

CREATING TRANSPORT MODELS THAT MATTER: A STRATEGIC VIEW ON GOVERNANCE OF TRANSPORT MODELS AND ROAD MAPS FOR INNOVATION

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Abstract

The basic use of transport models is that they help to increase our understanding of the mobility system. In more operational terms, they can be a basis for developing quantitative insights in the past and current state of the system or scenarios about the future. Models are also useful as impact assessment tools in decision making processes or for ex post evaluation. Each purpose places different demands on the availability and quality of information. The issue treated in this paper is how we can improve the organization of the supply side of the modeling market (including the influence of public agents on this market) in a way that the models can meet policy demands of the future. We consider two dimensions of model supply: (1) the contents dimension, i.e. the ability to inform policy makers on specific policy questions and (2) the dimension of governance of model development and model applications. We report on the findings of two studies that were conducted in 2009 and 2010 sponsored by the Dutch Ministry of Transport, Public Works and Water Management. The first study developed a long term vision on important governance aspects such as quality assurance and presentation of model results. The second study developed a long term road map for R&D of passenger and freight transport models. The combined result of the two studies should help to establish a new generation of transport models that is as rich in contents as needed, and as context friendly as possible.

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1. INTRODUCTION

The basic use of transport models is that they help to increase our understanding of the mobility system. In more operational terms, they can be a basis for developing quantitative insights in the past and current state of the system or scenarios about the future. Models are also useful as impact assessment tools in decision making processes or for ex post evaluation. Each purpose places different demands on the availability and quality of information. The issue treated in this paper is how we can improve the organization of the supply side of the modeling market (including the influence of public agents on this market) in a way that the models can meet policy demands of the future. We consider two dimensions of model supply: (1) the contents dimension, i.e. the ability to inform policy makers on specific policy questions and (2) the dimension of governance of model development and model applications. The paper is built up as follows. In section 2, we first introduce our starting point in terms of the requirements placed upon models by policy makers in terms of contents and the recent tensions resulting from a divergent development between policy makers' needs and operational models. Section 3 describes the results of a reflection on the necessity to innovate in the mode of governance of model development and use. Section 4 focuses in on the requirements in terms of contents and the resulting challenges to develop new knowledge, data and models. Section 5 concludes the paper.

2. MODEL REQUIREMENTS

2.1 Changing information needs in evidence based transport policy

There is no single model of a transport system. In general, a model is a simplified approximation of reality, and there must surely be many such approximations. Therefore, we have large and small models, passenger and freight models, unimodal and multimodal models, network models and non-network models, dynamic and static models, long- and short-run models, and so on. The model being used at any one time should be chosen, in part at least, relevant to the objectives for its use.

There are different criteria for fitness-for-purpose of models. They can be related to the contents of policy indicators (see van der Waard et al, 2007). These indicators may concern specific policy goals (e.g. reduction of CO₂ emissions by 2050), specific policy measures (e.g. adding a lane to a motorway) or specific exogeneous boundary conditions or developments (e.g. laws, oil prices). Given changes in the contents of policy questions, models that adapt to these changes, to produce the required information, are considered fit-for-purpose.

Besides with contents related indicators, we can also define process related indicators, depending for example on the stage in the policy evaluation cycle. At various stages of the policy evaluation cycle (see figure 1) there is a specific policy information need. In general this information relates to future trends in the transport and traffic system and the impacts of policy options.

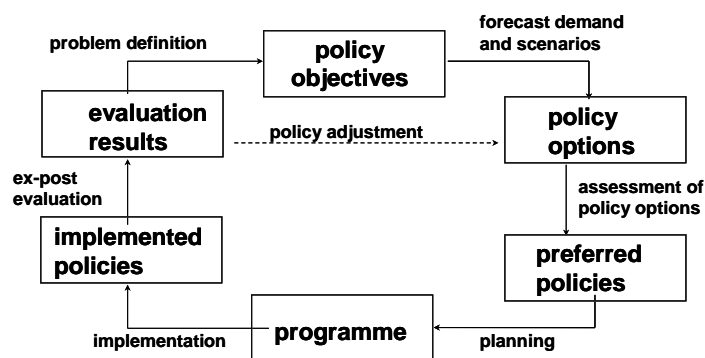


Figure 1: Policy evaluation cycle

These policy information needs relate to:

- policy preparation: what are the problems viewed from the perspective of the policy objective and what are the optimal policy solutions? (ex-ante evaluation in assessment of policy options)
- policy implementation: is the implementation on schedule (output), are the trends and impacts as expected and are the objectives still in sight? (monitoring)
- policy evaluation: how effective and efficient was the policy? (ex-post evaluation).

Early in the cycle high level policy options or groups or measures (strategic level) are defined; later in the cycle individual measures are specified further and tuned for implementation (tactical level). This is also illustrated in Table 1.

Table 1: Distinction between strategic and tactical information needs (Martens et al, 2010)

Strategic: high level policy options	Tactical: implementation policy measures
Integral	Sectoral
Global	Detailed
Plausible	Accurate
Interactive	Informing
Fast	Trustworthy
Customised	Standardisation
Flexible	Uniformity

For strategic policy questions information is needed to explain and understand the impacts of the various policy options on the transport system. This information is used for selection between alternatives and negotiation between the various partners/stakeholders involved in the evidence-based policy-making process. At the tactical level the information need is driven by support for decision-making on priorities in large-scale investment programmes and specific budget allocations. Impact assessments in this stage of policy measure implementation have to comply with severe legal rules. These obvious differences in information needs in the distinctive stages of an evidence-based transport policy assessment have consequences for the governance of transport models.

2.2 Evolution of models and application context

Transport models have various uses. They can serve as a tool to increase our understanding of the determinants of mobility patterns. They can be a basis for developing statistics that describe the past and current state of the system or provide scenarios about the future. Models are also useful as assessment tools in decision-making processes or for ex post evaluation. Each of these purposes places demands on the availability and quality of information.

The Dutch transport policy development has a fairly strong focus on ex-ante evaluation and the associated impact assessment methodologies. Therefore, traffic and transport models have for many years played an important role in the strategic policy development process. However, in recent years some developments around the model improvement and application process have led to a situation, in which the models no longer seem to correspond very well to the policy needs. In some instances this has caused strong delays in infrastructure project planning processes and therefore infrastructure realisation.

The current traffic models were created over the last 20 to 30 years, mostly driven by the emergence of new techniques and sometimes on ad hoc policy requests. Generally speaking, two partly contrasting drivers for development can be distinguished. On the one hand we can see that the need for complete and more detailed information, with focus on continuously emerging 'new' policy questions has driven developments and on the other hand we can see a more scientific interest or urge to improve the detail and dynamics in the abstractions of reality. This has led to the developments presented in Figure 2. The developments from the different perspectives have not been coordinated very well, which has led to duplications in research and development, while other subjects have not been addressed at all.

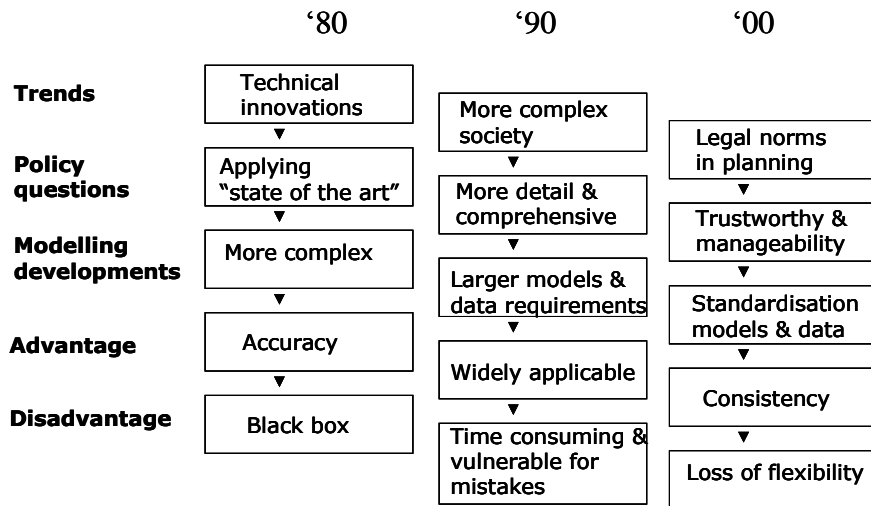


Figure 2: Development in demand for and supply of traffic and transport models (KiM, 2010)

The developments over the last 10 years have basically led to a situation in which some of the models no longer seem to correspond very well to the policy needs. These developments have caused problems in model applications, leading for instance in some strong delays in infrastructure project planning process and therefore infrastructure realisation. In general one could sum up the problems by stating that the process of generating impact assessment information has become too complex and therefore vulnerable.

An example of this 'overcomplexity' are the requirements set for traffic and transport model output in the process of assessing air quality consequences of future infrastructure projects. The translation of European air quality directives into local planning procedures is laid down in national legislation, to the level of detail of a directive for the way in which the future air quality research needs to take place. These methodologies implied for instance that future changes of 0,5 Microgram/m³ in road side concentrations of NO_x, resulting from a planned road widening scheme, can form the ground for a no-go decision on such a project, in areas with high back-ground concentrations. Such small impacts on air quality can be caused by only a few extra mid-sized trucks. The need to determine such effects in changed future traffic volumes cannot (and will never) be met by means of currently available traffic and transport models, which made the whole planning process rather vulnerable for questions for various parties involved in decision making, questioning the traffic data used in the assessment.

A second example of the consequences of ‘overcomplexity’ of the model application process have been some inconsistencies in network and other model input, mainly due to the size of the networks and the many parameters describing future socio economic and policy developments. Such an example was the case of the A4 motorway, where a small unnoticed inconsistency in the huge and complex networks (one lane missing), led to misinterpretation of results, resulting in extra project costs, because based on the model output an extra lane was thought needed. These extra costs resulted in a switched priority between the alternatives under consideration. This result led to questioning all traffic data used in the assessment process, by certain parties involved in the planning process and after the inconsistency was found, a severe delay in the planning process was the consequence. Recently, a quality system was introduced called “the NRM protocol” which tries to ensure quality control during the process of making forecasts in the infrastructure planning process both at the level of the actual model input and assessment of its output and at the process level : who decides about the assumptions e.g. with respect to policy variables and land use that are used.

2.3 Research & development in modelling

In order to improve the fit of transport models with the information needs of policy makers, we need to look into the organisation of the model R&D process. At present, transport model R&D takes place in an incremental and uncoordinated way. Individual model development projects can be of different nature: fundamental research, applied research, software development, data acquisition, updating of models and so on. Depending on the objective of model development, the ownership of models and the availability of funding, different initiatives are taken by different organizations, with leadership over the model development process varying from project to project. Although this need not be a problem in itself, generally there appears to be little co-ordination between initiatives, which leads to the following problems:

- little insight from the user community in model availability and quality;
- insufficient research in topic areas where there is a need for improved information;
- slow propagation of innovations from research towards the user community;
- lack of support for models from model users and affected non-users;
- waste of funds due to overlapping research without real competition;
- loss of scale economies in development efforts.

Especially (but not only) in situations when the results of models are used in decision making processes for transport policy, we can expect that the impacts on the success of policies of a better alignment of R&D initiatives will be high. If we look at the modeling

industry as if we would look at any other, the question arises whether we could create a high level, shared view on all the activities that determine the quality of models from the users' perspective and use this as an instrument for co-operation.

2.4 Lessons learnt

The main lesson learnt from three decades of model development and use is that there is a need to introduce strategic thinking about models, both in the pre-use and use phase. Firstly, guidance is needed on priorities and options for R&D concerning transport models; here, we introduce road maps for R&D as a means to make development efforts of researchers and practitioners more effective and demand-led. Secondly, new governance practices need to be introduced to improve model transparency and quality management, before and during applications. In the next 2 sections we summarize the findings of two recent studies that developed new ideas for R&D and governance of model use.

3. A NEW VISION ON GOVERNANCE OF MODEL DEVELOPMENT AND APPLICATION

In order to establish the need for governance improvements in the medium-term, the KiM Netherlands Institute for Transport Policy Analysis, at the request of the Mobility directorate-general of the Ministry of Transport, Public Works and Water Management, conducted a study of how strategic transport models are currently used in policy processes. The research focused on improving the governance of transport models. Improving transport model content, so that it better corresponds to new policy themes, falls outside the scope of this research.

KiM identified four primary challenges to be faced in the years ahead:

1. Transparent, varied and coherent models
2. Quality management
3. Improved presentation and use of model results
4. A stronger form of steering

Policy options were identified for each. We treat the challenges in more detail below.

3.1 Transport models must be more transparent, more varied and more coherent

Over time, transport models have become increasingly versatile and accurate, but consequently also more complex and elaborate, and less transparent. At times too many, and too complex, calculations are made, whereas a global response would suffice. More calculations do not always lead to another or a better decision. More than ever before,

policymakers need models in which they can make essential assessments regarding the economy, environment and safety.

The following policy options can be considered for greater transparency, variation and coherence:

1. The first policy option is to make existing models more transparent, as this will allow greater use to be made of visualizing data in maps and charts. Additionally, the accessibility to transport models, for example via internet, can be improved.
2. A second option is bringing more variation in the available modelling tools. In addition to the current models, simpler transport models, rules of thumb and expert knowledge can be utilised.
3. A third policy option is bringing more cohesion among models.. This can be achieved through integration or coordination. Integration can be useful, but the integration of multiple models in one 'super' model is not always the most efficient solution. Coordination offers greater promise, and this can be achieved through the improved coordination of input data, calculation techniques and model output, as well as reaching agreements about which transport models should be used for what purposes and about how certain models should be used in conjunction with one another.

3.2 Quality management must improve

It happens on occasion that the parties concerned raise the issue of the applied transport model's quality, and thus the accuracy of the model's results. A lack of trust in model calculations is understandable, however. The quality management of many transport models is both unclear and incomplete. Moreover, there are no guarantees that quality controls are conducted independently. Policymakers therefore require greater quality assurance in the models and model results.

We see the following policy options for assuring quality

1. The first policy option consists of the frequent request for a 'second opinion' on model applications and an audit for model development. The disadvantage of this relatively simple solution is that it remains unclear which quality standards the model studies must adhere to.
2. A second, more structural, solution is the establishment of a quality framework for both the development and application of models, which, preferably, would be done in consultation with the key parties concerned. Such a quality framework includes - per type of information request - which quality standards apply to the quantitative

support of the response to a request, and, based on this, which standards the model development and model applications must adhere to.

3. A third option is the development of a hallmark, or quality mark, for models and/or model results, and subsequently making the use of this hallmark mandatory.

3.3 Improved presentation and use of model results

The third challenge to be faced in the coming years involves the use of model results. Oftentimes the expectations of policymakers, administrators and politicians are simply unrealistic. People expect, for example, that a transport model will produce highly accurate and reliable estimates of congestion on a stretch of road in the far distant future. The models' inherent limitations, and the uncertainty inherent to any prediction of future scenarios, are often overlooked. Moreover, model results are sometimes presented as 'absolute truth'. Meanwhile, frank discussions about the uncertainties associated with prognoses are avoided.

The following are policy options for improved presentation and use of results:

1. The first option is an improved presentation of model results. Unrealistic expectations are often also a consequence of a lack of insight on the part of the users. By thoroughly explaining the calculations and visualizing the results, non-specialist can also come to understand the results. By explaining the storyline - also called 'storytelling' - of how the effects were arrived at, it is easier to engage and inform the non-specialists.
2. Second, a guideline can create more clarity about the correct use of model results in policy processes. Much of the communication associated with models is focused on the technical aspects, and not on the question of how model results can be used in the policy formation processes. Setting up separate communication strategies for the various target groups (policymakers, administrators, politicians) is desirable.
3. A third policy option is cultural transformation. This means that 'big changes' are required. We refrain from 'counting on the calculations' and accept that the experts' qualitative estimates can also sometimes lead to better decisions.

3.4 A more general requirement is a stronger form of steering

To realize the three challenges mentioned above another form of governance for model development in terms of steering is needed. The current traffic models are often created based on the emergence of new techniques and ad hoc policy requests. Much is already gained when users and producers joined hands to work together on the road maps, but a further step should be a more clear and consistent steering of the development of traffic

and transport models. One way to establish this improved steering is by means of a permanent steering group of relevant users of model results, which can:

- Ensure that the models correspond well to information needs by clearly formulating information requests;
- Establish clear agreements about who must perform what tasks;
- Ensure the involvement of, or coordination with, the various model administrators (Rijkswaterstaat, Dutch Railways (NS), ProRail, the regions)
- Develop a long-term vision to elaborate on the previous three bullet points.

In line with these recommendations, Rijkswaterstaat and TNO took the initiative to develop a first long term road map for passenger and freight transport models. We present this project in the next section.

4. ROAD MAPS FOR MODEL DEVELOPMENT

In this section we report on a 2-year project in the Netherlands that has recently been completed, aiming at the development of a detailed road map⁶ for the development of a new generation of passenger and freight transport models that are able to provide the policy makers with the information that is necessary. In order to develop a strategic view on the development of a new generation of the national transport models, two road maps were developed that identify and link long and short term development trajectories for passenger and freight transport models. The study was carried out by TNO (TNO, 2009a,b) at the request of the Rijkswaterstaat agency of the Ministry of Transport, Public Works and Water Management, as main responsible for the national transport models.

In many industries road maps are used to align technological development and user needs and are a means of communication to identify potential consequences of choices (implicit or explicit) on critical aspects such as technology platforms and architectures, standards and norms⁷. The road mapping process benefited from the collaboration between government bodies, the research community and model developers. It started with the identification of needs and an inventory of ongoing and planned research. In a cyclical

⁶ We use the term road map in the context of planning by analogy with technology road mapping. "A technology road map is a plan that matches short-term and long-term goals with specific technology solutions to help meet those goals. It is a plan that applies to a new product or process, or to an emerging technology." (Wikipedia).

⁷ Note that this does not reduce chances for competition. Firstly, road maps allow explicitly for alternative routes to model development goals. Secondly, road maps will seldomly be defined at a level of detail which obviates competition.

process, model users and developers were challenged to connect their worlds through intermediate research steps (knowledge, data and models) and offer concrete propositions to policy makers. The final result is a series of road maps which span a development period of 5-10 years and have gained broad support from different communities.

4.2 Embedding the road map in the model development process

In order to achieve the desired results by means of the road map, the Center for Transport and Navigation of Rijkswaterstaat in close cooperation with TNO, set up a process to ensure that model supply would be able to match demand. The figure below shows the phases in a commonly used process for model development. Note that the term model refers to any kind of tool related to transportation forecast, i.e. model systems, quick scans and rules of thumb.

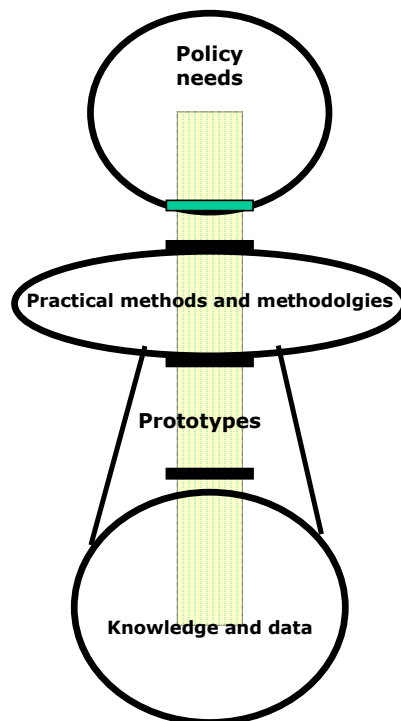


Figure 3: Phases within transportation model development

Model development starts with knowledge development and data gathering and ends up with the new model in operation for policy purposes. The phases of the process include the following activities:

- Model development grounds on available empirical and/or theoretical knowledge. The available data is also essential for all the phases of the process and need to be taken in account from the start. The results of this phase are both scientific material (i.e. paper, thesis, etc) describing the theoretical basis for a certain model and data sets.

- Based on the results of the first phase, prototyping can start towards proven and workable modeling concepts. The output of this phase is broad applicable modeling methods and methodologies.
- The third phase aims at making the model operational for policy aims, leading to a tool that fully comply with the user requirements, both functional and technical. This phase starts with an inventory of usable proven methods and methodologies; followed by a selection and/or best combination for the implementation of an operational tool.

The dotted area in the middle of the figure represents the continuous selection of usable inputs for the next phase. Selection points have been marked in the figure by means of black bars. These selection points assure focus through the whole process, leading to efficiency and effectiveness in the supply process towards solutions for policy needs.

The figure below is an extension of the first figure, showing the position of the road map and the roles within the process.

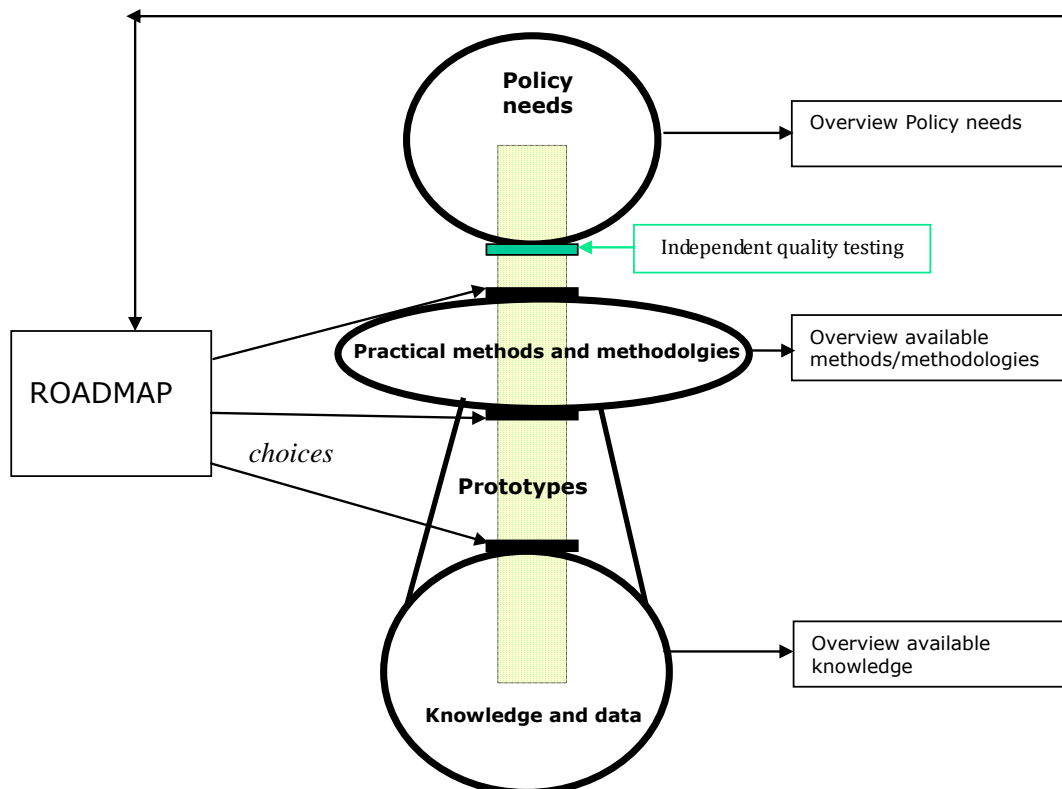


Figure 4: The position of the road map and the roles in the model supply process

The road map plays a central role for making choices in model development and has to be kept up to date in order to fit into a dynamic world of changing policy needs, available tools, methods, knowledge and data. For this periodical update, roles need to be defined and

distributed for maintaining an overview of available knowledge and data; available tools, methods/methodologies and policy needs.

By means of an updated road map, choices can be made through the whole process. As already mentioned, these choices are represented in the figures by three black bars, the so-called filters:

- Filter 1: the decision on financing a certain prototype development is made on the basis of the availability, risks and costs of using the available knowledge and data in combination with the urgency of policy needs for this kind of model.
- Filter 2: the decision on the development of a new model is made on the basis of availability, risks and costs of usable prototypes in combination with the urgency of policy needs for this kind of model.
- Filter 3: within this last filter, an independent quality and applicability check of the developed model takes place before taking it into operation.

4.2 Approach and results

The study followed an iterative process to align demand for information and supply of transport models, in terms of contents, rather than form. A series of workshops was held to identify:

- a) the policy issues requiring model support (demand for models)
- b) the state of practice in modelling including latest developments in methods and techniques, as well as data availability (supply of models)
- c) promising linkages between demand and supply.

The process to develop a road map involved a large number of parties in the Netherlands that are involved in model use and development (>20 institutes and firms). In total about 160 manhours were spent in workshops to elaborate on demand and supply of models, and their interaction. The workshops participants included government staff (some model experts and mostly policy staff with little or no expertise in modelling) and model developers (academics and consultants).

The result of this process was a broadly agreed set of development challenges, areas of model innovation where there was both a demand for new models and state of the art

knowledge being developed. Each of these challenges was derived from policy questions obtained from Ministry staff by means of personal interviews and workshops⁸.

Our focus was on the needs of national government and on those suppliers that were already involved in existing models or research. As a consequence, the road map is not meant to be exhaustive in its coverage or to be a tool that excludes alternative routes of development not identified and agreed here. Rather it should act as a first basis of agreement on ideas that should be strong enough to support and survive future debates on modelling priorities. Our approach could be very well be complemented by a more systematic inventory within a national modelling context such as those carried out in the UK (WSP, 2002).

For each of thematic development challenge, a link was made between the policy issues and streams of modelling research within or outside the Netherlands. For applications for the Dutch national models, ongoing or potential research projects were identified that could contribute to the acquisition of new data or empirical research. The resulting structures were visualised as shown in Figure 5.

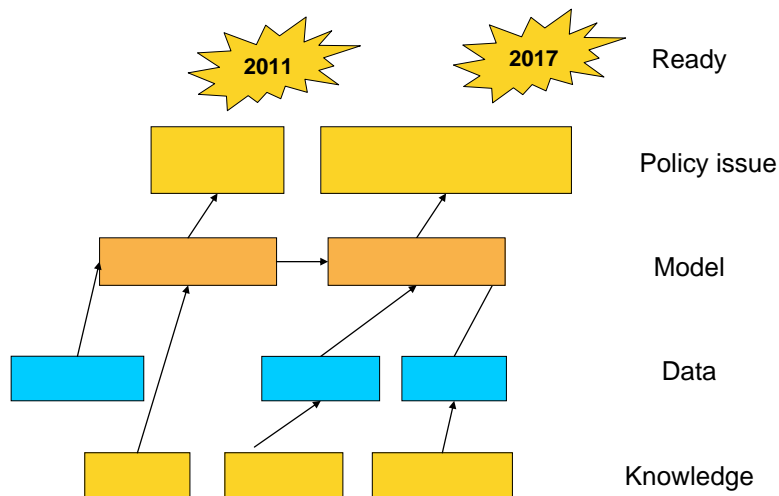


Figure 5 The basic road map scheme for transport models

The bars on top denote the policy questions. The rows in the figure denote 3 types of action necessary for model development, 1) advances in knowledge leading to theoretical specifications, 2) data acquisition and 3) model building. These activities build on each

⁸ Note that these requirements need not be short term ones. Some policy topics carry on for far longer than one administration. The interviews showed that policy makers were looking far ahead and not just at short term political priorities.

other, creating a vertical flow of work in consecutive steps. Diagonally, the figure shows distinct streams of model development. These can be competing or complementary developments, that eventually contribute to answering policy questions. Finally, note that the horizontal dimension denotes time – in our study, this dimension was only completed for illustrative purposes.

The thematic challenges identified for passenger and freight models were the following:

Table 2 Main development challenges identified in the road map

Passenger models	Freight models
1. Road capacity measures	1. Vehicle types
2. Infrastructure maintenance	2. Spatial and economic effects
3. Pricing policy	3. International trade and ports
4. Reliability and robustness	4. Logistics and intermodality
5. Sustainability	5. Reliability
6. Agglomerations	6. Air and pipeline freight demand
7. Elderly	7. Effect on congestion
8. Recreation	8. Hazardous materials

Each of these themes was detailed out as shown in Figure 6. Here we provide one visual example of a result for the topic “international trade” from the freight road map.

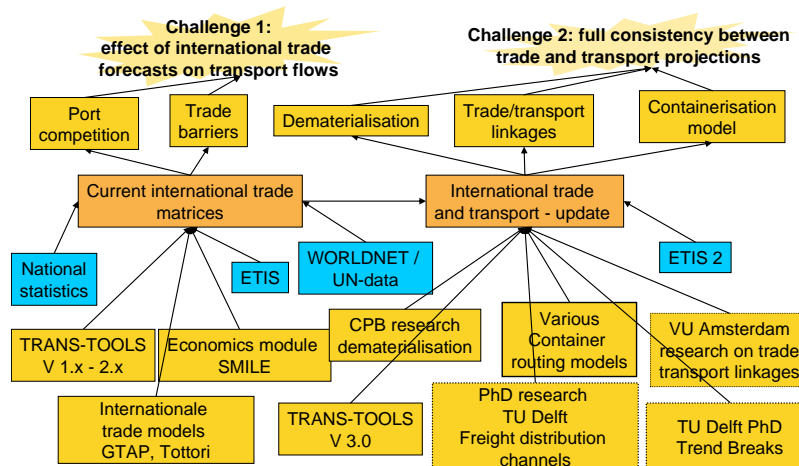


Figure 6 Example of a road map element: trade and transport modelling

We summarize the headings of the various themes in the table below. We note that this listing is not exhaustive but meant to provide an impression of the scope and level of detail of the road maps. Partly the development challenge is concerned with the building of completely new models, partly the challenge is concerned with extension of existing

models. Further work is needed to develop the road map into detailed plans for research, data acquisition and model development.

Table 3: Summary of main development challenges in the road maps

(see also list of abbreviations)	Knowledge	Data	Models
Passengers			
1. Road capacity measures: keeping roads accessible	Aggregate effect analysis Effects of ITS	Travel times On board data Traffic flow detail	Quick scans DTA TOD models
2. Infrastructure maintenance: financial trade-offs between building and maintenance	LCA, CBA	Freight	LCA tools
3. Pricing policy: how to introduce effective ways of transport pricing	New technologies Ex post evaluation	Chip Card On-board data Price elasticities	Behavioural responses, Financial impacts
4. Reliability and robustness	Policy impacts Design methods Effects of ITS	Incident data travel time data demand changes VOR	Effect of traveller information Supply models DTA
5. Sustainability	Mobility effects EV Weather effects	Weather/traffic data Local traffic data EV diffusion	Climate risks Local QoL Technology impact
6. Agglomerations	Agglomeration and productivity Activity networks	Activity/tour data Investment forecasts	Multimodal route choice Land price
7. Elderly	Preferences Captivity	Segmentation Activity data	TOD models Equity impacts
8. Recreation traffic	Changes in travel patterns Value of recreation	Trip generation Event data	Activity models 24/7 models
Freight			
1. Vehicle types	Vehicle stocks Choice of means	LGV Shipment sizes	Vehicle conversion
2. Spatial and economic effects	Trade patterns	Regional accounts Regional I/O tables	Indirect effects
3. International trade and ports	Port choice factors	Port data Transport statistics	Port choice Trade models
4. Logistics and intermodality	Logistics choices	Inventory locations Transport chains Shipment sizes	Mode chains Inventory choice Trip generation
5. Reliability	Effects on logistics re-organisation	VOR Network reliability	Multiclass DTA Logistics choices
6. Air and pipeline freight demand	flow composition (scriptive)	Flow statistics, detailed	Basic demand models
7. Effect on congestion	Route choice TOD	PCU-values Route data	Multiclass DTA
8. Hazardous materials	Trip generation	Transport statistics	Risk models

An additional benefit of this approach was that, by aggregating actions across the various development challenges, we could identify an overall agenda for the 3 types of supporting

activity: theoretical specification, data acquisition and model development. These cross-listings can be useful to develop broad implementation programmes or search for linkages between research, modelling and data acquisition initiatives.

We note that, as the discussions in this road map were mostly about the contents of the models and not on the form in which outputs were presented, this exercise did not yet produce solutions to many issues of governance of model development and application. The process related comments that were raised during the workshops were noted but not worked out in detail. These included the following:

- The need for simplicity and transparency in models and model application to reduce vulnerability
- The need for consensus on model assumptions and broad support for results
- Simultaneous standardisation of models, and customisation for individual projects dependent on the phase in the planning process
- The need to interpret model results in a wider context of “story telling” (see also Timms, 2008)

Further research could be done on the identification of methods and techniques for modelling, data processing and visualisation to satisfy these specific process-type requirements.

5. CONCLUDING REMARKS: THE WAY FORWARD

In this paper we report on two directions of strategic development of model development and use. Firstly, we emphasise the need for model simplicity and transparency to reduce the “overcomplexity” of large model systems created in the 90’s. Secondly, we explore thematic extensions of current models that allow to respond better to policy questions of the future. The solution direction for really useful models that are sufficiently rich in contents and context friendly, appears to lie in the improved organisation of model development and use. Aligning model R&D and policy makers’ needs more explicitly than before, while at the same time improving governance and quality assurance practices, could be the key to a new generation of transport models.

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LIST OF ABBREVIATIONS

ITS: Intelligent Transportation Systems

LCA: Life Cycle Analysis

DTA: Dynamic Traffic Assignment

CBA: Cost Benefit Analysis

TOD: Time Of Day model (departure time choice)

VOR: Value Of Reliability

TA: Technology Assessment

QoL: Quality of Life

EV: Electric Vehicles