https://doi.org/10.18778/1231-1952.1.2.03

EUROPEAN SPATIAL RESEARCH AND POLICY

Volume 1 1994 Number 2

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BEHAVIOURAL RESPONSES TO IMPROVED INFORMATION SUPPLY AND DEMAND MANAGEMENT IN TRANSPORT. A methodological approach illustrated by a case study in Barcelona

Abstract: This paper has two aims: (1) it offers an analytical framework for transport telematics policy with a particular view on behavioural responses of road users, and (2) it illustrates the methodology developed by means of a simple case study. The use of a so-called nested approach appears to offer a promising cohesive framework, which is tested by means of an empirical investigation into the impacts of information-based traffic control measures during the Olympic Games in Barcelona.

Key words: transportation systems, urban planning.

1. INTRODUCTION

Technological progress in **advanced transport telematics** (ATT) systems, which is nowadays taking place especially in Europe, the USA and Japan, is usually regarded as a sine qua non for alleviating the stress on a mobile society as a result of inefficient road use (resulting in traffic jams), traffic unsafeness and environmental decay caused by high pollution levels (e.g. BANISTER, 1992; KAWASHIMA, 1992 and Ministerie van Verkeer en Waterstaat, 1993). However, a significant improvement in traffic performance can only be reached if there is a substantial user response to new forms of information supply, user charge mechanisms and debiting systems for road users. Behavioural studies in the past show ambiguous results on this subject (e.g. EURONETT, 1992; MAHMASSANI and HERMAN, 1990; MANNERING et al., 1993). The need for a thorough assessment of the user side is therefore increasingly recognized in transportation policy.

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The objective of this paper is to offer an evaluation framework for the attitudes of potential users and the changes in their travel behaviour resulting from the introduction of ATT. It aims to address this issue through the identification and analysis of travel behaviour, where measurements are to be based on user responses during telematics pilot projects (see BATT, 1992a) which focus on all areas of operational interest and also cover possibilities for manufacturers in terms of the design and promotion of ATT products. This paper focuses in particular on such a pilot project in the Catalan city of Barcelona in the context of the 1992 Olympic Games.

By assessing the users' response it will be possible to:

– inform authorities of appropriate ways to implement such new technologies and hence to increase the success of ATT technology;

– inform the industry of suitable ways to promote and market ATT technologies in order to meet user requirements.

First, however, a concise overview of various types of ATT technologies will be given.

2. THE RANGE OF TECHNOLOGIES

A distinction can be made between two types of traffic management tools. First, there are dynamic traffic control applications (for instance, variable message signs) which can realize a safer and more efficient use of the available infrastructure. Secondly, we may distinguish demand management which is applied in order to regulate traffic demand by reducing car traffic growth. Demand may, for example, be influenced by improving the competitive position of public transport. To begin with, we will give an overview of the wide range of feasible and planned dynamic traffic management tools in various European countries. We will take the Netherlands as a frame of reference here (Rijkswaterstaat, 1992a).

2.1. Emergency telephones

Throughout the complete motorway infrastructure of the Netherlands a network of emergency telephones is available. The telephones are the result of a cooperation agreement between the government, the Dutch motorists organization and the Dutch telecommunication company. The telephones serve to help motorists who have technical problems. The motorists organization offers their members the opportunity to get help easily. In this way, improvement of traffic safety is also realized.

2.2. Road-side based information systems

Road-side based information systems are systems which make use of fixed road-side based infrastructure. The functions of these systems are traffic control on motorways, providing traffic information and offering traffic guidance. A typical characteristic of road-side based systems is that all drivers can be reached by using variable message signs and changeable direction signs. These systems include signalling, variable message signs, fog detection and warning systems, and urban traffic control systems. Each of these possibilities will briefly be described here.

2.3. Signalling

Signalling of information (for example, derived from a monitoring system) is a necessary condition to influence drivers' behaviour. Special applications of signalling are Automatic Incident Detection and Warning, or Road Works Warning and Smoothing (Rijkswaterstaat, 1992a).

2.4. Variable message signs

Variable message signs form a kind of dynamic route guidance. They can provide information about congested conditions, queue lengths, incidents, speed compliancies etc. The signs take only care of signalling information to the road users: a monitoring system must 'decide' what to tell the road user.

2.5. Fog detection and warning systems

Fog detection and warning systems are fully automated systems. Sight measuring equipment and fog detection stations are placed at regular intervals on the road. They are connected to the weather information service, a security system and a regional alarm system via operational control equipment. A linkage to a signalling system is necessary to inform drivers. In a country like the Netherlands (with frequent foggy conditions) the system has proven to be valuable for increasing safety on the road.

2.6. Urban Traffic Control Systems

The aim of Urban Traffic Control Systems (UTCS) is optimization of traffic flows in urban networks. Depending on local infrastructure and different (local) approaches on how to achieve this control, a UTCS can have also different objectives. However, an integrated approach between motorway control and urban control is always important for the integration of information derived from the motorway network and the urban network.

2.7. Parking Management Systems

Parking management can contribute to a more efficient use of the road network and also to demand management in combination with public transport information. Parking Management Systems can be either static or dynamic. Dynamic systems are more useful when local circumstances differ regularly and the need to adapt driver behaviour exists. In a more stable traffic situation, static systems (much cheaper) may have a satisfactory impact.

2.8. Priority measures

Priority measures provide advantages to specific road user groups: in this way their use is stimulated. One possibility is to give priority treatment to buses at traffic lights or bus lanes on high density (motor)ways in order to stimulate public transport. Travel time is then reduced and a competitive advantage is realized (Rijkswaterstaat 1992b). Another possibility is the high occupancy vehicle lane (or carpool lane), i.e. special lanes with access only for cars occupied with three or more persons, placed on high density (motor)ways which make carpooling much more attractive. As far as the priority measures concern the stimulation of public transport, their function is to influence demand management. On the other hand, when the priority measures regulate the behaviour of individual car drivers, traffic control is influenced.

2.9. In-vehicle systems

The principle of in-vehicle systems is their functioning on an individual basis. Drivers' behaviour is influenced by the provision of situation-specific

information. In-vehicle equipment and (one way or interactive) communication with a central control centre are needed to realize this dynamic route guidance. The application area of information can be small or large, depending on the specific tools and their geographical coverage.

2.10. Radio traffic broadcast services

In many countries broadcasting of traffic information does exist. The means by which traffic data are collected differ, but the most efficient one seems to be a connection to a nationwide monitoring system. Broadcasting takes place, depending on the size of the country, on a regional or national basis. Since usually the traffic information is not provided continuously, but on an interval basis the information loses part of its value. Therefore, sometimes little effect may be gained by this system (GROOT, 1992). Diversion of all congested traffic flows is then almost impossible to realize and traffic safety is marginally influenced.

A new type of instrument to receive traffic information via the radio is the Radio Data System (RDS). The system makes use of a special car-radio and a traffic message channel. The information given is derived from a motorway monitoring system. At present, various European pilot projects are running to test the effects of the system on traffic conditions and user behaviour. Implementation is expected to happen soon in various countries.

2.11. Dynamic route guidance and travel information systems

This category of systems includes a wide range of tools: dynamic and static ones, autonomous and centrally guided ones. The two main effects aimed at are route guidance and provision of information for drivers. The route guidance serves to contribute to an optimal use of the road network as a result of adherence to the individual advice by the driver (CATLING, 1993; SMITH, 1991).

Reliable travel information, extended with public transport information, will contribute to a lower demand for traffic. The latter function is especially suited for congested urban areas where the competitive position of public transport is very good. A compatibility with other policies of stimulating public transport or discouraging the use of cars is then possible. On a worldwide scale, many pilot projects are being tested (e.g. in the American IVHS programme) and further development of these tools is continuing.

2.12. Public transport information

With public transport information specific travel information is provided before the trip and during the trip. General static information may, for example, be a schedule with information on all train departures from a given railway station for the coming year. An example of dynamic information is a message sign at the bus stop with real-time information of a delay.

The goal of public transport information is, apart from offering a service to its users, to attract new customers. Besides information, the capacity and quality of public transport must be able to meet demand in order to keep users satisfied.

2.13. Road pricing

A wide range of road pricing possibilities, in terms of application area and of charge systems, are open to local and national governments. The application area may be a network of high density motorways, but also an urban quarter might be selected. Charge systems can be rather flexible, e.g. location and time dependent charges. They can be more or less user-friendly, e.g., depending on costs and payment forms. In many systems a combination with automatic vehicle identification is made to calculate the right charge.

3. A METHODOLOGICAL FRAMEWORK TO CAPTURE USER RESPONSES TO ATT

In assessing ATT impacts the BATT team has adopted a comprehensive methodology based on an extensive review to identify the most appropriate methods in telematics impact research. A new framework, based on a so-called Nested Approach, was developed (see BATT, 1992b) to tackle specific problems concerned with the types of change being measured; the representativeness of the sample and its size; the limited scale of the field trials; the necessary local co-operation from the pilot projects; and finally the range of possible behavioural changes resulting from the introduction of ATT.

The Nested Approach integrates most elements described above allowing the impacts of ATT to be measured at three separate levels:

- strategic level;
- market potential level;
- market response level.

At the strategic level, the concern is with the overall system-wide impacts, given certain types and certain levels of introduction of ATT. Within this

framework, various changes can be assessed in terms of user and producer benefits, the direct and indirect environmental impacts, reduction in accidents and fatality rates, energy savings and the use of the infrastructure. The assessment may cover total performance of the system, the distribution and equity implications, and the indigenous technological achievements.

At the market potential level, the concern is with the means by which the potential for ATT can be maximised in terms of acceptability and penetration to the various parts of the market. Part of this marketing is to access market awareness of the product, while the other part is to identify those segments of the market that are likely to represent the greatest potential for ATT. It is recognized of course, that some user groups will be more positive about the use of ATT than others and that not all people will use ATT in the same way. The identification of different markets is an important research issue, as it provides a link between research and the European telematics industry.

At the market response level, the focus is on the costs of the technology, changes in individual behaviour and the scale of implementation of ATT technology. The emphasis is here on the cost effectiveness and the direct benefits to the individual users of ATT, the range, scale and timing of the introduction of ATT, and the rate of behavioural change which might follow. Much (mainly hypothetical) research often based on simulation experiments has already been carried out on the impact of ATT, often in terms of rather optimistic scenarios assuming that saturation of the technology is achieved over a very short period of time.

Table 1 brings together the elements of the Nested Approach in a composite table, where the behavioural ATT interest is concentrated in the last two columns. The purpose of the Nested Approach is to focus on user response and to place behavioural telepathic research into a wider framework of evaluation methods, mainly at the strategic level.

Table 1. The Nested Approach

Evaluation criteria	Levels of reference		
	strategic	market potential	market response
Technical	Performance criteria	Marketing	Cost of technology
Socio--economic	Distribution and equity	Segmentation	User behaviour
Political and dynamic	Technological perspective	Awareness	Diffusion

It is also possible to further refine the areas of interest within the market potential and market response categories and to attach specific priorities to

particular elements, viz. Behaviour, Segmentation, Awareness and Diffusion. These are described below (cf. table 2).

3.1.1. Priority I – issue A: Behaviour

The argument here is that user behaviour will change as a result of the introduction of ATT, but that changes may vary according to the individuals, the situation and the type of ATT being tested. A range of behavioural responses has been identified which might be anticipated for a particular journey at one point in time. These include: mode shift, departure time, change in route and destination, trip generation/suppression, trip scheduling, parking choice and adherence to advice.

Ad 1. As a result of the introduction of ATT, users may change travel mode in order to gain time or save costs or meet their constraints.

Ad 2. A shift in departure time may occur, given ATT information on current levels of congestion or the generalized costs of the foreseen trip. Here, we assume that a maximisation of user utility is strived for.

Ad 3. Route choice may be modified by users after receiving advice from ATT tools. The influences of experience and familiarity with these ATT tools and reliability of the information provided are determining factors.

Ad 4. Destination choice may be changed by the user, for example, after receiving information about congestion on the previously chosen route.

Ad 5. Trip generation or suppression of the trip after receiving information is possible when the purpose and need of the trip allow this option.

Table 2. The main areas of interest

Areas of interest	Market potential	Market response
Socio-economic	Priority 1 – issue B SEGMENTATION 1) car availability 2) age 3) social group 4) income group 5) experience 6) familiarity 7) purpose	Priority 1 – issue A BEHAVIOUR 1) mode shift 2) departure time 3) route 4) destination 5) trip generation/ suppression 6) trip scheduling 7) parking choice 8) adherence to advice
Political and dynamic	Priority 2 -issue C AWARENESS 1) exposure to ATT 2) acceptability 3) publicity	Priority 3 – issue D DIFFUSION 1) pre-conditions 2) take-off 3) saturation levels 4) adaptation

Ad 6. Trip rescheduling is a rearrangement within a determined time period that may be considered when satisfactory or non-acceptable alternatives are suggested by ATT.

Ad 7. Parking decisions might be changed after receiving information about locations of car parks and their availability of space.

Ad 8. Adherence to advice is influenced by many factors; on the side of the user, for example, previous experience and user characteristics may act as explanatory factors. Looking at the information provided, it is noteworthy that factors like relevance and accuracy offer an indication of the information quality.

3.1.2. Priority 1 – issue B: Segmentation

Here the focus is on the main socio-economic characteristics of the individual which may influence both his decision to acquire a particular form of ATT and the actual use of that ATT at one point in time. The argument is that not all people require access to the same technology and that even if they would have that technology, their use patterns will vary.

Ad 1. Car availability is not only a social group indicator, but provides also other relevant information, such as the existence of alternatives or dependency on the public mode. Selection of such segments has proven to be useful in previous studies.

Ad 2. Age and sex of potential users may be explanatory factors for the response and penetration of ATT technologies.

Ad 3. Socio-economic group, type of employment, and some measure of class are factors which influence use patterns of ATT.

Ad 4. Income levels (closely related to social class) form strong explanatory factors for the decision to acquire the ATT technology or to obtain access to it.

Ad 5. Experience (positive or negative) may modify the usage of ATT.

Ad 6. Familiarity is important in determining whether pre-trip information is required in home (unfamiliar trips) or during the trip (familiar trips).

Ad 7. Purpose of the trip may help identify which activities have the best potential for ATT. From the category of travel for personal purposes, probably travel for shopping and travel for recreational activities offer greater opportunities than more regular trips (travel for work and education).

3.2. Priority 2 – issue C: Awareness

Innovation takes time for people to become aware of it, and to adopt it. Awareness and adoption are often related to exposure or experience. Part of that

process is publicity, but equally important is the public acceptability of innovation and its perceived necessity.

Ad 1. The exposure to ATT together with previous knowledge may be decisive in the usage of future applications. The exposure relates to knowledge, experience and acceptability as well as to user characteristics.

Ad 2. Acceptability refers to the acceptability of technologies, depending on the public opinion and many social factors.

Ad 3. Publicity and marketing can influence awareness and acceptability to promote ATT technology.

3.3. Priority 3 – issue D: Diffusion

Innovation diffusion also takes time as the market does not respond instantaneously. Even when all conditions are favourable, user responses have to be monitored and evaluated over a significant period of time, as standardisation becomes possible and substantial economies of scale prevail.

Ad 1. Pre-conditions are necessary political and technical conditions, which have to be present before any large scale application of ATT is made. The pre--conditions relate e.g. to willingness to address environmental and traffic problems.

Ad 2. Take off; as diffusion takes place, the initial interest begins to snowball and market penetration expands at a faster rate, after reaching a critical acceptance threshold.

Ad 3. Saturation levels refer to the identification of new markets or segmentation of existing markets approaching maturity.

Ad 4. Adaptation is a closely linked dynamic process outlined in the move from pre-condition to saturation. It is a multi-faceted phenomenon in which also feedback effects have to be considered.

Measurement of user response to ATT presents various conceptual difficulties. These include:

– the **range of user response** could be large;
– the **scale of response** is likely to be small;
– the **time of reaction** to change is likely to be long.

These three problems represent the classic dilemma for social research, as in general the range, scale and timing/diffusion of innovation make it very difficult to measure changes properly. Even if this could be measured, the difficulties of sample identification and capture again generate problems for obtaining sufficient data to use the results on a statistically solid basis. The Nested Approach is a strategy which has been developed to overcome partly these

problems, as its typology allows for transferability to other cases. The significance of the Nested Approach will now be illustrated by means of a simple field trial in Barcelona.

4. CASE STUDY FOR BARCELONA

Demand management is the central aim of a telematics project, called GAUDI (Generalized and Advanced Urban Debiting Innovations), carried out in Barcelona. Through the development of an integrated automatic debiting system an attempt is made to manage usage of both public transport and private road networks. The overall objective is to provide the tools with which a city can reorganise the travel demand of its residents and visitors so as to achieve environmental and energy-related objectives. The pilot project in Barcelona focuses strongly on a socio-economic assessment of telematics: research of the acceptance, usage and evaluation of ATT.

Within the framework of this project, a zone access control test was carried out during the Olympic Games in 1992 (cf. GAUDI, 1992a). Access controls were implemented in the Poble Sec district, a residential area with narrow streets. It was expected that because of the Olympic Games many people would move to this area, worsening the existing traffic problems with additional problems of parking, circulation, noise, pollution etc. Characteristics of the Poble Sec area to be taken into account are its high population density, a large number of small enterprises/shops and high concentrations of bars/restaurants and workshops/garages.

The test tried to guarantee that inside the perimeter itself the most rational use of urban surface would be achieved. By taking advantage of security road closures, control of an area of 0.74 km² containing some 37,042 residents with 12,895 registered vehicles was achieved using only four entry gates during three weeks. Between 11.00 and 22.00 only authorized vehicles directly related to the neighbourhood (inhabitants, employees etc.) were granted access. Identification of these authorized vehicles was to be made with the help of a sticker placed on the vehicle. Stickers could only provide access at the manual control entries. Also some 30% of the vehicles were equipped with On-Board Equipment (OBE) which permitted automatic vehicle identification (AVI).

Distributional data on residence and parking address were collected at the time of issue of the user equipment. By combining these individual characteristics with the AVI transaction data obtained at the four entry control points, origin-destination matrices could be constructed and fluctuations of trip demand in the area could be detected. Together with telephone surveys with vehicle owners living in the Poble Sec area, an empirical base was created for the evaluation of

the impact of the policy measure in terms of acceptance of the system and behavioural change (cf. GAUDI, 1992b).

5. AN EVALUATION OF THE OLYMPIC ZONE ACCESS CONTROL TEST IN THE FRAMEWORK OF THE NESTED APPROACH

In this section the results of the GAUDI field trial in the Poble Sec district will be evaluated according to the Nested Approach outlines above. An assessment of the elements of the Nested Approach will be made, as far as the field trial and the data base allows for this test. It will also be investigated to which extent this evaluation methodology offers a way to organise and evaluate the Poble Sec field trial into a market directed framework.

5.1. Market potential: segmentation issue

1. Car availability: some 340 vehicles per 1,000 inhabitants were registered in the Poble Sec area (1990). This rate is a little lower than the Barcelona average of 380 vehicles per 1,000 inhabitants. Nevertheless, the motorization rate is rather high in this area.

2. Age/sex: 83% of the tag users is male and 17% is female. The age group of 18-29 years forms 14% of the population. The three age groups 30–39, 40–49 and 50–59 form respectively 20%, 20% and 27% of the population. The age group of 60 years and older forms 14% of the tag user group.

3. Social group: in the questionnaire itself no socio-economic indicators were taken up. Figures from a socio-economic study of the area in 1990 show the following subdivision of four professional categories of the workforce:

Workers:	38.0 %
Administratives:	18.3 %
Managers:	6.5 %
Others:	37.2 %

This information can be used as an indication of social groups and can be compared with the results from the telephone survey. Though the terms used are not unambiguous, it may be concluded that the majority of the labour force works at a rather low job level. In the telephone survey a workforce survey was made: 65% of the population answered to be employed, 16% answered to be retired, 10% self-employed, 4% unemployed, 2% house wives, 2% others and 1% students. More information on social groups to be distinguished in Barcelona is unfortunately not available. Such information, together with social group info-

rmation of all tag users like type of employment and other class related measures, would have been a source of rich information to the Nested Approach.

4. Income: the only information found is a family economic capacity index for the neighbourhood; it reaches a value of 75 (1988) (Barcelona = 100). The low economic capacity index confirms our idea that many people work in a lower social class. According to the Nested Approach, research on different income levels would provide much more valuable information.

5–6. Experience and familiarity: the Poble Sec field trial forms part of a new and innovative project. Past experience with AVI systems in urban access control – is not to be expected.

7. Purpose: a distinction has been made between different types of vehicles: private cars, vans and lorries. These groups make up respectively 23.5%, 43.5% and 9% of the total census population.

5.2. Market potential: awareness issue

1. Exposure to ATT: this concerns people who received the tags: they could make use of the entries equipped with the AVI technology. The group consists of 3,931 people. The vehicle owners who did not have the need to possess a tag, or did not receive one, had to make use of a sticker. With this sticker only entrance at the manual control entries was possible.

2. Acceptability: the acceptability of the technology used, referring to its social image, was fairly good. A success in citizen participation was realized concerning the demand for the tags and the return of the tags after the test. A positive opinion on the global consideration of measures applied to the Poble Sec area was measured (85% positive, 11% negative and 4% no answer). For the Nested Approach, the assessment of such a general social acceptability of AVI technology is useful. It is important to remark here that the occurrence of the Olympic Games formed an extraordinary circumstance in the case of the Poble Sec area. Another remark has to be made here on stated infringement levels. It was measured and concluded in the technical evaluation of the test that the infringement level of AVI is much higher than the manual alternative (10.8% compared to 5.1%). A plausible reason for this higher infringement level may be the parallel use of both systems. People wanting to enter the zone, while knowing that they are actually not allowed to enter, will try to enter at the AVI entrance, probably unaware of the fact to be registered by the system. After detection by the video camera and receiving a financial punishment at home, a correction in behaviour is likely to take place.

3. Publicity: a publicity campaign to citizens was organized prior to implementation. Also as a result of the forthcoming Olympic Games, much attention to the project was given by the local and national press.

5.3. Market response: behaviour issue

Precise information on shifts in travel modes chosen, route choices, destination choice, trip suppression/generation and trip rescheduling during the test is hardly available. Some observations on these issues in the case of the Poble Sec test led to the following result:

1. Mode shift: while no price was yet to be paid for the tag, probably no mode shift occurred as a result of this factor. However, it is likely that a mode shift has occurred for reasons of travel time reduction by drivers from outside the area with a destination inside the area. Knowing that they are not allowed to enter the zone by car, they have likely chosen for public transport.

2. Departure time: information of this kind gives, in combination with the average time savings and reductions of delay, an indication for the reaction of people on reduced travel times within the zone.

3–4. Route and destination: these aspects were assessed by means of a proxy, viz. via the construction of origin-destination matrices on the basis of the (limited) data collected by the AVI system. The focus of these data is on the variation in trip movements by drivers equipped with AVI. This measurement approach has produced encouraging results concerning route and destination choice shifts, which turned out to be beneficial to the Poble Sec society (GARCIA RAMON et al., 1993).

5–6. Trip generation/suppression and trip scheduling: these issues refer to stronger behavioural responses to ATT than, for example, mode shifts and departure time changes. This information is unfortunately not available. More information on these issues might provide better insight into the acceptability of the project. A test on a larger scale and with a longer duration would then be necessary to identify such behavioural changes.

7. Parking choice: a reduction in demand for parking of 14.6% was measured inside the zone. Also the average duration of the parking activities decreased during the test. The decrease in parking duration was the largest during the mid-day period: an average decrease of 18%. During the morning the average decrease was 16% and during the evening 10%.

8. Adherence to advice: this issue is not relevant here for this kind of measure, since no information and/or advice is provided to the drivers.

The impact in terms of behavioural response to this field trial may also be highlighted by the fact that the use of the tag was low, in relation to the high interest of citizens to possess a tag. This raises the need for more insight into the demand for entering the zone by private car. The data obtained from the telephone survey in Barcelona did not allow for this. In order to model and predict access demand, it is necessary to measure drivers' intentions towards the measure in terms of specified travel choices (BANISTER and CAMARA, 1993).

5.4. Market response: diffusion issue

1. Pre-conditions: this refers to the necessary political and technical conditions present before the actual test was carried out. The Olympic Games may have formed a significant contribution to the necessary pre-conditions. A large willingness to address the traffic problems was proven by the high demand for the tags by the citizens.

2–3. Take-off and saturation levels: after a certain level of diffusion, the interest in a new technology normally begins to snowball and market penetration can expand at a faster rate, following a logistic curve. In the stage of maturity, a level of saturation is reached and new markets can be identified; alternatively, a segmentation of existing ones is a plausible option. In the Poble Sec test, these levels could of course not be reached because of the relative short duration of this first field trial. Take-off levels and saturation levels of the technology are more connected to large scale applications and longer term effects of these applications.

4. Adaptation: this concerns the modification of behavioural patterns and changes in driving habits. Also in this case, effects are likely to be more relevant for larger scale and longer term ATT applications.

The Barcelona test case shows that ATT applications may have a significant potential impact. However, it is also clear that evaluation of such experiments should not only take place *ex post*, but should be built up simultaneously with the technical design of field trials.

6. CONCLUSIONS

New applications of Advanced Transport Telematics, whether or not in combination with demand management, have the potential to cause revolutionary changes in road transport: these technologies may increase travel efficiency and traffic safety and may reduce the negative impacts on the environment. The functions of information supply and demand management in transport were in this paper described according to a functional classification of these kinds of technologies. It was illustrated that a pure technical and financial analysis is not sufficient for the evaluation of future applications of dynamic traffic management. It is therefore recommendable to take into account that all such systems try to influence the social environment, and to identify and estimate relevant social and behavioural parameters at both an individual and a more aggregate level.

The recently developed framework for capturing the user response to ATT, viz. the Nested Approach, provides a systematic and complete basis to deal with

the issues of segmentation, awareness, diffusion and behaviour. The use of the Nested Approach studying the acceptance of demand management in combination with ATT offers an effective and efficient way to obtain proper insight into potential ATT users (market potential), and also of the best ways how to meet user requirements (market response).

It will be clear that the rapid development of various new ATT technologies creates a broad range of policy options. One of the main related issues and one of the targets of the European DRIVE II project, is the assessment of systems that have a promising potential user response. In this context, it is necessary to systematically evaluate these various applications regarding their potential to influence travellers' behaviour. The framework shown in this paper may be helpful as an analytical framework.

This paper is based on the results of a study undertaken in the framework of the EC DRIVE II programme by the research group BATT (Behaviour and ATT); members of the team are among others: Yorgos Argyrakos (Athens), David Banister (London) and Lauri Pickup (Oxford).

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