THE IMPACT OF TELEMATICS IN EUROPE

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ABSTRACT

The EU DRIVE II programme (1992-1994) has supported a wide range of transport telematic applications in projects throughout Europe. Whilst a key emphasis has been on the promotion of interoperable systems/system elements, the many demonstrations have produced results which take forward our understanding of the potential impacts of telematics. This paper gives an overview of some of those key results.

Users of travel and traffic information systems found them to be worthwhile generally, and were prepared to pay for services. The benefits perceived by the individuals could also be translated into network benefits, although issues relating to ownership of, and access to, information remain.

Traffic management, operations and control applications have built on the substantial systems already developed in Europe. New incident detection, network monitoring and integrated strategies/systems have shown to produce substantial savings in time and hence costs. Technology to support vulnerable road users has also been shown to be worthwhile.

Technologies and systems for the on-line management of public transport with support from priority and passenger information systems has been applied and shown worthwhile benefits. However, resulting longer term changes in modal split are not yet able to be demonstrated, except in specific situations such as park and ride.

The growing applications of automatic debiting and demand management techniques has demonstrated the effectiveness of the technology and the potential environmental and other benefits in a series of specific circumstances. Substantial economic and other benefits have been demonstrated resulting from the application of telematics technology in the area of driver assistance and cooperative driving, largely to provide driver monitoring and support.

1. INTRODUCTION

Research and Development in the area of transport telematics has been supported since 1989 in the 2nd and 3rd European Framework Programmes, commonly referred to as DRIVE I (1989-91) and DRIVE II (1992-1994). This paper describes the main socio economic impacts of DRIVE II which were reported mainly during 1995. It is based largely on a review undertaken for the EU by the authors and others, but comments and interpretations remain the responsibility of the authors. Clearly, in a paper of this length, only an overview can be presented, with more detailed background and results being available in the many papers produced by the Project participants.

The results may be presented in a variety of ways, by domain, by type of impact or by project. In this paper the six domains used to coordinate DRIVE II have been used. These were:-

- Travel and traffic information
- Traffic management, operations and control
- Public transport
- Automatic debiting and demand management
- Freight and fleet management
- Driver assistance and co-operative driving

2. TRAVEL AND TRAFFIC INFORMATION

At a pre-trip level these include portable on line interactive services using standard digital mobile networks. Developments in network monitoring and integrated transport data bases have supported the provision of information systems and services. Static terminals have been installed to provide public access to core databases of traveller information, to particularly encourage consideration of modes other than car. In general, public access terminals were welcomed by the survey respondents; most found them easy to use (92% of those using the terminals found the information very adequate). The Munich and Rhine Corridor Trial found RDS-TMC services were used in about 70 % of trips for pre-trip information. There was also evidence of a substantial increase in peoples' knowledge about public transport services after using the terminals. 60% of the users were influenced by the information provided, 40% changed their departure time, 30% changed the departure date and 20% used an alternative route. Advice given by the road operator leads to a spreading use of the road network especially during rush-hours. There was, however, no significant change to other transport mode when the first choice corresponded to the road.

A range of in-car systems for on-trip information have evolved during the programme with various traffic information, navigation and dynamic route guidance functions. Users generally rated relevance, accuracy, timeliness, credibility and comprehensibility as being average to good, although only a small number of equipped vehicles were available. However, the more extensive RDS-TMC tests showed very positive results with the majority of drivers finding the information useful and the service satisfactory and easy to use (70-92% in different field trials). More than half the users would be willing to purchase a system (100 ECU). Important features contributing to the added value was the possibility of being able to request information when needed, to select

messages, and to repeat messages. The RDS-TMC messages of relevant congestion led to changes in route choice (20-24%) and a simulation study estimated that total travel time could be decreased by 3-9% by using a RDS-TMC service. Also, 30% of test drivers at one site claimed that RDS-TMC led them to reduce speed when approaching an incident, before the queue was visible.

The use of variable message signs (VMS) to provide network information has been successful. Typically, in Scotland, a 20% reduction in delays likely to occur following an incident on the Forth Road Bridge may be expected using VMS, with other savings of 5 to 10 minutes when problems occur on other parts of the network. A large majority (82% by questionnaire) who use the route regularly indicated that they would follow VMS information even if it was in conflict with other sources.

Drivers have seen substantial benefits in terms of reduction in delay (20% on interurban routes), and high levels of satisfaction have been found amongst drivers with two thirds following advice. Trials utilising the 350 VMS around the Peripherique in Paris established that 80% of drivers preferred to be informed about travel time rather than queue length. VMS used as part of a weather traffic management system resulted in a 10% speed reduction and up to 30% less accidents in rainy conditions and 85% reduction on foggy days. It was found that the use of pictograms improved the comprehension of messages for foreign drivers, and enhanced its perception.

Dynamic route guidance trials have not been sufficient to enable full impact assessments and evaluation has centred on technical performance of systems and driver response, using a common questionnaire, logbooks and some data from other studies. In general, more than half the drivers agreed that the systems could be beneficial with a smaller proportion following the advice (20% or more). Perceived benefits included greater security and a reduction in stress as well as travel time reduction. Half the drivers were willing to pay 750 ECU or more for route guidance equipment. Most would pay between 180 and 350 ECU per year for a corresponding dynamic traffic information service. Modelling has shown significant network benefits with only low proportions of guided drivers (e.g. 6% reduction in travel time with a penetration rate of 20% and 100% compliance).

3. TRAFFIC MANAGEMENT, OPERATIONS AND CONTROL

(i) Incident and Emergency Management: The use of computer vision analysis techniques for incident and emergency management has resulted in high detection rates (>93%) and low false alarm rates (<8%). The transfer of information between TICs and TCCs has been progressed by a number of projects and task forces, each focusing on a specific area in the information chain.

(ii) Emergency Calls: A number of initiatives have been developed to address public safety and facilitate the means of calling for assistance. These range from trials of vehicles fitted

with impact sensors which automatically trigger a radio signal in the event of a major accident which includes location (GPS).

A reduction in the response time (43%) of emergency vehicles has been measured on systems fitted to vehicles carrying dangerous goods. Using these systems has increased survival rates (between 7 and 12%) and a potential reduction in the long term severity of any injury incurred.

(iii) Motorway Traffic Control: Modelling has shown that a re-routing strategy can reduce traffic delays by up to 20%, CO by up to 10%, HC by 5% and NOx by 5%. The need for an architecture framework and open system architectures for traffic management has been highlighted.

(iv) Urban/motorway Traffic Control, Integration: VMS installed on the motorway providing information concerning parking or park and ride schemes have been very effective with an 80% increase in park and ride users. In Paris, control strategies using ramp metering and 350 VMS on the entire Peripherique and the Boulevard des Marechaux increased the mean speed by 21%, 16% and 19% for the motorway, parallel network and total corridor respectively. Similar results were obtained in Amsterdam when ramp metering produced a reduction in delay by 19% for all traffic on the ramps.

(v) Traffic Control for Pedestrians: Trials of new microwave detection of pedestrians with new control strategies have achieved improvements for pedestrian safety with a decrease in red light violations and the number of pedestrian-vehicle encounters. The main benefits of this technology related to an increase in comfort and safety for pedestrians, with benefits to particular pedestrian groups, such as the elderly and the disabled.

(vi) Weather Related Traffic Management: A weather monitoring station has been developed and implemented using a range of new weather monitoring detectors together with in-vehicle systems used to warn drivers of changes in road conditions. These have led to speed reduction (<10%) and accident reduction (>30%). Speed control was most effective.

(vii) Urban Traffic Control: Achievements in DRIVE II have included new UTC systems/strategies and new integrated functions such as public transport priority, variable message signing, Automatic Incident Detection and new facilities for pedestrians. Advanced UTC systems such as SCOOT and UTOPIA have been proven to be cost effective in reducing vehicle delays. In DRIVE II, evaluation of PRODYN and the new MOTION system have indicated typical reductions in travel time of 10% with associated savings in fuel consumption and emissions. Pollution control in one city incorporating UTC and VMS has achieved predicted reductions in emissions of some 26-30% (CO, NO_x, HC) in the controlled area in two instances of severe pollution.

4. PUBLIC TRANSPORT

(i) Information Management: DRIVE II projects and Task Forces have addressed the issues which are expected to provide benefits from improved integration of systems.

(ii) Vehicle Scheduling and Control Systems (VSCS): In DRIVE II, projects have focused on providing higher order services, including (i) location through satellite-based GPS (Global Positioning System), (ii) location for passenger information and public transport priority systems and (iii) integration with new Demand Responsive Transport Systems. No impacts of VSCS have been assessed in DRIVE II projects, although impacts of applications supported by AVM are summarised in the following sections.

(iii) Public Transport Priority: The implementation of public transport priority in advanced Urban Traffic Control (UTC) systems has been an important telematics application in DRIVE II, supported by a range of vehicle detection/location technologies, including bus transponders with inductive road loops, bus tags with roadside beacons and AVM radio technologies. Projects have produced consistently favourable results. Delay savings for buses and trams at signals due to priority averaged some 50% across all assessments (up to 97% in one application) with negligible impacts on private traffic. Other quantified operational benefits recorded included (i) reduced variability in PT journey times and delays (up to 29%), (ii) improved regularity of PT services (11%), (iii) savings in fuel consumption and emissions (4%-6% in simulation studies in Gothenburg, using enhanced UTC with PT priority) and (iv) some evidence of increased PT patronage. Economic cost-benefit analyses undertaken for four systems/strategies indicated very favourable rates of return, with payback periods varying from 3-16 months.

(iv) Passenger Information: Passenger response to the usefulness of at-stop real-time information has been positive (57-90%). 18%-64% of passengers perceived reduced waiting times, even though punctuality did not generally improve. Users have reported a very high acceptance of information provided by public access enquiry terminals, with some evidence of increased public transport usage resulting. An application of travel centre enquiry support reported increased mobility (10%) and increased public transport usage (8%) based on the results of interviews. For both, in-home terminals and/or portable personal units, surveys have revealed a strong potential for the product.

(v) Demand Responsive Transport (DRT): The use of VSCS in one DRT project has highlighted benefits to the operator, including driver time saving of 30-60 minutes per day, and potential benefits for the community through increased mobility and reduced access time for users.

5. AUTOMATIC DEBITING AND DEMAND MANAGEMENT

(i) Automatic Toll Collection: The average time saving with Automatic Toll Collection is expected to be over 40h/year for the average motorway commuter. Safety of private and

commercial vehicles is also expected to be improved as a result of extensive deployment of automatic tolling on motorways due to the elimination of traffic channelling at toll plazas as well as of possible queues; this result should also improve the air quality and reduce the energy consumption of the average motorway commuter by about 5%. By replacing one out of five manual toll gates with a mono-lane enforcement system (in combination with a multi-lane tolling gantry) it has been calculated that the passage time of the equipped cars could be reduced from 156 s to 45 s, irrespective of the traffic increase. Assuming a progressive increase of subscriber market penetration for cars from 5% in 95-97 to 25% in 2004-06, even non equipped vehicles would also benefit of a 30% reduction in the toll gate passing time due to the reduced demand in the manual lanes. An assessment of both the vehicle operating costs and the economic value of travel time saving indicated a payback period for the infrastructure operator of 6 years. Also, road maintenance costs could be significantly reduced by discouraging the overloading of Heavy Goods Vehicles through the use of automatic weighing for toll collection.

In Trondheim, Norway, the toll ring which operates as a cordon around the central area with 12 entry points is used successfully with 76,000 subscribers having AVI tags in their cars. Tolls must be paid entering the cordon during business hours, and over 85% of the locally registered vehicle stock now use the equipment successfully for payment of the tolls. There has been a 10% reduction of crossing of the cordon during toll hours with trips redistributed in time and spatial patterns in response to the toll system. Public transport usage has increased by 8% for the whole city area. Surveys concerning user response have also found that citizens had less awareness of road pricing than of any other demand management measures and questioned its effectiveness in influencing modal choice and travel behaviour. In Trondheim, the attitude towards road pricing showed that 46% of respondents have negative opinions and 37% have positive opinions. People inside the existing toll ring area are more positive towards road pricing than those outside. Modelling of the travel impacts of Road Pricing based on user response studies in Gothenburg, showed that the implementation of a road toll over a defined area of the city would result in a 1.9% decrease in trips by car for work, and a 6% decrease in car trips in the area for shopping.

(ii) Access Control: An average 18% reduction in travel time inside the Barcelona special events zone was identified following access control. Surveys also indicated a 15% increase in both on-street parking availability and in on-street space usage resulting from a shift of parking from the inside to the border zone, with a 20% perceived reduction in congestion problems. The citizens' perception of the quality of information provided by the public authorities on the pilot implementation of Access Control systems was rated good by 89% of people surveyed. In Barcelona, residents of the special events zone were 70% in favour and 24% against the measures implemented.

The non-stop access control application in Bologna showed a 55% reduction of the total recorded entry volume, with major re-assignment to the Inner Ring Road. Within the Access Control trials, pollution monitoring showed a 50% reduction of emission in the central area. In terms of financial return on investment (excluding intangible benefits) it

was estimated that the pay-back period should be between 2 and 5 years depending on the actual violation rate. In Bologna, where the card had only been used for the bus service, a survey indicated that 75% of the users were in favour of an extension to a multiservice operation. The same city-wide survey on the acceptance of non-stop access control measures showed a rather close 40/37% split between for/against options.

(iii) Parking Control: In Munich the use of Variable Message Signs to advise motorists approaching the city of a new Park and Ride facility resulted in a modal shift that reduced the use of private car by 1.6 million km/year for that site (a reduction of fuel consumption of at least 200,000 litres/year). From surveys made during the trials, 16% of the respondents attributed their decision to the availability of VMS information about parking space availability; over 26% of the parking facility users on weekdays and 46% of the users on special event days stated they would have otherwise used the car for the entire trip to the city centre. A cost-benefit analysis indicated that the provision of VMS for parking access information and guidance can only be commercially viable for sites of 500 spaces or more. A similar system in cologne more than doubled the use of the Park and Ride facility with 33% of users doing so directly because of the information; many of the cars would otherwise have proceeded to the city centre.

(iv) Integrated Payment: Trials of the use of smart cards for integrated payment applications have shown very high levels of user satisfaction (70-90%). Also, high user satisfaction was reported by the parking operator in a multi application trial in Dublin.

6. FREIGHT AND FLEET MANAGEMENT

On the basis of the average trials results, Freight and Fleet management functions should provide savings in travel time close to 5% (trials range 0-16.5%) and savings in dispatch time above 12% (trials range from -4.2 to 35.2%). Travelled distance should accordingly be reduced by over 6% (trials range 0.3-21.3%). As a result of EDI use, data have become more reliable and transport order cycle time has been reduced. Both drivers and dispatchers feel comfortable in using the new Fleet Management equipment, since it reduces stress, enriches work and let drivers feel more secure. It also increases the range of services that can be offered to customers.

Experience with Inmarsat-C satellite communications, used on 32 vehicles at 5 companies, indicated an estimated saving of 2% mileage in international transport with a payback period of 4-8 years. Other results showed that up to 37,5% of the currently wasted time (waiting time, pick-up time, delay time) could be saved using Mobile Data Communications for freight and fleet management functions and that, with the use of Transport Telematics, the number of delayed arrivals decreased by 35%. The systems used in the IFMS trials were expected to lead to a payback period of 3.4 years.

Cost estimations have shown that, in average, the use of Mobile Data Communications for Fleet Management applications would lead to a marginal increase of transport cost per vehicle and km in the amount of only 1 ECU/1000 km.

As a result of freight and fleet management functions, an average reduction of fuel consumption of 2,350 litres per vehicle and year was measured, resulting approximately in a 4.4% fuel reduction based on 150.000 km /year travelled distance and 35 l/100km specific fuel consumption.

For Intermodal Tracking and Tracing applications trials showed that the average waiting time for vehicles of the transport fleets was reduced by up to 20%, whilst, for the combined mode, the pick-up and waiting time for switching from road to rail was reduced by hours. Savings in distance travelled could lead to a reduction in 150 fatal accidents per year.

7. DRIVER ASSISTANCE AND CO-OPERATIVE DRIVING

(i) Driver Monitoring: The use of an Accident Data recorder on commercial vehicles for driver monitoring purposes resulted in statistically significant reduction in accident occurrence (41%) and beneficial reduction in accident costs due to lower accident severity. The average user response also indicated that the implementation of a driver monitoring function has a slightly negative impact on driver comfort but has shown a positive assessment of its contribution to a better safety. UK trials on driver monitoring showed a downtrend in the number of observed "overspeeds" per 1000 km by the fleets of equipped commercial vehicles, leading to a likely reduction of fuel consumption and related emissions; at the fleet level, a reduction of the commercial vehicles operating costs was observed as a result of reduced accident related damages, repair cost /km decreased up to 40 %; a reduction of consumption and wear out costs (fuel, tyres and other vehicle components) was also observed, often leading to a recovery of the equipment cost within one year.

(ii) Cooperative Driving: The use of Collision Warning functions resulted in an increased average time headway. Tests on a driving simulator have showed that Intelligent Cruise Control systems use may improve safety as a result of a reduction in average vehicle speed (5% for the informative mode) and an increase of average time headway (30% for the informative mode). Track tests on ICC systems have indicated an average time headway increase in the car following scenario of between 5 and 10% (from low to high speed), a modification of the Headway Time distribution (which showed a reduction at low frequency and an increase at medium frequencies) and an increase up to 35% of the average time-to-collision for the approaching phase (under stationary speed conditions). There was an improvement in speed harmonisation (especially at higher speeds) resulting in improved safety conditions due to the lower relative speeds. Tests on a driver simulator indicated that informative-only Intelligent Cruise Control systems contributed less to driver comfort than ICC systems operating in the automatic mode.

(iii) Driver Support: The majority of the elderly drivers who have tested route guidance support systems indicated that they would increase their propensity to travel. Vision enhancement aids allowed drivers to see/identify pedestrians and road features at a greater distance in night driving, leading to reduction of potential collisions with vulnerable road

users. The availability of vision enhancement would allow 60-70% of elderly people to drive more at night.

Driver support and collision avoidance systems have so far found a higher level of acceptance from people that would otherwise suffer some limitation in their ability or willingness to drive (disabled people in general and elderly drivers with respect to congested or unknown areas and limited visibility conditions). However, in dense fog conditions, collision avoidance systems, though subjected to limited real-life testing, have found acceptance, if a very low rate of false alarms could be achieved.

8. CONCLUSIONS

The substantial research, development and application of transport telematics in DRIVE II has resulted in common understandings of the impacts, benefits and opportunities. Whilst much is still to be achieved, the outcomes have provided a sound basis for the 4th Framework activities in which generally more comprehensive applications of technology are taking place.

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