SUCCESSFUL DEVELOPMENT AND IMPLEMENTATION OF TRANSPORT POLICY INNOVATIONS: TACKLING CONGESTION ON PORT HINTERLAND LINKS

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ABSTRACT

The pre-crisis traffic volumes at the seaports of Western Europe have demonstrated the unsustainability of port traffic turnover growth, often due to an important bottleneck: the hinterland connections of the ports. The governments are under pressure from industry to take actions, but often the efficient infrastructure optimization measures that are available are not implementable in practice for different reasons. In this research, the implementation of these measures is dealt with. The aim is to identify certain conditions under which they have a high chance of getting successfully implemented.

A three-step framework, which includes cost-benefit analysis approach, but also the analysis of non-financial parameters, is proposed. As the first step, impacts simulation is done, because the impacts of a proposed policy mechanism can differ depending on factors like design of the measure, specific infrastructure network layouts, characteristics of competing modes and existing policies in place. As the second step of the approach, a social cost-benefit analysis of the measure is performed. As the third step, the Systems Innovation approach, which focuses on the interactive mechanisms that shape the emergence and diffusion of innovations, is used. This allows determining the chances of the innovation to be successfully implemented.

The framework is applied in practice to road pricing scenario. This allows drawing conclusions about success factors that are important in practice for introducing a policy

measure aimed at tackling congestion on port hinterland connections. Hence, it is of use to governments as well as to logistics and port operators affected.

The political and practical dimension of the research results makes them relevant to a range of stakeholders within the transport community, particularly governments, transport practitioners and transport providers. Tailoring the Systems Innovation approach to transport projects is novel and hence scientifically rewarding in its own.

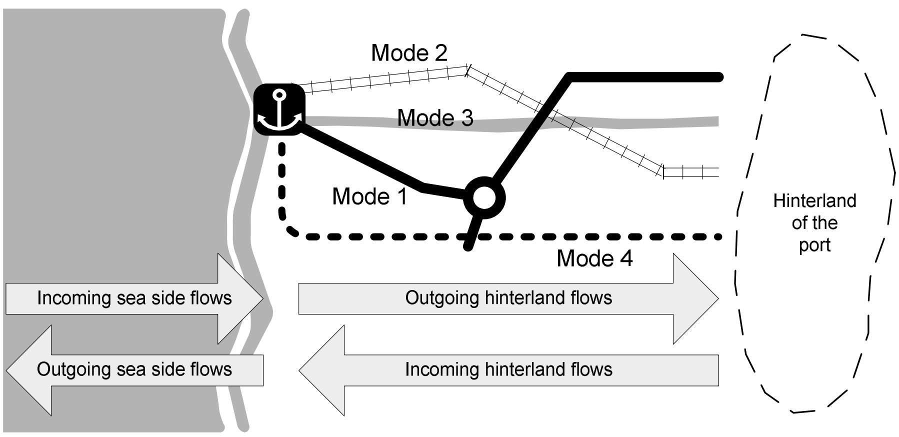
Keywords: policy implementation, seaports, hinterland transport, congestion, infrastructure pricing, mode choice

1. SETTING

1.1 The situation in focus

The research deals with a typical port hinterland situation depicted in Figure 1. It features a port which has incoming and outgoing cargo flows on the seaside and, similarly, incoming and outgoing cargo traffic flows on the land side. On the sea side the incoming and outgoing cargo is transported to and from other ports by sea. On the land side alternative modes of transportation exist. In the simplified model in Figure 1 a choice between four alternative modes of transport exists.

Figure 1: A typical port hinterland situation



Competition for space exists on all hinterland modes. On the port hinterland links the freight traffic competes for the use of infrastructure with other users. On inland waterways the barges share the capacity with recreational vessels; on the rail the cargo trains share slots with passenger trains; and on the road trucks share the road infrastructure with passenger cars and other vehicles. This research focuses only on measures that are applicable to freight traffic on these hinterland links of the ports.

These applicable measures include different pricing measures, regulatory measures and infrastructure measures that could be applied. The pricing measures could be different variations of pricing schemes. In each situation with its geographical and cargo traffic characteristics a different pricing scheme would be optimal. Regulatory measures are rules or laws put in place by the government that set the specifications or performance characteristics of transport operations. Infrastructure measures are related to construction of new or making changes to the existing infrastructure. The measures targeted at passenger traffic are not investigated in this research.

1.2 Traditional measures for tackling congestion

A range of literature on possible measures for tackling the congestion problems on road transport infrastructure is available. The literature review done in this research focussed on sources covering the most important approaches used for capacity optimisation, which are usually considered by the policymakers: infrastructure measures, road pricing and regulatory measures.

Road pricing measures
Literature on road pricing as a solution to congestion problems dates back to Smith (1776). Pigou (1920) in his book "The Economics of Welfare" he developed Alfred Marshall's concept of externalities, costs imposed on others that are not taken into account by the person taking the action. Walters (1961) discussed the applicability of marginal cost pricing (first-best) on the highways to deal with peak-load problems. Based on empirical evidence he proposed use of gasoline taxes and special tolls in congested areas. Mohring and Harwitz (1962) were the first to show that optimal pricing and investment decision for highways can be dealt with analytically in a single model. Marginal cost pricing is the first-best pricing where congestion is the only externality. When road usage is linked with other externalities in practice according to Diamond and Mirrlees (1971) second-best theory should be applied.

Since the 1990s, second-best pricing has had ample attention in literature. The main reason for this according to Verhoef (2002) is that first-best pricing policy for a congested road network is a rather theoretical concept and transport regulators often consider second-best solutions only. Examples of second-best pricing mentioned in Small and Gomez-Ibanez (1998) include pay-lanes, toll cordons, parking charges, area permits and others. Road pricing implementation cases can be seen around the world. Currently available technologies for implementation are listed and described in de Palma and Lindsey (2009).

Regulatory measures
Regulatory measures are legal restrictions or rules for action set by a government authority in order to induce actions which would otherwise not occur. A full list of all EU transport legislation acts is available from the website of the International Transport Forum (2010). Local country, region or city specific measures also apply.

Infrastructure measures
Expansion of existing road capacity has been the traditional response to growing congestion. It is also often considered an important determinant of economic growth and means for lowering social inequality, see Lopez (2003), Kerali (2003) and Calderon and Serven (2005).

Of course, constraints that construction of new roads can face should be taken into account. Those include, but are not limited to shortage of public funds, space and environmental issues.

1.3 The problem

When developing the applicable measures for reducing congestion, the impacts for the individual actors in the society are usually not taken into account. Most of those measures that could be implemented for tackling congestion are “painful” to one or another actor. That causes problems in practical implementation. And if those measures for tackling congestion do get implemented, the design of the measure is often impacted by those actors affected, which can decrease the efficiency of the measure. The problem is that the traditional approaches do not tackle the practical implementation path of those measures.

With the increased port traffic turnover growth the goods traffic flow on hinterland transport modes increases and leads to congestion at certain times of the day. This is a common phenomenon which can be observed on the hinterland connections of many ports, usually on the road networks.

In the context of freight traffic, congestion results in increased costs related to time, uncertainty about arrival times, waste of fuel, increased wear of vehicles and other negative effects, including those on the environment. Also, increased levels of congestion on the land side negatively affect the competitive position of ports.

In the literature a range of applicable measures for tackling the congestion problems are listed. The efficiency of the available capacity optimization measures is evident, but the problem is that the implementation almost always faces strong opposition from the public or some interest groups. Therefore in this research the implementation process of these measures is investigated with the aim of identifying certain conditions under which there is a high chance of successful implementation.

This research is relevant, because literature on pricing measures does not target the practical implementation of these measures. But practical implementation is important for any result being achieved at all. This research, therefore, bridges this gap between the literature which develops possible infrastructure use optimization measures and literature which analyses the success conditions of innovations.

2. METHODOLOGY

To tackle the research problem, a three stage approach is followed. First, an impacts simulation was done with the aim of determining the impacts of the proposed policy scenarios tackling congestion on port hinterland links. This allows selecting a case study for further investigation. Then, having the results on the expected impacts of the measure, as the second step, social cost-benefit analysis of the innovation process with focus on the actors of the innovative process is performed. Last, the Systems Innovation (SI) approach is used as an alternative method for analysis of the innovation process and suggesting steps for the market up-take of the innovation.

In the **first stage**, impacts simulation is done, because in practice the impacts of an innovative policy measure are hard to estimate for a concrete situation. The case-specific impacts simulation includes the following steps:

Step 1: qualitative analysis of port traffic evolution and impacting factors;

> Here, in order to select and quantify variables for the Step 3 of the impact simulation the influencing factors on the case in focus were detected, because in every case those factors will differ and the impacts they have will differ as well.

Step 2: linking of selected influencing factors with the freight model used;

> The previous step allowed to gain general understanding of the influencing factors for the case study investigated. Here the selected influencing factors are linked with the variables that exist in the freight model.

Step 3: analysis using the freight model;

> In the third step of impacts simulation the variables are fed into the freight model and the simulations are run.

Step 4: evaluation and selection of a case study.

> In this step the interpretation and evaluation of the modelling results is done with the aim of selecting a suitable scenario for implementation and analysis in the next stages of this research.

The outputs of impacts simulation in the form of tonkilometre matrixes for the scenario runs contain information on the impacts of each scenario on the cargo flows. In the cost-benefit analysis, those are used for calculating the costs and benefits for the society from the measure tested in the scenario.

In the **second stage**, the cost-benefit analysis for the selected case study is done. The case study is treated as an innovation and broken down to cost components per actor. The benefits or revenues from an innovation are put one side. On the other side, there are the private or social costs that are associated with implementation of the innovation. This allows making predictions of the chances of the innovative process to end with the success – being implemented.

In this research the road pricing case is treated as an innovation, and in literature innovation is defined by Peter Drucker in Hesselbein *et al.* (2002) as a "*change that creates a new dimension of performance*". Introduction of an innovation is always associated with costs and benefits. The innovator faces costs that are related to the development and introduction of the innovation and enjoys the benefits that the innovation brings. The society as well is impacted by the innovation and faces certain costs and benefits. Some costs and benefits are common for the innovator and the society. Based on Arduino *et al.* (2010), there are two possible views on this: industrial-economic point of view (from the perspective of innovator) and welfare-economic point of view (from the perspective of society).

From an industrial-economic point of view, for an innovative actor (e.g. company) the following can be defined: ΔR_p - change in private revenues as a result of innovation; ΔC_p - change in private costs as a result of innovation. This equation shows the impacts of the innovation for the innovator: $\Delta R_p - \Delta C_p$. As a result of innovation, an innovating actor will face some additional costs ΔC_p. The revenues will increase by ΔR_p during the lifespan of the new product as a result of the increased value of it to the customer. In this situation, the innovation will initiate only if the increase in costs of innovating are justified by the increased final product value that the customer is willing to pay for.

From the welfare-economic point of view, for society, the following can be defined: ΔB_s - change in social benefit as a result of innovation; ΔC_s - change in social cost as a result of innovation. This equation shows the impacts for society of an innovation: $\Delta B_s - \Delta C_s$.

Other exogenous factors related to the introduction of an innovation exist. First are the subsidies, which are payments which can be given by an actor to support the innovation. Those could be given to the innovator S_p or to the society S_s. Second are the barriers, which are reasons for the innovation to fail.

For an innovation to succeed, in general, the following relations should be true:

$$\begin{cases} \Delta R_p - \Delta C_p + S_p > x \\ \Delta B_s - \Delta C_s + S_s > y \end{cases}.$$

Here x and y are threshold values that a private or public innovation actor requires in order to continue the innovation process, or to stop the innovation process.

The success algorithm shown in Figure 2 below describes the possible situations that can occur under different economic conditions. The success algorithm shows solution path for any possible innovation situation graphically to reach success or failure.

Last, as the **third stage**, the Systems Innovation (SI) approach for the analysis of the innovation is used. The reason for doing it is that it allows identifying the causes of success and failure of an innovation in the different temporal development phases of an innovation: initiation, development and implementation phase. It allows indicating which actions are required to establish the success conditions and the area where actions would not promote the success in the innovative process.

In Systems Innovation (SI) approach, an innovation is perceived as an interactive and nonlinear process, which involves a variety of actors and institutions. By focusing on interactions between these actors and institutions, the SI approach allows identifying combinations that lead to innovative success and failure. The approach is based on Arduino *et al.* (2012) and it allows working on innovation cases where there is lack of quantifiable data. The inputs that the approach needs are qualitative and require studying of a range of innovation cases.

The SI approach is not meant to replace the cost-benefit approach, but to complement it by providing additional results, which are valuable for policy makers in practice.

3. APPLICATION

3.1 Impacts simulation

Step 1: qualitative analysis of port traffic evolution and impacting factors
Factors exist that are external to the innovation itself, but have influence on the development path and, most importantly, success of the innovation. Those factors are different developments in the economy and could be global, like the global economic growth, but also local like developments in local transport infrastructure. With the focus on the typical port hinterland situation (as shown in Figure 1) investigated in this research, these possible influencing factors are determined. This step is necessary in order to select and quantify variables for the modelling stage of the research.

For the situation analysed, those impacting factors include the following: economic developments, global trade patterns, energy prices, demographic changes, national and international policies, production and distribution patterns, technological developments, developments in port traffic, and developments in hinterland transport modes.

Step 2: linking of selected influencing factors with the freight model used
The previous step gives the general understanding of the impacting factors for the port hinterland situation. In this step the selected influencing factors are linked with the variables that exist in the freight model used.

In this research the Freight model for Flanders is used. It is a classical 4-step model that allows simulating future freight flows, split up by mode (road, rail and inland waterways) and NST freight category. The model was commissioned by the Flemish Traffic Centre and developed by K+P Transport Consultants, Tritel and Mint. It is described in detail in Aronietis *et al.* (2009).

This step was accomplished by simply matching the identified factor from step 1 to the corresponding variable in the freight model. The quantification of the inputs was based on a set of assumptions and trusted sources in the literature (European Commission (2006), Federaal Planbureau (2008), NEA Transport research and training and Universiteit Antwerpen (2007) and others).

Step 3: analysis using the freight model
Several scenarios were built to construct a min-max range. Each scenario is a combination of several assumptions: economic assumptions, policy assumptions, assumptions of population and household consumption, assumptions of import and export (expressed in value), assumptions of inland navigation and port assumptions. The scenarios were run in the model and quantitative results obtained, which include origin-destination matrixes describing cargo flows for each scenario and a reference scenario. These feed in as data for cost-benefit analysis.

Step 4: evaluation and selection of a case study
The full simulation results are available in the report by Aronietis *et al.* (2009). The aim was to determine a realistic scenario that would be suitable for practical implementation. As a result of the impacts simulation, the most likely scenario to be considered by the Belgian government for practical implementation was chosen for further investigation.

The case selected deals with introduction of road pricing for heavy goods vehicles on Belgian motorway network. The price for using the motorway network for heavy goods vehicles is set to be 0.15 €/km for the use of highways in Belgium and it replaces the circulation tax and Euro-vignette. For the neighbouring countries, it is assumed that in Netherlands and Luxembourg similar pricing conditions are introduced. In Germany and France current pricing environment is assumed to stay in place. For other modes, for rail the scenario assumes that a higher user fee will be introduced at 1.67 €/train-km. For inland navigation, the continuation of current policies is assumed.

It is assumed that the government (which could be a body or a company created by the government or a private partner under concession agreement) in this case is the innovator that develops and introduces the required infrastructure on the road network. This entity also bears the cost related to the development of the system. The road transport companies (road users), to be able to use the motorway network and pay the user fee, are requested to equip each heavy goods vehicle with an onboard unit, similar to those in use in other countries.

3.2. Cost-benefit analysis of innovative process

The quantification for the cost-benefit analysis of the selected case was done based on trusted sources of literature (Net Resources International (2005), Rajnoch (2009), Walzl (2008), Blauwens *et al.* (2008), Maerivoet and Yperman (2008), Shires and de Jong (2009), Bak *et al.* (2008), Anthony *et al.* (2006) and others). Having calculated the values for the variables for the formula, they can be inserted in the equation defining innovative success. The values are discounted to the value at the beginning of the project, see Table 1.

It is clear that here the financial outcomes are positive for the innovator – government or an agency which would be implementing the road pricing system. Also, the outcomes of the innovation are highly positive to the individuals. The time savings do not outweigh the toll cost for the companies, therefore opposition in the innovation process from this actor should be expected.

In this case the innovation will most likely proceed, because government is the innovator and also the one capable of stopping the innovation. The positive impact on the benefit for the voters might play a role to continue with the innovation and ignore the opposition from commercial road users.

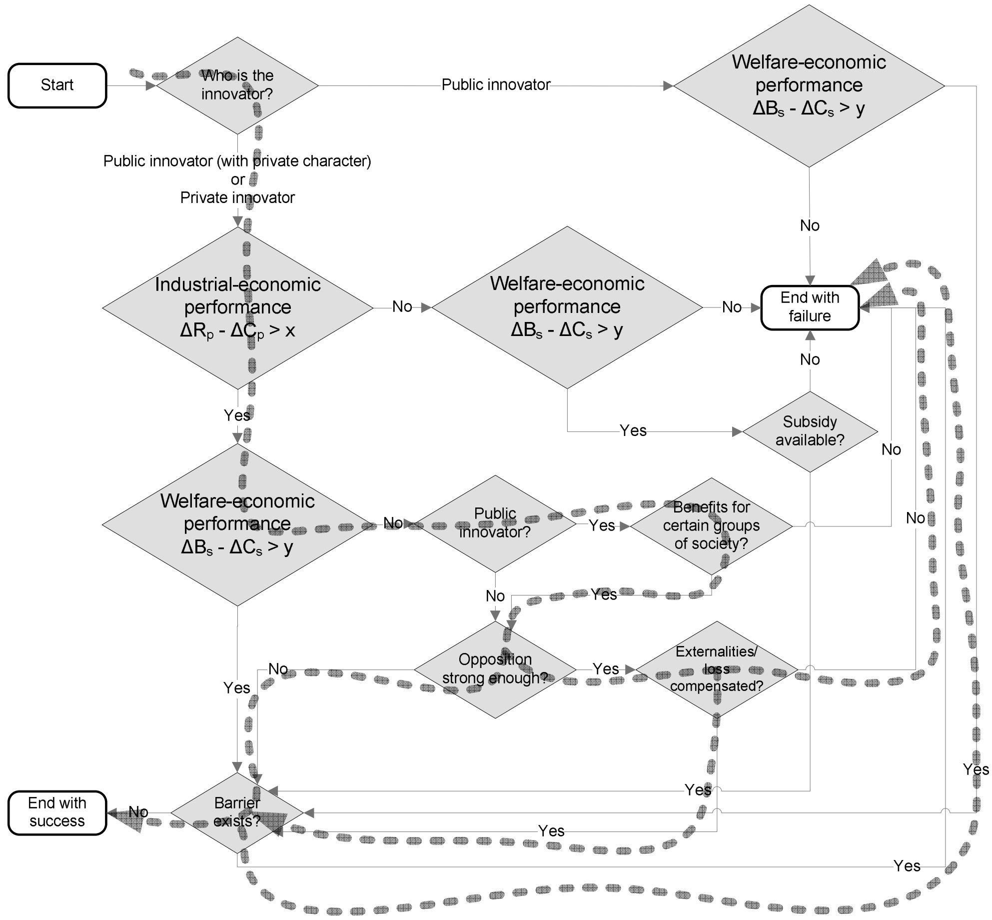
Table 1: Success conditions, m €

Actor/CBA component	Benefit	Cost
Government (the innovator)		
System development	ΔR_p	ΔC_p 150
System operation		321.766
Tolls	4902.964	
Total for innovator	**4902.964**	**471.766**
Companies (road users)		
Equipment (onboard unit or similar)	ΔB_s	ΔC_s 1.156
Tolls		4902.964
Time	169.675	
Consumer surplus	1176.591	
Individuals		
Time	261.339	
Externalities	54.413	4.713
Total for public	**1662.018**	**4908.833**
TOTAL	**6564.982**	**5380.599**
NET BENEFIT	**1184.383**	

In relation to introduction of the system, most of the costs are paid by the government as the innovator and the decision maker. Of course, those costs would be recovered through the toll collected. For the government the cash flows of the project are important. In the financial analysis of the project done, taking into account the revenues from user charges, it can be seen that the financial side of the project is beneficial for the innovator.

In sensitivity analysis, the value of time, the discount rate and the inputs from the impacts simulation stage had to be tested. Sensitivity analysis confirms that the changes of value of time can have substantial impact on the results of the cost-benefit analysis. A decrease in the value of time seems unlikely. The sensitivity analysis shows that the outcomes of the project are positive at the values of the discount rate used, but become negative as the discount rate is increased above ~50%. The modelling outcomes can have substantial impacts on the results of the cost-benefit analysis and consequently the decisions taken. Therefore, great care should be taken to ensure the accuracy of the modelling results.

Figure 2: Success algorithm and innovation path (with dotted lines)



3.3 Systems Innovation analysis

As the last stage of the methodology, to further contribute to the results of the cost-benefit analysis, the System Innovation (SI) methodology is used. This is a way to go a step further and add richness to the analysis by determining the success conditions of the innovation in focus of this research. In SI approach, an innovation is perceived as an interactive and nonlinear process, which involves a variety of actors and institutions. By focusing on interactions between these actors and institutions, the SI approach allows identifying combinations that lead to innovative success and failure.

In this research the SI approach is applied based on the results of an EU-financed research project InnoSuTra (for details see Arduino *et al.* (2012)), which the author of this research was involved in. Based on the outcomes of the case study analysis described in Arduino *et al.* (2011) the resulting mapping is applied to the innovation case investigated here to determine the areas where the actions taken would ensure successful market take-up of the innovation.

The Case in Detail

The case investigated deals with the possible adoption of a road pricing scenario on Belgian road network for the heavy goods vehicles. The case does not deal with the development of the technology of the road pricing itself, but rather the innovation path of the related policies and actions, which should enable the development of the road pricing system for the road transport network.

The case addresses the need to make the appropriate decisions from the innovators side. In this case the innovator is the government. The actions would include making appropriate decisions, assigning financing, subcontracting and other tasks for the road pricing system to be introduced. In real life the case of introduction of pricing on Belgian road network is currently in the beginning of the initiation stage of development.

The application of SI analysis is done to assess the current situation in the development of the case and propose areas for actions during the different stages of development that could ensure success of the innovation. The suggestions are based on other previously analysed cases from the InnoSuTra project Arduino *et al.* (2012) that fall in the category of managerial, organisational, cultural – market (policy initiatives).

In recent years, following the example of the other European countries, the introduction of road pricing has been discussed in Belgium on federal level, GVA (2009)[1]. The possibility of linking the cancellation of the tax on first registration and yearly circulation tax with introduction of road pricing is discussed. On the regional political levels similar discussions have taken place. In general, the topic is considered controversial. An agreement to introduce road pricing for heavy goods vehicles by 2013 was reached by the Belgian communities in January 2011, HLN (2011b)[2]. Currently the agreement concerns only heavy goods vehicles of more than 3.5 tons, and the expansion of the system to all vehicles does not seem likely in the short term.

The opposition parties, however, fear that the introduction of the road pricing at a stage where the Netherlands have cancelled the plan to do it could put the Belgian logistics sector in an unfavourable position. Therefore, in 2011 Belgian politicians called the new Dutch government to re-evaluate the decision to stop with the project, because it was planned that Belgium and the Netherlands would both introduce road pricing. Another opposition argument from VAB (Vlaamse Automobilisten Bond), which represents the interests of road users, states that this is a measure to fill the budget at the expense of road users and that in this case the environment is an excuse for extra taxation, HLN (2012b). Also, the support of public is low for the introduction of road pricing in Belgium, HLN (2012a). On the other hand, UNIZO, the organization of small- and medium-sized entrepreneurs, supports the introduction of the road pricing and states that it should be done together for all Benelux countries, UNIZO (2009).

[1] Gazet van Antwerpen (in English Antwerp Gazette) is a newspaper based in Antwerp, Belgium.
[2] Het Laatste Nieuws (in English The Latest News) is a newspaper based in Brussels, Belgium.

SI Overview of the Introduction of pricing on road network case: initiation phase

The shaded cells in initiation phase, in Figure 3, show the where the actions should be taken in general for the managerial, organisational, cultural – market (policy initiatives) type of innovations. The darkest cells are more important. Taking into account the specifics of the case, the ovals show the suggested areas of attention for this specific case. The ovals with line pattern show the areas where actions were already noticed during the research. It can be seen that in the Initiation phase the interventions in the hard rules section are the most important to cover, specifically targeting transport operators and the lobbyists that represent them. Other areas marked with white ovals should not be neglected as well.

Figure 3: Initiation phase

	Knowledge Institute	Public Funding	Private Funding	Standard Bodies	Initiator/ Entrepreneur	Developer/ Industry	Transport Operators	Lobbyists
Infrastructure *Ports, etc.*								
Institutional *Hard: Laws, regulations*								
Institutional *Soft: norms, values*								
Interaction *Weak network*								
Interaction *Strong network*								
Capabilities								
Market Demand								
Key Competitor Mode								

Source: Arduino *et al.* (2011)

Proposed Policy Interventions and Actions

The innovation case has not yet reached the development phase, or the implementation phase, but for future reference, based on the evidence of other cases, some areas of attention can be suggested (see Figure 4 and Figure 5). The shaded cells show the areas that should get attention relevant phase (for darker cells more attention is required).

As can be seen in Figure 4, in the development phase, like in the initiation phase, targeting transport operators and lobbyists stays important. In addition to that in development phase the interaction conditions gain importance. Strengthening of weak interaction links between actors (developer of the system, transport operators and lobbyists) and dealing with the strong network conditions in the form of oppositions from various parties becomes important.

Figure 4: Development phase

	Knowledge Institute	Public Funding	Private Funding	Standard Bodies	Initiator/ Entrepreneur	Developer/ Industry	Transport Operators	Lobbyists
Infrastructure *Ports, etc.*								
Institutional *Hard: Laws, regulations*								
Institutional *Soft: norms, values*								
Interaction *Weak network*								
Interaction *Strong network*								
Capabilities								
Market Demand								
Key Competitor Mode								

Source: Arduino *et al.* (2011)

During the implementation phase, in addition to the areas of attention in the previous stages, soft rules section becomes important, see Figure 5. Additional actions should focus on building the positive perception of the innovation introduced.

Figure 5: Implementation phase

	Knowledge Institute	Public Funding	Private Funding	Standard Bodies	Initiator/ Entrepreneur	Developer/ Industry	Transport Operators	Lobbyists
Infrastructure *Ports, etc.*								
Institutional *Hard: Laws, regulations*								
Institutional *Soft: norms, values*								
Interaction *Weak network*								
Interaction *Strong network*								
Capabilities								
Market Demand								
Key Competitor Mode								

Source: Arduino *et al.* (2011)

Proposed interventions in detail

The overview shown in the diagrams above provides only an indication of the areas where it appears that the policy-maker (in this case the Belgian federal government) should provide the correct stimuli. However, it is necessary to examine more closely what initiatives perhaps should be taken. This is done with reference to the SI structural categories.

Infrastructure Conditions. In the initiation stage that the innovation case is currently undergoing actions targeting infrastructure conditions are not required, however some are already taken, like the test project described in HLN (2011a). At the current stage of innovation the presence of certain infrastructure conditions is not required for successful outcome of the innovation process. At later stages of the innovation process, specifically in the implementation phase, the creation of appropriate infrastructure for the operation of the road pricing system is important and should receive sufficient attention.

Institutional Conditions

Hard rules. The development of this case includes policy, technological and cultural components. In the hard rules area of activity the policy component is the one that plays the key role for success. In similar cases, historically, the innovation process has been policy-driven. As can be seen from the figures above (see Figure 3, Figure 4 and Figure 5), the actions throughout all three stages of the innovation process should cover a range of actors (standardizing bodies, entrepreneurs, developers/industry, transport operators and lobbyists). From what can be seen currently (in Figure 3 in row “Institutional Hard”), at the current initiation stage of the innovation, not enough steps have been taken by the government in this area. From the practical side, in the development stage, the interaction should involve standardizing bodies, to ensure the interoperability requirements of the system developed. Also, at this stage the timing of the created legislation is important, because this will allow the road operators and their clients to be well informed and make informed business decisions. Also, a change that is further away in the future is easier to accept. In addition to those aspects, in the implementation stage, an efficient involvement of an industrial partner, in this case the company or consortium that builds and creates the system becomes important.

Soft Rules. The experience from other analysed cases shows that soft rules are of lesser importance during the initiation and development phases, but it is very important that soft rules are targeted by appropriate actions of the government specifically in the implementation phase of the innovation. In the development and implementation phase the actions of the government should be targeted at the following actors: standardizing bodies (only in development phase), initiators/entrepreneurs, developers/industry, transport operators and lobbyists. Those actions should highlight the benefits of the road pricing scheme to stimulate positive perception of the pricing measures to be implemented.

Interaction Conditions

Weak Network Conditions. Those are characterised by weak links between the actors involved in the innovation process. Those weak links often do not allow reaching an optimal solution, because they do not allow sufficient exploration of alternative approaches. As demonstrated in Figure 3, Figure 4 and Figure 5, actions targeting weak network conditions should be performed mostly in the development and implementation phase. In practice, actions should be taken to reduce the difficulties related to knowledge transfers and misunderstandings related to interpretations of hard rules. Specifically for this case, it might be important to ensure efficient cooperation of the different levels of governmental structures and the private partners involved.

Strong Network Conditions. Experience shows that strong network conditions can have substantial impacts on the development of this type of innovation cases. The strong network conditions should be tackled in the development and implementation phase, where they can considerably slow down the implementation of the innovation. In practice, the strong network conditions can be the different pressures or lobbying from industry organizations with the aim of either gaining certain competitive advantages, or reducing required investments or costs related to implementation of the road pricing system. Political will is needed from the government to counter strong network conditions.

Capabilities are the skills and abilities that the innovating actors possess that are relevant to the development of the innovation in focus. In this innovation case the investment in development of the capabilities were observed already in the initiation phase of the innovation process. The funded research projects indicate this. Usually the support for development of capabilities of the actors is needed mainly in the development and implementation phases of the innovation. In the development and implementation phase there should be a shift of focus to targeting the capabilities of the organization or consortium developing the road pricing system.

4. DISCUSSION

4.1 The methodology

This research proposes and applies a novel methodology constructed based on two previously unlinked fields with real-world application in mind. The application of the methodology has allowed evaluating the proposed methodological framework and seeing possible practical applications of it.

In general, the application of the proposed methodology has been done successfully for the road pricing case in Belgium. The methodology provides a set of results that are important for the innovator, in this case the government. This allows considering the application of the proposed methodological framework for other cases in the future.

The impacts simulation allows the innovator to gain insight in the outcomes of the potential policy innovation in the longer run. If required, results for different scenarios or specific stretches or points of the motorway network could be obtained. Creation of the model itself for this task can be a very time and cost consuming task, therefore in a real-life application, the use of an existing model, like it was done in this research, is advisable.

The cost-benefit analysis, as an important building block of the methodological framework, provides an opportunity to gain insight in the structure of the costs and benefits related to the implementation of the project for the different actors. This provides the innovator with an understanding of the involved cost-benefit structure, which allows identifying possible reactions from different actors that the innovator would have to tackle.

The SI approach draws input from the previous stages of the methodology, case studies and also other information. It is important for taking appropriate steps targeted at particular actors, if necessary, to ensure successful implementation of the innovation.

One of the main advantages of the proposed methodological framework is its transferability. Although the methodology was developed for the purpose of identifying the success for an approach to tackle congestion on port hinterland links, it could also be applied for introduction of other innovations. One would always start with and innovation, which would have detectable impacts on the economy. Then, the application of the methodology would allow determining weather the innovation is favourable and in which areas should the steps be taken to successfully promote it and bring to implementation. The areas where the approach could be applied are not limited to the field of transport. It can be done in any field where there is an innovation to be implemented with high involvement of the government, which has important impacts on different actors of the economy.

Sometimes there are cases where the uncertainty about the details of the project and the outcomes of it is too high. This makes the cost-benefit analysis impossible. The proposed methodology allows overcoming this problem by allowing the SI analysis to overcome the problem of unavailability of some quantified data. This enables the methodology to be applied to a wider range of case studies to produce exploitable results.

The methodological approach allows generation of results, which are useful in practice. Governments of different levels might be interested in this approach, because of the benefits it provides. It empowers the decision makers with information on the following levels:

First, it allows obtaining information on detailed impacts of the measure considered, and, possibly, optimize its design for the specific situation that it would be applied to. Here an approach with different scenarios, modelling cost and different other design parameters, could be used and the optimal one chosen.

Second, it produces data concerning the monetized impacts of the measure to the different actors involved, including the public, companies and the innovator himself. If detailed data is available, the listing of involved actors can be expanded, for example, going into different detailed groups of population depending on the number of the vehicles in the household, for example, and so on.

Last, the SI analysis produces a set of concrete suggested actions in different areas at each stage of the development of the innovation. This allows tailoring support actions for successful market uptake of measures to be implemented. This should allow shortening the timeframe that the innovation path takes, because the most suitable actions could be chosen.

4.2 Lessons learnt from the case analysed

The case analysed showed that the proposed methodological framework is applicable in practice. But it also demonstrated the complexity that can be involved in such cases when it comes to real-life examples. Each stage of the research brought richness of information for understanding of the road pricing case in Belgium.

In the Stage 1, where the impact simulation was done, it was observed in the simulations that the impacts of a pricing measure on a road network are not homogenous. One scenario could have different or even adverse impacts at different locations of the road network. The simulation results showed that sets of measures with similar consequences have greater effect. This was clearly demonstrated by scenarios 8, 11 and 12 where a set of combined policy measures were enacted. On the main port hinterland links, like the E313 motorway for the port of Antwerp, there are strong impacts of assumptions on port growth. The increased/decreased port throughput assumptions had an influence both on incoming and outgoing flows. These observations provided a deeper understanding of what the impacts of the concrete measure chosen would be on the concrete road network.

In the Stage 2 the application of the cost-benefit analysis for determining the outcomes of implementation of the road pricing scenario was done. The analysis showed positive impacts of the project, which is and indicator for high likelihood for this innovation to succeed. But more importantly, it showed the costs and benefits for the involved actors. The analysis shows that the most benefits, which come from time savings and reduction of externalities related to cargo traffic volumes, are enjoyed by the individuals. For companies that are road users the benefits come from time savings and consumer surplus, but those do not outweigh the toll that has to be paid. The government bares the system development costs, which it covers with toll revenues. This summarized in the Table 1 of success conditions allowed predicting which actor will be in favour and which against the innovation.

In the Stage 3 of the research concrete actions are suggested for the government to alleviate the implementation process of the road pricing in Belgium. They describe what interactions with which actors should be encouraged. It can not be said that without following these developed suggestions the innovation would necessarily fail. But enacting these identified support measures should allow developing a more efficient implementation plan and avoiding certain problems that might occur in the innovation path.

5. CONCLUSIONS

Congestion problems can be observed on the hinterland links of most of the ports. In the context of freight traffic, congestion results in increased costs related to time, uncertainty about arrival times, waste of fuel, increased wear of vehicles and other negative effects, including those on the environment. Also, increased levels of congestion on the land side negatively affect the competitive position of ports. In this situation governments and port authorities are under pressures from the industry to act and come up with solutions. But at the same time governments have to deal with financial constraints and the political unviability of the available solutions.

The challenges the governments are facing require new approaches and methodologies to be developed. This research results in an approach that can be applied in this situation. First, with the help of impacts simulation a suitable measure for implementation is chosen. Then, the definition of success conditions for an innovation case is developed and a success algorithm is derived from it. Those are applied to the chosen case study of road pricing to determine its innovation path. Last, the systems innovation analysis of the case study was done to produce specific detailed recommendations for interventions and actions during the three development stages of the innovation case: initiation, development and implementation phase.

It is clear that the congestion problems on Belgian motorway network cannot be solved by pricing measures that are applied only to heavy goods transport, because the other main contributors to the congestion problem are the passenger vehicles. There are still benefits from implementation of the road pricing for heavy goods vehicles. It would be more efficient if the pricing was applied to all road users. Unfortunately, this is currently unlikely for political reasons.

This research proposes a methodology for development, evaluation and successful implementation of measures for tackling congestion on port hinterland links. The methodology is sufficiently general to be applied to other innovation cases. The political and practical dimension of the research results makes them relevant to governments with applications in transport and other fields. The results of this research contribute to the development of more efficient contemporary solutions for problems that transport policies are called to solve.

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