ASSIST

Assessing the social and economic impacts of past and future sustainable transport policy in Europe

SYNTHESIS

Synopsis of ASSIST findings

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ASSIST

Assessing the social and economic impacts of past and future sustain-able transport policy in Europe

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Table of Contents

List of Tables

List of Figures

1 Introduction

The ASSIST project had to deal with the social and economic impacts of sustainable transport policy. Of course, the project did not neglect the environmental and institutional dimension of sustainability, but the focus of the project was on social and economic impacts, which in many cases effectively represent the two sides of the same coin. This holds for instance for transport policies that improve accessibility thus providing better access to jobs, culture, leisure facilities, and social impact, but also improve productivity and competitiveness thus fostering economic development, the economic impact, and employment, which is rather a social impact.

The link between social and economic impacts is not always that straightforward. They are not even heading always in the same direction. In many cases, the social impacts emerge via the environmental impacts. Transport policies that reduce transport-related emissions or noise improve the citizens' health affected by these environmental impacts. Social impacts deriving from changes of the environmental impacts of transport often exhibit a distributional dimension, i.e. they affect only certain social groups of the population e.g. those living alongside larger roads. Most often the distributional impact is linked to the local nature of environmental impacts like pollution and noise.

Actually we did not look only at the classical transport policy (e.g. pricing, taxation and infrastructures), but introduced the wider term of "*Transport Policy Measure*" (TPM) that also includes categories like vehicle efficiency standards or research and innovation. Thus, the categories reflect the measures proposed by the European Transport White Paper which conceives the single European transport area (European Commission 2011).

The task of assessing the impacts of TPMs was twofold, as both impacts have already occurred in the past and expected impacts of future sustainable transport policies were considered. This meant that we undertook (1) an ex-post analysis of impacts of existing transport policies, and (2) we developed a tool for prospective analysis of impacts until 2030 and even until 2050. In addition, the analysis was combined with qualitative considerations about the variation of TPMs impacts through changes of the framework conditions given by the socio-economic systems and the environment. We called these changes "*future challenges*"; examples of future challenges affecting transport and TPM impacts include an ageing society, climate change and increase of extreme meteorological events, strongly increasing or very volatile prices of resources, etc.

The basic hypothesis concerning the TPMs impacts was that genuine win-win situations, i.e. situations in which all environmental, social and economic impacts of a TPM would be positive, are rare, so that our assessments in most cases revealed trade-offs between the different impacts or between different social groups or economic actors.

2 Direct and indirect impacts of TPMs

Social and economic impacts of transport policies do not arise directly from the transport policy; they develop through causal chains and constitute mainly indirect impacts, whereas the direct impacts are those affecting the transport system itself.

Implementing a transport policy measure has multiple effects and consequences (impacts) for different "user" segments (passengers, operators, economy, society etc.) and systems (transport system, economy, environment, society). However, it is expected that all the different types of measures (e.g. infrastructure developments, traffic regulations, fiscal regulations, new vehicles etc.) will first affect the *transport system*, e.g. by changing user travel times and costs, influencing trip origins / destinations, mode and route choice and finally the traffic conditions (1st level impacts).

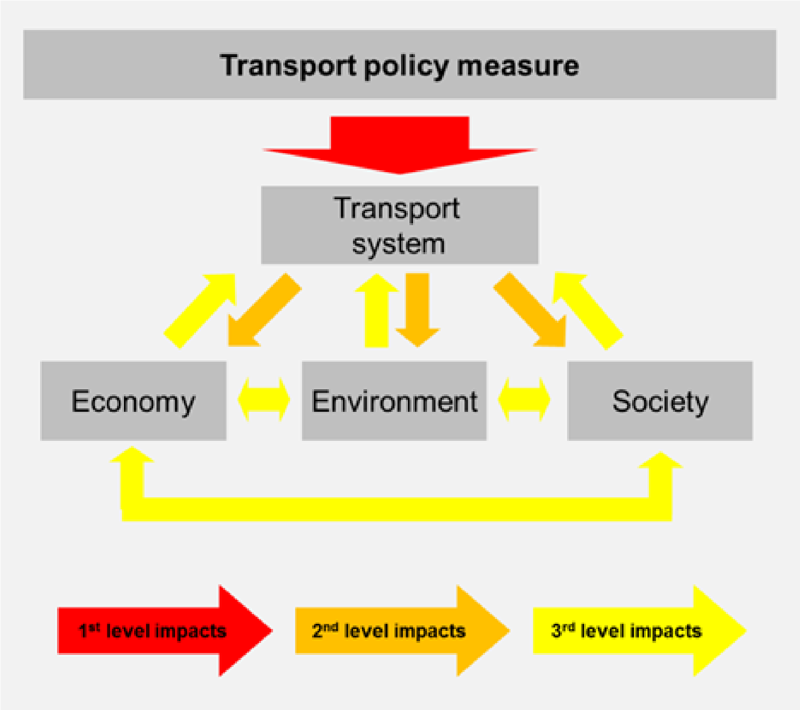

Figure 2-1: Interdependencies of transport, economic, environmental and social system

At a subsequent stage (2nd level impacts), changes then mainly emanate from the transport system and influence the *economy* (e.g. due to less congestion, reduced travelling times for transport users and clients, changing transport costs for individuals and firms, improved accessibility for more advantageous location choice for production and services), the *environment* (e.g. reduced air pollution and noise) and *society* (e.g. due to better health conditions, more acceptable working conditions in transport, easier access to vehicles, higher quality of life of the surrounding areas, fewer accidents) with no straight or decisive sequence. The next impact level (3rd level impacts) describes the impacts on all four systems (the transport system, the economy, the environment and society), irrespective of the direction or kind of action. Hence it is also possible for there to be repercussions on the transport system.

3 Assessing the impact of TPMs

Given that TPMs cause impacts within the transport system and potentially in the economic, environmental and social system, the issue of assessing the impacts in all systems becomes relevant. Basically two approaches can be differentiated: (1) quantitative assessment and (2) qualitative assessment; while some kind of qualitative assessment can always be performed, quantitative assessment tends to be more complicated.

Starting with transport impacts (e.g. modal-shift, transport performance measurement) and extending the analysis to environmental impacts (e.g. emissions estimation), the quantification of impacts by established methodologies and models become feasible. In a next development step of quantitative methodologies, the transport and environmental impacts are translated into economic indicators, such as weighing travel time changes with the value of time or with a cost value per unit of emission derived from health and environmental studies. The subsequent step is to develop economic models linked with the transport models and providing economic impacts based on indicators made available by the models, e.g. equivalent variation, value-added or gross-domestic product; such models would be integrated assessment models (e.g. econometric or system dynamics models) or (spatial) computable general equilibrium models (SCGE). On the other hand, measuring social impacts of transport in quantitative terms by models is still in its infancy, though ASSIST contributes to make progress in this field.

Since the last two steps, economic impact modelling and social impact modelling, reveal deficits, other options need to be considered to provide the full picture of impacts of a TPM. Story telling is one of these qualitative approaches that enable to do so. These approaches are important as we agree with the WorldBank that "*By explicitly addressing issues such as social diversity and gender, institutional norms and behavior, stakeholder analysis and participation, and social risk, projects are more likely to contribute to equitable and sustainable development*." (WorldBank 2006, p. vi). Chapter 5 explores story telling in more detail.

Broadly this synthetic document reports on the three main activities undertaken by the ASSIST project:

- assessing the social and economic impacts of existing TPMs ex-post,
- analysing the impacts of relevant future challenges on the impacts of TPMs, and
- providing improved tools to quantify social and economic impacts of European policies to foster sustainable transport by preparing the ASTRA-EC model.

4 Policy impacts and future challenges

Based on desk research, the ASSIST project screened more than 300 policies or measures and carried out a detailed ex-post and ex-ante analysis of social and economic impacts of 61 introduced or implemented, currently discussed and future TPMs, organised according to the eight policy categories defined by the transport White Paper of 2011. These categories include:

- Pricing
- Taxation
- Infrastructure
- Internal market
- Standards and flanking measures
- Transport planning
- Research and innovation
- Others.

The following paragraphs briefly summarize the findings from the assessment of these 61 TPMs.

4.1 Social and economic impacts measured ex-post

In general, social impacts on the society as a whole or on groups have been defined in the context of economic and environmental impact assessments. The qualitative and quantitative extent of impacts of individual TPMs strongly depends on the geographical area of implementation (scale), the individual design (e.g. measures within the same TPM category do not necessarily have the same design) and how the measure is supported (financially, politically etc.).

The overall assessment of the TPM clearly shows that, if any social groups are affected, these are mostly income groups.

Economic impacts[1]

- Regarding economic impacts (in the sense of being influenced), the most frequently affected segments are transport operators, who are clearly positively influenced by the majority of policy measures, especially by the *E-Freight* and *End-to-End secu-*

[1] The TPMs mentioned as examples are explained in detail in ASSIST deliverable D2.1.

rity certificates. In comparison, other segments[2] such as passengers, society, the economy as a whole etc. are less frequently affected by economic impacts.

- *Pricing* and *Taxation* measures challenge transport operators, users and the economy as a whole. As pricing and taxation measures influence transport costs directly, their efficiency depends on the economic framework and the preconditions of their implementation.
- Transport costs, competitiveness and revenues in the transport sector are the economic impact fields most frequently addressed by the selected TPMs.
- *End-to-end security certificates*, *E-freight* and *Elimination of TEN-T bottlenecks* are assumed to have the most positive economic impacts on transport costs, revenues, spatial and sector competitiveness and insurance costs.

Social impacts

- Positive impacts in social terms are mostly expected for residents, the society, the economy, employees and public bodies. Especially measures like the introduction of *SESAR*, *End-to-End security certificates*, *Low emission zones* as well as the *European Rail Traffic Management System (ERTMS)* have undisputable benefits for some of these groups.
- Many TPMs contribute to improve safety and health; by far the most (positively) affected social impact fields.
- In our sample of TPMs there is no transport policy measure which affects the cultural heritage or culture in general.
- To summarise, the ex-post analysis of transport policy impact assessment studies did not come up with adversely affect societal issues or specific social groups even if some TPMs directly affect working conditions of employees in the transport sector. Only a very few measures were assessed to have effects on specific social groups.

Environmental impacts

- Although as mentioned above, the social impact analysis showed many positive results, the environmental effects of transport policies are even more beneficial. Almost 95% of all impacts are environmentally positive.
- The TPMs investigated will help significantly to reduce air pollutants and noise emissions, which also has a direct positive impact on the society.

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2 ASSIST differentiates groups of the society affected by the TPM for each impact field (Transport, economic, social and environmental impacts). They are entitled as “segments” and comprise e.g. users of transport modes, transport operators, employees of the trabsport sector as well as the economy as a whole.

- Measures allocated to the categories *Transport planning* (*Influencing demand for sustainable transport – promotion of cycling within urban / suburban areas*, *City logistics*) and *Infrastructure* (*Reduction of TEN-T missing links*, *Green transport corridors*, *Deployment of roadside-based ITS infrastructure for information services*) have the most frequent environmental impacts.

The TPMs *Noise emissions restrictions* and *Park and ride systems* are the measures with the most positive impacts on the environment. In contrast, the visual quality of the landscape and the land use are least affected by transport policy measures.

Concerning the impacts mentioned above, a Handbook has been drafted. For different TPMs the *Handbook of Social and Economic Impacts of Sustainable Transport Policies* provides an example on how to assess the transport, social, economic and environmental impacts. It provides a qualitative overview of the TPMs, including a description, references and the different impacts. The impacts can be positive and negative and include a sign whether the impact is going up or down. The Handbook can be found at www.assist-project.eu.

4.2 Spatial and sectoral competitiveness of TPMs

As competitiveness is a major concern of European policy-making a specific task was dedicated to the analysis of impacts of transport policies on competitiveness.

Over the past two decades, great attention has been paid to competitiveness due to the limitations and challenges posed by globalisation. The EC has also focused more on this issue and has implemented policies to increase competitiveness, both within Europe and between the EU and the rest of the world. The broader definition of the EC[3] covers both spatial and sectoral competitiveness:

- Spatial competitiveness refers to competitiveness on a geographical level like a municipality, region or nation.
- Sectoral competitiveness relates to the competitiveness between firms of a sector in different sectors like agriculture or industry.

In both cases, competitiveness aims to increase productivity. Obviously, this analysis does not claim to present a comprehensive definition or measurement of competitive-

3 'When identifying economic impacts, particular attention should be paid to factors that are widely considered as being important to productivity, and hence to the competitiveness of the EU. Competitiveness is a measure of an economy's ability to provide its population with high and rising standards of living and high rates of employment on a sustainable basis. Vigorous competition in a supportive business environment is a key driver of productivity growth and competitiveness.' [EC (2012), p. 4].

ness, but it does try to link the concept of spatial and sectoral competitiveness to the transport system, transport policy and the impacts of transport policy measures.

Spatial competitiveness analysis

Spatial competitiveness concerns the improvement of employment and productivity on a certain geographical level, such as a region or a nation. The changes in employment and productivity are benchmarked against other regions or nations. Productivity improvement is dependent upon different factors, such as research and development or foreign direct investments. For a region or nation, sufficient accessibility is a precondition to stimulate employment or economic growth.

The impacts of TPMs have been checked concerning the area's accessibility. In the transport system, the most relevant key variables are travelling time, distance, costs and perception (such as comfort or reliability). A change in any of these variables will affect the accessibility and consequently the spatial competition.

The most important TPMs influencing transport costs and hence the accessibility of certain regions belong to the categories 'Pricing' and 'Taxation', such as e.g. area charging, internalisation of external costs for specific modes of transport or the energy taxation directive. Supply measures such as infrastructure and internal market also have been relevant as they usually provide for a positive effect on accessibility, thus increasing competitiveness in terms of economic growth, productivity and employment. However, some distributional effects regarding spatial competitiveness (e.g. from one region to another) may occur as well.

Research and innovation do not lead directly to improved accessibility, they often prepare for TPMs. However, increasing research and innovation improves the employment situation of this sector. Also, top level research is able to increase the positive public image of a region or nation.

Sectoral competitiveness analysis

Sectoral competitiveness is closely linked with productivity. Its fundamental determinants include qualitative and quantitative changes of inputs and technological improvements as well as unit labour costs and price / quality competitiveness. Two different types of sectoral competitiveness must be distinguished:

'Intra-sectoral' changes of competitiveness deal with the structural (modal) shifts within the transportation sector which imply changes concerning the competitiveness of transport operations. If possible, the competitiveness changes influenced by the individual transport policy measure have been explained by the variables cost, time and level of service (reliability, frequency etc.).

The ‘inter-sectoral’ level identifies direct and indirect impacts of measures on the competitive preconditions for clustered economic sectors (and services) on a broader scale. In a holistic consideration of measures and their impacts on competitive aspects, it became obvious that positive effects prevailed with respect to the general European policy objectives. Although negative intra- and inter-sectoral impacts appear, they do not seriously influence the competitiveness of transport operators and economic sectors.

Secondly, generally it can be stated that transport policy measures affect “intra-sectoral” aspects much more than “inter-sectoral” competitiveness. Furthermore, the analysis revealed that intra-sectoral agents like transport operators, as mostly road and rail transport service suppliers, are much more affected by TPMs than others. This is clearly caused by the type (recipient) of measures, which constitute the different categories and its areas of application.

It became evident, that the competitiveness analysis was a first attempt to provide insights into the impacts of TPMs. It makes no claims to be complete; further, measure-specific assessments focussing on competitiveness are required, preferably supported by additional quantitative investigations or surveys.

4.3 Importance of future challenges for transport policy

For the purpose of the ASSIST project, a ‘challenge’ is defined as “*an exogenous condition or change at a structural level, already taking place or expected for the future, which brings about structural modifications of the current state or that requires an adaptation of current habits and policies to be addressed*.”

This definition requires some further explanations: The term ‘*exogenous’* means that the condition or change is originated in the macro-environment outside of the transport system (e.g. thus the development of electric cars is a response not a challenge).‘*Structural level*’ means the involvement of a fundamental aspect rather than a specific circumstance. ‘*Challenge*’ is used rather than ‘trend’ for two reasons. First, a ‘challenge’ communicates that attention should be paid to what is going on and the way transport policy could be affected. Second, a trend provides more the idea of some ‘natural’ movement in one direction, whiles the challenges which are considered to become important by ASSIST, are in several cases not ‘natural’ but policy driven. Some of them are not evolving conditions, but existing or foreseen circumstances that might exist in a certain time and disappear afterwards (for example the debt issue).

Transport policies are first confronted by the challenges of sustainability. These challenges, environmental, social and economic, involve the crucial questions of energy costs and climate change, but also relate to financial constraints. The transport sector is directly concerned and it is interesting to observe how the priorities of transport policies are changing in many European countries. Instead of encouraging road and motorised traffic, the goal of transport policies is now to promote sustainable mobility. But up to what extent are transport policies ready to constrain or even to reduce passenger and goods mobility? What are the consumer behavioural changes which have to be set up to consider all the upcoming challenges?

Several other external challenges can affect the transport system in the future. Most of these challenges are already recognisable (such as globalisation, urbanisation and sprawling, debt), while others can become relevant in the near future (such as diffusion of ICT and migration pressure). Also, there are challenges with longer term issues that nevertheless should be addressed (such as shortage of fossil fuels and climate change). Most of the challenges are already recognised by policy makers and have been addressed in several documents by the European Commission. Especially in the White Paper, references to climate change, fossil fuels shortage, ageing and migratory pressure, globalisation, urbanisation, air and noise pollution are included. The debt problem (both public and private) is at the top of the EU agenda at the time of writing this report.

In order to identify the list of future challenges which are relevant with respect to social and economic impacts, we collected information on challenges from various references, classified these challenges with reference to their relevance according to the ASSIST purposes (i.e. making reference to impacts of TPMs), and produced a list of selected future challenges. Challenges may vary in the driver behind them, the probability of their occurrence, the scale and the time horizon and they must be relevant with respect to transport policy and its social and economic impacts.

Based upon this approach fifteen relevant challenges were selected. Table 4-1 provides an overview of these challenges.

Table 4-1: Selected challenges and the driver they belong to

Drivers	Challenges
Environment	Fighting climate change
	Shortage of fossil fuels and other natural resources
	Increasing air pollution and noise
	Urbanisation and sprawling
Society	Ageing of the European society
	Migratory pressure
	Unemployment
	Income inequality or income distortions
	Terrorism and the feeling of insecurity
	Individualism
Technology	Diffusion of ICT
	Third manufacturing revolution
Economy	Globalisation and outsourcing
	Public and private debt
	Fragility of the European Monetary Union

Source: TRT

The analysis also revealed other challenges were revealed from the analysis as well, with reference to a variety of contexts: e.g. earthquakes and volcanic eruptions, geopolitical conflicts, illicit trade and organised crime, growth of global population, resurgence of nationalisms, power shift eastward, obesity, etc. These other challenges were considered to be less relevant for the purposes of the ASSIST project and were therefore not included in the analysis. For instance, we excluded the challenge of shifting global power eastwards, though we believe that the *power shift eastward* is of utmost importance, but at the same time we consider that, as far as transport policy is concerned, its implications are not significantly different from those addressed by the challenge of globalisation.

5 Story telling as part of the analysis

The link between transport policies, future challenges, social and economic impacts is often best explained by telling a plausible story about it. Story telling also constitutes a potential means for analysis and assessment of social impacts that supports completeness of analyses. Stories enable, though not all impacts and causal chains of impacts can be quantified, to demonstrate that there could be wider impacts not captured by the quantitative analysis. Therefore this section presents two brief examples of story-telling to demonstrate the connection between the previously discussed TPMs, future challenges and social impacts.

5.1 Example 1: Resilient transport networks

Climate change increases the risk of extreme weather events, which may cause direct impacts on transport systems, as well as significant social impacts through impacts transmitted via the transport system. Extreme events relevant to transport can be storms/hurricanes and floods, both at the coast and along rivers or even in the country side, as recent examples in Central Europe in May/June 2013 have shown. Seven European countries located along the rivers Elbe and Danube have been severely affected by storms and long lasting intense rainfalls. In some areas the country side kilometres away from the river Elbe was flooded for days and the infrastructure was partially destroyed. This includes housing, public facilities infrastructure and transport infrastructure. Even two months later, in mid August, the German high-speed rail system was not fully operational, and according to the latest announcement repairing the high-speed link will last until December 2013. Obvious social and economic impacts are the destroyed houses of the population in the flooded area and the devastated agricultural harvest. But also the economic and social impacts of the blocked high-speed link are substantial. Berlin is a city offering a high number of qualified employment opportunities such that commuters from the regions West of Berlin are affected by longer travel times or even cut-off connections, impacting on their jobs and social life.

One could argue that planning failures are the cause of these social and economic impacts. On the other hand the transport infrastructure is prepared at least to stand the 30 years flooding risk – but of the flooding level experienced some decades ago. The future challenges, in this case climate change, together with continuous downgrading of water retention capabilities of rivers, lakes and soil alter these empirically grounded construction guidelines for infrastructures. Thus the future challenges also alter the impact of transport policies, in this case the building of the high-speed infrastructure, which is at risk to become regularly taken out of service by flooding events. The negative effects would become even more severe, if in parallel to building the high-speed link other links constituting alternative routes to that link were closed.

5.2 Example 2: Transport infrastructure charging

Ideally each TPM that comes to mind has only positive impacts: a win-win situation for all. So a positive impact on transport system users (passengers and operators), on the transport system itself (e.g. reduced travel time, improved service level), on the economy (e.g. reduced transport expenditures), on society (e.g. reduced crime, improved well-being) and on the environment (e.g. less emissions). However, in many cases there is a kind of trade-off. Some gain more than others. And some might even experience adverse effects.

In the past years, traffic and transport has been growing. The renewal and implementation of infrastructure did not keep pace, with growing congestion as a result. City centres with limited possibilities to enlarge their road capacity, are most susceptible. Some centres (of major cities) have become choked with traffic. As a remedy, local policy makers might have decided to charge motorised vehicles for entering or driving in a certain area thus charging the use of road space. By doing so policy makers aim to increase travel costs, thus influencing the demand for (local) road use and mode choice. In general this should lead to increased travel by public transport and slow modes. The modal share of passenger cars will be reduced (and so its emissions), and when used, its average occupancy rate is likely to have increased.

The positive side is that it regulates traffic and generates revenues, which in turn can be used e.g. for improving and/or financing public transport systems. As traffic and emissions will be reduced, residents in the charged areas will benefit as will society and public bodies, because of collected revenues.

The negative side of this TPM is that it (indirectly) distinguishes between groups of people as the “wealthy” are not likely to change their behaviour, in contrast to lower income groups. Another side effect is that e.g. discretionary trips (to shopping malls) show a tendency to move away from the charged areas. Locations outside are becoming more attractive.

It is important to understand that the effectiveness of such a TPM depends on the local situation. Future challenges should thus also include the identification of negative side effects, and paying attention to them. First the underlying cause of congestion needs to be identified. Counter measures and solutions need to be developed, before implementing any measures.

As an example: trucks (un)loading in narrow streets might be the major cause of hindered traffic flow in the area. Without adequate measures or solutions, area charging or cordon pricing will not resolve the congestion problem. It merely becomes a revenue generator (positive impact for society and public bodies) that has a tendency to push businesses out of the charged area (negative impact) and in addition discriminates between income groups (no win-win).

Charging motorised vehicles for using local road space has its counterpart in other transport modes but on a larger scale: for example railways. The European Union encourages the establishment of a fair charging system for infrastructure usage.

It seems likely that the modal share of rail, due to this infrastructure charging measure, will change due to competition from modes like road and inland waterways. The basic principle of this policy measure ("user/polluter pays") seems fair as similar measures will apply to other modes. However, modality trends are yet unclear.

On the one hand charging provides incentives to railway operators to make appropriate investments in order to cut costs. Furthermore, it paves the way towards optimising railway infrastructure use, to infrastructure improvements and investments. Public bodies therefore benefit. Also due to charging, trip planning and scheduling will improve as delays result in additional costs. Reservations for the use of ancillary services (stations, depots, marshalling yards) will be made. Competitiveness will increase. Better planning and allocation of such services is likely to have a positive effect on safety. That is beneficial to passengers and operators.

On the other hand the measure leaves very much room for interpretation and implementation. When comparing countries, charges per train kilometre show a great variety. In Eastern Europe charges are highest. In other words, there is regional discrimination. Some of these differences can be explained, e.g. by ground conditions and age levels of infrastructure. However it is very likely that most variety of charge levels is due to the degree to which governments are willing, and able to bear the costs of infrastructure. Because of a lack in government resources some countries will simply aim at full cost recovery.

An example where much room for interpretation and implementation of the measure has a negative impact, follows. The Oresund Bridge and Storebelt Bridge that connect Sweden-Denmark-Germany, charge freight trains for passing and thus using the infrastructure. This charge is independent of the train length. This results in an incentive to run the longest trains possible, in order to reduce operating costs. However, this in turn will reduce the service frequency offered to freight shippers. In contrast, charging per gross tonne would not have affected the length of freight trains, and would not have affected service levels.

The challenge is to develop a measure that is clear and leaves no room for interpretation. A measure that does not bear regional discrimination, and does not lead to reduced service levels. Furthermore, measures like infrastructure charging (or in general “user/polluter pays”) will ultimately result in modality changes. These changes can and will have a far-reaching and profound effect on the infrastructure network and its use, and thus on the environment. These in turn will affect the economy, employment and society. The challenge is, before implementing any such measures, to identify these effects, study and quantify them.

5.3 Will future transport policies tend to increase inequality?

The answer to this question could be a moderate “yes”. For a number of reasons most studies assuming future transport cost trends expect cost increases. There seem to be two major reasons for that:

1. Energy costs are expected to grow, in particular due to the growth of fossil fuel prices driven by growing energy demand in emerging countries. Taking into account that transport on average depends to more than 90% on fossil fuels this should cause growth in transport energy costs, even though part of that growth can be offset by efficiency improvements.
2. Major transport policies would lead to increasing costs either by increased taxes on fuel/energy, by infrastructure charges or by other market-based instruments (e.g. emissions trading). Political reasons for doing so are grounded in the internalisation of the different external cost of transport, in infrastructure funding needs, in particular as maintaining the existing infrastructure will require growing budgets for transport, and in reducing the financial support for public transport and improving its self-financing.

On the other hand, two trends are debated that together with increasing transport cost would potentially increase inequality: (a) zero- or moderate economic growth over a longer-term period, and (b) despite economic growth catching-up growing disparities between income groups, in particular leaving lower income groups behind. In both cases there would be substantial population groups that experience a reduction of their mobility due to the diverging trends of stagnating/reduced income and on the other hand growing transport cost.

As for well-off groups the transport cost increase might be uncomfortable but does not really affect their mobility, the social and economic inequality would increase in societies affected by these developments. In some countries, the situation could be aggravated by their ageing, which means that the share of retired persons increases, while the share of the active labour force decreases. As a most probable result retirement pensions would decline putting a growing share of retired people at risk of constraints on mobility.

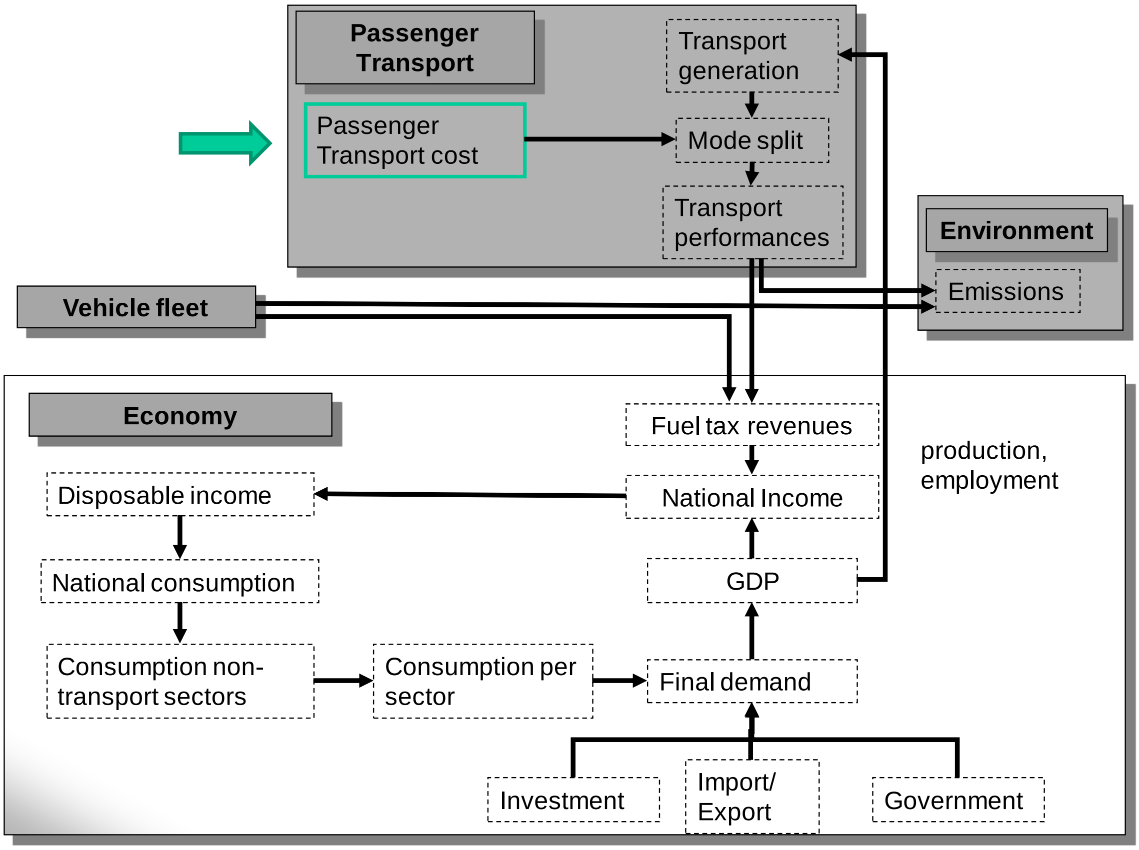
6 Capability of ASTRA-EC to cover social and economic impacts

One of the major outcomes of ASSIST is the development of ASTRA-EC: a modelling tool that can be applied for the strategic assessment of transport policy measures in the medium and longer period (up to the year 2050).

ASTRA-EC is a model based on the principles of system dynamics, which is the simulation of how different elements evolve over time given the interactions among each other. In ASTRA-EC a large number of different elements are represented. Part of them belong to the transport system – e.g. number of trips, tonnes moved, mode split, vehicle fleet – whereas other elements are part of the demographic system (segmented population), the economic system (e.g. consumption, investment, taxation, trade), the environmental system (energy consumption, emissions) and the social system (employment, accidents). A complex modelling structure links the various elements, also by means of parameters representing technological levels (e.g. emission factors), behavioural attitude (e.g. demand elasticity with respect to cost) and policy environment (e.g. fuel taxation).

Thanks to its multidimensional structure, ASTRA-EC is capable of simulating a wide range of impacts stemming from the application of a transport policy measure. Making reference to the concepts introduced earlier in this note (see section 2, Figure 2-1), ASTRA-EC can address direct impacts as well as second-level and third-level impacts of transport policy measures. Figure 6-1 provides an example of how the impulse generated by a change of transport cost (e.g. due to different energy taxation) modifies the transport system, propagates to other domains like the economy and the environment and also again gives feedbacks to transport.

ASTRA-EC can cover *economic impacts* thanks to a detailed representation of the linkages between the transport sector at the microeconomic level and the macroeconomic level. For instance, in the example of Figure 6-1 passenger transport costs are represented in the model at a “micro” level for each transport mode, with energy costs separated by driver costs, fuel taxes explicitly recognised, etc. Changes to some components of the transport costs give rise to a different expenditure for transport, which in macroeconomic terms means different aggregate consumption, which in turns has effects on GDP.



Source: Fraunhofer-ISI - TRT

Figure 6-1: Some effects generated by passenger transport cost variations in ASTRA-EC

The main micro-macro bridges modeled in ASTRA-EC concern:

- Passenger transport and sectoral consumption
- Transport and sectoral investment
- Transport and sectoral employment
- Freight transport and total factor productivity
- Transport and intermediate inputs of input-output tables
- Transport and exports.

Social impacts are addressed by ASTRA-EC in two manners. On the one hand, the model provides some indicators related to the social dimensions such as safety (number of accidents, fatalities), accessibility and employment. On the other hand, some results in the transport and economic domain are segmented by income groups.

In fact, income distribution itself is modelled in ASTRA-EC, simulating the complex coherences with socio-economic trends on the basis of the age structure of society, educational skills, the dynamics of household structure, employment per sector and the development of the demand and supply side of economies. This differentiation is an important input to simulate passenger transport. Krail (2009) confirms this by analysing mobility surveys. The analysis demonstrates that income distribution has a visible impact on transport mobility habits.

Therefore, several variables reflecting mobility and consumer patterns in the field of transport are segmented by social groups, differentiating people according to their income, age, gender and household type. This enables to differentiate the reactions of social groups and analyse the social impacts of transport policy, e.g. in terms of transport expenditure by income group as well as mode split or average distance travelled. Using these indicators, it is possible to assess whether policy measures affect social dimensions and whether a particular income group is more or less affected than another one.

6.1 ASTRA-EC interface

One of the key features of the ASTRA-EC model is its user interface. The interface has been developed to enable accessing the model by all type of users (including non-modeling experts). They should be able to explore the model structure, to carry out simulations by changing model parameters (e.g. transport pricing, car taxation), to read results and to compare different single policy scenarios and policy packages.

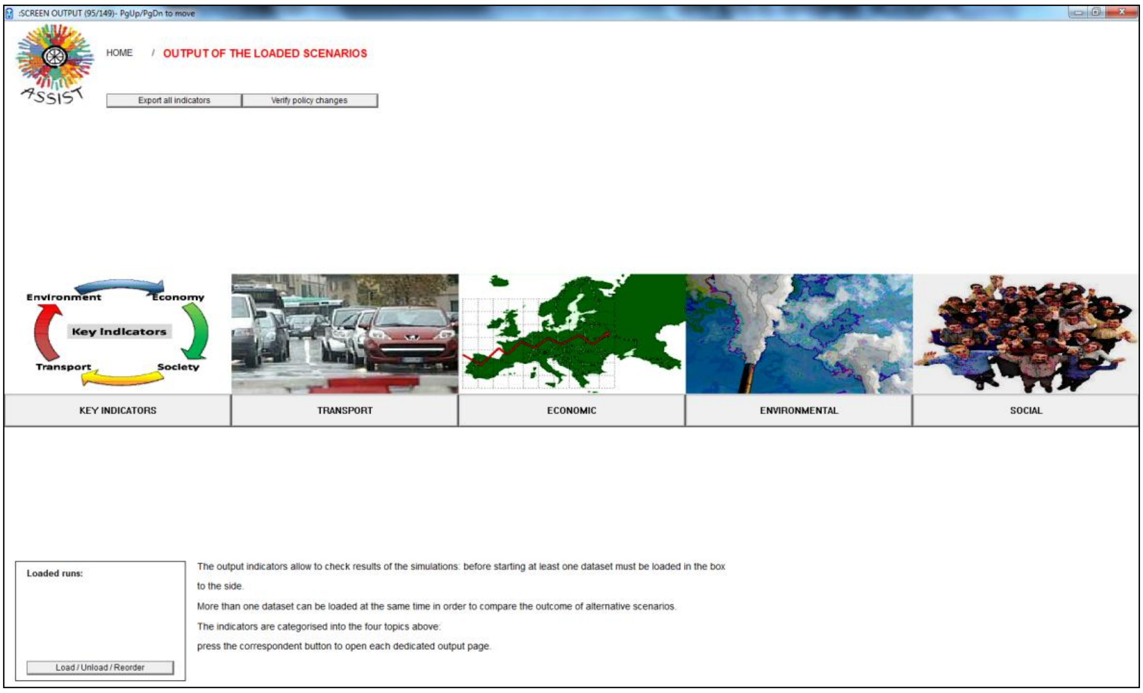
The interface is developed using the internal Vensim® language. It consists of three main parts, concerning:

- the structure of the ASTRA-EC model,
- the inputs to set up the simulation of transport policies and scenarios,
- the outputs of a simulation.

In the first part the user can access a set of graphical schemes representing the structure of each module (transport, population, vehcile fleet, etc.), in order to understand and discover the key variables, linkages and feedbacks.

In the second part the user has the possibility of setting values for several leverages in order to simulate transport policies individually or as packages. In addition, the interface allows simulating scenarios with different sets of exogenous assumptions (e.g. external cost, emission factors, etc.).

Finally, the ASTRA-EC interface allows reading and interpreting the outcome of the simulation of a given scenario. The user can have a close look at results for selected key outputs in the fields of transport, economy, society and environment over the whole simulation period. The user can compare the results of different policy scenarios with the interface in order to evaluate potential impacts.



Source: TRT

Figure 6-2: The ASTRA-EC user interface

6.2 Validation of ASTRA-EC

A crucial step towards an impact assessment model producing reliable results for transport policy measures is a comprehensive calibration and validation of key indicators. Validation can be understood as the process to enable the reproduction of trends of a model. ASTRA-EC has been calibrated such that endogenously calculated key transport, social, economic and environmental indicators fit to the observed development of these indicators in real world for the period from 1995 to 2010.

Due to the integrated model structure considering not only causal relations within the transport system but also linkages with the socio-economic system, the technology and the environment ASTRA-EC is a tool to provide endogenous forecasts sensitive to key determinants. Nevertheless, ASTRA-EC as a decision-support tool needs to follow at least major trends simulated by other impact assessment models. Results of model-based policy impact assessments can only be compared if the framework is consistent. Therefore, trends for major transport, economic and social indicators in ASTRA-EC from 2010 to 2050 have been made in line with the 2012 Reference Scenario from PRIMES-TREMOVE. GDP, population, passenger and freight transport performance as well as car fleets are in line with PRIMES-TREMOVE (see Krail et al. 2013). Marginal differences have to be accepted due to the need for internal consistency of the model. E.g. under consideration of improving load factors, the growth of truck vehicle fleets needs to be lower than road freight transport growth.

Table 6-1: Major economic trends in EU27 in the ASTRA-EC Reference Scenario

Indicator	Absolute values			Annual Growth in %	
	2010	2030	2050	2010-'30	2030-'50
GDP [bn. $€_{2005}$]	11,245	16,184	21,080	1.8%	1.3%
Consumption [bn. $€_{2005}$]	4,981	7,302	9,705	1.9%	1.4%
Investment [bn. $€_{2005}$]	1,662	2,563	3,172	2.2%	1.1%
Trade Balance [bn. $€_{2005}$]	1,174	1,898	2,727	2.4%	1.8%
Employment [Mio pers]	219.3	219.9	214.7	0.0%	-0.1%

Source: ASTRA-EC

GDP in real terms increases by +1.6% annually in EU27 from 2010 to 2050 (see Table 6-1). The impacts of demographic change in EU27 are visible via differing economic growth from until 2030 and beyond 2030. Today, every 5th person in EU27 is above 60 years old. Even under the optimistic assumption that people migrating towards EU27 are mainly between 15 und 44 years old, the problem of ageing societies becomes clear. In 2050 on average every third inhabitant of EU27 will be above 60 years old. Potential labour force will decrease from 60% to 50% until 2050.

The transport trends in the Reference Scenario are those provided by the PRIMES-TREMOVE model. In the EU27, passenger transport activity is expected to grow until the year 2050 but with a descending rate (Table 6-2). In the first half of the forecasting period (i.e. between 2010 and 2030) the expected growth rate is +1.1%. In the second half – between 2030 and 2050 – the expected growth rate falls to +0.7%. Different trends by mode of transport are expected. Rail and air transport are projected to grow more than other modes. Forecasted air growth rates are +2.7% per year until 2030 and +1.6% from 2030 to 2050. Rail trend is still over the average but more moderate: +1.8% per year until 2030 and +1.1% afterwards. Road modes, car and bus, are instead expected to grow less than the average.

Table 6-2: Passenger and freight transport demand (Gpkm and Gtkm) and average growth rates per year in the ASTRA-EC Reference Scenario

Indicator	2010	2030	2050	2010/30 per year	2030/50 per year
Passenger-km	6268	7729	8889	1.1%	0.7%
Ton-km	3652	5044	5772	1.6%	0.7%

Source: ASTRA-EC

ASTRA-EC estimates a growth of freight demand by +1.6% per year until 2030 and +0.7% per year from 2030 to 2050 in the EU27. Unlike the passenger case, growth rates by mode are quite similar especially after the year 2030. Only from 2010 to 2030 rail freight is expected to grow significantly more than other modes (2.2% per year).

6.3 TPM analysis with ASTRA-EC

A selection of 26 out of the 61 TPMs analysed in the desk research line of ASSIST is implemented in the ASTRA-EC model. After the validation of the ASTRA-EC model in order to provide a Reference Scenario in line with the 2012 Reference Scenario from PRIMES-TREMOVE, the ASTRA-EC model reactions on the selected TPMs were evaluated. A comparison between expectations on impacts in the different fields (society, economy, transport and environment) derived from the ex-post analysis in Deliverable D2.1 and the ASTRA-EC model reactions was used to validate the ASTRA-EC model were appropriate. Nevertheless, ASTRA-EC identified for some TPMs different direction of impacts than those collected in the factsheets. An example for such a different direction of transport impacts is the TPM *Energy Taxation*. As opposed to the literature used for preparing factsheets in the ASSIST deliverable D2.1 (Kritzinger et al. 2012) ASTRA-EC identified a higher growth of road passenger transport performance than in the Reference Scenario. The main reason for this contrary result is the assumption of refunding of additional tax revenues back to private households. Additionally, high taxation of kerosene induces a modal shift from air to rail and road due to increasing air ticket prices. As regards social impacts the TPM affects all income groups but increasing fuel costs and air ticket prices are assessed to mainly hit medium and high income groups. In case that a direction of impacts different than in the ex-post analysis could be explained by different model structure, the model reaction was not revised or made in line with the expected impacts from the ex-post analysis.

Another difference in the direction of impacts could be identified for the TPM *Electromobility Road* in the category *Research and Innovation*. Assuming higher learning rates for battery and hybrid electric vehicles (BEV, PHEV and HEV), additional investments in R&D to increase reliability of EVs, the build-up of a charging infrastructure and promotion of EVs ASTRA-EC assesses an increase of passenger-km for cars. The boosting effect of investments on the economy, lower costs of operation for EVs and an accelerated diffusion of EVs in EU car fleets lead to this effect. Even if purchasing prices for EVs are today significantly higher than for conventional fossil fuel cars, they are even today for a large number of driving cycles beneficial due to lower energy costs per driven km. Higher shares of EV induce lower average costs for car mode which impacts modal shift such that modal share of cars increases as opposed to ex-ante assessment results.

In most cases, the results of the simulations match the impacts anticipated in the analysis described in Deliverable D2.1. For instance, from the TPM *Internalisation of external costs*, the main effects expected were: some mode shift towards alternatives producing less externalities, an increase of transport costs and some reduction of energy consumption and emissions. These impacts are actually reported by ASTRA-EC, which also highlights the sharp increase of revenues from charging.

Another example for matching directions of impacts is the TPM *EU-wide common job quality and working conditions for truck drivers*, the ASTRA-EC results confirm the expected impact in term of higher transport costs (and also transport times, which is however an input for the model rather than an outcome of the simulation). ASTRA-EC adds a slightly negative impact on the economic growth because of the influence of increasing freight transport generalised cost (i.e. including travel time) on technical progress reflected by Total Factor Productivity in the economic module of ASTRA-EC.

The anticipated effects of setting restrictive *CO_2 emissions limits* for new road vehicles (cars, LDVs and HDVs) were especially an increase of traffic because of lower transport costs for road modes, but nevertheless a reduction of emissions and some more economic growth and employment. ASTRA-EC results are in line with such effects, even if the increase of demand is limited (total transport activity is not augmented, but there is a shift towards road modes) as well as the economic impact (especially on employment).

Finally, according to Deliverable D2.1 (Kritzinger et al. 2013), the TPM *City logistics* is expected to have positive impacts on transport by reducing costs and times, less road traffic (and therefore improved travel times) and lower emissions. The ASTRA-EC simulation results for this TPM confirm these impacts except for travel time. Travel time impacts cannot be identified in that detail as ASTRA-EC does not contain a network-based transport model.

7 Handbook of Social and Economic Impacts of Sustainable Transport Policy

One of the two main objectives and "products" of the ASSIST project is to compile and publish a *Handbook of Social and Economic Impacts of Sustainable Transport Policy*, which is addressed to a large user community of policymakers and experts from the EC and Member States. The handbook is accessible via the ASSIST website[4]. It includes a TPM analysis of past effects and future developments to help policymakers, administrations and scientists conduct ex-ante assessments. The following chapter describes the structure and broad setup of the handbook and renders assistance on how to "read" it.

As a first step for developing the handbook, work package 2 (WP2) targeted to identify the potential social, economic and environmental impacts of transport policy measures, which are based on sustainability criteria, by conducting an impact assessment by means of so called "fact sheets".

The impact assessment is the process used to identify and analyse the effects and consequences of policies (or projects or programmes) in order to ensure that such measures are:

- economically sound (viable),
- environmentally sustainable, and
- socially equitable.

The assessment not only looks at direct impacts, but at all sorts of indirect effects, both short-term and long-term. Indirect impacts on different social groups (e.g. by age, gender, income level, physical status etc.) are also relevant to ASSIST.

Each policy measure (c.f. chapter 4) is assessed according to four impact fields: the transport system, the economy, society and the environment, delivering input for the handbook to support the assessment of the social and economic impacts of sustainable transport policies.

4 http://www.assist-project.eu/assist-project-en/content/fact-sheet-list.php

Concept and setup of the handbook

The structure of the handbook and its setup is closely related to the approach of the impact assessment compiled by the fact sheets. Each fact sheet consists of three main parts:

First Part - General Information

The first part identifies the selected TPM by title, policy category and subcategory. The TPM is described in summarised text form. The policy background and objectives are mentioned, complemented by implementation examples if applicable, such as the national implementation of EU legislation or specific implementation projects. This part also provides an overview, in qualitative terms, of the intended key changes regarding traffic and transport.

Second part - Impacts

The second part is the main part of the handbook. In four sections, the various impacts triggered by the TPM are documented in a formally structured way with supporting verbal summaries. The impacts are labelled in compliance with the terminology used in the impact assessment guidelines published by the European Commission [SEC (2009)92 final]. Methodologically, five categories of impacts are distinguished:

- <u>Traffic impacts:</u>

  As TPMs are essentially intended to influence the transport sector, the impacts on all parties in this sector are reported first. The main impact fields are travelling time, risk of congestion, vehicle mileage and service and comfort.

- <u>Economic impacts:</u>

  They are regarded as primarily relevant at the micro-economic level such as transport costs, revenues for transport operators and public authorities or changes in the value of real estate (triggered by improved accessibility or negative environmental impacts like noise). It also considers the competitiveness of the transport industry sectoral and spatial competitiveness.

- <u>Social impacts:</u>

  When looking at the social side of TPMs, the handbook focuses on impacts on safety, health, employment and accessibility to transport systems. Social impacts describe the extent to which TPMs influence the societal structure – do they help to reduce differences or do they aggravate social disparities?

- Environmental impacts:

  The handbook is not intended to replace a full environmental impact assessment, but it does emphasise the main environmental impacts with social relevance affected by the respective TPM.

All the impacts are presented in a standardised grid distinguishing the various groups affected. If impacts are judged to be relevant, the position of an arrow shows the change caused by the TPM in a simplified quantitative way. The underlying colour of the box indicates whether this change is positive (blue) or negative (red) referring to the policy aims of the White Paper. Impacts vary significantly between implementation and operation phase, which are reported in two separate lines.

Segments

The *columns* in the handbook mainly comprise the groups of persons / companies, which are directly and indirectly affected by one or more impacts of the specific TPM.

Overall, there are 16 different segments possibly affected by the implementation of a TPM, main segments allocated to two major groups: *passengers (transport users)* and *transport operators (service providers)*. The latter represent the companies supplying transport services including both passenger and freight transport. Subsequently Table 7-1 further divides these main groups according to the relevant modes of transport concerned.

Table 7-1: Differentiation of affected groups by mode of transport

Mode	Passengers	Transport operators
Road	Car drivers, motorcyclists; car and motorcycle passengers	Road hauliers (freight)
Rail	Train passengers	Train companies (for passenger and freight)
IWW (inland waterways)	negligible	Barge operators, inland port authorities (freight)
Air	Airline passengers	Air carriers, airport authorities (passengers and freight)
Maritime	Not covered	Ship-owners, seaport authorities (freight)
Public transport	Bus, coach and light rail passengers	Public transport operators (passengers)
Slow modes	Pedestrians, cyclists and other non-motorised forms of transport	negligible

Source: ProgTrans

In addition to passengers and transport operators, other "user" segments considered in the handbook are:

- *Employees in the transport sector*

  Employees are those persons working in the transport sector and potentially affected by a TPM.

- *Residents*

  Residents are directly affected by TPM impacts like noise, emissions or changes in the value of real estate caused by transport systems.

- *Economy*

  "Economy" is regarded as a directly and indirectly affected broad reservoir of users such as companies, employees, markets etc. Economy covers businesses and branches not belonging to the transport sector. These benefit from a better (or worse) accessibility, higher or lower turnovers or changes in the value of their real estate.

- *Public bodies*

  Public bodies are, depending on the geographical level of the TPM, either local, regional, national or European authorities or agencies. The impacts are primarily linked to taxes, revenues or impacts on long-term financial obligations for infrastructure investments and operation.

- *Society*

  Society mostly encompasses environmental and economic impacts which are not directly assignable to a specific group. Additionally, in some cases there may be opposing impacts on different groups depending on whether society as a whole profits from the transport policy measure.

8 Conclusions and recommendations

Conclusions

ASSIST aspired to improve the state-of-the-art in terms of assessing and modelling economic and social impacts of transport policies. The ex-post analysis of TPMs selected with reference to the Transport White Paper of 2011 developed a compendium of existing knowledge on economic and social impacts differentiated into impact on transports modes, spatial impact and impacts on certain population groups. The analysis revealed that in general social impacts could be improved by the White Paper policies at the European level. However, at the local level this conclusion would not always be appropriate, as social impacts may also be negative. In general it emerges that it lacks both the European tools to assess the social impacts and, most often, the European responsibility to mitigate the impacts due to the subsidiarity principle.

An important outcome of ASSIST is to point to the potential difference between impacts of the same transport policy in the past and in the future. This difference emerges because (some) of the future challenges becoming reality and thus changing the framework conditions for transport policies. Obvious examples of these challenges would be ageing, with different age groups having different vehicle ownership and mobility patterns, or strongly increasing crude oil prices, causing other mode choices, income inequalities and a tendency towards fuel efficient vehicles. To further explore the TPMs and future challenges, we refer to the ASSIST website (www.assist-project.eu) for an overview of the social, economic and environmental impacts of different TPMs.

A suitable tool to consider these changing framework conditions seem to be the ASTRA model approach, as it enables the implementation of scenarios over time, i.e. scenarios with changing trends of oil prices, population structure, technology features, etc. The newly developed ASTRA-EC model enables quantitative assessment of economic, social and environmental impacts, though it must be clearly said, that the full picture of impacts can still not be provided. Indeed, the capabilities to quantify economic impacts (e.g. in terms of gross domestic product, valued added, investment or exports) can better be tackled by the ASTRA-EC model than the social impacts, for which only a few like employment or the distributional effects on different income groups could be reflected. As concerns economic impacts of transport policies ASTRA-EC enables a holistic impact assessment. This means that the policies can be differentiated according to their time path. Furthermore, ASTRA-EC takes costs of a transport policy for users, state and companies as well as the revenues and their use into account. This is crucial for a comprehensive economic and social impact assessment as it can change results significantly. Another value-added of the integrated dynamic model structure of ASTRA-EC is that rebound effects can be identified. This can provide the necessary information for a redesign of TPMs in order to compensate or avoid non-intended rebound effects.

In general, the ASSIST project made good progress in assessing the social and economic impacts of past and future sustainable transport policy in Europe, but it still leaves room for improvement of the quantitative assessment tools as well as for qualitative approaches to describe and consider, in particular the social impacts of European transport policy-making.

Recommendations

The ASSIST project has revealed that social impacts of transport policy measures need more attention. The quantification of these impacts is weak. The Handbook of Social and Economic Impacts of Sustainable Transport Policies[5] shows different examples of TPMs where the social impacts could only be assessed in a qualitative way. Further investigations into the social impacts are needed to get a better grip on these impacts, taking them into account in assessments.

While assessing transport policy measures, the Handbook provides a guideline on how to assess the different impacts. It structures thinking about the impacts. Nevertheless the Handbook needs to be considered as a current draft covering in a comprehensive way today's knowledge about social, economic and environmental impacts of transport policies. As the design of transport policies will change or even new transport policies will need to be developed matching the needs of upcoming challenges, the Handbook needs to be revised in the future accordingly. This can also be done by adding findings of impact assessment studies of further TPMs or by external audits on the covered TPMs in the different categories. This will keep the Handbook a living document and increase the value-added as a tool for decision-support of policy-makers.

One of the findings of ASSIST is that the degree of quantifying social impacts of TPMs on European level is limited. Social impacts of TPMs are multi-fold with winners and losers on different spatial level. ASTRA-EC could provide valuable information about impacts on European or country level. In order to identify social impacts on local level a linkage of ASTRA-EC together with a micro-level model could be a solution to overcome this gap in social impact assessment.

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5 http://www.assist-project.eu/assist-project-en/content/fact-sheet-list.php

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