DELIVERABLE 3.3
GOOD MODEL PRACTICES FOR INFRASTRUCTURE PROJECTS

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Table of contents

1. Introduction

1.1 Project background

The European Union turned a new page with the start of the 'Europe 2020 Strategy' (see EC, 2010). By replacing the previous Lisbon Strategy (2000 – 2010), the transition process between the two strategy plans coincides with the EU's hardest economic crisis since its formation. The objective of getting out of the crisis in the context of fiercer competition on the global market with the new emerging economies has made Europe's competitiveness and economic performance fundamental issues.

In line with the 'Europe 2020 Strategy' flagship initiatives, the White Paper for transport (2011) summarizes the main objectives of the European transport strategy. The objectives help to establish a system that underpins European economic progress and offers high quality mobility services, while using resources more efficiently. As a consequence, it is essential to clarify the relationship between investments in transport infrastructure on economic growth and competitiveness.

Given the above challenges and strategy setting, it is obvious that stronger role and bigger contribution of the transport sector in the improvement of European economic growth and competitiveness are highly expected. It is essential to clarify the relationship between the transport sector and economic growth and competitiveness. Also, it is important to elaborate a framework, so that transport policy intervention effectively improves the European economic growth and competitiveness.

I-C-EU is a project that aims to clarify the relationship between transport infrastructure investment and its wider economic impacts, in particular competitiveness and economic growth. This will be made possible by exploring the state-of-the-art of the assessment tools, analysing the current and future situation of European economic and competitiveness, and taking into account the current European strategy to improve its economic performance and competitiveness. This concept allows I-C-EU to provide recommendations to the European Commission on making political interventions in order to enhance competitiveness of Europe in relation to the rest of the world as well as between its member countries and regions.

Departing from this concept, the I-C-EU project has four distinct, measurable and verifiable main objectives:

1. To understand the relationship between transport infrastructure, competitiveness and growth.
2. To contribute to the development of a methodology to quantify the impacts of the different investments in transport infrastructure on competitiveness and economic growth.
3. To include the impacts in the assessment methodologies.
4. To make recommendations on the assessment of EU policy regarding competitiveness and regional growth.

1.2 Goal and structure of this deliverable

One of the tasks within the I-C-EU project relates to the review of transport and economic models, which are used in the assessment of transport infrastructure. For this task, three goals are defined:

1. Determine to which degree the effect of competitiveness and regional growth has been considered in past assessments;
2. Analyse ex-ante and ex-post results of assessments of infrastructure projects;
3. Formulate improvements and recommendations.

This report concentrates on the *third objective*, the formulation of improvements and recommendations for the use of models in large infrastructure projects. The formulation will be done in the form of good modelling practices for transport and economic models.

Step 1, the review of a selection of strategic long term economic and transport models has been made earlier (see Kiel et al, 2013). The review determines to which degree the effects of competitiveness and regional growth are considered by a selection of models. The analysis concerns the descriptions of models, which are used for major infrastructure projects and mobility plans in the EU, as well as in member states. The analysis provides an overview of the way the selection of models contribute to the determination of effects of infrastructure projects on accessibility and competitiveness.

Step 2, the analysis of ex-ante and ex-post results of assessments of infrastructure projects is presented in Kiel et al (2014). This deliverable elaborates on the results of five different infrastructure projects in Europe, being the Amsterdam Orbital, Malaga Airport, Altenwerder Terminal Hamburg, HSR Barcelona – Madrid and Corridor 06 Lyon-Budapest. Some of the projects show that the use of models is not robust enough. Different aspects relate to this: models are not available anymore, technical documentation is lacking, or documentation, model and input are confidential.

Based upon the findings of step 1 and 2, this deliverable provides the formulation of improvements and recommendations for the application of models in infrastructure projects. This will be done in the form of good modelling practices. This deliverable is structured as follows:

Chapter 2 looks at the findings of step 1. It summarizes the concepts of competitiveness and accessibility and reviews these concepts in relation to the use of transport and economic models.

Chapter 3 describes the findings of the analysis of the five case studies and their conclusions.

Chapter 4 provides the good modelling practices (GMPs) for transport and economic models. It starts by looking at other domains first. Then the GMPs for transport and economic models are provided. These are based upon the findings in other domains as well as the conclusions from chapter 2 and 3.

Chapter 5 gives conclusions and further recommendations.

2. Accessibility and competitiveness

2.1 Introduction

The impact of large infrastructure projects on competitiveness is the focus of I-C-EU. One of the questions is, 'to what extent can models contribute to measuring competitiveness?'. This question is answered in Kiel et al (2013). This chapter summarises the findings of this report. First we will look at competitiveness and economic models in section 2.2. Then we look at accessibility and transport models in section 2.3. Finally, the relation between transport and economic models is summarised in section 2.4.

2.2 Competitiveness and economic models

Competitiveness

Competitiveness has raised more awareness over the past two decades, due to limitations and challenges posed by globalisation. In Smit (2013) this concept has been explored for the I-C-EU project. Competitiveness is a term with many definitions. In I-C-EU we use the following definition for 'competitiveness': '*Competitiveness is the extent to which firms in a particular region can compete with those elsewhere. Critical factors for competitiveness are those that determine the level of productivity in a region in relation to other regions'* (Smit, 2013).

The concept of competitiveness between nations or regions is not without criticism. Krugman (1994) argues that competitiveness is a meaningless word when applied to national economies (and thus local or regional economies). Krugman states that defining competitiveness for a nation is more problematic than defining that for a corporation. Corporations, who perform badly, will go out of business. But countries do not go out of business whether they are happy or unhappy about their economic performance. Concerning the national competitiveness Krugman sees three dangers: wasting government funds to enhance competitiveness, protectionism and bad policy[1].

Concerning national competitiveness, Dunn (1994) makes remarks that *criticising measurement concepts does not imply that the subject of examination itself is meaningless. What methodological and empirical difficulties do call for is the development of better measurement concepts of competitiveness*. The measurement of competitiveness by looking at different factors is another way of trying to get grip on the concept. Often factors such as Gross Domestic Product or Employment are used to measure 'competitiveness'. In that sense, competitiveness is a concept that contains different items. Based on this, one could argue that competitiveness is more a marketing concept, than a concept that can be measured.

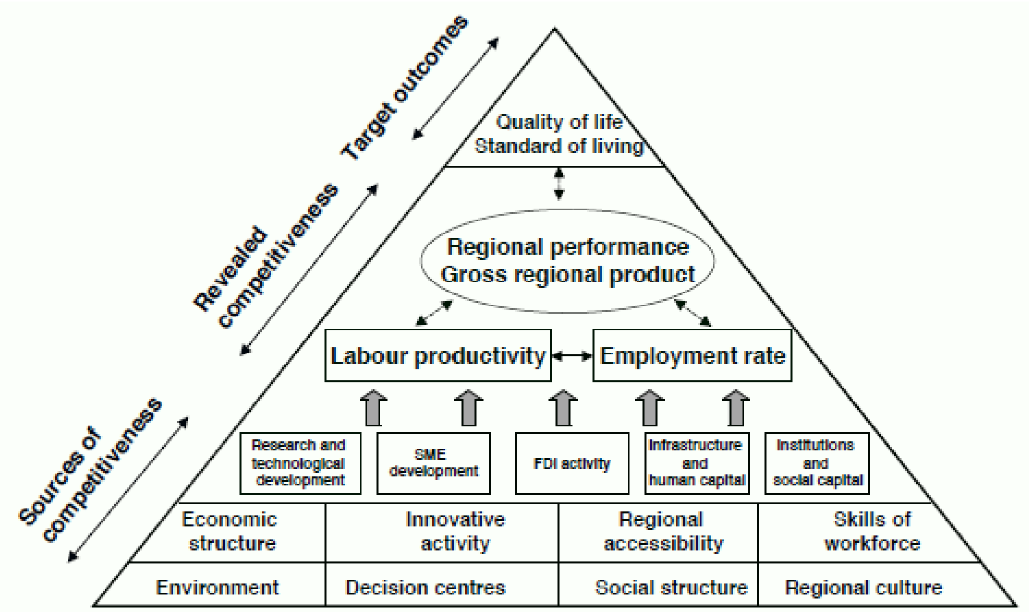
1 The article of Krugman led to a vivid debate on competitiveness, see for example Thurow (1994) and Prestowitz (1994)

Different factors play a role in the measurement of competitiveness. Lengyel (2004) constructed a 'Pyramid Model' of competitiveness, which was enhanced by Gardiner et al (2004). Lengyel distinguishes direct and indirect components concerning factors that influence regional competitiveness. Economic output, profitability, labour productivity and employment rates are important factors. But also success determinants with an indirect impact need to be taken into account such as social, economic, cultural and environmental processes.

With regard to the objective of regional development programming and the various characteristics and factors influencing competitiveness, Lengyel distinguishes three levels:

- *Basic categories* which measure competitiveness, including income, labour productivity, employment and openness.
- *Development factors* which concern factors that have an immediate impact upon the basis categories.
- *Success determinants*, which comprise social and environmental conditions. These have an indirect impact on the basic categories and development factors.

Lengyel places the characteristics that determine competitiveness on a chart, which form a pyramid. Figure 2.1 provides an overview of this conceptual model.



Source: Lengyel (2004) & Gardiner et al (2004)

Figure 2-1: Pyramid model for regional competitiveness

As can be seen in figure 2.1, gross national product, labour productivity and employment rate form the factors that together describe national or regional competitiveness. These three factors can be derived from statistics or from forecasts made with economic models.

Accessibility is regarded as one of the driving forces for competitiveness. Changes in accessibility could impact competitiveness, more specifically gross domestic product, labour productivity or employment rate. The pyramid model suggests a causal relation, but this could be argued. There are studies showing a correlation, but this does not imply a causal relation. The concept of accessibility is discussed in the next section, as well as its relation with transport models.

Economic models

The economic models reviewed in I-C-EU comprise RAEM, CGEurope, RHOMOLO, ASTRA SASI and RegFin. The models all have their own characteristics, strengths and weaknesses. See Kiel et al (2013) for an overview of these models.

For the economic models the following conclusions were drawn:

- From the input and/or output of the economic models, it is possible to derive an accessibility indicator for regions. However, due to the aggregated level of the economic models, modes, purposes and commodities are not always included in full detail.
- Networks and assignment models are usually not part of these models (except for SASI). A link or interface to a transport model is needed, in order to include detailed information about travel time, distance and costs.
- The economic models are able to predict changes in GDP and employment, due to changes in the transport system. These include changes in transport infrastructure as well as changes in to measures like pricing. Changes in transport infrastructure usually have effect if these can be described in terms of changes in transport costs.

2.3 Accessibility and transport models

Accessibility

In figure 2.1, accessibility is listed as a factor that contributes to the (regional) competitiveness. The accessibility, transport networks and geographical location of successful regions seem to be more advantageous than that of other regions. As with the concept of 'competitiveness', defining 'accessibility' is not without discussion, several definitions exist. As Peter Gould (1969) states it: 'Accessibility is a slippery notion…one of those common terms that everyone uses until faced with the problem of defining and measuring it!'. Different overviews for the concept of accessibility are available, such as Litman (2012), Geurs & van Wee (2013).

Litman (2012) found different factors that affect accessibility. These comprise transportation demand, mobility, transportation options, user information, integration of the transport system, affordability, mobility substitutes, land use factors, transport network connectivity, roadway design and management, prioritization and inaccessibility. Litman concludes that there is no single indicator to capture accessibility. In fact it depends on the goal of the study how accessibility should be measured.

For the measurement of accessibility, Geurs et al (2013) make a distinction between infrastructure-based accessibility measures, location-based accessibility measures, person-based accessibility measures and utility-based accessibility measures. Infrastructure-based measures are related to analysing the transport system itself, such as length of networks, level of congestion or speed. The location-based measures analyse the accessibility of locations at a macro level. The person-based measures relate to the accessibility at an individual level. Utility-based analyse the benefit people derive from access to spatially distributed activities (see also de Jong et al, 2005). Although the utility based analyse is technically the best, the use of a location-based accessibility measure expressed in general costs would be most appropriate (see Kiel et al, 2013).

Transport models

The transport models reviewed in this report comprise Landelijk Modelsysteem (LMS), BASGOED, Extended Riga Model (ERM), Great Britain Freight Model (GBFM), National Transport Model Denmark (NTMD), VACLAV, TransTools and World Container Model (WCM). These models capture passenger or freight transport. ERM and TransTools capture both passenger and freight transport.

The models all have their strengths and weaknesses in relation to the assessment of the impact of transport infrastructure investments upon accessibility and competitiveness. All transport models produce output that can be used to derive a location-based accessibility indicator. However, all transport models reviewed, except ERM and TransTools are partial, in the sense that the models regard either passenger transport demand or freight transport demand. This poses limitations upon the direct usability of the models in relation to competitiveness. When one would need an overview of the impacts of transport infrastructure investments, preferably both types of demand should be taken into account.

From the review of transport models the following conclusions were drawn (see Kiel et al, 2013):

- To assess competitiveness for regions, the information needed has to be complete. However, most transport models provide partial information. On one hand either passenger or freight transport demand is included, on the other hand some modes are missing.
- From the results of the transport models an accessibility indicator can be derived. However, due the fact that most models provide partial results, the overall accessibility to a region is difficult to assess.
- In order to assess the overall accessibility, different models need extra information, either from a passenger model or a freight model. If possible, an interface between the two is needed in other to calculate the overall accessibility of a region. In some cases such as LMS and BASGOED this is already available, in other cases such as TransTools and ERM the model contain both passenger and freight demand.
- To capture accessibility, most transport models include an assignment model. An assignment model is a network model and enables route choice for different modes and in some cases also delays and congestion. It predicts travel distance, travel time, travel costs and volumes for both passenger and freight transport. In the case of passenger transport usually congestion is taken into account, which is not always the case for most freight transport models.
- From the results of transport models, except one (TransTools), it is not possible to assess the impacts upon economic indicators such as GDP and employment. At least an interface and a macro-economic model are needed for this purpose. TransTools includes an economic model, which allows a feedback from the transport system to the economy, and thus indicators such as GPD and employment.

2.4 Relation between transport and economic models

Figure 2.2 shows that the transport system is dependent upon, and embedded in a macro-environment, containing demography, economy, society, technology, environment and politics. The transport system is both affected by these drivers and has an impact upon (some of) these drivers. The conceptual framework is explained in Kiel et al (2013).

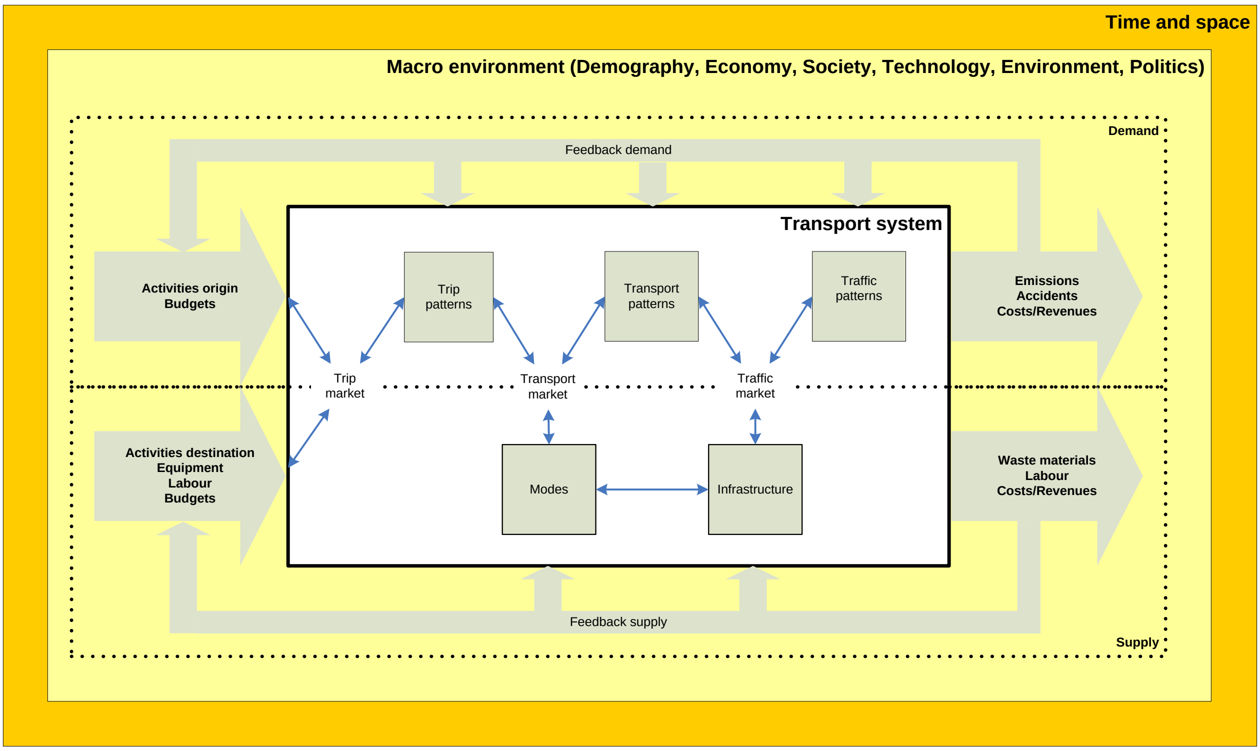


Figure 2-2: Conceptual framework of the transport system (see Kiel et al, 2013)

Investments in the transport system are made on the supply side, in both modes and infrastructure. These investments may concern different elements, such as renewal of a vehicle fleet, improvement of logistic services or new railway lines. All these investments are supposed to have an impact in the first place upon the trip, transport and traffic markets. Through changes in the key variables of these markets, a new equilibrium will be established. The key variables of the transport system concern travel distance, travel time, travel costs, volume of passengers, volume of freight, perception (such as comfort and reliability) and capacity. Changes in one of these key variables lead to a change in accessibility and thus output of the transport system.

Transport models should at least be able to provide accessibility as an output, or results with which accessibility can be calculated. However, this is not sufficient output. Accessibility needs to be linked to competitiveness. Concerning accessibility, there are different perspectives, geographical scales, users and indicators. This is also the case for competitiveness. Concluding, there are different ways to link accessibility to competitiveness. There is not one path that can be followed to connect accessibility to competitiveness.

The economic models (spatial general equilibrium models or LUTI models) are able to address the issue to connect transport investments to economic growth. There exists a large amount of literature with a consensus on the mechanisms on how changes in the transport infrastructure affect economic and productivity growth. A reduction of transport costs may cause a change in costs for the private sector. Furthermore, it may increase specialisation and labour division. Also, it may lead to changes in factor markets and firm location decisions (see Schade, 2006).

The review of economic models reveals to what extent these models are able to connect the changes in the transport system to changes in economic growth. To quantify the effects of a change in the transport system, transport models are applied. For the quantification of larger economic effects, such as employment and gross regional product, economic models are used. In order to use these models, they should be able to take changes in the transport system into account.

The review of transport and economic models shows that both types of models have their pros and cons when assessing the impacts of investments on competitiveness. In order to capture the impacts due to investments, the ideal situation is to use both types of models in combination. For this purpose an interface between the two is needed. In some cases, this interface already exists, such as the interface between LMS and TIGRIS XL or between ASTRA and VACLAV. Models such as TransTools have an internal interface, feeding back changes in the transport system to the economy.

The exact format of an interface is dependent upon the models. In most cases the interface concerns data exchange in the form of origin-destination matrices, containing variables such as time, (generalised) costs, distances or volume.

3. Findings from case studies

3.1 Introduction

For a deeper investigation of the findings presented in Kiel et al (2013), we looked at five cases of large infrastructure projects, where transport and economic models were used. The findings were described in Kiel et al (2014). This chapter summarises the findings of the report. First we present a brief overview of the case studies in section 3.2. Then we look at findings from the five case studies in section 3.3. At the end of this section, also some general remarks are made.

3.2 Brief overview of the case studies

In Kiel et al (2014) 5 case studies are presented in which models were used to assess the impact of investments in the transport infrastructure on the transport system and the economy. These cases concerned:

- Amsterdam Orbital
- Container terminal Altenwerder Hamburg
- Malaga Airport
- Corridor 06 Lyon-Budapest
- HSL Barcelona-Madrid

For the selection of five projects for deeper analysis, some criteria were used. In the first place, the set of projects came as a recommendation from Betancor et al (2013) in which screening criteria were applied. Through the application of this methodology we tried to identify those projects whose impact upon competitiveness and economic growth are expected to be important or relevant. In addition and for modelling purposes we also had to consider the following criteria:

- The project is (partly) completed;
- There is data available on the actual developments since the completion of the project;
- Models, input data, results *or* documentation are available for a deeper analysis.

In I-C-EU, a model is regarded as a set of instructions and formulas that are combined in a piece of software. This software can be run several times for different scenarios, in order to see the impacts of different variants. The model uses input data such as socio-economic variables and networks. It produces output in the form of OD-matrices, loaded networks and changes in socio-economic variables such as GDP and employment. The model can be a transport model, an economic model or a combination.

In some of the cases the models are still available, while in other cases they are not. This is important for performing a backcast. The non-availability can have different causes, such as software that is not operational anymore. Other causes, not mentioned for these cases, could be that the models are private and cannot be accessed. In our selection we looked at those models that are in principle available.

The data and results also need to be available. The data concern the input of the models, while the results comprise both data and documents. Usually documents are publicly available. For data this is not always the case. Furthermore, in one case a detailed ex-post analysis was performed. This is exceptional, as in most projects only a detailed ex-ante analysis is performed.

3.3 Findings from the case studies

The broad range of input data, models and results, as well as the range of cases provide a good overview of the way models are used in infrastructure projects. The following remarks can be made.

Amsterdam Orbital

The study for the Amsterdam Orbital was performed from 1990-1994. It comprises an ex-ante and ex-post evaluation. This enables a comparison between the modelling results and the observed situation after opening of the project. For large studies this is valuable information that helps to improve the models.

The data and models are not available anymore, which makes a reproduction of the results impossible. The documentation of the project exists, but could be more transparent. In itself, the available documentation is not enough to allow a good reproduction. Details on scenario, model parameters and input data are lacking.

Despite the lack of data, it is possible to make a fairly accurate backcast with the present version (LMS 2013) of the model. The assumptions, model parameters and scenario lead to a result that is accurate at screenline level[2] (in this case North Sea Canal). On the level of individual roads the differences are larger. If more details can be found for both network data and socio-eocnomic data the results can be improved. The backcast shows that the model is robust. Also, the backcast shows that one needs to pay attention to building good and realistic scenarios. These help to improve the value of the forecasts.

Looking at accessibility and competitiveness, the model used (LMS) is capable of capturing the accessibility. On the other hand, competitiveness was not taken into account through macro-economic models. These were not available at that time. Nevertheless, nowadays these models do exist. If the study would have taken place today, probably a macro-economic model would have been run in order to capture at least the wider economic impacts, including impacts on employment and GDP. For the backcast this model was not available however.

[2] A screenline is an imaginary line drawn across major transportation facilities, typically following a feature such as a river, canal or railway that has limited crossing points, to capture travel demand activity.

Container terminal Altenwerder Hamburg

Only an ex-ante evaluation is available for the container terminal Altenwerder project. A comparison of assumptions from the original evaluation with observed data after completion of the project is feasible. The Altenwerder case is small in size and is typical for other infrastructure projects that concern freight transport through key nodes within a wider transport network. One of the common characteristics in these projects is, that a tailor made model is used. The model concerns effects of an increased container handling capacity in the Port of Hamburg. Several benefit categories related to an increased capacity are evaluated with benefits of employment effects prevailing the outcome. Yet, considered benefits are confined spatially to the Federal State of Hamburg.

The original data and model are available in the assessment report. However, for some part they are not described in full detail and only aggregates are given. This makes a reproduction difficult. Nonetheless, it was possible to rebuild the model on the basis of the assumptions and model parameters that were published and reproduce the results of the original appraisal. This shows that if a model or data is lacking, good and transparent documentation helps to see what has been used in the project.

Through a backcast it was shown that the growth in demand for container handling was underestimated in the original evaluation while the potential to create additional income (through more jobs or higher income per employee) by increasing container volumes was overestimated. This was due the fact that at the time of making the forecasts, the impact of the fall of the iron curtain on container volumes to and from Eastern European countries was underestimated. Further, the assumption that (anticipated) productivity growth in the jobs directly and indirectly related to container handling would allow workers to increase real wages correspondingly turned out false. Despite significant increases in freight volumes in Hamburg the total number of port related employees was more or less constant, a development also seen in comparable port cities, and real wages did not increase noticeably. This corresponds with recent research suggesting that the assumption that increases in labour productivity lead to increases of labour income has its limits. Further, it shows once more that building a good and realistic scenario is difficult, if possible at all. Nonetheless, if the parameters in the model are changed according to observed data the project still brings along a favourable benefit-cost ratio within the backcast calculation.

The Altenwerder project increased the capacity for container handling in the port of Hamburg. Together with technological and operational improvements, this led to increased accessibility of the port both from the maritime and land-side. Beneficiaries of this improvement include all hinterland regions and oversees destinations which route cargo through the port. However, this is not underpinned by a model, but rather determined in a qualitative way.

Competitiveness also improved. To what degree this is, due to the Altenwerder project specifically or whether other macro-economic or political aspects played a role, is hard to say. What can be retrieved from the observed data is that the container handling in Hamburg grew significantly over the past two decades. This enabled the port to increase its market share compared to other ports in Western Europe which indicates to a strengthened competitive position of the port. The regional economy in the metropolitan area of Hamburg also benefited from this development. Especially the logistics sector prospers due to a comparative advantage which arguably stems from the high container volumes handled in the port. Nevertheless, neither competitiveness nor accessibility were comprehensively covered in the applied model. One reason for this lies in the spatially limited scope of the assessment. The project was financed by the Federal State of Hamburg. Accordingly only benefits occurring for the State were considered in the argumentation to justify the investment in a port expansion.

Malaga Airport

The Malaga airport is similar to the Altenwerder Terminal case, as it concerns a node. The models are tailor made. The assessment is publicly available and the models and data can be obtained upon request. A reconstruction of the cost-benefit analysis was made. The case shows that the cost-benefit analysis gave a positive net present value, which is an indication that an investment will pay itself back.

The original assessment was conducted with a conventional approach of CBA that did not consider wider economic impacts. Nevertheless an econometric model that includes capacity restrictions within a panel data set was applied in order to forecast demand values. The capacity of the airport was modelled as well in order to account for congestion within the assessment.

The impact of the extension of Malaga airport on aspects such as accessibility and competitiveness is not captured in the original assessment. Only in a more qualitative way some statements can be made on accessibility and competitiveness. As the airport is extended in size and thus capacity it can be stated that the accessibility has improved. The observed data for Malaga shows that this has led to time savings, though this is not generally true for other projects. We conclude that the project may have had some wider economic impacts and thus improved the competitiveness of the Malaga Airport in terms of employment and GDP, though it is difficult to prove this.

This case study is being subject to a wider analysis in Deliverable 2.3 on 'Screening of projects and analysis of particular case studies'. We expect this analysis, based on the integration of conventional CBA and additional information is given by Tourism Satellite Accounts will shed light on the wider economic impacts of the Malaga Airport enlargement.

Corridor 06 Lyon-Budapest

The Lyon-Budapest corridor is mainly about improvement of rail freight transport between Lyon and Budapest. The results were not produced for the corridor, but rather used as a test bed for the calculation of indirect network effects. This however provides important information on how to link a transport model and an economic model. In the I-C-EU project we refer to this as the accessibility and competitiveness aspects.

Results were available from both a transport model and a macro-economic model. This serves to make the case study stronger, as this type of combination is rarely applied. The documentation provides information on how the models were linked and how they were used. A drawback is, that a good description of the original scenario is not available. This makes a reproduction hard if not impossible, as well as the interpretation of the results.

The models were not available for a backcast. Software problems, as well as the fact that the results were physically produced at two locations, made it impossible to reuse the systems. The input data were not properly archived. This is an aspect that a lot of projects suffer from. We recommend that more attention should be paid to the management and maintenance of models, input data and results. This is critical for a good evaluation afterwards.

Comparison with observed data was cumbersome. The corridor was renamed into Corridor D Valencia-Budapest. Although the intentions are well described, it is hard to find observed data which can be compared to the modelled situation. From what has been found, it seems that there are differences between the two. However, as both modelled and observed data are sparse, it is difficult to draw conclusions other than that these are not transparent.

The case shows that it is possible to link a transport model and an economic model. The results show that the direct and indirect impacts can be significant. The direct impacts concern time savings for rail freight transport. The indirect impacts concern in this case the impacts on GDP only in the different countries. Employment was not reported. For the corridor Lyon-Budapest the main impacts are in Slovenia and Hungary, countries were infrastructure improvements have a relatively large impact due to the initial poor stat of infrastructure. Those effects are reduces in areas where infrastructure is better developed.

Accessibility and competitiveness can be addressed as this case study shows. The transport model is able to capture accessibility through time savings, while competitiveness is addressed through improvements in GDP. Employment was not taken into account. A drawback of the study is that the results are available at European and national level, but not specifically for the corridor. The results would improve if more attention was paid to the corridor specifically.

HSR Barcelona-Madrid

For this project an assessment has been made of a partial cost-benefit analysis that focuses on direct economic impacts. The approach considers changes in resources and willingness to pay. This shows that the travel time savings give the main benefits, except for the case in which HSR compares with the plane. On the other hand also new traffic was generated. The main drawback of this assessment is that data was not directly provided by the operators of infrastructures or services. Consequently, the original appraisal required the use of different assumptions that were defined in the evaluation.

The assessment is based on a tailor made model. Demand was forecasted according to GDP expected rate of growth. The assessment is publicly available and models and data can be obtained upon request. This allowed the interpretation of the results and also allowed a retrospective look at the project. This case shows that rebuilding the cost-benefit analysis gave again a negative net present value.

The observed travel time savings alone would create an improvement of the accessibility of both Madrid and Barcelona. However, the new HSR competes with air transport. At the time of opening, this was one of the world’s busiest air routes. So, the accessibility was already good, though by another mode. Keeping this in mind, one could argue that the competitiveness due to this infrastructure project is limited. Changes in employment may occur as well as a change in GDP, but they might be small.

Finally, this case study is being subject to a wider analysis in Deliverable 2.3 on “Screening of projects and analysis of particular case studies”. We expect this analysis, based on an econometric approach of employment density will shed light on the wider economic impacts of this HSR infrastructure.

General

The models used for different cases have been explored. Although a lot of data, models and documentation have been collected, it does not mean that we had access to all items. Some data and models were not available due to bad or incomplete archiving, while in other cases items were not available due to the fact that they were privately owned.

The applied models have been diverse, ranging from broad strategic models to tailor made models. This also affects the results. These are in some cases detailed, while in other cases the results are only available at a broad level. In some cases there is the lack of detailed information about the models, such as input data, scenario’s used, assumptions made. A main guideline for the transparent use of models in infrastructure projects should be that the results can be reproduced with a minimum of efforts. This is not the case for many of the cases we have studied.

A difference can be made between nodes and links. Models used for infrastructure concerning nodes such as ports, terminals, airports and stations might be more inclined towards a tailor made model, while studies into links (corridors, roads, rail, etc.) are more inclined towards models that can be re-used for other studies as well.

Concerning the use of models and data, an important recommendation is about archiving the data, the model and the documentation. Some cases that have been examined, lack a good archive that is accessible to third parties. This would make the outcomes of a project more valuable as in the future a project might be evaluated, taking into account the original assumptions, data, models and scenarios. This way wishful thinking about a project can be diminished.

For the different infrastructure, usually different scenarios were used. It is recommended to make a distinction between background scenarios, covering our socio-economic future, and policy scenarios, which cover the different variants of an infrastructure project. Both types of scenarios need to be realistic. For the background scenario, this might produce some problems. A backcast could be done to validate the model and the plausibility of the background scenario.

Finally, archiving model, input, documents and model results is important. As mentioned before, the ambition should be an archive that allows the reproduction of the results. Whether this archive is public or private is open for discussion. Our recommendation is that it should at least be public for large infrastructure projects or infrastructure projects that are co-financed by the European Commission.

4. Good Modelling Practices

4.1 Introduction

Modelling transport has taken place for many decades. Many decisions on transport infrastructure investments require models as the questions related to the investments are complex. Many policy measures have different impacts on the choices of travellers and freight transport operators. As the investments involve several millions or even billions of Euros, decisions to spend budgets need to be taken carefully. Underpinning decisions with results from models is therefore a necessity nowadays. This implies that the transport models and their results need to be reliable, transparent and consistent.

Reliable, transparent and consistent results from transport models are often at stake. A number of reasons can be mentioned. Without being complete one can point at aspects such as the transport model being a black box, input data being incorrect, different models producing different results, a model that has not been validated, results that have not been checked for plausibility, lack of archive, bad management and maintenance, and a lack of organisation. Although things have improved over the past decades, initiatives to come to good modelling practices in transport are lacking in general.

Good modelling practices are more common outside transport. For example, in ecology, water management, environment and bioprocesses different initiatives were undertaken in the past to come to good modelling practices. Examples can be found in Kell et al (1995), STOWA (1999), Crout et al (2008), Schmolke et al (2010) and the EU project CREAM/TRACE (www.cream-itn.eu). Handbooks on good modelling practices for transport do exist but not under the name 'good modelling practices'. Kiel (2010) and Heynickx et al (2013) both describe a transport modelling approach, but this is more an aspect of good modelling practice.

Despite the available handbooks and initiatives on good modelling practices, one aspect is often overlooked. This is the organisational aspect of good modelling practices. These have been described in Kiel (2008) and Kiel et al (2009) on management and maintenance of transport models. Further aspects such as protocols, planning and budgets are described in Kiel (2010) and Heynickx et al (2013). Organisation of models in all its aspects need to be included in good modelling practices.

This chapter provides an overview of good transport modelling practices (GTMP) from the viewpoint of investments in transport infrastructure and its impact on competitiveness. This implies the development, use and organisation of transport and economic models. This chapter is organised as follows:

- Section 4.2 looks at good modelling practices in other domains such as ecology and water management.
- Section 4.3 presents good modelling practices for transport and economic models.

4.2 Good modelling practices in different domains

For Good Transport Modelling Practices (GTMP), a conceptual framework is needed. This section will propose a GTMP, based upon the references mentioned in the introduction. Although more references can be provided, the references mentioned in this section provide a good overview of the possibilities to come to good modelling practices for transport and economic models. In this section we will pay attention to Kell et al (1995), STOWA (1999), Crout et al (2008) and Schmolke et al (2010) and Grimm et al (2011). The last two authors also contributed to the CREAM/TRACE project.

Kell et al (1995) provide *some* recommendations for good modelling practices from the perspective of estimating the present or future state of bioprocesses. They realize that the recommendations they give are not complete. The recommendations Kell et al (1995) give are:

1. Correctly identify the parameters and variables of the system under study, whether measurable or not.
2. Identify whether a problem is true forward or inverse[3], and to what extent it makes sense to study a mixed model.
3. Describe which inputs and outputs were chosen for the model, and why.
4. In reporting the outcome of predictive modelling experiments of this type one should attempt to state what parameters were used, their values, and what the outcomes were in terms of speed of learning and precision of prediction.
5. Data should always be plotted to show the relationship between the predictions and the 'true'(gold standard) data.
6. Show whether the predictive time-series model can do significantly better than that based on a first- or second-order trivial predictor.
7. Any nonlinear predictive model should always be compared with the performance of the best types of linear multivariate calibration models for the same dataset.
8. Provide quantitative data and performance criteria for predictions so that the effectiveness of models can be assessed.
9. Do not claim general superiority of any particular algorithm or predictive modelling approach when it has been tested on only a limited dataset.

As can be seen from the recommendations by Kell et al, the good modelling practices are not categorized in some way or another. It mainly concerns the development and evaluation of the model. Application and description are not really mentioned. The organisation, management and maintenance are not taken into account.

STOWA (1999) has set up a handbook for good modelling practices for water management models. Although drafted for water management, the handbook can be used for different types of models as well. STOWA describes clear objectives for the handbook: provide guidelines for model use, stimulate more careful use of models in water management and improve the reproducibility and transferability of model studies. Different domains of models are taken into account, such as groundwater models,

[3] In a forward problem the parameters and starting conditions of a biological system are known. In an inverse problem, the parameters are difficult or impossible to measure. They must be determined by working back from variables that can be measured. This modelling point is specific for bioprocesses.

morphological models, ecological models, models for water related economic sectors and emission models.

STOWA distinguishes seven steps for good modelling practices:

1. *Start a model journal*
2. *Set up the modelling project*: Describe the problem, define the objective, analyse the context and reach agreements on the justification, specify the requirements, and draw up a working plan and a budget
3. *Set up the model*: Choose the beginning: data analysis, system definition or conceptual model, analyse the data, make a system definition, make a conceptual model, choose from existing model programs, choose a discretization for the model in space and time, choose a numerical approach, implement the model, and verify the model
4. *Analyse the model*: Make a planned approach for the analysis activities, make a general analysis of the model, carry out a sensitivity analysis, carry out (formal) identification, calibrate the model, carry out an uncertainty analysis, validate the model, and determine the scope of the model
5. *Using the model*: Make a planned approach for the simulation runs, perform the eventual simulation runs, verify the results, and raise the question 'Is this all?'.
6. *Interpret the results*: Describe the results, discuss the results, describe the conclusions, check whether the objective has been achieved, summarise the results, and analyse the consequences for the research question.
7. *Report and file*: Report in the language of the target group, make the model study reproducible.

The guidelines made by STOWA (1999) are a step forward compared to Kell et al (1995). The good modelling practices are more formalised by means of sequential steps. Not only technical aspects have been dealt with, also more organisational aspects such as drawing a working plan and taking care of budgets. Despite this, some organisational aspects are still missing such as archiving the results and the management and maintenance of models. In a sense, the guidelines were a success. Even in such a way that the US Environmental Protection Agency uses the checklist and template provided by STOWA (see US Environmental Protection Agency, 2010).

Crout et al (2008) drafted good modelling practices for environmental modelling. They distinguish some general components of best modelling practice: (1) definition of purpose; (2) model evaluation; and (3) transparency of the model and its outputs. More concrete the components are described as follows:

1. *Model purpose.* Defining of the model's purpose, answering the question 'What is the model for?
2. *Model evaluation.* The evaluation should include both the model and the input. Evaluation should not be an aftermath.
3. *Performance measures.* The role of the measures is to indicate the fit between model and observation.
4. *Stating and testing model assumptions.* The modeller should make a series of simplifying assumptions or hypotheses to describe complex natural systems using simple mathematical models.
5. *Ongoing model testing and evaluation.* This relates to the general process of software development. Underestimation of budget, failure to understand and appreciate what is expected of the system, lack of technical expertise and proper development of tools, and inherent uncertainty of the software development process.

6. *Model transparency and dissemination.* The model's purpose should be described in a transparent way. This concerns assumptions, formulation and evaluation. Attention needs to be paid to terminology, reporting format and the dissemination of the work

The work of Crout is an important step forward, but the good modelling practices mainly concern the development and testing of the model. The application through scenarios and the management and maintenance remain out of scope.

Schmolke et al (2010) and Grimm et al (2011) propose good modelling practices for documenting ecological models. Their good modelling practices can be found in the CREAM/TRACE project as well (see www.cream-itn.eu). Both Schmolke and Grimm define for good modelling practices: model development, model testing and analysis, and model application.

The model development requires problem formulation, design and formulation, model description, parameterization and calibration. The model testing and analysis comprises verification, a sensitivity analysis and validation. The model application contains results, uncertainty analysis and recommendations. These steps have been put together in the modelling cycle. See figure 4.1.

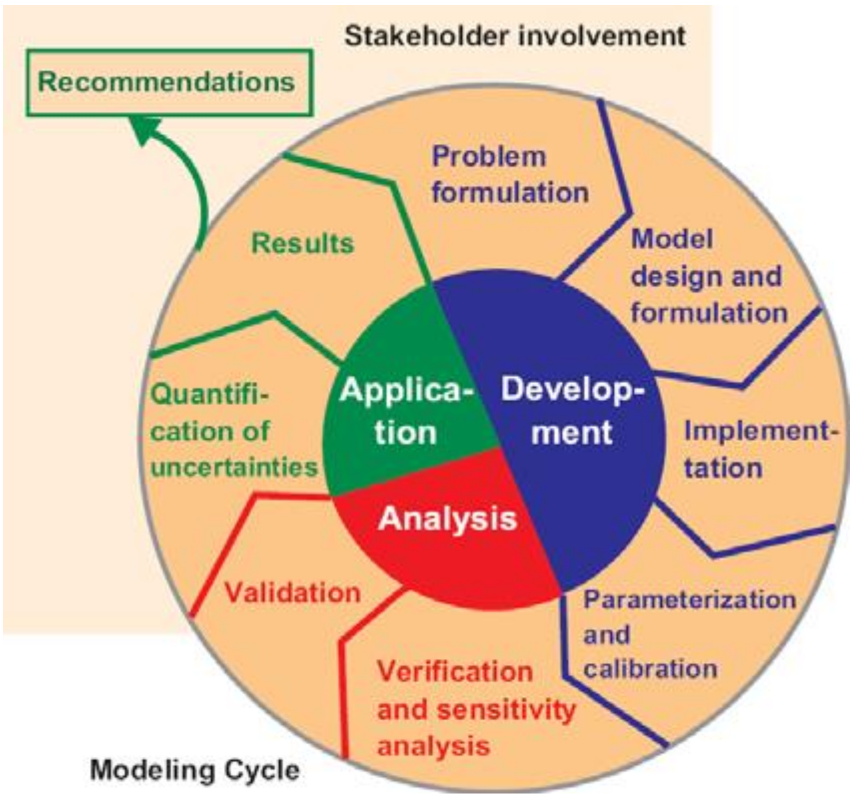


Figure 4.1: The modelling cycle (see Grimm & Schmolke, 2011)

The modelling cycle shows different aspects of good modelling practices. Not only the technical modelling aspects are included, but also the stakeholders. However, the organisation of model management and maintenances remains out of scope.

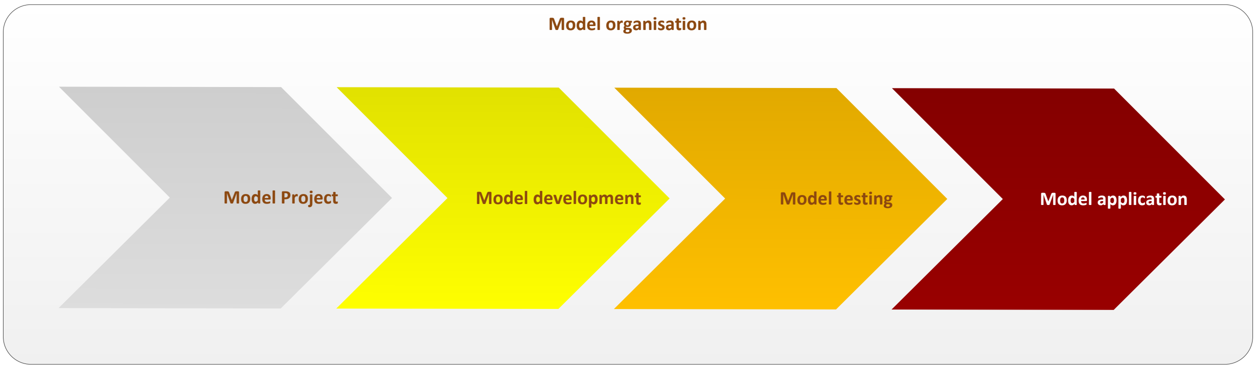
Concerning the good modelling practice in other domains than transport and economics, in this section a number of GMPs have been described. The good modelling practices mainly describe the technical aspects. Organisational aspects are only taken into account at a limited level.

4.3 GMPs for transport and economic models

Based upon the work in I-C-EU some good modelling practices for transport and economic models can be drafted. We base ourselves upon previous I-C-EU work presented in Kiel et al (2013) and Kiel et al (2014) and summarized in chapter 2 and 3. Furthermore, we base ourselves on good modelling practices in other modelling domains (see previous sections) as well as previous work mentioned in Kiel et al (2004), Kiel (2008) and Kiel et al (2010). For both transport and economic models we propose the same good modelling practices.

Figure 4.2 provides an overview of the GMPs for transport and economic models. All aspects from the previous chapters and section have been taken into account. As a basis, STOWA (1999) and Grimm (2011) and Kiel et al (2012) are used and further extended. The different aspects of the figure are being described below.

Figure 4.2: Overview Good Modelling Practices for transport and economic models



1.1 *Stakeholder involvement*. This is needed to get those who are necessary for the success of the model projects on board for the project. The stakeholders concern organisations such as governments, developers, consultants. Stakeholders may perform activities such as advice, data, and comments on intermediate results.

1.2 *Formulate the problem and objective.* This describes the problem area or the background, and the objectives of building and using a model and the questions the model needs to answer (see STOWA, 1999).

1.3 *Specifications of requirements and scope*. The initial requirements describe expertise needed, the estimated manpower, dissemination (what knowledge will be shared with whom? And how: workshops, reports) and other requirements such as data needs (see STOWA, 1999).

1.4 *Draw up a work plan and a budget.* The activities needed to carry out the model development and model testing are written down in a work plan. The specifications of requirements are taken into account when drafting a work plan. Items include step 1.2 and 1.3 as well as how the project will be done. This includes a planning and budget for step 2 and 3 for the development and testing. The application can be included, but in case of a multiple purpose model, it will be used several times. Then probably per (series of) model runs, a separate work plan is needed.

2.1 *Sketch the overall system (a conceptual model)*. Make a rough sketch of the overall model system. This includes the sub models, inputs and outputs of the system. The sketch serves as a first overview of the system and will be filled in in the course of the model development tasks. The sketch should show the functional relationships between the different components of the model system. Requirements on software dimensions, variables and scope (geographical and time) are taken into account as well. When sketching the overall system it must be kept in mind that transport and economic models may be connected to each other. This should explicitly be taken into account.

2.2 *Design and formulate the submodels and the database*. This task is a first step towards a technical documentation of the model system. For the submodels, this task describes in detail the submodel objective, its structure (input, submodel, output), its formulas and further aspects that needs attention. For the database, each dataset is described. This concerns the metadata (such as source, availability, quality, supplier), and per data file the characteristics, data formats, dimensions and variables. The description can be split into more reports if necessary. The description serves as a basis for the software development, building the database and the final technical documentation.

2.3 *Collection of data*. In this task the data needed for the model system will be collected. This concerns data such as census data, surveys and counts. These data will be used as direct input (such as socio-economic data), to estimate parameters or the calibrate parts of the model system.

2.4 *Build the input database*. The input database will contain all input for the model system. These comprise data such as socio-economic data, trade data or networks. Also, some synthetic data such as base OD matrices should be included in the database. These will be calibrated in later steps. The database should be easily accessible to the users. It should be made possible to exchange the data. On one hand it should be possible to add new data, on the other hand it should also be possible to retrieve data from the database.

2.5 *Estimate parameters*. The model as described in task 2.2 needs parameters or coefficients for the formulas. These parameters are estimated based on data such as travel surveys collected in step 2.3. The estimated parameters are described in such a way that reproduction would be possible. For the interpretation of the model results, the parameters and coefficients are delivered together with the relevant statistics such as Students-t and R^2.

2.6 *Make a prototype of interface and submodel*. The prototype can be distinguished in a user interface and submodels. The prototype interface gives an idea how the system will look like when the user applies it. The prototype interface should be discussed with the stakeholders who use the model. The prototype submodels needs to be tested in a small test environment. The formulas (see task 2.2) in each sub model are tested in a simple environment such as a spreadsheet.

2.7 *Develop and test the model software*. The model software can be developed as soon as the previous tasks are completed. The software developer will build the system and test it. The tests are technical (does the system work properly) and functional (can the tests from task 2.5 be reproduced?). As soon as the full system is ready, a full test needs to be performed. This will be done in task 2.9.

2.8 *Calibrate datasets*. Some datasets made in task 2.4 such as base matrices, need to be calibrated. This means that the synthetic data matches with the observed data such as traffic counts. The calibration process should be reported in a transparent way. Tests from the assessment framework in step 3.1 might be used. Also, the quality of the final results need to be described (e.g. what is the difference between the observations and estimations?).

2.9 *Validation of the model system.* The validation is used to check whether the model system is able to produce plausible results. It also determines whether the model system meets with the objectives of the model. In case a connection is made between a transport and economic model, this should be explicitly validated.

2.10 *Final technical documentation.* Based upon the draft technical documentation from task 2.2, this task finalizes the technical documentation. All flaws noted in the tasks between 2.2 and 2.10 will be corrected in the draft documentation, in order to make it a final version.

2.11 *Draft a user guide.* Based upon the final model system, a draft user guide will be made. This user guide will be made final after the model testing in step 3. The user guide will be drafted in such a way that the user can apply the model system without further help. The guide includes a quick start, installation procedures and detailed guidelines.

3.1 *Define an assessment framework*. The assessment framework provides guidelines for the interpretation of the tests and results. This comprises a document describing the standard output that will always be needed or used for the interpretation of the results or tests.

3.2 *Carry out a sensitivity test*. The sensitivity test is performed to see the reaction to changes in the input or model settings. This can be done by using the final model or by using the prototypes. It gives insights as to the size of the impacts due to changes in the input or model settings have upon the output. It is recommended to look at both normal and unrealistic changes. The normal changes should give normal output. The unrealistic changes should give abnormal results. In principle changes in all possible input and settings are being looked at.

3.3 *Perform a backcast*. A backcast as a way to test a model is very powerful. Instead of predicting a future year, the transport of economic model predicts a past year. For example, using an economic model and predict economic variables for 1995, starting with 2010 as a base year. The advantage is that the background scenario and policy variant are fixed, because we know what happened. Performing a backcast provides good insights into the quality of the model.

3.4 *Validate the model by means of case studies*. Case studies are an excellent way to check the plausibility of the results of the model. By using different background scenarios and policy variants the developer (and potential user) get an insight into the quality of the results. It is recommended to use at least 3 different cases.

3.5 *Make the final user guide*. The draft guide from step 2.11 is used to perform task 3.2, 3.3 and 3.4. Both the user and developer may have further comments, which should be taken into account when drafting the final user guide.

4.1 *Define and describe background scenario*. The background scenario provides information on the future of demography, economy, society, technology and environment. Usually, it concerns variables such as number of inhabitants (by sex and age), employees and cars. Background scenarios are mostly used more than once. The stakeholders should agree upon the use of the background scenario. The background scenario is written in such a way that all sources, assumptions and data handling is transparently and completely described. The background scenario will be turned into data input for the model.

4.2 *Define and describe policy variants.* The policy variants concern in our case transport policy measures such as transport infrastructure improvements (new road, port, adaptation of speed, other capacity, etc). It also may involve items such as pricing or new technologies such as electric bike or light rail. The stakeholders should agree upon the policy variants. The policy variants are written in such a way that all sources, assumptions and data handling is transparently and completely described. The policy variant will be turned into data input for the model. One special policy variant concerns the base-case. This variant serves as a references to compare the policy variants.

4.3 *Perform a reproduction run.* When using the background more than once, a reproduction of a future year helps to see whether the correct input is used as well as the correct model settings. The output should be reproduced 100%.

4.4 *Perform model runs.* The model runs can be performed as soon as step 4.1-4.3 have been completed. The model run itself is kept under control especially when runtimes are long.

4.5 *Check the intermediate model results.* When runtimes of a model become long (say more than 4 hours), checking intermediate results may provide a first indication whether the model run is doing well. If not, the model run shall be stopped. Checks should be made on step 4.1 and 4.2 to see whether the input is correct. If correct then the model itself needs to be checked.

4.6 *Analyse the final model results.* The final model results of a model run need to be analysed according the assessment framework developed in step 3, as well as further specific analysis that relate to the policy variant.

4.7 *Report the results.* The final results of the model runs will be reported transparent and complete. The report describes the main results, details can be put in an annex. This concerns all the work of task 4.1, 4.2 and 4.6. The main results concern an overview of the background scenario and the policy variants, and the differences between the policy variants and base-case variant. Furthermore, all model settings are reported.

4.8 *Discuss the results on their plausibility.* The stakeholders involved in the model project should discuss the results and see whether the results are plausible. This can be done by discussing results in tables, graphs and maps. For all results a plausible interpretation should be available. On case of non-plausible results the stakeholders need to decide what to do. This needs to be reported in a transparent way.

4.9 *Describe the conclusions and summarize the results.* As soon as task 4.8 has been completed successfully, the conclusions can be drafted and the results summarized for the further decision process. This task should take into account that there is a large step from science and model to advice. To the client the origin, status and reliability of an advice are inconceivable (see STOWA, 1999). Decision makers want clear answers to complex questions. So, jargon should be avoided. Story telling could be a way to present the results.

4.10 *Backup and archiving of the model runs and results.* The backup and archiving of model results should make it possible to look at the runs and results at a later stage. The backup should include all input used, the model version that was used, as well as all the results. In principle this should make it possible to reproduce all the results and to perform further runs and analysis at a later stage.

5.1 *Organisation.* The model development, test and application need to be embedded in an overall organisation. This organisation comprises members and functions such as a coordinator, administrator, technical support team, other stakeholders, helpdesk, administrator and management and maintenance. Furthermore, attention needs to be paid to the finance of the model system. Who will finance management and maintenance? Who is responsible for funding and fund raising? How much budget is needed per year?

5.2 *Roles and responsibilities of the organisation.* Each member of the organisation has a role and a responsibility in the organisation around a model system. The role and responsibilities for the coordinator, helpdesk, administrator, technical support team, other members and users. Examples of roles and responsibilities are chairman, writing model project plans for further improvements, coordination of the helpdesk, intake of model related questions at the help desk, etc.

5.3 *Resources for the model system.* To keep the model system and its organisation alive, funds and manpower are needed. This can be done structural (e.g. each year) or on an ad-hoc base. For this budgets and work plans need to be drafted.

5.4 *Protocols*. For the procurement, development and application of the model system protocols are needed. These tell us who is responsible for a certain process and what he/she has to do. For example, initiating a procurement process for further model development could be a responsibility of the coordinator of the organisation. He/she will start the process by drafting a work plan, including a planning and budget. The second step in the protocol would then be to approve the work plan by the members of the organisation. Altogether, the protocols should give guidance on how to approach work and what appointments need to be made for this.

5.5 *Planning*. The planning for development, update and application of the model system has to be drafted. This can be a cycle of activities, lasting for a longer time. For example, of updating the model system a planning is need from start (writing a work plan) to finish (adapting the final user guide).

5.6 *Management and maintenance*. The model, its inputs and the model runs need to be properly managed and maintained. This should be done in a transparent way, keeping an eye on consistency and quality of the results.

5.7 *Archiving model, input and results*. This task is related to the overall management and maintenance. Each time the model is adapted or improved, it receives a new version number. When using the model we have to report with which version we work. This way it will always be possible to trace back the model we used for our model runs. The input data is stored in an database and requires a similar treatment. Whenever changes are made to the data, we have a new version. The results from the model runs need to be zipped and archived as well, in such a way that we can reproduce them whenever needed.

5.8 *Communication and dissemination*. Concerning communication two types can be distinguished: internal and external communication. Internal communication is about meetings of the members of the organisation and other communication. External communication concerns the dissemination of products such as newsletters, website, conferences and reports.

5.9 *Legal aspects*. The legal aspects should be taken into account as well. Is the model public or private owned? Is the model and its input open accessible or confidential? If the model is used, under what conditions can it be used? In case of misuse, what sanctions? These and other types of questions should be embedded in a legal framework.

4.4 Concluding comments

The GMPs for transport and economic models, as described in the previous section provides guidelines on how to develop, use and maintain the models. From the case studies, we saw that different aspects of the GMPs have not been taken into account. In different cases, model results were incomplete, models did not exist anymore, models were improperly archived, or management and maintenance did not exist.

There are several reasons why GMPs have not been taken fully into account as sketched in the previous chapter such as no budget, no need, or never thought about it. This does not necessarily mean that organisations don't do their work properly. But it does show that improvements are still possible in modelling transport and economy. The guidelines provide help in the development, testing, application and organisation of the models.

5. Conclusions and recommendations

5.1 Conclusions

The objective of this deliverable is ‘to formulate improvements and recommendations’ for the use of models in infrastructure projects and their impact on competitiveness. In Kiel et al (2013) it was explored to what extent transport and economic models could contribute to the question ‘What is the impact of infrastructure projects on competitiveness’. It was concluded that this is complex matter. There exist several definitions for competitiveness and, related to this, accessibility. The concept of competitiveness as such is hard to quantify (if possible at all). Instead gross national product or labour rate are used. This leads to the conclusion that competitiveness as a concept is often used as a marketing tool or ‘container’ concept to say something about labour rate or employment.

The relation between transport and (other parts of the) economy seems to be available. However, hard evidence to show causal relations are not known. Instead correlations are known, but this does not tell whether there is a causal relation. Knowing this, it will be hard to make firm connections between transport and economic models based on revealed evidence. Instead changes in the transport system have an impact on economy. The changes in the transport system comprise distance, time, costs, perception and capacity. These are the key variables for which changes can have an impact on economic variables such as GDP or employment.

From the case studies we saw that the underlying infrastructure projects have been well studied. But reproducing what has been done or making backcasts proved to be a step too far. In some cases the model and its input was confidential, in other projects the archiving was not properly performed. All this shows that improvements should be made. After all millions or even billions of Euros are invested. The underpinning of these investments by means of models should be done properly in a transparent and robust way. The good modelling practices described in this report should help the use of models in these projects forward, especially concerning the organisation of the transport and economic models.

5.2 Recommendations

It is recommended to use the guidelines drafted in this deliverable as a guidance to develop, test, apply and organise transport and economic models. It will help to make the models and their even more reliable and transparent. The guidelines could be applied on different geographical levels: local, regional, national and international. This helps to underpin the expenses on large infrastructure projects and to make them more transparent.

Furthermore, it is recommended to provide further resources to improve the GMPs and let it be approved by a wider model audience. Only this way we will succeed in making the GMPs for transport and economic models a success. The expense of billions of Euro's on transport infrastructure needs good data, models, organisation and documentation. The GMP for transport and economic models provide a good base for this.

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