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A Dutch Case Study

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THE RELEVANCEAND USE OF INFORMATION AND TELECOMMUNICATION NETWORKS AS STRATEGIC TOOLS IN THE TRANSPORT SECTOR: A DUTCH CASE STUDY

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Abstract

New information and telecommunication technologies in the transport sector, often named 'Advanced Transport Telematics' (ATT), play a key role in the new European network economy, as they have the potential to offer new solutions to the emerging transport problems in Europe. However, the successful exploitation of ATT in European transport markets depends on the technology being implemented in a way which meets the distinct needs of the different road user groups in order to achieve social acceptance and thereby politica1 approval. It is therefore vitally important that decision makers (i.e. those influencing the adoption of ATT) have sufficient information on the needs of (commercial) road users and on the way they perceive ATT options in addressing those needs.

The ATT market comprises a large number of actors from both the public and the private sector. At the demand side, some major potential market sectors can be identified. In addition to private users, there are intermediate or collective users (e.g., road authorities) and commercial users (e.g., the freight sector). In the latter case ATT may play a strategic role by facing the need of the freight sector to orient itself towards the opportunities offered by the European intemal market, which has far-reaching impacts not only on organisations operating in intemational networks, but also on those operating nationally.

The aim of the underlying study is to investigate the potential ATT market among these main user and interest groups, where the range of telematics applications will be restricted to those applied to inter-urban road transport. The focus will be on collective users (road managers) and commercial users (road freight operators). Surveys and in-depth interviews have been used to gather relevant information on the views, attitudes **and** expectations of these potential users. This empirical information provides interesting and policy relevant insights into the potential of ATT applications for each of these market segments.

1. The Strategic Role of Information and Telecommunication

Mobility and interaction are essential features of spatial networks. Europe is gradually but steadily moving towards a network society, characterized by economic integration, politica1 coordination, regional autonomy and mobility of people. Networks connect people and places and are able to generate socio-economic added value tbrough synergy and interaction. Such networks may be physical, immaterial, organisational or club-oriented in nature, while exhibiting a wide spectrum of multi-layer configurations, e.g. roads, railways, telecommunications, e-mail etc.

New network tecbnology has promoted satellite and fibre optic networks for communications, the ensuing reductions in costs of computing and networking have provoked "real time" decisions in business strategies, and huge data bases are available to assist in policy decisions of both the private and the public sector. The move to the post-industrial society has revolutionised the ways in which existing networks are used and has created opportunities for new forms of communications through city networking, data exchange and research networking (Knowles 1993).

Connectivity to (tele)communication and information networks becomes increasingly a critical success factor for urban and regional development (see also Capello 1994 and Graham 1994). The latter author makes a distinction into four types of policy objectives regarding communications, information and transaction networks initiatives at a decentralized level, viz. indigenous local economic development, inward investment and intemational competitiveness, social and community cohesion and spatial (interurban) networking. Needless to say that there is a variety of network services favouring such objectives. In the context of the present paper we will in particular focus on telematics services as a way of alleviating some of the basic impediments to physical transport in an ever increasing mobile network economy. First however, we will make some background observations.

It goes without saying that the construction of a network society does not materialize automatically, but requires dedicated efforts from both the public and the private sector. Substantial capita1 investment is required to construct a high quality network and difficult decisions have to be made if the European dimension is considered as important as the national concerns. Traditionally, most transport infrastructure investment has been carried out by national governments in the public sector, and only recently in the (tele)communications sector the possibility of private capita1 funding has been more explored. New European agencies (e.g. EBRD and EIB) have been set up to adjudicate on new investments, and at present possibilities are also being considered of joint venture projects between the private and the public sectors. In the operations of transport and communications markets, many European countries have had different traditions, some based on strong centra1 intervention and others allowing much greater market freedom. Under these different politica1 regimes, networks evolve in different ways. For example, with respect to bus and air transport in a deregulated market the structure moves from a comprehensive network of services with many links more to one based on a hub and spoke configuration with longer distances to be travelled, but with more frequent services. There may then be significant savings to the operator, but entry to the market may be difficult while access to and use of (tele)communications services is a sine qua non.

In the context of regulatory policy on networks the role of govemments is of utmost importance. Most decisions on European networks are taken by national govemments through well established procedures. As transnational European networks evolve, many decisions will have to be taken by intemational agencies. This requires that new institutional, organisational and legal frameworks be established. The roles of the different political, legal, financial and planning agencies will have to be resolved, together with an understanding of how decisions are taken. The implications of decisions taken at one level in the process will have to be accommodated at other levels, if integration, equity and efficiency are to be maintained. In addition to the EC politica1 dimension, there are important issues of harmonisation and standardisation in networks, access to information, the organisational culture of networks and institutional and organisational barriers in networks.

Networks generate synergy through (physical and non-physical) spatial inter-action. Clearly, transportation fulfils a key role in the modem European network economy, not only for road users, but also for many other actors, such as public authorities, network operators, industry or society at large. In the same vein, transport is assuming a centra1 role in the new European force field. The context and nature of European trade and transport is thus nowadays entering a new era. As a result of globalization and the rapid rise in intemational interaction and communication, transportation in an integrated Europe (both passengers and freight) has grown enormously, especially in recent years.

The rise in road mobility has been one of the most marked social developments in recent decades. Growing road mobility accompanied by an unprecedented (five fold) increase in car ownership over the last 30 years and a rapid increase in road transport volumes has led to similar increases in energy consumption, road accidents and environmental costs. Forecasts suggest that this growth will not decline in the next decade (MARTA 1993).

The available infrastructure will not increase at the same rate to absorb this further rise in mobility, and hence congestion will increase. European regions face common problems in this respect, albeit with different intensities. Therefore, there exists considerable scope for deftig common strategies and solutions in the face of increasing congestion. There is a growing policy consensus that traditional strategies and available levels of investment will not be sufficient to match Europe's growing demand for mobility.

Furthermore, the structure of production, distribution and transport goes through a rapid transition phase. Integrated logistics inside firms is increasingly linked to extemal distributional and market logistics, a tendency which leads inter alia to logistic platforms in an intemational network in order to fulfil the needs of just in time (JIT) delivery and material requirements planning (MRP). Multimodal transport will play a critical role in this new development, as is also witnessed in recent policy documents of the Commission, e.g. in the framework of the EURET programme.

The trend towards globalisation (or at least intemationalisation) and the need for more competition at all levels in the new European setting have provoked a profound interest in the functioning of networks in Europe. Traditionally, the interest in nehvorks was instigated by supply side motives, but it is increasingly recognized that new competitive behaviour of firms in Europe necessitates US to focus much more directly on those actors who coordinate, manage and operate flows in this network.

Many improvements in transport efficiency might be generated, if better information on the state of the network would become available to planners and users. In this respect, Advanced Transport Telematics (ATT) is often advocated as the transport planner's 'secret weapon'. ATT is the application of telecommunications and information technology in the transport field. It can address the functioning of all transport modes as well as the integration of these modes. This effectively opens up the transport market to the large communications sector and also enlarges the opportunities for producers of software and system designers. Systems developed for monitoring and data processing, information dissemination and processing in fields such as defence or the oil industry now become applicable to transport. What remains uncertain in the future policy environment is the size and nature of the market.

ATT has the potential to offer new solutions to the great many transport problems in Europe. However, the successful exploitation of ATT in European transport markets depends on advanced telecommunication technology to be implemented in such a way that it meets the multi-faceted needs of the different road user groups in order to achieve both social acceptance and politica1 approval. It is therefore vitally important in the ongoing programmes on ATT research and development in Europe that decision makers (i.e. those influencing the adoption of ATT) have sufficient infonnation on the needs of (commercial) road users and on the way they perceive ATT options in addressing those needs. This is necessary in order to exploit the competitive advantages of the transport sector in various European areas.

The ATT market comprises a large number of actors from both the public and the private sector. At the demand side, various major potential market sectors can be identified. In addition to private users, there are intermediate or collective users (e.g., road authorities) and commercial users (e.g., the freight sector). In the latter case ATT may play a strategic role by facing the need of the freight sector to orient itself towards the opportunities offered by the European intemal market, which has far-reaching impacts not only on organisations operating in intemational networks, but also on those operating nationally.

The aim of the underlying study is to investigate the potential ATT market among these main user and interest groups, where the range of telematics applications will be focused on those applied to inter-urban road transport. The attention will be devoted to collective users (road managers) and commercial users (road freight operators). The Netherlands will be taken as frame of reference. Surveys and in-depth interviews will be used to gather relevant information on the views, attitudes and expectations of these potential users. This empirical information should then provide interesting and applicable results on the potential of ATT applications for each of the distinct market segments.

The following section starts with some genera1 considerations regarding the interaction between road transport and its (potential) value-added services in general. Section 3 treats the case of road infrastructure managers. It contains also empirical results from a series of in-depth interviews with representatives of the national Dutch road authority. In Section 4 we will focus in particular on the behaviour and needs of freight transport operators. Here, recent results will be presented from a national survey among Dutch companies. Finally , in Section 5 the main results will be placed in a strategic context.

2. The Interaction between Communication and Transport

Road transport started in the reahn of engineering but has nowadays become such a complex array of operations and organisations that research and development have to involve many other disciplines, e.g., economics, management, computer science, geography and political science. Whatever the progress of engineering, in the road transport equipment industry new products have to be integrated in the technical road transport system and its broader economic market. The technical system takes for granted that vehicles, infrastructure and operating techniques will evolve in harmony, as was for instance the case for the TGV in France. The identification of the market and its potential is a problem in itself.

The existence of the road transport market in the true sense of the term is all the more essential in view of the diversity of both the demand of travellers - which is dependent on income, trip purpose and physical and geographical conditions -, and of the type of goods - which is dependent on their nature, destination, batch size and frequency of delivery. Only a genuine market combining a diversity of products and tariffs can meet this multiplicity of needs.

The major technical and commercial systems will call for all resources of science and organisational and information technologies. Complexity needs to be managed and this requires the creativity of the ATT industry which is investing primarily in the non-material software and which has the ability to transmit the right messages to individual users and logistic operators on the basis of an almost instantaneous knowledge of demand. These logistic operators are set to be the prime users of the future service-integrated numerical networks of the ATT industry and the value-added networks. These will be able to integrate the whole process from production to distribution and thereby fulfil a logistic role which is nothing else than the provision of value-added transport (Giannopoulos et al. 1992). This transition will place the transport sector at a competitive edge (see Nijkamp 1994).

It is evident that within the above mentioned context the future of road transport in Europe will not be just engineering or just road infrastructure provision. It will rather have to be developed in a complex interplay of a number of decisive factors the most important ones being:

- the technology available for the construction and operation of vehicles and road infrastructure
- the development of the demand for road transport services
- the mechanisms of interaction that will allow for the satisfaction of user needs, and
- the various constraining factors, mainly those referring to the quality of the environment and sustainable transport.

In this context, telematics plays a crucial role, not only in the European DRIVE programme, but also in the American IVHS programme. In the sequel we will focus on two main categories in the telematics market, viz. public operators and private users (namely freight operators). After a genera1 description, we will in each case focus on Dutch fmdings.

3. Public Managers' Views on Transport Telematics

Public authorities in the area of transport telematics are usually road managers normally associated with departments of national and local govemments. These institutions have the responsibility for the performance and guidance of traffic flows on inter-urban road corridors. For many ATT applications, the efficiency of individual trips may be increased, although this will not necessarily result in a greater overall benefit to the transport system in terms of safety, traffic flow efficiency or a better quality of the environment (Emmerink et al. 1994).

In investing in and implementing ATT equipments, road authorities start usually from a firm strategic policy basis for transport in their area. These policy objectives are then developed into a number of operational strategies some of which may be applicable and relevant to ATT products. Each strategy has normally various methods of implementation, and ATT methods will have to be compared to altematives in order to evaluate the most cost-effective way of achieving the strategy and therefore the policy objectives concemed. It turns out that nowadays road authorities need to demonstrate a significant added value accruing from costly ATT investments.

3.1 ATT technologies for inter-urban road management

The road authority sector as part of the public sector is an important market area for ATT. The ATT requirements for inter-urban road management vary largely; the most important ones are shown in Table 1. The requirements from Table 1 can be met by a broad range of advanced inter-urban ATT applications, already existing and/or in development. Some of the most promising technologies are (EC 1993):

Automatic debiting systems

A wide range of automatic debiting possibilities, in terms of application area and of charge systems, are open to local and national govemments. The application area might be a network of high density motorways, but also an urban quarter might be elected. 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 in order to calculate the right fare.

Table 1. ATT requirements for inter-urban road management.

Policy objective	ATT requirements
Demand management	Sharing of reports of incidents with emergency services and other control centres Monitoring and forecasting traffic demand Provision of information about altematives, travel times, availability Operating road pricing Giving early waming of potential problems within the road network
Capacity management	Fast response to incidents Provision of effective directional guidance for road users Planning and understanding network behaviour and problems Enhancing and maintaining the capacity of the existing road system Quick response to faults Installing and operating route guidance
Safety management	Operating incident detection, wamings or speed controls Faster emergency services response with traffic coritrol co-operation
Environmental nanagement	Linkage of local pollution forecast to traffic control strategies

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 comprise genera1 management and traffic control on motorways and the provision of traffic information to drivers. A typical characteristic of road-side based systems is that all drivers can be reached. These applications include inter alia signalling systems and variable message signs. These systems can provide road users information about road status, weather conditions, pollution, incidents, road works, congested conditions, queue lengths, speed compliancies etc.

Navigation and dynamic route guidance

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 centra1 control centre are needed to realize navigation or dynamic route guidance. The application area of information can be smal1 or large, depending on the specific tools and their geographical coverage.

Travel planning information systems

Reliable (pre-trip) travel information, extended with public transport information, will contribute to a lower demand for traffic. The latter function is especially suited for congested 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.

These genera1 observations will now be tested against the views of experts/road managers in the Netherlands.

3.2 Attitudes and expectations of road managers

The attitudes and expectations of road managers towards the possibilities of applying these information and telecommunication technologies to their networks have been explored by a series of in-depth interviews, which were held in the Netherlands with key persons of Rijkswaterstaat, the national public road manager in the country. These interviews were held in June and July 1994 and concemed fíve key persons. Respondents were selected both at the centra1 department as well as at some regional subdivisions of this state agency. The selection ensures that opinions are included of those experts who are involved in planning and research (centra1 department), as well as of those involved in the actual implementation of new informatics technologies (regional subdivisions).

The respondents expected that debiting systems would have a relatively high potential to smoothen traffic flows in relation to the potential of the provision of traffic information. However, this measure has in genera1 a weak public support in the Netherlands. Especially in the case of advanced automatic debiting systems which trace car trips, privacy aspects are a sensitive matter. The lack of public support is believed to be a serious bottleneck to the implementation of debiting systems. Therefore, the focus in the interviews was clearly on the provision of various kinds of travel information to motorway users. The attitudes and expectations towards these systems are depicted in the following list of items.

Perceived added value from ATT technologies

Respondents agreed that currently available driver information systems are useful to some extent, but that its quality is certainly not yet sufficient. For instance, traffic information provided by various media (radio, TV) is repeatedly not sufficiently updated because the channel from source to driver is too long. The collection of the information is often subjective, while different sources may provide conflicting information. These issues make the information in genera1 not very reliable and accurate. Consequently, a significant added value is expected from more sophisticated user-oriented and improved information systems.

Basic requirements

Some basic requirements may be seen as absolute conditions for a successful implementation of ATT technology on motorways. These include the development of an open or flexible systems architecture according to agreed uniform standards, fully reliable information and a full acceptation by road users. While the fust issue relates to the hardware of the technology, the latter two relate to the user side. Clearly, user acceptation is of critical importance for the further development of ATT technologies. Besides, it is widely believed that recurrent misinformation of an ATT system will immediately reduce the confidence - and hence the acceptation - of such a system.

Perceived potential contribution of ATT to environmental conditions, efficiency and safety

Although the contribution of ATT applications to the achievement of higher traffic efficiency may be limited, it is in genera1 believed that this effect will stil1 be significant. The significance of the impact is supported by the fact that traffic queues usually occur when traffic demand marginally exceeds the road infrastructure capacity. This means that even when only a smal1 share of drivers were rerouted, this might already have a large impact on traffic performance. Improvements of traffic flows as estimated by the various respondents varied between 3% and 15 %. Regarding the possible impacts of ATT on alleviating traffic pollution, it was generally recognized that positive impacts on traffic performance would not directly mean that also positive impacts on pollution by cars might be expected. This effect might in the long run indeed be negative, since ATT policy in fact enlarges usable capacity. By rerouting of vehicles, the total mileage might be enlarged. This effect might then neutralize the benefits of reduction of congestion pollution. Finally, ATT has also much potential to improve traffic safety. Some clear examples are fog waming systems and signalling systems that are already operational in the Netherlands. Fog waming systems and signalling systems that filter out extreme speeds appear to be quite effective. Furthermore, also the provision of dynamic traffic information to car drivers is regarded to have a positive contribution to safety, since it may decrease the driver's uncertainty resulting in less distraction from the driver's task. In general, there is some scope for optimism on the impact of ATT systems on safety.

Expected drawbacks

The use of ATT technologies brings along also possible (negative) side-effects. The main side-effects of information provision to road users are the following:

- Drivers may be distracted from the driving task by digesting too much information at one time or by a visual interface. These problems mainly concern in-vehicle systems, and therefore there is more confidence in systems with verba1 interfaces. Critical is also the size of text displays of variable message signs.
- In certain cases congestion may be not reduced but transferred to other parts of the motorway network (called 'squeezing a sausage').

- Another problem is that an undesirable use might take place of secondary roads as a result of re-routing.

Expected major problem areas in the implementation process

Major potential bottlenecks which may delay the process of implementation of inter-urban ATT applications will probably not be of a technological, operational or financial nature. It is more plausible that conflicts with local (car unfriendly) policies of large cities will cause delays in ATT development, although such policies will likely not be able to obstruct the ATT implementation in the long term.

Expected future developments

In the past five years the development of ATT systems has shown a rapid acceleration. The driving factor behind this has been the growing public view that unlimited expansion of road infrastructure will put serious strain on the environment and will not be sufficient to meet all kinds of traffic problems. However, until the present time the emphasis has mainly been on the development of the technology itself and pilot tests. Therefore, it is now time for broader implementation of those systems that are at present fully standardized. It is expected that within the next five years various existing technologies may be implemented and/or launched on the private market. This is, for example, the case for VMS systems and the Radio Data System-Traffic Message Channel (RDS-TMC). The wide-scale introduction of other in-vehicle driver information systems will likely take place over a longer period (in the next 10 to 20 years). It may be expected that various different systems may exist parallel to one another, given the fact that the end-user market will be segmented. In general,. the actual speed of development of ATT technologies will continue until at least the year of 2000 to 2010, although it may show development waves dependent on waves of public interest. In the longer run, it seems plausible that no limits will exist regarding the development of new generations of ATT systems.

In conclusion, on the basis of expert opinion, it is clear that, although the limitations in applying information and telecommunication technologies in inter-urban road transport management are recognized, public road managers are rather optimistic about the use and adoption of these systems, in light of the relatively low costs compared to other measures for increasing road traffic capacity . This may be an important indication for future adoption rates of these technologies by collective users. The question is now whether this perspective of public road managers is also shared by the users. Therefore, in the next section we will present the result of a broad inquiry among commercial freight operators, who may be expected to have a direct interest in ATT.

4. Road Freight Operators' Views on Transport Telematics

4.1 Introduction

Road freight operators show a considerable variety of size classes and forms of operation in Europe with different organisational and operational problems to be overcome. Smal1 hauliers constitute the vast majority of the sector, but when considering the number of vehicles operated, it is clear that the large hauliers play a dominant role, especially for long-distance hauling. A great variety of market segments can be distinguished within road freight operating companies, based on different criteria (e.g. product type transported, operation type etc.). Significant changes are expected in the freight sector in the EU in the years to come (Bollo 1992). Some important developments which need to be mentioned in this respect are the completion of the European intemal market, the subsequent deregulation of the European and national freight markets, and the changing requirements of major users of freight services. These developments will likely have advantageous impacts such as the simplification of customs procedures, reduction in trading and transport costs, removal of cabotage restrictions and thus a better access to markets. In this light we may mention the evolution of 'mega-companies' which will offer full logistics services with also other transport modes (Cooper et al. 1992). In fact, these integrated carriers are expected to be the architects of future transport systems by investing large amounts in informatics and ATT, while sub-contractors will mainly do the actual trucking.

In light of the above developments and the increasing congestion levels on Europe's roads, it is clear that in addition to the collective ATT users like road managers, road freight operators are a very important potential actor at the demand side of the transport telecommunications market. These companies may differ from road managers in the sense that the adoption of new technological innovations will be dependent here on clear economic criteria rather than on issues of public or social interest. Investrnent costs of these technologies will simply be compared with their expected advantageous impact on operating costs. This assumption will be tested in Subsection 4.3, but first we will give an overview of the type of ATT equipment that may plat a role in commercial fleet operations .

4.2 ATT technologies for commercial fleet management

The action radius and the logistic demands of fleet operations are increasing and, therefore, the requirements of road freight operators regarding the use of information technologies are varied. A list of such needs is shown in Table 2. These requirements can be met by a large range of ATT applications which are currently available or stil1 in development (OECD 1992). These systems include computer generation systems of goods (e.g., by bar coding and radio tags), electronic data interchange (EDI) systems, vehicle location systems, mobile communication systems and navigation systems. Especially the latter four

Table 2. ATT requirements of road freight operators.

Freight & logistics management	
Planning:	Long term-transport planning. Transport demand/resources. Transport offer calculation. Transport order.
Execution:	Notice of dispatch. Transport documents. Customs clearance.
Controlling:	Cargo tracking. Shipment status. Transport status. Delivery information.
Administration:	Cost and performance follow-up. Invoices and payment. Post-analysis of logistic performances.
Fleet management	
Planning:	Fleet monitoring. Tactical route planning.
Execution:	Operational route planning. Load plan. Preparation plus transfer of documents.
Controlling:	Route guidance and traffic information. Vehicle/cargo tracking. Fleet monitoring.
Administration:	Cost and performance follow-up for vehicle fleets.
Vehicle management	
Planning:	Vehicle preparation. Traffic/weather information. Trip preparation. Cargo/storage control. Documentation control.
Execution:	On-board vehicle/cargo monitoring. Trip route selection. Automatic debiting. Consignment delivery/pick-up. Genera1 communication. Emergency calls.
Controlling:	Recording of vehicle performance data, cargo data, trip data. Genera1 information.

systems deserve much attention. While navigation systems are the same as in the case of applications for private car users, the other three deserve a more detailed description.

EDI systems

EDI systems comprise the electronic exchange of transport documents, orders, etc. in a standardised form between road transporters, clients and receivers. EDI requires technical cohesion between participating organisations, since different intemal processing systems have to be logically integrated by the EDI system.

Automatic vehicle location systems

Automatic vehicle location (AVL) systems make it possible to follow all movements of freight vehicles. By using this technology, the efficiency of the vehicles' operations can be improved.

Satellite conununication system

These applications establish a bidirectional communication between the operator and the drivers to very long distances (the communication means is generally based on satellite networks; for simplicity reasons the term 'satellite communication systems' is often used). Some existing products offer both automatic vehicle location as well as the possibility for satellite communication.

AVL systems and satellite communication systems envisage software equipment both in vehicles and in the fleet operator centre for tracing purposes. It is likely that the market penetration of these systems will be strongly affected by the geographical coverage and by the cost of the on-board equipment.

4.3 The attitudes of road freight operators

Given the fact that the Netherlands plays an important logistic role in Western Europe as a so-called ‘distribution nation’ and since it has the highest European share in intemational freight transport, it is a suitable country to investigate the potential interest in freight telematics and fleet telematics systems. In Spring 1994 a survey was carried out among Dutch road freight operators on the potential development of freight (and fleet-related) telematics applications in this sector. It consisted of a structured postal survey with a sample size of 320 companies. It addressed all possible categories of goods transport by road. These categories comprise pick-up and delivery services, courier services, transport of light goods and animals, container transports, heavy goods transports, bulk goods transports, trucking services and transport of chemical/dangerous goods.

A statistical subdivision according to the number of employees of the total population of all Dutch road transport companies from the above mentioned categories is given in Table 3. It shows that about 80% of the total number is made up of smal1 companies (less than 10 persons employed). However, when looking at the total number of persons employed, the bigger companies (more than 20 persons) make up about half of the employment size of the road transport industry .

Table 3. Company size (employees) of Dutch road freight transporters (1994).

Number of employees	Number of companies	% of companies
< 5	6566	65%
5-9	1338	13%
10-19	1063	11%
20-49	770	8%
> 49	346	3%

Source: Dutch Association of Chambers of Commerce.

The survey has been stratified in order to include mainly the middle-sized and large companies. Beside the fact that these companies make up relatively a very high share of the freight market in terms of persons employed and vehicles operated, it is plausible that larger companies are likely to invest earlier in these new technologies than smaller ones, and hence will play a pioneering role in this market development.

The investigation concemed the following topics with regard to various ATT application areas in freight and fleet management:

- the investments in ATT equipment already made
- the purposes for which these applications are used
- the expected benefits of and the main decisive factors to invest in ATT
- the main bottlenecks to investments in ATT.

A distinction was made between on the one hand electronic data interchange (EDI) systems, and on the other hand road (mobile) telematics applications. Within the second category a distinction has been made between the (standard) car phone/mobilophone, and (advanced) automatic vehicle location systems, satellite communication systems and in-car navigation systems.

Companyprofile

Since the survey has been targeted to the upper segment of companies concerning their size, the profile of responding companies follows a pattem that is different from the national figures, and is hence biased to categories of firms with 21 and more vehicles. The relative share of these categories is comparable to the national population. The categories 2 1-30, 3 1-40 and more than 40 vehicles make up about 25%, 10% and 25% of the survey, respectively.

The geographical area in which the firms investigated operated is concentrated in Western Europe (60 % of the companies), while in total 70% is intemationally oriented. Only 25% of our sample appears to operate regionally or nationally (see Figure 1).

About 55% of the companies appear to transport particular freight types. Transporters of low-valued heavy goods, high-valued light goods and perishable goods made up about 25%, 15 % and 10%, respectively. About 45% of the companies were not specialized in any type of goods.

More than half of the companies claimed to work on the basis of fixed contracts with forwarders, while 10% works only with incidental orders. This means that the majority of companies deals with regular routes and destinations.

The existing leve1 of automation of fleet trip planning and route planning operations is significant. About 30% of the companies uses advanced technology for at least one of both activities: for fleet trip planning, route planning and for both activities about 15%, 5% and 10%, respectively.

Familiaritywithtelematicssystems

The Dutch freight hauliers have also been inquired on their familiarity with a range of telematics systems (see Figure 2). In general, about 40% of them was not familiar with the possibilities of these technologies, which is a relatively high share. Another 40% was quite familiar with its potential, while only 10% was already very familiar. It seems that there were no large differences between the technologies distinguished in this survey. EDI was in genera1 slightly more familiar to these companies than road telematics systems, while they were slightly less familiar with the possibilities of in-car navigation systems.

Actual use of telematics systems

EDI was currently been used by 48 of the 320 companies (15 %). From these, 60% used the system as frequent as was expected in the period of purcha-

Figure 1. Geographical area in which is operated (% of pop).

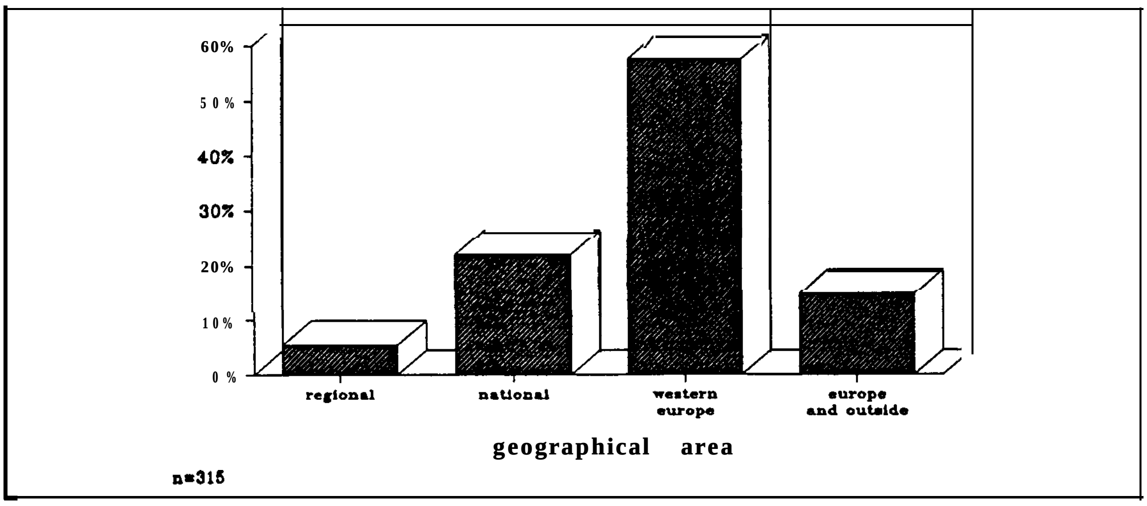
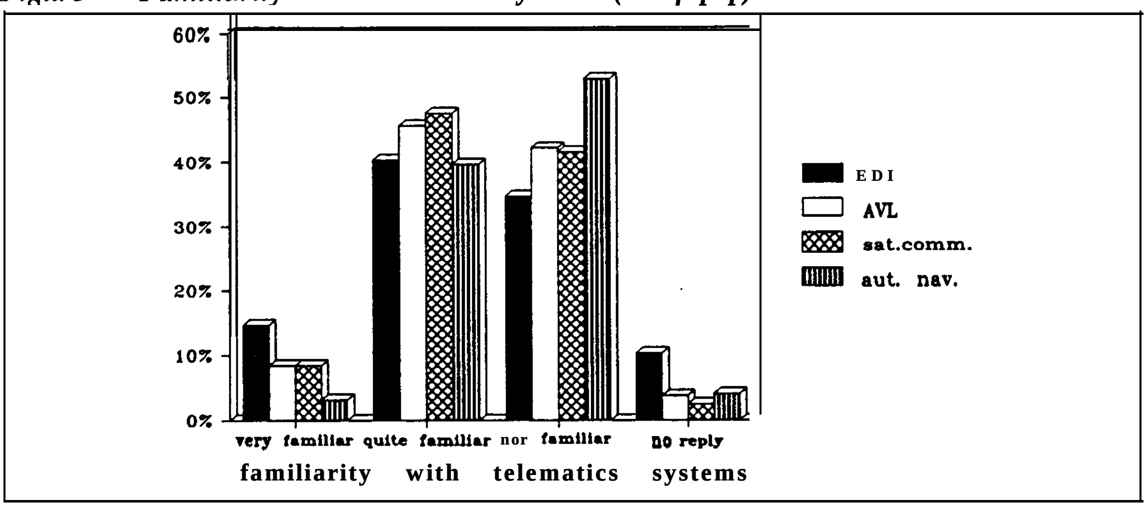


Figure 2. Familiarity with telematics systems (% of pop).

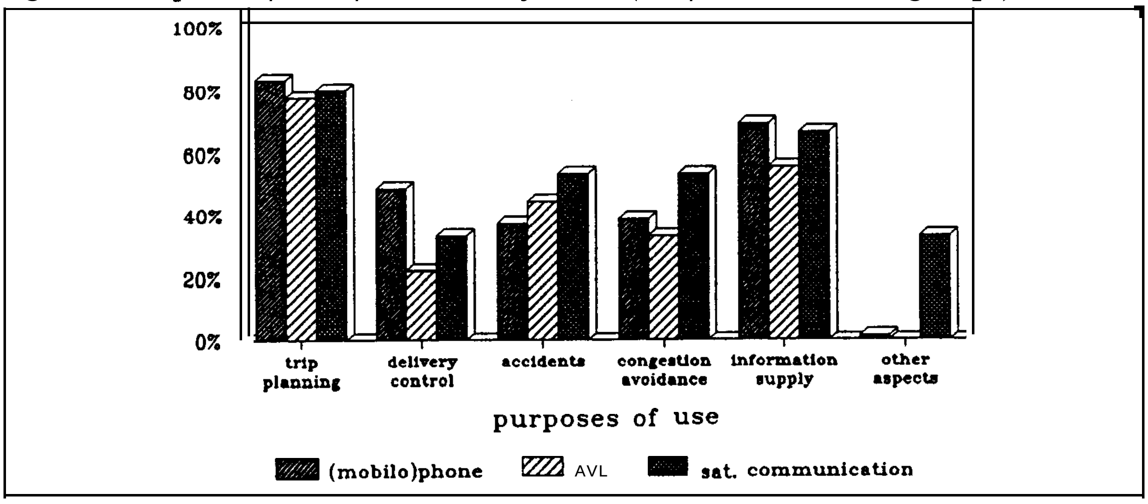


sing it. About 20% used the system more intensively, while another 20% appeared to use it less intensively than was expected. Satisfaction rates were quite high. Almost none of these users were negative: only 2% was unsatisfied and 10% was neutral. About 70% were satisfied and 20% even very satisfied about the implementation of EDI in their company.

The number of companies that had already invested in road telematics systems was low. Car (mobilo)phone were relative popular; about 25% had invested in such a mobile communication system. The more advanced technologies AVL and satellite communication were applied by respectively 3% and 5 % of these companies. NO company had invested yet in autonomous navigation systems.

When looking at the purposes of use of those systems currently being applied by the companies (see Figure 3), it seemed that the mam purposes of use were the planning of the trips of the vehicles and the information supply to clients. Less mentioned were purposes like the control of deliveries, coordination in case of accidents and the avoidance of congested roads.

Figure 3. Purposes of use of telematics systems (% of respective user groups).



It also tumed out that there was a slight difference between mobile communication systems and vehicle location systems. The former are slightly more intensively used for purposes like delivery control, congestion avoidance and information supply to clients.

The levels of satisfaction with road telematics systems were, just as in the case of EDI, quite high. Only in the case of car (mobilo)phone, a considerable share of 7% was unsatisfied. In the cases of AVL and satellite communication, there are no negative responses, while more than 60% were satisfied and 40 % was very satisfied. It must be noticed here that these results are based on only a limited number of actual users, which make genera1 conclusions not straightforward to infer.

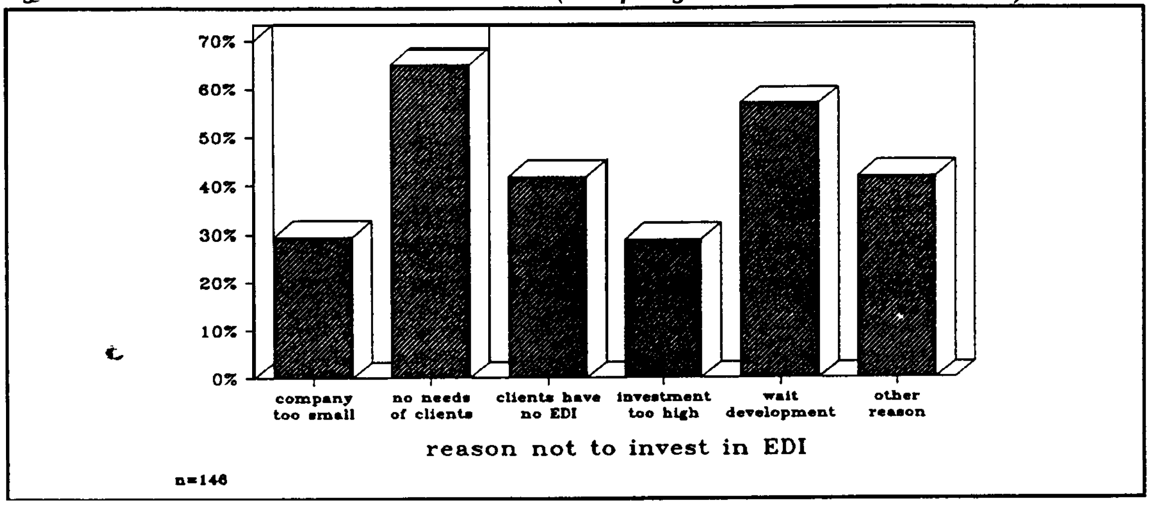
Investment plans and barriers

All respondents have been asked about their plans to invest (or to expand existing investments) in EDI within a (limited) period of two years. About 45% of them had no plans to invest, while 30% was uncertain. Another 20% claimed to have serious plans to invest in EDI within two years.

Those who were negative to any investment were asked on the most striking or significant reasons (see Figure 4). It appeared that two of the most important reasons were the lack of needs of clients (65%) and the preference to wait for further technical EDI developments (60%). A third reason was the lack of EDI investments by clients (40%). Less mentioned motives were size of the company and the investment amount.

Existing plans to invest in advanced road telematics systems were less than in the case of EDI, but nevertheless considerable. In general, about 70% of the companies had no serious plans to invest in these systems, 20% was uncertain, while 3% to 13% had serious plans to invest in road telematics within the next two years. The share of positive answers was relatively the highest in the case of satellite communication systems (13 %). This share was lower in the case of AVL (7 %) and autonomous navigation equipment (only 3 %).

Figure 4. Reasons not to invest in EDI (% of negatives to EDI investment).



The companies that were not negative to any investment in either of these systems were asked on the advantages they perceived to be generated from the use of these systems (see Figure 5). The advantage most often mentioned was the possibility to improve information streams to the forwarders and receivers, an issue which was mentioned by 75%. This was followed by improvements in the accuracy of delivery times and the efficiency and mileage of the vehicles (all about 55 %). Less mentioned issues were the company's competitive position, the avoidance of traffic congestion and the monitoring of dangerous goods. Although not explicitly mentioned, the most important perceived advantages are both strategic (improvement of service to clients) and economic (reduction of operating costs) .

A very important issue was the price of the equipment which would be considered to be acceptable in the cases of the three technologies AVL, satellite communication and autonomous navigation (see Figure 6). Maximum acceptable prices for the respective on-board equipment seem to be relatively higher in the case of satellite communication systems. In the case of the other two technologies, only about 3% of the companies that were not negative to investments in the respective technology claimed to be prepared to pay a price of more than 3250 ECU for the on-board equipment. For satellite communication this figure amounted to 8%.

For the related office- and management equipment only 5% of those companies that were not negative to investments in at least one of the above mentioned road telematics systems stated to be prepared to invest more than 21,000 ECU.

Figure 5. Perceived benefits from road telematics (% of positives toward investment).

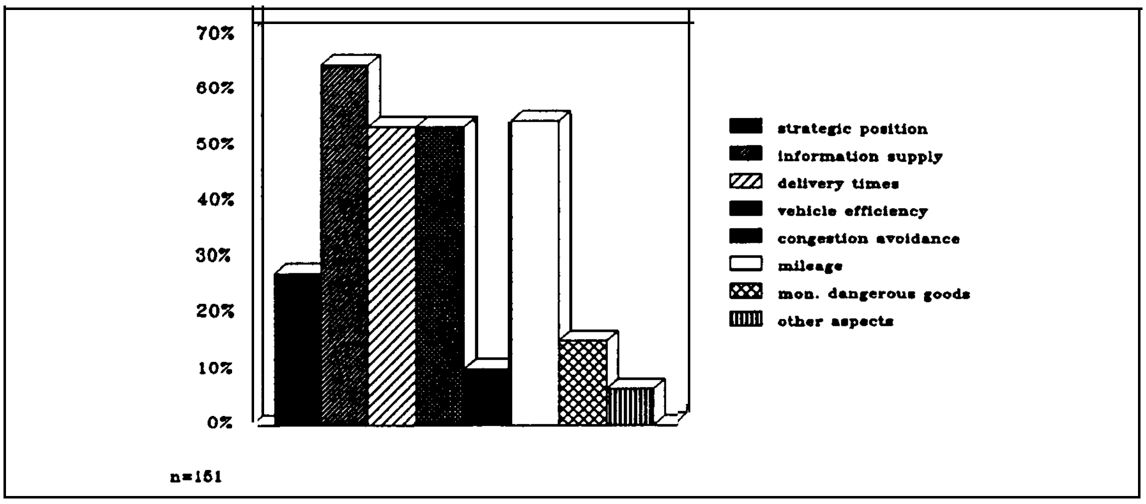
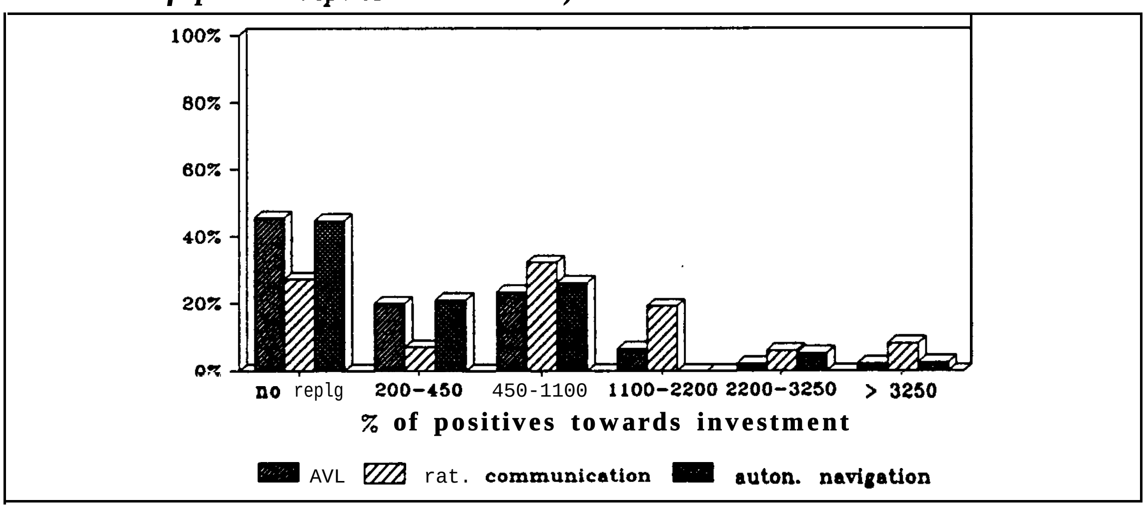
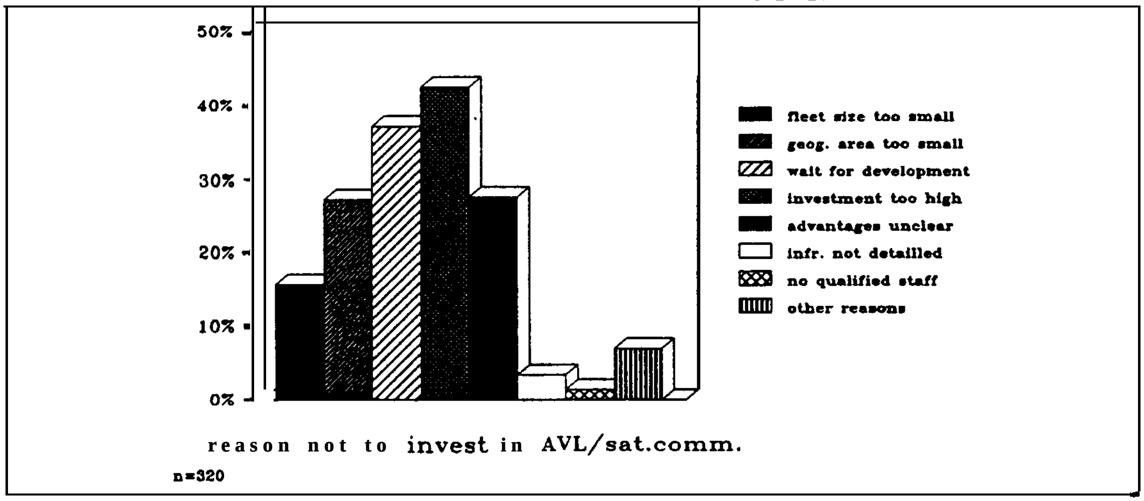


Figure 6. Perceived maximum investment costs of on-board equipment (ECU) (% of positive replies to investment).



All respondents were asked on the bottlenecks they perceived as most striking regarding any investments in AVL and satellite cormmmication technologies (see Figure 7). The most frequently occurring bottleneck seemed to be the costs associated with the implementation of the systems (about 45% of the companies mentioned this aspect). A second main bottleneck was the uncertainty about the speed of development of these systems, mentioned by about 35% of the companies. These are followed by issues like a too smal1 area in which the company operates to generate advantages from the use of these systems and the fact that these advantages are stil1 unclear to the companies (both bottlenecks mentioned by about 25 %). Issues that seemed to be of less relevance were the size of the vehicle fleet (15 %), the perception that the available infrastructure of the systems are not yet adequate and detailed enough, and the quality of the staff to work with these systems (both less than 5%).

Figure 7. Reasons not to invest in AVL/sat. comm. (% of pop).



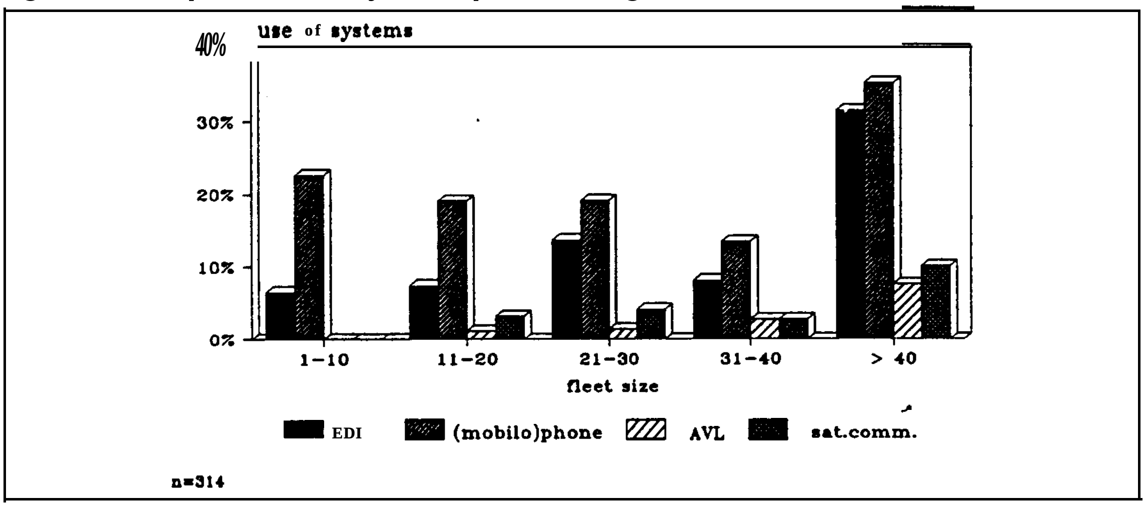
The influence of key company characteristics

The influence of some typical key company characteristics, like the **number** of vehicles operated, the geographical area in which the company operated, the type of freight transported, the relationship with forwarders, and the existing level of automation of **the** company's trip scheduling and route planning were **also** investigated. It seems plausible that the **first** four characteristics determine the budget available for **ATT** investment and the direct operational benefits to the company, while the level of automation of trip and route planning **functions** indicates the existing experience of a company **with** logistic investments in fleet operations. It **may** be hypothesized that the potential of **ATT** is the. highest for proven 'technology-minded' **companies.** A contingency table analysis was used to identify relationships showing a **sufficient significance** level **(below** 5% using the Pearson method).

The actual use of EDI was positively correlated with **the size** of **companies.** Small and **middle-sized categories** showed a lower use of EDI **than** big **companies** (see Figure 8). From the **companies** operating less than 20 vehicles, 7% used EDI, while for **companies** operating more than 40 vehicles **this** figure was 30%. In the case of (mobilo)phones, these **respective figures** are 20% and **35%,** which meant that **this** product was relatively more popular in the smaller **categories** compared to EDI. In the case of AVL these **figures** were 1% and 8 % , and in the case of satellite communication and satellite communication 2% and 10% , respectively . It must be remembered **that** in case of the **latter** two **products** these numbers were small, so that our results **may** not be entirely representative for **all companies.** This **result** indicates in **any** case that large **companies indeed** play a pioneering role.

The use of EDI was **checked** against the type of relationship **with** forwarders. It seemed that those **companies using** EDI have mainly **fixed** relationships with forwarders (70%). This **result stressed** the **importance** of the factor of uncertainty **faced** by **companies** with **regard** the **use** of EDI by their relations. This uncertainty might be lower in a situation with **fixed** relations.

Figure 8. Use of telemutics systems for size categories.



The use of AVL and mobile commtmication systems was **also checked** against the geographical area in which was operated. It seemed that there was a strong relationship between these two. In the cases of (mobilo)phone, AVL and satellite communication, companies that **operate** in various European countries and outside Europe made up respectively **70%,** 90% and 100% of the groups **having** invested therein **(care** has again to be taken with **regard** to the low numbers of AVL and satellite communication users). It could be concluded that those road freight **transporters having** invested in road telematics systems were mainly large companies which are internationally oriented.

The existing intentions to **invest** in EDI followed a similar intensity pattem **across** company **size** categories as the actual use of systems. A positive relationship between this variable and the **size** of the company was found; the smal1 and middle-sized companies (less than 20 vehicles) showed a **rate** of 7% that have intentions to **invest** in EDI. This **figure** was for large companies (more than 40 vehicles) 50%.

The same picture arose regarding investment plans in AVL **and** satellite **communications. Also** here a positive relationship between the willingness to **invest** and the **size** of the company appeared to exist. In the case of AVL systems, there was an increasing share of companies for the **successive size** categories showing a positive attitude to investments within the next two years (from 0% of companies **with** less than 10 vehicles to 14% of the large companies with more than 40 vehicles). In the case of satellite communication systems these **figures** ranged **from** 4% to 22 % .

When relating these investment plans to the geographical area in which was operated, it seemed that those companies operating intemationally showed the highest percentages of positive minded companies. For AVL and satellite communication, there were in this group respectively 9% and 16% positive answers regarding investments, while for **the** other companies these **figures** amounted to 4% and **2%,** respectively.

Investment plans in AVL and satellite communication did not seem to have any relationship with the existing leve1 of automation of company functions that assist in trip- and route planning. This means that the interests in road telematics systems was shown to the same extent by companies that did not use computer-assisted logistic planning of their trips and routes and companies that managed logistic planning assisted by computer software applications.

Finally, the relationship between investment intentions in AVL/satellite communication systems and the type of freight specialisation was investigated. It might be expected that dynamic information on freight movements would be regarded as more useful the more the freight has an urgent character. It appeared indeed that companies specialized in very urgent goods showed to a larger extent intentions to invest than companies specialized in heavy freights. This was the case for both technologies AVL and satellite communication.

Developments in the adoptìon of systems

The results from the above survey provided an opportunity to compare these attitudes of the road freight sector toward telematics with the situation of three years ago, when a similar survey was carried out by the Dutch Ministry of Transport (see Rijkswaterstaat 1992) on the potential of especially AVL technologies. It should be noticed however, that this latter survey was not stratified to larger companies. The conclusions from this comparison are summarized below :

Familiarity wìth systems:

* Three years ago there was a far lower familiarity with the possibilities of AVL systems. For example, only 2% of the companies indicated to be familiar with the LORAN-C system. This awareness seemed to have slightly increased. In 1994 only 40 % of the companies declared not to know AVL technologies .

Use of systems:

* Three years ago almost none (1%) of the Dutch road transporters used EDI. This has changed rapidly; about 15% of the companies used EDI in 1994. This indicates a rapid development regarding the implementation of EDI.
* Three years ago only about 2% had invested in an AVL system. This figure had not changed significantly: in our survey only 3% used an AVL system. It may thus be concluded that the process of EDI implementation was more dynamic than the AVL implementation.

Investment plans:

* The number of companies having intentions to invest in EDI has also increased considerably . While three years ago the number of companies having intentions to invest in EDI within a period of 5 years was about 10%, in 1994 20% of the companies were willing to invest within the next two years. One has to take in mind however, that the majority of positive companies were larger ones to which the survey has been stratified.

* The intentions to invest in road telematics systems are stil1 low. Positive intentions to invest in AVL were expressed by 7% of the companies while 25% is uncertain. Three years ago similar measures showed a positive intention of respectively 8% and 8%. Only an indicative conclusion may be drawn that there are slightly more companies nowadays considering the possibility to invest in AVL systems.
* The most frequent reasons for not investing in road telematics have not changed in the past few years. The most important ones are stil1 the perception that drivers are in most cases familiar with the area in which they drive, and the size of investment costs.
* 70% of the companies that plan to invest in AVL systems intend to combine this with satellite communication. From the earlier survey, it appeared that all of these companies wish to combine AVL with any mobile communication system. This fact stresses the need for a telematics product combining both functions.

5. Conclusions

Advanced transport telematics technologies have the potential to offer new solutions to the transport problems in Europe. However, a critical success factor of these technologies is the adoption of these technologies by the potential users.

The ATT market comprises a large number of actors from both the public and the private sector. At the demand side, some major potential market sectors can be identified. In addition to individual users, these are collective users and commercial users. The aim of this paper was to investigate the potential ATT market among representative organizations of the latter two user groups.

The results of two interesting case studies, both in the Netherlands, were presented, namely an investigation of the attitudes and expectations of road managers by means of in-depth interviews and an investigation of the attitudes of commercial road freight operators by means of a survey. The latter case was the more interesting one, since it seems plausible that ATT may play a strategic role by facing the need of the freight sector to orient itself towards the opporhmities offered by the European intemal market. ATT may then be seen as a critical success factor in an integrating network economy.

The road management representatives are in genera1 optimistic about the success of public inter-urban ATT applications. It is taken for granted that ATT may significantly contribute to the achievement of higher traffic safety and traffic efficiency. Strong success factors of these ATT applications were believed to be their relative low costs accompanied with only a few drawbacks in relation to other means to improve traffic performance. The importance of basic requirements like the development of an open flexible systems architecture according to agreed uniform standards and a full acceptation by road users has to be stressed. In the public domain it is expected that no major bottlenecks on either the supply or demand side may stop the process of implementation of these ATT applications. Based on the developments in the past five years, the actual speed of ATT developments will likely continue at a sirnilar pace until at least the end of the century. Also in the longer run no limits seem to exist to the development of new generations of ATT systems.

If we look at the potential of commercial telematics products within the road freight industry, it is striking that there is a low actual use and a low familiarity with these telematics systems. The actual use is relatively largest in the case of EDI systems, which are used by 15% of the companies, a share which seems to have rapidly increased in recent years. The satisfaction rates of these users however are quite high in the case of each ATT technology. The main purposes of the use of road telematics were the planning of the vehicle trips and the information service to clients.

It is also noteworthy that some 20% of the sample has plans to invest in EDI. Intentions to invest in road telematics are low, and have not significantly changed in the last two years. For these companies an improved quality of information service to clients was the most important perceived benefit. The most striking bottlenecks to any investments appeared to be the size of the investments, together with the existing uncertainty regarding the technical development of these systems.

Our empirical study also confiiied the pioneering role of large companies that are intemationally oriented. Positive relationships were found between the actual use and intentions to invest in EDI and road telematics systems and the size of companies, as well as the size of the geographical area in which they operate.

A final conclusion is that, although the actual technical development of information and telecommunication technologies applied to road transport is promising, the adoption of the technologies may differ between different user groups. On the one hand, there is a case for optimism about the future implementation of public ATT systems, but on the other hand empirical findings show that the adoption rates of information and telecommunication systems in the commercial environment are stil1 relatively low. It is clear that the ongoing development of information systems applied to transport will need a thorough assessment of the user side. Much will depend on the logistic requirements in an advanced network economy .

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