NEW GENERATION DUTCH NATIONAL AND REGIONAL MODELS — AN OVERVIEW OF THEORY AND PRACTICE

Dusica Joksimovic
Public Works and Water Management (Rijkswaterstaat), Ministry of Infrastructure and the Environment, The Netherlands
Rik van Grol
Significance, The Netherlands

ABSTRACT

This paper deals with the new generation Dutch national en regional models, used to make forecasts for the *long term* future of mobility in general and the traffic and transport conditions in particular. The models are used for two main purposes: a) answering policy questions regarding e.g. major infrastructure investments, and b) to forecast the effect of regional infrastructure projects in the exploration and planning phase.

The overall focus of the new generation models was to realize maximum *consistency*. In the previous situation the techniques of the models were in principle the same, but in practice many small differences and deviations resulted in different outcomes that were hard to explain. Different implementations of the same models were used as well as different versions of the same software. Additionally there were differences in input, differences in assumptions, etc.

The new suite of models (one national and four regional models that together cover the whole of the country) are built to ensure maximum consistency. This is realized by using the exact same *input data*, by using the *same models*, the same *model parameters*, the same assumptions, etc.

In the paper the main reasons for building a consistent system of models for the national and regional level are further explained. The structure of the model as well as the input and output of the model is described in more detail. The most important innovations and major improvements regarding the previous version of the models are described. The lessons learned regarding the project organization of the project are outlined. Finally, the examples of case studies will be used to illustrate the improvements of the developed model system.

1. INTRODUCTION

The Dutch Ministry of Infrastructure and the Environment uses strategic transport models to analyze *strategic policy plans* and *road scheme investments* for the national road system. At the national level the ministry uses the **National Model System** (NMS) while at the regional level the relevant **Netherlands Regional Model** (NRM) is used.

The development of the national and regional strategic models has been conducted by Rijkswaterstaat (RWS), the department of the Dutch Ministry of Infrastructure and the Environment called Public Works and Watermanagement, and started at the end of the 1980's. The model system was set up in a hierarchical way. All models, national and regional use the same modeling approach. The first system consisted of the NMS, and six operational NRM's that together covered the whole of the Netherlands.

The model system has been used successfully over the past decades. It has been improved and updated several times, which has given RWS a lot of experience in both the development as well as the application of strategic transport models. Despite the positive achievements, RWS recognized that there was still room for improvements. As the models needed to be updated (the base year of the former model system was 1995) RWS set up a development program to bring the model system to the 21st century while making some improvements.

In the period running up to 2011 the model system has been updated and improved. In April 2011 the model system has been released to be used. Many smaller and larger model innovations have been made, but the core theme of the development was to improve the *consistency between the NMS and the NRM's* and *amongst the NRM's themselves*. Although the same modeling approach was used there were several degrees of freedom in choosing, e.g. the base year, the traffic assignment model, and the model for the calibration of the base matrices that made it difficult to easily compare results of the models. Another need to improve the model system is the requirement for more detailed and accurate model results.

Over the last couple of years more attention has been drawn to the strategic transport models that are used in road scheme studies. On one hand the Dutch legislation makes it necessary to produce detailed information with appropriate strategic models. On the other hand the complexity of such models makes them very sensitive to mistakes (for example incorrect input data).

This paper describes the new model system of the Dutch national and regional strategic traffic and transportation models. It will consider several aspects relating the development of the models, amongst which the improvements made in both the models as well as the administrative/organizational aspects.

2. DESCRIPTION OF THE MODEL SYSTEM

Traffic and transport policy studies need to provide insights into the traffic and *transport mobility* of the country. Different aspects such as population growth, welfare gain, and employment rate (both its value and distribution) can have great impact on the (future) mobility. For the Dutch Ministry of Infrastructure and Environment it is of the great importance to be able to analyze t*he effects of different traffic policy measures and regulations*. It should be mentioned that the traffic analyses with the model system (both the NMS and the NRM's) are primarily done to analyze the effect on the freeway road network (and primary roads).

2.1. Properties of the Model System

The model system can be classified as a *multi-modal* strategic traffic and transportation model. The traffic modeling can be further classified by transports modes, day periods and travel purposes.

The model knows six **transport modes,** namely car driver, car passenger, truck, train, BTU (Bus, Tram, and Underground), bicycle, and the pedestrian (walking) transport mode. The traffic is modeled in three **day periods**: morning peak, evening peak, and the remainder of the day. Five main *home-based* **travel purposes** are modeled: home-work, home-business, home education, home shopping, home-other. Additional *non-home* travel purposes modeled are home-business, work-education, work-other, child-education, child-shopping and child-other.

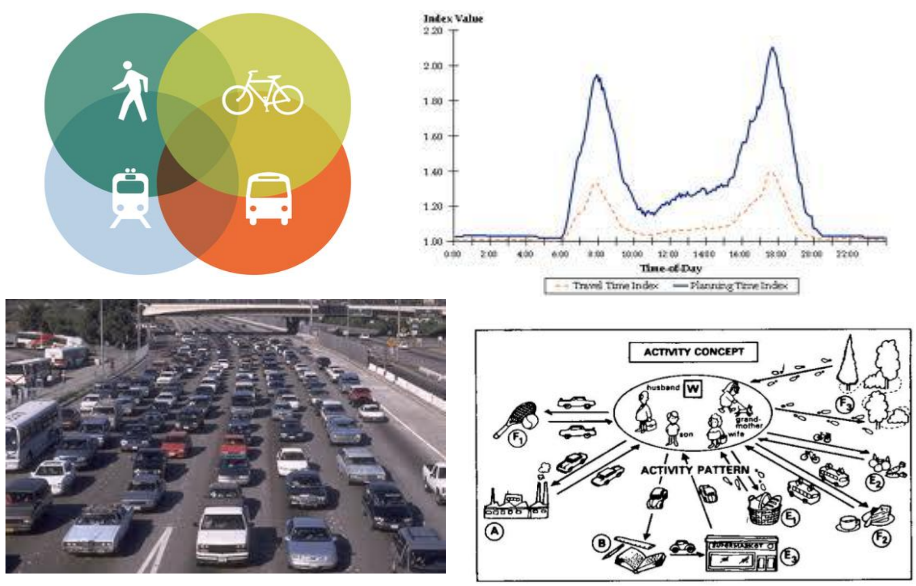

Figure 1: An illustration of multimodal traffic and transport models

As already said, the focus of the model system is mostly the modeling of the traffic on the *highway road networks* although the model is multimodal and capable for e.g. evaluations of major improvements in the train services. The secondary road networks are also included in the modeling framework but the modeling on that level is less accurate. It should be noted that the origin-destination matrices are calibrated *for truck traffic and cars simultaneously*. Further, the origin-destination matrices (traffic demand) are assigned to the road network (traffic supply) producing different network characteristics e.g. amount of traffic in peak and off-peak periods, travel times, travel speeds, congestion locations and other characteristics of a utilized traffic network.

It should be noted that an *average workday* is modeled, which includes vacation periods, but excludes the weekends and national holydays. The model is *tour-based* model meaning that the frequency of traveling is made on basis of tours (and not on basis of trips). For every tour the primary travel purpose and the primary transport mode is determined.

In order to gain more insight into the dimensions of modeling an overview of the number of zones, links and nodes is given in Table 1. NRM West modeled the most congested part of the country comprising the four big cities in the Netherlands (Amsterdam, The Hague, Rotterdam and Utrecht).

Table 1: amount of zones, links and nodes in NMS and NRM-West

	Zones	**Nodes**	**Links**
NMS	Total: 1538 Study area: 1379	35478	51573
NRM West	Total: 3608 Study area: 2122	56624	87158

2.2. Input for Model

NRM uses a huge amount of input data. The NRM input comprises, among others: the zone system, the road network system, de socio-economic data, given policy principles for e.g. fuel costs, parking prices, etc.

The zone system in NRM is modeled in the following way: the study area is modeled in most details, while the influence area, the rest of the Netherlands and abroad is modeled with less details. An example of the NRM South zone system is given in Figure 2. A part of the network of NRM South is shown in Figure 3.

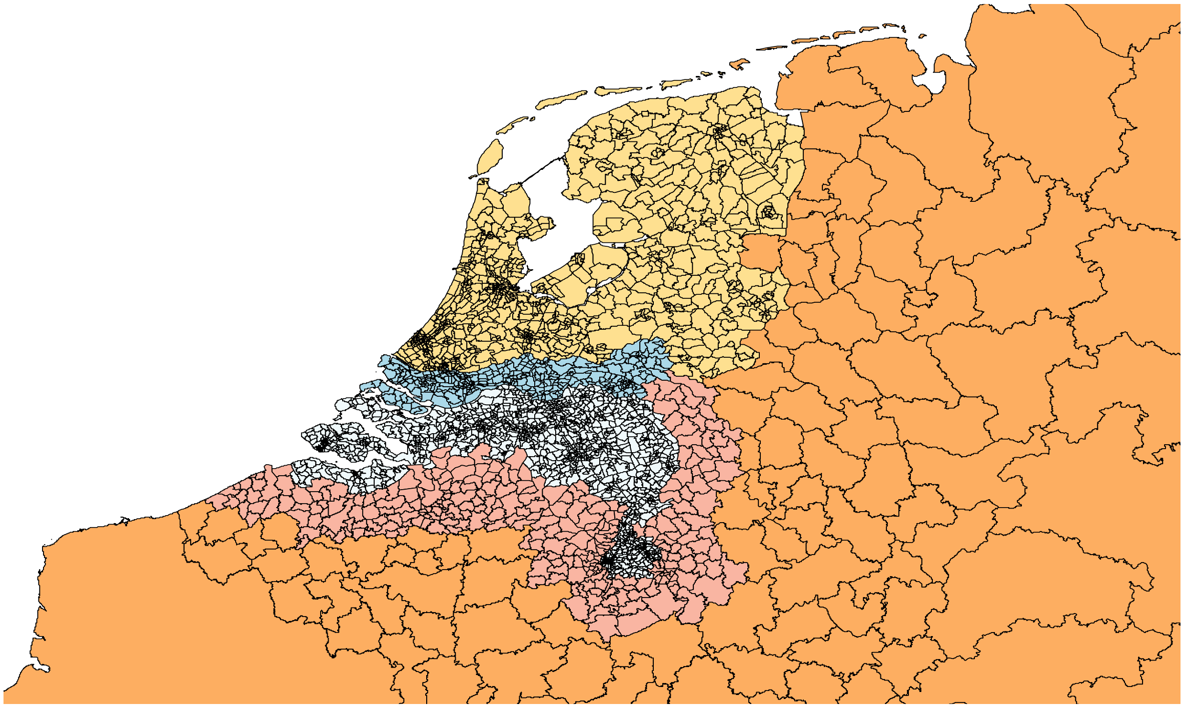

Figure 2: An example of the zone system of NRM South

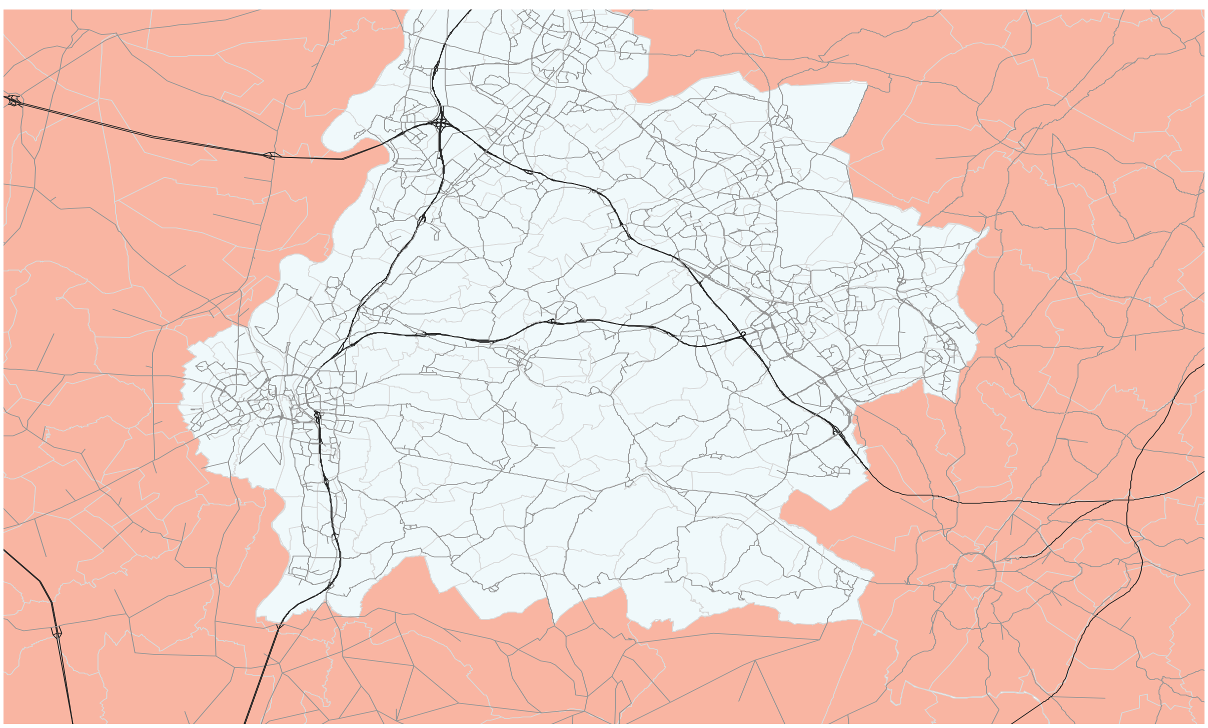

Figure 3: A part of the network of NRM South

The zones in the NRM South are represented with light gray lines in Figure 2. Different areas modeled with different detail level are given with different colors.

Namely, in NMS and NRM different zone topologies are used:

1. ‘**study area’** (white): the zoning and network modeling is most detailed;
2. ‘**Influence area in the Netherlands’** (blue): this is the area adjacent to the study area; this area is less detailed modeled but the zoning and network modeling are still quite detailed (this is necessary because of the interaction with the study area);
3. **‘outlying area in the Netherlands’** (yellow): this is the area further away from the study area; the zoning and network modeling are the same as in the NMS;
4. ‘**cross border influence area’** (pink): area in Belgium and Germany adjacent to the study area
5. **’outlying area cross border’** (orange); area further away in abroad: Belgium, Germany and France. The zoning and network modeling is of the same detail level as in NMS.

The network shown in Figure 3 is depicted with dark gray lines for the secondary road network while the highways are given using the black lines.

2.3. The Model Framework

The NMS and NRM are so called *marginal models* or *pivot point* models. That means that the traffic forecast is obtained by multiplying the calibrated base matrices with the calculated growth factors using discrete choice models.

The NMS and NRM produce *long-term* traffic forecasts based on the economy development scenarios in the Netherlands traffic and transport system. Currently forecasts are made for 2020 and 2030. The forecasts are made based on the given long-term scenarios published by the Dutch planning agencies.

The NMS and NRM are complex strategic models consisting of many components. The most important components are:

1) **Base matrices** that represent the mobility in the base year, which is currently 2004; Base year data (observed) and traffic counts (empirical) are the basis for the process where the ‘’car driver’’ and ‘’freight’’ base matrices are calibrated**.** The base year matrices for car driver and truck are built in the so called BASMAT process.
2) **Regional Freight Model (RFM)**, the model for producing the input for the building of freight base matrices in the BASMAT process as well as the freight forecast matrices; The freight base matrices are calibrated with traffic counts. The freight forecast is based on the calculating of the growth factors with respect to the base year.
3) **Growth model (GM)**, the model for generating the forecast matrices based on the pivot point method. The GM uses base year data (observed) and forecast year data (prognoses), and a scenario to calculate growth

factors with which the base matrices are multiplied to determine forecast matrices.

The growth model itself consists of a suit of sub models, but the core is formed by the *demand model* that, based on input data for a year and a scenario, produces a synthetic demand matrix. It is named synthetics because it is a model result rather than an estimation result based on observations. The synthetic demand matrices for both the base year and the forecast year are then used to determine growth factors. The growth factors are multiplied with the base matrix to determine the forecast matrices, see Figure 4a.

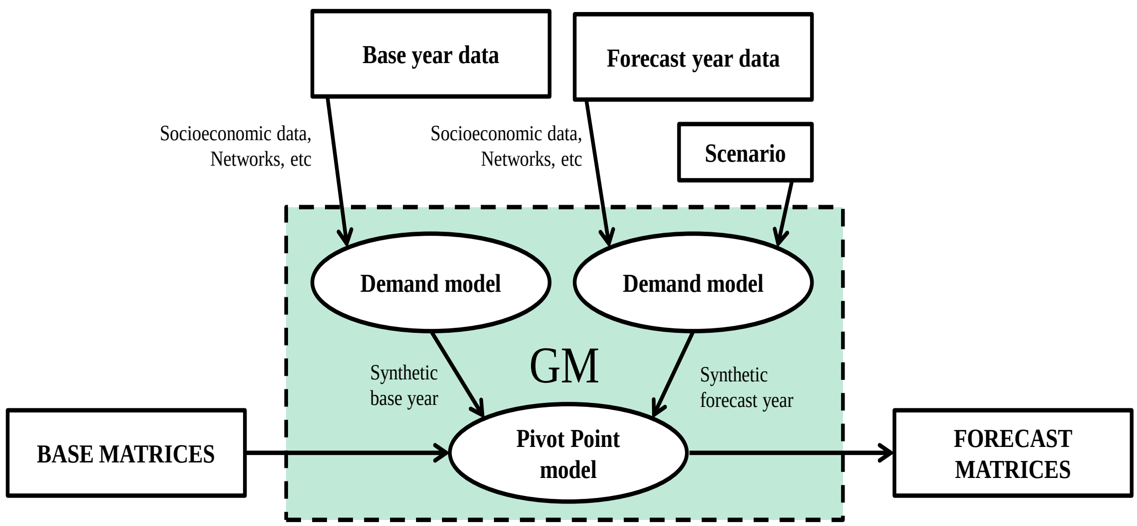

Figure 4a: The core process in determining the Forecast matrices using growth model

Figure 4a does not show the full complexity of the model system. The influence of congestion is not shown. Taking account of that effect leads to an iterative process in which the congestion on the road network interacts with the demand generated by the demand model for car travel.

In the growth model the mobility choices of persons (according to their own environment and their personal circumstances) are modeled. Focusing on the growth model of the Dutch strategic models several sub models can be distinguished (see Figure 4b).

The population model is the demand part of the growth model where production per zone depending on e.g. the number of households and persons per zone, characteristics of persons and households (such as income, car driver license, car ownership, etc.) is modeled. The *accessibility model* is the supply part of the growth model where the accessibility of the zones is calculated. The characteristics of the zones such as the employment rate per sector, the number of students, etc are used in this model. The attraction per zone depends on accessibility by car, public transport, train, freight as well as of the characteristics of the traffic network. *The foreign traffic model* captures the traffic going to the Netherlands, the traffic going out from the Netherlands, and the foreign traffic connected with the biggest international airport Schiphol.

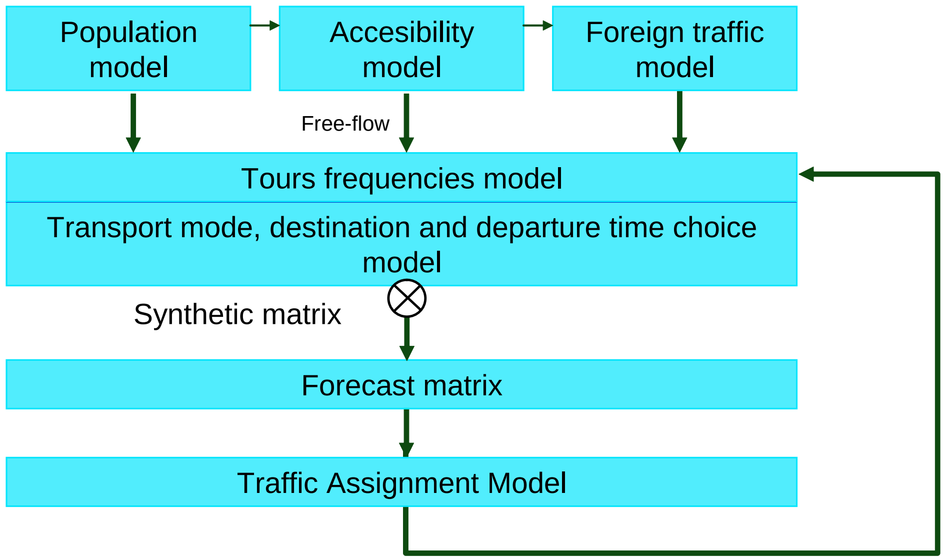

Figure 4b: The Growth model framework

The information from all these models are input for the *tour frequency model* where the choice to make a tour or not at all, and further making of exactly one tour or more tours, and so on is modeled. After that, the choice of the combination of transport mode, departure time and destination is made in the *transport mode, departure time and destination model* resulting in a synthetic matrix for base year. The same procedure is done for the forecast year.

The traffic assignment model used in strategic models is Qblok. It is a semi-dynamic, traffic equilibrium model based on the Wardrop principle. In this model the blocking- back effect is modeled, and some improvements are done to better capture congestion. The separate user class for freight traffic is introduced in the last version of the strategic models.

In strategic traffic and transportation models different discrete choice models are used (class of logit models). To model the tour frequency choice the *0/1 model* and *stop/repeat* models are used while for the modeling of the combination of the transport mode, departure time and destination choice a nested logit model (NML) is used. More information about these models can be found in the technical rapport of NRM and NMS.

2.4. Model Results

The model system generates various results. The most important results are the forecast matrices and the utilized traffic networks (the result of the assignment of the forecast matrices with the traffic assignment model Qblok). The results are used for different purposes: analyzing the current mobility, analyzing future policy plans, or as a basic input for other model analysis.

	Travel indices compared to the base year						
Modes	**Train**	**Car driv**	**Car pass**	**BTM**	**Bicycle**	**Walking**	**Total**
Home-work	1.318	1.210	0.970	1.094	1.089	1.070	**1.118**
Home-business	1.287	1.318	0.898	1.089	0.950	0.950	**1.167**
Home-education	1.211	1.307	0.934	1.073	0.989	0.964	**1.209**
Home-shopping	1.173	1.406	0.971	1.053	1.030	1.185	**1.178**
Home-other	1.167	1.433	1.029	1.112	1.043	1.079	**1.195**
Work-business	1.779	1.294	0.876	1.319	0.965	1.041	**1.190**
Work-other		1.419	1.007	1.783	1.048	1.178	**1.237**
Child-education			1.063	1.242	1.150	1.147	**1.131**
Child-shopping	1.157		1.087	1.125	1.083	1.083	**1.085**
Child-other	1.127		1.066	1.097	1.056	1.056	**1.061**
Total	**1.280**	**1.370**	**1.020**	**1.094**	**1.037**	**1.112**	**1.164**

Figure 5a: An example of results – indices of the amount of travel (travelled km's) for all combinations of purposes and travel modes compared to the base year (source: NMS model, forecast year 2030).

Figure 5a gives the indices of travel by different transport modes, and for different travel purposes with respect to the base year. The results can be given for the whole county as well as for one part of the country, or for a particular city. It should be noted that some combinations of travel modes and travel purpose do not exist because there were no available observations; others are not possible, such as a child as car driver.

Figure 5b shows a utilized traffic network where the colors indicate the increase (red) of decrease (green) of the traffic after e.g. an infrastructure investment on the traffic network.

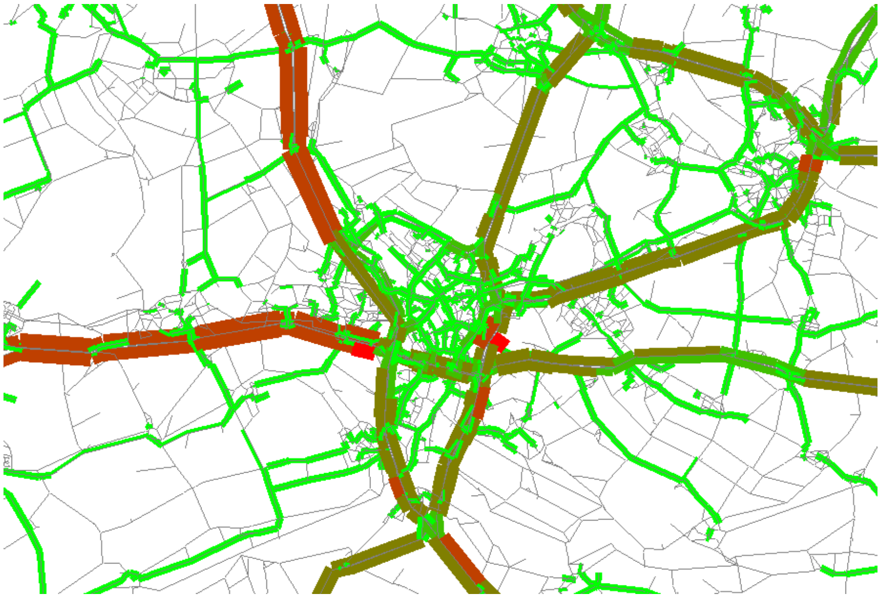

Figure 5b: An illustration of the utilized traffic network

2.5 Application of the Strategic Models in Practice

As stated before, the NMS and NRM models are used for the evaluation of strategic policy plans and regional and national road scheme investments. The effects of different policy measures, e.g. building a new highway, or adding extra capacity to the existing highways, improvements in the train services etc. can be *modeled, analyzed, tested and evaluated* using the model. The results of the model are further used for the analysis and calculation of the effects of noise and air pollution of the particular policy measure and infrastructure investment. The cost-benefit analysis also uses the model results to make policy decisions about the efficiency of different policy measures. Furthermore, the model data are used as input data in the other local traffic models (e.g. dynamic models).

NRM models can be used as a traffic and transportation information source in the region. Parts of the model can also be used for further development of other local traffic and transportation models for e.g. for the local models of the municipalities.

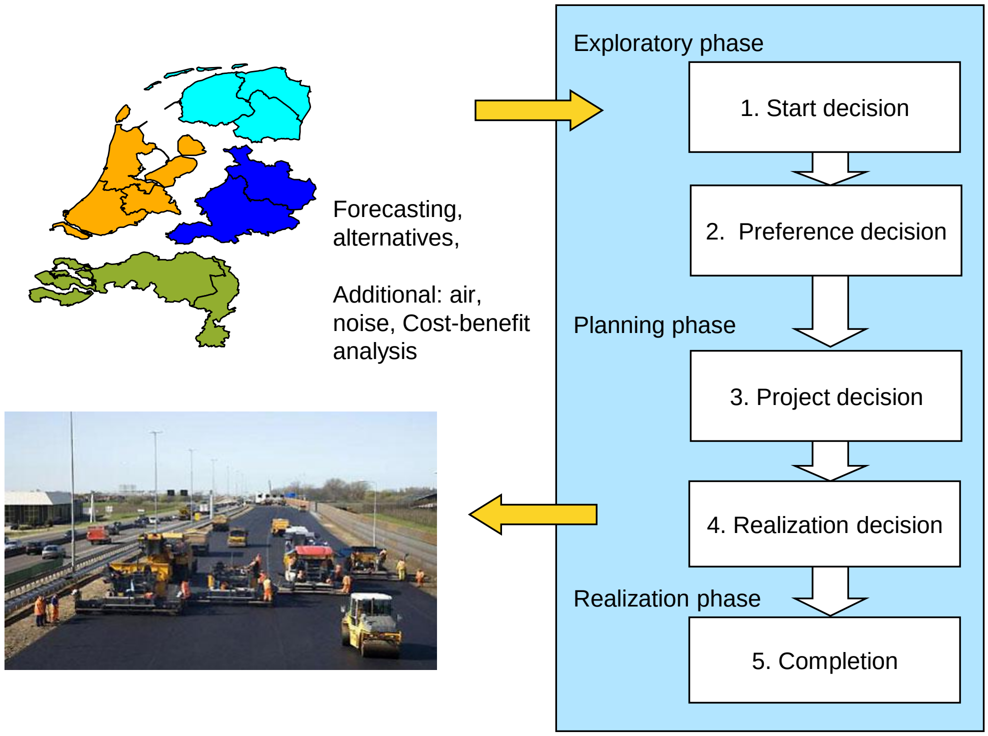

Figure 6: Typical phases in a planning studies

In the exploratory phase the existence of future traffic and transportation problems are first identified and potential solutions are outlined. In this phase the use of models is generally not necessary. The decision making about the promising solutions is mostly based on the expert judgment. The result of this phase is set of promising alternatives. Furthermore, a *preferred alternative* is chosen on the basis of the model results. The use of the NMS or relevant NRM model is mandatory in the second phase of the explanatory study (see Figure 6). In the planning phase the models are used for more elaborate calculation of the different variants of the chosen alternative.

It should be noted that in order to improve the quality assurance of the model Rijkswaterstaat developed a *protocol*. It is compulsory to abide by this protocol during every application of the NRM models (in different planning phases in the project).

3. NEW GENERATION OF THE DUTCH STRATEGIC MODELS

In the world of strategic traffic and transportation models the Dutch NMS and NRM models are present for a long time. At the end of the 1980's the development of the models started by using the same modeling approach for all models. More concretely, for building the regional models the aim was to use the same toolbox. This led to the name of New Regional model (NRM), which has been in use since 1994.

The current *Nederland* Regional Model is a logical continuation of the development of the *New* Regional model. From 2004 the importance of the using strategic traffic and transportation models to support the Netherlands infrastructure projects strongly arises (see Figure 7). The consistency as well as the quality assurance was increasingly important and gained political attention. Rijkswaterstaat as a national organization realized that the existing models, although they are satisfactorily to model the regional traffic streams, have limitations. The harmonization between the models and the consistency of model results originating from different NRM models was not optimal. This was caused by several factors, such as:

- There were to many degrees of freedom in the development of an NRM (e.g. choice of base year, different input to the models, etc.)
- Choice of assignment model to assign the forecast matrices differed between different NRM models

Differences with the NMS were additionally caused by the use of physically different implementations of the growth model.

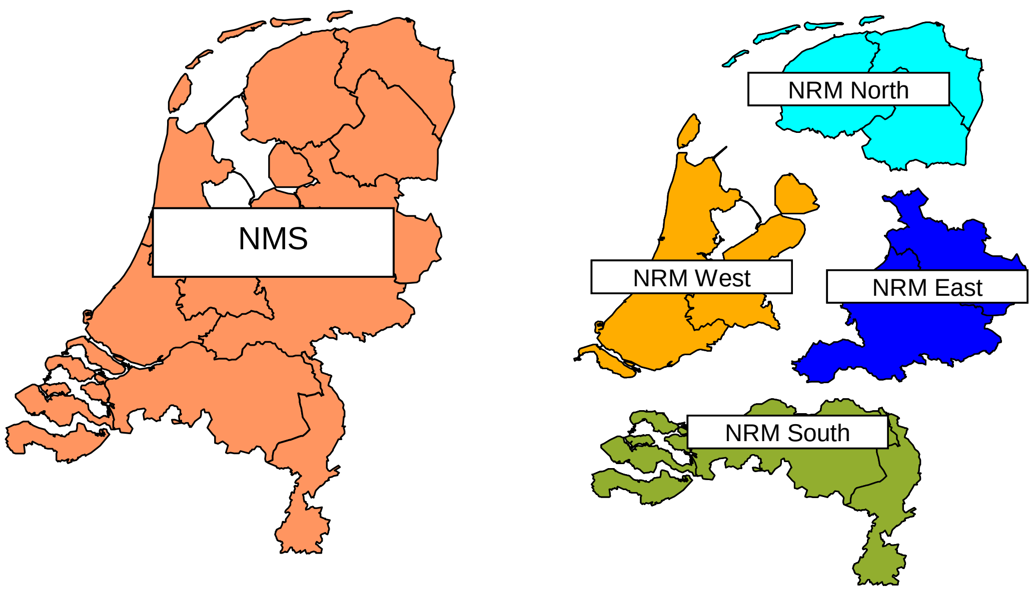

Figure 7: Study areas of the NMS and the NRM's

For the new generation models the following measures were taken:
The handbook for the realization of the NRM was improved by eliminating all degrees of freedom, starting with the choice of the same base year which from now on would be the same for both the NMS and the NRM's. This allowed the following essential prerequisites for consistency:

- **The input of all models**, NMS and NRM's, is the same and based on the same source (corrections are made in the source rather than separately in the derivatives);
- **The assignment model** is the same: QBLOK;
- The procedure and model for **base matrix production** is the same;
- The **Growth Model** is the same for NMS and LMS (not only in approach, but physically in terms of software and model parameters);
- There is one set of **handbooks and documentation** for the NMS and NRM's.

The new modeling system consists of four different NRM models (instead of six) having the same input, model techniques and documentation, and the NMS (see Figure 7). In figure 7 the study areas of the NMS and the four NRM's are depicted. The four NRM together comprise the Netherlands. Each model covers the Netherlands as a whole including a representation of part of Europe. Outside the influence areas each NRM is equal to the NMS (the same zone system and network). Only inside the study area (and to a less extent the influence area) a higher level of detail is introduced (while maintaining consistency).

3.1 Alignment and Harmonization of the Models

In order to achieve the alignment of the models it is decided to bring all the models to same base year, 2004. All needed input data and information about the traffic networks, the zone system, the (individual) count data of the roads, the socio-economic data per zone, etc. are first collected. The Handbook NRM with the main principles about the strategic model is also updated. For all options where several possible choices exist, the decisions were made to use a specific uniform approach.

The process of the alignment and harmonization of the models consist of the following steps:

1. Decision about harmonization of models;
2. Update of the NRM handbook;
3. Collected data base year;
4. Improvement of the traffic assignment model (QBLOK);
5. Building of the zone and network system;
6. Base matrix estimation;
7. Estimation of the Growth model;
8. Producing the forecast matrices;
9. Quality control.

All basic input data and information needed to build and apply the models are included in a national database file. From this (master) database the specific networks, socioeconomic data, etc. for the NMS and all NRM's can be generated. This ensures that the input data for all models are consistent.

Additionally a procedure is implemented that ensures that every improvement or update of the data and information in one of the models is registered in the database. In that way every update can be used in all other models. It should be noted that this type of model uses a huge amount of data.

Apart from the consistency in the input data there is also full consistency in the methodology used and software tools for calibration of the base matrices, traffic assignment and forecasting of the travel conditions.

3.2. Improvements in the New Generation Models

Next to harmonization efforts in making the models consistent there have also been a number of other model improvements. The most significant model improvements are shown below.

Model input:

- The traffic networks are built on the basis of the *national road GIS-system*. The aim of this improvement was to assure a geographically correct network.
- The traffic networks for each of the models (NMS and NRM) are extracted from a *master network*. This way the consistency of the different attributes used in shared network links for all models is achieved.
- The *same base year* (2004) is used for the NMS as well as the NRM's (in the past the model could have different base years causing undesirable differences in forecasts).

Model methodology

- The principle of the *peak-period modeling* is improved. Usually, peak-periods are defined by strict time frames (7-9 hours and 16-18 hours). With this improvement the peak-matrices contain all peak-period related traffic (while the whole day traffic volume stays unchanged).
- *Re-estimation of the discrete choice models* using recent National Travel survey and new Stated Preference (SP) data.
- *The extension of the number of travel modes*, the number *of travel purposes, the number of the household types, the number of the person* types, thus increasing the level detail in the modeling. The effects of changes in household incomes are captured in a better way.
- Further improvements have been made in the modeling of *traffic traveling abroad, and of Schiphol related traffic.* The modeling of train mode has been improved.

Traffic assignment model

- The speed-flow curves are calibrated using recent data for the car traffic as well as for the freight traffic. A significant number of new speed-flow curves were introduced.

- *Freight traffic was already assigned as a separate user* –class, but in the new model freight traffic has its own speed-flow curves.
- *The blocking back mechanisms* in the traffic assignment model is improved to better capture congestion

4. AN EXAMPLE OF THE QUALITY CONTROL

During the calibration process of the base matrices several different quality indicators were used. Only one indicator has a formal quantitative target; the so-called *T-statistic*. This target was the main target used during the calibration. The other targets were used to monitor the calibration process, and to determine whether certain characteristics of the matrix or assignment deteriorate during the calibration. Many of them proved to be useful in the sense that they helped to identify problems in the network or in the calibration data.

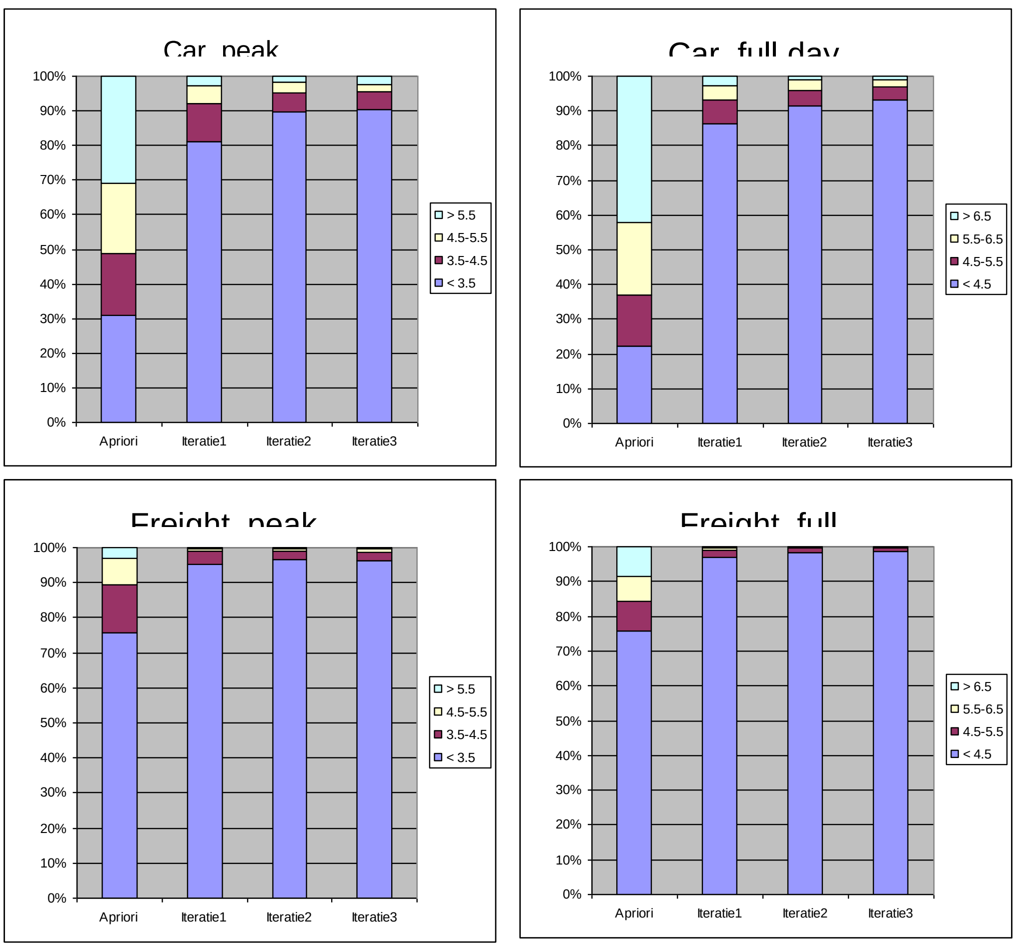

Figure 8: T-statistics Region South. A-priori matrix and iterations 1, 2 and 3

Figure 8 shows the T-statistics for Car Driver and Freight matrices with the comparison between the a-priori matrices (first model results) and the calibrated matrices (1st, 2nd, and 3rd iteration) for the region South. It can clearly be seen that the *convergence* of the calibration is very fast. Note that the T-statistic does not take into account the quality of the traffic counts themselves. During the calibration a confidence level was given to each count depending on the way the traffic counts were determined.

As explained in the section on modeling principles the NRM and NMS are marginal models where the calibrated base matrix is multiplied with growth factors to obtain the future matrix. Hence, a zero value in a calibrated OD relation stays unchanged, no matter how large the growth factor will be. If the growth model software calculates a growth for a relation where the estimated matrix contains a zero value, the software imputes synthetic values for those relations in order to catch the calculated growth. The use of this procedure however should be kept to a minimum. At the other hand it is to be expected that there will be zero's in the matrix due to the great amount of zones used in the models. Even the a-priori matrix contains zero values. Therefore it is important to monitor if during the calibration the amount of empty OD relations remains more or less the same.

4.1 Visual Check of Geographical Match between Assignment and Traffic Counts

This test is to evaluate if there are 'black spots' where either in the a-priori assignment, or during the calibration procedure a poor fit with the traffic counts persists. As can be seen form the plots (and the bar graph in Figure 8), three calibration iteration were sufficient to reach a good match of the assigned matrix and the traffic counts. This check proved to be useful during the calibration in the sense that was helpful to detect errors in the input data (network errors, wrong coupling of counts and network).

After correcting of errors it is demonstrated that the calibration of the matrices improved in more than just the location where the correction was identified.

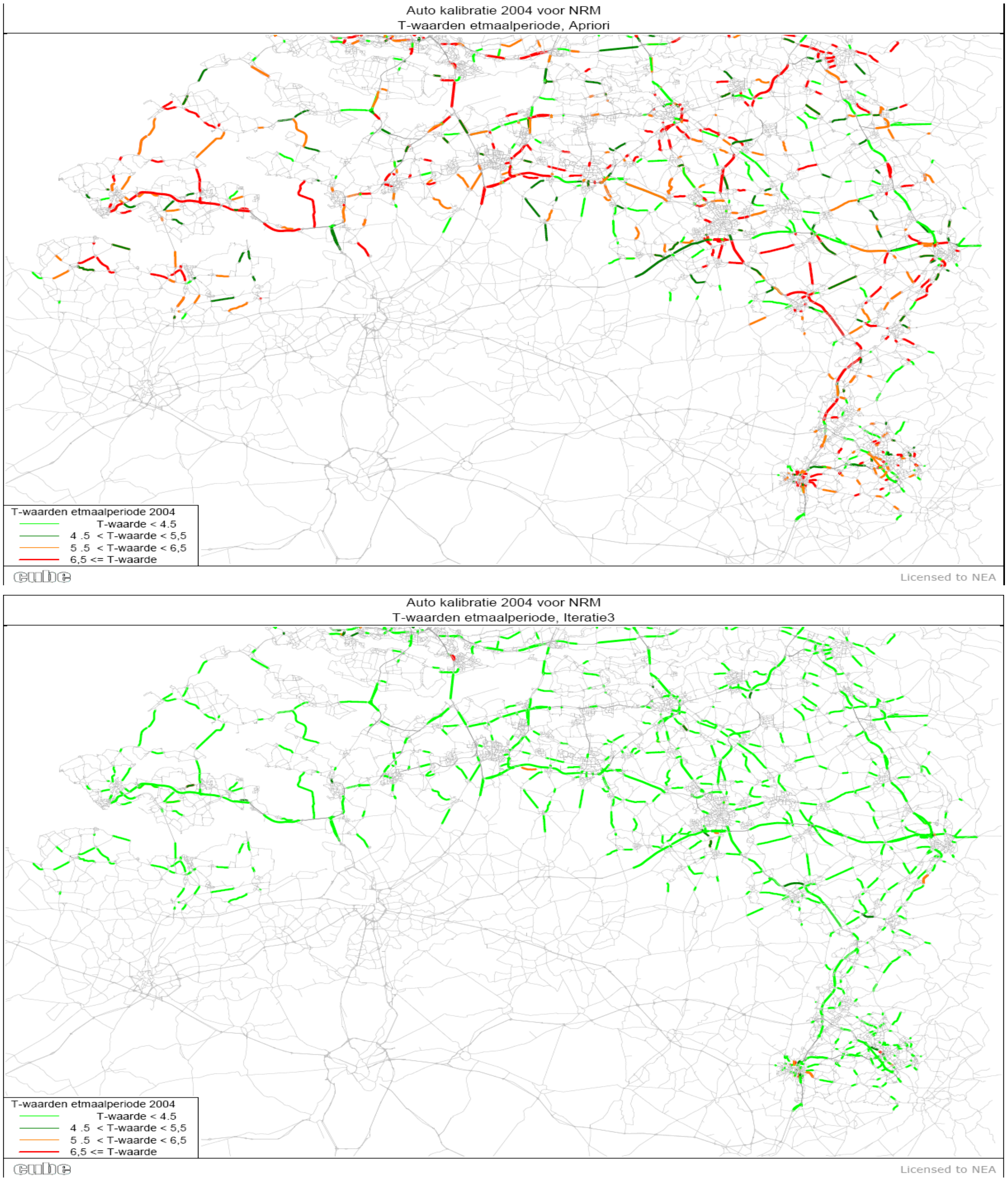

Figure 9: A comparison between a priori matrices and results of the third iteration

5. EVALUATION OF THE PROJECT

In order to improve the development of the NMS and NRM in the following projects, Rijkswaterstaat decided to evaluate the recent development project. The evaluation was conducted by an independent consultant specialized in evaluation of complex governments projects. The focus of this evaluation was on the process. Another evaluation regarding the content of the strategic models (e.g. to assess the methods used in terms of being state-of-the-art, etc) will be conducted later.

The evaluation had several phases:

- a desk-research on the approach chosen for the evaluation;
- interviews with relevant stakeholders;
- a reflecting session with stakeholders at which the results of the interviews were presented and the opposite opinions discussed;
- a report on the results of the evaluation, including recommendations for future projects.

5.1. Some Results of the Evaluation

It should be noted that all stakeholders agree that the development of a new generation strategic models was very useful and necessary. That holds also for the future: there is no question about the need for future actualizations of the strategic models. There are however some questions about how the process can be improved.

The development of a new generation of strategic models covering the whole country is a very complex process in terms of *project organization*, collaboration of *different stakeholders*, accommodation of *opposite interests* of involved parties, etc. In such a project a high level of collaboration of different stakeholders is required. According to the participants in the evaluation this goal has been reached. Looking at the development of new generation strategic models from a single *perspective does not* seem enough because many actors are involved.

Moreover, the project of development of strategic traffic models is sensible to the unexpected *government and political decisions* causing important changes during the project. That makes the management of the project challenging (with respect to the given quality and planning requirements). Finally, modeling of the traffic and transport for the whole Netherlands is a huge project where necessary scientific knowledge as well as implementation is needed. The existing market should have enough competencies and capacity to perform such a task within given requirements.

Some lessons may seem obvious but being obvious does not mean that the implementation is simple. However obvious, applying new guidelines is a complex issue in such a project.

Some examples of the improvements are classified by the following areas, namely:

- **the contractor-client relation**: at the beginning of the project the roles of different parties should be clear;

- **the scope of the project**: changes to the scope should always be approved by the contractor, after that the consequences for the planning, budget, etc. are considered;
- **the project-organisation**: The responsibilities for different roles in the project should be appointed at the beginning of the project;
- **the stakeholders:** it is necessary to pay more attention to the expectations, involvement, and agreement of different stakeholders in the project.
- **the market:** the market strategy (e.g. European public tender) as well as the quality assurance should be improved.

Based on these lessons, the current projects of development of the strategic models are significantly improved.

6. CONCLUSIONS

Over the last couple of years more attention has been drawn to the strategic transport models that are used in road scheme studies. On the one hand Dutch legislation makes it necessary to produce detailed information with appropriate strategic models. On the other hand the complexity of such models makes them very sensitive to mistakes (for example incorrect input data).

This paper deals with the new generation Dutch national en regional models, used to make forecasts for the long term future of mobility in general and the traffic and transport conditions in particular. The models are used for two main purposes: a) answering policy questions regarding e.g. major infrastructure investments, and b) to forecast the effect of regional infrastructure projects in the exploration and planning phase.

The new suite of models (one national en four regional models that together cover the whole of the country) are built to ensure maximum consistency. This is realized by using the exact *same input data*, by using *the same models* and the *same model parameters*. Moreover, improved maintenance and tighter administration of the models has resulted in better quality assurance.

The *consistenc*y between the models is assured by the following requirements:
-The input of all models, NMS and NRM’s, is the same and based on the same source (corrections are made in the source rather than separately in the derivatives);
-The assignment model is the same:
-The procedure and model for base matrix production is the same;
-The Growth Model is the same for NMS and LMS (not only in approach, but physically in terms of software and model parameters);
-There is one set of handbooks and documentation for the NMS and NRM’s.

Next to harmonization efforts in making the models consistent there have also been a number of other model improvements. The most significant model improvements regarding to the model technology are shown below.

- The principle of the *peak-period modeling* is improved. With this improvement the peak-matrices contain all peak-period related traffic (while the whole day traffic volume stays unchanged).
-*Re-estimation of the discrete choice models* using recent National Travel survey and new Stated Preference (SP) data.
-*The extension of the number of travel modes*, the number *of travel purposes, the number of the household types, the number of the person* types, thus increasing the level detail in the modeling. The effects of changes in household incomes are captured in a better way.
-Further improvements have been made in the modeling of *traffic traveling abroad, and of Schiphol related traffic.* The modeling of train mode has been improved.

The development of a new generation of strategic models covering the whole country is a very complex project in terms of project organization, collaboration of different stakeholders, accommodating opposite interests of involved parties, etc. In such a project the high level of collaboration of different stakeholders is needed. According to the participants in the evaluation this goal has been reached. However, some subjects such as the contractor-client relation, project organization as well as market strategy can be improved.

References

-(2006) Handboek NRM
-4Cast (2008),Handboek Calibratie, commissioned by DVS
-Remko Smit, Hans Flikkema (2010), *Quality Assessment of the Dutch National and Regional models*, proceedings of ETC conference
-Rik Grol, Frank Hofman and Remko Smit (2010) "*Convergence of the Dutch National Model System"*(Rijkswaterstaat Dienst Verkeer en Scheepvaart), paper European Transport Conference, Glasgow.
-Remko Smit, Dusica Joksimovic (2011), *Het Nederlands Regional model*, proceeding of CVS conference
-Significance (2011), Technical documentation NMS and NRM, commissioned by DVS