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vrije Universiteit *amsterdam*



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**THE RELEVANCE AND 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 political 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 internal market, which has far-reaching impacts not only on organisations operating in international 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, political coordination, regional autonomy and mobility of people. Networks **connect** people and **places** and are able to **generate socio-economic** added value through 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 technology 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 international 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 capital 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 capital **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 central intervention and others allowing **much** greater market freedom. Under these different political 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 governments is of **utmost importance**. Most decisions on European networks are taken by national governments through **well** established procedures. As transnational European networks evolve, **many** decisions **will** have to be taken by international 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 political 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 modern 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 central 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 international 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 defining 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 external distributional and market logistics, a tendency which leads **inter alia** to logistic platforms in an international 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 internationalisation) 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 networks 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 political 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** information 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 internal market, which has far-reaching impacts not only on organisations operating in international 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 general 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 realm 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 general description, we **will** in **each** case focus on Dutch findings.

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 governments. 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 alternatives in order to **evaluate** the most **cost-effective** way of achieving the strategy and therefore the policy **objectives** concerned. 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 governments. 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 alternatives, travel times , availability Operating road pricing Giving early warning 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, warnings or speed controls Faster emergency services response with traffic control co-operation
Environmental management	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 general 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 compliances 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 central **control centre** are needed to **realize** navigation or **dynamic** route

guidance. The application area of information **can** be small 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 general 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 concerned five key **persons**. Respondents were **selected** both at the central 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 (central 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 general 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 general 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 acceptance by road users. While the first issue relates to the hardware of the technology, the **latter** two **relate** to the user **side**. Clearly, user acceptance 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 acceptance - 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 general believed that this effect **will** still 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 small 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 warning systems and signalling systems that are **already** operational in the Netherlands. Fog warning 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 verbal **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**. Small 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 internal 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. Investment **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** play 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 still 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. General communication. Emergency calls.
Controlling:	Recording of vehicle performance data, cargo data, trip data. General 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 internal 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 communication 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 international 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 small 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 concerned 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.

Company profile

Since the survey has been targeted to the **upper** segment of companies concerning their **size**, the **profile** of responding companies follows a pattern 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 internationally 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 level 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.

Familiarity with telematic systems

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 general 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 telematic 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).

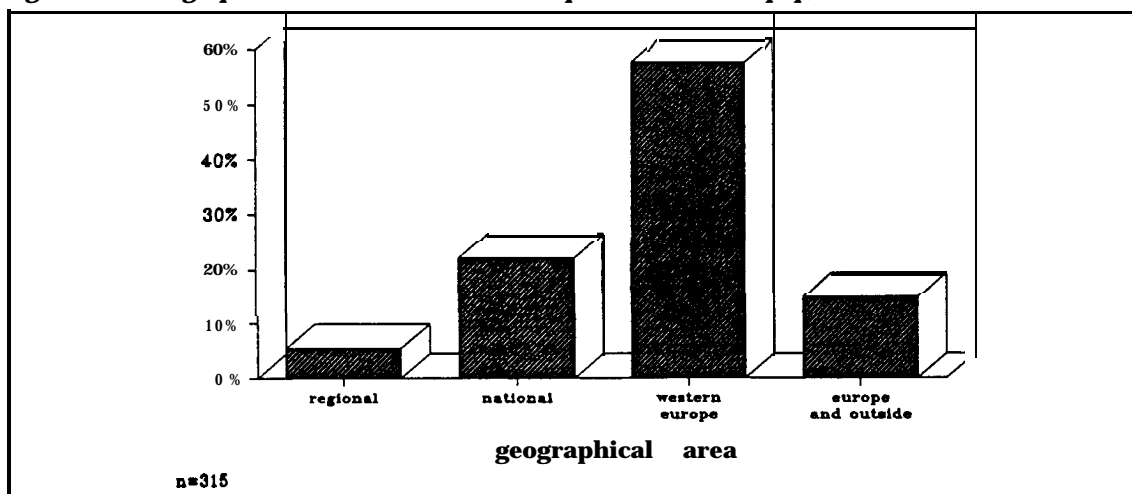
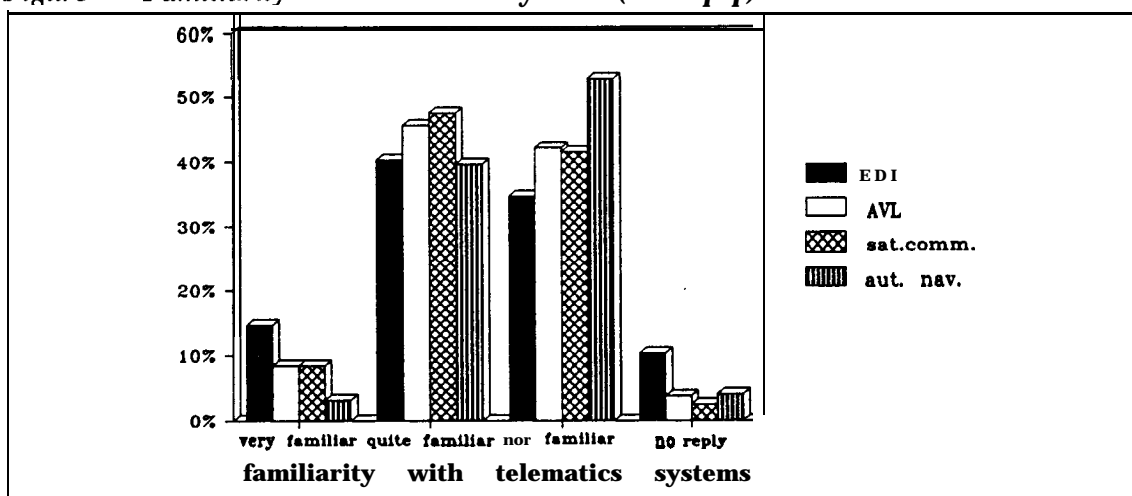


Figure 2. Familiarity with telematics systems (% of pop).



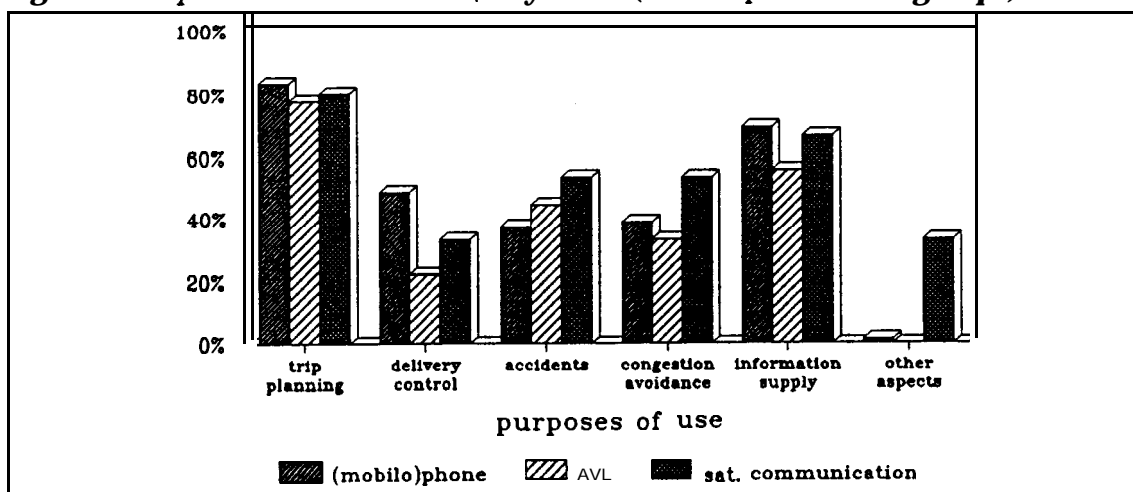
sing it. About 20% used the system more intensively, while another 20% appeared to use it less intensively than was expected. Satisfaction rates were quite high. Almost none of these users were negative: only 2% was unsatisfied and 10% was neutral. About 70% were satisfied and 20% even very satisfied 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 main 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 turned 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 (mobile)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 general **conclusions** not straightforward to infer.

Investment plans and barriers

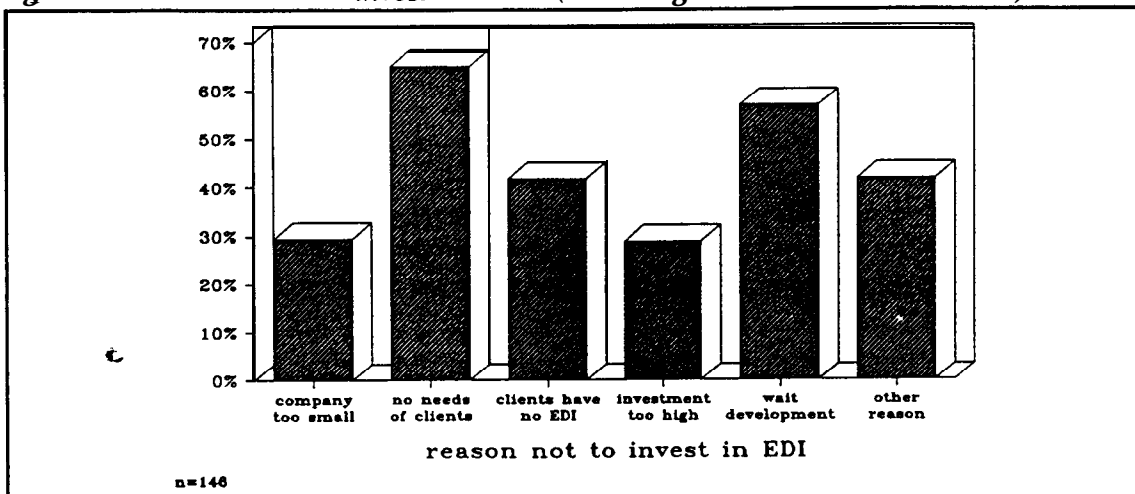
All respondents have been asked about their **plans** to **invest** (or to expand existing investments) in EDI within a (limited) period of two years. About 45% of them had no **plans** to **invest**, while 30% was uncertain. Another 20% **claimed** to have **serious plans** to **invest** in EDI within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

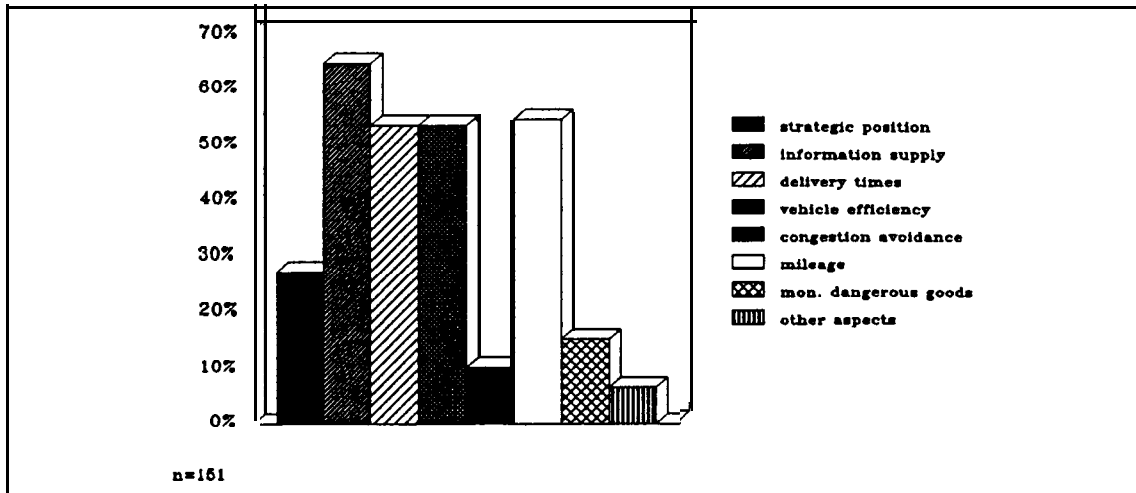
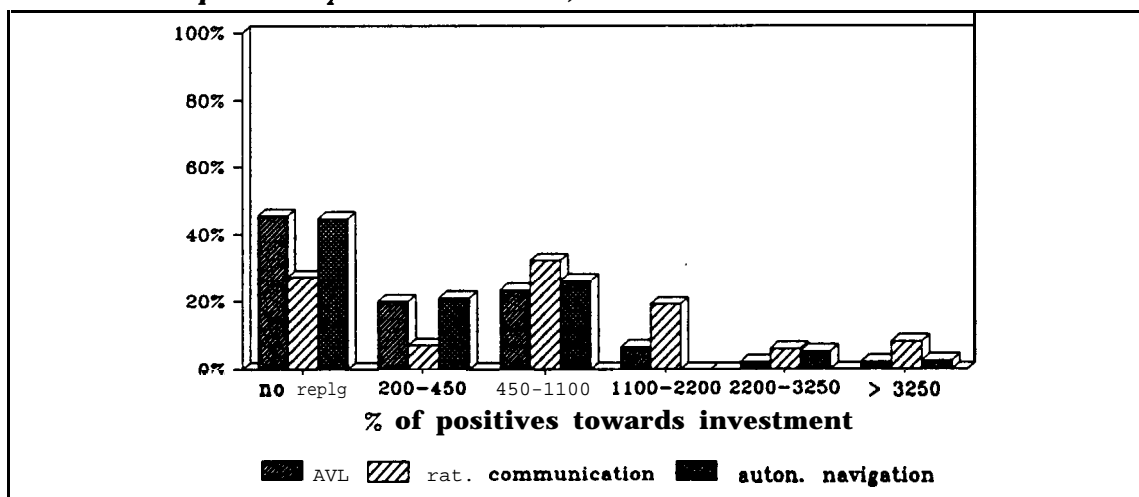
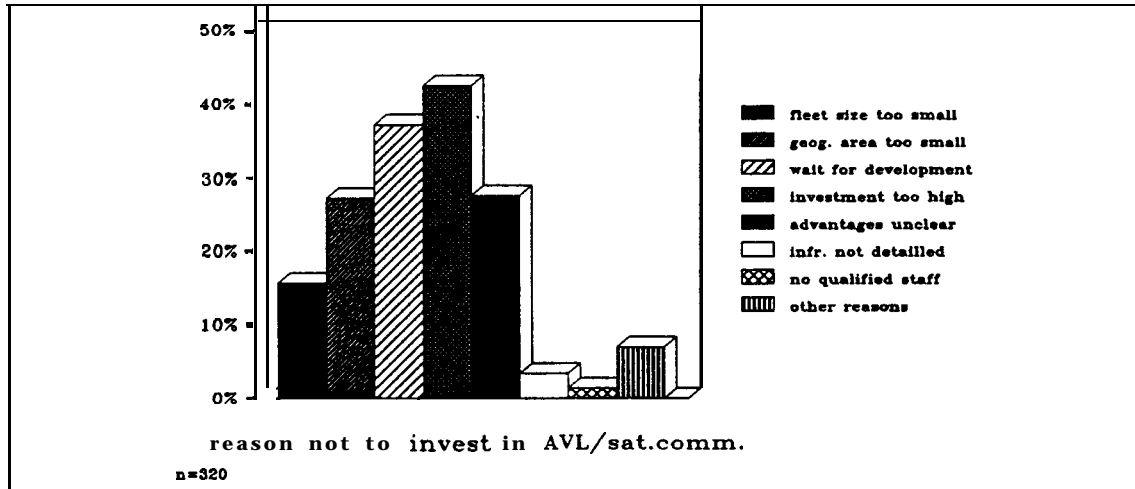


Figure 6. Perceived maximum investment costs of on-board equipment (ECU) (% of positive replies to investment).



All respondents were asked on the bottlenecks they perceived as most striking regarding **any** investments in AVL and satellite communication 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 small area in which the company operates to **generate** advantages from the use of these systems and the **fact** that these advantages are still 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 A VL/sat. comm. (% of pop).



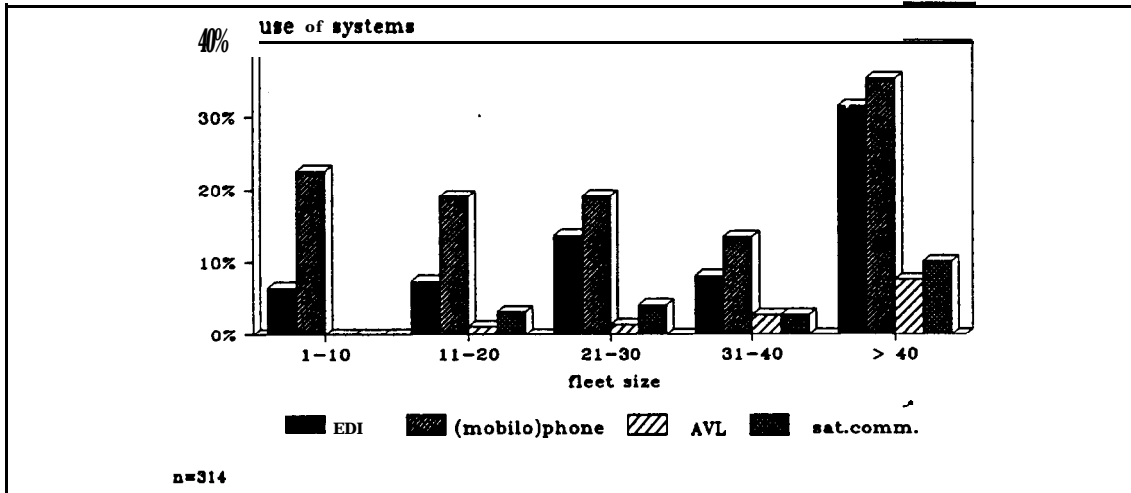
The influence of key company characteristics

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 (mobile)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 telematics systems for size categories.



The use of AVL and mobile communication 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 pattern **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 small 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 internationally 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 level 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 adoption 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 with 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 still 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 still 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 opportunities offered by the European internal market. **ATT may** then be seen as a critical **success** factor in an integrating network **economy**.

The road management representatives are in general 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 acceptance 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 similar **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** confirmed the pioneering role of large companies that are internationally 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 still 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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