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Deliverable 5

Integrated Theoretical Framework

Final Guidelines for Case Studies/Simulations

Simulation Model Application

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Dissemination Level		
PU	Public	
PP	Restricted to other programme participants (including the Commission Services)	X
RE	Restricted to a group specified by the consortium (including the Commission Services)	
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Foreword

The ENACT Deliverable 5 was produced by TIS.Pt (Prof. Rosário Macário, Carlos Marques, João Bernardino) and received contributions from the following members of the consortium:

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This document is set to be Public (PU), and should be referenced as:

"ENACT- Design Appropriate Contractual Relationships, Deliverable 5"

Besides the report itself, this Deliverable is complemented by a software tool based on MS EXCEL and VBA (visual Basic for Applications) sent together in a CD-ROM. In its accompanying version to this report (V1.0, 03/11/2008), the dissemination level of this software should be restricted to other programme participants (including the Commission Services) as it is set to undergo a refinement process during the preparation of the case studies, before being made public.

The EST Software should be referenced as

"ENACT Simulation Tool (EST)", v1.0

This version of the EST is therefore a Draft Working Version, delivered to the European Commission on the 2008-11-03 together with Deliverable 5 (Work Package 5).

<u>QUALITY CONTROL INFORMATION:</u>

Version	Date	Description
0.1	29/10/2008	Draft version of ENACT D5 for partners comments
0.2	29/10/2008	Draft Final version ENACT D5 for quality control
0.3	30/10/2008	Final (revised) version ENACT D5 for quality control
Final 1.0	03/11/2008	Submission of ENACT D5 final version to the EC

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List of Acronyms

EST	ENACT Simulation Tool
HGV	Heavy Good Vehicle
HVF	Heavy Vehicle Fee
ICAO	International Civil Aviation Organisation
IM	Infrastructure Managers
IWT	Inland Waterway Transport
LCC	Life Cycle Costs
MEC	Marginal External Cost
MTOW	Maximum landing and Take-Off Weight
PPP	Public Private Partnership
SMC	Social Marginal Cost
SMCP	Social Marginal Cost Pricing
SRMC	Short Run Marginal Cost
WP	Work Package

EXECUTIVE SUMMARY

The primary objective of the ENACT project is to perform an in-depth research on the workings of Public-Private Partnerships (PPP) and the practical issues that could affect them by fully integrating SMC pricing principles in the use of transport assets. In this sense the project aims to devise ways to apply Social Marginal Cost pricing within Public-Private Partnerships in the provision of transport infrastructure/services in order to set transport pricing to socially optimal levels (at least, to second-best solutions) and to enhance a more efficient, rational and balanced use of resources available. After accomplishing most of the theoretical research involved in the project in previous work packages 2, 3 and 4, the project has reached the point where it is possible to integrate the essential results into a single consistent document towards the development of the ENACT Simulation Tool (EST) for the elaboration of the Case Studies in WP 5.1. The report is therefore built around the following main topics:

- Theoretical integration of previous research
- Development of analytical sub models and requirements for case studies
- Simulation Application (EST)
- Conclusions

As a pre-final report of the project, it constitutes a major milestone of ENACT by providing an overall perception about what is at stake at both a theoretical and practical level, regarding the possible uptake of SMC pricing in PPPs compared to conventional pricing schemes, considering the following perspectives:

(i) incentives generated (created) by each PPP contract between two distinct but rational agents (the state and the private companies) with conflicting interests and asymmetric information, and

(ii) financial markets' perception and valuation of risk and, consequently, from the ability of the private party to raise, profitably, adequate financing for the project.

To achieve such results, this Deliverable departed from the review of the deliverables of work packages 2, 3 and 4. From these, main topics of relevance concerning the application of social marginal cost pricing in transport infrastructure were identified and selected for later analysis in the case studies. The Simulation Tool to be used by the case studies covers the largest share of these topics.

A **summary of the main practical topics of analysis for the case studies** is presented in the table below, along with the identification of the topics **covered by the ENACT Simulation Tool.**

Table 1 - Main topics of analysis for case studies and topics addressed by the Simulation Tool

MAIN TOPICS OF ANALYSIS FOR CASE STUDIES	Addressed by EST
Practical implementation of SMCP and its revenues (WP2)	
What revenues are derived from SMCP?	●
Are SMCP revenues sufficient for cost recovery?	●
If not, what additional price or subsidy is necessary for cost recovery?	●
Is it possible to apply a sound SMCP scheme in practice?	
What effects of changes of marginal costs through time?	●
Incentives of SMCP (WP3)	
What Investment incentives are caused by SMCP?	●
What Performance incentives are caused by SMCP?	●
May passing on specific parts of SMCP revenues to the State have better incentive effects?	●
What second best pricing can better conciliate social objectives of SMCP and Value for Money of PPP's?	
Risk of SMCP revenues (WP4)	
What differences in risk of user fee revenues between SMCP and conventional pricing?	●
What is the additional risk premium demanded by the private party with SMCP?	●
What is the most efficient risk allocation between the private and public parties?	
In designing a SMCP scheme, what is the most efficient balance between risk aversion and correction of the externality?	

As an instrument for analysis, the simulation tool should not be expected to address all points left unchecked in the table above, as some of them should be subject to careful interpretation. Still, the EST is able to provide support to such interpretative work on the possible effects of various PPP design alternatives

Hence, the ENACT Simulation Tool seeks primarily at assisting the analysis to be made in the case studies by providing quantitative results. These are expected to provide indications on the practical feasibility of applying SMCP in the PPP's as well as guidance on required PPP specifications in order to conciliate SMCP application with a economical and operational performance of PPPs.

The case studies, with the support of the EST, should be able to point the major elements of disturbance posed by SMCP in conciliating social with private party objectives. There are various **alternatives of contractual design,** with a few being particularly relevant within the scope of ENACT, namely:

- Who should get revenues from SMC pricing?
- Which complementary instrument(s) of cost recovery may be applied?
- Whether and which kind of performance incentives may be applied ?

The choice between the multiple available alternatives of PPP contractual design should focus on the optimization of some objective, which in fact must cover an aggregation of several objectives.

The objectives present in conventional PPP's are those of providing the desired service with the least possible cost, i.e. getting the highest possible value for money. In PPP's with SMCP an additional objective is introduced of optimizing infrastructure user behaviour from the social point of view.

None of the conceivable PPP design alternatives does without its costs over one or several of the three mentioned objectives. Not giving performance incentives may render an inadequate behaviour from the concessionaire, but giving performance incentives does imply monitoring costs. In case SMCP revenues are not sufficient for cost recovery, applying a 2nd best SMC pricing scheme affects the efficiency of user behaviour, while remunerating the private party with subsidies has operational and economic costs related to the collection of the necessary public funds. Letting the public instead of the private party collect the revenues from SMCP may prevent inadequate behaviour from the private party and also reduce its demanded risk premium, but in return implies again the use of costly public funds and returns uncertainty of fiscal revenues (i.e. a public risk premium). Figure 1 in page 25 maps the main possible choices of PPP design in the scope of SMC pricing. Before all the existent trade-offs, maximizing the social benefit out of the PPP design requires the choice of design alternatives to rationally fall over the one with the lowest overall costs.

Such goal probably may be successfully achieved in different ways in different PPP's. The ENACT case studies should explore alternatives of SMCP PPP schemes and analyse their performance over the social objectives of service quality, minimal service costs and infrastructure user behaviour optimization. With that aim, the ENACT Simulation Tool will provide guidance by:

- Estimating revenues generated by SMCP and evaluating economic feasibility of the private party with SMCP revenues, assessing the need for complementary instruments for cost recovery
- Evaluating the risk premium demanded by the private party by virtue of its SMCP revenues and compare it with the risk premium that would be demanded in a conventional demand-based revenue scheme
- Assessing the direction of incentive of the concessionaire over the level of capacity of the infrastructure, and consequently predict its behaviour both to maximize infrastructure availability and to expand capacity.

Answering the primal question of which best PPP design would best achieve the accomplishment of social goals, the case studies will clear up issues and suggest which kind of design alternatives may be most appropriated for each case, identifying conditions for their success.

In addition, the case studies will check schemes devised in the present PPP's to face the problem of conciliating public with private objectives. This will provide examples and possibly best practices of how issues of risk allocation and incentives can be contractually handled, providing insight on how the same kind of issues might be solved in the realm of SMCP PPP's. In particular, the case studies will look into performance-based remuneration schemes or identify reasons behind the devised risk distribution schemes.

The Chapter 2 reviews the main findings of work packages 2, 3 and 4, towards the actual elaboration of the simulation tool. It resulted that there are a number of key points to retain when considering the application of SMCP in PPP's, namely :

- The main objective of the implemented pricing schemes among all transport modes is the cost recovery;
- However the degree to which the costs can be covered through social marginal cost pricing may be insufficient;
- Second best pricing solutions seem to be more appropriate for cost recovery needs when there is involvement of private funds;
- An available set of marginal cost estimates is neither complete nor robust enough to claim that welfare optimising prices are known;
- Marginal costs change (decrease) with time due to technology.;
- There are perverse incentives of SMCP: the private party has an interest to keep social marginal costs high;
- When users are able to observe performance and have alternatives, private party has adequate incentives to perform well;
- SMC pricing may inhibit innovation. However this may be avoided through appropriate pricing/revenue structure;
- Yield management and price discrimination may not be possible with user fee SMCP;
- Social objectives of SMCP and Value-For-Money of PPP's may be conciliated through adequate revenue and pricing separation;
- SMCP has implications over risk of demand and risk of revenue, and consequently on the risk premium demanded by the private party;
- Choice of risk sharing between the public and the private parties should maximize allocative efficiency and productive efficiency;
- SMCP may impose higher revenue risk from user fees due to non-linearities in the relation between demand and SMC user fees;
- In such case there is a trade-off to balance between the risk aversion and correction of the externality.

These findings were translated into main issues for analysis in case studies and into the elaboration of the simulation tool, as already described above.

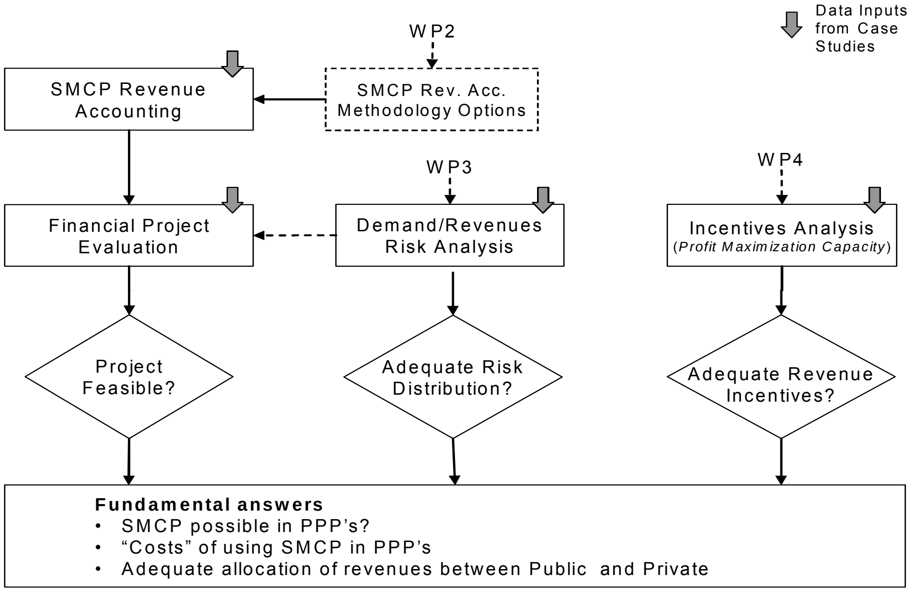
In support of the development of the EST, Chapter 3 describes then the methodologies used in the ENACT Simulation Tool and sets the data requirements for its use by the case studies. It constitutes a fundamental formal outline for the EST, bearing in mind its main objectives, namely:

(i) To produce an analysis of the sensitivity of output variables to choice variables to see how outcomes of contractual relationships change in accordance to changes in design choices. This creates understanding of interferences between design elements.

(ii) To assess how the factors involved affect this sensitiveness to determine which design elements may have a greater influence on possible outcomes no matter the choice of other design elements (the resulting design elements are most important in designing correctly in order to achieve objectives, since its adequate understanding will be crucial in the development of the case-studies).

(iii) After the case studies are carried out in subsequent WP5.1, the simulation model should be able to be 'trained' by plugging in the data of the different cases. This will allow to analyze the impact of design changes and to consider potential improvements to the design of contractual relations in the case studies at hand as well as the Simulation Tool itself. In addition, it will also shed light on policy recommendations for the design of contractual relations beyond the specificities of the case studies to be addressed.

The following figure shows the general structure of the EST and its key features



The technical implementation of this model is built on VBA (Microsoft Visual Basic for Applications) in a MS EXCEL environment, thus allowing a rather universal platform for further use in the subsequent case studies.

The methodologies behind the simulation tool involve:

- Estimation of social marginal costs (and consequently SMCP revenues) taking place, through the assumption of cost parameters for aggregate volumes on transport activity discriminated by relevant characteristics.

- Calculation of a risk premium associated with SMCP revenues, based on assumptions on risk valuation and on the comparison of the risk levels of conventional demand-based revenues and SMCP revenues.
- Calculation of the *profit maximization capacity* for the concessionaire, which provides indications on its expected behaviour.

The data requirements for case studies include data on the transport activity, particular characteristics of transport activity and infrastructure with relevancy to the level of social marginal costs taking place, behaviour of demand before different pricing and infrastructure performance circumstances and infrastructure characteristics with relevancy to its performance in relation to the level of demand.

In Chapter 4, following a review of existing SMC accounting tools (particularly the GRACE model), the ENACT Simulation Tool anticipated information and transferability constraints found previously and was designed as to provide flexibility to case studies both in data collection and in cost parameterization. This was done through:

- The provision of more than one SMC calculating function ("Revenue Accounting Methodology Options") for the modes and cost categories for which the literature provided different feasible alternatives.
- The possibility to use case-specific values for cost parameters in alternative to the default values of the Simulation Tool, which may be particularly useful for cost categories where transferability is not applicable with a good degree of confidence.
- The possibility to use case-specific SMC calculating functions, enabling the case studies to use variables (cost drivers) and cost parameters consistent with the availability of data and particular features of the case study.

Finally, an illustrative case study is presented as a preliminary test to the capabilities of the "Simulation Model Application". Such illustration is intended to introduce the reader to the Simulation Tool (as an integral part of D5) by presenting a series of "interface screenshots" according to the steps that users will follow for the development of the Case Studies.
This "testing Case Study", taken from a real motorway in a European country, provides an insight on how the Simulation Model can be used in a real context based on actual data. This hypothetical discussion provides therefore an indication about the added value expected from the ENACT Simulation Tool, not only in the scope of the Case Studies but also a tool for subsequent public use. Based on such "realistic representation" of a case study, an example of the outcome that EST may produce in WP5.1 is produced.

1 INTRODUCTION

1.1 Objectives

The design of contractual relations, also in the scope of PPP, is about the creation of the right incentives for all the actors involved, so that set objectives get realized. Contractual relationships entail a myriad of complex relationships that work in different directions and with different intensities. To this extent, the research performed in Work Packages 2, 3 and 4 has been primarily concerned about describing (i) the fundamental theoretical and practical issues on the strict technical adoption of SMC pricing and (ii) the framework to assess such complex relationships, the incentives and risks involved with an impact on contract design choices, such as ownership structures, risk allocation, institutional setups, financial arrangements, procurement, pricing, etc.

Based on this theoretical background, the two major objectives of this report are therefore:

- To integrate research performed in the previous Work packages.
- To devise strict guidelines for the elaboration of the Case Studies and Simulations of WP 5.1. envisaging to compare conventional pricing practices with the simulation of what would happen if it would be replaced by SMC pricing, in order to conclude about the level of financing thereby resulting

This may be considered as a major milestone of the whole project towards the end of the ENACT project, by allowing a better perception of what is at stake at both a theoretical level and practical level, whenever SMC pricing in PPPs is considered:

(i) from the perspective of the incentives generated (created) by each PPP contract between two distinct but rational agents (the state and the private companies) with conflicting interests (the state primarily wishing to maximise social welfare and the private companies wishing to maximize profits) and asymmetric information, and

(ii) from the perspective of the financial markets' perception and valuation of risk and, consequently, from the ability of the private party to raise, profitably, adequate financing for the project.

1.2 Structure

In order to achieve the objectives above, this report is built around four sections with the following contents:

- Chapter 2 - Theoretical integration of previous research
- Chapter 3 - Development of analytical sub models and requirements for case studies
- Chapter 4 - Simulation Model Application
- Chapter 5 - Conclusions

These sections meet the ENACT Deliverable 5 tasks (Task 5.1 to 5.4) on the Integrations of Theoretical Framework SMC issues in the scope of Public Private Partnerships in transport infrastructures.

2 INTEGRATION OF PREVIOUS RESULTS

As described above, a major objective of Deliverable 5 is to promote the integration in a consistent document of all research performed in the previous Work packages. This is a major milestone of the project, allowing a better perception of what is at stake at both a theoretical level and practical level, whenever SMC pricing in PPPs is considered. In that sense, and also in view of the development of the simulation tool in WP5, it is important to start by noticing that the context in which SMCP is unfolding has evolved from a theoretical viewpoint towards the creation of the conditions for its practical application. This justifies that the spotlight is now put in the SMCP implementation aspects, while ensuring the coherence with the SMC fundamental principles.

This chapter includes therefore the systematization and a concise and general overview on the main theoretical findings of the research undertaken in the previous work packages. Useful lessons on how to integrate the complementary theoretic analytic modules are integrated from past research, towards the development of an applied modelling tool. As such, it constitutes itself as the main theoretical framework for the elaboration of the Case Studies/Simulations.

In view of the above, Chapter 2 is structured in three sections:

- Section 2.1 describes the main results of the work previously undertaken in relation to Social Marginal Cost Pricing
- Section 2.2 describes the importance of adopting a sensible approach to Incentive and Contract Theory in SMC Pricing Schemes, in view of developing an integrated perspective to SMC pricing compared to conventional pricing when incorporated in Public-Private Partnerships (PPPs).
- Section 2.3 describes Financing and Risk Issues in PPPs, addressing the financial structure of PPPs and the risks entailed, which constitute closely related topics.

2.1 Social Marginal Cost Pricing in PPPs

In previous reports of this project, namely Deliverable 2, we have reviewed both theoretical and practical issues regarding the application of SMCP pricing schemes. That part of the work, which was mainly based on desk research upon published information, represents a major share of the background knowledge upon which this Deliverable 5 is now developed, as it provided:

- An outlook of the ongoing theoretical discussion on the use of Social Marginal Costs (SMC) as a basis for an efficient charging system and second best pricing alternatives
- Ways to define SMC schemes in support of the simulation model completed in WP5

- A thorough discussion about the possibility of an effective generalisation procedure to extend estimated marginal costs values to different contexts;

The next sections will recap the major conclusions taken from WP2, with a view to the practical exercise of trying to establish in this report a sound comparative methodology addressing the impacts of adopting conventional pricing in PPPs against SMC pricing regarding transportation infrastructures.

2.1.1 Theory and Reality

We have recalled in D2 that welfare economics looks upon price as a method of resource allocation which maximises social welfare rather than simply the welfare of the supplier. The price that maximises the social welfare is the price at which marginal cost is equated with demand, so theoretically social welfare is maximised whenever price is set equal to marginal cost.

The social efficiency requires that users pay for all the internal and external marginal costs that they impose to society, and therefore an efficient structure of charges should be able to confront users with the social marginal cost linked to their decisions. In the case of transport infrastructures, social marginal costs comprise:

- The producer marginal costs (e.g. infrastructure wear and tear. For example on the road sector, heavy good vehicles damage increases as the fourth power of the axle weight);
- The marginal external costs (e.g. congestion costs, environmental costs, external accident costs): i.e. those costs generated by the transport activities that do not fall on those individuals whose choice have caused them, but on other individuals or on society as a whole. Congestion externalities arise when higher traffic flows lead to lower average speeds and higher travel times and costs per kilometre: additional traffic imposes an external cost on all other users. Accident and environmental externalities affect non-users as much as users.

In general, the rules of SMC pricing assume that all complements, substitutes and inputs to the transportation service are also priced at marginal cost. However pricing a service at marginal cost might not be optimal if at least one potential complement, substitute or input is not also priced at its marginal cost (Lipsey and Lancaster, 1956). In addition, several theoretical demonstrations have shown, that, among others, the following conditions should be met, to validate the SMCP:

- Markets should be fully transparent and competitive (firms act as price-takers);
- Cost functions should show no increasing return to scale and must be differentiable;
- There should not be any information asymmetry.
- Absence of transaction costs
- Lump sum taxes for a welfare-neutral distribution of profits or financial burdens exist
- Cost and preference functions of all actors are known by all market participants
- The state acts fully benevolent and users act fully rational.

These situations are often referred to as "first best", and are hardly met completely[1]. The existence of additional constraints to the "first best" approach thus lead to the sub-optimality of SMCP implementations, making it necessary to amend the simple SMCP rule.

Second-best policies are considered for when it is not possible to set prices equal to social marginal costs due to the presence of constraints within the transport sector or distortions elsewhere in the economy.

The distinction between first-best and second-best pricing relates to the fundamental distinction in economics between first-best and second-best *optima*. The former defines a full optimum; the latter are based on realistic representations of available or existing technologies, legal and institutional frameworks (structures, systems) as well as barriers and all other conceivable constraints on practical pricing policy. Also a difference between first and second best is that first-best SMCP needs to differentiate strongly between time, location and user/vehicle. Any way of aggregating charges already constitutes a second best alternative.

Along with the theoretical considerations detailed in D2 regarding SMC pricing of transport infrastructures, a major issue that becomes fundamental in setting up a comparative ground between SMC and conventional pricing is to understand each of these frameworks and respective implications in terms of cost recovery capability.

As described in D2, both the implied violation of the constant-economies-to-scale assumption and the introduction of discrete capacity will lead to a break-down of the self-financing result, with implications in terms of feasibility of "optimal" SMC pricing in real world conditions. This is a major SMC pricing constraint in view of the participation of private sector in the provision of transport services, which is the testing case in WP5.

While it is acknowledged that cost recovery may be set as a constraint is such arrangements, whether infrastructures are public or private, whenever the private sector is involved, cost recovery becomes a fundamental feature. This can be achieved either through user charges alone or a mixture of user charges and government subsidy. Nevertheless, the implications are that SMC pricing may give rise to either surplus or deficit in revenues compared to infrastructure costs while there is no guarantee that the total revenues from social marginal cost pricing are sufficient to cover all infrastructure costs.

This is acknowledged by the EC, by stating that in the case when social marginal cost pricing "*is not sufficient to fully cover infrastructure costs (i.e. in case of high fixed costs or low traffic density areas) and if this is considered necessary, complementary approaches can be implemented*" (DGTREN Preparation of an Impact Assessment on the Internalization of External Costs).

In line with the above, the most common SMC alternatives have been discussed in D2, namely:

[1] Rothengatter (2003) states that none of these conditions is met in real markets and thus the theoretical welfare gain will never be achieved. However, prices close to SMC provides valuable information for designing incentives for more sustainable user behaviour.

- Short Run Marginal Cost with markups
- Ramsey-pricing,
- Multi-part Tariffs.

These issues have been generally embedded in the approach adopted in WP5, whereas the ambition of comparing conventional vs. SMC pricing approaches using a pragmatic simulation model (as it is the case in D5) implies adopting a feasible, yet methodologically correct, SMCP approach to evaluate consequences on revenue levels.

2.1.2 Schemes Overview by Mode

The findings of the project support the notion that the applicability of social marginal cost pricing is prevented by technical barriers, with data availability being the most evident one. In this respect, ENACT produced a synthetic overview of the existing pricing schemes per mode with the objective of studying the applicability of SMC from an empirical viewpoint for the development of the simulation model. The project has assessed existing pricing systems upon case studies comparing the following aspects:

- The coherence with the social marginal cost theory;
- The capability of fully costs recovering and involving private funds;
- The possibility of transferability of the pricing method to other countries, overcoming the national specificities.

For each mode the availability of data to develop an updated and thorough analysis was discussed based on existing literature and comparing with previous research projects in order to identify the way to go forward towards a more empirical and pragmatic approach to SMC pricing. The pricing schemes were selected and compared in WP2 in their capacity for complying with the cost recovery requests in view of PPP schemes, attracting private investors without disregarding the social component of the transport provision, such as the internalisation of external costs of transport through the modulation of tariffs. The results have shown that the existing second best pricing solutions seems to be more appropriate for cost recovery needs, even considering possible Public-Private Partnership solutions, as summarised below in relation to the COHERENCE and COST RECOVERY review.

2.1.2.1 Road Sector

Regarding the cross analysis, the six case studies developed in WP2 have shown little COHERENCE with the SMC pricing principle. Despite the differences between countries and some growing interest in SMCP due to environmental concerns, the main findings of the survey were that the schemes rarely rely on SMC, but rather on financial concerns and are based on second best solutions and average costs (ECOPLAN, 2002). With an exception for air pollution, noise and accidents costs in Switzerland and the congestion costs in some motorways in the Paris region (where experiments of tariffs modulation according to time are in progress), the pricing schemes do not expressly take into consideration external costs.

Nevertheless, some elements of SMC pricing can be found such as distance-based heavy goods vehicle charging systems, which, in comparison with the traditional matrix-based pricing systems have the advantage of allowing a more rigorous application of the user pays principle for “getting the prices right”, i.e. making the users pay for the costs they cause. Other examples of SMC like pricing schemes include the distance-based system of Switzerland, Germany and Czech Republic of the HGV tariff differentiation by emission category (Euro class), taking indirectly into consideration the environmental costs, in addition to the infrastructure ones, while the distance-dependent Swiss Heavy Vehicle Fee (HVF) applied to the whole network (including local roads) that differentiates polluting trucks partially meets one of the basic requirements of SMCP.

Regarding congestions costs, we have seen that the French experience of motorway charges modulation according to time takes into consideration the congestion level. On several tolled motorways in France toll levels are differentiated during holiday season to spread returning traffic more evenly over the day, with tariffs modulated according to peak and off-peak hours.

Regarding COST RECOVERY, all the case studies have shown that road tolls are primarily aimed at the cost recovery of infrastructure or even to ensure cross subsidisation of other modes, as it is the case in Switzerland (where the HVF has the objective to raise revenues to finance large scale railway projects), Germany (the LKW-Maut is set to raise revenues to finance new transport infrastructure road, rail, inland shipping).

In countries with conventional road pricing system, such as Italy and France, toll rates are set to contribute to finance the total cost, including investment and return on investment for the concessionaires. This seems to be a major driver for the rising number of projects with Public-Private Partnership all around Europe, considered as an answer to the problem of increasing deficit in the budget of the transport sector.

Finally, in terms of PPP in infrastructure financing, the German experience seems to be the best practice, whereas the German government allowed the private financing of road infrastructure (motorways, tunnels, bridges, alpine passes) with the Private Sector Funding of Trunk Road Construction Act in 1994, involving private resources in pursuing an integrated policy to link transport modes through two types of private financing models made to entrust a private operator to run the system[2].

2.1.2.2 Rail Sector

Regarding the theoretical methodology coherence, and judging from the selected rail case studies we could conclude that Marginal Cost pricing is usually advocated in order to encourage efficient use of the railway network. However railways tend to exhibit economies of density and so, the marginal cost of extra network utilization is below the average cost. Thus, full cost recovery cannot be achieved through (simple) marginal cost pricing. The review revealed that two main alternative pricing principles are applied: marginal cost pricing with markup (MC+) which is applied only in Germany and Italy and the pricing to recover full cost less government grants (FC-).

Both MC+ and FC- are aimed at full cost recovery less government grants; however the MC+ approach, being based on marginal cost pricing, is viewed as less distorting in terms of incentives.

Maintenance, renewals, train planning and operations, congestion and scarcity, accidents and environmental costs are used as the cost base to determine both social marginal cost (in the MC and MC+ approaches) and average cost (in the FC and FC- approaches). We have also seen that no country charges for all of these categories but all countries (except Italy) charge for maintenance expenditure. Some even charge for train planning and operations. Charges for congestion and scarcity, accidents and environment are only undertaken by a minority of countries. Only in Sweden environmental/accident costs are included in the charging methodology, while scarcity/congestion costs are taken into account in France and Germany.

Regarding COST RECOVERY and involvement of private funds, in most cases the revenues only recover part of the total costs of railway transport infrastructure. As pointed in WP2, there are few PPP projects compared to the road sector. Notwithstanding, in all monitored countries there is a growing number of PPP rail projects in the preparatory or realization phase. In most cases, these ventures provide a special service that is somehow differentiated from the rest of the network operation.

Despite the efforts undertaken by the European Commission to promote a harmonised charge approach throughout Europe, a range of different pricing regimes is being introduced differently in the Member-States.

2.1.2.3 Air Sector

Data on tariff structures was basically available for all airports in WP2. Together with the ICAO Aircraft Emissions Database operated by the Swedish CAA, it was possible to perform a detailed analysis of actual tariffs by aircraft type. To compare them to marginal cost structures, information

[2] Contracts awarded so far are running into difficulties and thus many of the envisaged new PPP projects are delayed or cancelled.

of local marginal cost estimates is needed, but they are extremely sight specific. While for many airports local studies at least for noise and air pollution exist, for the course of this stud only information for Frankfurt airport have been accessible. In any case, it was interesting to see that in most cases combined noise and emission related landing fees are applied. In this respect all pricing systems seem to comply with the principles of social marginal cost pricing. However, in most cases, aircrafts and their engine types are clustered into more or less broad classes of noise or NOx emissions, lacking detailed and actual information, with the exception of Sweden, which shows that it is viable to improve on this particular issue.

Concerning the case studies on congestion charge, it is common sense that airport slot charges should take into account the costs of delayed flights from other than the priced aircraft's airline. Consequently, charges should not only vary with the length of queues at airport but also with the size of the carrier. However there is an argument that such system might hinder the sector competition, by giving a considerable advantage to airlines with a high share of flights at the airport, which makes the market entry for small airlines more expensive. Indeed, when operating an additional flight, big airlines origin delays on themselves which means that they already internalise their congestion costs.

Regarding COST RECOVERY and involvement of private funds, we have seen that in both the Swiss and the German case, emission charges are part of the MTOW (Mean Take-Off Landing) dependent landing fees, designed to cover the full economic costs of operating, maintaining and expanding the airport (ICAO). In other cases these costs include obligations of the airports to finance nature rehabilitation programs and in others the externality charges are levied on top of the full cost based infrastructure costs. Thus, in all cases the coverage of total airport infrastructure costs is guaranteed.

In this respect ENACT could not state any clear preference for one specific scheme from the perspective of cost coverage. For acceptability issues, however, an emissions charges scheme seems the most transparent as it earmarks the use of the revenues for environment related purposes.

As far as noise surcharges are concerned virtually all airports have some kind of noise abatement in operation, which is financed through the revenues of the noise surcharges.

The findings suggest that the introduction of social elements in airport user charges does not reduce the attractiveness of airports for private capital involvement as it is demonstrated by German airport operators having or envisaging private capital involvement.

2.1.2.4 Maritime / IWT Sector

The three case studies analysed in D2 (Norway/Coastal freight trade, Sweden/Port of Norrköping and Netherlands/Amsterdam-Rhine Channel) have shown little coherence between the charging methods of waterborne transport and the principle of SMC pricing. In most cases the use of

infrastructure is charged according to average cost, with cost coverage being the major concern in relation to charging policies for municipalities and private entities (port owners). Yet, several elements of "second-best" solutions have been identified, with the size of the vessel being the differentiating feature for charging. Nevertheless, the marginal costs and the variable part of the charges have little in common, while only fuel charges are able to somehow reflect the marginal costs.
Although sound from a theoretical viewpoint, the fact is that the level of charges is rather low to reflect calculated marginal environmental costs. Only a few cases feature environmentally differentiated charge levels linked to the emission of CO2, sulphur and NOX from the fuel and also port congestion, supporting the principle of SMC pricing, while in other cases the average cost pricing of the services of ports and locks contain a weak element of SMC pricing.

Regarding full cost recovery and involvement of private funds, we have seen that most ports are separate economic entities owned either by the municipality and/or private shareholders. Cost recovery is therefore essential, becoming the main principle of all port charging practices reviewed.

To adopt SMC pricing principle would require much more information than what is currently available to estimate the marginal costs involved in the Maritime Sector, and therefore remains as one the major drawback regarding the development of the simulation model. Nevertheless, the project has adopted all information available and collected in this respect allowing to build a working simulation model that could be further improved.

2.1.3 Integration of Results

Though a large number of studies has come up with the proof that social marginal costs can be estimated, the available set of cost estimates is neither complete (all modes, all relevant cost types) nor robust enough (large uncertainties) to claim that the welfare optimising prices are known. Indeed, ENACT has shown that a number of barriers for SMCP implementation remain. They refer to technical, organisational and institutional issues, including the need for a variety of methodologies to estimate the social marginal cost and to overcome difficulties in the availability of appropriate data.

The case studies have also shown that the main objective of the implemented pricing schemes among all transport modes is the cost recovery to face the financial constraints. However the degree in which the costs are covered by the charge revenues is frequently insufficient. Moreover, the empirical applications made clear that existing second best pricing solutions seem to be more appropriate for cost recovery needs especially in a context that requires the involvement of private funds. This reminds us that WP5 should depart from the assumption that there is a potential conflict between the interests of private agents investing in transport infrastructures and the implementation of SMCP, to the extent that it will decrease user charges when infrastructures are improved (lower renewal costs) or extended (less congestion). In this sense, second best solutions, taking into account the need for cost recovery, are deemed appropriate in D2 when considering Public-Private Partnership solutions.

The findings and the reflections above call the attention to the need to develop the Simulation Tool by adopting a pragmatic approach differing between cost categories, covering major external costs such as congestion (especially for road transport), with environmental and accident costs assuming an increasing relevance. This was considered in the simulation model, in view of addressing context-specific cost categories in the scope of the case studies, adopting a top-down perspective with specific SMC coefficients derived from aggregated averages.

Although it would have been desirable to avoid generalisations of output values or unit values among source context and countries, the pragmatic objectives entailed in WP5 obliged, however, to base the development of the simulation tool on sound literature sources, available from previous R&D projects, despite the somewhat significant variations across countries. As to congestion, environmental and accident costs, these also vary greatly from context to context. The simulation tool should nevertheless be able to provide default values, which can be replaced by specific figures in each case study and it should be ready to provide a test-bed for simulations of potential conflicts between the implementation of SMCP and the private agent's investing in transport infrastructures.

2.2 Incentive and Contract Theory in SMC Pricing Schemes

In order to develop an integrated approach to Social Marginal Cost pricing compared to conventional pricing it is necessary to identify – from the incentives perspective – the most important issues arising from SMCP or second best alternatives when incorporated in PPPs.
Before suggesting preliminary solutions to incorporate those principles into Public-Private Partnership schemes, it was examined to what extent the introduction of SMC pricing or second best alternatives may or may not hinder the further development of PPP schemes in the transport sector, including taking the players' incentives and the risks involved into consideration. Such preliminary solutions anticipated in D3 are to be further tested and worked out in the Case Studies and Simulations. The topic on "Incentive and Contract Theory" in the scope of SMC pricing schemes gains a particular importance in identifying what might be the impact of a certain SMC pricing practice on the managerial choices of an infrastructure manager, e.g. by avoiding investing on infrastructure in order to seize congestion as a driver to benefit from a non-linear charging opportunity.

This had therefore an impact on the development of the Simulation Tool and respective estimations of the effects of different incentives policies on the behaviour of the affected systems, constituting a crucial matter pointing to the need for regulation and adequate contractual designs. Indeed, as we will see in further sections dedicated to the description of the simulation model, the module on Incentives Analysis will study the incentives posed by SMCP based revenues on the contractor's behaviour, based on specific data introduced, including balancing conflicting drivers of demand variations over the increase and/or decrease of SMCP based revenues.

This is all the more important as it is crucial to understand what are in practical terms the kind of incentives required in the scope of a PPP (consubstantiated in an adequate contractual design) in relation to the "private interest " of the concessionaire/contractor, for instance:

- If the concessionaire/contractor's profit maximization capacity turns to be lower than the capacity of the infrastructure, then it does have an incentive to artificially reduce the infrastructure capacity (e.g. by prolonging capacity reductions due to maintenance works or accidents).
- If the concessionaire/contractor is allowed to increase capacity during the concession timeframe at its own judgment, will it do so on a socially optimum way?
- In the event of a PPP contract for a transport service operation where the concessionaire/contractor has the freedom to increase service frequency and such an action influences social marginal costs, will it do so on a socially optimum way?

2.2.1 SMC Pricing in PPP Contracts

From the incentives' perspective, the research undertaken on arising issues related to the incorporation of Social Marginal Cost pricing (SMCP) or second best alternatives in Public-Private Partnerships (PPPs) suggests that during the course of the PPP-contract, some measure of flexibility is required in the level of the SMC price to take account of changing circumstances (e.g. technological developments, efficiency gains, etc.). On the other hand, only when the PPP generates its revenues directly from user payments, will the introduction of SMC pricing become important, as explained hereunder.

We have also seen that when SMC pricing is implemented as a rigid price regulation, yield management and price discrimination to optimise utilisation of capacity and maximise revenues will not be possible. On the other hand, because of possible returns to scale, SMC pricing may yield insufficient revenues for the private operator to cover all infrastructure costs, calling for supplemental payments from the government.

One of the main issues when incorporating external marginal costs in the price charged by the private operator is that it may produce perverse incentives on the long run. For instance, the private operator will have an incentive to treat one type of user (for which external costs are high) different than another type of user (for which the external costs are low). Furthermore, on the longer run the private party has an interest to keep costs of congestion, environment and accident high. It is possible however to pass the part of the SMC price that should cover these external marginal costs on to the government. The private operator will then receive only the part to cover marginal cost of infrastructure, and perhaps in addition, supplemental payments by the government to cover a possible shortfall in revenues.

However, it may be difficult for a public party to get reliable information on the marginal cost of infrastructure from the private party. When supplemental payments are to be paid to a private operator, a major difficulty remains on how to ascertain the correct height for these payments.

Regarding innovation incentives, SMC pricing may inhibit firms to innovate. Hence, private concessionaires are likely to require to charge above SMC and thus obtain above normal profits in order to take the risks involved in innovation.

Finally, there is a risk that the government's perception of SMC (related to infrastructure costs) may differ from that of a private party, because of a different sensitivity for and appreciation of risks, which will be reflected in a different valuation. This will mean that the SMC will be different when perceived from the private party than when perceived from the government, regarding the non-social SMC components.

It should be noticed that these issues will by and large remain valid (except for the issue on revenue shortfall) when addressing second best alternatives to SMC pricing.

2.2.2 Incentives in the Scope of SMC Pricing in PPPs

We have seen in WP3 that even simple contracts require incentives to ensure that the 'agent' exercises an appropriate amount of effort to achieve the goals set by the principal, i.e. delivering the level of service required as efficiently as possible. In such a situation the principal may simply want to observe the level of service and leave the detail of the basis of pricing to the agent, subject to a regulation on overall price levels. However, when there are more specific policy objectives with regard to pricing, as in the case of SMC pricing, multiple objectives are combined, both with regard to service delivery and with regard to pricing, bringing about more complex incentive issues.

The primary objective of a PPP, however, should be to obtain Value-for-Money in the provision of transport infrastructure and services by creating optimal incentives. Regulating price setting according to SMC pricing in PPPs would be tantamount to introducing another policy objective. Combining the two objectives of generating Value-for-Money on the one hand, and pricing transport according to SMC pricing on the other hand, will create considerable difficulties.

However, some of these difficulties will only be relevant for some PPP-contract types, without affecting all types of PPP. This is the case of several types of PPP founded on performance based payment by the government, according to e.g. availability, usage or service level. When transport is priced according to SMC pricing, it will be inconsequential for these types of PPP. Only when the PPP generates its revenues directly from user payments, will the introduction of SMC pricing be important, and will the issues outlined below be relevant.

Flexibility in the level of SMC price: Over the course of a PPP-contract, many changes will take place with regard to the components that make up the Social Marginal Costs, requiring the incorporation of PPP contractual provisions to regularly review the SMC price and adjust it accordingly. However, with regard to the infrastructure cost component it is important to realise that the private party should be incentivised to implement cost savings, benefiting from the savings it may realise. This means that SMC prices should not immediately be adjusted downwards when infrastructure costs are reduced, but adjustment should proceed slowly in order for the private party to reap benefits from its cost saving efforts. Moreover, the private party will have an incentive not to reveal its true cost level with regard to marginal infrastructure costs in the reviews. Audits, benchmarking and market testing may help reduce to this problem.

Revenue shortfall: returns to scale are prevalent in all modes of transport, thus prices set equal to short run marginal (infrastructure) costs will be below average costs, preventing recovery of all costs. Hence with SMC pricing it may not be possible for a private party to generate enough revenues to profitably operate a PPP. One of the possible solutions is to implement SMC pricing, supplementing any revenue shortfall as a government responsibility, with the problem of revenue shortfall reduced to a large extent by a one-off capital payment at the end of the construction phase.

Perverse incentives: the problem of revenue shortfall may also be (partly) solved by allowing the private party in a PPP to also charge users for the external marginal costs, i.e. the marginal cost of congestion, environment and accident. The private party will not incur any of these costs and hence charging according to the full SMC price will mean additional revenues. However, even once these external marginal costs are incorporated, it is still not certain whether infrastructure costs will be fully recovered. Moreover, it could also be the case that the private party will earn excess profits. The SMCP regimes also provide incentives to reduce external costs and thus the revenue shortfall may re-occur in the long-run. Incorporating external marginal costs in the SMC price to be charged by the private party in a PPP may be undesirable however. It is unclear why the private party would 'deserve' this part of the SMC price, and why charges to users for the costs environment and accident should contribute to infrastructure cost recovery. It should be noticed however, that regarding congestion, it can be considered equivalent to fixed, capacity related infra costs. Under ideal conditions the "cost recovery theorem" (cf. ENACT D2) says that marginal infra costs plus

congestion revenues will equal full cost coverage, but at the cost of excessive state control to enforce "optimal" investment behaviour from the private party. On the long run the private party operating a PPP will have an incentive to keep the external marginal costs as high as possible. Hence, when the level of the SMC price is regularly reviewed and adjusted, the private party may attempt to create extra congestion, effects on the environment, or perhaps even accidents as to ensure that the SMC price is adjusted upwards. A prediction of such possible behaviour will be attempted by the simulation model.
Moreover, including external marginal costs may create other perverse incentives when external costs of one type of user (e.g. trucks in case of road infrastructure) are higher in comparison to other types of users (e.g. normal cars). Since the former kind of user would be more profitable for the private provider than the latter this may influence the private party's behaviour towards the two types of users, producing unwanted effects.

Information problems: Imposing price setting based on SMC pricing in PPPs requires information on the different Social Marginal Cost components. For external marginal costs this information will be difficult to acquire and will involve complex methodological problems. However, for these components, there is no asymmetry of information between the government and the private party. For the marginal cost of infrastructure however – though methodologically less challenging – problems of asymmetric information will be important. The public authority would preferably need clear evidence on SMC from its own sources to be able to apply regulations leading to a desired outcome by ensuring a level of effort which produces the output and price associated with the known level of SMC. However this is often not the case. Moreover, some elements of the infrastructure costs may be lower and some higher due to the differing market conditions in which private and public sector firms operate. Thus, for example, private sector firms may face higher costs of capital, but lower costs of labour and other inputs. Together with other considerations in this respect that can be also found in a rather detailed manner in D3, it allowed to conclude that the information problems surrounding SMC pricing in PPPs seem hard to solve. It will be therefore very difficult to get the information to estimate an adequate SMC price ex ante, and to correctly adjust the SMC price during the course of the contract when circumstances change. Moreover, when SMC pricing leads to a shortfall in revenues, it will be problematic to get the right information on the height of supplemental payments, without independent, reliable, ex ante information on either the level of marginal costs of infrastructure or the cost structure of the private operator (in order to estimate the size of the revenue shortfall).

Impediment to yield management / price discrimination: price discrimination and yield management may have potentially beneficial effects on overall welfare if they lead to a better utilisation of existing capacity and the provision of services which would not otherwise be provided. For instance, a rail infrastructure manager may apply yield management / price discrimination to sell as many of the slots available for a given route and maximise its revenues. Price discrimination and yield

management would be much harder to implement if operators were subject to rigid price regulation based on SMC pricing. Also rigid price regulation will mean the private operate has less instruments available to influence demand. Therefore, transferring demand risk to the private party in a PPP is only efficient when demand is relatively certain (and the private operator hence holds a monopoly in which users have little or no alternative options), or the private party is better able to control demand, e.g. through the quality of its services, promotional activities and/or price setting. Implementing the SMC price as a rigid price will imply that the private operator is no longer capable of influencing demand through price setting. This may therefore also entail that transferring demand risk to the private party will in fewer instances be efficient.
Value of risks / cost of capital: the government's perception of SMC may differ from that of a private party. Most notably, the treatment of risk and the costs of capital may be different in the private sector. The private party will normally be more risk sensitive and in many cases also more risk averse. This will imply that it will value risks differently. The cost of capital will hence also be higher for the private sector than for the public sector. Because a valuation of risks should also be incorporated in the SMC, this means that the SMC will be different when perceived from the private party than when perceived from the government.

Impediment to innovation: SMC pricing could also be detrimental to innovation in PPPs. Firms may require to charge above SMC and thus obtain above normal profits in order to take the risks involved in innovation. Here the problem for the regulator is to determine the extent of deviations from SMC pricing which may be permissible in order to achieve the greater gains from this innovation. Where the public authority is prepared to take a greater share in the risks in the PPP, these deviations from SMC pricing may be smaller. Also here information problems will loom large.

2.2.3 Implementation Issues

The impacts arising from the implementation of SMC pricing in PPPs call for the design of adequate contractual provisions taking into account constraints such as incentives and regulatory framework.
Major issues to be considered include revenue shortfall, perverse incentives, flexibility of the SMC price level, or inhibition of innovation. Although it is possible to anticipate solutions, these often only at the expense of other issues, most notably information problems, since without reliable information available on the marginal cost of infrastructure and on the cost structure of the private operator (which will be the case in many instances), it will not be possible to resolve all the issues simultaneously. As referred in WP3, it is however possible to bypass many of the issues by separating reward from provision and income from pricing. In such a situation the operator is paid according to a performance based payment, while prices are set and received by the regulator, which is the case in PPPs where usage can be registered and observed independently. In such a case, the private party just receives an adjusted price per user for the government, instead of the

SMC price directly from the user. When performance can be described and measured in more detail it will be possible to develop more sophisticated payment mechanisms based on performance (e.g. payment based on availability or service level, bonuses and penalties for specific achievements).

In Europe there are already many PPPs that are based on performance based payments, especially in road and rail infrastructure and in public transport. In road infrastructure there are many instances of PPPs with performance based payments based on shadow tolling, in which the public authority pays the operator on behalf of the individual user. Also payment based on availability are now prevalent especially in road and rail. In addition, net cost contracts are not uncommon in public transport. Fares are then set centrally and operators remunerated according to levels of service provided. The public authority has information on the components of costs and sets prices accordingly; the incentive for the operator is to make efficiency gains to maximise the margin over and above SMC. Since usage can normally be registered reliably in almost all cases, the model of separating reward from provision and income from pricing, can also almost always be applied.

Overall, WP3 concluded that the application of PPPs in the transport sector will not be hampered by SMC pricing, meaning that its adoption should not have to hinder the further development of PPPs in the transport sector. Yet, there may still be circumstances in which direct payment by users is still preferable, even when SMC pricing is implemented. In case users are better able to observe performance and have alternatives to their disposal, the private operator will have adequate incentives to perform well in order to attract as much demand as possible. If the information problems with incorporating SMC pricing into a PPP can be overcome, direct charging of users will then be better than the model of separating reward for provision and income from pricing. These circumstances are most likely to be met in the case of PPPs with regard to airport and port infrastructure and services, because they often face national and international competition, and users are well capable of observing performance.

2.3 Financing and Risk Issues in PPPs

The financial structure of PPPs and the prevalence of risk constitute closely related topics, making it necessary to assess the impact of the financial structure of an infrastructure project on the productive efficiency with respect to risk. Therefore, it is crucial to understand the “financial structuring” of such projects and the economic rationales behind these structures in order to identify and mitigate risks involved in the PPP contractual arrangements.

2.3.1 Financial Structures

We have seen in WP4 that the most important features regarding PPP structuring include:

- The establishment of a separate entity (the “special purpose vehicle” or SPV) for the purpose of the project.
- The high leverage with which the SPV is financed (often 80 to 95% debt).
- The main contractors provide equity in the SPV and thus act as the SPV’s sponsors.
- The equity of the SPV is concentrated in the hands of only a few companies and is privately held.
- The management board of the SPV is affiliated with the sponsoring companies.
- The many parties that are involved and the many contracts that are concluded between these parties.

Installing these features brings with it large transaction costs compared to a situation where a project is on-balance with a company and is financed through corporate finance. Preparing, negotiating, writing and monitoring the many agreements of which the typical PPP structure is made up, can be very expensive.
Nevertheless, in certain cases, this structure can have a number of advantages, which in turn are related to the Theory of Incentives referred in the previous section, namely:

Incentives and monitoring of project management: Because a separate entity is formed for the purpose of a specific project, it is possible to put in place a specific ‘governance system’ for the project. When a project would be financed through corporate finance and would be executed within the parent company’s existing structure, such a ‘tailor-made’ governance system for the project would not be there. Through a number of ways the specific governance system of a PPP ensures that the management of an SPV (and with that the management of the project) is much more prone to act in the interests of the main sponsors. Further details on this issue may be found in D4.

Disciplining of contractors: It is usually not possible to write and monitor sufficiently comprehensive contracts for the main services to be contracted by the SPV. Because the main contractors are also sponsors in the SPV (and are hence so-called residual claimants of the results the project generate), they have an additional incentive to deliver good quality, within cost and on schedule and because there is a separate entity for the purpose of the project, it is furthermore possible to have multiple sponsors sharing in the performance of the project (instead of only one as when the project is on-balance with a company)[3]. Further details on this issue may also be found in D4.

Disciplining of government and third parties: the initial investment in infrastructure that is part of a PPP-project is extremely asset specific: for the infrastructure concerned very little alternative

[3] The example provided in ENACT D4 (p.25) on the “Channel Tunnel” offers an example (albeit a negative example) of how financial structuring can generate (or fail to generate) incentives

revenue generation options exist apart from the one described in the PPP-contract. This means that the private parties in a PPP are susceptible to a hold-up: once the investment has been made they are vulnerable to the government or third parties (e.g. suppliers that supply critical inputs, individual customers that are important for the project) making use of their deteriorated bargaining position (now a situation exists with large sunk costs in which they can no longer threaten not to do the investment). Further details and sources on this issue may also be found in D4

Risk management from a private perspective: another advantage of the typical PPP-structure compared to a situation in which the project is on-balance with a company, is that the damage in case of financial distress caused by the project is greatly reduced. When a project is on-balance and financed through corporate finance, so-called 'risk contamination' may occur: financial problems in one project negatively affect the company's assets and cash flows unrelated to the project. This may bring with it significant distress costs. Default of a corporation will be much more costly than default of an SPV. Restructuring the debt of a corporation or even liquidation of its assets will be a costly affair, whereas for an SPV this will be less troublesome. Also the indirect distress costs can be significant for a corporation when one of its big projects is failing: suppliers and customers may be discouraged to transact with the firm, finance may be much harder to obtain and may only be obtained at unfavourable conditions, etc. These problems will be avoided in case of non-recourse through an SPV. So, overall, we have seen that identifying, analyzing, evaluating and dealing with risks become especially important, because within one project very few possibilities exist for 'positive risks' cancelling out 'negative risks'. Further details and sources on this issue may be found in D4.

2.3.2 Perspectives on Risk Assessment

All projects involve some degree of risks, and PPPs are no exception. In the case of infrastructure projects, these have been so far mostly the responsibility of the government, so an important reason for the government to procure a PPP project instead of a traditional one may be to increase productive efficiency by transferring risks to parties that are most capable of controlling it, minimizing its negative impacts and, ultimately, bearing it. There is a general belief that the contractors of the private sector possess an "efficiency edge", e.g. the qualities to make them able to handle the challenges of all project phases in a better way than the public sector itself or bodies owned by the public sector, despite the fact that a publicly owned agency or construction firm may possess to a large extent the same abilities. However, it is claimed that in many cases it will not have the same efficiency e.g. due to soft budget constraints, ambiguous objectives and the heterogeneity of the public sector (Välilä, 2005).

Also the fact that a PPP project is financed by private capital[4] in the form of loans or equity causes investors and banks to bear the risks related to the project. These risks will have to be assessed and valued in monetary terms, otherwise they will not be embedded in the decisions.
Financial risk has some properties in common with the technical project risks, but there are also some additional 'financial' features that need to be taken into consideration.

Stakeholders and risk sharing: To the extent that risks in PPP are priced more correctly than in a conventional project it is usually expected that it will lead to a higher degree of efficiency both concerning allocative efficiency and productive efficiency. This implies that risk should be transferred to the party that is able to handle it in the best way. If none of the parties can control the risk, it may be shared. This may be settled through contract details, or the contract may be incomplete, leaving the outcome to negotiations. However, there is a chance that too much of the risk is handed to one of the parties. Therefore, it should be considered that transferring all the risk to the party that as the best control of it may not turn out to be the best solution, since it might lead to excessive risk compensation.

Risk management: the risk management process can be said to consist of several stages over the lifetime of a project. A risk management framework, which may be applied to master the risks that are related to a project over the whole of its life cycle, is detailed in D4 and can be described by the following steps: Establish the context, Identify risks, Analyse risks, Evaluate risks, Manage risks.
These risks may be identified by communication and discussions with users, specialists, project managers, government representatives and experienced business colleagues.

Global risks: In valuing risks it is useful to distinguish between risks that can be controlled and risks that are beyond the control of either party. The latter may be called global risk or risk that is external to the project. The global risk is usually impossible or very difficult to eliminate by any of the parties. It includes both systematic and non-systematic risk. Systematic risk includes general business cycles and more specific the demand directed towards the project. Non-systematic risk is related to natural conditions like extreme weather and geological conditions.

Project risks: The internal project risks are under control by the parties. Project risks are related o every phase of the project. Construction risk is an important part of it and includes the risk of cost over-runs as well as the risk of delayed opening of the project. Such risks are often the responsibility of the private partner inasmuch as it may have the best influence over that part of the project[5] . However, systematic risk exists also in the construction phase. Construction costs,

[4] In the case of a joint venture public capital may be engaged as well.

[5] The EVA-TREN project shows, however, that on the basis of world bank project data there is a systematic bias towards cost overruns particularly in the railway sector, due to e.g. hidden agendas and prestige of the public sector.

like wages and material costs are also subject to business cycles. The Principal-Agent theory may be applied to PPP in this case. A solution is to offer a contract that shares the responsibility between the parties by offering a variety of contracts formulated so that it makes the efficient agent choose a contract with a high degree of cost responsibility and the inefficient one choose a contract with a low degree of cost responsibility. The use of incomplete contracts may be of interest here. It is not feasible to contract everything in a project lasting for 25-30 years, and in many cases it is not possible either.

2.3.3 Demand risk in a PPP and Interaction with SMCP

In WP4, ENACT presented a theoretical model for optimal remuneration for building and operating an infrastructure project under different assumptions using optimal control theory. Next we will discuss how this relates to a "real world" PPP project and present some recommendations.

Regarding the influence of SMCP on PPP risks, one trade-off is that the use of SMCP increases the revenue risk from user fees for the private partner. In short, benefits from internalizing the congestion externality are proportional to some power of demand (oftentimes the power of four or even five). So if demand varies, so do congestion benefits but to a much larger extent. Hence, given that revenues are to a large extent user fees, imposing SMCP increases risk compared to some fixed price scheme (for example) and hence a trade-off exists between the risk aversion of the private partner and the correction of the externality. The trade-off is dependent on the existence of the subsidy inefficiency or moral hazard, since otherwise full insurance would be optimal. This aspect deserves therefore an important part of the WP5.1 Simulation Tool.

Overall, the research undertaken in respect to Financing and Risk issues suggested ways to model demand risk in a PPP and how it impacts the design of an optimal reward scheme in the presence of different degrees of risk aversion, subsidy inefficiency and information asymmetries coupled with agency problems. We have also seen that optimal contract is characterized by thresholds dividing different "categories" of lifetime demand states. Trade-offs that turned out to be relevant includes subsidy inefficiencies vs. risk aversion asymmetries as well as incentive provision against risk aversion asymmetries. Secondly it was also highlighted how SMCP interacts with the financial side of a PPP and, thirdly, that a flexible contract length might be undesirable as it may impose additional uncertainties not easily accountable in a model.

On the other hand, availability payments seem preferable compared to "shadow toll" contracts, otherwise it would impose demand risk on the private partner alone. For such cases, which well may be the majority of current road projects, it is advisable to decouple "User Charging" based on SMC from the actual remuneration of the PPP contractor. Also when user fee revenues and subsidies are paid to the contractor/concessionaire depending on realized demand, a risk transfer will occur.

However, one should not rely solely on user charge revenues since this imposes too much risk on the private firm and these results are valid irrespective of the pricing scheme in use. Moreover, f demand is such that expenses are not covered, transfers of financial resources from the government to the concessionaire will necessarily occur, inasmuch as they may be justified by the estimated non-tangible benefits for users and non-users, requiring a careful cost benefit assessment. Paying a subsidy to give the right incentives to the users as well as the PPP contractor may often be a reasonable price to pay in this respect.

3 DEVELOPMENT OF ANALYTICAL SUB MODELS AND REQUIREMENTS FOR CASE STUDIES

3.1 Introduction

This chapter provides a description of the methodologies behind the analyses to be made in the scope of the case studies in WP5.1. Data collection requirements may vary depending on the methodology chosen. The ENACT Simulation Tool, for which a practical description is provided in Chapter 4, consists of three main analyses:

- SMCP Revenue Accounting
- Financial and Risk Analysis
- Incentives Analysis

SMCP Revenue Accounting consists on an estimation of the revenues drawn from a social marginal cost pricing scheme.

The Financial and Risk Analysis examines whether these revenues are enough to pay for the concession remuneration. This also includes the analysis of the risk and respective risk premium posed by the risk towards revenues of making these dependent on the social marginal costs incurred by the correspondent transport activity.

Finally, the Incentives Analysis calculates the contractor's *profit maximization capacity* which will allow taking inferences on expected behaviour of the contractor and consequently on adequate remuneration schemes and attribution of responsibilities.

The methodologies and data requirements[6] for case studies, associated with the three features afore mentioned are detailed in the following sections. Prior to these, general notes on the goals of case studies are given, specifying their framework of analysis and expected results.

3.2 General notes on the goals of case studies

The challenge behind the design of a PPP it is to conciliate social objectives with the objectives of the concessionaire. Applying SMCP is an additional constraint within it. The case studies should be able to identify major elements of disturbance posed by SMCP in conciliating social with private party objectives. Like in all PPP's, those involving SMCP face various alternatives of contractual design. A few are particularly relevant within the scope of application of SMCP in PPP infrastructures, namely:

- Who gets revenues from SMC pricing?

[6] Data requirements for case studies are signalled in this chapter as grey shadowed fields

- Which complementary instrument(s) of cost recovery to apply?
- Whether and which kind of performance incentives to apply?

The choice between the multiple available alternatives of PPP contractual design should focus on the optimization of some objective, which in fact must cover an aggregation of several objectives. The objectives present in conventional PPP's are those of providing the desired service with the least possible cost, i.e. getting the highest possible value for money. In PPP's with SMCP an additional objective is introduced of optimizing infrastructure user behaviour from the social point of view.

None of the conceivable PPP design alternatives does without its costs over one or several of the three mentioned objectives. Not giving performance incentives may render an inadequate behaviour from the concessionaire, but giving performance incentives does imply monitoring costs. In case SMCP revenues are not sufficient for cost recovery, applying a 2nd best SMC pricing scheme affects the efficiency of user behaviour, while remunerating the private party with subsidies has operational and economic costs related to the collection of the necessary public funds. Letting the public instead of the private party collect the revenues from SMCP may prevent inadequate behaviour from the private party and also reduce its demanded risk premium, but in return implies again the use of costly public funds and returns uncertainty of fiscal revenues (i.e. a public risk premium). The figure at the end of this section maps the main possible choices concerning PPP design in the scope of SMC pricing. Before all the existent trade-offs, maximizing the social benefit out of the PPP design requires the choice of design alternatives to rationally fall over the one with the lowest overall costs.

The ENACT Simulation Tool seeks to assist the analysis to be made in the case studies by providing quantitative results which should allow to evaluate major problems of SMCP and test some possible solutions. Such quantitative results are, in particular, expected to provide indications on the practical feasibility of applying SMCP in the PPP's covered and guidance on necessary PPP specifications to conciliate SMCP application with a socially desirable economical and operational performance of the PPP.

Such goal probably may be successfully achieved in different ways in different PPP's. The ENACT case studies should explore alternatives of SMCP PPP schemes and analyse their performance over the social objectives of service quality, minimal service costs and infrastructure user behaviour optimization. With that aim, the ENACT Simulation Tool will provide guidance by:

- Estimating revenues generated by SMCP and evaluating economic feasibility of the private party with SMCP revenues, assessing the need for complementary instruments for cost recovery

- Evaluating the risk premium demanded by the private party by virtue of its SMCP revenues and compare it with the risk premium that would be demanded in a conventional demand-based revenue scheme
- Assessing the direction of incentive of the concessionaire over the level of capacity of the infrastructure, and consequently predict its behaviour both to maximize infrastructure availability and to expand capacity.

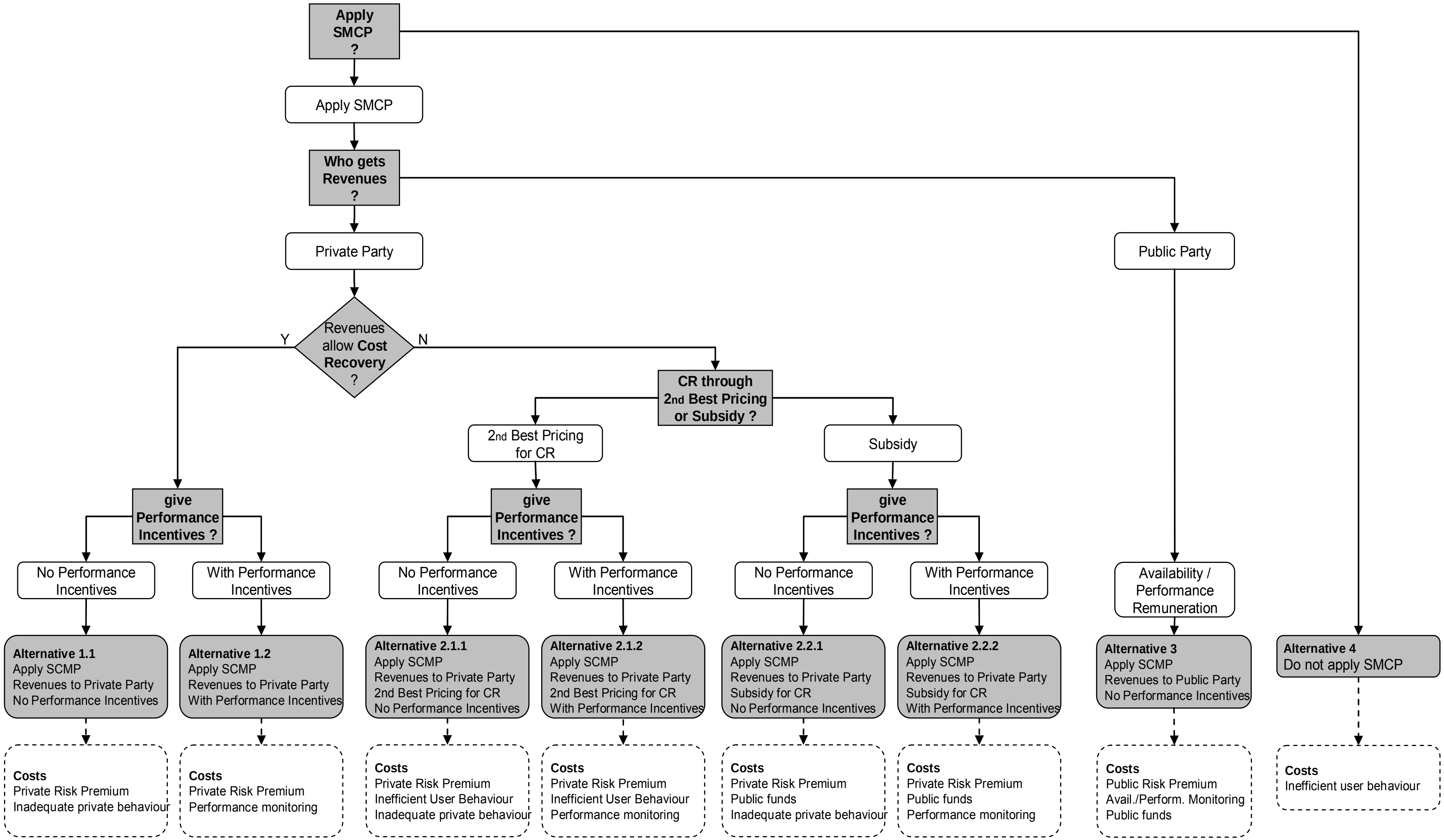
However, as an instrument for analysis, the simulation tool does not by itself give final answers. In this, the case studies will still require interpretation of results and discussion over the possible effects of various PPP design alternatives over the relevant costs/benefits stated above on the studied PPP. Answering the primal question of which best PPP design would best achieve the accomplishment of social goals, the case studies will clear up issues and suggest which kind of design alternatives may be most appropriated for each case, identifying conditions for their success.

In addition, the case studies should check for schemes, devised in the present PPP's under study, to face the problem of conciliating public with private objectives. Possible examples of such design schemes are:

- Monetary incentives associated with high transport activity levels
- Sharing of unexpected deviations from predicted revenues
- Incentives associated with number of accidents
- Penalties for temporary capacity reductions

The information on solutions of PPP design will provide examples and possibly best practices of how issues of risk allocation and incentives can be contractually handled, providing insight on how the same kind of issues might be solved in the realm of SMCP PPP's. In particular, the case studies will look into performance-based remuneration schemes or identify reasons behind the devised risk distribution schemes.

Figure 1 - Decision tree of PPP design in the scope of SCMP pricing



3.3 Dealing with Social Marginal Cost Pricing Revenues in the Simulation Tool

3.3.1 Methodology

The simulation tool features the estimation of revenues generated by SMC pricing for comparison purposes with conventional approaches derived from the case studies. In doing so, it departs from a top-down approach with revenues being estimated on the basis of the aggregate social costs incurred by demand using the infrastructure. This was done without the specific knowledge of specific SMC-based tariff structures, assuming that whatever the tariff structure to be later used, it should however produce revenues similar to the social costs incurred by transport activity.

Real SMC are approached best when cost calculation is highly differentiated by user groups, vehicle technology, type of infrastructure, time and location. In order to limit the costs of data collection, the revenue accounting options proposed in the ENACT revenue estimation tool have limited requirements. Further refinement is nevertheless viable, depending on the data obtained and the progress of the case studies in WP5.1.

The calculation methodologies proposed in the simulation tool for revenue accounting are based on top-down social marginal cost accounting formulations based on various sources:

- Methodologies proposed in Work Package 2 (Deliverable 2-II) with empirical quantification of cost parameters
- Other methodologies available in the literature with empirical quantification of cost parameters (mainly extracted from IMPACT[7])
- Other proposed methodologies, potentially prone to parameterization and useful for the case studies

The top-down calculation of SMCP revenues requires data on transport activity in the infrastructure as well as the parameterization of the social costs implied by that activity. For the sake of simplicity and testing, for each mode and cost category the tool provides alternative default SMCP revenue accounting Options, based on the proposed revenue accounting methodologies.

For each mode and social marginal cost category, the default revenue accounting Options comprise the following elements:

- A **bottom-up** SMCP revenue accounting option, which theoretically would perfectly calculate social marginal costs user by user. This option is not intended to be strictly applied by the case studies given that the implied disaggregated level of information should not be attainable. However, it is provided as a reference for possible bottom-up

[7] Internalisation Measures and Policies for All external Cost of Transport (2008)

cost/revenue accounting schemes, designed by the case studies in accordance with their availability of information and other specificities.
- At least one **top-down** revenue accounting methodology option, based on the sources indicated above. The case studies will later provide data for at least one of the revenue accounting methodology options proposed, unless they propose themselves an alternative adequate revenue accounting option.

Despite proposing concrete revenue accounting formula options, as implied from the above these should not be considered as fixed methodologies by the case studies, which may later apply alternative cost/revenue accounting methodologies. This way the simulation tool is able to provide flexibility as to the applied revenue accounting schemes, while allowing the user of the tool to straightforwardly establish and apply revenue accounting specific options adapted to the case study concerned. This is all the more appropriated if the data available from the case study does not suit the methodologies proposed as default. This means that during the development of the case studies it will be always possible to propose appropriate alternative SCMP revenue accounting options (formulas and input sets), provided that:

- The alternative SMCP revenue accounting methodology is valid for its own purpose, i.e. that the total calculated revenue is expected to equalize the sum of social marginal costs caused individually by all the users of the infrastructure.
- Empirical parameterization data for social marginal costs is available (within the case studies or from other sources)

The instructions/directives for case studies on how to consider SMCP revenue accounting are thus to either:

- Obtain data requested by at least one of the SMCP revenue accounting options provided in the tables below, or else
- Propose a valid alternative SMCP revenue accounting option and obtain its data and parameterization for the case study concerned.

For comparison purposes and whenever additional data is available, it is recommended to experiment more than one methodology to allow discussing about the outcome of different settings.

Expected variations in time of variables included in the cost/revenue accounting methodological option applied by the case studies will be provided be these. This is an essential input from the case studies for demand related inputs (e.g. vehicle-kilometres), while for cost parameters (e.g. emissions/vehicle-kilometre) general assumptions on time variations may be adopted should case studies not produce case-specific expectations.

Default revenue accounting options – description and directives

The default revenue accounting methodology options are depicted in several reference tables included in the following sections, per mode and cost category. These tables contain descriptions and directives for application within case studies (CS). Several options are considered and duly characterized in terms of the variables and formulas used to estimate SMC revenues.

The following "table-template" illustrates the proposed methodology:

Table 2 - Table-model of the SMCP revenue accounting methodology options proposed for the CS

<table>
<tr><td rowspan="3">Option</td><td colspan="6">Option 1</td></tr>
<tr><td>Name</td><td colspan="2">Description</td><td colspan="2">Source</td><td>CS data request?</td></tr>
<tr><td>Name of the option.</td><td colspan="2">Description of the option.</td><td colspan="2">Source of the option both in terms of its basic cost accounting function and the quantitative values of its parameters.</td><td>Statement of either data corresponding to the option is requested from CS</td></tr>
<tr><td rowspan="4">Variables</td><td>Type</td><td>Name</td><td>Description</td><td>Unit</td><td>Value</td><td></td></tr>
<tr><td>Statement of the type of variable.</td><td>Name of the variable
(with statement of related dimensions)</td><td>Description of the variable.</td><td>Measure unit of the variable.</td><td>Value of the variable.</td><td>Specification of requirements concerning data collection by the CS, for each variable.</td></tr>
<tr><td colspan="6"></td></tr>
<tr><td>Dimensions</td><td>Variable dimensions</td><td colspan="4">Entries of variable dimensions</td></tr>
</table>

Multi - Option Fields

<u>Name</u>: name of the option.

<u>Description</u>: description of the option.

<u>Source</u>: source of the option both in terms of its basic cost accounting function and the quantitative values of its parameters.

<u>CS data request</u>: statement of either data corresponding to the option is requested for case studies or not. Even if the field statement is "yes", data provision is not compulsory as long as data for another revenue accounting option is provided. This field is marked in grey colour whenever data is requested from case studies.

Variable fields

<u>Type</u>: statement of the type of variable, which can be either an "input" or a "parameter". Inputs relate to specific data of transport activity and its characteristics (e.g. "vehicle-kilometres of passenger cars") and parameters establish the relations between inputs and SMCP revenues.

<u>Name</u>: name of the input. Some variable names are followed by one or several fields inside round brackets, which happens whenever the variable is not a scalar but an array or matrix variable. For

example, the parameter variable *emission vkm passenger car (day period)* is an array variable with dimension *schedule*, a dimension which contains entries *day*, *evening*, *night*. This implies that in this example the case study must provide information of the number of vehicle-kilometres of passenger cars discriminatively in the schedule sections of day, evening and night. Description: description of the variable. Unit: measure unit of the variable. Value: value of the variable. This field only applies to parameter variables and is attributed whenever information is available in literature and generally applicable outside the framework of the case studies. CS data request: this field specifies which variables are either compulsively or facultatively requested or not requested for the case studies, if case studies do apply the option concerned. This field is marked in grey colour whenever data is requested from case studies. Dimensions: Variables can be scalar, array or matrix variables. When the proposed options have dimensional variables, the entries of the dimensions are specified in this field. E.g. a dimension called *area type* may have entries *inside settlements, outside settlements*. In this case, the case studies will provide three values for the concerned variable, one for each dimension entry.

List of abbreviations for SMCP revenue accounting tables
CS – case study SMC – Social Marginal Cost SMCP – Social Marginal Cost Pricing tbd – to be determined vkm – vehicle-kilometre

3.3.2 Road

3.3.2.1 Infrastructure

Table 3 - Road infrastructure SMCP revenue accounting Bottom-Up Option 1

Option 1					
Name	**Description**		**Source**		**CS data request?**
Bottom-up approach	Perfect SMCP		-		no
Type	**Name**	**Description**	**Unit**	**Value**	
input	load factor (vehicle, trip)	Load factor of each vehicle-trip (e.g. gross-tonne km and/or axle-load km).	load unit	-	-
input	vkm (vehicle-trip)	Number of kilometres of each vehicle-trip. For the same reason as above, this is an array variable.	km	-	-
parameter	renewal & maintenance costs	Renewal and maintenance costs per unit of vehicle load-kilometre.	€ / load unit.km	-	-
parameter	other costs	Other costs as a function of vehicle-trip and/or vkm and/or vehicle load. e.g. Turnpike costs.	€ / unit(s)	-	-

Dimensions	vehicle-trip	array of vehicle-trips (a vehicle-trip refers to the combination of a trip with a specific vehicle, being characterized by the km realized and the load unit of the vehicle)

Note 1: The application of such a perfect SMCP pricing scheme would imply the knowledge of an exact load factor of each vehicle in each trip and that load factor would have to be perfectly related to infrastructure costs through the expressed parameters.

Note 2: Theoretical perfect SMCP bottom-up approaches like this one (one is presented for each mode-cost category) may present theoretical concepts like "load factor" without specifying exactly its practical meaning (which could be e.g. "vehicle weight", "axle-load", or a mix of box). In fact, as mentioned above, the objective of presenting this type of options (always referred to as Option 1) is merely for reference purposes; therefore the exact specification of the formula variables in not essential and should not become a source of questioning during case studies data collection.

Table 4 - Road infrastructure SMCP revenue accounting Top-down Option 2 (CS data requested)

Option 2					
Name	**Description**		**Source**		**CS data request?**
Top-down approach - Average costs per vehicle class	Average costs per vehicle, per vehicle class		ENACT D2-2 p.20, UNITE - D15 (2003)		yes
Type	**Name**	**Description**	**Unit**	**Value**	
input	vkm passenger cars	Number of passenger car vehicle kilometres	vkm		yes
input	vkm light duty vehicles	Number of light duty vehicles (<3.5t GVW) vehicle kilometres	vkm		yes
input	vkm heavy duty vehicles	Number of heavy duty vehicles (>3.5t GVW) vehicle kilometres	vkm		yes
parameter	cost passenger cars	Marginal costs of passenger cars per vkm	€ / vkm	0,00108	if available
parameter	cost light duty vehicles	Marginal costs of light duty vehicles per vkm	€ / vkm	0,00128	if available
parameter	cost heavy duty vehicles	Marginal costs of heavy duty vehicles per vkm	€ / vkm	0,04684	if available

3.3.2.2 Congestion / Scarcity

Table 5 - Road congestion/scarcity SMCP revenue accounting Bottom-up Option 1

Option 1					
Name	**Description**		**Source**		**CS data request?**
Bottom-up	Perfect SMCP		-		no
Type	**Name**	**Description**	**Unit**	**Value**	
input	delays (vehicle-trip, road section)	Time delay caused to other vehicles by each vehicle in each road section.	hours	-	-
parameter	value of time	Average value of time per vehicle.	€ / hour	-	-

Dimensions	vehicle-trip	array of vehicle-trips (a vehicle-trip refers to the combination of a trip with a specific vehicle, being characterized by the exact delay time caused to other vehicles in each road section)
	road section	array of road sections

Note: The application of this pricing scheme would imply the real-time calculation of time delays caused by each vehicle on other vehicles.

Table 6 - Road congestion/scarcity SMCP revenue accounting Top-down Option 2 (CS data requested)

Option 2					
Name	**Description**		**Source**		**CS data request?**
Top-down - average costs per vkm	All day average costs per vkm		ENACT D2-2 p23, UNITE 2003.		yes
Type	**Name**	**Description**	**Unit**	**Value**	
input	vkm cars	quantity of car vehicle-kilometres	vkm		yes
input	vkm HGV	quantity of heavy-goods vehicle-kilometres	vkm		yes
parameter	cost per vkm cars	All day average external equilibrium congestion cost per vkm for car vehicles.	€ / vkm	0,15	if available
parameter	cost per vkm HGV	All day average external equilibrium congestion cost per vkm for heavy-goods vehicles.	€ / vkm	0,27	if available

Note: The congestion cost parameters in this function refer to “equilibrium” congestion costs, i.e. the costs that happen for the flow conditions resultant from the demand equilibrium generated by the application of SMCP.

Table 7 - Road congestion/scarcity SMCP revenue accounting top-down Option 3 (CS data requested)

Option 3					
Name	**Description**		**Source**		**CS data request?**
bottom-up approach - average costs per vkm	Marginal social cost prices (optimal external costs) of congestion by road class and type of area		IMPACT D1 (2008), p.32		yes
Type	**Name**	**Description**	**Unit**	**Value**	
input	vkm passenger cars morning peak (road class; area type)	passenger car vehicle-kilometers at morning peak	vkm		yes
input	vkm passenger cars off morning peak (road class; area type)	passenger car vehicle-kilometers off morning peak	vkm		yes
input	vkm goods vehicles morning peak (road class; area type)	goods vehicles vehicle-kilometers at morning peak time	vkm		yes
input	vkm goods vehicles off morning peak (road class; area type)	goods vehicles vehicle-kilometers off morning peak time	vkm		yes
parameter	marginal costs passenger cars at morning peak (road class; area type)	marginal social cost of congestion by road class and type of area for passenger cars at morning peak	€/vkm	(0,50; 0,50; 2; 0,75; - | 0,25; 0,30; -; 0,30; - | 0,10; -; -; -; 0,05)	if available
parameter	ratio morning peak / off morning peak marginal costs	Ratio of morning peak marginal costs over off morning peak marginal costs		0,5	if available
parameter	PCU of HGV (road class)	passenger car units of heavy good vehicles by road class for passenger cars	PCU	(3.5; 2,5; 2; 2; 2,5)	if available

Dimensions	road class	motorways, urban collectors, local streets centre, local streets cordon, trunk road
	area type	large urban areas, small and medium urban areas, rural areas

3.3.2.3 Environment - Air Pollution

Table 8 - Road air pollution SMCP revenue accounting Bottom-up Option 1

Option 1					
Name	**Description**		**Source**		**CS data request?**
Bottom-up	Perfect SMCP				no
Type	**Name**	**Description**	**Unit**	**Value**	
input	emissions (emission type, vehicle, road section)	Quantity of emissions of each type per each vehicle, in each road section	ton	-	-
parameter	value of emissions (emission type, vehicle, road section)	Monetary value of emissions of each type per road section	€ / ton	-	-

Dimensions	emission type	emission types considered
	vehicle	array of vehicle trips
	road section	array of road sections

Table 9 - Road air pollution SMCP revenue accounting Top-down Option 2 (CS data requested)

Option 2					
Name	**Description**		**Source**		**CS data request?**
Top-down - segmented average costs	Average costs per vkm, vehicle class, fuel and type of area		ENACT D2-2 p.23, UNITE (2003) IMPACT (2008)		yes
Type	**Name**	**Description**	**Unit**	**Value**	
input	vkm car urban (fuel)	Number of car vehicle-kilometres in urban environment per fuel type.	vkm		yes
input	vkm car interurban (fuel)	Number of car vehicle-kilometres in interurban environment per fuel type.	vkm		yes
input	vkm HGV urban	Number of heavy-good vehicle-kilometres in urban environment per fuel type.	vkm		yes
input	vkm HGV interurban	Number of heavy-good vehicle-kilometres in interurban environment per fuel type.	vkm		yes
parameter	cost per car vkm urban (fuel)	Pollution costs per urban car vehicle-kilometre per fuel type.	€ / vkm	(0,185; 0,855)	if available
parameter	cost per car vkm interurban (fuel)	Pollution costs per interurban car vehicle-kilometre per fuel type.	€ / vkm	(0,24; 1,085)	if available
parameter	cost per HGV vkm urban	Pollution costs per urban heavy-good vehicle-kilometre per fuel type	€ / vkm	(- ; 11,10)	if available
parameter	cost per HGV vkm interurban	Pollution costs per interurban heavy-good vehicle-kilometre per fuel type	€ / vkm	(- ; 4,775)	if available

Dimensions	fuel	petrol, diesel

Table 10 - Road air pollution SMCP revenue accounting Top-Down Option 3 (CS data requested)

Option 3					
Name	**Description**		**Source**		**CS data request?**
Top-down - segmented average costs	Average costs per vkm, vehicle type, vehicle size, EURO-class and type of area		IMPACT (2008) D1, p. 57, Table 15		yes
Type	**Name**	**Description**	**Unit**	**Value**	
input	vkm (vehicle type, vehicle size, EURO-class, area)	Number of vehicle-kilometres per vehicle type, size and EURO-class and per type of area			yes
parameter	costs per vkm (vehicle type, vehicle size, EURO-class, area)	Air pollution costs per vkm, per vehicle type, size and EURO-class and per type of area	€ct/vkm	IMPACT (2008) D1, p. 57, Table 15	no

Dimensions	vehicle type	passenger car petrol, passenger car diesel, trucks
	vehicle size	<1,4L, 1,4-2L, >2L, <1,4L, 1,4-2L, >2L, <7.5t, 7.5-16t, 16-32t, >32t
	EURO-class	EURO-0, EURO-1, EURO-2, EURO-3, EURO-4, EURO-5
	area	metropolitan, urban, interurban, motorways

Note: it is possible to apply this option without differentiation per dimension "area" through the application of average values for all areas

3.3.2.4 Environment - Global Warming

Table 11 - Road global warming SMCP revenue accounting Bottom-up Option 1

Option 1					
Name	**Description**		**Source**		**CS data request?**
Bottom-up	Perfect SMCP		-		no
Type	**Name**	**Description**	**Unit**	**Value**	
input	emissions (vehicle-trip)	Quantity of global warming emissions per each vehicle-trip	ton CO2eq	-	-
parameter	value of emissions	Monetary value of global warming emissions	€ / ton CO2eq	-	-

Dimensions	vehicle-trip	array of vehicle-trips

Table 12 - Road global warming SMCP revenue accounting Top-down Option 2 (CS data requested)

Option 2					
Name	**Description**		**Source**		**CS data request?**
Top-down - average costs per vehicle class	Uniform pricing through vehicle class, according to its average estimated CO2 emissions.		-		yes
Type	**Name**	**Description**	**Unit**	**Value**	
input	vkm passenger cars petrol	number of petrol passenger car vkm's	vkm		yes
input	vkm passenger cars diesel	number of diesel passenger car vkm's	vkm		yes
input	vkm light duty vehicles petrol	number of petrol light duty vehicles (<3.5t GVW) vkm's	vkm		yes
input	vkm light duty vehicles diesel	number of diesel light duty vehicles (<3.5t GVW) vkm's	vkm		yes
input	vkm heavy duty vehicles	number of heavy duty vehicles (>3.5t GVW) vkm's (diesel)	vkm		yes
input	consumption passenger cars petrol	average specific consumption passenger cars petrol	l/vkm		yes
input	consumption passenger cars diesel	average specific consumption passenger cars diesel	l/vkm		yes
input	consumption LDV petrol	average specific consumption light duty vehicles petrol	l/vkm		yes
input	consumption LDV diesel	average specific consumption light duty vehicles diesel	l/vkm		yes
input	consumption HDV diesel	average specific consumption heavy duty vehicles diesel	l/vkm		if available
parameter	emissions per liter of petrol	specific global warming emissions perl liter of petrol	g CO2eq / liter	2,41	if available
parameter	emissions per liter of diesel	specific global warming emissions perl liter of diesel	g CO2eq / liter	2,66	if available
parameter	value of emissions	Monetary value of global warming emissions	€ / kg CO2eq	IMPACT Handbook p. 80, Tab. 26	no

Note: If this Option is applied, "emission per vkm" parameters will be estimated (unless directly provided by the case studies) on the basis of assumed specific fuel consumptions and known fuel to CO2 conversions.

Table 13 - Road global warming SMCP revenue accounting Top-down Option 3 (CS data requested)

Option 3					
Name	**Description**		**Source**		**CS data request?**
Top-down - average costs per vehicle class and demografic context	Average costs global warming costs per vehicle class and demografic context.		ENACT D2-2 p.23, UNITE (2003).		yes
Type	**Name**	**Description**	**Unit**	**Value**	
input	vkm car urban (fuel)	Number of car vehicle-kilometres in urban environment per fuel type.	vkm		yes
input	vkm car interurban (fuel)	Number of car vehicle-kilometres in interurban environment per fuel type.	vkm		yes
input	vkm HGV urban (fuel)	Number of heavy-good vehicle-kilometres in urban environment per fuel type.	vkm		yes
input	vkm HGV interurban (fuel)	Number of heavy-good vehicle-kilometres in interurban environment per fuel type.	vkm		yes
parameter	cost per car vkm urban (fuel)	Monetary value of emission costs per vkm of passenger car per urban car vehicle-kilometre per fuel type.	€ / vkm	0,52; 0,37	if available
parameter	cost per car vkm interurban (fuel)	Monetary value of emission costs per vkm of passenger car per interurban car vehicle-kilometre per fuel type.	€ / vkm	0,405; 0,305	if available
parameter	cost per HGV vkm urban (fuel)	Monetary value of emission costs per vkm of passenger car per urban heavy-good vehicle-kilometre per fuel type.	€ / vkm	- ; 2,64	if available
parameter	cost per HGV vkm interurban (fuel)	Monetary value of emission costs per vkm of passenger car per interurban heavy-good vehicle-kilometre per fuel type.	€ / vkm	- ; 2,655	if available

Dimensions	fuel	petrol, diesel

Note: If this Option is applied, “cost per vkm” will be updated to current and future expectations on the basis of assumed specific fuel consumptions, known fuel to CO2 conversions and CO2 emissions economic valuation.

3.3.2.5 Environment - Noise

Table 14 - Road noise SMCP revenue accounting Bottom-up Option 1

Option 1					
Name	**Description**		**Source**		**CS data request?**
Bottom-up	Perfect SMCP		-		no
Type	**Name**	**Description**	**Unit**	**Value**	
input	emissions (vehicle, road section, time of day)	Quantity of emissions per each vehicle, in each road section and time of day.	dBa	-	-
input	annoyance level potential (road section, time of day)	Annoyance level caused by a dBA for each road section and time of day. Depends on number of persons exposed and on external noise level.	annoyance factor unit / dBA	-	-
parameter	value of emissions (road section, time of day)	Monetary value of noise emissions per road section and time of day.	€ / annoyance factor unit	-	-

Dimensions	vehicle	array of vehicle trips
	road section	array of road sections
	time of day	array of time of day intervals with different emission value functions

Table 15 - Road noise SMCP revenue accounting Top-down Option 2 (CS data requested)

Option 2					
Name	**Description**		**Source**		**CS data request?**
Top-down - segmented costs	Average costs per vkm, vehicle class and fuel, type of area, and time of day		ENACT D2-2 p.23, UNITE (2003)		yes
Type	**Name**	**Description**	**Unit**	**Value**	
input	vkm passenger car urban (time of day)	Number of vkm of passenger cars in urban environment per time of day	vkm		yes
input	vkm passenger car interurban (time of day)	Number of vkm of passenger cars in interurban environment per time of day	vkm		yes
input	vkm HGV urban (time of day)	Number of vkm of heavy goods vehicles in urban environment per time of day	vkm		yes
input	vkm HGV interurban (time of day)	Number of vkm of heavy goods vehicles in interurban environment per time of day	vkm		yes
parameter	emission cost per vkm passenger car urban (time of day)	Noise emission costs per vkm of passenger cars in urban environment per time of day	€ / km	(0,006400; 0,008800; 0,019850)	if available
parameter	emission cost per vkm passenger car interurban (time of day)	Noise emission costs per vkm of passenger cars in interurban environment per time of day	€ / km	(0,000595; 0,000595; 0,00094)	if available
parameter	emission cost per vkm HGV urban (time of day)	Noise emission costs per vkm of heavy goods vehicles in urban environment per time of day	€ / km	(0,0904; 0,1204; 0,2746)	if available
parameter	emission cost per vkm HGV interurban (time of day)	Noise emission costs per vkm of heavy goods vehicles in interurban environment per time of day	€ / km	(0,01517; 0,01516; 0,025195)	if available

Dimensions	time of day	day, evening, night

Table 16 - Road noise SMCP revenue accounting Top-down Option 3 (CS data requested)

Option 3					
Name	**Description**		**Source**		**CS data request?**
Top-down - segmented costs	Average costs per vkm, vehicle type, time of day and type of area		IMPACT (2008) handbook p. 68		yes
Type	**Name**	**Description**	**Unit**	**Value**	
input	vkm (vehicle type, time of day, type of area)	number of vehicle-kilometres per vehicle type, time of day and type of area	vkm		yes
parameter	marginal costs (vehicle type, time of day, type of area)	marginal costs per vehicle type, time of day and type of area	€ct/vkm	IMPACT (2008) D1 p. 69, Table 21	if available

Dimensions	vehicle type	car, motorcycle, bus, light goods vehicle, heavy goods vehicle
	time of day	day, night
	type of area	urban, suburban, rural

3.3.2.6 Accident

Table 17 - Road accident SMCP revenue accounting Bottom-up Option 1

Option 1					
Name	**Description**		**Source**		**CS data request?**
Bottom-up	Costs per vehicle exactly proportional to its accident risk value.				no
Type	**Name**	**Description**	**Unit**	**Value**	
input	vkm (vehicle type, road section, schedule section, speed)	Number of km of each vehicle-trip in each road section and schedule section, with identification of vehicle type and speed.	km	-	-
parameter	accident rate (vehicle type, road section, schedule section, speed)	Average number of accidents per volume of demand, per road section, schedule section, vehicle type and speed.	accidents/vkm	-	-
parameter	cost per accident (vehicle type, road section, schedule section, speed)	Average cost per accident.	€ / accident	-	-
input	insurance coverage (vehicle-trip)	Insurance coverage of accident costs per vehicle.	€ / vehicle-trip	-	-

Dimensions	vehicle-type	array of vehicle types with different emission value functions
	road section	array of road sections
	schedule section	array of schedule sections with different emission value functions
	speed	array of speed intervals

Table 18 - Road accident SMCP revenue accounting Top-down Option 2 (CS data requested)

Option 2					
Name	**Description**		**Source**		**CS data request?**
Top-down - average costs per environment	Average costs per vkm and type of area.		ENACT D2-2 p.24, UNITE (2002). (also in IMPACT D1 T.10) Note: parameter values to be used accordingly with country		yes
Type	**Name**	**Description**	**Unit**	**Value**	
input	vkm (type of area)	Total vkm per road type.	vkm		yes
parameter	cost per vkm (type of area)	Cost per vkm in each type of environment.	c€ / vkm	(0,012; 0,002; 0,014; 0,048)	if available

Dimensions	type of area	all roads, motorways, inside settlements, outside settlements

3.3.3 Railways

3.3.3.1 Infrastructure

Table 19 - Railways infrastructure SMCP revenue accounting Bottom-up Option 1

Option 1					
Name	**Description**		**Source**		**CS data request?**
Bottom-up	Perfect SMCP.		-		no
Type	**Name**	**Description**	**Unit**	**Value**	
input	vehicle load factor (slot)	Load factor of each vehicle-slot.	load factor unit	-	-
input	km (slot)	Number of kilometres of each trip-slot.	km	-	-
input	stops (slot)	Number of stops per slot.	stops	-	-
parameter	costs of maintenance per km.load factor	Marginal cost per unit of vehicle load and km.	€ / km.load factor	-	-
parameter	costs of maintenance per stop.load factor	Marginal cost per unit of vehicle load and stop.	€ / stop.load factor	-	-
parameter	other costs	Other costs as a function of vehicle-trip and/or km and/or vehicle load and/or number of stops and/or schedule.	€ / unit(s)	-	-

Dimensions	slot	array of train-trip slots

Table 20 - Railways infrastructure SMCP revenue accounting Top-down Option 2 (CS data requested)

Option 2					
Name	**Description**		**Source**		**CS data request?**
Top-down - average costs per train-km	Average costs per train-km.		D2-2 p.26, parameter value proposed for France, L. Menard		yes
Type	**Name**	**Description**	**Unit**	**Value**	
input	train-km	Number of train-km	train.km		yes
parameter	cost per train kilometre	Average marginal costs per train-km	€ / train.km	1,7	if available

3.3.3.2 Congestion / Scarcity

Table 21 - Railways congestion/scarcity SMCP revenue accounting Bottom-up Option 1

Option 1					
Name	**Description**		**Source**		**CS data request?**
Bottom-up	Perfect congestion charge per passenger / good.		-		no
Type	**Name**	**Description**	**Unit**	**Value**	
input	opportunity costs of slot occupation (slot)	Opportunity costs of slot being occupied by its train-trip	€	-	-
input	passenger delay (slot)	Delay caused by each train-trip slot on other passenger train-trips.	hour	-	-
input	Passengers affected (slot)	Number of passengers affected by delay per train-trip slot.	passengers	-	-
parameter	value of time of passengers (slot)	Average value of time among passengers affected.	€/passenger.hour	-	-
input	average goods delay (slot)	Delay caused by each train-trip slot on other goods train-trips.	hour	-	-
input	goods affected (slot)	Tons of goods affected by delay per train-trip slot.	tons	-	-
parameter	value of time of goods (slot)	Average value of time among goods affected.	€/ton.hour	-	-

Dimensions	slot	array of train-trip slots

Table 22 - Railways congestion/scarcity SMCP revenue accounting Top-down Option 2 (CS data requested)

Option 2					
Name	**Description**		**Source**		**CS data request?**
Top-down - average costs per delay	Average marginal costs per congestion/scarcity driven delay.		-		yes
Type	**Name**	**Description**	**Unit**	**Value**	
input	average opportunity costs of slot occupation	Average opportunity costs of slot being occupied by its train-trip (slot reservation price may be used as proxy)	€		yes
input	train-trips	number of train-trips	train-trip		yes
input	average congestion delay per train-trip	average delay due to congestion, per train-trip, for all train-trips	hour / train-trip		yes
input	fraction of passenger trains	percentage of passenger trains among all trips	%		yes
input	average passengers per train	average number of passengers per train	passengers / train		yes
input	average goods per train	average weight of goods per train	tons / train		yes
parameter	value of time of passengers	average value of time among passengers	€/passenger.hour	tbd	if available
parameter	value of time of goods	average value of time per ton of good	€/ton.hour	tbd	if available

Table 23 - Railways congestion/scarcity SMCP revenue accounting Top-down Option 3 (CS data requested)

Option 3					
Name	**Description**		**Source**		**CS data request?**
Top-down - costs per pkm	Average costs per passenger-kilometre		ENACT D2-2 p.27, UNITE (2003). Rail congestion (7AB).		yes
Type	**Name**	**Description**	**Unit**	**Value**	
input	pkm	total passenger kilometres	pkm		yes
parameter	costs per pkm	costs per passenger-kilometre	€ / pkm	0,002	if available

Table 24 - Railways congestion/scarcity SMCP revenue accounting Top-down Option 4 (CS data requested)

Option 4					
Name	**Description**		**Source**		**CS data request?**
Top-down - costs per train-km and schedule	Average costs per train-kilometre and schedule section (peak, off-peak)		D2-2 p.27. UNITE, 2003. Rail congestion (7AB).		yes
Type	**Name**	**Description**	**Unit**	**Value**	
input	train-km peak	total train-kilometres realized during peak time	train-km		yes
input	train-km off-peak	total train-kilometres realized during off-peak time	train-km		yes
parameter	costs per train-km peak	Costs per train-kilometre during peak time.	€ / train-km	0,21	if available
parameter	costs per train-km off-peak	Costs per train-kilometre during off-peak time.	€ / train-km	0,135	if available

Note: Unless case study specific parameterization is provided, Option 2 (average costs per delay time) is strongly recommendable as opposed to Options 3 or 4 (average costs per passenger-km). This option implicitly assumes an average congestion delay per vkm which may be extremely variable from case to case given that it depends directly on the capacity and demand specific to the case study concerned. However, data to feed Option 2 will most likely be very hard to achieve.

3.3.3.3 Environment - Air Pollution

Table 25 - Railways air pollution SMCP revenue accounting Bottom-up Option 1

Option 1					
Name	**Description**		**Source**		**CS data request?**
Bottom-up	Perfect SMCP		-		no
Type	**Name**	**Description**	**Unit**	**Value**	
input	emissions (emission type, slot, network section, time of day)	Tons of emissions per each train-trip slot, in each network section and time of day.	ton	-	-
parameter	value of emissions (emission type, network section, time of day)	Monetary value of emissions per road section and time of day.	€ / ton	-	-

Dimensions		
	emission type	array of air pollutant emissions
	slot	array of train-trip slots
	network section	array of railway network sections
	time of day	array of time of days

Table 26 - Railways air pollution SMCP revenue accounting Top-down Option 2 (CS data requested)

Option 2					
Name	**Description**		**Source**		**CS data request?**
Top-down - Segmented average costs	Average costs per train-km per vehicle type, energy source, vehicle class and type of area		ENACT D2-II p.27, IMPACT D1 (2008), TREMOVE base case		yes
Type	**Name**	**Description**	**Unit**	**Value**	
input	train-km (vehicle type, energy source, vehicle class, type of area)	Total train-kilometres per vehicle type, energy source, vehicle class and type of area	train.km		yes
parameter	cost per train-km (vehicle type, energy source, vehicle class, type of area)	Cost per train-km per vehicle type, energy source, vehicle class and type of area	€ / train.km	IMPACT D1 (2008), p. 59, T. 16	if available

Dimensions		
	vehicle type	passenger, freight
	energy source	electric, diesel
	vehicle class	locomotive, railcar, high speed train
	type of area	metropolitan, urban, interurban

Note: Relaxation of dimension "vehicle class" is possible.

3.3.3.4 Environment - Global Warming

Table 27 - Railways global warming SMCP revenue accounting Bottom-up Option 1

Option 1					
Name	**Description**		**Source**	**-**	**CS data request?**
Bottom-up	Perfect marginal cost price allocation		-		no
Type	**Name**	**Description**	**Unit**	**Value**	
input	emissions (slot)	Tons of global warming emissions produced.	ton	-	-
parameter	value of emissions	Monetary value of global warming emissions.	€ / ton	-	-

Dimensions	slot	array of train-trip slots

Table 28 - Railways global warming SMCP revenue accounting Top-down Option 2 (CS data requested)

Option 2					
Name	**Description**		**Source**		**CS data request?**
Top-down - Segmented average costs	Average costs per train-km per train types and type of area.		ENACT D2-II p.27, IMPACT D1 (2008)		yes
Type	**Name**	**Description**	**Unit**	**Value**	
input	train-km passenger electric (type of area)	Total passenger electric train-km.	train.km		yes
input	train-km passenger diesel (type of area)	Total passenger diesel train-km.	train.km		yes
input	train-km freight electric (type of area)	Total freight diesel train-km.	train.km		yes
input	train-km freight diesel (type of area)	Total freight diesel train-km.	train.km		yes
parameter	cost per train-km passenger electric (type of area)	Costs per passenger electric train-km.	€ / train.km	(0,1311; 0,1251)	if available
parameter	cost per train-km passenger diesel (type of area)	Cost per passenger diesel train-km.	€ / train.km	(0,2707 ;0,1026)	if available
parameter	cost per train-km freight electric (type of area)	Cost per freight electric train-km.	€ / train.km	(- ; 0,3064)	if available
parameter	cost per train-km freight diesel (type of area)	Cost per freight diesel train-km.	€ / train.km	(- ; 0,3457)	if available

Dimensions	type of area	urban, interurban

3.3.3.5 *Environment - Noise*

Table 29 - Railways noise SMCP revenue accounting Bottom-up Option 1

Option 1					
Name	**Description**		**Source**		**CS data request?**
Bottom-up	Perfect SMCP				no
Type	**Name**	**Description**	**Unit**	**Value**	
input	emissions (slot, network section, time of day)	Additional noise load per each train-trip slot, in each network section and time of day.	dBA	-	-
input	annoyance level potential (network section, time of day)	Annoyance level caused by a dBA for each network section and time of day. Depends on number of persons exposed and on external noise level.	annoyance factor unit / dBA	-	-
parameter	value of emissions (network section, time of day)	Monetary value of emissions per road section and time of day.	€ / annoyance factor unit	-	-

Dimensions	slot	array of train-trip slots
	network section	array of railway network sections
	time of day	array of time of days

Table 30 - Railways noise SMCP revenue accounting Top-down Option 2 (CS data requested)

Option 2					
Name	**Description**		**Source**		**CS data request?**
Top-down - Segmented average costs	Average costs per train-km per train types and type of area.		D2-II p.27, IMPACT 2007		yes
Type	**Name**	**Description**	**Unit**	**Value**	
input	train-km passenger day (type of area)	Total passenger daily train-km and type of area context.	train.km		yes
input	train-km passenger night (type of area)	Total passenger night train-km.	train.km		yes
input	train-km freight daily (type of area)	Total freight daily train-km.	train.km		yes
input	train-km freight night (type of area)	Total freight night train-km.	train.km		yes
parameter	cost per train-km passenger day (type of area)	Costs per train-km passenger during day time.	€ / train.km	(23,65; 20,61; 2,57)	if available
parameter	cost per train-km passenger night (type of area)	Costs per train-km passenger during night time.	€ / train.km	(77,99; 34,40; 4,29)	if available
parameter	cost per train-km freight daily (type of area)	Costs per train-km freight during day time.	€ / train.km	(41,93; 40,06; 5,00)	if available
parameter	cost per train-km freight night (type of area)	Costs per train-km freight during night time.	€ / train.km	(171,06; 67,71; 8,45)	if available

Dimensions	type of area	urban, suburban, rural

3.3.3.6 Accident

Table 31 - Railways accident SMCP revenue accounting Bottom-up Option 1

Option 1					
Name	**Description**		**Source**	**-**	**CS data request?**
Bottom-up	Accident risks and costs segmented by network section, time of day, vehicle type and speed.				no
Type	**Name**	**Description**	**Unit**	**Value**	
input	train-km (slot, vehicle type, speed, network section, time of day)	Number of km per train-trip slot in each network section and time of day, with identification of vehicle type and speed.	km	-	-
parameter	accident rate (slot, vehicle type, speed, network section, time of day)	Average number of accidents per train-trip slot in each network section and time of day, with identification of vehicle type and speed.	accidents / train-km	-	-
parameter	cost per accident (train type, network section, time of day, speed)	average external cost per accident per train type, network section, time of day, vehicle type and speed.	€ / accident	-	-
input	insurance coverage (slot)	insurance coverage of accident costs per slot	€ / train-trip	-	-

Dimensions	slot	array of train-trip slots
	vehicle type	array of vehicle types
	speed	array of speed intervals
	network section	array of network sections
	time of day	array of time of day intervals

Table 32 - Railways accident SMCP revenue accounting Top-down Option 2 (CS data requested)

Option 2					
Name	**Description**		**Source**		**CS data request?**
Top-down - average costs	average costs per train-km		ENACT D2-2 p.28, IMPACT (2008)		yes
Type	**Name**	**Description**	**Unit**	**Value**	
input	train-km	Number of train-km	km		yes
parameter	cost per train-km	Average cost per train-km	€ / train-km	0,014	if available

3.3.4 Aviation

3.3.4.1 Infrastructure

Table 33 - Aviation infrastructure SMCP revenue accounting Bottom-up Option 1

Option 1					
Name	**Description**		**Source**	**-**	**CS data request?**
Bottom-up	Costs per movement depending on vehicle load factor.		-		no
Type	**Name**	**Description**	**Unit**	**Value**	
input	movements	Number of plane movements	movement	-	-
input	vkm (movement)	Number of kilometres of ground movement	vkm	-	-
input	vehicle load factor (LTO)	Load factor of each vehicle.	load factor unit	-	-
parameter	AFTM / ATC services (movement)	AFTM / ATC services	€/LTO		
parameter	costs of maintenance per km.load factor	Unit cost per unit of vehicle load and kilometres of ground movement	€ / km.load factor	-	-
parameter	other costs	Other costs as a function of movement load factor and/or vkm.	€ / unit(s)	-	-

Dimensions	movements	array of plane movements

Table 34 - Aviation infrastructure SMCP revenue accounting Top-down Option 2 (CS data requested)

Option 2					
Name	**Description**		**Source**		**CS data request?**
Top-down - average cost per movement	average cost per movement		ENACT D2-II p.29. GRACE 2006 (average between 11 GRACE case studies).		yes
Type	**Name**	**Description**	**Unit**	**Value**	
input	movements	Number of plane movements	movements		yes
parameter	cost per movement	Average infrastructure costs per movement.	€ / movement	750,6	if available

3.3.4.2 Congestion / Scarcity

Table 35 - Aviation congestion/scarcity SMCP revenue accounting Bottom-up Option 1

Option 1					
Name	**Description**		**Source**		**CS data request?**
Bottom-up	Perfect congestion charge. Congestion charge varies per slot depending on number of passengers and goods affected by that movement.		-		no
Type	**Name**	**Description**	**Unit**	**Value**	
input	opportunity costs of slot occupation (movement)	Opportunity costs of movement slot being occupied by its plane-trip	€	-	-
input	average passenger congestion delay (movement)	Average delay caused by each plane movement on other passenger planes.	hour	-	-
input	passengers affected per movement (movement)	Number of passengers per plane (during movement operation time).	passengers	-	-
parameter	value of time of passengers	Average value of time among passengers affected.	€/passenger.hour	-	-
input	average goods congestion delay (movement)	Average delay caused by each plane-trip movement on other goods planes.	hour	-	-
input	goods affected (movement)	Tons of goods affected by plane movement.	tons of goods	-	-
parameter	value of time of goods	Average value of time among goods affected.	€/ton.hour	-	-

Dimensions	movement	array of plane movements

Table 36 - Aviation congestion/scarcity SMCP revenue accounting Top-down Option 2 (CS data requested)

Option 2					
Name	**Description**		**Source**		**CS data request?**
Top-down - average costs per delay	Average congestion costs per delay.		-		yes
Type	**Name**	**Description**	**Unit**	**Value**	
input	average opportunity costs of slot occupation	Average opportunity costs of slot being occupied by a lane-slot (slot reservation price may be used as proxy)	€		yes
input	plane-movements	Number of plane-movements.	plane-movement		yes
input	average congestion delay per movement	Average delay due to congestion, per movement.	hour / plane-movement		yes
input	fraction of passengers over goods	Number passengers per number of tons of goods, amongst all trips	passengers / tons of goods		yes
input	average passengers per plane	Average number of passengers per passenger plane.	passengers / plane		yes
input	average goods per plane	Average weight of goods per freight plane.	tons / plane		yes
parameter	value of time of passengers	Average value of time among passengers.	€/passenger.hour	tbd	if available
parameter	value of time of goods	Average value of time among all goods.	€/ton.hour	tbd	if available

Table 37 - Aviation congestion/scarcity SMCP revenue accounting Top-down Option 3 (CS data requested)

Option 3					
Name	**Description**		**Source**		**CS data request?**
Top-down - average congestion costs	Average congestion costs per landing and take-off cycle (LTO) cycle.		ENACT D2-II p.31, UNITE, 2003 (* - parameter value for Madrid airport. Case study specific data desirable)		yes
Type	**Name**	**Description**	**Unit**	**Value**	
input	LTO cycles	Number of landing and take-off cycles.	LTO cycles		yes
parameter	costs per LTO cycle	Average costs per LTO cycle.	€ / LTO cycle	3066 *	if available *

Note: Unless case study specific parameterization is provided, Option 2 (average costs per delay time) is strongly recommendable as opposed to Options 3 (average costs per LTO cycle) if data may be found. This is for the later option implicitly assumes an average congestion delay per vkm which may be extremely variable from case to case given that it depends directly on the capacity and demand specific to the case study concerned. However, it is noted that finding the necessary data to feed Option 2 is likely to be very difficult.

3.3.4.3 Environment - Air Pollution

Table 38 - Aviation air pollution SMCP revenue accounting Bottom-up Option 1

Option 1					
Name	**Description**		**Source**		**CS data request?**
Bottom-up	Costs proportional to emissions per route and schedule sections.		-		no
Type	**Name**	**Description**	**Unit**	**Value**	
input	emissions (emission type, LTO cycle, types of area)	Quantity of emissions per each vehicle-slot, in each type of area and schedule section.	ton	-	-
parameter	value of emissions (emission type, types of area)	Monetary value of emissions per type of area and schedule section.	€ / ton	-	-

Dimensions	emission type	array of emission types
	LTO cycle	array of plane LTO cycles
	types of area	array of types of area

Table 39 - Aviation air pollution SMCP revenue accounting Top-down Option 2 (CS data requested)

Option 2					
Name	**Description**		**Source**		**CS data request?**
Top-down - pollution costs per LTO cycle	Air pollution costs per LTO cycle		D2-2 p.32, IMPACT 2008, based on UNITE 2002. Average between Berlin Tegel and London Heathrow.		yes
Type	**Name**	**Description**	**Unit**	**Value**	
input	LTO cycles	Number of LTO cycles	LTO cycle		yes
parameter	cost per LTO cycle	Average pollutant emissions costs per LTO cycle	€ / LTO cycle	52,58	if available

3.3.4.4 Environment - Global Warming

Table 40 - Aviation global warming SMCP revenue accounting Bottom-up Option 1

Option 1					
Name	**Description**		**Source**		**CS data request?**
Bottom-up	Air pollution costs proportional to emissions				no
Type	**Name**	**Description**	**Unit**	**Value**	
input	emissions (movement)	Quantity of emissions per each movement.	ton		
parameter	value of emissions	Monetary value of emissions .	€ / ton		

Dimensions	movement	array of plane movements

Table 41 - Aviation global warming SMCP revenue accounting Top-down Option 2 (CS data requested)

Option 2					
Name	**Description**		**Source**		**CS data request?**
Top-down - average costs per LTO cycle	Global warming average costs per LTO cycle		ENACT D2-2 p.32. IMPACT 2008, based on UNITE 2002. Average between Berlin Tegel and London Heathrow.		yes
Type	**Name**	**Description**	**Unit**	**Value**	
input	LTO cycles	Number of LTO cycles	LTO cycle		yes
parameter	cost per LTO cycle	Average global warming emission costs per LTO cycle	€ / LTO cycle	96,16	if available

3.3.4.5 *Environment - Noise*

Table 42 - Aviation noise SMCP revenue accounting Bottom-up Option 1

Option 1					
Name	**Description**		**Source**		**CS data request?**
Bottom-up	Air pollution costs proportional to exposure to emissions				no
Type	**Name**	**Description**	**Unit**	**Value**	
input	emissions (LTO cycle, type of area, time of day)	Quantity of emissions per each LTO cycle, in each network section and time of day	dBA		
input	annoyance level potential (type of area, time of day)	Potential annoyance level caused by a dBA for each type of area and time of day. Depends on number of persons exposed and on external noise level.	annoyance factor unit / dBa		
parameter	value of emissions (type of area, time of day)	Monetary value of emissions per type of area and time of day	annoyance factor unit / dBA		

Dimensions	LTO cycle	array of plane LTO cycles
	type of area	array of types of area
	time of day	array of schedule intervals

Table 43 - Aviation noise SMCP revenue accounting Top-down Option 2 (CS data requested)

Option 2					
Name	**Description**		**Source**		**CS data request?**
Top-down - noise emissions costs per LTO cycle	Average noise emissions costs per LTO cycle.		ENACT D2-II p.31. Average of various studies on average aviation costs		yes
Type	**Name**	**Description**	**Unit**	**Value**	
input	LTO cycles	Number of LTO cycles	LTO cycle		yes
parameter	cost per LTO cycle	Average noise emission costs per LTO cycle	€ / LTO cycle	292,9	if available

Table 44 - Aviation noise SMCP revenue accounting Top-down Option 3 (CS data requested)

Option 3					
Name	**Description**		**Source**		**CS data request?**
Top-down - noise emissions costs and time of day	Average noise emissions costs per LTO cycle.		(further source search needed)		yes
Type	**Name**	**Description**	**Unit**	**Value**	
input	LTO cycles day	Number of LTO cycles during the day	LTO cycle		yes
	LTO cycles night	Number of LTO cycles during the night	LTO cycle		yes
	cost per LTO cycle day	Average noise emission costs per LTO cycle during daytime	€ / LTO cycle	tbd	if available
parameter	cost per LTO cycle night	Average noise emission costs per LTO cycle at night	€ / LTO cycle	tbd	if available

3.3.4.6 Accident

According to Deliverable 2-II of ENACT data on external accident costs in the aviation sector were not found in literature. In this virtue, unless the case studies may provide any specific data on the matter, accident costs will not be tested in the simulation tool with empirically supported parameterization.

Table 45 - Aviation accident SMCP revenue accounting Bottom-up Option 1

Option 1					
Name	**Description**		**Source**		**CS data request?**
Bottom-up	Accident risks and costs discriminated by route section, schedule section and vehicle type		-		no
Type	**Name**	**Description**	**Unit**	**Value**	
input	plane-km (plane type, airspace section, schedule section)	Number of km per plane-trip in each airspace section and schedule section, per plane type.	km	-	-
parameter	accident rate (plane type, airspace section, schedule section)	Average number of accidents per plane-trip in each airspace section and schedule section, per plane type	accidents / plane-km	-	-
parameter	cost per accident	Average external cost per accident.	€ / accident	-	-
input	insurance coverage	insurance coverage of accident costs per plane-trip	€ / ship-trip	-	-

Dimensions	plane type	array of plane movements
	airspace section	array of airspace sections
	schedule section	array of schedule intervals
	speed	array of speed intervals

Table 46 - Aviation accident SMCP revenue accounting Top-down Option 2 (CS data requested)

Option 2					
Name	**Description**		**Source**		**CS data request?**
Top-down - average costs per LTO cycle	Average external accident costs per LTO cycle		IMPACT D1 (2008) p. 45, based on INFRAS/IWW (2004)		if available
Type	**Name**	**Description**	**Unit**	**Value**	
input	LTO cycles	number of LTO cycles	LTO cycle		yes
parameter	cost per LTO cycle	average accident external costs per LTO cycle	€ / LTO cycle	12 to 309	if available

3.3.5 *Maritime/IWT*

3.3.5.1 *Infrastructure*

The data available reveals negligible marginal infrastructure costs for ship movements as compared to other SMC costs (ENACT D2-II, p.35). Unless opposing information is suggested from case studies, data for infrastructure SMCP revenue accounting is therefore not required from these.

Table 47 - Maritime infrastructure SMCP revenue accounting Bottom-up Option 1

Option 1					
Name	**Description**		**Source**		**CS data request?**
Bottom-up	Marginal costs per movement		-		no
Type	**Name**	**Description**	**Unit**	**Value**	
input	cost per movement (movement)	actual cost per movement	€ / movement		-

Table 48 - Maritime infrastructure SMCP revenue accounting Top-down Option 2 (CS data requested)

Option 2					
Name	**Description**		**Source**		**CS data request?**
Top-down - Average costs per traffic work	Average infrastructure costs per traffic work unit		* ENACT D2-II p. 36, Eriksen et al (1999, Norway)		no (unless found relevant)
Type	**Name**	**Description**	**Unit**	**Value**	
input	vkm passengers	Passenger ships vehicle-kilometres	vkm		no (unless found relevant)
input	vkm freights	freight ships vehicle-kilometres	vkm		No (unless found relevant)
parameter	cost vkm passenger	Infrastructure passenger ships costs per vehicle-kilometre	€ / vkm	0 * (specific assumptions tbd by CS)	no (unless found relevant)
parameter	cost vkm freight	Infrastructure freight ship costs per vehicle-kilometre	€ / vkm	0 * (specific assumptions tbd by CS)	no (unless found relevant)

3.3.5.2 Congestion / Scarcity

Available empirical data reveals negligible congestion/scarcity costs for ship movements (ENACT D2-II, p.36). However, it is well known that some ports experience high levels of congestion. For that reason, it is suggested that if case studies reveal relevant levels of maritime congestion, SMC accountancy should be made. In that case a deeper search of empirical quantification of cost parameters will be performed.

Table 49 - Maritime congestion/scarcity SMCP revenue accounting Bottom-up Option 1

Option 1					
Name	**Description**		**Source**		**CS data request?**
Bottom-up	Perfect congestion charge per passenger / good. Congestion charge varies per movement depending on number of goods affected by that movement.		-		no
Type	**Name**	**Description**	**Unit**	**Value**	
input	average congestion delay (movement)	Average delay caused by each ship movement on other ship movements.	hour	-	-
input	goods affected (movement)	weight of goods affected by ship movement caused delay	tons	-	-
parameter	value of time of goods	average value of time among goods affected	€/ton.hour	-	-

Dimensions	movement	array of ship movements

Table 50 - Maritime congestion/scarcity SMCP revenue accounting Top-down Option 2 (CS data requested)

Option 2					
Name	**Description**		**Source**		**CS data request?**
Top-down - average congestion delays	Average congestion delays per ship movement		-		yes
Type	**Name**	**Description**	**Unit**	**Value**	
input	ship movements	number of ship movements	movement	-	yes
input	average congestion delay per ship movement	average delay due to congestion, per ship movement	hour / movement	-	yes
input	average goods weight per ship	average weight of goods per ship	tons / ship	tbd	if available
parameter	value of time of goods	average value of time among all goods	€/ton.hour	tbd	if available

Table 51 - Maritime congestion/scarcity SMCP revenue accounting Top-down Option 3 (CS data requested)

Option 3					
Name	**Description**		**Source**		**CS data request?**
Top-down - costs per traffic work	Congestion/scarcity costs per traffic work unit		* ENACT D2-II p. 36. Eriksen et al (1999, Norway)		yes
Type	**Name**	**Description**	**Unit**		
input	vkm passengers	passenger ships vehicle-kilometres	vkm	-	yes
input	vkm freights	freight ships vehicle-kilometres	vkm	-	yes
parameter	cost vkm passenger	passenger ship congestion costs per vehicle-kilometre	€ / vkm	0 * (specific CS value tbd)	if available
parameter	cost vkm freight	freight ship congestion costs per vehicle-kilometre	€ / vkm	0 * (specific CS value tbd)	if available

3.3.5.3 *Environment*

The empirical parameterization for maritime port environmental marginal costs found in literature relates to aggregate environmental costs. The requested data therefore pertains to all types of environmental costs together and is tabled below.

Table 52 - Maritime environmental SMCP revenue accounting Top-down Option 2 (CS data requested)

Option 2					
Name	**Description**		**Source**		**CS data request?**
Top-down - average costs per transported units	Average environmental costs per transported units		from D2-II p.36, Eriksen et al (1999)		yes
Type	**Name**	**Description**	**Unit**	**Value**	
input	passenger-kilometres	Quantity of passenger-kilometres transported	p.km		yes
input	tonne-kilometres	Quantity of tonne-kilometres transported	ton.km		yes
parameter	environmental costs per passenger-kilometre	Environmental costs per p.km. These include emission pollutants and climate change costs.	€ / p.km	0,115	if available
parameter	environmental costs per tonne-kilometre	Environmental costs per ton-km. These include emission pollutants and climate change costs.	€ / p.km	0,004	if available

Table 53 - Maritime environmental SMCP revenue accounting Top-down Option 3 (CS data requested)

Option 3					
Name	**Description**		**Source**		**CS data request?**
Top-down - costs per traffic work	Environmental costs per traffic work		D2-2 p.36. Eriksen et al, 1999 (Norway)		yes
Type	**Name**	**Description**	**Unit**	**Value**	
input	vkm passengers	passenger ships vehicle-kilometres	vkm		yes
input	vkm freights	freight ships vehicle-kilometres	vkm		yes
parameter	cost vkm passenger	passenger ship environmental costs per vehicle-kilometre	€ / vkm	3,67	no
parameter	cost vkm freight	freight ship environmental costs per vehicle-kilometre	€ / vkm	4,226	no

Bottom-up SMC accounting options are still given below for reference, for each of the environmental cost types considered.

Air Pollution

Table 54 - Maritime air pollution SMCP revenue accounting Bottom-up Option 1

Option 1					
Name	**Description**		**Source**		**CS data request?**
Bottom-up					no
Type	**Name**	**Description**	**Unit**	**Value**	
input	emissions (emission type, movement, schedule section, route section)	Tons of emissions per each vehicle-slot, in each network section and schedule section.	ton (emission type)	-	-
parameter	value of emissions (emission type, schedule section, route section)	Monetary value of emissions	€ / ton	-	-

Dimensions	emission type	array of emission types
	movement	array of ship movements
	schedule section	array of schedule intervals
	route section	array of route sections

Global Warming

Table 55 - Maritime global warming SMCP revenue accounting Bottom-up Option 1

Option 1					
Name	**Description**		**Source**		**CS data request?**
Bottom-up	Marginal costs proportional to global warming emissions		-		no
Type	**Name**	**Description**	**Unit**	**Value**	
input	emissions (movement)	Quantity of emissions per each vehicle-slot, in each network section and schedule section [array(ship-incidence)]	ton	-	-
parameter	value of emissions	Monetary value of emissions	€ / ton	-	-

Dimensions	movement	array of ship movements

Noise

Table 56 - Maritime noise SMCP revenue accounting Bottom-up Option 1

Option 1					
Name	**Description**		**Source**		**CS data request?**
Bottom-up	Marginal costs per noise emission.				no
Type	**Name**	**Description**	**Unit**	**Value**	
input	emissions (movement, route section, time of day)	Quantity of emissions per each ship movement, in each route section and time of day	dBA	-	-
input	annoyance level potential (route section, time of day)	Potential annoyance level caused by a dBA for each route section and time of day. Depends on number of persons exposed and on external noise level.	annoyance factor unit / dBa		
parameter	value of emissions (route section, time of day)	Monetary value of emissions	€ / dBA	-	-

Dimensions	movement	array of ship movements
	route section	array of route sections
	time of day	array of schedule intervals

3.3.5.4 Accident

Table 57 - Maritime accident SMCP revenue accounting Bottom-up Option 1

Option 1					
Name	**Description**		**Source**		**CS data request?**
Bottom-up	Average accident marginal costs per movement				no
Type	**Name**	**Description**	**Unit**	**Value**	
input	ship-km (ship-km, ship type, route section)	number of km per ship-trip in each route section and ship type.	ship-km	-	-
parameter	accident rate (ship type, maritime space section)	Average number of accidents per ship-trip in each route section and ship type.	accidents / ship-km	-	-
parameter	cost per accident (ship type, maritime space section)	Average cost per accident.	€ / accident	-	-
input	insurance coverage (movement)	Insurance coverage of accident costs per ship-trip.	€ / ship-trip	-	-

Dimensions	movement	array of ship movements
	route section	array of route sections
	ship type	array of ship types
	speed	array of speed intervals

Table 58 - Maritime accident SMCP revenue accounting Top-down Option 2 (CS data requested)

Option 2					
Name	**Description**		**Source**		**CS data request?**
Top-down - average costs per transported units	Average costs per transported unit-km's		ENACT D2-II p. 36, Eriksen et al, (1999, Norway)		yes
Type	**Name**	**Description**	**Unit**	**Value**	
input	vkm passengers	Passenger ship vehicle-kilometres	vkm		yes
input	vkm freight	Freight ship vehicle-kilometres	vkm		yes
parameter	cost per vkm passenger	Average cost per passenger ship vehicle-kilometres	€ / vkm	0,003	if available
parameter	cost per vkm freight	Average cost per freight ship vehicle-kilometres	€ / vkm	0,000068	if available

Table 59 - Maritime accident SMCP revenue accounting Top-down Option 3 (CS data requested)

Option 3					
Name	**Description**		**Source**		**CS data request?**
Top-down - accident average costs per traffic work unit	External accident average costs per traffic work unit		ENACT D2-II p. 36, Eriksen et al, (1999, Norway)		yes
Type	**Name**	**Description**	**Unit**	**Value**	
input	vkm passengers	Passenger ships vehicle-kilometres	vkm		yes
input	vkm freights	Freight ships vehicle-kilometres	vkm		yes
parameter	cost vkm passenger	Passenger ship external accident costs per vkm	€ / vkm	0,068	if available
parameter	cost vkm freight	Freight ship external accident costs per vkm	€ / vkm	0,068	if available

3.4 Financial and Risk Analysis

In the synthesis of the research undertaken in previous work packages, we have pointed out that the financial structure of PPPs and the prevalence of risk constitute closely related topics, making it necessary to assess the impact of the financial structure of an infrastructure project on the productive efficiency with respect to risk. Therefore, it is crucial to understand the "financial structuring" of such projects and the economic rationales behind these structures in order to identify and mitigate risks involved in the PPP contractual arrangements.

In the scope of the simulation tool for the case studies, the Financial and Risk Analysis comprises two main goals:

- Verify whether the revenues achieved through SMCP are enough to cover the required project financing;
- Assess revenue risk posed by SMCP and assess their correspondent financial risk premium.

3.4.1 Financial Analysis

The first goal is achieved through the calculation of the net present value of the project for the contractor when its revenues are strictly dependent on SMCP. This requires information on all the relevant costs of the project. Depending on the PPP type, the financial analysis will take account of all relevant costs and revenues – construction and planning, financing, equipment, operation and management, maintenance, asset surplus, subsidies, taxation – which the tool will apply according to the type of PPP. The cash-flows obtained through the data collection for each case study (costs and revenues) as well as those resulting from SMCP estimations are combined with a certain level of "discount rate". This will allow the simulation tool to evaluate the feasibility of a project if based solely on SMCP, compared to the conventional approach.

The dynamics of demand, which is critical to revenues, depends very much on the pricing policy. For instance, the application of a SMC based pricing instead of the currently applied price scheme (conventional approach) might cause a different user behaviour, thus affecting their travel choices.

In order to account for demand differences caused by SMC pricing the model will depart from the elasticity of demand to price:

$$\varepsilon_{D,T} = \frac{\Delta D / D}{\Delta P / P}$$

With

$\varepsilon_{D,P}$ - elasticity of demand to trip time

ΔD – variation in demand

D – initial demand

ΔP – variation in travel price

P – initial travel of travel price

The information on elasticity of demand to price crossed with pricing differences between currently applied prices and SMCP allows an estimation of demand variations between the two scenarios. It also enables the estimation of demand variations caused by time related changes of social marginal costs (e.g. changes driven by technological advances or evolving congestion levels).

Additionally, the tool is aimed to evaluate the financial burden differential caused by the risk premium associated with the use of social marginal cost pricing, as compared to a basic traditional demand based revenue scheme, whereby revenues are linearly proportional to demand. The methodology for such evaluation is described in the following section.

3.4.2 Demand Revenue Risk Analysis

The evaluation of a risk premium linked to deviations on demand based revenues is supported on the comparison between such deviations and consequences upon projected revenue levels. In the case of a basic demand based revenue scheme, where revenues are linearly proportional to transport activity (demand), it is obvious that so are their related risks. For instance, whenever demand is deviated by -10% from the estimated demand, revenues also deviate -10% from expected revenues. However, such linear proportionality is not necessarily kept if we apply social marginal cost based tariffs.

The analysis proposed in the simulation tool considers therefore that SMCP revenues are not linearly related to demand. Although it is plausible to assume that all categories of social marginal costs have this property, the case studies will focus on those measurable and, presumably, most risk distorting ones, namely:

- Congestion/scarcity costs (for all modes)
- Environmental atmospheric emissions (specially for road and air sectors)

The methodology applied considers also that there is a close relation between transport activity and social marginal costs for the infrastructure concerned, allowing to comparatively evaluate the risks associated to both traffic demand and resulting revenues. The methodology adopted for such evaluation is described next according to the following four steps:

1. Risk definition

Risk is broadly defined by the probability of specific eventualities. For practicality of analysis, risk (R) will here be represented by the ratio between the standard deviation (σ) and the expected value (*E*) of demand:

$$R_{demand} = \frac{\sigma_{demand}}{E(demand)}$$

The same kind of risk representation applies for the risk of revenues.

2. Relation between demand and revenues

The model assumes relationships between demand and SMCP revenues for the cost categories under analysis. In the road sector, a flow-speed function[8] is adopted:

$$v(Q) = \frac{v_0}{1 + \alpha . \left(\frac{Q}{c} \right)^{\beta}}$$

With: v_0 - free flow speed
Q - traffic level
c – infrastructure capacity
α, β - function parameters (depend on type of road)

The knowledge of infrastructure capacity, free flow speed and other road features allow to estimate practiced speed, with which we may then calculate congestion marginal costs through the following relation (IMPACT, 2008):

[8] BPR function (Bureau of Public Roads). Depending on the characteristics of the road infrastructure of the case studies, other functions may be used, e.g. from the COBA Manual (Department for Transport UK, 2004).

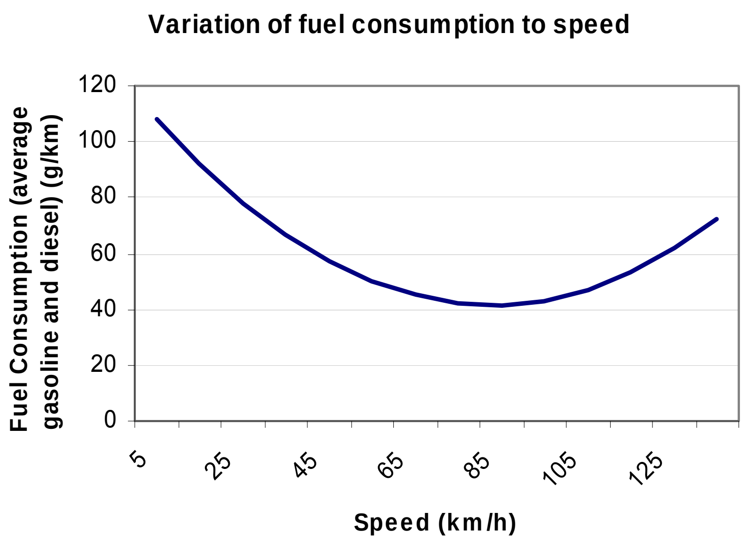
$$SMC_{cong} = \frac{VOT.Q}{v(Q)^2} \cdot \frac{\partial v(Q)}{\partial Q}$$

With: VOT – value of time

While the relationship between demand and SMCP revenues can be estimated for the road sector through speed/flow relationships parameterized for typified road sections, for railways and airports, “the interdependency between user costs and traffic demand is very difficult to be determined” (ENACT D2-I p.35)[9] which limits the expectation of performing simulations quantitatively rigorous for these two sectors. Despite this circumstance, general assumptions concerning such interdependency for the rail and air sectors may be applied to test possible profiles for revenue risks. In the absence of empirical parameterization for the concerned relation for the maritime sector, general assumptions are adopted. Again, it should be noticed that the simulation tool is not intended to be a blackbox where everything is set and unchangeable, but on the contrary, it is always possible to improve by adding new information, should it be made available.

A<u>tmospheric emissions</u> (*air pollution* and *global warming*) are analyzed for the road sector from the revenues risk perspective. Assuming that atmospheric emissions are proportional to fuel consumption[10], it is possible to obtain differential variations in atmospheric emission social marginal costs through the assumption of a fuel consumption-speed function:

Figure 2 - Variation of fuel consumption to speed



Source: based on COPERT 4 Methodology and Software Updates (presentation, Brussels, 2006-03-30)

[9] See also e.g. Nash and Samsom (1999), Calculating Transport Congestion and Scarcity Costs

[10] This is rigorous assumption for global warming emissions, but an approximation for air (local) pollutants

Due to technological development, price incentives and evolving regulations (Euro Emission Standards), not only are the average emissions per vehicle-kilometre values changing through time but so is their profile of variations with speed (as expressed in the figure above). For example, electric-hybrid vehicles highly reduce emissions at low speed levels, as compared to conventional vehicles. For this reason, different emission-speed functions may be tested against the effects over demand/revenue risks and also performance incentives (section 3.5).

3. Revenue risk assessment

The relation between demand and SMC based revenues is obtained by the relations above.

$$rev_{SMC_i}(D) = f_i(D)$$

With rev_{SMCi} -SMC pricing revenues of cost category i

f_i - function that relates demand with SMC pricing revenues of cost category i

Assuming that the standard deviation of revenues is obtained by[11]:

$$\sigma_{rev} = \sigma_{f_i} = f\left(E(D) + \sigma_D\right) - f\left(E(D)\right)$$

From which we get the measure of risk for SMC revenues:

$$R_{SMC_i} = \frac{\sigma_{SMC}}{E(SMC_i)}$$

4. Risk premium

The risk premium (RP) expected by a contractor for project appraisal increases with perceived risk. We may assume that:

$$RP = (rp.E(rev)).R$$

Where RP – Risk Premium (€)

rp – relative risk premium, as percentage of revenues

rev – revenues

[11] Which is either true or an approximation depending on the shape of the probability distribution for demand.

Relative risk premium (rp) can be intuitively understood as the extra percentual volume of expected revenues that would be demanded by the contractor for it to accept to carry out a project where revenue risk would be unitary, i.e. $\sigma_{rev} = E(rev)$.

3.4.3 Requested Data from Case Studies

3.4.3.1 Data on Costs and Revenues

The Simulation Tool is prepared to accept all relevant data for costs and revenues from Case Studies, as in the template described below:

Table 60 - Data requested for costs and revenues calculation

DATA REQUESTED	DESCRIPTION
General data	
Contract Duration	Contract duration, in years
Transport Activity	Transport activity (as requested as *inputs* in Chapter 2) for SMCP revenue calculation
Expected profit margin	Expected profit margin of the project
Costs	
Land Acquisition Costs	Costs with land acquisition imputed to the contractor
Construction and Planning Costs	Costs of infrastructure construction and project related planning, including insurance costs
Financing Costs	Financing costs of the project
Equipment Acquisition Costs	Acquisition costs of operations and maintenance equipment
Recruitment and Technical Training Costs	Costs of recruitment and technical training, particularly at the beginning of the project
Operation and Management Costs	Fixed and variable costs of operation of the service. Variable costs to be given as a function of vehicle-kilometres. (includes insurance costs, surveillance and enforcement, monitoring, administration, external impacts costs)
Maintenance Costs	Fixed and variable costs of repair & maintenance activities. Variable costs to be given as a function of vehicle-kilometres, including insurance costs. (includes insurance costs, monitoring, administration, external impacts costs)
Profits Taxation	Profits tax
Other Specific Taxation	Other specific taxation
Disposal/scrappage Costs	Costs with disposal or scrappage of equipment or infrastructure
Other Costs	As required by CS
Revenues	
User Charges	Revenues from collection of user tariffs
Fixed State Remuneration	Remuneration given by the state independent from demand level or performance of the contractor
Performance Remuneration	Remuneration dependent on contractor performance indicators
Shadow Toll Revenues	Remuneration dependent on demand not tolled
Asset Residual Value	Value of contractor assets at the end of the contract duration
Subsidies	Subsidies (EU or other)
Other Revenues	Any other costs and revenues

Some of the data categories above may not be applicable to some case studies. In fact only costs and revenues allocated to the contractor are relevant in the scope of the CS. If, for example, the PPP agreement does not include the infrastructure construction then this category should not be included in the dataset.

On the other hand, additional cost and revenue topics may be inserted in the simulation tool, under proposition of each case study, provided that "demand dependent costs" are duly specified and parameterized as a function of demand.

Finally, the analysis of demand variation caused by SMC pricing compared to conventional pricing schemes (as taken from CS) will require information on elasticity of demand to price from the current pricing scheme, should it be available or estimated.

Table 61 - Data requested for evaluation of demand variations due to SMCP application

Data requested	Description
Elasticity of Demand to Price	Elasticity of Demand to Price
Current pricing scheme	Quantitative description of current pricing scheme

The quantitative information on elasticity of demand to price is expected to be obtainable through demand forecasting models previously carried out for the infrastructure concerned.

3.4.3.2 Data for Revenue Risk Analysis

The analysis for the Road sector will depart from the following assumptions and data requests:

Table 62 - Assumptions for revenue risk analysis and data requested in road sector CS

Cost category	Model assumption on cost/activity relationship	Data requested for the road sector
Infrastructure	Linear	None
Congestion / Scarcity	Non-linear	- Infrastructure capacity - Infrastructure length - Infrastructure free flow speed - Transport activity in *vehicles/day* - Relationship between transport activity and speed
Air pollution	Non-linear	
Global warming	Non-linear	
Noise	Linear	None
Accident	Linear	None

For the remaining sectors, the data stated in the example above is only partially requested.

For further details, please refer to the following table that synthesizes the information requested for each sector:

Table 63 - Data requested for Revenue Risk Analysis

Cost category	Data requested
Road	- Infrastructure capacity - Infrastructure length - Infrastructure free flow speed - Transport activity - Relationship between transport activity and travel time
Railways	- Infrastructure capacity - Infrastructure length - Actual transport activity - Potential transport activity (*potential* transport activity, or demand, is that which would happen if the infrastructure had no capacity limitations)
Aviation	- Infrastructure capacity - Actual transport activity - Potential transport activity
Maritime	- Infrastructure capacity - Actual transport activity - Potential transport activity

Data requested on capacity, free flow speed, length and transport activity should be discriminated through network sections whenever capacity or free flow variables differ between sections (applicable for road and railway case studies). Any planned changes during the project lifetime of the items requested in the table above will need to be detailed.

Whenever information on the relationships between transport activity and social marginal costs due to congestion is not attainable by the case studies, the simulation tool will assume general relationships for simulation and qualitative analysis purposes.

Regarding environmental costs for the road sector, the simulation tool will adopt common assumptions such as in the case of the relationship between flow speed and congestion level caused by the traffic volumes.

3.4.3.3 Other relevant information

The case studies should supply any relevant information on contractual conditions relevant for the financial and risk analysis, particularly for comparison of SMCP with the actual contract conditions, namely concerning distribution of risks between private and public parties and foreseen contractual future options (like capacity expansions or service volume changes).

Other relevant information either for comparison purposes or to be entered as simulation input is project financial appraisal criteria from the contractor like the used discount rate or the risk premium.

Particularly concerning risk and risk premium of revenues, any information that would allow to parameterize the proposed methodology (3.4.2) is requested, namely the standard deviation of the probability profile of demand (σ_D) and the correspondent relative risk premium (rp). Whenever such kind of information will not be possible to obtain or do not apply to all case studies, the simulation tool may adopt general assumptions for purpose of analysis.

3.5 Incentives Analysis

As we have seen in WP3, revenues accrued from SMCP schemes may introduce incentives to the contractor that are contrary to social goals. In particular, the contractor has long term related incentives to keep SMC high. The simulation tool is therefore designed to account for the direction of the incentive produced, i.e. whether it is directed for or against social goals.

3.5.1 Methodology

The methodology consists in calculating the contractor's *profit maximization capacity*. The *profit maximization capacity* is the hypothetical infrastructure capacity that would maximize contractor's revenues (assuming fixed costs). Two possibly contradictory forces balance this variable:

- the amount of transport activity
- the amount of marginal social costs caused per passenger.

For instance, while a high capacity clearly contributes to increase transport activity, it may simultaneously have a negative contribution to increase SMCP revenues (take e.g. congestion costs), contrary to the private interest of the contractor.

3.5.2 Requested data from Case Studies

The data necessary for calculating the *contractor's profit maximization capacity* is:

- Volume of transport activity
- Relation between volume of transport activity and SMCP revenues (demand)
- Relation between capacity and demand

The first two items of data are already requested for in accordance with the provisions laid out in the previous chapter. It is acknowledge that establishing a relation between capacity and demand differs conceptually between transport sectors. Indeed, such a relation is hard to conceptualize and gathering data for sectors other than road can prove difficult. For this reason, the simulation tool performs an incentive analysis attached to real data only for case studies within the road sector, whereas for the other sectors general assumptions on the relation between capacity and demand will be adopted. The approach followed and data requested, sector by sector, is described below:

Road Sector

The relation between capacity and demand may be derived by the elasticity of demand to travel time, given by:

$$\varepsilon_{D,T} = \frac{\Delta D / D}{\Delta T / T}$$

with

$\varepsilon_{D,T}$ - elasticity of demand to trip time

ΔD – variation in demand

D – initial demand

ΔT – variation in travel time

T – initial travel time

Elasticity of demand to travel time is therefore a requested input for road case studies. Discriminated elasticities for different network sections should be provided if variations occur along the network. This quantitative information is expected to be obtainable through traffic forecasting models previously executed for the infrastructure of the case study.

Railway Sector

In the case of the railway sector, if potential demand is higher than capacity (with the consequent scarcity cost pricing collected to actual demand) such a demand can be totally accommodated through a capacity increase. On the other hand, the maintenance of a capacity smaller than potential demand increases scarcity costs. A model for testing such incentives will be used. This model will depart from information on the infrastructure capacity, its actual and potential demands (data already requested above) and the adopted general assumption on the relation between capacity, potential demand and scarcity costs.

Aviation Sector and Maritime/IWW Sectors

Regarding the aviation and maritime/IWW sectors, the methodology and type of data is similar to the railway sector, with the due differences in traffic volume representation.

4 SIMULATION APPLICATION

The several sub-models described in the previous chapter are hereby integrated to form a single simulation model for the elaboration of the Case Studies/Simulations. The technical implementation of the model recourses to VBA (Microsoft Visual Basic for Applications) on MS EXCEL, allowing a universal platform for further use in the development of the case studies. The simulation model tool will herewith designed as the ENACT Simulation Tool.

This chapter presents the general description of the ENACT Simulation Tool and its possible outputs for the analysis of effects of application of Social Marginal Cost Pricing (SMCP) in PPP's. It also features an illustration of the application of the tool, by showing a series of screenshots reflecting the user interface for the Case Studies.

4.1 General Description

The ENACT Simulation Tool is intended to test the theoretical construct of the previous Work packages, namely through finding whether social marginal cost pricing can be made reasonably consistent (from the revenues viewpoint) with the involvement of the private sector in the provision of transport infrastructure and/or services, while helping to point out the most efficient ways to share of responsibilities and risks between the public and private parties.

In line with the review of the work performed in previous stages of the ENACT project, the Simulation Tool covered the following key topics:

- SMCP Revenue Accounting Issues
- Financial and Risk Analysis
- Incentives Analysis Issues

The first topic (<u>SMCP Revenue Accounting</u>) features the estimation of revenues generated by SMC pricing. Revenues are calculated based on the social costs caused by the expected demand on the infrastructure, which are supposed to equalize the sum of social marginal costs caused by all individual infrastructure users. The tool enables the application of top-down SMCP revenue accounting methodologies based on empirical knowledge supplied by the literature gathered in Work Package 2 as well as other reference sources.

The second topic (<u>Financial and Risk Analysis</u>) covers a financial project evaluation and a demand/revenue risk analysis. The financial project evaluation includes the consideration of the demand/revenue risk analysis into the project financial appraisal. The Financial and Risk Analysis therefore comprises two main goals:

- Verify whether the revenues achieved through SMCP are enough to cover the required project financing.
- Assess revenue risk posed by SMCP and assess their correspondent financial risk premium.

The first goal is achieved through the calculation of the NPV (Net Present Value) of the project. The demand/revenue risk analysis features the evaluation of an additional financial burden caused by the use of social marginal costs and its possible risk premium. The fact that SMCP driven revenue is proportional to social costs, instead of proportional to transport activity like in common PPP's, may cause additional revenue risks. The simulation tool evaluation takes into account the relation between transport activity and social costs and derives the risks on revenues resultant primarily from risks on transport activity based on risk premium applied by the common revenue structures present in the case studies. Finally, the financial and risk analysis determines the amount of extra or deficit remuneration required for financing the private parties involved in the PPP.

The third topic (Incentives Analysis) assesses the incentives to the contractor to meet social goals in connection to a pricing scheme based in SMCP. This implies the assumption that the contractor has long run incentives to keep social marginal costs high and therefore the simulation tool is ready to provide an account of the direction of the incentive, i.e. whether it is directed for or against social goals.

The methodology used in this "Incentives Analysis" consists in calculating the contractor's *profit maximization capacity* (as methodologically described 3.5.1). The relevance of applying the notion of the *profit maximization capacity* is that it helps assessing contractor's incentives e.g. in relation to Capacity provision, either increasing or decreasing it.

This question should lead to analyse several possible incentive related issues, such as:

- If the contractor's *profit maximization capacity* turns to be lower than the capacity of the infrastructure, does it work has an incentive to artificially reduce the infrastructure capacity (e.g. by prolonging capacity reductions due to maintenance works or accidents).
- If the contractor is allowed to increase capacity during the concession timeframe at its own judgment, will he do so on a socially optimum way?
- In the event of a PPP contract for a transport service operation where the contractor has the freedom to increase service frequency and such an action influences social marginal costs, will it do so on a socially optimum way?

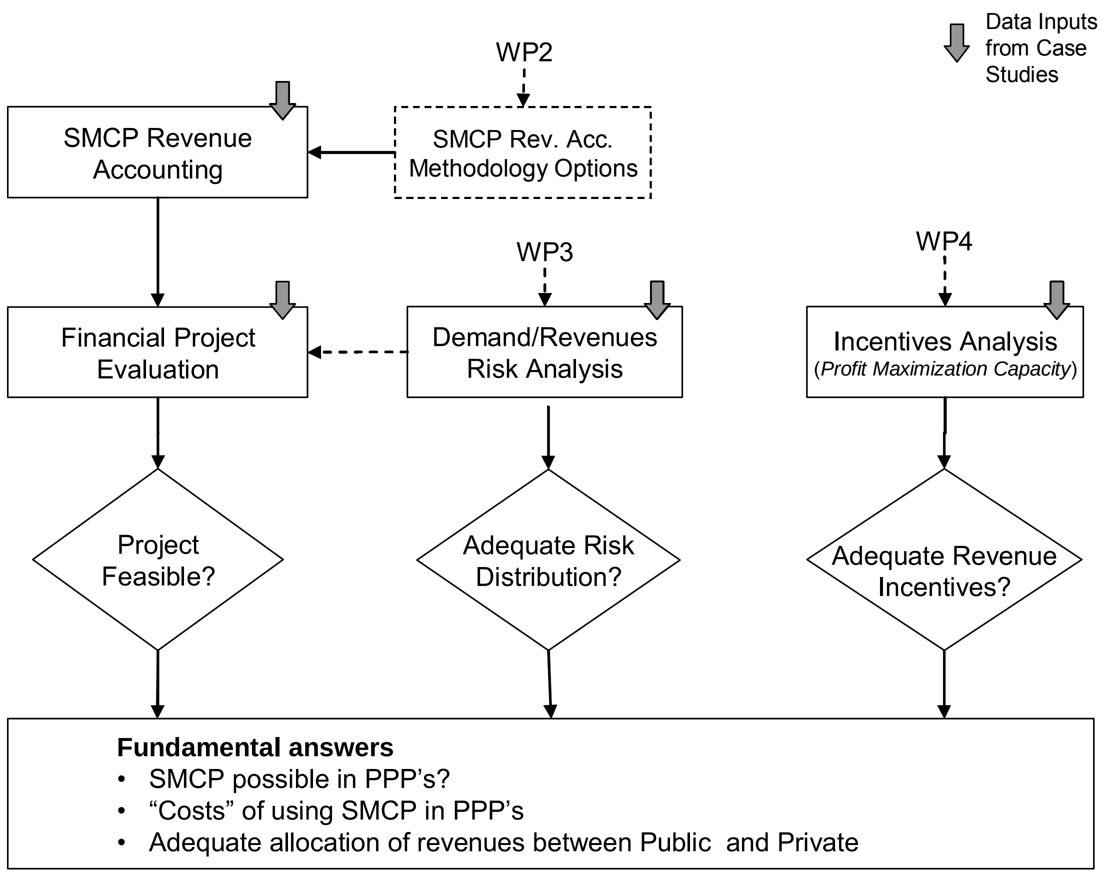
Given that the various social cost categories may cause different directions of incentive, the tool is ready to simulate the effects of selecting and leaving out some categories of SMC revenues.
It should be noticed that the conclusions from case studies, based on this feature of the ENACT Simulation Tool, are assumed to be qualitative to the extent that they will be able to point out the direction of incentives resulting on the contractor side.

The Simulation Tool is formed by the following main modules:

- PPP General Features
- SMCP Revenue Accounting
- Financial Evaluation
- Demand/Revenues Risk Analysis
- Incentives Analysis
- Summary of findings

The following Figure shows the general structure of the ENACT Simulation Tool and its key features:

Figure 3 - ENACT Simulation Tool general structure, inputs and outputs



4.2 Review of Existing SMC Simulation Tools

The most relevant simulation of SMC within the transport sector is the GRACE[12] model. Within the GRACE - Generalization of Research on Accounts and Cost Estimation – project (2005), a software tool was developed in order to assist the user in the estimation of marginal costs.

The GRACE model covered road, rail, air and maritime transport and accounted for marginal costs of air pollution, noise, accidents, congestion/scarcity, global warming and wear and tear. It was designed with the particular aim of covering sections/nodes of the TEN-T for which all the detailed information required for a fully fledged, bottom-up calculation does not exist. It was thus designed to serve user cases for which no deep data collection would be available, providing them with a more straightforward way of estimating marginal costs.

Like the SMC Revenue Accounting module of the ENACT tool, it drew heavily on previous RTD projects that have addressed the calculation of marginal costs, and also GRACE case studies. The GRACE tool incorporated methods aimed at ensuring the transferability of marginal costs estimates and their generalization, i.e. identifying the variables (cost drivers) and parameters whereby existing marginal costs could be adapted to different contexts and/or new estimations carried out.

Marginal costs estimates for the use of transport infrastructure have been produced for a wide range of situations, and using a variety of different approaches. GRACE case studies have in general shown that:

- There is no standard methodology for marginal costs estimation, and that the methodological approaches available are strongly influenced by data availability issues and by the type of transport mode under examination.
- Transferability methods cannot be implemented with the same degree of confidence across all cost categories. Although much of the effective implementation depends on sheer data availability, the level of difficulty varies with the cost categories.

Finally, the GRACE case studies confirmed through the application of the tool that there are large differences in marginal social cost by time, space and vehicle types that are not internalised in existing charges.

The ENACT Simulation Tool anticipated the information and transferability constraints found by

[12] GRACE - Generalization of Research on Accounts and Cost Estimation (2006)

GRACE and was designed such as to provide flexibility to case studies both in data collection and in cost parameterization. This is done through:

- The provision of more than one SMC calculating function ("Revenue Accounting Methodology Options") for the modes and cost categories for which the literature provided different feasible alternatives.
- The possibility to use case-specific values for cost parameters in alternative to the default values of the Simulation Tool, which may be particularly useful for cost categories where transferability is not applicable with a good degree of confidence.
- The possibility to use case-specific SMC calculating functions, enabling the case studies to use variables (cost drivers) and cost parameters consistent with the availability of data and particular features of the case study.

The ENACT Simulation Tool performs a similar task as the GRACE marginal cost calculation model in calculating expected marginal costs caused by the use of transport infrastructures. However, it differs in the way it is designed to provide flexibility towards data collection and methodological cost accounting approaches, given its goal to be adaptable to specific features of the ENACT case studies.

In addition to cost calculation, the ENACT model goes further and provided entirely new insights by testing:

- practical implications of social marginal cost pricing over the possibility of infrastructure cost recovery;
- risks associated with SMCP revenues, and;
- incentives placed on operators by the pricing structures implied by SMCP.

4.3 Testing Case Study

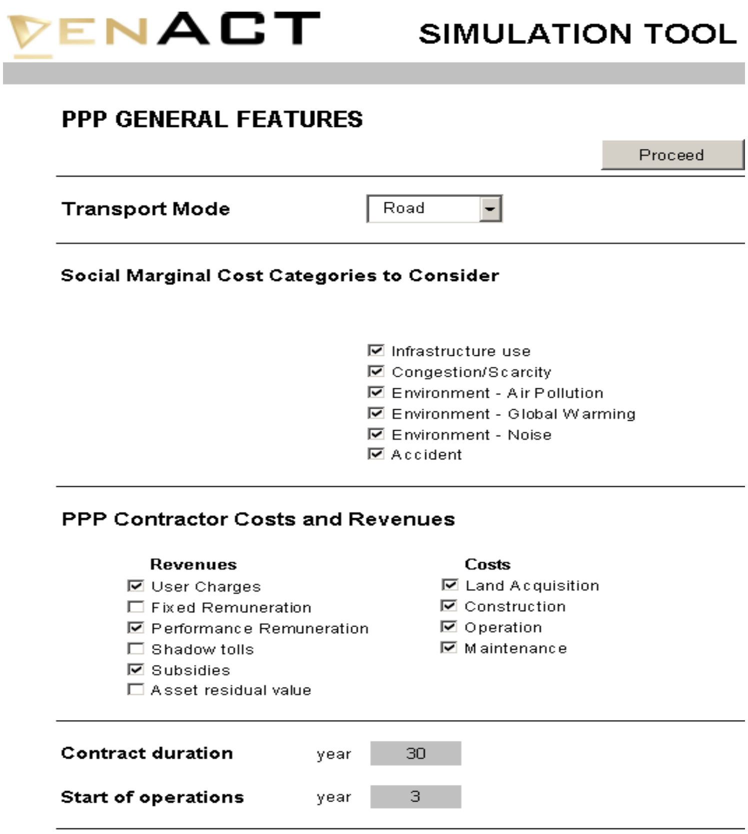
The following sections present a description of the modules based on a testing case study for a real motorway in a European country. The example briefly shows how the Simulation Model can be used in a real context based on actual data to perform the comparative analysis that underlies the objectives set for the simulation tool, i.e. to assess whether SMC pricing can, under any circumstances, be competitive in relation to conventional approaches from the perspective of total revenues accrued.

4.3.1 PPP General Features

In the first module of the ENACT Simulation Tool general information on the PPP Case Study is introduced, namely:

- **Transport mode**: Road, Railways, Aviation or Maritime
- **Social Marginal Costs** to be considered: Infrastructure use, Congestion/Scarcity, Environment – Air Pollution, Environment – Global Warming, Environment – Noise, Accident
- PPP contractor applicable **Costs and Revenues**: Selection of revenues and costs for the contractor included in the PPP contract for the case study concerned. Revenues include User Charges, Fixed Remuneration from the State, Performance based Remuneration, Shadow Tolls, Subsidies and Asset Residual Value. Costs include Land Acquisition, Construction, Operation and Maintenance.
- **Contract duration**: duration of the PPP contract, including construction time
- **Start of operations**: start of operations of the infrastructure / service

Figure 4 - ENACT Simulation Tool: PPP General Features



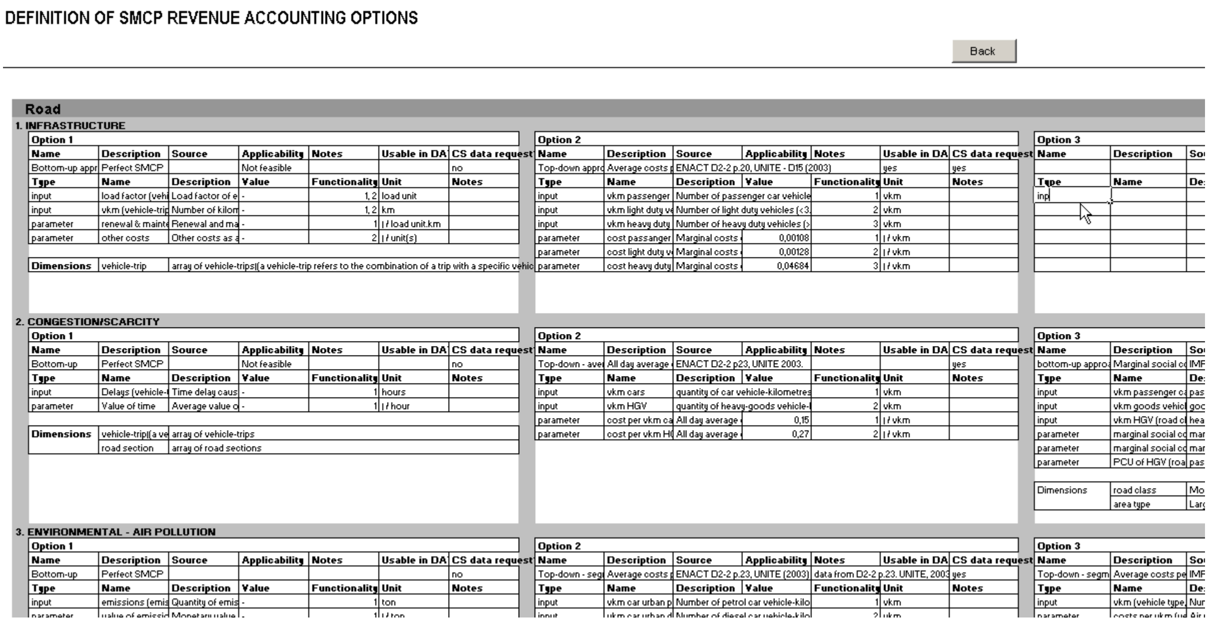
4.3.2 SMCP Revenue Accounting

In SMCP revenue accounting the Simulation Tool estimates the amount of revenues that would be received from SMC pricing. For this task the user has at least one available default revenue accounting methodology Option for each of the Cost Categories.

It is possible for the user to add and apply other options within the Revenue Accounting Options Database. This requires establishing a linear function relating variables (inputs and parameters) with SMCP revenues. Its variables must be inserted and its units, values and “role” (functionality) within the revenue accounting formula specified.

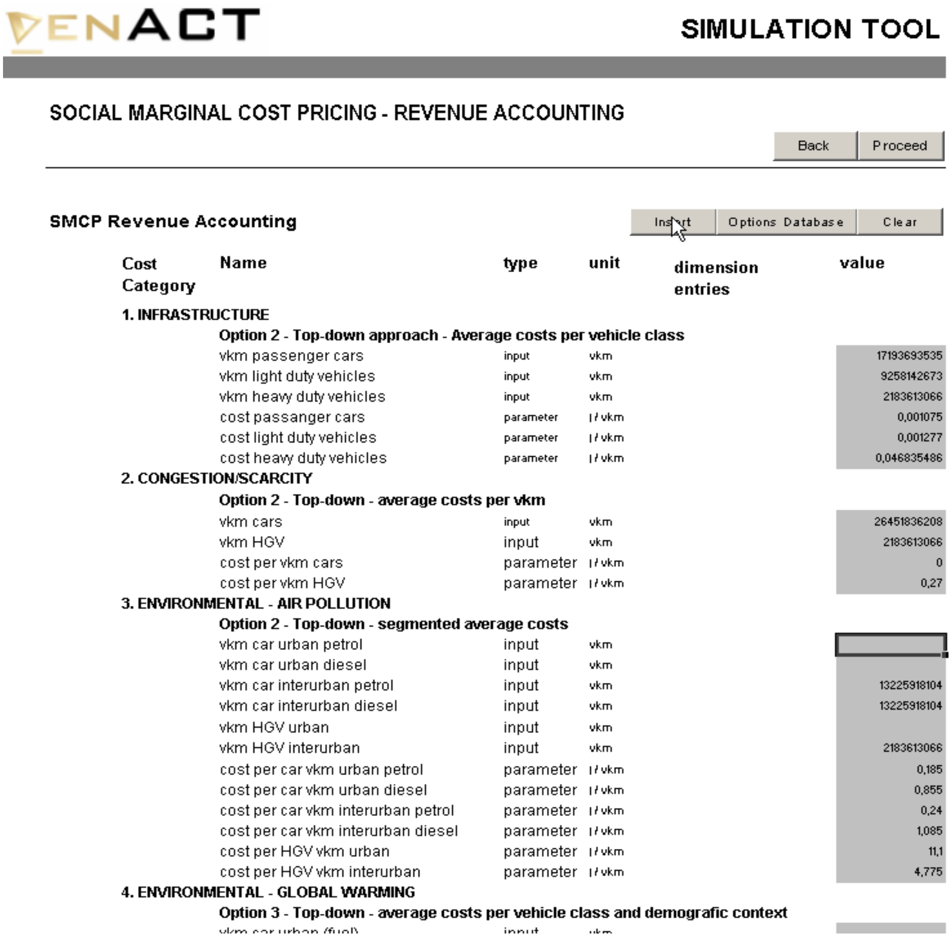
Variables within revenue accounting formulas are of two Types: Inputs and Parameters. Input variables refer to specific data of transport activity and its characteristics (e.g. “vehicle-kilometres of passenger cars”) and parameter variables establish the relations between input variables and SMC/revenues.

Figure 5 -ENACT Simulation Tool: SMCP Revenue Accounting Options Database



The user is given the choice to use one among the revenue accounting options available in the options database, for each SMC cost category. After choosing the options most suited to the case study, the user is set to introduce the input values of the case study.

Figure 6 - ENACT Simulation Tool: SMCP Revenue Accounting



4.3.3 Financial Evaluation

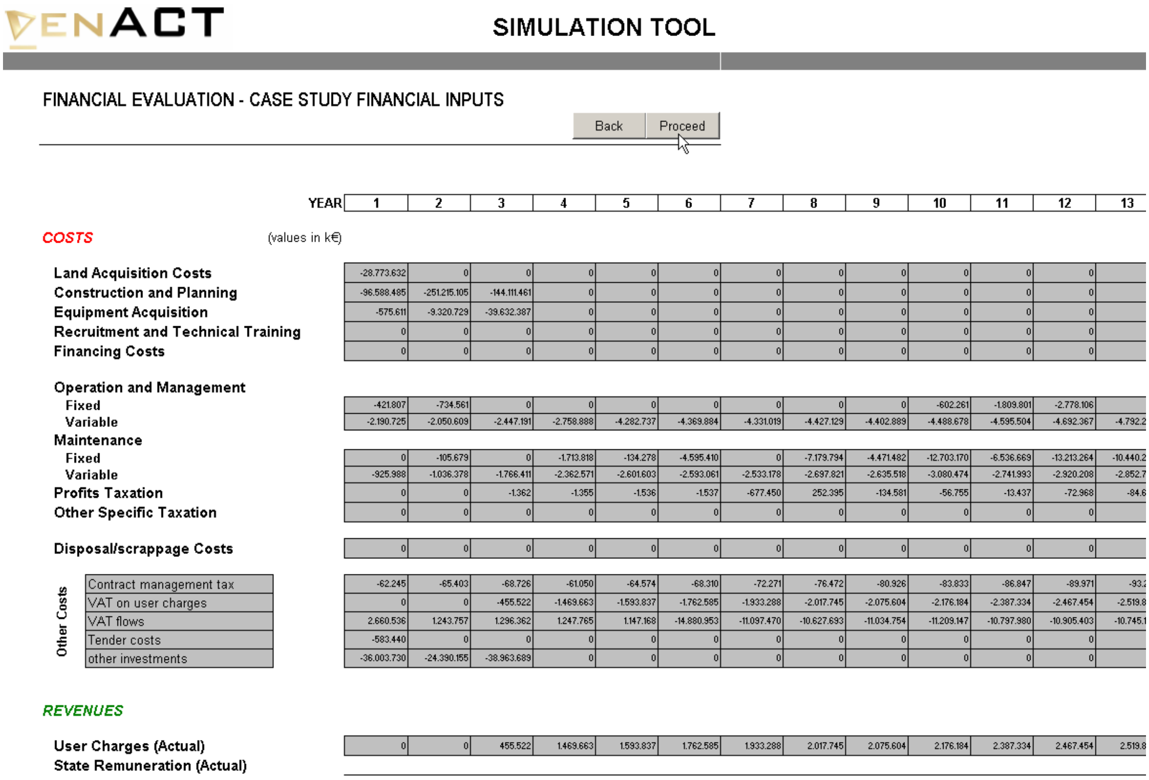
The financial evaluation calculates the Net Present Value (NPV) of the project for the case study in the actual situation and in the SMCP scenario. The SMCP scenario assumes that the contractor is remunerated not only through SMCP revenues but also by any Subsidies or Other Revenues (like commercial revenues) present in the actual remuneration scheme.

The financial evaluation additionally compares different NPV's calculated under different demand based revenue risk assumptions:

- With no revenue risks considered
- With "conventional" demand based revenue risks
- With "full (SMCP)" demand based revenue risks

The user is first requested to introduce all relevant costs and revenues of the case study. This data is requested yearly, for all the time period of the contract, in real terms.

Figure 7 - ENACT Simulation Tool: Financial Evaluation - Case Study Financial Inputs

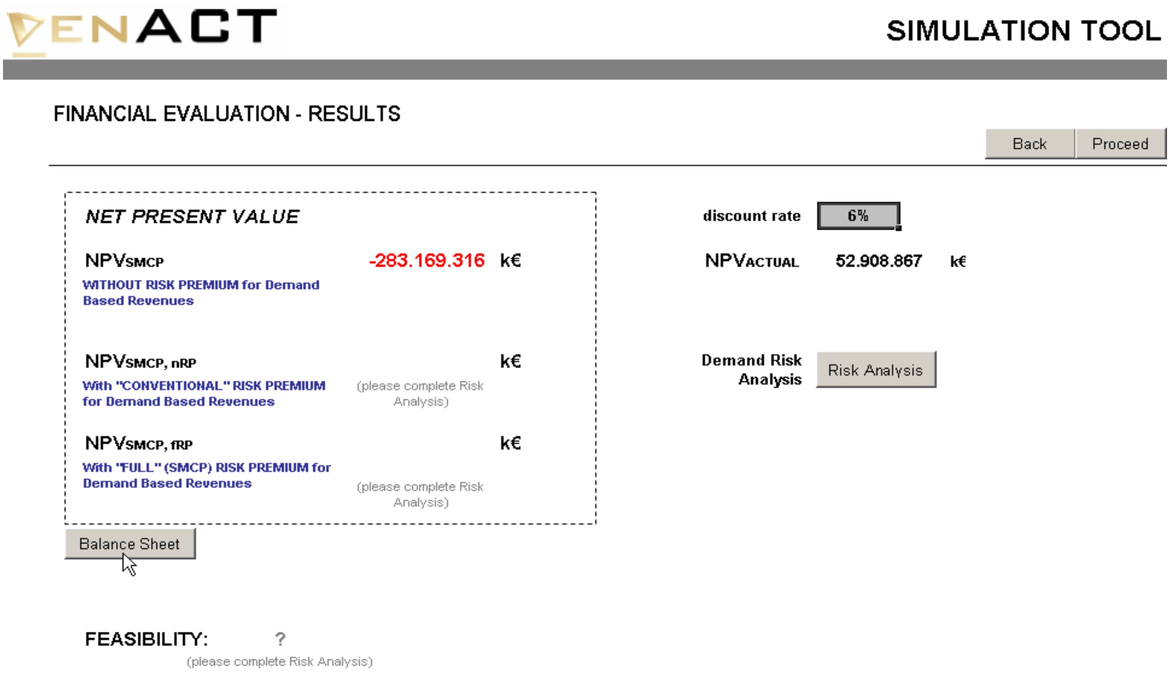


FINANCIAL EVALUATION - CASE STUDY FINANCIAL INPUTS

YEAR	1	2	3	4	5	6	7	8	9	10	11	12	13
COSTS (values in k€)													
Land Acquisition Costs	-28.773.632	0	0	0	0	0	0	0	0	0	0	0	
Construction and Planning	-96.588.485	-251.215.105	-144.111.461	0	0	0	0	0	0	0	0	0	
Equipment Acquisition	-575.611	-9.320.729	-39.632.387	0	0	0	0	0	0	0	0	0	
Recruitment and Technical Training	0	0	0	0	0	0	0	0	0	0	0	0	
Financing Costs	0	0	0	0	0	0	0	0	0	0	0	0	
Operation and Management													
Fixed	-421.807	-734.561	0	0	0	0	0	0	0	-602.261	-1.809.801	-2.778.106	
Variable	-2.190.725	-2.050.609	-2.447.191	-2.758.888	-4.282.737	-4.369.884	-4.331.019	-4.427.129	-4.402.889	-4.488.678	-4.595.504	-4.692.367	-4.792.2
Maintenance													
Fixed	0	-105.679	0	-1.713.818	-134.278	-4.595.410	0	-7.179.794	-4.471.482	-12.703.170	-6.536.669	-13.213.264	-10.440.2
Variable	-925.988	-1.036.378	-1.766.411	-2.362.571	-2.601.603	-2.593.061	-2.533.178	-2.697.821	-2.635.518	-3.080.474	-2.741.993	-2.920.208	-2.852.7
Profits Taxation	0	0	-1.362	-1.355	-1.536	-1.537	-677.450	252.395	-134.581	-56.755	-13.437	-72.968	-84.6
Other Specific Taxation	0	0	0	0	0	0	0	0	0	0	0	0	
Disposal/scrappage Costs	0	0	0	0	0	0	0	0	0	0	0	0	
Other Costs: Contract management tax	-62.245	-65.403	-68.726	-61.050	-64.574	-68.310	-72.271	-76.472	-80.926	-83.833	-86.847	-89.971	-93.2
Other Costs: VAT on user charges	0	0	-455.522	-1.469.663	-1.593.837	-1.762.585	-1.933.288	-2.017.745	-2.075.604	-2.176.184	-2.387.334	-2.467.454	-2.519.8
Other Costs: VAT flows	2.660.536	1.243.757	1.296.362	1.247.765	1.147.168	-14.880.953	-11.097.470	-10.627.693	-11.034.754	-11.209.147	-10.797.980	-10.905.403	-10.745.1
Other Costs: Tender costs	-583.440	0	0	0	0	0	0	0	0	0	0	0	
Other Costs: other investments	-36.003.730	-24.390.155	-38.963.689	0	0	0	0	0	0	0	0	0	
REVENUES													
User Charges (Actual)	0	0	455.522	1.469.663	1.593.837	1.762.585	1.933.288	2.017.745	2.075.604	2.176.184	2.387.334	2.467.454	2.519.8
State Remuneration (Actual)													

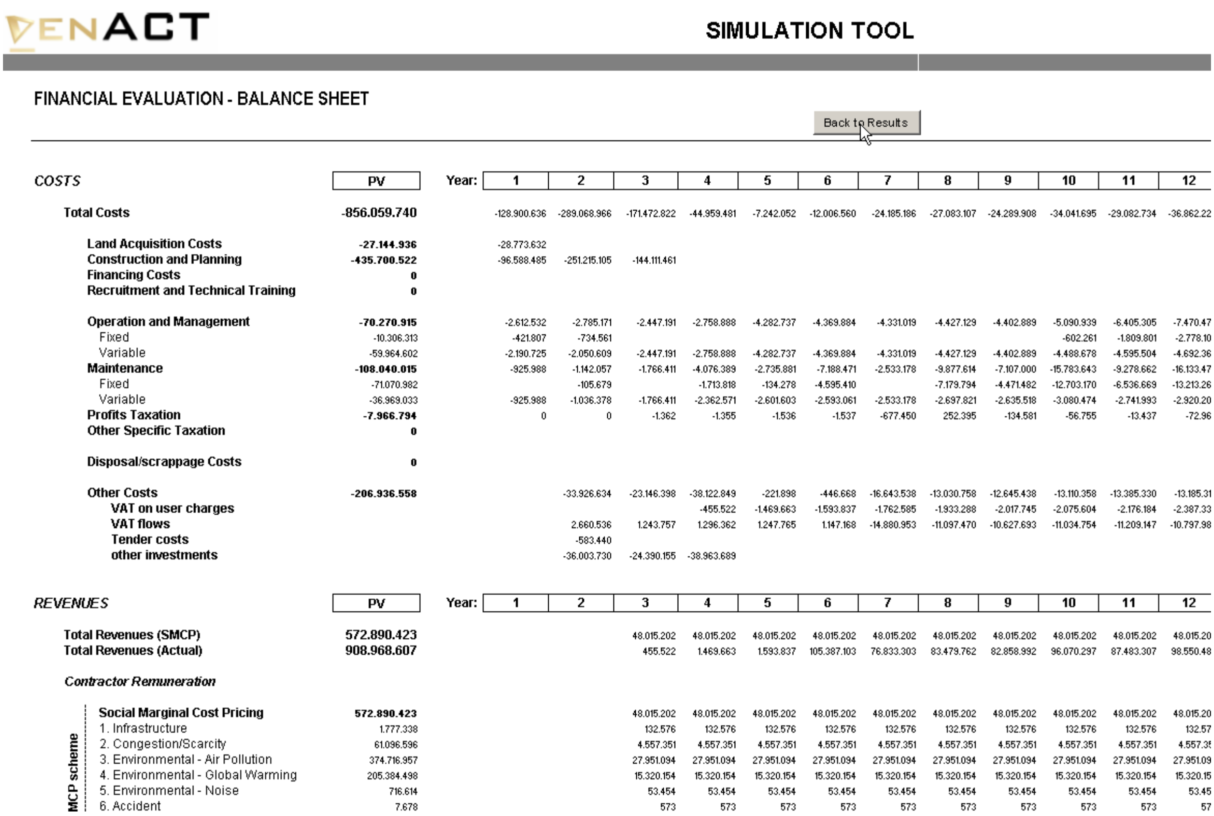
With all data on actual costs and revenues of the case study and SMCP revenues inserted, and for a provided financial discount rate, the Simulation Tool is able to calculate the NPV with "no revenue risk" for the actual scenario and for the SMCP scenario, which may at this point be compared with each other. A positive (negative) value of the NPV for the SMCP scenario means that SMCP revenues are (not) enough to cover for the desired remuneration by the private party.

Figure 8 - ENACT Simulation Tool: Financial Evaluation - Results



The drivers of the result may be observed in the financial balance sheet of the project, including actual and SMCP revenues:

Figure 9 - ENACT Simulation Tool: Financial Evaluation - Balance Sheet



COSTS	PV	Year: 1	2	3	4	5	6	7	8	9	10	11	12
Total Costs	**-856.059.740**	-128.900.636	-289.068.966	-171.472.822	-44.959.481	-7.242.052	-12.006.560	-24.185.186	-27.083.107	-24.289.908	-34.041.695	-29.082.734	-36.862.22
Land Acquisition Costs	**-27.144.936**	-28.773.632											
Construction and Planning	**-435.700.522**	-96.588.485	-251.215.105	-144.111.461									
Financing Costs	**0**												
Recruitment and Technical Training	**0**												
Operation and Management	**-70.270.915**	-2.612.532	-2.785.171	-2.447.191	-2.758.888	-4.282.737	-4.369.884	-4.331.019	-4.427.129	-4.402.889	-5.090.939	-6.405.305	-7.470.47
Fixed	-10.306.313	-421.807	-734.561								-602.261	-1.809.801	-2.778.10
Variable	-59.964.602	-2.190.725	-2.050.609	-2.447.191	-2.758.888	-4.282.737	-4.369.884	-4.331.019	-4.427.129	-4.402.889	-4.488.678	-4.595.504	-4.692.36
Maintenance	**-108.040.015**	-925.988	-1.142.057	-1.766.411	-4.076.389	-2.735.881	-7.188.471	-2.533.178	-9.877.614	-7.107.000	-15.783.643	-9.278.662	-16.133.47
Fixed	-71.070.982		-105.679		-1.713.818	-134.278	-4.595.410		-7.179.794	-4.471.482	-12.703.170	-6.536.669	-13.213.26
Variable	-36.969.033	-925.988	-1.036.378	-1.766.411	-2.362.571	-2.601.603	-2.593.061	-2.533.178	-2.697.821	-2.635.518	-3.080.474	-2.741.993	-2.920.20
Profits Taxation	**-7.966.794**	0	0	-1.362	-1.355	-1.536	-1.537	-677.450	252.395	-134.581	-56.755	-13.437	-72.96
Other Specific Taxation	**0**												
Disposal/scrappage Costs	**0**												
Other Costs	**-206.936.558**		-33.926.634	-23.146.398	-38.122.849	-221.898	-446.668	-16.643.538	-13.030.758	-12.645.438	-13.110.358	-13.385.330	-13.185.31
VAT on user charges					-455.522	-1.469.663	-1.593.837	-1.762.585	-1.933.288	-2.017.745	-2.075.604	-2.176.184	-2.387.33
VAT flows			2.660.536	1.243.757	1.296.362	1.247.765	1.147.168	-14.880.953	-11.097.470	-10.627.693	-11.034.754	-11.209.147	-10.797.98
Tender costs			-583.440										
other investments			-36.003.730	-24.390.155	-38.963.689								

REVENUES	PV	Year: 1	2	3	4	5	6	7	8	9	10	11	12
Total Revenues (SMCP)	**572.890.423**			48.015.202	48.015.202	48.015.202	48.015.202	48.015.202	48.015.202	48.015.202	48.015.202	48.015.202	48.015.20
Total Revenues (Actual)	**908.968.607**			455.522	1.469.663	1.593.837	105.387.103	76.833.303	83.479.762	82.858.992	96.070.297	87.483.307	98.550.48
Contractor Remuneration													
MCP scheme: **Social Marginal Cost Pricing**	**572.890.423**			48.015.202	48.015.202	48.015.202	48.015.202	48.015.202	48.015.202	48.015.202	48.015.202	48.015.202	48.015.20
1. Infrastructure	1.777.338			132.576	132.576	132.576	132.576	132.576	132.576	132.576	132.576	132.576	132.57
2. Congestion/Scarcity	61.096.596			4.557.351	4.557.351	4.557.351	4.557.351	4.557.351	4.557.351	4.557.351	4.557.351	4.557.351	4.557.35
3. Environmental - Air Pollution	374.716.957			27.951.094	27.951.094	27.951.094	27.951.094	27.951.094	27.951.094	27.951.094	27.951.094	27.951.094	27.951.09
4. Environmental - Global Warming	205.384.498			15.320.154	15.320.154	15.320.154	15.320.154	15.320.154	15.320.154	15.320.154	15.320.154	15.320.154	15.320.15
5. Environmental - Noise	716.614			53.454	53.454	53.454	53.454	53.454	53.454	53.454	53.454	53.454	53.45
6. Accident	7.678			573	573	573	573	573	573	573	573	573	57

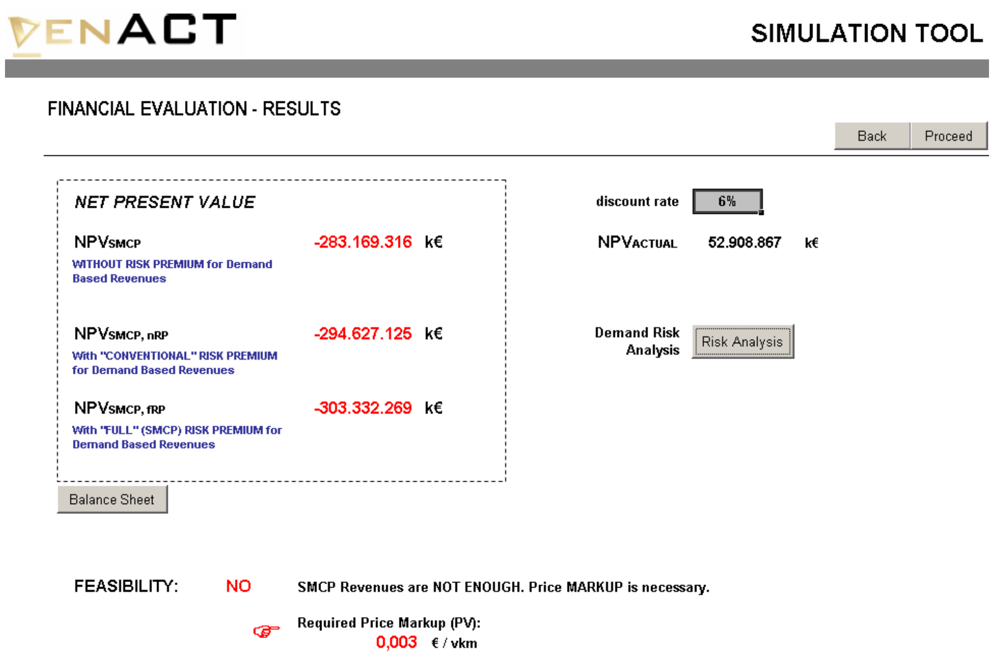
The calculation of "conventional" and "full (SMCP)" demand based revenue risk NPV's requires the fulfilment of the risk analysis module of the tool (see its description in the following section). That done, NPV's are calculated which incorporate "conventional" and "full (SMCP)" risk premiums into the financial analysis, as SMCP risk premium is the one appropriate for a financial analysis of a SMCP based PPP.

The "conventional" risk is the one that would occur with a conventional pricing scheme. A conventional pricing scheme is defined by having prices independent of the level of demand. In this case, revenues are linearly proportional to demand, which as seen before does not happen with SMCP revenues.

SMCP demand based revenues risk may either result higher or lower than conventional risk. As seen in the following section, this outcome will depend on:

- The price-demand functions considered
- The level of transport activity (demand)
- The characteristics of the case study.

Figure 10 - ENACT Simulation Tool: Financial Evaluation - Results with Risk Analysis

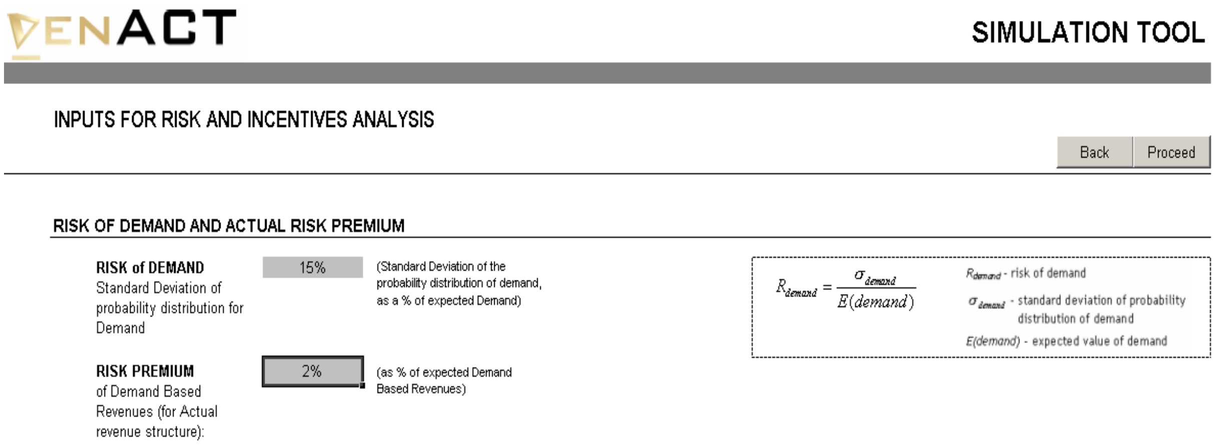


The financial analysis finally concludes on the financial viability of the project based on the SMCP NPV with full risk considerations. Depending on the outcome, either negative or positive, the Simulation Tool respectively quantifies the average price markup necessary for the project to hold or the average revenue per infrastructure user in excess of minimum revenue requirements. In alternative to a price markup, the user may calculate the cost of public funds associated with the total subsidy required to guarantee cost recovery.

4.3.4 Demand/Revenues Risk Analysis

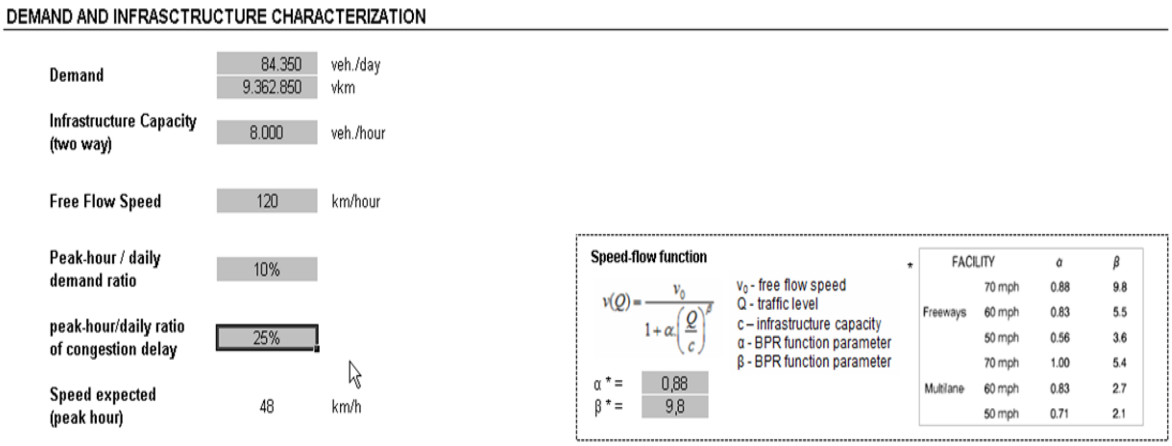
The demand based revenues risk analysis aims to compare revenues dependent on the level of demand, between a conventional demand/revenue structure approach and the SMCP approach. Based on this comparison, and on the risk premium attributed to the risk of demand based revenues in the case study, a risk premium for the given SMCP demand/revenues structure is calculated. Several inputs are requested here, with "Risk of Demand" and "Relative Risk Premium" for the actual case (as defined in section 3.4.2) being a common input to all modes.

Figure 11 - ENACT Simulation Tool: Inputs for Risk and Incentives Analysis - Risk of Demand and Risk Premium for demand based revenues



Demand and infrastructure characterization is then requested for insertion. Its contents will depend on the transport sector concerned and require "demand" and "capacity" information.

Figure 12 - ENACT Simulation Tool: Inputs for Risk and Incentives Analysis - Demand and Infrastructure Characterization



DEMAND AND INFRASCTRUCTURE CHARACTERIZATION

Demand	84.350	veh./day
	9.362.850	vkm
Infrastructure Capacity (two way)	8.000	veh./hour
Free Flow Speed	120	km/hour
Peak-hour / daily demand ratio	10%	
peak-hour/daily ratio of congestion delay	25%	
Speed expected (peak hour)	48	km/h

Speed-flow function

$$v(Q) = \frac{v_0}{1+\alpha\left(\frac{Q}{c}\right)^{\beta}}$$

v_0 - free flow speed
Q - traffic level
c – infrastructure capacity
α - BPR function parameter
β - BPR function parameter

α * = 0,88
β * = 9,8

*	FACILITY	α	β
Freeways	70 mph	0.88	9.8
	60 mph	0.83	5.5
	50 mph	0.56	3.6
Multilane	70 mph	1.00	5.4
	60 mph	0.83	2.7
	50 mph	0.71	2.1

The relevant social marginal costs are subsequently calculated, for positive and negative standard deviation shifts of expected demand, on the basis of the assumed functions of SMCP revenues to demand. This allows the relative comparison of risk of demand (conventional revenues) with risk of SMCP revenues, as illustrated in the figure below

Figure 13 - ENACT Simulation Tool: Inputs for Risk and Incentives Analysis - Social Marginal Costs Calculation

SOCIAL MARGINAL COSTS CALCULATION

CONGESTION

Value of Time 15 €/veh.h

$SMC_{cong.}$ calculation	Demand level			unit
	E(D)	E(D) - std(D)	E(D) + std(D)	
Demand	84.350	71.698	97.003	veh/day
Speed	48,4	92,3	17,6	km/h
dv(Q)/dQ	-0,0336	-0,0292	-0,0152	1/veh.
peak-hour $SMC_{cong.}$	15.277,6	2.641,1	69.118,2	€/hour
total SMC_{cong}	61.110	10.564	276.473	€/day

E(D) - Expected demand
std(D) - standard deviation of demand

Congestion SMC function

$$SMC_{cong} = \frac{VOT.Q}{v(Q)^2}\cdot\frac{\partial v(Q)}{\partial Q}$$

VOT – value of time
v(Q) – Speed-flow function

GLOBAL WARMING and AIR POLLUTION

Social Marginal Costs

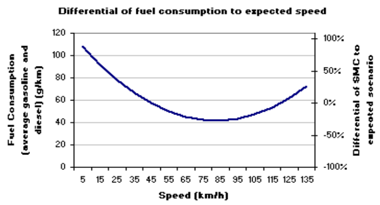
	With E(Demand)	With E(Demand) - st.dev.	With E(Demand) + st.dev.	unit
Speed	48,4	92,3	17,6	km/h
total $SMC_{A.P.}$	374.716.957	297.846.723	595.451.415	k€
total $SMC_{G.W.}$	205.384.498	163.251.485	326.370.311	k€

Fuel consumption to speed function

$$FC = a + b.v + c.v^2 + d.v^3 + e.v^4$$

v - speed

a	b	c	d	e
116,97	-1,83	0,0111	0	0



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The crossed knowledge of risk of demand, actual risk premium for demand based revenues and relative risk comparison between conventional and SMCP scenarios, enables the calculation of the differential Risk Premium between the two scenarios and consequently the absolute Risk Premium for SMCP. This feeds the risk weighed NPV calculation of the Financial Evaluation module.

Figure 14 - ENACT Simulation Tool: Risk Analysis - Risk Premium of SMCP Revenues

ENACT SIMULATION TOOL

RISK ANALYSIS - RISK PREMIUM OF DEMAND BASED REVENUES

Back | Proceed to Results

RISK of DEMAND
Standard Deviation of probability distribution for Demand: **15%**

Social Marginal Cost Pricing Revenue Scheme

RISK PREMIUM on REVENUES from:	Risk Premium as % of revenues	Risk Premium in k€	Expected Revenues (k€)
Social Marginal Cost Pricing	**3,5%**	**20.162.953**	**572.890.423**
1. Infrastructure	2,0%	35.547	1.777.338
2. Congestion/Scarcity	11,0%	6.737.962	61.096.596
3. Environmental - Air Pollution	2,7%	10.249.364	374.716.957
4. Environmental - Global Warming	2,7%	5.617.735	205.384.498
5. Environmental - Noise	2,0%	14.332	716.614
6. Accident	2,0%	154	7.678

Comparison Between Schemes

	Risk Premium as % of revenues	Risk Premium in k€
Conventional Pricing Scheme	**2%**	**11.457.808**
SMC Pricing Scheme	**3,5%**	**20.162.953**
Diference between SMC and Conventional Pricing Scheme	**1,5%**	**8.705.144**

The SMCP scheme requires a HIGHER RISK PREMIUM than the Actual Scheme, requiring extra 1,5% of expected revenues.

4.3.5 *Incentives Analysis*

The module of Incentives Analysis studies the incentives posed by SMCP based revenues on the contractor's behaviour. It applies essentially the data introduced so far, plus data on elasticities of demand to price and to time. The analysis is done through the calculation of the contractor's *profit maximization capacity* (PMC). Depending on whether its outcome is higher or lower than the actual capacity, one may derive qualitative expectations on the contractor's rational behaviour.

Figure 15 - ENACT Simulation Tool: Incentives Analysis - Profit Maximization Capacity

ENACT SIMULATION TOOL

INCENTIVES ANALYSIS

Back

INPUTS

Elasticity of Demand to Price	-0,25
Elasticity of Demand to Time	-0,3

Calculation of PROFIT MAXIMIZATION CAPACITY

Find PMC		Current	New	unit	% change
Capacity		8.000	134.884	veh./day	1586%
Demand		65.000	64.631	veh./day	-1%
Speed (peak-hour)		107,6	120,0	km/h	12%
Revenues	Infrastructure	174	173	k€/day	-1%
	Congestion	3.663	0	k€/day	-100%
	Air Pollution	36.665	42.793	k€/day	17%
	Global Warming	20.096	23.455	k€/day	17%
	Noise	70	70	k€/day	-1%
	Accident	1	1	k€/day	-1%
TOTAL		60.669	66.492	k€/day	10%

PMC is HIGHER than actual capacity. The private party has an incentive to make sure that capacity is fully used / expanded.

Particularly, answering the question above allows us to reason on possible incentive related behaviour, depending on the PPP features and contractual responsibilities and options of the contractor:

- If the contractor's *profit maximization capacity* turns to be lower than the capacity of the infrastructure, then it does have an incentive to artificially reduce the infrastructure capacity (e.g. by prolonging capacity reductions due to maintenance works or accidents).
- If the contractor is allowed to increase capacity during the concession timeframe at its own judgment, will it do so on a socially optimum way?
- In the event of a PPP contract for a transport service operation where the contractor has the freedom to increase service frequency and such an action influences social marginal costs, will it do so on a socially optimum way?

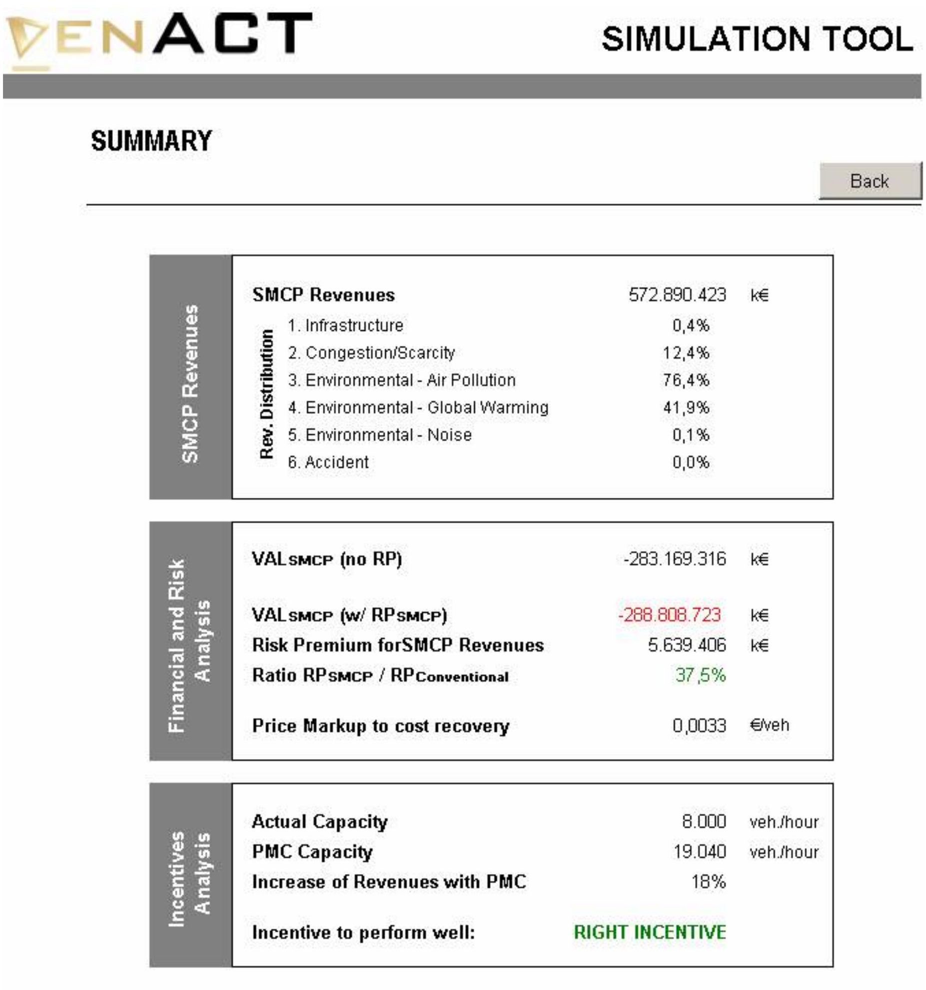
In the example in Figure 15, the private party is willing to do without congestion revenues in exchange of maximizing other revenues, particularly air pollution and global warming revenues which enlarge with the speed increase driven by capacity expansion. Would congestion revenues be more relevant in absolute terms or environmental pricing not related to speed (thus with a linear demand-revenue relation) and the outcome could be towards a lower PMC than actual capacity.

Recommendations on the appropriate PPP design with SMC pricing may be drawn from the incentive analysis. This will be further developed upon the analysis of simulation results of the case studies. Additionally the tool enables testing the result under other revenue distribution schemes, with part of the cost category revenues being directed to the state instead of the concessionaire.

4.3.6 Summary of findings

The last module of the ENACT Simulation Tool presents a synthesis of its findings from its three main elements of analysis (SMCP Revenues, Financial and Risk Analysis and Incentives Analysis).

Figure 16 - ENACT Simulation Tool: SUMMARY SCREEN



In brief, the illustrative case study has given the following results, expressed in the Summary panel of the Simulation Tool:

- The revenues generated from social marginal cost pricing, for the six cost categories considered, would not be enough to cover for the minimum remuneration demanded by the private party;
- If, for that aim, remuneration would be added by a price markup, it would have to amount to 0,003 €/vehicle-kilometre, at present prices;
- The revenue risk of a social marginal cost pricing scheme, with congestion and air emission costs non-linearly related to demand, would be higher than demand risk of a conventional revenue scheme linearly dependent on demand. With the cost-demand functions and the infrastructure characteristics considered, the risk premium demanded by private party would be 37,5% higher than the risk premium that would be demanded in a conventional pricing scheme with the same amount of demand-based revenues;
- The incentives analysis simulated a *Profit Maximization Capacity* higher than the actual capacity of the infrastructure considered. This means that the operator faces an incentive to perform in a way to optimize the use of actual capacity, or even to invest in the infrastructure in order to increase capacity.

4.4 Added Value

The research of the previous Work Packages pointed out and discussed relevant matters for the study of the possible implications of the application of social marginal cost pricing in transport PPP's. The simulation of the application of SMCP in selected case studies will predict practical outcomes for several implications afore identified. This is particularly relevant regarding issues for which the design of a SMCP mathematical model is feasible and for which input data can be found or at least reasonably estimated.

Besides, we have seen that the effects of having constraints and drivers for the application of SMCP vary from sector to sector and from case to case. We have seen that different sectors have different structures of SMC formation, possibly with wholly distinct consequences over the possibility of cost recovery. The rail sector, for instance, is regarded for causing smaller externalities as compared to the road sector, particularly environmental and accidents. It should therefore be more prone to generate small revenues compared to e.g. road. The EST may also help illustrating how differences even within the same sector can be outstanding, not only due to the conventional factor of demand variations, but either because (1) the size of social marginal costs depends on contextual elements (e.g. urban versus interurban areas) or (2) because with SMC pricing demand variations do not necessarily produce linearly proportional revenue variations, as is clearly the case for congestion costs and environmental costs.

These contextual determinants and the non-linear revenue dependence structure, along with the fact that total SMCs are composed of several cost categories, implies that a complete typification of revenue outcomes, risks and incentives from given sets of basic PPP features is a complex task to perform. The Simulation Tool aims instead to provide a quantified "x-ray" of the performance of each case study, in order to enable conclusions on:

- whether SMC are sufficient for cost recovery in a given setting;
- if not, what would be the necessary price markup;
- whether the revenue risks posed by SMCP are higher (or lower) compared to conventional demand based revenues, and (as a function of the known Risk Premium assumed for the latter) what would the Risk Premium be for the former;
- whether the structure of SMCP based revenue formation produces "good" or "bad" incentives for the private party to deliver a desirable performance.

More than stating the outcomes outlined above, the Simulation Tool allows understanding causes, such as which types of social marginal costs contribute the most to cost recovery and which ones provide good or bad risk profiles and/or incentives?

Finally, the Simulation Tool allows exploring alternatives for more adequate financing regimes of the private party, from the point of view of social welfare or the risk distribution between parties, addressing questions such as.

- What are the effects on cost recovery, revenue risks and performance incentives resulting from removing one or several cost categories from the private party's revenue sources?
- How can SMC pricing structures influence these aspects?
- What for instance would be the effect over risks and incentives of adopting a second best pricing formulation for environmental costs, based solely on discrete infrastructure use instead of the first best linkage to flow conditions (e.g. speed)?

In summary, the ENACT Simulation Tool (EST) is intended to help seeking what would be the most efficient sharing of responsibilities and risks between the public and private parties, by bridging the gap between the theoretical construct of the previous work packages and the real world practise of the Case Studies considered. There are two main responsibility and risk sharing efficiency drivers

- The profile of financial risk aversion of each of the two parties (risk premiums)
- The potential deviation of social goals put by SMCP based contractor remuneration incentives

The simulation model seeks therefore to assess revenue risks posed by SMC based pricing as compared to traditional traffic level and availability based remuneration schemes. The intersection of such knowledge with the financial risk aversion profiles of the parties will theoretically allow finding an optimal risk distribution between state and the private party. However, we have seen that this is hardly quantitatively measurable (at least from the State perspective). Despite that, the assessment of SMCP revenue risk sought by the simulation tool allows to speculate on optimal risk sharing based on risk aversion assumptions, an information that is most useful for decision makers at tender design or renegotiation stage.

A PPP contract should converge social with private party's objectives. Doing this requires giving the contractor the right incentives. Incentives received by the contractor depend on one side on its contracted powers and responsibilities and on the other side on its revenue formation profile (apart from information asymmetry and monitoring ability by the principal, a matter that is not subject of a quantitative analysis). The simulation tool addresses this issue through the calculation of the designated private party's *profit maximization capacity*, which as described above allows to some degree to assess the extent to which the contractor may try to influence costs (namely congestion/scarcity and environmental) to maximize revenues in a socially non-optimal way. This allows both to judge the adequacy of basing contractor revenues on SMCP and on the adequacy of handing certain powers and responsibilities to the private party, as well as perceiving the extent of needed contractor performance monitoring (e.g. if, by chance, private party's incentives provided by SMCP would naturally converge with social goals, a performance monitoring from the principal would theoretically not be needed).

Finally, the simulation tool allows testing mixed SMCP revenue schemes, where only selected social marginal cost types are directed to the contractor as revenues, being the remaining ones headed to the State. This allows one to discriminately judge the financial and incentive performance of the revenue scheme and desirably find the most efficient revenue structure through a balance of the two risk sharing efficiency determinants above.

The Simulation Tool as a whole is designed to allow undertaking:

- A Comparative Analysis Between Theoretical and Simulation Approaches
- An Analysis of Feasibility of Application of SMCP in PPP's
- A Check-up of Consequences for Design of Regulatory and Legal Frameworks, aiming at the most efficient responsibility and risk sharing between the parties involved in a PPP

After the case studies are carried out in subsequent WP5.1, the simulation model should be able to be 'trained' by plugging in the data of the different cases. This will allow to analyze the impact of design changes and to consider potential improvements to the design of contractual relations in the case studies at hand as well as the Simulation Tool itself. In addition, it will also shed light on policy recommendations for the design of contractual relations beyond the specificities of the case studies to be addressed.

5 CONCLUSIONS

The synthesis of previous research stated in this report allowed ENACT to achieve a broader and more integrated understanding about the crossed implications associated to the possibility of implementing SMC based pricing schemes in the scope of PPPs. The implications of such design have been discussed in association with contractual relations in the scope of PPPs, addressing not only the technical and theoretical issues linked to SMC implementation, but also the context for the creation of adequate incentives for all the actors involved.

We have seen that contractual relationships entail a myriad of complex relationships that work in different directions and with different intensities. To this extent, the research performed in Work Packages 2, 3 and 4 has been primarily concerned about describing (i) the fundamental theoretical and practical issues on the strict technical adoption of SMC pricing and (ii) the framework to assess such complex relationships as well as the incentives and risks involved with an impact on contract design choices, such as ownership structures, risk allocation, institutional setups, financial arrangements, procurement, pricing, etc.

Though a large number of studies have come up with the proof that social marginal costs can be estimated, we have reconfirmed that the available set of cost estimates is neither complete nor robust enough to claim that the welfare optimising prices are known. Indeed, ENACT has shown that a number of barriers for SMCP implementation remain, at technical, organisational and institutional level, including the need for a variety of methodologies to estimate the social marginal cost and to overcome difficulties in the availability of appropriate data.

Nevertheless, in real world conditions the objective of pricing schemes among all transport modes is the achieve cost recovery to face the financial constraints, with the degree of costs covered by charging revenues being often insufficient. In this respect we have concluded that empirical applications developed in WP2 made clear that existing second best pricing solutions seem to be more appropriate for cost recovery needs especially in a context that requires the involvement of private funds. In turn, this aspects will link to the consideration of having the correct incentives, as there is a potential conflict between the interests of private agents investing in transport infrastructures and the implementation of SMCP, to the extent that it will decrease user charges when infrastructures are improved (lower renewal costs) or extended (less congestion).

In this sense, second best solutions, taking into account the need for cost recovery were deemed appropriate when considering Public-Private Partnership solutions and were therefore taken as a reference approach in the major construction of WP5, namely the Simulation Tool for the development of the case Studies. In that sense, the Simulation Tool has adopted a pragmatic approach differing between cost categories, covering major external costs such as congestion (especially for road transport), with environmental and accident costs assuming an increasing relevance. This was considered in the simulation model, in view of addressing context-specific cost categories in the scope of the case studies, adopting a top-down perspective with specific SMC coefficients derived from aggregated averages.

Based on this theoretical background, it has been possible to develop a set of analytical sub models and requirements for case studies. This became a fundamental formal outline for the simulation tool, in view of producing an analysis of the sensitivity of output variables to choice variables to see how outcomes of contractual relationships change in accordance to hypothetical changes in pricing schemes taking the case studies as a “test bed”. The target of seeking the most efficient sharing of responsibilities and risks between the public and private parties is therefore one of the foundations of the simulation tool, by bridging the gap between the theoretical construct of the previous work packages and the real world practise.

The added value of the “Simulation Model Application” lies therefore in its integration capacity as simulation environment for the elaboration of the Case Studies/Simulations, allowing common platform for further use. The example of the application of the Simulation Model has shown that it is possible to produce sensible outputs for the analysis of effects of application of Social Marginal Cost Pricing (SMCP) in PPP’s in the scope of WP5.1, in order to perform the comparative analysis that underlies the objectives set for the Simulation Tool, i.e. to assess whether SMC pricing can, under certain circumstances, be competitive in relation to conventional approaches from the perspective of total revenues accrued.

After the case studies are carried out in WP5.1, the simulation model should be able to be 'trained' by plugging in the data of the different cases. This will allow to analyze the impact of design changes and to consider potential improvements to the design of contractual relations in the case studies at hand as well as the Simulation Tool itself. In addition, it will also shed light on policy recommendations for the design of contractual relations beyond the specificities of the case studies to be addressed.

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