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A Decision Support Tool for the Strategic Assessment of Transport Policies – Structure of the Tool and Key Features

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Abstract

Decisions on transport policy measures proposed by the European Union (EU) have long-term and important impacts on economy, environment and society. Transport policy measures can lock up capital for decades and cause manifold external effects – thus, policy measures may have a tremendous scope, especially if proposed on a European level. In order to allow European policy-makers to evaluate transport polices, a strategic assessment tool is required to compute economic, environmental and social impacts of transport policies. The paper illustrates the conceptual phase of development of the strategic high-level transport policy assessment instrument HIGH-TOOL.
After careful identification of user requirements, on the basis of EU policy documents and user surveys, the conception stage of the strategic transport policy assessment tool is described in terms of tool structure, scope of output indicators, transport policies covered and other key features.
Besides elaborating the structure and key features of the assessment instrument, the paper demonstrates the complexity and sensitivity associated with the conception stage of the development of a policy assessment tool. Several targets of a policy assessment tool are mutually conflicting, which results in the need to carefully counter-balance these targets, under consideration of methodological and implementation-wise aspects. The paper elaborates trade-offs between different tool objectives and derives a magical polygon of targets of an assessment instrument.

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Keywords: impact assessment; transport policy; economic, environmental, social impacts; assessment tool; European Union; model; decision support; model conception.

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1. Introduction

Decisions on transport policy measures proposed by the European Union (EU) have long-term and important impacts on economy, environment and society. Transport policy measures can lock up capital for decades and cause manifold external effects – thus, policy measures may have a tremendous scope, especially if proposed at the European level. In order to allow European policy analysts to evaluate and identify advantageous transport policies, a strategic assessment tool is developed to compute economic, environmental and social impacts of transport policies. The increasing importance of such impact assessment tools as decision support instruments for policy makers is recognized by various authors such as Sieber et al (2013), Nilsson et al. (2008) and McIntosh et al. (2011).

Representing an interface between science and policy, an impact assessment tool ranges from rather simple supportive tools (e.g., questionnaires, checklists, decision trees) to standardized tools (e.g., cost-benefit analysis), and finally to elaborate instruments which model complex relationships between a high number of entities (Nilsson et al., 2008). The development of a strategic assessment tool for the evaluation of transport policies belongs to the latter category of assessment instruments, since transport policy has manifold effects on economy, environment and society.

It is widely acknowledged that the functionalities of such impact assessment tools need to be carefully aligned with user needs, which have to be identified during the tool's development process (e.g., van Delden et al., 2011, McIntosh et al., 2008, Jakeman et al., 2006). The main users of the tool presented in this paper are policy analysts of the European Commission. Thus, a careful analysis of EU policy documents, such as the European Commission's White Paper on Transport (European Commission, 2011a) and the Impact Assessment Guidelines (European Commission, 2009), is combined with user workshops to identify the most important user needs. These requirements, as well as modelling and implementation aspects form the basis for the development of the structural framework and key features of the tool.

The paper describes the development concept of the strategic transport policy assessment tool HIGH-TOOL (high-level strategic transport model), particularly in terms of structure, scope of output indicators and transport policies covered. Furthermore, it identifies a number of trade-offs, which need to be tackled during the conception stage of the development of an assessment tool to evaluate transport policies. The paper is structured as follows: chapter 2 elaborates on the EU policy requirements in terms of policies, output indicators and other tool requirements. Chapter 3 deals with the assessment tool's structure, output indicators and other key features. The scope of trade-offs, which are to be considered when drafting a transport policy assessment tool, and the magical septagon of assessment tool development are explained in chapter 4. The paper concludes with chapter 5, the summary and conclusions.

Nomenclature

CGE	Computable General Equilibrium	GVA	Gross Value Added
DG MOVE	Directorate General for Mobility and Transport	HDV	Heavy-Duty Vehicle
		LDV	Light-Duty Vehicle
EC	European Commission	NST	Eurostat's Standard Goods Classification for Transport Statistics
EU	European Union		
EU28	28 Member States of the European Union	NUTS	Nomenclature of Territorial Units for Statistics
GDP	Gross Domestic Product		
GHG	Greenhouse Gas	TEN-T	Trans-European Networks for Transport

2. EU policy requirements

The EU policy requirements for the assessment instrument are first determined by the scope of priority EU policy and its key targets, since the assessment instrument will have to respond to several of them. Secondly, related to the latter, the scope of indicators for the assessment of transport policies is elaborated on the basis of recent EU policy documents, to receive an indication on the scope of output indicators to be generated by the assessment instrument. Finally, other policy requirements need to be considered, such as timeline, validation sources and technical features. All these requirements are summarized in this chapter.

2.1. EU policies and political targets

By assessing transport trends of the previous years, the European Commission concluded in 2011 that business as usual is not sustainable, because they have not sufficiently addressed the following three key patterns of the European transport system (European Commission, 2011b):

- Persistent oil dependency and expected long-term increase of oil prices;
- increasing congestion and worsening accessibility of peripheral regions of the EU;
- and deterioration of climate and local environment.

Thus there is a clear need for EU transport policy to facilitate changes in trends. In the Commission Staff Working paper accompanying the Transport White Paper 2011 it is stated that past policies have failed to sufficiently address these three patterns. Four main reasons are identified which prevent the EU transport system from becoming sustainable (European Commission, 2011c):

- Inefficient pricing: Most of the external costs of transport are not internalized and where existent, internalization schemes are not coordinated between modes and Member States. Many taxes and subsidies which have been designed without the internalization goal in view have a distorting effect on behavior.
- Inadequate research policy: Despite promising results from research, fast deployment of technologies for sustainable mobility is constrained by market and regulatory failures.
- Inefficiency of transport services: Efficiency and competitiveness of multimodal and cross-border transport is hampered by a number of remaining regulatory and market failures such as regulatory barriers to market entrance or burdensome administrative procedures. Furthermore, the different modes of transport are still not sufficiently integrated, and the policy to develop Trans-European Networks for Transport (TEN-T) has lacked financial resources and a true European and multimodal perspective.
- Lack of integrated transport planning: Land-use planning and location decisions are taken at various spatial levels, ranging from the local to the continental level. Decision-makers do not necessarily properly take into account the consequences of their choices on the operation of the transport system as a whole, which typically generates inefficiencies.

In 2011, the European Commission issued the Transport White Paper "Roadmap to a Single Transport Area – Towards a competitive and resource efficient transport system", a strategic document that addresses long-term challenges of the transport sector and develops a policy framework for the coming years (European Commission, 2011a). The key targets of European transport policy are to facilitate European economic progress, supporting competitiveness and offering high quality mobility services while using resources more efficiently. Thus transport has to decrease its energy consumption, use cleaner energy, and make more efficient use of the infrastructure.

The Transport White Paper’s central target is the European Union’s commitment to reducing greenhouse gas emissions from transport by 60% by 2050 with respect to the 1990 level. This target is a precondition to ensure consistency with the long-term requirements for limiting climate change to 2°C and the EU overall target of reducing emissions by 80 to 95% by 2050. In this context, the Transport White Paper proposes ten goals for a competitive and resource-efficient transport system, which are benchmarks for achieving the 60% GHG emission reduction target. In brief, the ten goals are as follows (European Commission, 2011a):

- Halving the use of ‘conventionally-fuelled’ cars in urban transport by 2030, phasing them out in cities by 2050, and achieving essentially CO_2-free city logistics in major urban centers by 2030.
- Reaching low-carbon sustainable fuels in aviation of 40% by 2050, and reduce EU CO_2 emissions from maritime bunker fuels by 40%.
- Shifting 30% of road freight over 300 km to other modes by 2030, and more than 50% by 2050, facilitated by efficient and green freight corridors.
- Completing a European high-speed rail network by 2050. Triple the length of the existing high-speed rail network by 2030 and maintain a dense railway network in all Member States. By 2050, the majority of medium-distance passenger transport should go by rail.
- Completing the fully functional and EU-wide multimodal TEN-T ‘core network’ by 2030, with a high quality and capacity network by 2050 and a corresponding set of information services.
- Connecting all core network airports to the rail network, preferably high-speed, by 2050; ensure that all core seaports are sufficiently connected to the rail freight and, where possible, inland waterway system.
- Deployment of the modernized air traffic management infrastructure (SESAR) by 2020 and completion of the European Common Aviation Area. Deployment of equivalent land and waterborne transport management systems and of the European Global Navigation Satellite System (Galileo).
- Establishing the framework for a European multimodal transport information, management and payment system by 2020.
- Moving close to zero fatalities in road transport by 2050, and halving road casualties by 2020.
- Moving towards full application of “user pays” and “polluter pays” principles and private sector engagement to eliminate distortions, generate revenues and ensure financing for future transport investments.

During the user survey conducted among policy specialists of the European Commission, Directorate-General Mobility and Transport (DG MOVE) the following policy categories were prioritized for consideration by the strategic assessment tool (Vanherle et al, 2014):

- Policy measures relating to the objectives of the internal market;
- Internalization of external costs;
- Infrastructure charging;
- Multimodal transport;
- Safety.

2.2. Policy-relevant impact indicators

To analyze the scope of impact indicators relevant for impact assessment by the European Commission the *Impact Assessment Guidelines* (EC, 2009) are – albeit not transport sector-specific – a key reference. Furthermore, key impact variables can be derived from the Transport White Paper and related policy documents (European Commission, 2011a; European Commission, 2011c; European Commission, 2011d), the Roadmap for moving to a competitive low carbon economy in 2050 (European Commission, 2011e) and the EU Reference Scenario 2013 (European Commission, 2013). Further assessment variables are identified in other research projects such as SUMMA (Rahman and van Grol, 2005), TRANSFORUM (van der Waard, 2007), REFIT (Sessa et al., 2007), iTREN-2030 (Fiorello et al., 2009) and ASSIST (Maurer et al., 2011). The user survey conducted among policy specialists of DG MOVE resulted in following priorities (in this order) (Vanherle et al, 2014):

- GHG emissions
- Economic growth
- Employment

- Cost savings
- Safety
- Transport sector employment.

Summarizing the indicators and grouping them by impact categories, Table 1 provides an overall view on policy-relevant impact indicators (source: Vanherle et al, 2014).

Table 1.Consolidated set of impact indicators.

Category	Impact indicator
Transport impacts	» Passenger volume
	» Freight volume
	» Passenger transport performance(passenger-kilometer)
	» Freight transport performance(ton-kilometer)
	» Vehicle mileage
	» Load factors
	» Modal share passenger
	» Modal share freight
	» Unit costs for passenger transport
	» Unit costs for freight transport
	» Congestion
	» Car ownership
Economic impacts	» Economic growth (GDP)*
	» Value added of the transport sector (GVA)
	» Household income
	» Employment level*
	» Trade (import, export)*
	» Oil price, fuel price*
	» Tax net revenue for government
	» Effect on competitiveness of business (sectoral, spatial)
	» Insurance (i.e. due to accidental injuries)
	» Time savings
Social impacts	» Accessibility
	» Safety (number of fatalities, value of freight lost)
	» Security (injured and attacked people)
	» Choice of travel modes (availability, capacity, cost, time, information, privacy)
	» Health (noise, emissions)
	» Social cohesion
Environmental impacts	» GHG emissions
	» Air pollution
	» Noise pollution
	» Local air pollution
	» Energy use
	» Market share of new fuels and propulsion systems
	» Market share of electric-internal combustion engine hybrids
	» Market share of biofuels

*) … this variable can be used both exogenously and endogenously

Although not all impact indicators listed in Table 1 are affine with the features of a high-level, strategic assessment tool – e.g., noise pollution can only be soundly assessed under application of detailed local data –, it provides a baseline for the tool's scope of output indicators.

2.3. Further user requirements

Besides the user requirements originating from transport policy priorities and targets, there are various further user requirements to be considered, ranging from the use of specific distance bands to geographical scope, validation/calibration and time horizon. The main requirements are the following ones (Vanherle et al., 2014):

- Free, open source and transparent (traceability);
- Endogenous projections for passenger & freight transport activity at regional level for EU Member States (EU28);
- Differentiation by distance classes (< 300 km; between 300 km and 1000 km and > 1000 km);
- Spatial scope: NUTS-2 level;
- Consideration of all transport modes and vehicle technologies for the assessment of economic, social and environmental impacts of transport policy options;
- Modular structure allowing stepwise validation;
- 2050 time horizon.

3. Conceptual tool development

The conceptual phase entails setting up of important modelling features such as a zoning system or demand segmentation, the development of a general tool structure, and identifying policies the tool will be responsive to. This implies that the different types of requirements are carefully aligned with

- modelling methodologies
- data availability considerations
- and software engineering aspects.

The choice of modelling methodologies entails decisions on the basis modelling approach (e.g., classical transport demand model, Computable General Equilibrium model, system dynamics model), as well as decision on the modelling approach for specific modelling entities (e.g., vehicle fleet modeling). Furthermore, key modelling features such as the zoning system or demand segmentation, are defined. All aspects of model methodology are closely linked to data availability considerations. Although ETISplus data provide a wide scope of consolidated data at regional level for Europe and beyond (Newton et al., 2014), the requirement of particularly specific data (e.g., detailed data on fleet structure at regional level) at European scale may still impose certain methodological restrictions due to data gaps. In accordance with all other methodology- and data-related specifications the technical implementation is elaborated, covering aspects such as defining the tool's development environment and data handling.

3.1. General tool features

The assessment tool is designed as a high-level strategic assessment tool which is partly based on existing tools, and where necessary, complemented by new models. Due to its character as a strategic high-level instrument it does not cover detailed networks. The core of the model are transport demand models for passenger and freight, following the structure of the classic transport model (e.g., Ortúzar and Willumsen, 2011), however without assignment of flows on networks.

Its geographic and spatial scope is the level of NUTS-2 for all EU Member States (EU28), Norway and

Switzerland, NUTS-0 for EU neighboring countries, and country bundles for intercontinental transport. In order to ensure consistency with the long-term horizon of the White Paper, the tool's timeline is represented by 5-years steps from 2010 (base year) to 2050.

All modes of transport are covered and differentiated by vehicle technologies. In order to take into account demand segment specific preferences and characteristics, passenger demand is differentiated by four trip purposes and freight demand by NST-2 commodities. To facilitate consistency with White Paper targets, the demand is subdivided into three distance bands.

The baseline scenario, i.e. the scenario the transport policy measures are to be assessed against, is the EU Reference Scenario 2013 (European Commission 2013), which runs until 2050.

The tool is responsive to transport policy measures and is thus sensitive to a set of independent variables. As far as is feasible, its results for the base year and the baseline scenario are in line with EU transport in figures and other national statistics, as well as the EU Reference Scenario 2013, respectively.

The general tool features are summarized by Table 2.

Table 2.General tool features.

Model feature	User requirement
Type	Strategic high-level model derived from existing tools, models, equations and elasticities; where necessary enriched by new models; no detailed network model
Geographic Scope	EU28, Norway and Switzerland: NUTS-2; EU neighboring countries: NUTS-0; other countries worldwide: country bundles
Timeline	5-years (1-year) steps from 2010 to 2050
Modes	Passenger: air, rail, road (passenger car and powered 2-wheelers), long-distance coach, urban public transport, slow modes; further differentiation by vehicle technologies
	Freight: air, rail, road, maritime, inland waterways, maritime transport; further differentiation by vehicle technologies
Transport Types	Passenger by trip purpose (business, private, vacation, commuter; for intercontinental passenger trips only business and non-business). Freight transport commodity (NST2, for air no commodities)
Distance Bands	0–300 km, 300–1000 km, 1000+ km
Model Sensitivity	The dependent variables of a module are sensitive to a variety of independent variables to model transport policy measures
Validation	EU Reference Scenario 2013, EU transport in figures/ Statistical Pocketbook; ETISplus
Baseline	EU Reference Scenario 2013

3.2. Transport policy measures

Condensing the scope of EU policy priorities presented in the previous chapter and analyzing the results of surveys among future tool users of the European Commission (see Vanherle et al. 2014), following key focal points of transport policy had been identified: policies related to the GHG emissions reduction target; improving road safety and accomplishing the internal market. Thus the scope of transport policy measures addressed by the tool are organized along four policy categories as shown in Table 3: efficiency standards and flanking measures, internal market, pricing and taxation, as well as research and innovation. Some of the policy measures fit to more than one policy category while in the table they are assigned to just one.

Table 3. Transport policy measures.

Category	Transport policy

Efficiency standards and flanking measures	CO_2 emissions limits for road vehicles
	Deployment of efficient vehicles
	Diffusion of electric cars
	Diffusion of H_2 fuel cell cars
	HDV limitation for urban areas
	Improving local public transport
	LDV speed limit
	Pollutant limits for road vehicles
	Replacement of inefficient cars
	Replacement of inefficient LDVs and buses
Internal market	Acceleration of TEN-T implementation
	HDV limits in urban areas
	Access to rail infrastructure
	Enhance service quality at airports
	Enhance service quality at ports
	European Rail Traffic Management System
	Freight corridor management
	Harmonization of rail safety
	Harmonized handling of dangerous goods
	Harmonized social rules for truck drivers
	Maritime traffic management system
	Opening the internal IWW market
	Opening the internal rail market
	River information system
	Single European road market
	Single European Sky
	Single rail vehicle authorisation and certification
Pricing and taxation	Circulation tax for cars
	CO_2 certificate system for road transport
	CO_2feebates for road transport
	HDV infrastructurecharge
	Internalization of external costs
	Urban road charging
Research and innovation	Dynamic traffic management for road
	Improvement of energy efficiency of vehicles
	Intelligent road vehicles
	Intelligent traffic information system for road
	New fuels and propulsion systems
	Road vehicle safety technology protecting other transport users
	Safety systems for road vehicle users

The 39 policy measures are spread across all modes and a variety of policy topics. The tool allows the user to define a policy scenario for a policy assessment according to four dimensions:

- the specification of the policy measure characteristic (within a predefined interval preventing the user from abusing the system),
- the time horizon of policy implementation 2010 to 2050 (by 5-years steps),
- the geographic scope (at NUTS-0and NUTS-2 level), and
- the composition of a policy portfolio consisting of a combination of policy measures whereby some limitations are imposed in case policy measures are highly interdependent.

3.3. Overall tool structure

The conceptual framework for the strategic policy assessment tool follows a modular approach. The following modules form the core of the modelling part:

- Demography (DEM)
- Economy & Resources (ECR)
- Passenger Demand (PAD)
- Freight Demand (FRD)
- Vehicle Stock (VES)
- Environment (ENV)
- Safety (SAF).

The Data Stock ensures the data exchange between these modules, provides exogenous input for the modules and stores intermediate and output data. Finally, the user interface allows the operation of the model and provides access to assessment results.

The Demography module (DEM) provides demographic data at regional level, ensuring consistency with the demographic forecasts underlying the EU Reference Scenario. Demographic trends influence economic performance, passenger transport demand and demand for vehicles. Thus it provides inputs to ECR, PAD and VES.

The Economy & Resources module (ECR) supplies estimations of economic performance, such as purchase power, employment, trade and resource consumption. Economic indicators are an important driver of passenger and freight demand, as well as demand for vehicle stock. Thus ECR provides inputs to PAD, FRD and VES for t+1. Furthermore, it delivers input to DEM on employment and income, in order to ensure consistency of population distribution and spatial economic development. Since the economic performance and resource consumption is dependent on transport activities, transportation costs, the type of vehicles purchased, as well as the labor force, ECR uses inputs from FRD, PAD, VES and DEM.

Since the composition of the vehicle stock demand is dependent on the economic performance and demographic patterns, as well as on passenger and freight demand, VES receives inputs from ECR, DEM, PAD and FRD. Furthermore, it delivers outputs to PAD and FRD for t+1 in terms of vehicle stock related costs, as well as to ENV in terms of emission factors.

Passenger demand (PAD) is influenced by economic and demographic pattern and thus requires inputs from DEM and ECR. Furthermore, it requires vehicle stock related cost data from VES. PAD's demand data are inputs for the calculation of environmental impacts (ENV) and safety indicators (SAF). Since passenger demand has an impact on the demand for vehicles and economic performance, it delivers demand data for t+1 to VES and ECR.

Freight demand is dependent on economic and trade-related characteristics, as well as on vehicle stock related cost data. Thus, ECR and VES provide inputs to FRD while FRD's demand data are provided to ENV and SAF for the computation of environmental and safety impacts. Freight demand has an impact on the demand for vehicles and the economy, thus FRD delivers demand data for t+1 to VES and ECR.

For the computation of environmental impacts, ENV applies passenger and freight demand data from PAD and FRD, as well as data on vehicle fleet composition from VES. For the calculation of safety impacts PAD and FRD provide demand data to SAF.

Figure 1 displays the structure of the assessment tool and reflects the interdependencies of the modules' components.

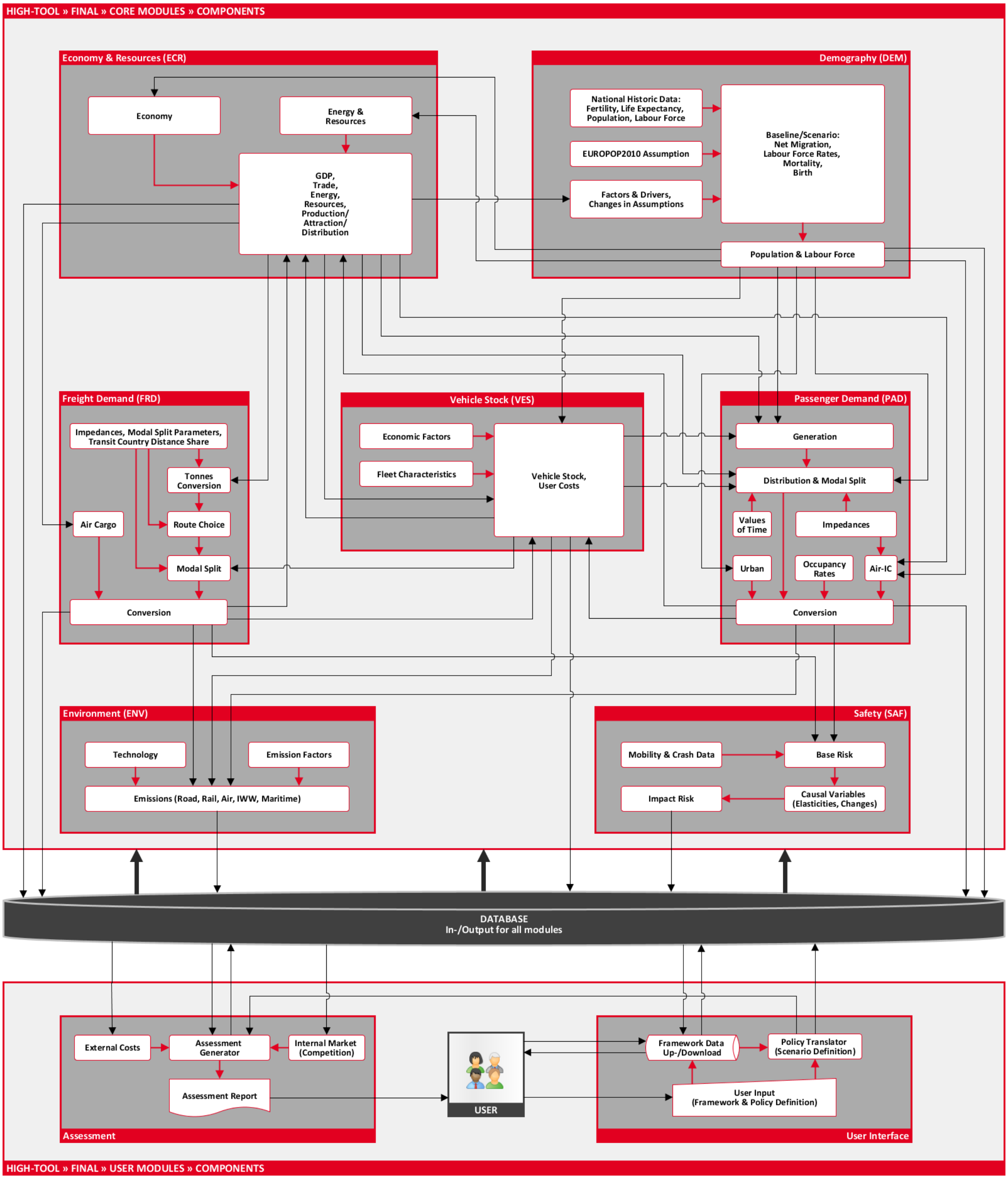

Fig.1.Structure of the assessment tool.

3.4. Chronological sequence of module calls

As introduced in the previous paragraph and displayed by Figure 1, several loops between the modules exist. To ensure low runtimes requested by the user the decision was made to apply a sequential approach of module interaction. The sequential solution reduces the computation loops, as results for a period t are passed to computations in t+1. An iterative process would be much more time consuming as the modules would interact, re-compute, store and read data several times until the results for a certain time period become available and the model can move forward to the next time period.

The sequence starts with DEM to produce demographic outputs for t, under consideration of ECR inputs of the time step t-1. Subsequently ECR is run, fed by DEM results of time step t and by VES, PAD and FRD outputs of time step t-1. Afterwards VES is activated, on the basis of DEM/ECR (step t), and PAD/FRD (step t-1) outputs. Subsequently, PAD and FRD are run, using results from DEM/ECR/VES, and ECR/VES, respectively. Finally, results by PAD, FRD and VES are delivered for all years to ENV for the computation of the environmental impacts and by PAD and FRD to SAF for the computation of the safety impacts. The tool's base year is 2010. Thus, the first time step 2015 is partly driven by 2010 results, and 2020 by 2015 results etc. This time lag can be avoided to a large extent when the user selects the yearly computation. The yearly modus will increase the runtime while enhancing the correctness.

Figure 2 illustrates the chronological sequence of a model run.

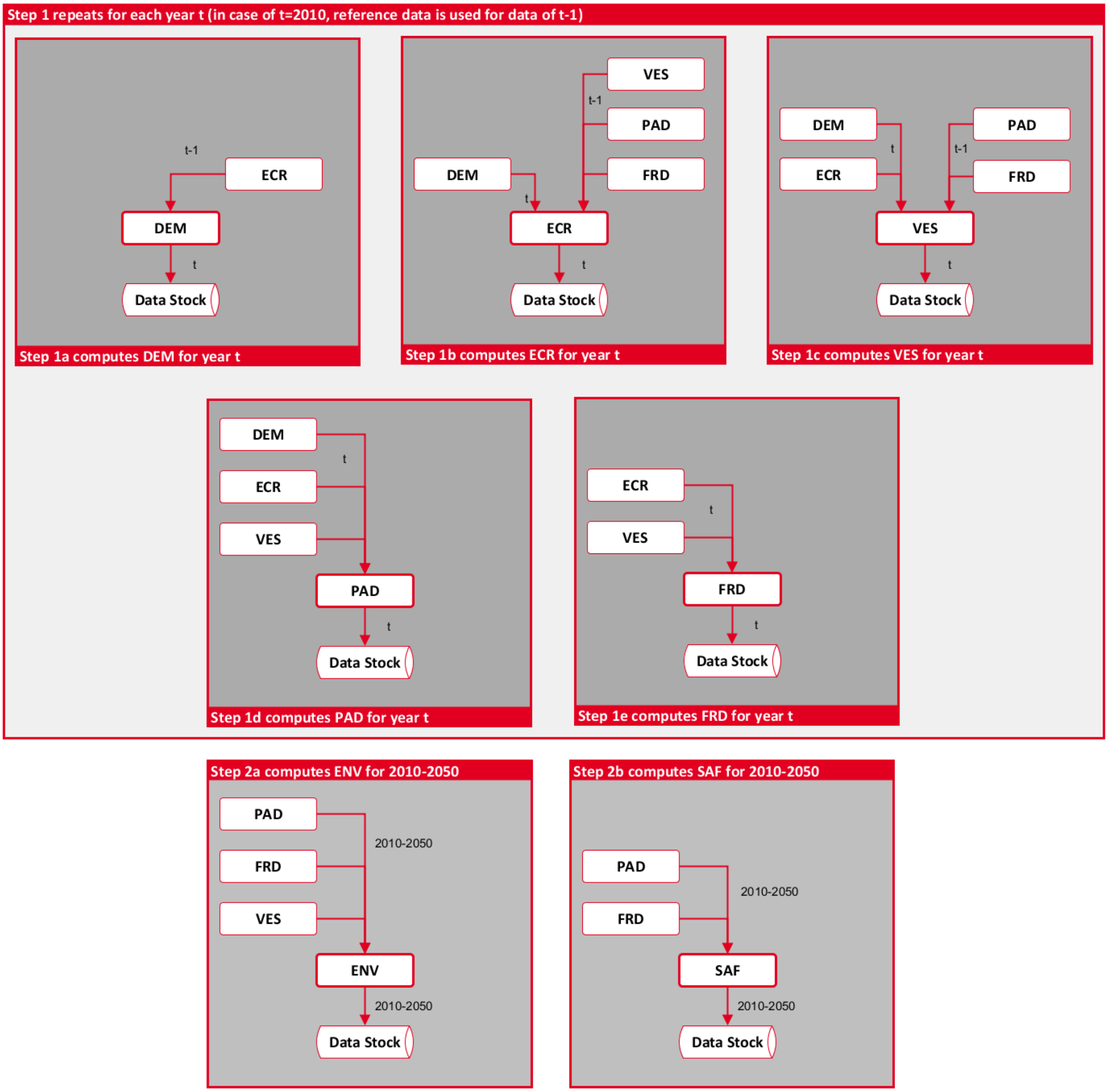

Fig. 2. Chronological sequence of a model run.

3.5. Output indicators

Taking into account the scope of policy-relevant indicators summarized in section 2.2, the methodology and capability of the modules, and the scope of available data at European level, the set of potential impact indicators can be derived. The scope of potential output indicators is largely in line with the set of policy-relevant impact indicators. Indicators on network congestion however cannot be an output of a strategic assessment tool, since for measuring congestion a detailed network model is required. Also measuring noise pollution exceeds the range of use of a strategic assessment tool, as it requires the application of a detailed network model, which is spatially joined with topographical and land-use data. The assessment of transport policies in terms of security requires either very detailed models or qualitative analyses. However, both possibilities are not affine to a strategic high-level assessment instrument. The consolidated set of potential output indicators is summarized in Table 4.

Table 4. Consolidated set of potential impact indicators.

Category	Impact indicator
Demography	» Labor force » Population
Economic impacts	» GDP » GVA » Consumption per capita » Trade » Labor supply » Wages » Income » Emissions » Resource use » Household consumption » Taxes » Capital returns » Capital stock » Price index
Freight Demand	» Transport performance (ton-kilometer) » Mileage (vehicle-kilometer) » Transport volume (tons carried) » Costs
Passenger Demand	» Transport performance (passenger-kilometer) » Mileage (vehicle-kilometer) » Transport volume (number of trips) » Costs
Environment	» Emissions (CO_2, CO, NO_X, SO_2, VOC, particulate matter) » Fuel consumption
Safety	» Accident costs » Fatalities » Slight & serious injuries
Vehicle Stock	» Cost components per vehicle-kilometer/ passenger-kilometer/ ton-kilometer » Fuel costs per litre/gramme » Vehicle stock » Detailed mileage (vehicle-kilometer) » Vehicle purchase costs

4. Trade-offs & the magical septagon of assessment tool development

The conceptual phase of the development of the assessment tool is characterized by the alignment of

- user requirements
- method and data availability
- and the technical implementation environment.

User requirements are provided by the scope of policies to be covered, the scope of output variables, segmentation (e.g., zoning system, demand segments, supply segments, vehicle technologies), as well as by other tool features such as runtime and scope of manual interventions into the system. The choice of method implies the identification of the type of model(s) to be applied: in the first step, it may be decided whether a modular modelling approach shall be chosen or a unique model. Subsequently the modelling methodologies for the unique model or each module need to be defined, which also depends on the scope of available models and data.

Regarding the technical implementation environment, decisions have to be taken concerning hardware configuration as well as software requirements and the programming environment.

Aligning all these aspects in the conception stage of tool development is a highly complex task, since there are a significant number of trade-offs, which need to be resolved and since several targets of the tool are diametrically opposed. Some of the key trade-offs are explained in the following:

- Level of detail: Strategic model vs. detailed assessment via network model
  A strategic model is designed for a more abstract level of detail, in contrary to the disaggregated level of modelling by a network-based approach. In transportation research a detailed network representation and a fine zoning system together with a close segmentation of demand and supply provides the highest degree of detail. A strategic model misses the level of detail in terms of traffic flows at the network level and in terms of scope of demand and supply segments. Compared to a strategic tool, a detailed network-based model at European scale features data issues (both in terms of data availability and data up-to-dateness), and suffers from long runtimes.

- Target group: Policy specialists vs. modeling and software experts
  A further trade-off is the positioning of the tool by its target group: It makes a significant difference whether the tool is designed to be applied by modelers and programmers, or by policy specialists to develop and assess transport policies. In the latter case, high requirements have to be regarded in terms of user-friendliness, transparency, documentation, and as far as possible easy-to-understand structure and modeling methodology.

- Scope of policies: Limited number of policies vs. wide variety of policies
  A tool for the assessment of a restricted number of policies represents a more compact instrument than a tool, which addresses a broad range of different policies. A wide scope of policies to be covered implies the application of more complex models reflecting a wide range of interrelationships and requiring detailed demand and supply segmentation, while an assessment tool for a limited number of policies tends to be more compact.

- Flexibility: Stationary vs. alterable tool
  A stationary tool is not intended to be changed by the user. Thus it represents fixed structures, methodologies and model parameters. In contrast, an alterable tool allows the user to make changes, e.g. by adjusting model parameters, updating the tool to a more recent base year, modifying methodologies or even replacing certain elements of the assessment tool.

- Degree of transparency: “Black box” vs. open tool free of royalty

  Related to the latter trade-off, also the degree of openness of a model represents a crucial decision in the conception stage. If its source code is not accessible, the tool represents a “black box”. In contrast to an open tool, a black box approach neither allows the user to check equations and model parameters, nor to make any changes or to further develop the assessment tool. The creation of an open tool makes higher demands on model development, since all modeling details including model parameters are open and accessible. Ideally, an open tool features a consistent programming language to facilitate future modifications.

Several expectations one may have on a transport policy assessment tool are diametrically opposed. Thus a magical polygon of objectives of a policy assessment tool can be derived, consisting of following elements:

- Low runtime;
- Coverage of every policy;
- High level of transparency;
- Open tool;
- Simple maintenance (in terms of data update and methodological update);
- Provision of high level of detail (in terms of input and output data);
- Intuitive and user-friendly application.

Some of the conflicting relationships between the targets of the magical polygon (see Fig. 3) are explained further: Low run time is a highly desirable feature of a policy assessment tool, since it allows efficient operation by the users. The objective of a low run time however, is contrary to providing a high level of detail in modelling and output provision: for instance, the number of zones applied for the transport model has a quadratic impact on the number of arithmetic operations and data storage needs. The number of demand segments (e.g., trip purpose, NST groups) and the number of supply segments (e.g., transport modes, vehicle categories) multiply the number of computations and the volume of data storage. Also a wide variety of policy measures to be tested increases the necessity for complex modelling to cover all aspects and to secure the representation of interrelationships. Finally, the target of a low run time is conflicting with specific transport policies, such as a detailed assessment of any transport policies related to transport infrastructure (e.g. infrastructure charging, infrastructure investments, SESAR) which require a network-based transport demand model. A network-based demand model involves enhanced run time for the assignment under consideration of capacity constraints and route choice.

Coverage of every policy is not only conflicting with low run time, but also with the target of simple maintenance, since a large scope of policies to be addressed results in a high number of interrelationships and large input data sets, which make maintenance more complex.

A high level of transparency tends to be diametrically opposed to the coverage of every policy and provision of a high level of detail, since a large number of policies covered and a high level of detail increases the complexity of the tool in terms of the number of relationships and data requirements.

The target to provide an open tool which is free of royalty, transparent and easy to read for users (one programming language) may conflict with the provision of high level of detail. The latter requests specific algorithms and programming dedicated to specific problems which require the usage of commercial tools, such as equilibrium algorithms to determine network loads under consideration of congestion, or CGE models to mirror complex interdependencies requiring a certain programming language. Such types of fragmentation prevents users from understanding the underlying theory, programs and models. This makes it also very difficult to substitute or adapt modules once technique and science are further developed as the tool is neither open for changes nor easy to read for users and it imposes the purchase of licenses, resulting in a higher effort of maintenance particularly if multiple software packages are used.

Although the issue of contradicting targets is clearly prevailing, the magical septagon reveals complementary objectives, too: For instance, a tool with a low runtime tends to be a compact tool with a limited number of interdependencies that uses and computes mainly aggregate data, which may facilitate simple maintenance.

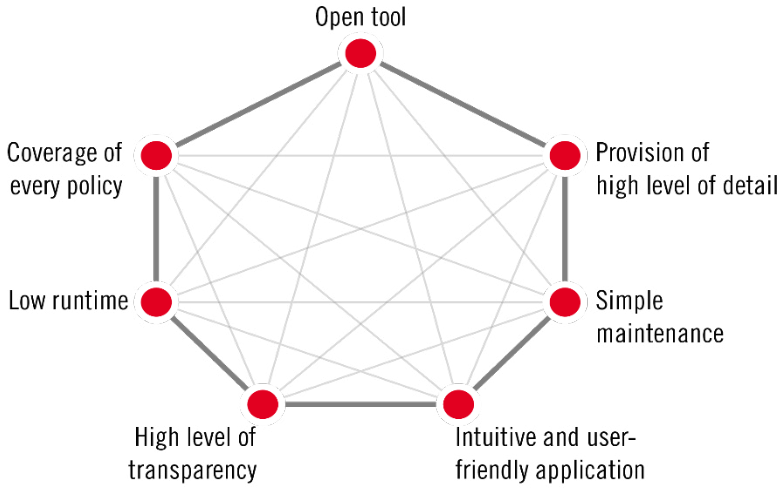

Fig. 3. Magical septagon of targets of a transport policy assessment tool.

5. Summary and Outlook

The paper has illustrated user requirements and the key conceptual features of the strategic high-level transport policy assessment instrument HIGH-TOOL, which is currently being developed on behalf of the European Commission. Since the individual targets of a policy assessment tool are conflicting with each other, the conception stage, in which structure, method and functionalities of the tool are decided, represents a highly sensitive and complex task. The paper shows examples of trade-offs which need to be addressed and develops a magical septagon of transport policy assessment tools consisting of tool targets which carefully need to be compromised against each other.

Some of the limitations of assessment tool objectives involved with the magical septagon can be solved through a tool, which consists of different layers that can be switched on and off according to the type of policy and type of assessment required. For instance, such tool would have the potential to run at various spatial levels, ranging from a fine, detailed level consisting of a high number of traffic zones to an aggregated level at country scale. Furthermore, such tool would optionally allow assignment on detailed networks. Such tool would cover the utmost number of policies, provide – if required – a high level of detail and feature query-specific runtimes: low runtimes for high-level strategic assessments at aggregated level, and longer runtimes for the detailed assessment of policies which require assignment runs (e.g., detailed infrastructure investment policies, infrastructure charging).

The compilation of input and calibration data for a policy assessment tool implies considerable efforts, particularly for a tool covering a whole continent. Synergies can be exploited if data compilation and assessment tool development are carried out in the same research activity – as currently tendered by the EU (European Commission, 2015) – instead of conducting data work and model development in different research activities.

It is highly beneficial for the model user to have a policy assessment tool without any “black box”, mainly because of four reasons: first, an accessible source code ensures transparency of computations, which is of high importance if political decisions based on these computations need to be justified against stakeholders and explained to publics. Second, only a tool with accessible source code will allow the experienced user to modify calculations. Third, only an assessment instrument without “black box” will make the user independent from the original tool developer. Finally, since a tool with accessible source code can be modified and adjusted by any modeler, the open source concept is likely to support innovation.

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