European Centre
for Economic Research
and Strategy Consulting
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Final report (summary)

Environmental impact of traffic control and information technologies for raod transport

On behalf of the German Federal Environmental Protection Agency, Berlin
(F&E Nr. 294 96 024)

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Basel, Juli 1999
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Umweltwirkungen von Verkehrsinformations- und -leitsystemen im Straßenverkehr

Untersuchung im Auftrag des Umweltbundesamtes Berlin

(F+E-Vorhaben 294 96 024)

Juli 1999

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Contents (full version)

Executive Summary

Overview

(1) Telecommunication technologies and informatics – in short „telematics“ – experience rapid progress and increasingly influence everyday life. This includes applications in transport. The use of telematics in transport aims at

- providing relevant traveller and traffic information
- organisation of procedures in private and public transport
- improvement of safety
- optimisation of routing
- linking various modes
- improvement of infrastructure use.

The use of modern traffic management and information systems is frequently considered a most important way to guarantee mobility. In some applications such as air transport, telematics are well established and indispensable.

(2) Though this is not the primary goal, transport telematics are linked with benefits for the environment. Telematics are considered a magic word **combining mobility and environment**. Benefits for the environment are expected from

– optimised handling in transport

– improvement of traffic flow

– improved position of environmentally friendly modes of transport

– allocation of cost to the responsible parties.

In road transport, **unwelcome environmental effects** of telematics are possible, e.g. harmonised traffic might imply increased use of passenger cars; avoiding congested roads could lead to long ways around etc. Resulting changes in traffic volume and flow could balance positive contributions. From the start it is not obvious which overall effects result.

(3) Hitherto, there were only few numerical results on the environmental effects of road transport telematics. The existing analyses usually refer to special cases gained from field trials most of which were concentrated on technical aspects of telematics. Hence, environmental effects were often treated secondarily and isolated from the context. Influence on transport demand and modal choice was usually not considered. Because of different approaches, the results for the various telematics systems were incomparable. Thus, the

existing approaches do not provide a clear tool for the assessment of the environmental effects of telematics in road transport.

This was the starting point for the German Federal Environmental Protection Agency (Umweltbundesamt) to commission a comprehensive study on **„Environmental impact of traffic control and information technologies for road transport".** Contractor is a syndicate consisting of Prognos AG (main contractor) and Benz Consult GmbH, Ingenieurbüro für Verkehrsplanung IBV W. Hüsler AG, and TÜV Automotive GmbH (ex FIGE GmbH).

(4) The goal of this study is the analysis of the overall environmental impact of various telematics applications in road transport (passenger and freight) taking into consideration the relation to rail and non-motorised traffic. The analysis employs integrated numerical methods and homogeneous criteria within a well-defined framework. The study focuses on the question to which degree the telematics systems under consideration have positive and negative environmental effects and which systems have an overall positive account with respect to the environment. However, a concluding assessment of transport telematics in general appears pointless.

(5) For this study, a choice of telematics systems to be considered had to be made. The focus was set on road transport. Systems only relating to rail or air transport are not considered. Within these areas, telematics applications are being used since long and are indispensable for safety. In this study intermodal aspects are taken into account by investigation of telematics application that influence modal-split. The following telematics systems were selected:

Systems for collective traffic control

- Motorway traffic control
- Vehicle actuated traffic signal control with/without priority for public transport
- Electronic toll collection (on motorways/on any road, with cordon pricing for city centers)
- Automatic limitation of access to minor roads

Systems for individual traffic management

- Automatic vehicle guidance in several variations
- Automated enforcement of speed limits on motorways

Traveller and traffic information, communication

Dynamic park and ride information

Traffic and travel invormation (pre trip/pre trip and on trip)

Fleet management

City logistics.

(6) In reality, various telematics systems coexist and are at least partially used in parallel. Resulting interactions are investigated by consideration of two scenarios. While **scenario E** (“efficacy“) assumes a possible development without particular measures, **scenario U** (“environment“) assumes a far-reaching use of telematics aiming at the reduction of environmental effects of transport. The consideration of scenario U aims at the evaluation of the maximum environmental effects that can be achieved by road transport telematics.

Definitions

(7) The study considers demand for transport, trip distribution, choice of destination and route, and driving behaviour, i.e. all possible reactions. E.g. driving behaviour includes effects like congestion and increase of road capacity by harmonised traffic flow.

(8) Two regions were selected as examples: for urban traffic a part of the road network in **Köln-Deutz** was chosen. Traffic outside urban areas was considered for the motorways in the **Rhine/Main-area**. In both cases the minor roads and rail transport were also taken into account. For urban transport, non-motorised traffic was also considered.

(9) The results comprise the most important **toxic exhaust** (hydrocarbons, carbon monoxide, nitrous oxides, particulate matter) and the greenhouse gas **carbon dioxide**. Furthermore, **energy demand** serves as an indicator for the use of non-renewable resources. For the urban area, **noise** effects were also calculated.

(10) Regarding emissions from road transport, remarkable improvements due to progress in catalytic converter technology can be expected in the years to come. Therefore, the relative contribution of climate protection, depletion of non-renewable resources and noise will increase (compared to “classical“ toxic exhausts). In order to allow for these effects, the scope of the study is the **year 2010.** The telematics systems are evaluated relative to an imaginary “Nullfall“. The Nullfall consists of the projected traffic volume of the year 2010 without telematics.

The calculations of the emissions take into account the relevant foreseeable developments – including the legal framework (EURO IV). The calculations make use of the method provided by the Federal Environmental Protection Agency and the latest emission factors.

Results

(11) The assessment has to distinguish between

- use of non-renewable resources
- greenhouse effect (indicator CO_2)
- toxic exhaust (CO, HC, benzene, nitrous oxides, particulate matter) and
- noise (indicator: noise scores).

The table on the following page summarises the environmental effects of the telematics systems under consideration. For the interpretation of these findings one has to keep in mind the assumed framework.

(12) Road transport telematics **can contribute to ease environmental burdens**, though there can be negative effects in special cases. The most distinct positive effects with respect to the environment arise from **automatic toll collection**. Road pricing as considered in this study has an enormous impact on transport. A sensible implementation of road pricing is only possible employing automatic toll collection.

(13) A positive balance with respect to energy and exhausts results from “true“ reductions of miles travelled, which can be reached e.g. by optimised back haul, linking of activities, and avoidance of “superfluous“ trips. In urban areas, non-motorised transport is obviously the most environmentally sound means of transport.

Increased use of public transport also contributes to the relief of environmental burdens, particularly since – due to remaining capacities – small increases in passengers can be settled without additional demand for energy (i.e. “neutral“ with respect to the environment).

System		Global (CO_2)	Local	
			Air-pollution	Noise
1.1	Motorway traffic control (variable speed limits)	+	n.d.	n.d.
1.2	Vehicle actuated traffic signal control with priority for public transport	0	0	0
1.3	Electronic toll collection	++	++	0/+
1.4	Automatic limitation of access	0	+	0/+
2.1.1	Automated vehicle guidance – individual routing	0	0/-	0
2.1.2	Automated vehicle guidance – collective routing	-	-	0
2.2	Automated enforcement of speed limits	+	n.d.	n.d.
3.1	Dynamic park-and-ride information	0	0/+	0
3.2	Dynamic traffic and traveller information (pre trip)	+	+	0
3.3	Fleet management	+	n.d.	n.d.
3.4	City logistics	0	0/+	0
Scenario E		+	+	0
Scenario U		++	++	0/+

Legend:
++ clearly
\+ positive
0 neutral
\- negative
n.d. not determined

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(14) It is generally assumed that optimised traffic management (in the sense of shorter travel time) is not just welcome by drivers but is also positive from an environmental point of view. This could not be verified in general: Altogether positive and negative contributions often counterbalance, hence the resulting overall effect is small. To avoid traffic jam is surely environmentally sound. For small traffic flows, however, a further shortening of travel time by traffic management leads to a broader distribution of velocities which are usually connected with higher emissions.

(15) The opportunities to reduce **noise** from traffic by means of telematics are limited and refer to areas with low traffic flows. This is a general problem regarding reduction of noise by means of traffic management and is not specific for telematics.

(16) The collective use of several telematics applications at one time leads to **only small positive interactions** (in the sense of the joint applications leading to less emissions than the sum of the single systems). On the other hand, saturation occurs occasionally when different telematics systems act by similar mechanism, e.g. the potentials for ride-sharing or back-haul are certainly limited.

The telematics systems considered in scenario U can lead to a reduction in CO_2-emissions of 13% to 17% (urban areas and outside urban areas, respectively). The reduction rates in other exhausts and in energy demand are of the same magnitude. These findings can be interpreted as the maximal environmental effect that can be achieved by optimal use of road transport telematics. About three quarters of these results can be obtained by automatic toll collection alone (with fees as assumed in this study).

(17) The results obtained in this study for the Köln-Deutz and Rhine/Main areas are certainly not completely representative for Germany since the effects can depend on local characteristics. However, they provide numerical information on the environmental impact of road transport telematics. Due to a consistent and homogeneous methodology, the results for the respective systems are mutually comparable. This study does not try to calculate the overall effect for the complete German road network from the results reached for the regions under consideration. Very likely this would merely lead to a confirmation of the tendencies found for the regions selected.

(18) The final results of the calculations with respect to the environment (considering the assumed framework, see chapter 2 and annex 1) are summarised in the tables on the pages to follow.

Survey environmental impact, urban area (Köln-Deutz) – weekly average

Change rates [%]

	Variant	Noise*	Energy	CO_2	NO_x	HC	Benzene	CO	Partikels
Reference	-	31.024 LEG/d	1.183 GJ/d	83.565 kg/d	105 kg/d	125 kg/d	3,1 kg/d	736 kg/d	5,2 kg/d
1.3 Electronic toll collection	U	-4,5	-13,4	-13,6	-10,4	-14,3	-15,7	-13,9	-10,5
1.4 Automatic limitation of access	U	0,3	-2,5	-2,3	-1,4	-1,9	-3,0	-3,5	-0,9
2.1.1 Automatic vehicle guidance: Individual routing	E / U	0,4	0,9	0,9	0,4	0,8	1,3	0,9	0,8
2.1.2 Automatic vehicle guidance: Collective routing	E	0,7	1,9	1,9	1,3	1,5	2,0	1,3	1,7
2.1.2 Automatic vehicle guidance: Collective routing	U	1,3	4,0	4,0	3,2	2,8	3,4	2,1	3,6
3.1 Dynamic park&ride information	E / U	-0,2	-0,6	-0,6	-0,4	-0,6	-0,7	-0,7	-0,4
3.2 Travel information (pre trip)	E	-0,4	-2,0	-2,0	-1,4	-1,9	-2,2	-2,1	-1,3
3.2 Traffic and travel information	U	-0,8	-3,9	-3,9	-2,8	-3,8	-4,3	-4,1	-2,5
3.4 City logistics	E / U	0,0	-0,4	-0,4	-0,9	-0,4	-0,3	-0,1	-1,2
Scenario E	-	-0,2	-2,3	-2,3	-2,5	-2,2	-2,2	-2,1	-2,3
Scenario U	-	-4,4	-16,5	-16,7	-12,6	-18,5	-21,4	-20,4	-11,6

* Only main roads

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Survey environmental impact, Rhine/Main-area – weekly average

Change rates [%]

a) Complete Rhine/Main-area

	Variant	**Energy**	**CO_2**	**NO_x**	**HC**	**Benzene**	**CO**	**Partikels**
Reference	-	44.605 GJ/d	3.224.112 kg/d	6.731 kg/d	1.237 kg/d	38,1 kg/d	9.463 kg/d	213 kg/d
1.3 Automatic toll collection	E	-7,1	-7,0	-6,9	-8,8	-10,3	-6,0	-5,8
1.3 Automatic toll collection	U	-9,1	-9,2	-7,2	-10,1	-13,7	-10,3	-6,0
2.1.1 Automatic vehicle guidance: Individual routing	E / U	-0,1	-0,1	-0,2	-0,3	-0,4	0,0	-0,1
2.1.2 Automatic vehicle guidance: Collective routing	E	-0,1	-0,1	-0,2	-0,4	-0,5	0,0	-0,2
2.1.2 A Automatic vehicle guidance: Collective routing	U	0,0	0,0	0,1	0,1	0,1	0,1	0,0
3.2 Traffic and travel information	U	-1,1	-1,1	-0,6	-1,1	-1,9	-1,4	-0,5
3.3 Fleet management	E	-2,5	-2,6	-4,1	-4,5	-3,3	-1,8	-4,1
3.3 Fleet management	U	-3,0	-3,0	-4,8	-5,3	-3,9	-2,2	-4,8
Scenario E	-	-9,9	-9,9	-11,1	-14,0	-15,3	-10,5	-10,4
Scenario U	-	-12,6	-12,8	-12,1	-16,1	-19,7	-15,8	-11,3

b) Motorway A5 – between Frankfurter Kreuz and Bad Homburger Kreuz

	Variant	**Energy**	**CO_2**	**NO_x**	**HC**	**Benzene**	**CO**	**Partikels**
Reference	-	10.254 GJ/d	742.008 kg/d	1.635 kg/d	314 kg/d	9,8 kg/d	2.369 kg/d	51 kg/d
1.1 Motorway traffic control, speed limit 80 km/h*	E	-10,2	-10,2	-8,7	-7,2	-15,4	-26,7	-21,6
1.1 Motorway traffic control, speed limit 100 km/h*	U	-4,2	-4,2	-2,5	-8,3	-16,3	-16,6	-6,5
1.1 Motorway traffic control, speed limit 120 km/h*	E / U	-1,9	-1,9	-0,3	-6,0	-12,0	-7,7	-1,5
2.2 Automated enforcement, speed limit 100 km/h*	E	-4,7	-4,7	-2,9	-7,5	-15,9	-17,0	-6,7
2.2 Automated enforcement, speed limit 120 km/h*	U	-1,3	-1,3	1,0	-8,2	-15,9	-9,0	-0,7

* Effects while speed limit valid

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