interested in the origin and destination of the complete journey. Also, cities may find that national or regional surveys are not representative for their situation. This allows cities to differentiate between types of respondents according to criteria that would not be used in national surveys (for instance inhabitants, visitors, companies, employees). The survey at the city level can also be held more frequently than the national surveys. In at least one country, the surveys held by the city authority follows a national methodology, to allow comparability over time and space.

In some cases, public transport operators find that the national or regional representation of the physical network is not detailed enough, and they collaborate with the city councils to develop more detailed network models. The optimal level of detail requires a delicate balancing between different criteria. One transport authority in a metropolitan area has taken the opposite direction and has actually reduced the number of zones used in the transport model, to reduce the cost of data collection, but also to reduce the computational requirements of the transport model. Indeed, in the model used by this authority, within each simulation year, there is a iterative process between the Generation Module, the Modal Choice Module and the Assignment Module, which ensures full convergence between these three modules – but computing such a “full equilibrium” has obvious implications in terms of running time of the model.

Combining data from different sources can be challenging, as the following examples make clear:

- Data often pertain to different time periods. For instance, in some locations, speed controls by the police are performed less than once per year, and as a consequence, the data obtained from the police remain very infrequent.

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- In at least one country, the publication of the (detailed) data at the level of the traffic zones used in the model usually lags several years behind the publication of (less detailed) data at the municipal level.
- Some organizing authorities integrate all information on ticket usage of all individual public transport operators on a daily basis – this gives them a good idea of where people have changed lines and/or transport modes. However, if private modes fall outside their remit, the authorities have no systematic information on the use of parking except for information on park-and-ride systems managed by the PT operators.

Data gaps

Despite all the talk about the date deluge, important gaps remain in the data. Paradoxically, some crucial data are currently harder to obtain than in the past. For instance, some countries have stopped conducting censuses, which had turned out to be very important sources of information in the past. Some data that were publicly available in the past are now also commercial secrets since the opening up of public transport markets.

Some cities have only now started to collect systematically data on the availability of parking spaces – finding information on private parking lots, for instance, can require a substantial investment. However, the availability of parking places is a crucial variable in transport policy, as it may induce new traffic, but also reduce congestion due to vehicles cruising for a parking place.

Where smartcards are not widely used in public transport (or have not been introduced at all), the operators can still capture the boardings with "traditional" systems and complement these data with counting campaigns at the bus- and tram stops, during the trips and at the main access roads to the large cities ("cordon counts"). Still, one respondent reported huge margins of error (20 to 30%) in the estimate of the length of public transport trips.

The institutional framework can also lead to important gaps, if the city does not control all aspects of mobility within the city limits. For instance, in one case we have studied, the city has no authority over the national railway companies or over the public transport operator, and thus has very little information on the use of public transport in the city.

Biases in data collection

In the cases we have described above, the actual gaps in the data were obvious. However, the way data are collected can lead to specific biases that can be overlooked:

- Sometimes, traffic count mainly take place in order to provide input data for upcoming infrastructure works. If these infrastructure works are planned to solve specific bottlenecks, these data can give a biased view of the overall situation in a network.

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- Surveys are often conducted during working days, and therefore do not always create a complete picture of travel behaviour for other motives than home-to-work and home-to-school trips. As a consequence, there is not always a good understanding of what is going on outside the peak hours. This focus on peak hour reflects that the main use of these surveys is to forecast infrastructure needs, but it reduces the usefulness of traffic projections to understand the environmental impacts of transport (which do not only occur during the peak hours).
- The way data are collected can also lead to the under-representations of some modes or trips. For instance, in urban areas, walking can have a very important modal share, but if no data are collected on intra zonal travel, it can be difficult to assess to what extent walking competes with public transport. In some cities, this leads to an important misrepresentation of home-to-school travel. In other cities, surveys are conducted mainly during the autumn and the winter, leading to an underrepresentation of bicycle trips. The inadequate representation of non motorized travel in the broader sense is an issue that has been raised by several respondents.
- Some surveys also still suffer from selection biases. For instance, in some cases, the survey is conducted by phone. However, if there is no directory of mobile phone numbers, and as the share of mobile phones is increasing, the people who are interviewed are not necessarily representative for the population of the city in general.
- Some commercial software use default values that are based on evidence in the home country of the developer. As mobility drivers and patterns can vary a lot over Europe, practitioners should avoid applying such default values blindly in their own country. However, the means are not always available to conduct studies that would be more representative for the local situation.
- National data from the vehicle registry are not very useful to estimate the number of cars used by residents because these data ignore leased cars – this is especially problematic if there is a high share of leased cars in use.

Field experiments as sources of information

In some countries, there is an interest in the use of Randomized Controlled Trials to evaluate systematically the effectiveness of policy measures targeting behavioural change, and some first experiments have been conducted.

Another example of an experimental approach to obtain information is to temporarily change characteristics of the transport system (for instance, closing a street) and measuring the effects to better understand behaviour. Such an temporary change can be the by-product of needed investment or maintenance, but can also be arranged for with the only purpose to understand the behavioural impacts.

One of the respondents even reported that, for small changes in infrastructure, a 'trial and error' approach is standard in his region. He reckons that this may be probably cheaper than using large scale models to simulate the impacts.

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New and emerging data sources

New technologies can provide new sources of data, but there are still strong doubts on, for instance, the statistical representativeness of floating car data, especially as tool to estimate traffic flows. For instance, one study in 2010 has found that just 3% of the surveyed vehicles were using their GPS. Therefore, at this stage, these data are often only used to estimate speed levels, not volumes.

It remains to be evaluated whether this still holds true with the ever increasing market penetration of smartphones with GPS. In some cities, there are trial projects going on with mobile data to monitor pedestrians, and it is envisaged to extend this to cyclists in the future. In other places, authorities are starting to use mobile phone data to capture origin-destination patterns. Several respondents are currently taking a cautious "wait and see" approach.

Sometimes, new data sources emerge as the result of enforcement schemes. For instance, in one city included in our survey, Automatic Number Plate Recognition (ANPR) will be used for enforcement of a Low Emission Zone that will soon be introduced. The ANPR can also be used to count traffic streams and to identify the types of vehicles that enter the LEZ. In the future, automating the enforcement of on-street parking could allow to scan the features of parked vehicles.

In the case of Randomized Controlled Trials, a lot of information can be obtained from project specific apps, from public transport smart cards and from new devices for monitoring individual cars.

Information gaps in travel surveys

Compared to other sources of information, an important advantage of surveys is that the researcher can decide himself which questions to ask, and can thus target them as a function of the policy question he is addressing.

Nevertheless, several respondents have pointed to important gaps in the information that is currently collected in travel surveys. Some of these issues are rather fundamental, other are very specific. Of course, not all travel surveys suffer from these data gaps.

For one of the respondents, the main challenge is how to incorporate parameters related to personal values, such as changing attitudes (especially of the young)[4] towards shared mobility and public transport. As far as the elderly are concerned, there is sometimes an important discrepancy between the mobility they would like to have and the level of mobility that is feasible for them. One public transport operator has pointed out that, although market research has confirmed the existence of a

[4] One of the respondents pointed out that these attitudes are becoming increasingly complex. For instance, there is indeed evidence in his country that younger people tend to be less avid car users. However, our respondent thinks that most young people merely postpone the purchase of a car until they think they need one (for instance because of changes in the composition of their household). Nevertheless, this behaviour could have lasting impacts, because there is evidence that the longer people postpone the actual purchase of car, the more they exhibit multimodal behaviour in the long run.

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"status quo bias" between "life stages"[5], this is not taken into account in the current version of their demand model.

To state the problem in more general terms, one essential issue is that mobility life styles are becoming increasingly diverse, and that simple variables such as age and gender are insufficient as input in predictive models.

These data gaps have immediate policy relevance. It has been argued that, in order to induce behavioural change, we need more detailed information on the characteristics of the population, which would enable the use of consumer market segmentation techniques. For instance, the European Maxsem project has identified 4 target groups for mobility behaviour, each of one needs a different strategy. To give just two examples:

- It requires a lot of energy to try to change the behaviour of someone who is a convinced car user, possible because he sees his car as a "status symbol". In times of limited resources it seems smarter to focus the efforts on the people who need just a small additional push to change their behaviour.
- If the policy issue is congestion during the peak hours, you need to understand who is actually stuck in the peak hour traffic and why. For some groups, price may be important, but then we need to understand who these groups are and whether there are any threshold effects. This information can then be used to fine-tune the measures, for instance, by making the price information more salient.

Some respondents have access to survey results that allow to identify specific target groups, and have found this information extremely valuable. For instance, one single transport authority reported having developed a Four Step Model that distinguishes several subgroups in the population differentiated according to their specific mobility (both in the Generation module and in the Mode choice module).

This situation seems to be exceptional, though.

The lack of information on "values" and mentalities is especially important in the following cases:

- Travel motives in the travel surveys are often split according to the 'classical' criteria (work, school, other), but there is no enquiry about the fundamental reasons why people travel (for instance, in the case of 'other', to visit friends, to care for elderly parents, for hobby activities etc). In general, there is little information available on the evolution of travel demand for other purposes than home-work and home-school.
- Surveys do not directly address the fundamental motives for modal choices: what is the most important for people (money, time, safety). Also, they do not adequately address how people perceive the comfort of the different transport modes.

[5] When something changes in their personal situation, people reconsider their mobility choices. However, once these choices have been made, people tend to stick to them until a new important change in their life occurs.

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As explained in MIND-sets deliverable D2.1 – Chap. ' The economic approach to mobility behaviour', stated preference surveys could incorporate more qualitative factors as parameters and be used to estimate hybrid choice models. However, hybrid choice models are not widely adopted by practitioners. One of the respondents attributes this to the increasing role of consultants in advising local authorities (at the expense of the role of academics). In the view of this respondent, both consultants and local authorities tend to be more conservative in their approaches than academics. However, there are also technical concerns with the use of such models. One of the practitioners pointed out that their current models are based on attributes of the complete population, and that is not clear how such models could integrate the results of hybrid choice models that would only cover a subsample of the population.

Another crucial element is that behaviour is changing very fast (think of the impact of electric bicycles on the mobility of senior citizens). However, the frequency of the surveys varies a lot from country to country, and even from city to city. In one city, an exhaustive travel survey has now just been conducted for the first time. Other cities hold annual surveys. In other contexts, the frequency of surveys is much lower (mainly due to cost considerations) and the underlying behaviour changes faster than the surveys can cope with. A problem with the low frequency of some surveys is that they assume that the behaviour of the respondents will remain constant over time, even though their personal situation and values can change in crucial ways between two survey periods. Large scale travel surveys can also lag behind in the identification of new mentalities.

Besides these fundamental issues, existing travel surveys sometimes suffer from important specific gaps in the information that is currently collected.

In the experience of one of the respondents, the most difficult issue is to find valid estimates of the opportunity costs of time. These values can be expected to vary according to travel motive, the socio-economic characteristics of the individuals and the type of activity they are engaged in (waiting, travelling, etc.). However, in practice, due to a lack of information, planners may have to work with averages. Obtaining more precise and disaggregated estimates would require an important investment in additional surveys, for which they do always not have the means. Therefore, in practice, they may use the default values of your transport modelling software and the literature of the topic.

In the case of freight transport, some important gaps in existing surveys are:

- If surveys do not include e-commerce, the share of light duty vehicles in freight is underestimated – one city authority has confirmed that they have no clear view of the impact of e-commerce on urban freight on the mobility flows within the city.
- They do not always include services delivered at home, such as care for the elderly or nursing services.
- They do not always account for within-company transport.

Finally, surveys do not always account for transit traffic or international tourism, which are becoming increasingly important in some countries. Moreover, the behaviour of tourists and other visitors

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deviates from the behaviour of residents, as they tend to use some modes (train and metro) more than others. In general, in cities, the travel behaviour of non-residents is not well documented. Where the public transport system provides smart cards for the whole metropolitan area, the data obtained from these cards can be used to (partly) compensate for this lack of information. In some cases, the tourist offices hold their own surveys, but the information gathered from these sources are not easily integrated in the mobility surveys.

Unfortunately, surveys are resource intensive. Several respondents have emphasized that cost considerations are crucial constraints in the design, the size and the frequency of surveys, and that not all shortcomings that have been discussed above warrant an additional investment.

Miscellaneous other topics

Backcasting versus forecasting

Two respondents pointed out that models can also be used for backcasting, ratherthan for forecasting. In such models, the desired end-state is the starting point of the analysis, and the models allows to explore the measures that can lead to the realization of these given objectives for the future.

For instance, such models could be used to explore how a given reduction in car transport can be realised. This would allow to identify the required investments in public transport and other measures that will ensure that the transport system continues to function.

Integration of broader impacts

Most tools used by the practitioners we have interviewed consider only the performance of the transport system. A limited number of these models are also integrated with other models to predict the impacts on air quality and noise levels, but such integrated models are not widespread.

Impacts of emerging technologies

Somewhat surprisingly for us, the role of emerging transport technologies has not been prominent in the feedback we have received.

In general, respondents doubt the capacity of existing models to understand the impact of emerging technologies. At least one respondent has emphasized that the impact of new technologies can only be assessed trough an analysis of diverse scenarios. We have already discussed that others are convinced that only ABM are suitable for the analysis of the impact of new transport technologies.

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On the specific point of electric bicycles, it seems that, in the countries where they are becoming a significant factor, their main current use is for recreational purposes (and mainly by the elderly). Moreover, there is a lot of seasonal variability. It's not clear for which mode they are the closest substitute, and thus what their long term impact on modal split will be.

The impact of "sharing" services remains very unclear as well, and has not been discussed in depth. For instance, according to one city authority, claims made in newspapers that the bicycle sharing system has led to a modal shift away from public transport in the city are not based on any rigorous analysis.

Similarly, few national studies are being conducted on emerging technologies such as autonomous vehicles.

Regional differences

The interviews have confirmed that the nature of the transport challenges and trends varies across Europe.

For instance, in some regions of Central and Eastern Europe, the population is decreasing and is becoming increasingly concentrated in a limited number of big cities. It is expected that, in the future, increases in transport demand will be limited to traffic between these cities. There is a very uneven regional development, which will lead to increasing isolation of elderly people in small villages (especially for those living in areas that are not served by subsidized public transport).

Just as in Western Europe, the population in CEEC is ageing. Elder people are also become more mobile compared to previous generations, but at a slower pace than in Western European countries.

Finally, in CEEC, there is no indication of any "peak car" phenomenon among young people. It is very important for young people to own car, except maybe in very large cities (where cycling is taking off). In rural areas, cars are crucial for mobility.

Suggested focus areas for new research

The answers we have received to this question were very diverse.

Some demands focused on a better understanding of the impact of technology on transport demand and supply. The following two issues were mentioned explicitly:

- The impact of autonomous vehicles on vehicle ownership, and the impact of changes in ownership on general mobility behaviour.

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- The impact of e-commerce

Some also think that a better understanding and representation of psychological factors would be an important priority for future modelling. However, as we pointed out above, not all respondents feel that there are fundamental problems with the current psychological assumptions underlying the model, or at least that these problems do not justify an important investment in radically new approaches or data. This appears to be a major area of disagreement.

Some respondents pointed to specific points where existing tools would need to be improved, or where new tools would need to be developed:

- It is important to understand the *distributive* impacts of measures such as distance based road charging, not just their global economic efficiency. In some countries, this would require significant additional data collection.
- As discussed above, a good visualisation of the results can help in communicating the results of transport models to non-specialists. This is not always a priority area in current large scale models.
- It is essential to better understand the effects of "soft" measures such as a preferential treatment for PT and (especially) using information to influence people's behaviou
- We need a better understanding of the impact major societal (demographics, living patterns) and technological changes, and of changing lifestyles and values, especially amongst the young and the elderly. Studies on these subjects should be held more frequently than the actual travel surveys, in order to keep up with fact paced change in these subjects. Models need to account better for the ever increasing diversity in mobility behaviour, and multimodal behaviour in particular.
- More work needs to be invested in the development of backcasting tools, to see which combination of measures can be taken in order to arrive at a particular objective (e.g. a given percentage of CO2 reduction), under different scenarios (e.g. regarding the network for some modes).

One very specific and concrete proposal is to invest in a standard smart city simulation tool that can be used everywhere in Europe using the same methodology – the respondent called it a "mobility COPERT". The tool would be on-line and should be fed by real life data (big data), complemented by survey data. It would be a tool with which different options could be explored easily in order to feed the discussion on policies and to get reactions on the output. Our respondent acknowledged that it would be a model with a weaker theoretical basis and limited reliability, but he thinks that it would be useful in showing some general points to stakeholders without going into detail.

As a final remark, let us note that one of the respondents warned against the development of (i) tools that become too complex and difficult to work with and (ii) tools that require unavailable or difficult to collect/ estimate data.

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Conclusion and further steps

We think that the following key messages have emerged from the discussions:

- At least in larger cities, the use of sophisticated formal models is widespread. These formal models are sometimes complemented with consultation and participatory processes.
- There is continuous need to communicate clearly to policy makers and the public what models can do, but also what their limitations are.
- Where formal models are used, the traditional Four Step Model remains the dominant approach. Practitioners are often aware of the existence of Activity Based Models, and they acknowledge their potential. However, they feel that ABM require important investments in terms of computing power and data. In the current situation, they do not feel that the additional insights that ABM could provide are worth this investment (or that it would be possible to obtain the resources that would be needed for their use).
- There are important divergences of view concerning the underlying behavioural assumptions of transport models. While most practitioners are comfortable with how traditional models deal with less-than-perfectly-rational behaviour, or think that the data lack for other approaches, some think that an important reconsideration of the underlying behavioural assumptions is needed if we want models to be relevant for policy support.
- New communication technologies hold a lot of potential to fill existing data gaps, but the profession is still in the process of learning how this can best be done.
- New technologies also radically reduce the cost of holding large scale field trials to test the behavioural responses to new policy approaches or changes in infrastructure.
- Models do not exist for their own sake, but need to provide support in addressing policy questions. If the policy questions evolve, the tools need to evolve as well. Models also need to be adaptable to local circumstances.
- There are important gaps in current survey methods. Surveys mostly focus on what is happening during peak periods. This is very useful for capacity planning. However, with ever increasing share of trips for non-work purposes, it is also important to better understand what is going on outside the peak hours if we want to reduce the environmental impacts of transport.

These preliminary findings will be further explored within future MIND-sets project activities. A wider set of responses to a simplified version of the questionnaire will be collected via the MIND-sets website. At the same time, the expert workshops organised in Barcelona on 29-30 October 2015 will provide further feedback and possibly innovative ideas on how to improve transport modelling and fill current gaps. These additions to the current D2.2 analysis will be included in the next MIND-sets Deliverable D3.3 'Future trends in mobility: challenges for transport planning tools and related decision making on mobility product and service development'.

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