

**NAVIGATION SYSTEMS FOR HEAVY GOODS VEHICLES AND THEIR
POTENTIAL FOR BETTER TRAFFIC MANAGEMENT**

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Samenvatting

Navigatiesystemen voor zware vrachtwagens en hun potentieel voor een beter verkeersmanagement

Navigatiesystemen zijn een vertrouwd onderdeel geworden van de uitrusting van elke moderne wagen. Maar hoewel vrachtwagenchauffeurs deze systemen meer en meer gebruiken, zijn ze niet aangepast aan de specifieke kenmerken van zware vrachtwagens. Nog te vaak gebeurt het dat vrachtwagens, door blindelings een routenavigatiesysteem te volgen, zich vastrijden of ernstige hinder veroorzaken voor omwonenden. Bij de routeplanning voor vrachtwagens moet immers rekening gehouden worden met zowel de fysieke kenmerken van het voertuig (breedte, hoogte) en de weg, als met lokale toegangsbeperkingen voor vrachtwagens (tonnage, toegangstijden, ...). Navigatiesystemen, specifiek voor zwaar vrachtvervoer, kunnen hierbij een oplossing zijn. In deze paper onderzochten we de meerwaarde van dergelijke systemen vanuit het standpunt van de overheid, de transportsector, leveranciers van digitale kaartgegevens en de aanbieders van navigatiesystemen.

Uit een bevraging van de transportsector in vijf Europese landen (waaronder België) blijkt dat vrachtwagenchauffeurs en transportplanners in de eerste plaats belang hechten aan een betrouwbare route. Dit zijn volgens hen routes die bij voorkeur smalle straten, bruggen en tunnels met hoogte- of gewichtsbeperkingen, files, verkeersongevallen en wegwerkzaamheden vermijden.

De leveranciers van digitale kaarten en de ontwikkelaars van navigatiesoftware doen intussen voorzichtige stappen in de richting van het ontwikkelen van specifiek kaartmateriaal en navigatiesoftware voor zware vrachtwagens. Commercieel gezien is de markt van de navigatie voor personenwagens op dit moment echter veel lucratiever. Er heerst blijkbaar nog heel wat onzekerheid over de toekomstige commerciële mogelijkheden van specifieke navigatiesystemen voor zware vrachtwagens waardoor van enige terughoudendheid sprake is.

Rekening houdend met het feit dat de overheid vooral het duurzaam karakter van het transport wenst na te streven, terwijl de transportsector en de aanbieders van navigatietechnologie in de eerste plaats winst beogen, adviseren we de overheid om een actievere rol op te nemen teneinde de implementatie van navigatiesystemen voor vrachtwagens te versnellen. De overheid kan ondersteunend optreden, zowel onderzoeksmatig als financieel, bijvoorbeeld door het beschikbaar stellen van nuttige kaartinformatie aan de ontwikkelaars van navigatietechnologie, of door het aanbieden van subsidies aan de transportsector voor het aanschaffen van dergelijke systemen.

1. Introduction

These days navigation systems emerge more frequently in vehicles, both for private and for commercial transport. Navigation systems, also called GPS-systems, are ‘computers’ connected with navigation- and location equipment that, by means of indications on a monitor and / or of spoken language, inform the driver of the vehicle during the trip about the route he has to follow. These systems can be classified as telematics, a junction of the terms telecommunication and information science. Telecommunication points to the transport of information. Information science points to the processing, saving and management of information. Nowadays the term ITS (Intelligent Transport Systems) is used more often.

Freight transport forms, already for ages, a necessary link in the economic process. In the present society, we call this globalisation: ‘a continual process of world-wide economic, political and cultural integration, with as central characteristic a world-wide labour partition’. Developments in the domain of transport and telecommunication make globalisation possible. Road haulage (mainly Heavy Goods Vehicles) transports the lion’s share of the goods.

Dynamic traffic management is the total of measures that aims to inform, conduct and steer (or correct) traffic flows, vehicles and the traffic demand to time and place, based on actual data. The general purposes are a good utilization of infrastructure, an improvement of the traffic safety and influencing the traffic flow.

A combination of these terms leads to an interesting whole and is as well the subject of this paper: Navigation systems for heavy goods vehicles and their potential for better traffic management.

The paper consists of three important parts: each part displays the view of one of the actors, these are the main partners concerned most about the development of a navigation system for heavy goods vehicles. Part 1 gives an overview of projects and research efforts that deal with heavy goods vehicles and GPS-systems, this part shows the view of the governments. The second part is the result of a survey conducted amongst transport planners and truck drivers across 5 European countries. Finally the last part deals with the vision of digital map providers and complete navigation systems.

2. Definition of the problem

“DREFELIN, CARMARTHENSHIRE, WALES (United Kingdom). On Monday evening a Belgian truck was stuck down a narrow farm track in Drefelin. The truck was on his way to pick up a consignment of cheese in Newcastle Emlyn and the driver was following his navigation system. In Drefelin the truck came stuck between trees and a farm. Despite six hours of attempting to recover the truck on Monday, it had remained trapped overnight. Trees had to be cut back before the lorry was finally freed on Tuesday. The driver, called Michel, said the "little small street" had proved impossible to drive down with the lorry.”
[Tuesday, 1 August 2006, 13:37 GMT, BBC news¹]

For transport companies the competition is high. It is getting more and more important to work at the lowest possible price, while still offering a maximum of quality and service. Technological applications, like navigation systems, are important tools to accomplish this goal. However, navigation systems are not specifically designed for trucks / Heavy Goods Vehicles (HGV), although they use it frequently. This creates problems for truck drivers, neighbours and for the road administrator / government.

For truck drivers, there are legal and physical restrictions that are not listed in the GPS system. It is hard for them to manoeuvre in a centre or a residential area. They lose time and money when they get stuck in traffic (congestion) or in a one-way street. Trucks now use roads that are not designed to accept them in large numbers. Furthermore, drivers can not be traced by the fleet manager when using a regular navigation system, or a change in the deliveries can not be reported to the driver. Road safety is another issue; especially when a HGV is driving in residential areas.

For neighbours, trucks often use smaller roads as short cuts. As a result, because of the larger amount of trucks, neighbours suffer from noise, higher emissions, congestion, vibrations, lower attractiveness of town/rural centres and health problems.

¹ Adaptation from BBC (2006). *Sat nav leaves cheese truck stuck*. 13, December, 2006, from http://news.bbc.co.uk/2/hi/uk_news/wales/mid_/5234396.stm

For road administrators/government, local roads have not been designed and constructed to accept bulky transport and as a consequence the asphalt will more rapidly be worn out, which means higher costs in the medium term. The local governing boards get complaints of neighbours because their village or city has suddenly become much less attractive: the liveability of the municipality decreases by the negative impact of the HGV.

A solution for many of these problems can be obtained by better traffic management with the help of specifically designed GPS systems for (large) trucks. The aim must be to develop a navigation system that considers the requirements of the transport companies and map providers (commercial aspect) and one that considers the wishes of the government (sustainable aspect). Now the software and the mapping material must be developed.

3. Part1: the view of the Government

In this first part we take a closer look on scientific projects concerning heavy goods vehicles or GPS-system, on several hierarchical government levels. On each hierarchical level a number of projects are discussed. Finally, the goal is to obtain an integral European approach that can also solve problems on a local area. All the discussed projects are very recent, some of them have in fact just started.

3.1. At the European level

Freight transport is a very important link in the national and European economy. Navigation systems can disperse the traffic over the national networks as efficient as possible. It is of the utmost importance that the organisation of freight transport, as well as the integration of the navigation systems in the transport system, is looked at supranational level, because Europe consists of many countries and cultures.

Currently, there are several projects in progress that are connected with freight transport over the road and / or navigation systems, and are financed by the European Union. The financing by the European Union is in pursuance of the White Paper 'European Transport Policy' (2001), which pursues a sustainable mobility. For example, by technological innovations (e.g. specific navigation systems for HGVs) Europe intends to disconnect transport from the negative effects that road traffic brings along.

We will examine three projects in more detail: the HeavyRoute project, the CVIS project and the GOOD ROUTE project.

3.1.1 HeavyRoute

The HeavyRoute project aims to develop an advanced route guidance system for HGVs. The project started in September 2006 and will take 30 months, at this moment the exploration has just begun. The total budget amounts to €3,280,000, partially financed by the European Commission, Research Directorate-General. The project is led by VTI, the Swedish National Road and Transport Research Institute. The main purpose is the development of an advanced HGVs management and route guidance system. Furthermore, one aims to achieve an improvement of road safety, an increase of the capacity of the involved road sections, a reduction of the negative impacts on the environment and a saving on the road and bridge maintenance costs. For this project the points of view of the major stakeholders (for example transporters, truck drivers, authorities, operators of bridges and roads, ...) are collected through workshops, interviews and surveys.

Unique about this project is the combination of off-board and on-board applications to steer freight transport. The objective is to make use of a European central control system for freight transport over the road, with input from data that are collected in real-time through navigation systems in HGVs. Therefore, state-of-the-art systems and technologies are used like sensors, digital maps, location and communication between infrastructure and vehicle. The purpose is an integrated approach of the whole trip of a HGV by use of route planning, support for the driver, monitoring of the heavy transport and management of the whole freight through Europe.

3.1.2 CVIS

CVIS means “Cooperative Vehicle-Infrastructure Systems”, and the project started in February 2006. The total budget amounts to €41,000,000, of which half is financed by the European Union. The leader of the project is ERTICO, the Intelligent Transport Systems and Services – Europe. The CVIS project aims to design, develop and test the technologies needed to allow cars to communicate with each other and with the nearby roadside infrastructure, on an effective and safe manner. Drivers can contact the traffic control system directly and get individual guidance with the fastest route to their destination. All vehicles get information

about the state of the traffic, the weather, speed limits,... and this information can be used to indicate the desired route. All vehicles, roads and traffic control centres must be connected in real-time by a wireless network. To validate the project's results, CVIS technologies and applications will be tested at one or more test sites in seven European countries.

3.1.3 GOOD ROUTE

GOOD ROUTE stands for "Dangerous GOODS Transportation ROUTing, Monitoring and Enforcement". This project started in January 2006 and will take 36 months. The total budget is €5,305,564, mostly subsidized by the European Union. GOOD ROUTE aims to develop a cooperative system for dangerous goods vehicles through route monitoring, re-routing (in case of need) enforcement and driver support, based upon dynamic, real time data, in order to minimise the societal risks related to their movements, whereas still generating the most cost efficient solution for all actors involved in their logistic chain. This project also contains the development of a Control Center algorithm, to oversee the routing and monitoring of all dangerous goods vehicles within a certain geographical area.

3.2. At the national level

Projects about the navigation of HGVs that are guided by just one national government are rather an exception. National governments choose more often to support supranational projects (for example the CVIS project). We discuss two national projects: the INVENT-project and the SHAFT-project.

3.2.1 INVENT

The INVENT-project ("Intelligent traffic and user-oriented technology") is started by the Federal Ministry for Research and Education from the German government, in cooperation with the Ministry for Transport, Infrastructure and Housing. This project is launched in 2001 to improve the traffic safety in Germany and keep traffic flowing in the face of growing demands on the road network. The INVENT-project is subdivided in three groups: traffic safety, traffic management and logistics. The project "Traffic Management in Transport and Logistics" focuses on the efficiency of the transport for the delivery of goods in urban areas. The idea is to dynamically optimise the use of transport routes, the delivery time and the vehicles.

3.2.2 SHAFT

SHAFT (“Standardized Hazardous goods transport Alerting Field Trail”) aims to develop a prototype for the monitoring of hazardous goods over the whole Austrian road network. A system concept is developed that allows involved authorities and operators to get information about the position and the status of each HGV on the Austrian Trans-European Road Network. In the future this information can be given to transport companies, truck drivers, tunnel authorities, etc.

4. Part 2: the view of planners and truck drivers

What are the needs and desires of planners and truck drivers concerning navigation systems? To get an answer to this question, a survey has been conducted across transport planners and truck drivers in 5 European countries (Austria, Belgium, France, Germany and Sweden). In fact, two separate surveys were constructed, one for truck drivers and one for planners; though part of the questions are similar. The questionnaire consisted of 4 parts regarding information about: the planning of the trip, driving assistance during the trip, control and management of goods transportation during the trip and socio-demographics. In total, the questionnaire consisted of 6 pages. Most questions were closed-form, where respondents had to rank opinions or they had to indicate their level of agreement to a certain statement using a likert scale. The distribution of the questionnaires started in March 2007.

4.1. With respect to the planning of a trip

As shown in Figure 1, the view of planners and truck drivers is quite comparable. More than 75% of the drivers and planners believe that height restrictions (of tunnels or bridges) and weight restrictions (of bridges) are important to be included in the planning of a route. Most planners and truck drivers are not interested in the route with least curves and slopes or routes with the best evenness quality. Taking the size of streets in urban areas into account seems not very important for half of the planners or truck drivers. However, figure 2 shows that taking speed limits into account during the planning of a trip is particularly important for truck drivers, whereas planners believe it is of less importance.

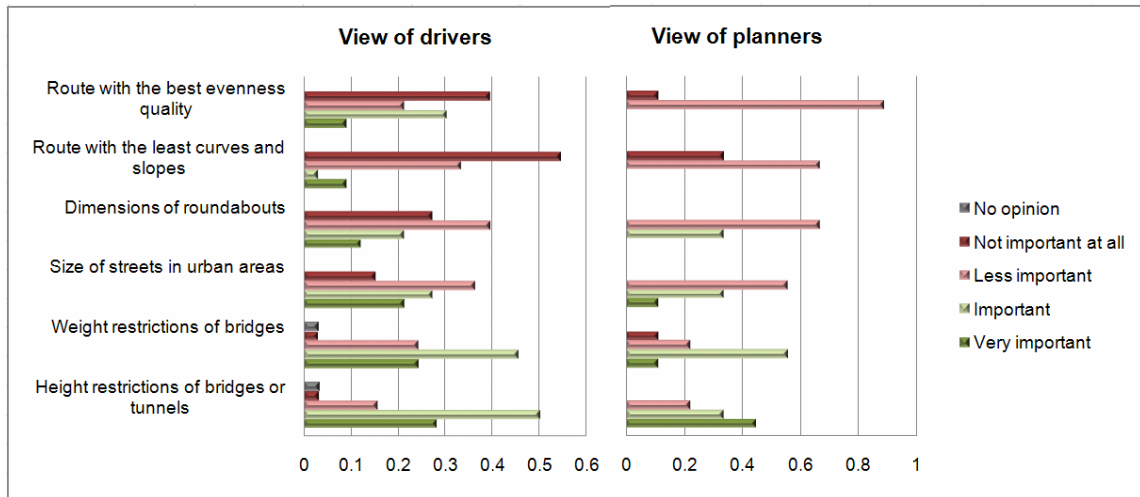


Figure 1: Importance of road and bridge conditions, opinions of drivers and planners

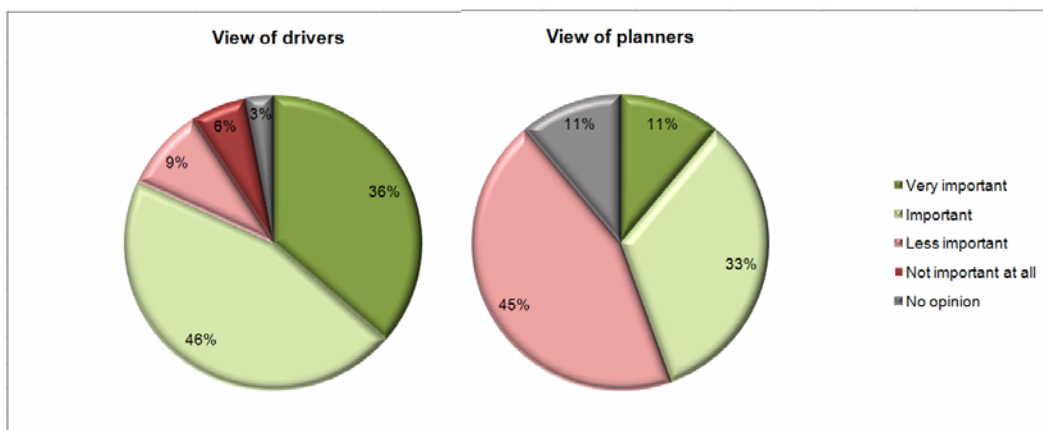


Figure 2: Importance of speed limitations on the route, opinions of drivers and planners

Furthermore, route planners and truck driver were confronted with five alternatives to be ranked from most important to least important with respect to planning a suitable route. It probes for their opinion about what aspects they think are the most important when planning a route. These five alternatives are:

- the quickest route even if you need to use more inconvenient short cuts;
- the safety of other road users (e.g. avoiding residential areas);
- the most reliable route to ensure arrival at a specified time;
- the most convenient route, even if it is longer (i.e. a trip using mainly main roads thus avoiding narrow, uneven roads with weak shoulders and areas with speed restrictions);
- the cheapest route.

As shown in Figure 3, the most reliable route is, by far, the most important for drivers and planners. The results also indicate that the most convenient route is of the least importance.

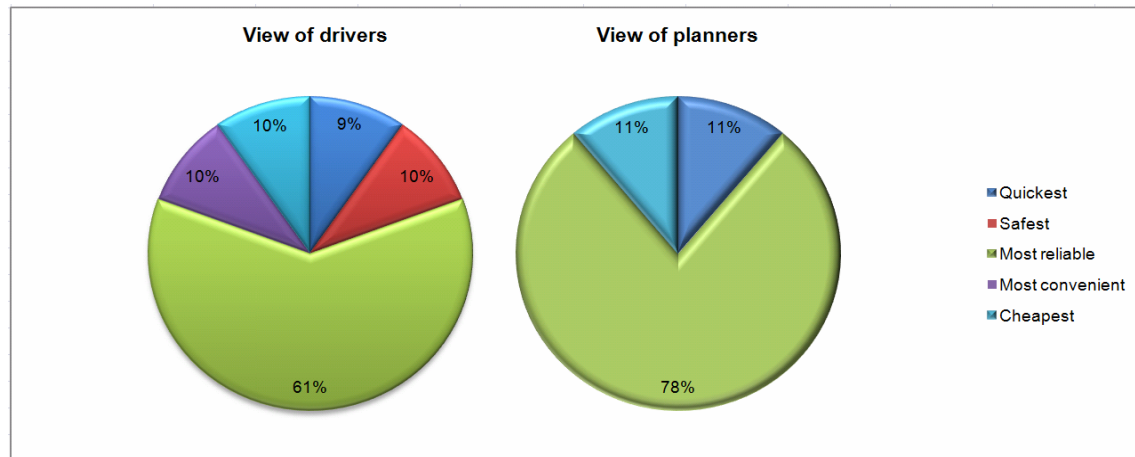


Figure 3: Ranking of alternatives, opinions of drivers and planners

4.2. With respect to driving assistance during the trip

As shown in Figure 4, more than 80% of the drivers finds it (very) important to be warned about accidents, congestions, worksites, temporary lorry bans and unsuitable infrastructure (dimensions, height of tunnel, load limits of bridges, etc.). Opinions differ on the importance of warnings for areas with severe weather conditions or areas with severe road conditions. Information about accidents or congestion can only be given when the navigation system is connected to a source of real time information. TMC (Traffic Message Channel) is such a source of real time, dynamic information which is already in use.

Information is one thing, but it gets really interesting for commercial transport companies when this information can be converted into profit for the company. This can be done by the navigation system. An alternative route can be generated to avoid an accident or a traffic-jam. This leads to less frustration for the driver and to less fuel usage, because being in a traffic-jam increases the use of fuel dramatically. Consequently 97% of the drivers finds it important that a navigation system has this functionality.

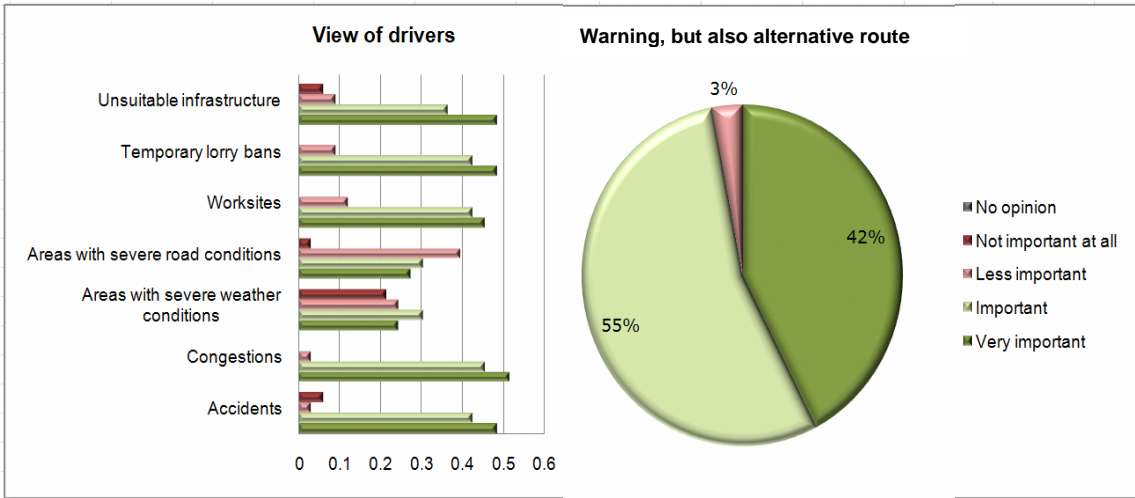


Figure 4: Warning about conditions and importance of alternative route, driver opinions

Furthermore, navigation systems typically also include certain Points of Interest (POI). A GPS system for a regular vehicle contains for example the location of train stations, hotels or airports. HGVs need some specific POI. Figure 5 shows that especially parking lots and secure resting places are rated as positive (70%) by truck drivers. Opinions differ for the other POIs.

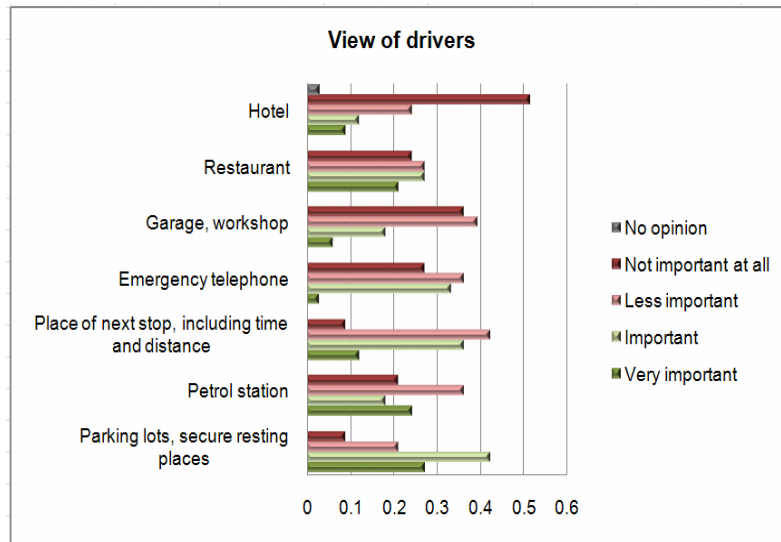


Figure 5: Information about Points of Interest, driver opinions

5. Part 3: the view of map providers and system vendors

5.1. The view of digital map providers

Worldwide there are two important players on the market of digital maps: both the Dutch - Belgian Tele Atlas and the American NAVTEQ provide map material for GPS systems. Although both companies are currently investing in special map material for HGVs, the map material for the traditional personal car market remains the most lucrative at the moment. It turns out that most HGVs drive the same routes and destinations every day so that there is not really a need for advanced navigation systems. Yet, the map providers realize that in the future there will be an increased demand for specific navigation systems for HGVs. One of the reasons is the enlargement of the European Union to Eastern Europe. Eastern European transport companies operate more and more on our market but they are not familiar with the West European road-system. Another cause is the increased extent of outsourcing, by which transport companies will stand in larger need of serving different customers and thus operate on different destinations and routes. Finally, the demand for 'Routing and Scheduling' (R/S) software will increase when more drivers have to follow an alternative route, as a result of congestion or accidents. To conclude, the present demand for navigation systems for heavy goods vehicles is not very large, so it is important to convince the companies of the benefits of specific navigation systems.

Currently, Tele Atlas and NAVTEQ offer truck specific 'Points of Interest' for HGVs, like petrol stations and truck stops. Both companies are also working on and have recently produced the first specific map material for HGVs with specific truck routes.

5.2. The view of complete system providers

A number of companies are working on the development of specific systems for heavy goods vehicles, but this market is still very limited. Currently, car navigation systems are often adapted to take into account truck related variables. In other words, classical car navigation systems with a 'truck mode'.

We discuss the companies Siemens VDO and TomTom WORK. In 2006, Siemens VDO has presented the first navigation system for HGVs: 'Integrated Truck Navigation'. It builds on the existing proven systems but also caters to the special needs of commercial vehicles. This truck navigation system takes into account the specific navigation requirements of

commercial traffic: it considers truck-specific restrictions (legal or physical) in the route calculation and map display, the system also consists of a TMC-receiver (Traffic Message Channel) and a database with Points of Interest. Moreover, this system can be linked with other telematics-, information- and entertainment applications. Siemens VDO makes use of the map material from NAVTEQ.

TomTom is a Dutch company and maker of small and mobile GPS systems. TomTom WORK gives transport planners the opportunity to control their fleet and communicate with them. From its research has become clear that navigation systems can give important financial benefits for commercial transport companies.

6. Summary and conclusions

To develop a navigation system that takes into account the wishes and the needs of all the people concerned, this paper has listed the views of three parties: government, transport planners and truck drivers, providers of digital maps and complete navigation systems.

An overview of the field has shown that currently several projects are supported by governments. Most projects are on the European level, with financing from the European Union. National projects are more limited, but they can contribute or initiate European oriented researches. The general view of all governments is one that builds on a sustainable development of the transport sector. This includes for example as little HGVs as possible through residential areas, minimization of maintenance costs for roads and bridges and enhance safety but still stimulate economic growth. An important tool to reach this objective are technological innovations like navigation systems.

Planners and truck drivers have similar requirements: they want the most reliable route. This route preferably has to avoid narrow streets; streets, bridges or tunnels with weight restrictions and height restrictions, traffic-jams, accidents and road works. For planners and truck drivers, a navigation system has to work with static (e.g. POI, height of tunnel) and dynamic (e.g. congestion, accidents) information.

Providers of digital maps, like Tele Atlas and NAVTEQ, are currently working with ‘truck modes’. This is a specific function in a regular GPS system. This ‘truck mode’-software can take into account physical restrictions (restrictions in width, height, length and weight), specific restrictions (for example “No entry for heavy goods vehicles”) and legal restrictions (imposed by the government). Siemens VDO has a system on the market since the beginning of 2007 which uses this software. TomTom WORK focuses more on fleet management systems in combination with a navigation device in the HGK.

Commercial map builders have to make maps with specific attributes for HGK, but this is a huge investment. To cover the costs, many truck drivers have to buy such a device. Though most planners and transport companies are not yet convinced. The task for the government is to facilitate the building-process, and maybe to stimulate the transport sector, for example through financial support.

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