

Innovations in Transportation: research and policy lessons of recent successful cases

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Paper prepared for the Six Countries Programme workshop “New Governance for Innovation – The Need for Horizontal and systemic Policy Co-ordination”
November 14/15, Karlsruhe, Germany

The author would like to thank Professor Dr. Ruud Smits (Utrecht University) for his comments on the draft version of this paper.

Introduction

Transport fulfils a crucial role in modern society. In Western countries households spend on average 10 to 15% of their income on transport. Besides people travel 60 to 75 minutes per day (Schafer, 1998). A substantial part of government expenditure is related to transport (investments in infrastructure, subsidies for public transport etc.). In 2001, for example, the total budget of the Dutch Ministry of Transport, Public Works and Water Management was about 5 billion euro (about 1.5 % of GDP). However it is questionable if these figures fully express the importance of transport for society. Transport is necessary to bridge the distance between different activities, making this demand for transport a derived demand, rather than a demand of the activity in itself. Modern societies cannot function without transport.

Passenger transport needs are mainly met by motorised transport modes using fossil fuels, while the transport of goods is almost completely reliant on these modes. Motorised transport has important external effects. Emissions of pollutants lead to poor air quality and acidification and emission of CO₂ are probable causes of climate change. Other external effects include noise, accidents and congestion. For example in the Netherlands the share of transport in emissions of NO_x, VOC and CO is 40 to 65% and the share of CO₂ almost 20%¹. Besides, about 25% of the population is seriously hindered by noise nuisance of road traffic, and about 12% by noise by aircraft (Rijksinstituut voor Volksgezondheid en Milieu, 2000). Every year about 1000 people are killed in road accidents. Estimated on a yearly basis, the value of the time lost on the main motorway network due to congestion is about 0.8 billion euro (NEA, 1998), the value of time lost on the secondary and local roads is of the same order of magnitude.

Forecasts for the next 2 to 3 decades show that both passenger and goods transport are expected to increase substantially. The share of the fast but relatively energy-consuming modes are likely to increase. In the Netherlands technological improvements will not be able to compensate the growth with respect to CO₂ and noise. However, emissions of NO_x and VOC will decrease, mainly due to improvements resulting from EU regulations (Feimann *et al.*, 2000). Besides, congestion levels are expected to increase unless a package of measures is introduced that exceeds, by far, current Dutch policies (AVV, 2000). The number of people killed in road accidents will probably decrease but remain on a level not much below the current one. The Dutch government's target, as proposed in the recently rejected draft National Traffic and Transport Plan (NVVP) was a reduction of road deaths in 2010 to 750.. Summarising, transport-related external effects will remain important in the next decades. External effects constitute an important reason for government intervention and resulting transport policy. In this paper, our main focus will be on environmental effects.

Environmental impact of transport depends on a number of determinants. The first is the overall volume of transport, expressed as passenger kilometres (persons) or tonne kilometres (goods). The second category is the modal split (for passengers this is car-driver, car passenger, train, bus/tram/metro, walking, cycling, aircraft, ship), and the third is the technology used. A fourth category is the efficiency of using vehicles (for lorries this is the load factor, and for cars, trains and busses it is the occupancy rate). The fifth is the manner in which vehicles are used (speed, acceleration, deceleration). Governments have several types of policy instruments to influence these determinants; these are regulations, prices, land-use planning, infrastructure planning, marketing and provision of information and organisation. Table 1 shows the relationship between the type of instruments and the determinants.

¹ In the CO₂ figure emissions of international transport by ship and aircraft are not included. If the tanked fuels of these vehicles would be included (not an official allocation mechanism) the share of transport is almost 40%.

Table 1: Dominant relationships between determinants for environmental impact of transport and policy instruments

	Volume	Modal split	Technology	Use of vehicles/ efficiency	Behaviour
Restrictions	*	*	*	*	*
Prices	*	*	*	*	*
Land-use planning	*	*		*	*
Marketing		*			
Information and				*	
Infrastructure	*	*		*	*

Source: Blok and Van Wee (1994)

Innovations and the related innovation system play an important role in transport. Following on from Metcalfe (1995, Smits and Kuhlmann (2002) define the innovation system as: *A system of innovations is that set of distinct institutions which jointly and individually contributes to the development and diffusion of new technologies, and which provides the framework within which governments form and implement policies to influence the innovation process. As such it is a system of interconnected institutions to create, store and transfer the knowledge, skills and artefacts which define new technologies.*

This definition applies to technology-related innovations. In this paper, we will take a broader stand to include non-technology related innovations, such as innovations in services or policy instruments.

Innovations can be related to technology, but also to all categories of instruments, as presented in Table 1. For example, innovations in pricing instruments are possible; this includes pricing vehicles per kilometre, dependent on vehicle category (car, lorry etc.); environmental characteristics of vehicles ("clean" cars, versus more polluting cars), and time of day and place. Besides, innovations in research may lead to a change in the impact of research on policy making. Though the list is not complete, categories of innovations in transport that are often discussed are:

- Other transport systems that might, at least partly, replace current road vehicles, ships, rail and aircraft. The introduction of new systems takes several decades, the last "new" technique being aircraft, which started playing a role between the first and second world wars.
- Improvements in current types of vehicles, fuels and infrastructures.
- Radical changes in transport services.
- Incremental changes in transport services.
- Application of existing concepts to new markets or in other geographical areas.
- Innovations in policy instruments.

The first and third type of changes can be considered radical innovations, while the second and fourth are incremental innovations. The fifth category is considered radical to the new market or area but not as an independent innovation.

It is not easy to label innovations as incremental or radical. For example, the introduction of the three-way catalytic converter to the EU market in the late eighties was incremental if one considers the passenger car to be the object of study (the systems approach): i.e. the functions of cars were not influenced by the converter. But if the exhaust system is the object of study (the module approach), the three-way catalytic converter is then a radical innovation. This example shows how the object of study relates to the question of whether innovations are radical or not.

The transport sector is not a very dynamic one from the perspective of radical innovations. Many ideas have been launched, but only a small minority of them have reached the pilot stage, and even fewer have been implemented. Long-term scenarios often assume that futuristic techniques such as monorail or the integration of private and collective vehicles play an important role. In reality such changes are very limited. In most western countries the current transport system does not really differ from that of 1970. There has been a shift between modes (more road and air transport and a decrease in the share of public and goods transport by rail). Furthermore, overall transport levels expressed as passenger and tonne kilometres per capita, have increased. Nevertheless, hardly any of the possibilities of modern societies today existed in 1970. Causes of the limited number of radical innovations in transport could be that: (1) many actors are involved (users, companies offering transport services, authorities), (2) interests and preferences of actors often conflict, (3) institutional and political barriers do exist and are of importance for change (Geerlings, 1998), (4) local, regional, national and international authorities play an important role in transport innovations, and are often not very successful in rapidly implementing the policy changes needed, (5) changing transport and land use takes a lot of time, and (6) investments in the current system in terms of infrastructure and vehicles are huge, making it less attractive to replace the current system with new systems (high “suck costs”).

Several more incremental innovations have indeed been realised. We will focus here on innovations that have been implemented in practice, trying for each case to identify crucial success factors and possible failure factors that have been successfully dealt with or that may still cause problems in the future. In some cases, the role of research has been the subject of study. The aim was to learn lessons for both policy and research. The results did not come from long-term scientific research using advanced methods, but were based on interviews with experts and accompanied by a limited literature survey. Experts interviewed were consultants and people working for independent institutes. We want to stimulate discussion on innovations in transport and the related role of research, rather than to provide a blueprint for innovations and related research and policies.

Section 2 focuses on policy making and the influence of research has on this. Systemic instruments are dealt with in section 3, while section 4 describes the cases, including actors involved, success and failure factors and the role of research. Finally, section 5 presents the main conclusions and discusses the results.

2. Policy making and the influence of research

Using the Netherlands as an example, we focus on policy making relevant for the country - national, regional and local levels – and for the EU. The aim of this section is to present a general overview of dominant kinds of policy on different spatial scales, making it clear that transport policy making is often fairly complicated.

Table 2 shows the dominant kinds of policy relevant for transport.

Table 2: Dominant kinds of policy relevant for transport

Subject	EU	National	Provincial	Local
New infrastructure	Setting the frame	Main infrastructure; policy framework for lower governments, partly financing infrastructure	Provincial roads, checking plans of local municipalities	Local roads, local spatial plans
Public transport	Stimulates harmonisation	Subsidies, permits, national public transport (mainly rail), setting the framework for regional and local public transport	Regional public transport	Local public transport
Pricing policy	Stimulates harmonisation, stimulates the use of pricing instruments	Levies for fuel, policy with respect to road pricing, setting the framework for provinces and local municipalities	Possibly: road pricing on provincial roads	Parking tariffs, selecting parking places for paid parking
Spatial policy	Stimulates European spatial policy	National spatial policy, setting the framework for provinces and local municipalities	Regional spatial plans, checking spatial plans of local municipalities	Local spatial plans
Speeds	Harmonisation of speed limits	National policy for speeds, speeds on main motorway network	Speeds on provincial roads	Speeds on local roads, traffic calming measures
Environmental policy with respect to vehicles and fuels	Regulations for vehicles and fuels	Stimulating vehicles that already meet next EU standards	Hardly relevant	Possible: selective access for certain vehicles

Source: Adapted from Annema, 2002

Table 2 shows that many kinds of policies have an impact on transport and that several levels of government (from EU to local) have policy tasks. The policy-making process is even more complicated than Table 2 suggests: for example, the policy for infrastructure and prices/subsidies is the responsibility of the Ministry of Transport, whereas the policy for vehicles and fuels is the responsibility of the Ministry of the Environment. Besides this, local municipalities often compete for funds from the national government. Besides, municipalities compete with each other for firms to be located in their respective municipalities. and for firms. Finally, different (sub)departments also exist within the ministries, resulting in a desaggregation of responsibilities that are often not very well co-ordinated.

In this overview it is seen why it is often so complicated to develop and implement successful innovations if several governments are involved. Besides, the public transport companies do not have a reputation of being among the most dynamic firms in the Netherlands. It has proven to be very difficult to change the culture in these companies. Experiences with deregulations and privatisation of rail (e.g. in the UK and the Netherlands) have not met with unquestionable success yet.

An important question to ask ourselves here is: why should the government intervene in the transport market? One of the most important reasons is because transport has important external effects. These are effects that users do not include in their decisions but that do have an impact on others. External costs are environmental effects (noise, emissions), safety impacts and congestion (see section 1). Therefore it would seem logical that the choice of policy options will be at least partly based on insights into these external effects.

But these insights alone are not sufficient: there is a broad consensus that criteria to evaluate policy options, in general, are effectiveness, efficiency and equity. Effectiveness relates to the question of the desired effects of the government being realised, for example, if a policy measure aims to reduce NO_x emissions, this measure is only effective if it really does reduce NO_x emissions. Efficiency relates to the question of the effects being obtained in an efficient manner. An important question here is: do other policy options result in the desired effects being obtained in a cheaper manner? In the case of NO_x emissions: are there other policy options by which NO_x emissions can be reduced at a lower rate (cost per kg of emissions reduced)? The efficiency criterion is often expressed as cost-effectiveness. Equity relates to the distribution of positive and negative effects in a population group, for example, according to income, or to other socio-economic or demographic variables or geographical region. An example: suppose a policy measure increases GDP in a cost-effective way, then the general effect will be an increase in average income. But suppose this effect is the result of a decrease of 50 euro in the average income of 10% of the population with the lowest incomes and an increase of 150 euro in the income of the 10% of the people with highest incomes. Do policy makers like these results? This is an equity question.

Researchers that carry out policy-related studies often spend much time trying to estimate costs, effects and cost-effectiveness, and to a lesser extent equity impacts of possible future policy options. The question arises if this kind of research will be sufficient to develop and successfully implement future policy options? For selecting or prioritising options these criteria are relevant, though often others, like psychological impacts, spatial consequences, and legal and institutional aspects, are important. However, for a successful implementation of policies there is a growing consensus that a more systemic approach is needed for the governance of new policies in general. For innovations this might even be of more relevance. Innovation is a systemic, horizontal phenomenon caused by and influencing a broad spectrum of factors. Policy institutions, however, are fairly narrow and vertical in their thematic focus, working on a departmentalised and fragmented level. This has an impact in the research they desire. If research has played a role in policy choices its role is often quite straightforward and limited to costs, primary effects and cost-effectiveness of policy options; sometimes it may be even more limited, e.g. only related to effects. A policy maker responsible for climate policy will be mainly interested in CO₂ impacts of policy options, and either not at all, or to a lesser extent, in other environmental impacts, not to speak of non-environmental impacts. This raises the question of what the role of research was in the successful cases. Was research focused on more systemic aspects of governance carried out? If so, what research specifically? And did it play a role in the policy making process?

Since 2000 the so-called OEEI (Dutch abbreviation for Research on Economic Effects of Infrastructure) guidelines have been in existence for the *ex ante* assessment of the possible future main transport infrastructure plans (Eijgenraam *et al.*, 2000). A Cost Benefit Analysis (CBA) has to be carried out according to these guidelines. Contrary to its name, the CBA also includes non-economic aspects such as environmental impacts, which are found in current practice in CBAs in many countries (Hayashi and Morisugi, 2000). The CBAs are fairly straightforward and only focus on effects, efficiency and (to a lesser extent) equity issues.

Systemic aspects of policy-making processes are not included. This kind of research is very scarce in the Netherlands. In the next section we will focus on these systemic instruments.

3. The systemic instruments

Starting from the co-evolutionary development of innovation practice, theory and policy, Smits and Kuhlmann (2002) identify five functions playing a crucial role in the management of present-day innovation processes:

1. management of interfaces ...not only aims at transferring knowledge but also at building bridges and stimulating the debate. Furthermore, the management of interfaces is not limited to bilateral contracts but also focuses on chains, networks and the system level.
2. (de-)constructing and organising systems. Construct and de-construct (sub) systems, initiate and organise, use discourse, alignment and consensus. Initiation of prime movers and ensuring that all relevant actors are involved also form part of this function.
3. providing a platform for learning and experimenting. Create conditions for various forms of learning such as learning by doing, learning by using, learning by interacting and learning at system level.
4. providing an infrastructure for strategic intelligence. Identify sources (technology assessment, foresight, evaluation, bench-marking), build links between sources, improve accessibility for all relevant actors and stimulate the development of capacity to produce strategic information tailored to the needs of actors involved.
5. stimulating demand articulation, strategy and vision development. Stimulate and facilitate the search for possible applications, develop instruments that support discourse, vision and strategy development.

The authors conclude that, in reality, financial instruments have been dominant. They state that a new type of instrument, the systemic one, should be included, more to better attune the instrument portfolio to the needs of actors involved in innovation processes than previously.

In the case studies we will try to answer the question if systemic instruments have played a role in the policy-making process and in the related research. In the interviews we asked about the general success and failure factors and about the impact of research on the process.

4. Cases

Cases were selected using three criteria:

- Dutch and non-Dutch cases were to be included;
- Both technical and non-technical (services) cases were to be included;
- Services should be related to passenger transport, because the impact of governments on passenger transport is much greater than on goods transport.

In the interviews we asked for the perceptions of interviewees on success and failure factors, and the role of research (see Appendix 1 for the questions). We did not focus on the research reports themselves. Therefore it is possible that the research report focused on aspects that the persons interviewed did not mention. The idea behind this approach is that if the person interviewed does not mention these aspects, they have probably not been of importance in the process. However, further research into these documents might add value to our approach.

Park-and-ride at the edge of town for shopping in the centre

Description

Since 1994 some cities and towns have introduced park-and-ride facilities on the edge of town, the so-called transferia (transfer points). Some of them are successful, others are not. In this paper we will focus on the successful transferia, introduces to bring people from outside town in the centre. The main example is the transfer point on the east side of Utrecht.

Other examples are found in the cities of Den Bosch and Dordrecht. Note that in Utrecht there is also a transfer point on the west side, but it is not successful. The transfer point on the east side of Utrecht focuses on people going to the city centre for shopping. Coming from outside town on Thursday night when the shops are open and on Saturdays, people can park their cars on the east side of town, at the parking lot of the soccer club, FC Utrecht. The few times a year when the shops in Utrecht centre are open on Sundays, the P+ R (park-and-ride) service is also available. Before this, that parking lot was (almost) empty. A bus brings the people to the centre. In the beginning the service was free but now people have to pay. A combined ticket for parking and the return trip by bus is cheaper than parking in the city centre. Introducing paid parking has not led to any noticeable decline the number of users .

Actors involved

The service is an initiative of the local municipality of Utrecht, the local bus company (GVU) offers the service and is paid for by the municipality. Thought the initiative and general concept originated in the local municipality, the concept was worked out in detail in cooperation with the GVU.

Goals

The main goal was not as much to reduce traffic and congestion on the routes from the east to the centre, as it was to reduce parking problems. The service is a much cheaper alternative for the municipality than building new parking garages in (or near) the centre.

Success and failure factors

An important factor for the success is the price: it is lower than the alternative of parking in the centre. A second factor is the ease and comfort compared to the alternative: driving into the centre and finding a parking place, which is often very difficult due to congestion and a lack of parking places. A third success factor is the quality of the service. Important elements are the high speed of the bus (short travel time), the high frequency, the surveillance at the parking lot and the continual presence of a bus waiting at the parking place. People arriving by car therefore can always immediately enter the bus where the driver is waiting. Therefore people experience the service as being safe. A final important success factor is the publicity given to service through several means, making it well known.

A possible thread for success is the need for permanent subsidies. Another possible thread for success is maintaining the information and reputation built up in the past. Before introducing the service the importance of information was recognised by the actors. The positive reputation is partly the result of a positive attitude of the local press (e.g. the regional newspaper Utrechts Nieuwsblad).

Research

The only research that was carried out in advance was the inventory carried out by the municipality about the introduction of the concept in other places like Bruges (Belgium), York and Oxford (UK) and what was learned from the successes and failures. No specific research for Utrecht was carried out. After introducing the service investigations were carried out periodically by a consultant on behalf of the municipality, focusing on the opinions (how to improve the service) and behaviour of users. This research showed that some of the users had not visited Utrecht centre before the service, but had gone instead to neighbouring towns or shopping centres in the outskirts of town. The investigations also showed that the service was working well.

Systemic instruments

Marketing has played an important role in the success of the service. Besides, the desires and needs of (potential) customers were given the main focus. Several categories of customers were recognised and the service was adapted to these categories. Communication between the municipality, the GVU and the soccer club FC Utrecht, and between the municipality and the public has also played an important role.

Park-and-ride near a tourist village

Description

Renesse is a small town on the coast in the southwest of the Netherlands. In the summer season it attracts many tourists to the town or the beach. People driving through town, often searching for a parking place, and parked vehicles caused many problems. In the mid-nineties a parking place was laid on just outside town. Buses and a horse tram brought people to the village for free. There is also a route followed to the entrances of the beaches, and the main camping sites were on the same route. Camping guests can also use the bus to go to the village or to the beaches. The timetable also fits well to the timetable of the regional bus, making a switch very easy for the users. Some buses have been adapted to the customers being almost exclusively tourists. For example, one of the old buses has the roof removed (giving a convertible feeling). Most of the interior of the bus has been taken out, there is sand on the floor to give people a "beachy feeling". There also is a horse tram as tourist attraction. Some hybrid mini-buses are also used. In the dunes they ride on electricity. Both supply and demand have increased since the introduction of this service.

Actors involved

The initiative came from the local municipality, which finances the yearly costs (about 135,000 euro); the Ministry of Transport subsidised initial costs. At the time of writing this paper there is was discussion on the yearly costs. Users may be obliged to pay in the future; firms in the village benefitting from the service may pay (part of) the costs. Initially it was not legally possible to have firms pay part of the costs, but the national legal system has been changed to make this possible. The hybrid mini-buses are partly subsidised by NOVEM, a government related institute responsible for such items as subsidising energy and environment-related projects.

Goals

The main goal was to free the village from car traffic (driving and parking).

Success and failure factors

An important success factor is the free service offered; other success factors are the positive image of the service and the fact that it is well known all over the country. Another factor is the marketing: it was not sold as "public transport" but as the last section of the car trip. Part of the success is also due to related measures: reducing the number of parking places in the village at the same time as introducing the service and introducing car-free streets.

One of the threads is the need to subsidise the service. Introducing a fee will cause legal problems: then users should be given a ticket but the ticketing machine is not in the busses., The project has been faced with several legal difficulties, which have, so far, been overcome.

Research

Before the introduction of the service a consultant carried out research on behalf of the municipality, focusing on the market potential and choice of transport mode of possible users. Because of the pilot character the Ministry of Transport claimed that periodic research had to be carried out, focusing mainly on the number of users. This research did not have much impact as it did not focus on

Evaluation carried out by a consultant shows that many users use the service frequently. It also shows that some tourists actually chose Renesse instead of other villages because of this service.

Systemic instruments

Again, the impact of marketing has been large. Making the users the central issue of the concept has been very important. Finally, combining the introduction of the service with the other policies related to parking in the village and car-free zones played an important role in the success.

Temporarily limited access on a route through a small town

Description

The region of Utrecht inaccessible from the south of the country by the A2 motorway. During the morning peak the A2 in the direction of Utrecht (north) is heavily congested. Many car drivers therefore took an alternative route via the small town of Vianen, and returned to the A2 north of Vianen, leading to much congestion and nuisance on that route. The complete section within the built-up area used to be congested during the morning peak hours, leading to safety problems, noise nuisance and parents who did not allow their children to go to school unaccompanied. It was therefore decided to limit access in one direction. The final decision was for a system that would limit access of vehicles coming from the south. A closed cordon of seven locations would regulate the traffic. In 1997 when Vianen introduced the concept, it was the first town in the Netherlands to do so. Note, however, that the discussion had started around 1988, with the first research dating back to 1990. In 2000 the system was also introduced successfully in the afternoon to avoid people taking the route via Vianen coming from the north.

Actors involved

The initiative came from the local municipality. One person playing an important role was the alderman for transport. Later on the Dept of Public Works (RWS in Dutch) for the province of Utrecht (a section of the Ministry of Transport responsible for the roads in the province) got involved. RWS realised the problem was the result of problem on the A2 motorway. Another important actor was the fire brigade: during the morning peak it was impossible for them to extinguish a fire, simply because destinations were more or less inaccessible due to the congestion. RWS offered to pay part of the costs on the condition that the local municipality accepted that access to the north of town to the motorway would be limited. Though the municipality did not like the proposal initially, later on it became acceptable to them. Because of the limited access of traffic coming from the south the inhabitants of Vianen would not have to wait so long after the introduction of limited access to the motorway north of town. RWS promised that the limited access would only be introduced during periods of congestion on the A2. One can consider the combined measures as a package deal.

Goals

The goal was to improve liveability and safety and to reduce congestion in Vianen during the morning peak.

Success and failure factors

An important success factor was the magnitude of the problem: everybody, including the inhabitants and firms in Vianen and the politicians of the various political parties agreed that the problem should be solved. Convincing people from outside the area was relatively easy: people of RWS and others who saw the video tape and the results of research (see below) were easily convinced that the old situation was unacceptable. The video tape certainly added to the result of the research. Another important success factor was the crucial role of the chairperson of the transport department of the municipality. Another success factor was due to the route not being completely closed but allowing limited access. Firstly, the plan was to completely close the route. Then some people claimed they should be exempted. This, for example, was the case for people living in the village of Lexmond, just south of Vianen. They would, of course, suffer from a closure. It was decided not to close the route but to limit access. Only a limited number of cars may enter Vianen from the south. This number is low enough to avoid the problems but high enough to allow people living just south of Vianen to drive to the A2 via Vianen. Also for legal reasons limited access is easier to implement than a closure. The people responsible for the system also have more flexibility in case of limited access compared to a closure. For example, they can easily adapt the time period of limited access. Limited access is regulated by a traffic light that allows one car at a time to drive on and proceed through Vianen.

Research

To convince the RWS and the Ministry of Transport research was carried out by a consultant on behalf of the local municipality. It was a study to show the magnitude of the problem. Number plates of cars were registered both at the start and finish of the alternative route via Vianen. The study showed that during the morning peak 95% of all cars entering Vianen via the south were cars that had left the A2, choosing the alternative route via Vianen and then

entering the A2 again. Another study was carried out to determine the impact of the additional limited access north of town, as proposed by RWS. The result convinced the local municipality that problems for inhabitants would be limited. Not really the traditional form of research, but interesting was the video made by a consultant on behalf of the municipality showing the problems. Not only did one see the congested route but also the impossibility of the fire brigade to leave the garage and drive to a possible destination.

Systemic instruments

The role of systemic instruments in this case is limited. The video tape played an important role, as well as the chairperson of the transport department who personally put much energy in the project by successfully speaking and dealing with other actors.

Reducing emissions of motor vehicles by EU regulations

Description

Emissions of NO_x, VOC, CO and lead from road transport in EU countries have decreased. For example, between 1991 and 1998 road transport emissions of NO_x decreased in the EU-15 by approximately 20%, despite the growth in vehicle kilometres. These reductions are mainly the result of EU regulations for cars and fuels (EEA, 2001). For example, the three-way catalytic converter was introduced to meet the 1993 standards for new cars. Lead was banned not only because of the health impact, but also because lead ruins catalytic converters.

Actors involved

Important actors are the European Commission, the EU member states and the manufacturers of cars and fuels. Negotiations between these (categories of) actors are very important for the final result.

Goals

The goal was to reduce the emissions of pollutants and so the negative impacts of transport on the environment.

Success and failure factors

An important success factor is the long tradition of regulations. The first regulations for cars originated in 1970. Practice shows that introducing new regulations replacing previous regulations is relatively easy, easier than introducing new regulations for vehicle categories that were not regulated before. This partly explains that only recently have regulations for barges been introduced, though reducing emissions from these ships is more cost-effective than further emissions reductions for road transport. The role of industry is very important. Thanks to numerous negotiations the regulations could be introduced successfully. Negotiations dealt mainly with the time of introduction, the emissions standards and the test procedure. However, the strong impact of industry resulted in lower standards or later introduction of standards than was technically possible. For example, the regulations for cars that were introduced in 1993 were more or less equivalent to regulations introduced in California in 1983. Nowadays differences between the USA and the EU are limited compared to the early nineties.

Research

Research in separate member states shows that expected effects and costs have played an important role with respect to the position of these member states. The Auto Oil programmes, in which the car and fuel industries also participate, have been influential at the EU level. These programmes focus on costs, effects and cost-effectiveness of new techniques for vehicles and fuels.

Systemic instruments

The role of systemic instruments is limited: the traditional approach of research into costs and effects, as well as negotiations between the EU, member states and industry dominates. These negotiations can be seen as systemic instruments.

Porous pavements on motorways

Description

Since 1987 porous asphalt has been applied on motorways in the Netherlands. The first experiments (small test sections on motorways) originated in the late seventies. The initial reason was safety: during rain or wet-surface conditions visibility is much better compared to the traditional asphalt pavements. A little later it became clear that the level of noise emissions from road traffic driving on porous asphalt is lower than of road traffic driving on regular asphalt. By the year 2000 over 50% of all motorways had porous asphalt. If motorways need new pavement this new pavement will be porous. Therefore by the year 2010 the complete Dutch motorway network is expected to have porous asphalt. The share in the Netherlands is higher than in any other EU country. In Europe as whole the Netherlands, Germany and Switzerland lead the other EU countries in taking measures to reduce noise nuisance.

Apart from porous pavement a second new type of pavement is under discussion at the moment. This is double-layered porous pavement, which has even better acoustical characteristics.

Porous pavement and double-layered porous pavement can also be applied to local roads. But additional costs are then higher compared to additional costs if applied to motorways due to the high costs of draining off the water. Besides this, double-layered asphalt cannot be applied in curves and if speeds vary greatly (e.g. near traffic lights), speed variations (accelerating and decelerating road vehicles) will cause surface problems. In this paper we will focus on porous pavement on motorways.

Actors involved

Two actors have been main contributors to the applications of porous pavement: firstly, the RWS, the part of the Ministry of Transport and Public Works responsible for the construction and maintenance of the motorway network, for example, and secondly, the firms manufacturing pavements, and constructing and maintaining roads. It is the interaction between the two that have led to the successful introduction of porous asphalt. The firms developed the new pavements for commercial reasons, and the RWS liked the better visibility (and therefore safety) as well as the acoustic characteristics.

Recently the Dutch Ministry of the Environment introduced a subsidy for local governments for doubly-layered porous pavement in which the Ministry would pay the additional costs. The subsidy is very successful: the total amount in subsidies exceeding by far the available amount of money.

Goals

The initial goal was to improve safety by improving visibility, but noise reduction was soon added.

Success and failure factors

An important success factor is the relatively low additional cost compared to traditional pavements. Additional costs including both construction and maintenance, are approximately 25 to 30% if applied on motorways. Another success factor is the positive contribution to two aspects: safety and noise. A problem for doubly layered porous pavements is the filth which fills the spaces in the asphalt, reducing the positive effects. The discussion on how to solve the problems is still going on.

A thread for porous asphalt is the application of salt to slippery pavement, which lengthens the braking time of the car compared to braking on regular asphalt. This problem was solved by developing and applying other types of salts.

Research

The asphalt firms carried out much research and also paid for research carried out by consultants on test sections on motorways. They also carried out research aiming to develop salt types that do not lead to longer braking distances. In some cases RWS paid part of the costs. Research was carried out by a consultant on behalf of the Ministry of the Environment on the cost-effectiveness of porous pavements (KPMG, 1999). The research supported the long existing policy to prioritise measures at the source (vehicles, infrastructure) instead of at the intermediate zone (noise barriers) or the receptors (construction of buildings).

Apart from these researches the impact of research has been limited.

Systemic instruments

The role of systemic instruments has been very limited. The interaction between RWS and the asphalt firms can be categorised as systemic. The innovation also followed the more or less traditional lines.

New markets for public transport at the regional level

Most western countries face a decline in the market share of public transport. Besides this, often substantial subsidies are needed to maintain current public transport. Despite this poor market position many cities and regions have made plans to improve local or regional public transport. In the past decade especially *light-rail* based concepts have been subject of study all over the world. However, the number of implementations of new public transport concepts, such as light rail, has been relatively limited. This raises the question about the factors that have resulted in successful implementation in those cities and regions. Cervero (1999) carried out research using 12 cases from around the world to answer this question. Several lessons can be learned from his research:

Visioning: transit metropolises evolve from well-articulated visions of the future. There must be a sense of exactly what the target is, both to gain public buy-in and to build political support. However, in pluralist societies, striking common vision can be difficult.

Visionaries: visions need visionaries who can articulate what the future might hold and convince others of a desired course of action. Many transit metropolises have benefited from inspired leadership. Efficient institutions and governance: efficient institutional structures and regional forms of governance that promote the close co-ordination of transportation and land use are very important.

Pro-active planning and urban management: transit-supportive built forms are substantially the result of farsighted, pro-active and strategic planning processes.

Viable centres: all transit metropolises maintain strong, vibrant central business districts.

Balanced development and traffic flows: to avoid unidirectional, radial movements into a dominant centre, intermixing land uses along linear corridors, can produce efficient bi-directional flows.

Competition and an entrepreneurial ethos: Cervero found elements of competition in many successful transit metropolises. Competition not only contains costs and rewards efficiency but also spurs on service innovations, something that is badly needed in many suburban travel markets.

Giving transit priority: it is especially important to make transit time competitive with the time travelled by private car.

Small is beautiful: Large-scale mega-projects are not necessarily the only means of creating a successful transit metropolis. In several cases, many of the successes are attributable to the cumulative effects of many modest, low-cost, but fast-turnaround actions.

Urban design: cities for people and places: a design philosophy of most transit metropolises is that cities are for people, not for cars. Parts of the centres have been given to pedestrians and sometimes also cyclists.

Auto equalisers: many metropolises have matched provisions for pedestrians, cyclists and transit users with restraints on motoring and auto ownership.

Hierarchical and integrated transit: many of the successful transit metropolises feature well-designed hierarchical forms of transit services. This makes it possible to provide good quality public transport for many origin-destination combinations.

Flexibility: especially for some of the smaller transit metropolises, bus-based technologies not only reduce capital outlays but also provide important flexibility advantages. Flexibility is probably easier to include in bus-based systems than in rail-based systems.

This overview shows that some of the crucial factors are related to the transport system itself (good integration with land-use planning, adequate networks, car-free sections etc. But some of the factors are more related to processes and to systemic instruments: visions and visionaries as well as competition and an entrepreneurial ethos have proven to be important factors. Cervero also concludes that successful cases support larger policy objectives: sustainability, accessibility, liveability, social diversity, entrepreneurship and the broadening of choices to do with where and how people live and travel. In short, many factors are relevant and many actors are involved for the successful implementation of public transport on a regional scale. Therefore it is very complex to successfully implement public transport at this level.

Innovations in the role of research for policy making

In 1997 / 1998 the Dutch government decided that part of the natural gas revenues should be invested in the country in such a way that future generations would benefit. The goal of the investment was to improve the quality of life in the Netherlands in a very broad sense, i.e., satisfying all kinds of economic, social and quality-of-life goals. Some 7 to 9 billion euro was to be reserved for these investments for the 1999-2010 period. All investments were to be additional to the investments that resulted from current policy. The ministries proposed plans for about 22 billion euro. In order to support decision making, a pragmatic method was developed to evaluate the plans. Very different kinds of investment plans were evaluated for economic, social, and ecological impacts and direct links were made with the policy-making process. Proposals included roads, public transport investments and many non-transport related plans such as improving the environmental quality or the vitality of large cities. A central government advisory committee (the ICES) asked four Dutch national research institutes (Netherlands Bureau for Economic Policy Analysis [CPB], Social and Cultural Planning Bureau [SCP], National Institute for Public Health and the Environment [RIVM] and the Transport Research Centre of the Ministry of Transport, Public Works and Water Management [AVV] to evaluate these plans (CPB, 1998). The institutes were asked to develop a general appraisal method and rank the investment proposals on the basis of this method. All the plans were labelled as (a) "a solid plan", (b) "possibly a solid plan but requiring improvements" (upgradable) or (c) "a weak plan". The method developed is, in itself, not new, but it certainly is of interest for the following five reasons:

1. Very different kinds of investment plans were evaluated using this method
2. Not only economic impacts were evaluated but also social and ecological impacts
3. Effects of investments were compared with effects of other policy instruments
4. Use of the method has been directly linked to a policy-making process, and
5. The study was carried out by independent institutes.

The methodology consists of three steps. In the first step policy tasks were identified on the basis of prognosis of future developments and policy goals. In the second steps, each individual investment plan was evaluated using several criteria: legitimacy, benefits, cost-effectiveness, uncertainties and risks, and alternatives. In the third step different combinations of policy measures were evaluated.

It is not within the scope of this paper to present the results. For a summary we refer to Annema *et al.* (1999). What is important is that this research was new and innovative for the five above-mentioned reasons. Also important is that part of the money was earmarked for research. Several research programme proposals were evaluated and several chosen. For transport two institutes are of particular interest: Connekt, which aims to bring together market-based actors (such as the car industry or the companies providing public transport) with the government and researchers, and Habiforum, focusing on multiple land use (e.g. building above infrastructure).

Another important aspect is the large impact the study had on decision making. All "solid plans" were selected, the total cost amounting to 5.5 billion Euro. There was about 3.6

billion euro left, which was used for a selection of “upgradable” plans. No weak plans were selected.

This example shows the importance research can have on decision making. The innovative character comes from the co-operation of institutes, and of the concept of evaluating all kinds of different proposals in a consistent way. The participation of the ministries developing the proposals in the process also formed an innovative approach.

5. Conclusions and discussion

In the past two decades reductions in transport emissions have mainly resulted from technical changes in vehicles and fuels. At the level of the transport system the innovations cannot be considered radical, while at the level of components of the system, radical innovations were introduced, the three-way catalytic converter being a dominant one. The technical changes are mainly the result of EU regulations for fuels and vehicles. The role of systemic instruments has not been very dominant in setting new standards. Nevertheless, one can consider the scene to be systemic, where there are formal and informal contacts between policy makers at the EU, and national level and industry.

Changes in the provision of public transport have played only a limited role in emission reductions on a national scale. The contribution of innovations in public transport services to national emission reductions has been more limited. Nevertheless, they can play an important role at the regional scale, contributing to fewer local emissions, and a more attractive local environment. Successful cases often not only include changes in public transport but in a reduction of the possibilities for car use and an improvement of facilities for slow modes. It is very difficult to draw general conclusions for success factors for innovations in transport services. The case studies as described in this paper are, of course, too limited in number and therefore can only serve as illustrations and lead to general conclusions. However, some tentative conclusions can be given:

Firstly, the services described can certainly result in local improvements in nuisance from parked and driven vehicles, noise and air pollution. Secondly, the local municipalities have played an important role in the introduction of the new services. Thirdly, in some cases the role of only one person (or a few persons) had a huge impact in the introduction of the services. Fourthly, in several cases the solution was not as much in expensive, high-tech measures, but in very simple but creative ways of using existing possibilities, e.g. the park-and-ride service for shopping in Utrecht using an existing parking lot. The service itself does not involve much more than offering a parking place and a bus to the centre. Fifthly, the role of research differs considerably among the innovations, sometimes being of crucial importance, but sometimes hardly relevant. Sixth, all functions that play a crucial role in the management of present-day innovation processes, as presented by Smits and Kuhlmann (2002), appear in some cases, though not in all cases. The management of interfaces brought actors together. The organising systems often did not exist before. Learning and experimenting played an important role in several cases. The demand articulation was very important in some of the cases: the services were organised starting from the perspective of the users. The role of providing an infrastructure for strategic intelligence in the cases has been limited.

In the case of the Dutch proposals for investments (“ICES”), the role of research was crucial: it has dominated decision-making. The relatively simple methodology, including a broad evaluation of all investments on economic, ecological and social aspects, and the interaction with policy makers, has proven to be successful.

For policy makers we have the impression that creative use of relatively simple “solutions” may prove very successful. The goals of a project should also be very explicit and communicated very well with relevant actors, sometimes including the public. Thirdly, services should be centred on the (present or possible) users.

With regard to research our impression is that at the level of individual innovations the role in the process should be very clear. In many cases multidisciplinary research is preferred above mono-disciplinary research.

At the level of innovations in transport, in general, it should be noted that our paper only presents a limited number of cases. More research into the success and failure factors for innovations is needed to be able to draw general conclusions on innovations in transport. Besides this, failures as well as successes should be studied.

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Appendix 1: Questions asked in the interviews

1. Can you give a general description of the case?
2. What were the goals?
3. What are the most important events and when did they happen?
4. Who were the crucial actors? Who initiated the case?
5. What were crucial success factors?
6. What were possible failure factors. How were they dealt with? Are there possible future failure factors that might cause problems?
7. What research was carried out in the several stages (before the innovation, after the implementation)? Who carried out the research, on behalf of whom?
8. What were the most important results?
9. What was the impact on decision making?
10. Did systemic instruments play a role? If yes? Which ones and how?