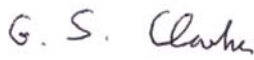


Wayfinding Research Using Satellite Navigation to Improve Efficiency in the Road Freight Industry

Research Report



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Executive Summary

Research Aims

With ever-higher operating and running costs, efficient goods vehicle fleet management is an important requirement for any business engaged in or reliant on freight transport. Time conscious customers demand flexible and reliable deliveries which can be costly if the efficiency of goods vehicles routing and scheduling is compromised.

The objective of this research was to test the effectiveness of satellite navigation on improving the efficiency of HGV operations. If, on balance, these are found to be positive for the freight industry, we would recommend the ways to improve the take up of satellite navigation systems in HGVs, with the aims of:

- Minimising mileage run;
- Congestion avoidance;
- Improving road safety;
- Using appropriate delivery routes;
- Reducing operator costs; and
- Reducing air pollution.

Background

Satellite Navigation systems (SatNav) are now being used in many aspects of everyday life. GPS can be a valuable asset that offers benefits to safety, reliability and expedience to aid a driver's travel.

As an illustration of the growing popularity of satellite navigation systems, sales of the portable "ready to go" units are booming in the private car market, currently running at 100,000 a month. (Source: Channel Five's motoring programme "Fifth Gear" on December 12th 2005).

Satellite navigation systems essentially come in two forms, models that are built into a vehicle and those that can be transferred between vehicles and require only a connection to the 12v power socket. Vehicle manufacturers are continuously evaluating applications that provide high customer value and return on investment and most are introducing built-in satellite navigation systems as an optional extra or sometimes as standard.

There is a selection of GPS navigation systems on the market. To date the take up of this technology by operators of HGVs has been limited.

It is reported that freight vehicles already using satellite navigation are sometimes being routed along unsuitable roads to reach their destination. This negative effect could be a serious issue if the take up of SatNav by HGV operators becomes more widespread.

Accurate digital maps, personalised location-based services and telematics have the potential to offer significant opportunities to increase SatNav sales to HGV operators and to shift perceptions of vehicle navigation systems from an option to a necessity.

Method

An eight week in-fleet trial of portable SatNav units was conducted in October/November 2005 in four HGV fleets to compare the before and after effects of the use of satellite navigation systems in the freight industry. Company vehicles were monitored without satellite navigation for the first four weeks and then, after a week of familiarisation with the satellite navigation systems, drivers' runs were monitored for a further four weeks using the systems.

Our research into available SatNav systems showed that systems manufactured by TomTom and Garmin are market leaders and therefore most suitable for a trial of this nature. The models used in the trial were the TomTom GO500, GO700, and the Garmin C320.

The selection of companies chosen to participate in the trial was intended to represent the diversity of freight transport operations. These were:

- Drinks 'Trunking' and 'Local' distribution (AG Barr Plc);
- Paper merchant/distributor (A1 Paper Plc);
- Chemical manufacturer/distributor (Quadralene Ltd); and
- ISO Container Distribution (Two Owner Drivers).

The technical review, market research and internal and external consultation phases of this research were designed to generate a better understanding of:

- Satellite navigation systems currently available on the market;
- General technical issues that would need to be resolved to develop the systems further, to specifically meet the needs of freight users; and
- Freight users experiences with the systems and the potential usefulness of the systems in the freight industry.

Summary of Findings

Following the successful trial period all data was collected and analysed in order to present both the positive and negative findings. There are three sets of findings, quantitative from the trial data, qualitative from a questionnaire issued to drivers and Transport Managers following the trial and general findings obtained from desktop research and informal consultation.

Quantitative Data

The quantitative data collected during the trial has been analysed by the University of Newcastle to see whether satellite navigation can be said to affect the:

- number of minutes lost by a driver when finding a delivery/collection point;
- kilometres driven per litre of fuel; and
- kilograms of cargo carried per litre of fuel.

Vehicle type was classified as Light (<7.5 tonnes max gross weight); Medium (7.5T mgw and <32T mgw); and Heavy (>32 T mgw). The findings are as follows:

Positive Findings:

- **Collection and delivery work** - The type of work rather than vehicle size appears to be the more important factor in determining whether SatNavs are going to be useful to a freight operator. Vehicles used on collection and delivery work, particularly multi-drop runs to or from a wide range of new addresses are likely to benefit significantly from the use of SatNav;
- **Unfamiliar routes** - All drivers are likely to benefit from having SatNav when on unfamiliar routes;
- **New/agency drivers** - New/agency drivers are generally unfamiliar with their routes and do stand to benefit the most from SatNav;
- **Minutes lost looking for destinations** - The trial found that on average drivers would spend 13 minutes a week, or 676 minutes a year, less looking for a destination when using a SatNav system;
- **Reduction in the amount of time looking for destinations, "lost"** – The reduction in the amount of time drivers spent looking for a destination depended on the type of operation. Multi-drop fleets saw reductions in minutes 'lost' of between 30% and 89% depending on the type of operation. However, other fleets on trunking operations between small numbers of fixed points did not report any time savings. This is mainly because little time is lost anyway in trunking fleets.

Negative Findings:

- **Fixed route runs** - Where drivers do the same journey daily, they are not likely to benefit. In fact the trial suggests that SatNav may, in fact, have a negative effect because of the time spent programming the SatNav system and because of occasional incorrect routing decisions by the SatNav system;

- **Extra distance** – 48% of drivers reported that extra kilometres were driven caused by misrouting by the GPS systems. Misrouting occurred where a driver was directed a longer way when a shorter suitable route could have been used. Narrow road problems meant the drivers had to find a new route as opposed to following the SatNav guidance; and
- **Freight Mapping problems** - Drivers of 7.5 tonne MGW vehicles and above reported routing problems caused by freight mapping issues (especially bridge heights, weights and problems of access). In fact the heavy vehicles experienced the greatest increase in distance due to mapping problems.

Inconclusive Findings:

- **Fuel consumption** – In theory SatNav could improve fuel consumption (km/litre), depending on the type of operation. Fleet 4 recorded an improvement of 14.2% in km/litre and fleet 6 saw improvements by 6.7%. Although these improvements were on multi-drop fleets that would stand to gain the most out of the use of SatNavs there could be other factors influencing these impressive savings. Overall fuel efficiency for all participating companies improved by 1.11%, suggesting the need for companies to assess the type of operation and likely benefits before investing in the systems;
- **Load planning** - The trial period was too short to report any meaningful changes in load planning; and
- **Kilograms of cargo carried per litre of fuel** – It was not possible to obtain conclusive data on this topic due to the short time period and the types of delivery runs which tended to vary from day-to-day.

Qualitative Information

The following is a summary of the qualitative information obtained from a questionnaire issued to drivers and Transport Managers after the trial:

Positive Findings:

- **Searching for locations** - 95% of drivers in the trial felt that SatNav systems can save time;
- **The need for SatNav in the freight industry** - 89% of drivers reported that it is worth having SatNav in the freight industry. All participating transport managers were considering using SatNav within their HGV fleets permanently;
- **Driver efficiency** - 85% of transport managers rate SatNav as 'very good' or 'good' for improving driver efficiency;
- **Reducing driver overtime costs** - 58% of managers said that SatNav could be effective in reducing driver overtime costs;
- **Reduced wasted mileage** - 75% of drivers and 72% of managers felt SatNav systems could reduce the amount of wasted mileage incurred;
- **Reducing fuel costs** - All managers rated SatNav as potentially effective in reducing fuel costs;
- **The current usefulness of SatNav** - 59% of drivers and 62% of all the transport managers rated the usefulness of SatNav as 'very good' or 'good'; and
- **Safer driving** - 52% of drivers rate SatNav as 'very good' or 'good' for safer driving but this percentage is not conclusive.

Negative Findings:

- **Quality of the routes generated** – A third of drivers felt that some of the routes generated were 'poor' or 'very poor'. There were concerns as to the appropriateness of guidance on the routes generated for freight drivers. Some of the drivers chose to disregard certain routes generated because they were inappropriate;
- **Freight mapping** - 58% of drivers and 28% of transport managers felt that the digital mapping in the systems trialed was 'poor' or 'very poor' for use in freight vehicles due to the lack of information on bridge heights, weight limits, narrow roads and other freight related

issues not being featured on the maps. It is important to stress that it is the mapping issues where the problems lie and not SatNav as a tool itself;

- **Value for money of the systems** - Transport managers and drivers felt the systems are expensive although it is recognised that prices are falling.

General Findings

In addition to the findings that came from the quantitative and qualitative research there are a number of other notable points that came from desk-top research or consultation:

Positive Findings:

- **Create Customer satisfaction** - The benefits of customer satisfaction following goods arriving on time and good service are difficult to quantify but lead to customer retention. It was felt that a softer benefit of SatNav is that more deliveries could be made on time;
- **Driver aid** – In the same way that having a good atlas or a local A to Z provides confidence that a destination can be found, a reliable SatNav can offer this “peace of mind”. This confidence needs to be built up over days of successful running and is not a quantifiable factor but nevertheless good systems can reduce worry;
- **Payback period** - The trial found that on average 13 minutes a week or 11 hours per unit a year would be saved. If the cost of a vehicle is approximately £25 per hour then the 11 hours per vehicle saved would equate to £275 per year. Assuming the cost of wayfinding equipment is about £400 then the payback on the initial cost would take about 1.5 years. If the units are acquired in a more targeted, selective way then the payback period would be shorter. This is a shorter payback period than for many other items in the transport industry; and
- **Integration with other computer systems** – SatNav systems will really become popular when vehicle routing and scheduling systems can automatically download routes into the SatNavs and the systems also feature “real-time” traffic information that informs the driver so that alternative routes can be taken. At this point it is likely to be a necessity for many larger fleets.

Negative Findings:

- **Last mile issues** - The systems did take the drivers to the general area of the destination however, for a proportion of journeys, some of the systems do not lead the driver to a precise enough location. This can leave a driver in the correct road but unsure of his final location. Some SatNav systems use a six or seven character postcode whereas others used street names or a four character postcode;
- **Security Issue** – The portable systems that are mounted on the dashboard or on the windscreen are very mobile, resulting in high theft rates from vehicles if left unattended and unlocked. Indeed we had a system stolen from one of the lorries in the trial which proves the point; and
- **Freight Mapping** – The following data is required to make SatNavs “freight friendly”, specifically details on:
 1. Road widths;
 1. Road weight limits;
 2. Bridge weight Limits;
 3. Bridge heights;
 4. No HGV through routes except for access;
 5. Severe gradients;
 6. One way streets;
 7. High occupancy lanes;
 8. No car lanes/bus lanes; and
 9. Risk of grounding (e.g. on hump back bridges).

In-fleet Trial Conclusions

Although it is difficult to be sure of the precise benefits of SatNav for vehicles of 7.5 tonnes MGW and above it is clear that in concept there are certain applications that they have the potential to become an everyday tool of the trade. This is especially so where new or temporary drivers are being used and where an experienced driver is often required to travel to unfamiliar destinations.

The barriers to SatNav spreading across the road freight industry centres on the non freight specific information held in the mapping software where the SatNav system takes its instructions from.

However, if a driver is aware of the potential misrouting and takes sensible decisions, it can be argued that the less familiar a driver is with the delivery address, the greater the contribution that a navigation system could make to operational efficiency. Similarly, the more locations a mobile worker has to visit each day, the greater the potential savings.

From the research team's knowledge of freight operations the following is a list of industry sectors for which satellite navigation might be particularly beneficial:

- Parcel/courier and home delivery services;
- Groupage / general haulage;
- Rural haulage operations (farms); and
- Specialist operations; for example car transporters, home/office relocation companies, skip companies and international haulage.

With most navigation systems mapping information is not specific to HGVs. As such, it does not take into account freight specific issues such as weight or height restrictions. With the current systems on the market, freight drivers will have to judge the road quality and suitability themselves and cannot rely on the system 100%.

With a growing satellite infrastructure providing more reliable and accurate signals, the transport sector has the largest ever range of technology options for asset management. However, it is not the technology itself that will convince the industry, but rather evidence of the reliability of systems, ease of use, integration with existing infrastructure and return on investment.

To be successful, satellite navigation-enabled systems for road freight operations must be carefully selected, installed and managed. The sector is generally not technology oriented but will adopt solutions that deliver value and reduce costs. It is expected that freight specific wayfinding equipment will become readily available at an affordable cost in the future and the use of satellite navigation will become more widespread across many sectors of the industry as a result.

When this report was written in 2006, it included information and guidance based on views known at the time. However, the industry is moving forward quickly and technology is changing rapidly. Portable satellite navigation equipment is becoming very popular for car users as the relative cost of the units comes down and the systems improve. It is likely that systems which download to mobile phone or other handheld pocket size units will also become popular. The downside of popularity is that the units are attractive items for thieves and they should not be left on view in cabs. If and when freight specific mapping can be provided for SatNav systems it is reasonable to predict that satellite navigation will become essential equipment in the freight industry over the next ten years.

Recommendations

The trial shows that if further enhancements were made to satellite navigation systems in the following areas they would become more attractive to road freight operators:

- **HGV specific mode for SatNav systems**
All of the different functionalities of SatNav systems appropriate for HGVs should be accessed through an HGV specific mode contained within the systems set up menu;
- **Digital mapping**
The provision of improved digital mapping to take into account HGV specific route information is required. This is the primary and most important recommendation;

- **Freight specific 'points of interest'**
Alongside more general points of interest locations such as truck stops, lorry parks and HGV fuel stops might be included in the base data on SatNav systems;
- **Real-time rerouting functions**
Real-time traffic information and re-routing abilities could lead to increased benefits;
- **Multi-drop postcode functions**
This would enable a user to download 'multi-drop' postcode information and automatically work out the best routes;
- **Environmental routing**
A logical extension to using HGV restriction in digital mapping is to include voluntary agreements between road freight operators and local authorities on roads that are deemed environmentally unsuitable for HGV traffic; and
- **Route planning download**
Enabling planned routes to be downloaded from a computerised vehicle routing and scheduling system into a vehicle based SatNav system.

These actions are in the hands of the systems and software providers and it is likely to be the private sector that drives the industry forward. However, there may be an intervention that government or public sector organisations can do to influence progress and that is to ensure that consistent information is made available to companies in the industry. Much of the freight specific information is held by Local Authorities and is often only in paper form hence, it may prove difficult to give to the digital mapping companies. Good freight mapping across the whole country would be of major benefit to the freight industry.

On a more general level the following is recommended:

- **Follow Up Research** - Further research to be carried out on the fleets in this trial that adopt satellite navigation and change their planning practices accordingly to see if the minutes saved in destination finding can be released as greater fuel efficiency; and
- **Good Practice Guide** – A Good Practice Guide, showing both the advantages and disadvantages of using satellite navigation systems in the road freight industry, should be produced. This guide should be careful to avoid a 'one-size fits all' approach, and may be best preceded by further work on equipment with a better understanding of infrastructure and vehicle class.

Freight Best Practice

The Freight Best Practice programme is funded by the Department for Transport (DfT) and managed by Faber Maunsell Ltd to promote operational efficiency within freight operations in England. The programme is a key part of the Government's commitment to improving the efficiency with which energy is used by stimulating the uptake of best practice. The programme conducts research into various aspects of the freight industry in order to promote the uptake of technology and best practice. To find out more about Freight Best Practice and to order any of the programme's publications, visit the website www.freightbestpractice.org.uk or call the Hotline 0845 877 0 877.

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1 Introduction

- ## 1.1 The Report Structure
- The wayfinding research report is split into six separate sections as follows:
- 1. Introduction:** This section introduces the Freight Best Practice programme and explains the aims and objectives of the wayfinding trial using satellite navigation systems in the freight industry;
 - 2. Background Information:** This section of the report explains what satellite navigation systems are and why they should be used in the freight industry. The justifications of using satellite navigation has also been discussed, including anticipated benefits and problems of using such systems in the freight industry;
 - 3. Technical Review:** The types of satellite navigation systems available, satellite navigation system features and product manufacturers have been discussed. In addition to this, digital mapping information and the current market of satellite navigation systems has been explained with a view from truck manufacturers;
 - 4. Market Review:** This section reports on the current use of satellite navigation systems in the freight industry. Both the positive and negative effects of the systems have been displayed by examples of press articles and examples of freight companies currently using the systems;
 - 5. The Trial:** The wayfinding trial that was conducted over the eight week period is explained in this chapter. The research proposal, trial methodology, the participating companies, and quantitative and qualitative findings for 'before' and 'after' using satellite navigation have been discussed; and
 - 6. Conclusions and Recommendations:** This chapter concludes the findings and suggests recommendations for further improvements in order to improve satellite navigation systems and to make them more suited to freight vehicles as opposed to only smaller vehicles and cars.
- ## 1.2 What is Freight Best Practice?
- Freight Best Practice is the new name for the Transport Energy Best Practice programme. It is funded by the Department for Transport and managed by Faber Maunsell Ltd to promote operational efficiency within freight operations in England.
- Freight Best Practice offers FREE essential information for the freight industry covering topics such as saving fuel, developing skills, equipment and systems, operational efficiency and performance management. Information is offered in the form of guides, case studies, videos and CD's designed to help freight operators save money and increase profits by improving operational efficiency.
- The aim of the Department for Transport (DfT) is transport that works for everyone. The DfT's objective is to oversee the delivery of a reliable, safe and secure transport system that responds efficiently to the needs of individuals and business whilst safeguarding our environment.
- One of the DfT's objectives is to improve the sustainability of the logistics sector. The Freight Best Practice programme is a key part of the Government's commitment to improving the efficiency with which energy is used by stimulating the uptake of best practice.

1.3 The Aims of the Satellite Navigation Trial in the Freight Industry

With ever-higher operating and running costs, efficient vehicle fleet management is an essential requirement for any business with its own transport operation. Time conscious customers demand flexible and reliable deliveries and these demands can be costly if driver's routes and schedules are not optimised.

For delivery drivers, it is frustrating to be within a mile of a delivery point and to then take another ten minutes to get to the final destination because they are not familiar with the local road network, a one-way system, roads which are not wide enough or no-one is aware of the customer location.

Even though there are a large number of GPS navigation systems on the market, research has shown that freight fleet operators have tended to avoid investing in satellite navigation devices. This is mainly due to the fact that operators do not fully understand the benefits of such systems and they feel the costs of such systems would not justify the benefits.

Delivery vehicles that are already using satellite navigation systems are being routed along unsuitable roads to reach commercial centres. The objective of this research is to test the benefits of and improve the take up of satellite navigation systems in HGV's, with the aims of:

- Minimising mileage run;
- Congestion avoidance;
- Improving road safety;
- Using appropriate delivery routes;
- Reducing operator costs; and
- Reducing air pollution.

A few years ago the Royal Institute of Navigation suggested that 'an ideal (routing) system would know where the journey begins and could calculate the most effective way to reach the destination, taking into account the amount of fuel to be used the time available, the traffic conditions likely to be encountered and the prevailing weather'. Apart from the weather aspect, such systems are now available and being offered by both car and commercial vehicle manufacturers as factory-fitted options.

The future for wayfinding systems for the freight industry looks bright. The availability of accurate position, time and speed from satellite navigation systems has widespread applications in the transport and logistics arena. Upgrades to GPS and the new European signals from EGNOS (European Geostationary Navigation Overlay System) and Galileo will provide enhanced capabilities in accuracy, coverage and signal integrity. These will greatly increase the range of satellite navigation based solutions available to transport and logistics management.

According to Centaur Communications, we can expect at least 60 and possibly 70 or 80 satellites, which would lead to increased signal availability and reliability, greater accuracy and less interference. (*Source: Sing from the same timetable – Engineer (Centaur Communications; 2/11/2005).*)

2 Background Information

2.1 Introduction

Global Positioning System (GPS) is now being exploited in all aspects of day-to-day life. GPS is an invaluable navigational asset that offers safety, reliability and expedience to aid a driver's travel, ensuring that they arrive on time.

Vehicle manufacturers are continuously evaluating applications that provide high customer value and return on investment. Services such as on-board navigation systems that integrate practical, location-based content into the everyday lives of drivers have quickly emerged as leading value-added solutions.

2.2 What are Satellite Navigation Systems?

Satellite navigation systems use radio time signals transmitted by satellites to enable mobile receivers on the ground to determine their exact location. The relatively clear line of sight between the satellites and receivers on the ground combined with ever-improving electronics, allows satellite navigation systems to measure location to accuracies on the order of a few metres in real-time. (Source: www.wikipedia.org).

Satellite navigation systems essentially come in two forms, those that are built into a vehicle and those that can be transferred between vehicles and require only a power connection to the 12v power socket. Vehicle manufacturers are continuously evaluating applications that provide high customer value and return on investment. Services such as on-board navigation systems that integrate practical, location-based content into the everyday lives of drivers have quickly emerged as leading value-added solutions.

Like many other branches of technology, satellite navigation systems are evolving rapidly, which makes it hard to classify them, but navigation solutions are as follows:

- **Built-in systems:** Built-in satellite navigation systems are becoming more common as options, but they are pricey and unable to keep up so well with advances in technology.
- **After-market fitted systems:** After-market fitted systems are cheaper, but they have to be installed in the vehicle and uninstalled when a driver changes their vehicle.
- **Portable systems:** These are dedicated systems, similar in many ways to hand-held systems, but with built-in GPS and without the additional features of a PDA. Examples include the Garmin StreetPilot and TomTom GO.



- **PDA-based systems:** The big growth area in the last couple of years has been the Pocket PC-based systems. These are usually add-ons to Pocket PC handheld computers, and as well as being good value, they are also portable between vehicles. You also get a pocket computer to organise your life with.



- **Phone-based systems:** There is a new breed of satellite navigation systems that are based on mobile phones, for example, the 'Wayfinder'.



For server-based products, the supplier's central system is used to calculate the best route and this information is sent to the driver. Server-based systems incorporate live traffic information into the route planning and they are lower in cost. On-board systems require more sophisticated and more expensive hardware due to their need to store map data and calculate routes. The various satellite navigation systems have been discussed later in the report.

The best vehicle navigation systems need to be able to present the driver with information which is concise and unambiguous. Simple visual displays showing direction and indicating which route to take at junctions or roundabouts are available. Systems now give verbal instructions and identify landmarks which allow the driver to concentrate on the road rather than having to look down into the vehicle.

Satellite navigation systems provide a wealth of navigational information including speed, distance, heading, position and time to destination. Drivers and operators will always know where their vehicles are positioned, where vehicles are going and approximately when a vehicle will arrive at their destination. Many GPS systems include detailed maps and are expandable to include additional city and street maps. Points of interest such as hotels, restaurants, petrol stations are available to satellite navigation users.

2.3

Why use Satellite Navigation in the Freight Industry?

The fundamental property of a GPS system is to utilise the Global Positioning System (GPS) satellites to determine the user's exact position at any given moment in time. If that positioning ability is coupled with software that processes the information all sorts of possibilities open up.

Highly accurate digital maps, personalised location-based services and telematics offer significant opportunities to vehicle manufacturers to increase customer adoption rates and shift perceptions of vehicle navigation systems from an option to a necessity. Once experienced, these powerful tools provide drivers with an unprecedented feeling of safety and security which in turn, reduces costs and generates profits for freight operators.

Vehicle tracking has also become a major application with GPS. Companies can track the locations of pick-up and delivery vehicles. Transportation and logistics companies are testing GPS-based fleet management systems that will provide the capability to monitor on-time performance or breakdowns and keep customers informed.

Unless freight drivers drive the same well-known route every time they get in the cab, satellite navigation systems can be invaluable for today's truck driver. Not only do they make for very relaxed driving, where a driver is told well in advance of any turn or junction that needs taking, but they can also save a lot of time in wasted miles by taking a wrong turn.

Given the traditional pressures on driving time such as tight delivery windows, drivers' hours restrictions and new pressures from the latest working time rules, the days when drivers can afford the time and fuel to spend half-an-hour looking for a particular destination are long gone.

Satellite navigation systems make for much safer driving, by removing the need for sudden manoeuvres such as, veering across four lanes of motorway at the last minute in heavy traffic because a driver has just realised that they are about to miss their junction.

2.3.1

Example Case Study Scenario

Below is an example scenario that displays the potential of satellite navigation for a fleet of vehicles in the freight industry. GPS systems can be a very useful tool for the freight industry in terms of cost saving and air pollution reduction. Consider the following example scenario:

A fleet of 100 lorries:

- Fleet operates for 250 days a year;
- It costs £30 per hour to run the fleet; and
- A GPS system could be installed in each vehicle at a cost of £600 per vehicle. This would save 10 minutes a day.

If a GPS system is used, what would the pay back be for this operation?

Saving Per Vehicle	$(10/60)*£30$	£5
Saving Per Vehicle for Year	$(250*5)$	£1,250
Cost of Unit		£600
Saving Per vehicle (Year 1)	$(1250-600)$	£650
Saving Per Vehicle (Year 2 onwards)		£1,250

As can be seen in the table above, the saving per vehicle if a GPS system is used would be £5 per day per vehicle. This was calculated by dividing 10 minutes into 60 minutes and multiplying by £30, to give £5 per vehicle per day. The saving on a yearly basis for each vehicle would be £1,250 based on 250 days a year (250 days multiply £5 equals £1,250). Therefore for the entire fleet (100 vehicles) the total saving would be £125,000 per annum (£1,250 savings per vehicle multiply by 100 vehicles equals £125,000).

In year 1 however, the saving would be £650 per vehicle due to the cost of implementing the GPS systems (£600 per vehicle). The saving for the 100 vehicles in year 1 would be £65,000. The pay back for this operation would be approximately 6 months.

Road freight has the complete opposites as far as wayfinding needs are concerned. A driver on general haulage may not know any of the drops for the next day, whereas a delivery driver on a fixed daily run will know all the delivery points. Multi-drop work tends to be more onerous than end-to-end trunking. Depending on the nature and type of freight operation, the cost benefit of satellite navigation would depend on factors such as:

- Delivery frequency;
- Regularity of run;
- Driver familiarity;
- Number and geographical location of customers;
- Quality of road signing to customer destination;
- Cost pay back period; and
- Driver turnover rate (number of drivers leaving the job, agency drivers).

Based on industry experience, the average time lost in finding a delivery point that is unfamiliar to the delivery driver is approximately 10 minutes per drop. Consider the following examples:

Example 1: A bread delivery distribution company. The deliveries are likely to be the same customers, hence delivery drop locations will be fixed on a daily basis. The driver would be on fixed runs and would therefore have a good understanding of the location of customers, as delivery runs would be standard and routine for the driver. With this operation the driver will not incur any lost running hence, the usefulness of satellite navigation for such operations would not be justified.

Example 2: A home delivery operation. If a driver has multiple deliveries a day it is likely that the driver would know how to get to a proportion of the destinations. As an example let us assume that the driver does not know how to get to six out of his 16 drops, and therefore experiences lost running. The total lost running for this particular driver (based on 10 minutes lost time per drop) would be 60 minutes per day (1 hour per day).

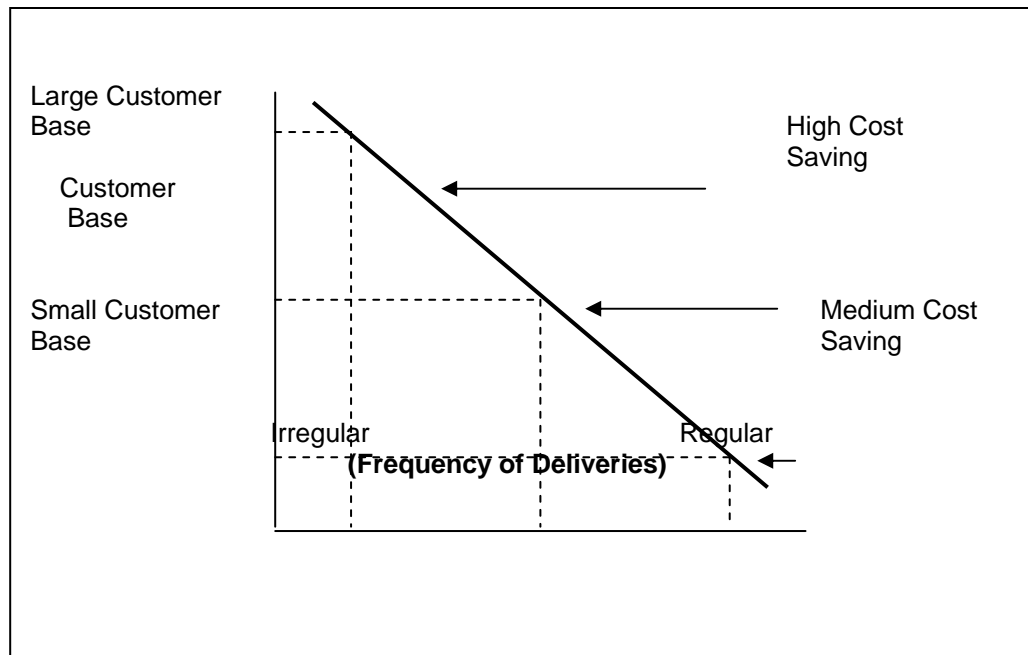
The cost saving for the home delivery operation based on £30 operating cost per hour per day would be £30 saving per vehicle as one hour is saved. If this company operated for 250 days a year, then the total saving for one vehicle per year would be £7,500 (£30 multiply 250 days). If the average cost of a satellite navigation system is £600 per vehicle, the pay back for this operation would be approximately one month. If this home delivery company has 50 vehicles on similar runs, then total yearly saving for this fleet operator would be £375,000 (£7,500 multiply by 50, equals £375,000). However, in year one due to cost of satellite navigation system and installation, the savings in year one would be £345,000, as the satellite navigation systems would cost £30,000 for the 50 vehicle fleet (50 vehicles multiply £600). This is a huge cost saving for the freight fleet operator, enabling the operator to be more profitable and efficient in the future.

As a means of deciding to have satellite navigation, the factors stated above would need to be considered. As a general rule, justifying the benefits of having satellite navigation in freight operation would depend on the delivery frequency of drivers. For example, the higher the frequency of delivery/collections to the same customers/locations, the less need for satellite navigation as drivers would know the route well enough (e.g. bread distribution). This would therefore, not justify the needs for satellite navigation as there is no cost benefit to the freight operator. It is like the benefit of road signs in your own local area, as it is unlikely that locals ever notice the quality of road signs as they are superfluous.

In theory, the lower the frequency of delivery/collections, the more need for satellite navigation, as it is very likely that drivers will get lost or stop to ask for directions. In this case satellite navigation can clearly be justified, not only for route finding, but also as a cost saving potential (e.g. home delivery, skip delivery/collection companies).

Figure 1 below shows the regularity of delivery to customer locations. The graph illustrates that if a driver makes one delivery per year to each customer and their freight company has a large customer base, the chances of the driver remembering customer locations is low. For this type of operation the uses and benefits of satellite navigation can be justified. On the other hand, if a freight operator has a small customer base and a driver makes regular deliveries to one particular customer, the chances are that the driver is very likely to remember the route for future runs therefore, the need for satellite navigation system can not be justified. There is an inverse correlation between customer base and frequency of delivery.

Figure 1: Regularity of Delivery to Customer Locations



As can be seen in the example above, the usefulness and cost benefits of satellite navigation to a freight operator would depend on the size of customer base and the frequency of deliveries.

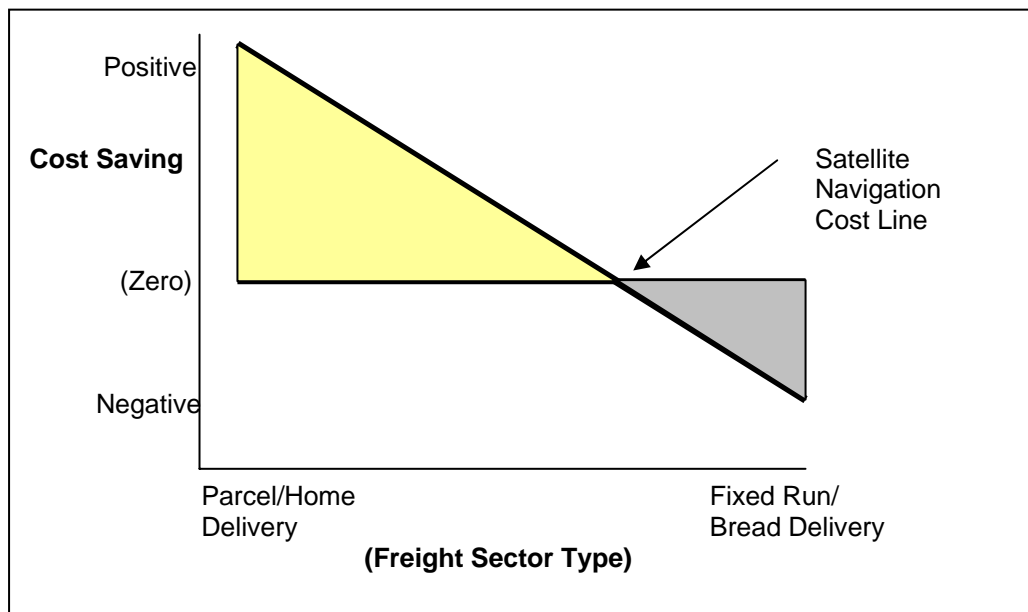
2.3.2

Anticipated Findings

The road freight transport industry is one of the largest service industries in the UK. Road freight is varied and wide ranging. The industry sectors below give a very general guide to the various sectors of the industry that satellite navigation could be beneficial for:

- Parcel/courier delivery services;
- Home delivery companies;
- Groupage/general haulage;
- Rural delivery operations (farms); and
- Special Types; for example, car transporters, furniture delivery companies, home and office relocation companies and Skip collection/delivery companies.

By referring to figure 2 below, the 'horizontal' line represents the cost of installing satellite navigation, and the 'sloping' line represents the nature of freight operation type. As can be seen in the illustration below, there is a 'cut off' point where satellite navigation could be clearly beneficial. The cost saving for having satellite navigation will depend on the various freight sector operations where regularity of runs and order frequency will vary (e.g. home/parcel delivery, skip companies, international distribution, rural deliveries, and fixed run trunking).

Figure 2: Cost Saving in Relation to Freight Industry Sector

As can be seen in the example graph above, fixed run trucking (to manufacturing/distribution/retail locations/local bread delivery runs) would not justify the need for having satellite navigation as drivers are unlikely to get lost as they would remember their delivery routes. Satellite navigation could be implemented in such operations but the cost benefits and pay back to the operator for having such a system would not be justified.

Having satellite navigation for freight operations above the satellite navigation cost line (vertical line) would give an indication of what type of freight operation would benefit most from having such systems. The system would mean an excellent return on investment as pay back would be soon rather than later.

In theory, the less well a driver knows a delivery address, the greater the contribution that a navigation system can make to operational efficiency. The more locations a mobile worker has to visit each day, the greater the potential savings.

Apart from the time saving, there is less wasted mileage and hence, a saving in fuel and reduced air pollution. However, if the freight operator links navigation with real-time traffic information, drivers can be re-routed in real-time around traffic hotspots, minimising delays. With most navigation systems the mapping information is not specific to vans and trucks, so it may not know about height and weight restrictions.

How a freight operator goes about selecting a satellite navigation system for their fleet operation will depend on the type of operation. There are questions that need to be addressed when it comes to selecting satellite navigation for freight fleet vehicles and these have been listed in a 'flow' diagram which can be referenced in the appendix.

2.4

Justification of using Satellite Navigation based on Facts and Figures

The freight industry is expected to continue to grow according to the Department for Transport (2004). Light van traffic is projected to grow by 39 % by 2010 on 2000 levels, 54 % by 2015 and 74 % by 2025. Articulated lorry traffic is expected to grow by 23 % by 2010, 33 % by 2015 and 45 % by 2025. With this projected increase in the future, satellite navigation for the freight industry will become even more beneficial in terms of helping control road congestion, enabling freight operators to reduce money, mileage/fuel reduction, and reducing the impact on the environment.

The total HGV vehicle parc in the UK is 434,000. Artics (97,000) are on average likely to travel 100,000 km per year, while it could be assumed that large rigidids (173,000) travel 80,000 km and smaller goods vehicles (164,000) 50,000 km. In total, this would equate to more than 31 billion kilometres of travel annually.

The Freight Transport Association have estimated that at any given time, as many as 16% of HGV's are lost. While this figure may well be an overestimate, even if the total distance travelled while looking for destinations is just 2% of the figure discussed above, this would equate to more than half a billion kilometres driven unnecessarily each year. Increased use of satellite navigation systems could play a significant role in reducing this.

According to the DfT Transport Trends (2002), the movement of freight (measured in tonne kilometres) increased by 42% between 1980 and 2002. However, since 1990 heavy goods vehicle tonne kilometres and vehicle kilometres have increased more slowly than GDP. Between 1990 and 2002 the average length of haulage by road has increased by over 40 %.

In terms of safety and accidents, heavy goods vehicles account for only 7 % of the vehicles on our roads (DETR) but were responsible for a fifth of all road deaths in 1999. Heavy goods vehicles tend to have lower accident involvement rates than most other types of road vehicles, but where they are involved the level of injury tends to be greater. Satellite navigation could also help reduce accidents because lorry drivers will have advance notice of the direction to take hence, eliminating the need for sudden manoeuvring. In addition to this, the systems will reduce the need for drivers to stop and ask for directions, which often causes disruption to other road users as they intend to impede a lane while asking for directions.

From an environmental point of view, according to the Department for Environment, Food and Rural Affairs (2005), carbon dioxide emissions from road haulage have increased by more than a third between 1990 and 2002. Road-freight now accounts for 8 % of UK carbon dioxide emissions, (Source: www.transport2000.org.uk). If annual mileage of a 10 vehicle fleet of artic (using distance figures presented earlier) could be reduced by 2% over a year, this would save 7,400 litres of fuel. This would equate to a saving of approximately £5,500 (based on £0.75pl) and approximately 20 tonnes of CO₂.

According to a Dutch report on saving energy with vehicle navigation systems, if a company visits a variety of locations in a set period, the driver can input their delivery/collection points at once and the system will work the quickest route for them. Satellite navigation systems achieve a saving of £6.43 per day, which equates to £1,636.20 pounds per working year for a passenger service/delivery van, and a saving of £9.61 or £2,413 a year for a truck/large van is easily achievable. These systems will also achieve time saving, distance travelled, fewer stops, wrong turns, much lower fuel consumption and therefore lower emissions. In addition to this, the US Department of Transport has indicated a reduction of 2.5% in accidents. (Source: www.SatNavshop.com).

2.5

Anticipated Benefits of using Satellite Navigation Systems in the Freight Industry

Like traffic information systems, navigation systems are designed for the use of the driver, and they can provide real cost saving benefits to a fleet operator if drivers use them effectively. However, satellite navigation systems have been developed primarily for the car market and to date systems have not included height and weight restrictions that affect the freight industry. This is the responsibility of the digital mapping suppliers such as Tele-Atlas, Navteq and Ordnance Survey.

However, the benefits of GPS satellite navigation for certain types of distribution (such as home delivery and skip operations) could readily justify the costs. The key benefits include:

- Journey time reduction;
- Reduced driver stress;
- Reduced overtime claims;
- Drivers guided direct to delivery point via postcode or address;
- Enables proactive customer service with advance warnings and delay explanations and assists re-routing decisions;
- Reduces the need for voice communications to secure new route planning information, saving time and money;
- Enables greater fleet utilisation by showing where vehicles are and where they have been;
- Eliminates the need for advanced driver knowledge of streets and road layouts;
- Optimises journey times, increasing the available working day for more customer visits and deliveries, reducing the need for overtime and increasing driver's own free time;

- Reduces wear and tear and depreciation on vehicles as distances to each defined location are reduced; and
- Reduces time on pre-journey planning, for example looking up addresses, sketching directions and receiving location maps, etc.

2.6

Anticipated Problems of using Satellite Navigation Systems in the Freight Industry

Satellite navigation is certainly a very useful tool for the freight industry to minimise mileage travelled, therefore reducing operator's costs, road congestion and air pollution. However, with any system, problems do exist, but no doubt the benefits of using satellite navigation systems in a freight fleet operation outweigh the problems. Below are common problems with satellite navigation:

- Blockage of signal transmission from tunnels, trees and high buildings;
- Multi-path signals generated by reflections from nearby surfaces or fences can also interfere with the GPS data;
- Security issues due to hacking;
- Costs, especially additional costs such as vehicle tracking and up-to-date information;
- GPS receivers use a lot of energy;
- Problems with freight specific mapping (bridge heights, weights, etc.);
- Maps will go out of date quickly; and
- Theft of the devices, especially for portable (plug and go) units. For example, if a driver is delivering a case to a customer and he leaves his cab, there is a possibility that his satellite navigation unit will be stolen.

All satellite navigation systems can suffer from certain shortcomings. For example, if a driver deviates from the selected route because they know a shortcut to their destination, the driver might find the satellite navigation system telling them to return to the original route right up to the point where the driver is only a couple of miles away from their destination. Even though doing so at such a late stage would involve much more time and mileage than continuing with the shortcut.

Digital maps can also be an issue, depending on where drivers are heading. There can also be operating problems in cities, where tall buildings can effectively block the line of sight between a satellite navigation system and the satellites it depends on. In such instances, built-in navigation systems have a further advantage over mobile systems as their connection to the vehicle's electronics and speedometer means they can make an accurate estimate at a driver's location based on their last known position, speed and bearing at the time.

Having discussed what satellite navigation systems are and their potential usefulness in the freight industry as a means of reducing 'wasted' mileage run and hence, a reduction in CO₂ emissions, the following chapter reports on the types of satellite navigation systems on the market. In addition to this digital mapping information has also been explored to determine the usefulness of the systems in the freight industry.

3 Technical Review

3.1 Types of Satellite Navigation Systems and Manufacturers

GPS makes traveling the roads and highways more enjoyable. When using GPS navigation a driver eliminates the need for obtaining detailed directions to their next destination in advance. Satellite navigation gives the driver freedom to concentrate on the road while their GPS guides the way.

Many unforeseen variables such as heavy traffic, construction work and road accidents can not only ruin the journey for the driver, but will result in delivery delays and increased costs for operators. GPS systems can easily navigate around these problem areas, giving the driver the peace of mind that ensures that they are on the right track.

With many advanced and affordable GPS navigation systems on the market today, the products and solutions that make the navigation, communications and travel experience more economical and enjoyable for the freight industry have been considered below.

As this research was conducted in August 2005 it must be noted that the satellite navigation prices quoted were obtained directly from the manufacturers and by reference to their websites. The costs are approximate retail prices and have been reported in good faith. Freight Best Practice accepts no liability for accuracy of the prices or for the availability of the technology at the rates quoted.

3.1.1

Garmin

Garmin claims to be a leader in Global Positioning System (GPS) technology. The company has various satellite navigation GPS products on the market. Garmin systems already have a 'truck mode' function for use in lorries, and potentially the most useful systems for the freight industry are as follows:

■ **Quest**

This is a pocket sized GPS navigator designed to provide automatic route calculations including voice guidance. Turn-by-turn instructions with detailed maps are pre-programmed into the unit hence, this system can be used straight away once out of the box. A 12v power socket can power the Quest. Further information regarding specification and product features can be obtained from the matrix in the appendix of the report. According to Garmin's website, the price of this unit is £369 and no specialist installation is required.



■ **Streetpilot 2610**

This product comes with a touch screen and remote control and provides turn-by-turn directions and voice prompts. Whole of Europe coverage is provided, and by transferring data directly through a USB connection and onto a memory card, can download additional map details. 'Manual' information can be saved on this product for routing purposes,. The Streetpilot 2610 has a built in truck mode and has a 'Custom Avoidance Feature' which allows drivers to mark problem roads/areas for future reference. The truck mode basically operates along 7.5 tonne limits in built up areas but does not know about remote rural low bridges. According to Garmin's website the price of this unit is £599 and no specialist installation required.



- **Streetpilot 2620**

This product is similar to the 2610 but comes with a powerful microprocessor for fast route calculation and map re-draw. The highest degree on GPS accuracy is enabled via WAAS/EGNOS support. 'Manual' information can be saved on this product for routing purposes. The Streetpilot 2620 has a built in truck mode and has a 'Custom Avoidance Feature' which allows drivers to mark problem roads/areas for future reference. The truck mode basically operates along 7.5 tonne limits in built up areas but does not know about remote rural low bridges. According to Garmin's website, the price of this unit is £699 and no specialist installation is required.

The only difference is that the 2620 comes with a pre-installed 2.2GB MagiStor hard drive. Garmin suggest due to vibration that it's not suitable for motorbikes. Unlike the other Garmin products, you will not receive a Garmin Cartography CD as it is pre-installed, so if you did wipe the maps by accident then you cannot re-install easily.

- **Streetpilot c320**

The recommended retail price for this unit is £499 according to Garmin's website. This product provides turn-by-turn guidance with voice prompts. The system is already preloaded with mapping information for UK & Ireland, but a CD-ROM for whole of Europe is provided that can be installed. There is no installation cost as unit can be plugged into vehicle using power adaptor.



- **Streetpilot c330**

This product is similar to the c320 but comes pre-loaded with maps for the whole of Europe. The c330 provides points of interest information such as hotels, services, etc. and is priced at £699 according to Garmin's website. Again, no specialist installation is required.

Further information on product specification for the above products can be seen in the matrix. Garmin products however, have a truck mode feature on their product for the freight industry and their products can be fitted into any car or light commercial vehicle but are not recommended for heavy goods vehicles. Because of the mapping data supplied by Navteq, they are unable to route HGV's, as satellite navigation mapping systems tend to be applicable to all road users, and not specific to heavy trucks.

3.1.2

Magellan

Magellan use Navteq as a mapping supplier so again, routing is restricted for heavy goods vehicles. Magellan wayfinding GPS systems that appear to be most suited to the freight industry are as follows:

- **Roadmate 300 Europe**

According to Magellan's website, this unit is priced at £495 and there are extra costs for installation cost. This product provides voice prompting and turn-by-turn 3D navigation guidance with the latest touch screen technology. Roadmate automatically updates directions when a person decides to take a detour and comes with a built-in map of major European roads. Points of interest (restaurants, petrol stations, etc.) are organised into categories and sub-categories for easy browsing and searching by name or nearest to location.



- **Roadmate 700 Europe**

This product has the same features as the Roadmate 300 but comes with a built-in map database of the whole of Europe. Roadmate 700 costs £799 according to Magellan's website and there is no need for specialist installation. More information on these products can be seen on the product matrix in the appendix.



Magellan products do not have a truck mode feature, but these products can be fitted into any car or light commercial vehicle but are not recommended for heavy goods vehicles. As the

mapping data is supplied by Navteq, they are unable to route HGV's as satellite navigation mapping systems tend to be applicable to all road users and not specific to heavy trucks.

3.1.3

Mio

Mio has various wayfinding GPS products on the market. The most useful systems that can be trialled for the freight industry are:

- **Mio 268**

According to Mio's website, this product is priced at £274.99 and no specialist installation is required. The Mio 268 comes with both touch screen and hardware buttons. Mapping information is only supplied for UK & Ireland. Turn-by-turn direction and voice guidance comes as standard. This item can be used straight away once out of the box.



- **Mio 269**

This product has the same features as Mio 268 but has mapping for Western Europe as well. All software and maps are already stored on the product hard drive, so the product can be used straight away. There is no installation costs associated with this item. Cost of Mio 269 is £379.99 according to Mio's website.



Mio products can be fitted into any car or light commercial vehicle but are not recommended for heavy goods vehicles. Mio systems have the capability for routing and monitoring any type of vehicle but because of the mapping data supplied by Tele-Atlas, they are unable to route HGV's as satellite navigation mapping systems tend to be applicable to all road users and not specific to heavy trucks.

3.1.4

Navman

Navman has various wayfinding GPS products on the market. The most useful systems for the freight industry are described below. The Navman systems that can be trialled for the freight industry are:

- **iCN 510**

According to Navman's website, the iCN510 costs £399 and there are no installation costs. This product provides mapping for UK & Ireland only. Its touch screen and multi-functional keypad enables a person to control operations easily. All the features of navigation, door-to-door navigation, voice guidance and points of interest all come with this product. A European city navigation CD is supplied on a CD that can be downloaded onto the system.



- **iCN 635**

This product has the same features as the iCN510 but comes with a remote control and 128MB of map memory. The product can be used straight away once out of the box. The iCN635 follows in the footsteps of Navman's best selling iCN630. The recommended retail price of this unit is £699 according to Navman's website and no specialist installation required.



- **iCN 650**

The price quoted on Navman's website for the iCN650 is £799 and there are no costs for installation. This product covers Europe and has a map storage capacity of 2GB hard disk. A remote control is included and can be used straight out of the box.

Navman can be fitted into any car or light commercial vehicle but is not recommended for heavy goods vehicles. Navman systems have the capability for routing and monitoring any type of vehicle but because of the mapping data supplied by Tele-Atlas, they are unable to route HGV's as satellite navigation mapping systems tend to be applicable to all road users and not specific to heavy trucks.

3.1.5

TomTom

Founded in 1991 in Amsterdam, TomTom provides navigation solutions to markets across Europe and America. The company claims to be continually exploring new and better ways to help mobile people reach their destinations quickly, safely and as easily as possible by developing new and smarter products to keep ahead of the rest.

TomTom has various wayfinding GPS products on the market. The most useful systems that can be trialled for the freight industry are:

- **Navigator 5**

The Navigator 5 for PDA's will turn the PDA into a personal travel assistant on the road. It offers users the most up-to-date features for easy and stress-free travel. Navigator 5 consists of an all-in-one car navigation system with HP iPAQ hx2110, navigation software, maps, GPS and car mount. According to TomTom's website, the product costs £410 per unit and there is no installation cost.



- **GO 300**

Having a simple touch screen operation, this product can be used straight away, with no need for specialist installation. Accurate turn-by-turn voice guidance and itinerary planning is available. Mapping is only for UK & Ireland and according to the company's website, the GO 300 costs £369.99. The TomTom GO products are 'plug and go' products so there is no installation costs.



- **GO 500**

Similar to GO 300, but this product has mapping information for UK & Ireland and major roads of Europe. GO 500 comes with assisted satellite navigation (works in tunnels) and offers hands-free phone capabilities. According to TomTom's website, there are no installation costs, and the GO 500 costs £469.99.



- **GO 700**

According to TomTom's website, the GO 700 has a retail price of £549.99 with no additional installation cost. GO 700 comes with a remote control and has pre-installed maps of the whole of Europe on a 2.5GB hard drive. This product also comes with assisted satellite navigation (works in tunnels) and offers hands-free phone capabilities.



TomTom products have built-in Bluetooth connection and are ready for TomTom Plus services. This new service from TomTom offers real-time, on demand traffic information and weather reports. With roads constantly changing TomTom Plus keeps the TomTom up-to-date by downloading the latest map of your region with new streets and buildings. Subscription and data charges apply and can only be used in conjunction with a Bluetooth enabled mobile phone.

TomTom can be fitted into any car or light commercial vehicle but is not recommended for heavy goods vehicles. TomTom systems have the capability for routing and monitoring any type of vehicle but because of the mapping data supplied by Tele-Atlas, they are unable to route HGV's.

3.1.6

Compucon

Compucon has developed a system called Navigator I. This is an integrated PC system that can be placed in any vehicle. The product offers users the following abilities:

- Internet Connection through GPRS for information search and Location Based Services (LBS);
- Forwarding location stigma through incorporated GPS;
- Receiving and forwarding messages from and to the Management Centre via GPRS securing effective fleet management;
- Wireless connection with local networks (LAN);
- Reproduction of HiFi image and sound in different formats;



- Image transfer ability; and
- Ability to use for regular communication.

The system is easy to use and selected maps can be loaded from a CD or Hard Disk. Map transfer to Navigator I can be made through Wireless LAN. Product features also include route selection and visual or voice navigation. The system records the route, including data such as location, speed, direction and events for further analysis or historical data. With Location Based Services (LBS) users can automatically receive information regarding the present situation or relevant information regarding their present location. Compucon's Navigation system also provides indicative information such as traffic, weather conditions or other events regarding destination or route points.

Fleetfinder are the sole agent for a Greek supplier called Compucon (www.compucon.gr). Compucon spent 18 months developing their tool and have put their system in 2000 taxis and several units into HGV's in Britain. The system does have a satellite tracking feature so that operators can know the whereabouts of its vehicles. According to Fleetfinder, the cost of install/de-install is about £40 each. Some companies pay about £14 per month for rental of this system.

3.1.7

ALK Technology

ALK Technology has various wayfinding GPS products on the market but potentially, the most useful systems that can be trialled for the freight industry is the CoPilot Live Pocket PC 5, which costs £354.96 (price quote taken from ALK's website). There is no installation cost and the product includes a comprehensive set of accessories for using it in a vehicle. This includes PDA car holder, suction mount and car cigarette charger.



CoPilot can be fitted into any car or light commercial vehicle but is not recommended for heavy goods vehicles. CoPilot systems have the capability for routing and monitoring any type of vehicle but because of the mapping data supplied by Navteq, they are unable to route HGV's, as satellite navigation mapping systems tend to be applicable to all road users, and not specific to heavy trucks.

3.1.8

Blaupunkt Navigation System

Blaupunkt, a Bosch subsidiary claims to be a market leader for car radios in Europe. Below are Blaupunkt satellite navigation products that can be used in freight vehicles:

■ **Stand-alone travelPilot DX-V**

The DX stand-alone range comes with a 16:9 wide-screen detachable monitor and split screen functionality, allowing simultaneous map and arrow view. According to Blaupunkt's website, the system costs £999.99. A variety of display formats are available ranging from split screen to large arrow or map. Route calculation is both quick and precise with guidance via clear spoken instructions and visual symbols. Operators can choose between a detachable monitor for theft protection and a motorised, retractable screen. The system can be accessed via logical menus including automatic traffic congestion avoidance function via RDS/ TMC (appropriate TMC source required), destination memory, split screen format (map/ arrow) and many other useful features such as:



- Route guidance with clear symbols, an informative map and voice guidance; a variety of displays (simultaneous arrow/map, large map or arrow) and map alignments (north, automatic and zoom on junction) available;
- On-board computer functions (display of arrival time and remaining distance from destinations, current speed, distance already travelled, total journey time and average speed);
- Route options - fast/short route and avoid motorway/ferry/toll; and
- A variety of additional components are available (for dynamisation, steering wheel remote control, video etc.).

■ 1-DIN Navigation

This system combines easy route guidance and mobile entertainment all in one. The system is the size of a conventional car radio, the integrated 1-DIN navigation systems with flip-out monitor combines radio, DVD, CD, MP3 and route guidance. Two different models are available to include Aspen IVDN-7003, and Chicago IDVN-7003.



According to the company's website, the Aspen IVDN-7003 costs £1899.99 and the Chicago IDVN-7003 costs £1999.99. The Blaupunkt navigation software gives precise information about the street network of the country in which the navigation system is used. Blaupunkt use Tele-Atlas to ensure that drivers are always guided on the optimal route without any unnecessary detours.

House numbers are provided for towns and cities in Great Britain. Postcode districts in urban areas and more detailed post code sectors in rural areas may be selected as destinations in Great Britain. More than 54,600 points of interest ranging from hotels to petrol stations are available.

Blaupunkt can be fitted into any car or light commercial vehicle but is not recommended for heavy goods vehicles. Blaupunkt systems have the capability for routing and monitoring any type of vehicle but because of the mapping data, supplied by Tele-Atlas, they are unable to route HGV's as satellite navigation mapping systems tend to be applicable to all road users and not specific to heavy trucks.

3.1.9

Trafficmaster Plc; (SmartNav GPS System)

Trafficmaster claim to be an established technology company, focusing on satellite navigation and digital traffic information. Trafficmaster's leading product is SmartNav, an easy to use, technologically advanced, satellite navigation system that guides you around the jams.

SmartNav uses Trafficmaster's unique live, incident, historic and predictive traffic data to calculate the optimum route at the start of your journey and will continue to monitor the route for delays until you reach your destination. The SmartNav service also incorporates 24-hour personal assistant support, emergency and breakdown service, nationwide safety camera alerts and GPS stolen vehicle tracking.



According to SmartNav's website, the product costs £898 per unit and there is also an additional charge of £250 per annum for unlimited route journey coverage. SmartNav covers UK & Ireland mapping and provides turn-by-turn voice and map guidance. A menu driven touch screen is also provided and there is no installation cost.

What differentiates SmartNav, apart from price, is that the system is based on a service provided from a call centre rather than from the in-car computer's map memory. It has a global positioning satellite (GPS) chip which tells the call centre where you are. There is a single button on the device, similar to a call me button on a website. When the driver pushes this, the call centre comes on the line and the driver can talk to them using a hands-free kit. The driver would tell them where they want to go and the call centre sends the information down to the device in the vehicle. Once the driver reaches a preset point the device directs him to his destination.

Another important point about this system is that it is easily fitted to any vehicle. The driver does not have to input a great deal of information into the screen at the start of a trip, nor do they have to pull over to the side of the road to re-input their destination or requirements if they change during a trip.

How SmartNav uses Trafficmaster Live Traffic Information to Amend Routes?

Trafficmaster provides real-time traffic information for accurate routing and avoidance of traffic jams on the SmartNav navigation system. According to SmartNav, Trafficmaster's real-time traffic information is derived from continuous data supplied by a network of sensor sites that consist of fixed infra-red sensors mounted on motorway over-bridges and Passive Target Flow Measurement (PTFM) 'blue pole' cameras installed at the roadside on trunk roads.

Trafficmaster's infra-red sensors and PTFM is explained in detail below:

- **Motorways Infra-Red**

The UK motorway network uses Infra-Red (IR) technology. Bridge mounted sensors sited over either the fast lane on two-lane motorways or the centre lane on three-lane motorways monitor the speed of the traffic breaking two infra-red beams projected on to the carriageway. The Trafficmaster system automatically feeds data to the control centre about the speed of traffic on motorways across the UK.

- **Trunk Roads – PTFM**

Trunk roads use a different technology to cater for the different traffic patterns experienced on such roads. Traffic turns off at junctions and may stop in lay-bys, shopping centres etc, so simple speed measurement would not generate quality data. Passive Target Flow Measurement (PTFM) uses number plate recognition technology to "grab" the four centre digits of a vehicle number plate. This is turned into a four figure electronic "tag" on site – no number plate data is retained.

(Source: www.SmartNav.com).

How live traffic links in with routing?

As the vehicle proceeds along the road and passes the next site(s), average journey times between sites are calculated and sophisticated computer programmes establish the speed of the traffic over those links. Traffic speed on that particular section of road is then delivered to the traffic information product (SmartNav in this case).

By having such systems monitoring the road network 24 hours a day, 7 days a week, traffic information is updated on a three-minute cycle, ensuring that the user is always supplied with the current status on traffic conditions for the Trafficmaster network.

Trafficmaster data does not depend on anecdotal input such as telephone calls from bystanders or motorists caught up in congestion. All traffic information supplied to Trafficmaster in-vehicle or stand-alone products, telephone information services or the Internet site is derived, computed and disseminated automatically, ensuring fast, accurate delivery to the customer.

Traffic information data is further enhanced by additional information gained from RAC Live and other incident-based recording databases. The SmartNav satellite navigation unit will inform the driver of the expected time it would take to get through a traffic jam and at the same time, provide an alternative route if the system felt it would be quicker to use the alternative route rather than waiting in the traffic jam. Either way, the driver will be given the option as to how to proceed.

SmartNav can be fitted into any car or light commercial vehicle but is not recommended for heavy goods vehicles. SmartNav is capable of routing and monitoring any type of vehicle but because of mapping data supplied by Navteq, they are unable to route HGV's.

3.2

Truck Manufacturers and Satellite Navigation Systems

In-vehicle satellite (GPS) systems for vehicle tracking and management are now well established in the freight market. As with any other industry, technology has had a huge impact in the logistics and transport sector. Truck manufacturers play an important role in providing the freight industry with the best vehicles not only for driver comfort but also for the latest in-cab technologies.

Research was carried out in August 2005 on the in-cab systems (particularly on satellite navigation systems) provided by truck manufacturers to their customers. The information in the following sections is provided by the manufacturers and has been reported in good faith. Freight Best Practice cannot be held responsible for any inaccuracies as these are the views of the contributing companies and not those of the programme.

3.2.1

Volvo Trucks

Volvo Trucks is launching an in-truck navigation system through Aftermarket, EUD. The system is called Siemens VDO Dayton MS5500. Two versions of the system will be offered, one integrated solution with Dynafleet Information Tool, the other system can be a "Stand-alone" solution for trucks without Dynafleet or integrated with the Dynafleet Communication Tool.



Dynafleet from Volvo Trucks is the market leading system for transport information. The new navigation system is now available at Truck Shop Europe and in the countries where Truck Shop is available.

In regards to mapping information, the Dynafleet maps are so detailed that drivers are able to follow the vehicle right down to street level. Information about times, drivers, speed, routes, cargo capacity and type of vehicle is available, which makes it easy to plan for the right truck and driver. Volvo offers different solutions to include:

Stand-alone System

This is a standard navigation system that does not rely on any Volvo component for its functionality. This means that it includes its own screen and relies on its own loudspeaker for voice guidance.

Integration with Dynafleet – NAV+CT

This is a stand-alone navigation system that is integrated with the Dynafleet CT in three ways:

- The DF GPS receiver is not needed because the position information is read from the navigation system;
- When used correctly the order module in DFpro, the load/unload locations that include the exact latitude/longitude information, will be sent to the navigation for immediate guidance to that location; and
- In case of Volvo radio VR200/300/400 the voice guidance is integrated with the radio speakers.

Integration with Dynafleet – NAV+IT

This is a stand-alone navigation system that is integrated with the Dynafleet CT in four ways:

- The DF GPS receiver is not needed because the position information is read from the navigation system;
- When used correctly the order module in DFpro, the load/unload locations that include the exact latitude/longitude information, will be sent to the navigation for immediate guidance to that location;
- In case of Volvo radio VR200/300/400 the voice guidance is integrated with the radio speakers; and
- The navigation system is using the original Volvo display and not the VDO standard display. An interface box is handling the way the different signals are sent to the screen.

Integration with Dynafleet – NAV + IT+BUP-MON (reverse camera)

This is a stand-alone navigation system that is integrated with the Dynafleet IT in four ways:

- The Dynafleet GPS receiver is not needed because the position information is read from the navigation system;
- When used correctly the order module in DFpro, the load/unload locations that include the exact latitude/longitude information, will be sent to the navigation for immediate guidance to that location;
- In case of Volvo radio VR200/300/400 the voice guidance is integrated with the radio speakers; and
- The navigation system is using the original Volvo display and not the VDO standard display. An interface box is handling the way the different signals are sent to the screen.

Besides the navigation system and Dynafleet IT this installation also includes the reverse camera that shares the same Volvo original monitor. Depending on the type of vehicle where the navigation system is to be installed, a variety of part numbers need to be bought from Volvo Parts if the customer desires to retrofit a Communication Tool (CT) or Information Tool (IT) together with the navigation system.

According to a telematics article to show the usefulness of Volvo's Dynafleet in the freight industry, Rick Sheehan, General Manager for logistics for building materials company CEMEX, offered proof that a concentrated plan to manage driver and vehicle performance could bring

real benefits. He had been running Volvo's Dynafleet system for 18 months and said fuel economy had increased from an average of 7.8 to 8.5 mpg. "That's a 7 % fuel saving, which amounts to £330,000 over a year."

Achievements included a 23% reduction in engine idling time, which came down to between 9 and 11%, including power take-off operation. CEMEX set drivers some KPI's, including fuel economy, and there was a recognition scheme for the top performers and regional "driver of the year" competitions. "There are other cost spin-offs too. More conservative driving means less wear and tear on vehicle components and the accident risk is reduced." (Source: 'Telematics – they work if you let them' – article in *mlogistics magazine*).

3.2.2 MAN / ERF Trucks

Due to low demand from customers, MAN/ERF trucks do not factory fit satellite navigation systems. However, because the 'in-cab' systems fitted in MAN/ERF trucks are supplied and manufactured by Clarion, MAN/ERF recommends the use of Clarion satellite navigation systems to customers.

3.2.3 Isuzu Trucks

Isuzu Trucks do not factory fit GPS wayfinding systems as they find that customers are not willing to pay the price for it. As Isuzu Trucks mainly specialise in the design and manufacture of light and medium commercial vehicles, demand for such GPS systems for these classes of trucks is low.

However, if Isuzu customers are interested in having a GPS wayfinding system, Isuzu recommends GPS systems manufactured by Clarion as all Isuzu in-cab systems (radio, etc.) are supplied by Clarion.

3.2.4 Scania Trucks

The GPS navigation systems Scania offer in-fleet management solutions come from the open market and are offered as applications on their Windows-based on-board PCs. Scania Trucks have two currently in use:

- TomTom Navigator; and
- ALK Co-Pilot 7.

Whilst both these systems provide good accurate navigation they are not specifically written for trucks and so do not warn or navigate around low bridges, weight limits or width restrictions. Similarly Scania currently have a link into real-time traffic information.

Whilst these systems are perhaps not ideal for heavy trucks, Scania find that demand from customers for such systems is relatively low. Consequently, those that do take it are happy with the systems today and consider vehicular restrictions when using them. Many customers seek the ideal of off-board route planning and then real-time monitoring of where the vehicles are.

A number of telematics and tracking systems suppliers offer the TomTom navigation system for handhelds, either integrated with their own software or as a stand-alone product. Scania has also upgraded its FAS in-cab package, adopting a more powerful Compaq iPaq PDA in place of the Casio PDA used previously.



3.2.5 Mercedes Trucks

The Mercedes FleetBoard DispoPilot system provides the driver with a navigation system that covers all of Europe, showing the correct route as well as providing audio directions. With the transmission of order data to a vehicle, the DispoPilot can transfer the received delivery or pick-up address directly into the navigation system. The territory monitoring function informs the driver and scheduler when a vehicle enters or leaves a defined area.

On FleetBoard Mapping's digital road map of Europe, drivers receive all the information they require at a glance. Thus the progress of individual vehicles can be displayed for a defined period, with breaks and the speed driven indicated.



Individual points on the map, e.g. unloading or loading locations of regular customers, can be defined using the POI (Points of Interest) manager. Useful information such as the locations of petrol stations, parking lots or motorway service areas is likewise shown.

As Mercedes Trucks tend to be sold to larger fleet operations as opposed to home delivery type operations, FleetBoard say that demand for such systems is very low as their customers have standard routes for their operations (e.g. delivery from manufacturers/suppliers to retail distribution centres).

However, the Vito will be the first Mercedes-Benz van to have the option of the company's latest Command satellite navigation system. This system includes an on-board journey and driver display with communications, navigation and CD/radio functions. Navigation information can be displayed on a split screen, with one side showing the map and the other turn-by-turn pictures. All the information is displayed on an LCD monitor mounted in the centre console. The RDS/TMC function is integrated, so routes can be updated in real-time to take account of actual traffic conditions.

Mercedes FleetBoard offers satellite navigation in conjunction with other in-cab systems that are used for operational performance checks, fuel levels, fuel consumption and work profiles of the drivers. The cost of their in-cab system varies from £1,500 to £3,000 per vehicle depending on customer requirements.

3.2.6

DAF Trucks

At this moment in time, after market navigation systems are being installed in DAF vehicles. These are of various makes with different functionalities. DAF Trucks are actually in the process of developing a new, dash integrated, telematics system with navigation functions.

Regarding the features for the GPS wayfinding system, DAF are including the following in their navigation system:

- Depending on the completeness of the map material and the features of the navigation software, bridge heights/weights, road weight/widths and point of interest for trucks will be included as much as possible;
- DAF will have a Traffic Message Channel (TMC) providing coded information about traffic events and their reported location on the road network;
- Dead reckoning features; and
- DAF system will have communication features, meaning that it can also get information from other sources. In this respect, DAF think it is important that trucks receive information about the route the truck must drive (e.g. dangerous goods) or eventual road blocks, toll roads, etc.

3.2.7

Foden Trucks

Foden used to offer GPS systems to their customers, but have now stopped because they find that demand for such systems is low. If customers of Foden Trucks are interested in wayfinding GPS systems, then it is up to the customer to find the best solution. Foden Trucks used to offer a solution using AES Fleetcom (an Australian based company) for mapping and performance monitoring system of lorries. As demand for such systems was low, Foden decided against offering such systems to customers. AES Fleetcom are advanced on-board computer systems, utilising the latest technology to monitor important vehicle and driving parameters. AES Fleetcom can be referenced on www.aespec.com.

3.2.8

Renault Trucks

Currently Renault Trucks UK only offers satellite navigation in the Master/Mascott vehicles. This covers weight ranges of 2.8 to 6.5 tonnes GVW. The satellite navigation uses a mapping CD and the base system allows an address to be entered with the addition of some route restrictions e.g. no motorway, no tolls and fastest/shortest route. The Renault satellite navigation system has a visual display combined with the radio/CD. It will give verbal turn-by-turn instructions as well as showing the immediate junction on screen.



The second system is similar to the above, but has a separate screen giving a road map. The versions offered do not give restrictions relating to weight limits, bridge heights, congestion, etc.

The satellite navigation systems fitted on Renault trucks are the same as offered by the Renault Car Division.

3.2.9 *Iveco / Ford Trucks*

Iveco Trucks do not offer a factory fitted GPS satellite navigation systems on heavy trucks as they also feel that there is no demand for this yet. Customers of Iveco normally tend to purchase their own wayfinding GPS system, but Iveco recommend the use of VDO Siemens satellite navigation system.

However, Iveco offers two versions of the Daily light van and truck range with GPS navigation. There is a model with a Becker DIN radio with inclusive satellite navigation and a more sophisticated CompuDaily, which features a Compaq PDA. The PDA incorporates a telephone, barcode reader and on-board data collection unit, as well as navigational capability.

3.2.10 *Summary of Truck Manufacturer Findings*

Based on our research findings, with heavy trucks there seems to be less demand for real-time navigation, perhaps because fleet tracking systems sometimes allow operators to download maps to in-cab computers as and when required. Vehicle manufacturers' telematic packages increasingly include satellite navigation systems as an option, as Volvo is incorporating a navigation tool into Dynafleet and Scania is trialing the TomTom navigation package on the latest version of its Compaq-based Fleet Analysis System.

3.3 **In-cab Satellite Navigation Systems used by Truck Manufacturers**

Most of the truck manufacturers listed above recommend to use VDO Siemens and Clarion as their preferred supplier of satellite navigation equipment. Research was carried out in August 2005 on the in-cab systems recommended by truck manufacturers to their customers. The information in the following sections was provided by the manufacturers and has been reported in this report in good faith.

Freight Best Practice cannot be held responsible for any inaccuracies as these are the views of the contributing companies and not those of the programme Siemens and Clarion claim to be market leaders in vehicle 'in-cab' systems, and their satellite navigation products are discussed below.

3.3.1 *VDO Siemens*

Siemens VDO has various wayfinding GPS products on the market. Potentially, the most useful systems that can be trialled for the freight industry are:

■ **MS5500**

The MS500 DVD-Rom based navigation system guarantees ultra-fast processing of large quantities of data and detailed information. With C-IQ – Intelligent Content on Demand, a range of different multimedia components are available to include up-to-date street level maps of your chosen country or Europe, travel information (hotels and restaurants), traffic information (up-to-date traffic information and alternative routing). According to Siemens website, the MS5500 costs £1,499.99 per unit and there are additional costs for installation as the product has to be fitted by the truck manufacturer or dealer.



■ **MS5400**

This is a CD-Rom based full colour navigation system. The MS5400 offers similar features as the MS5500 in that it has a touch screen, remote control and is compatible with C-IQ. According to the company's website, the MS5400 costs £1,099.99 and there are additional costs for using C-IQ for traffic/travel information and map selection. This product has to be fitted by the truck manufacturer or dealer hence, there are additional costs for installation.

In navigation mode (with both systems), the screen is split into two halves, with map details on the left and turn-by-turn or other information on the right. The larger screens mean maps and instructions can be displayed in large formats, so a quick glance at the screen will usually suffice. The result is virtually real-time navigation with hardly a perceptible delay between a command being entered and the map being presented on the screen.



With the C-IQ system, the idea is that instead of buying the CD map set, customers get a complete set of encrypted European maps and then pay on a per-use basis with an access code. You can pay for specific countries. According to Siemens website, the cost is £59.99 per annum for one country and £114.99 per annum for whole of Europe coverage.

VDO Siemens can be fitted into any car or light commercial vehicle. Heavy goods vehicle manufacturers such as Volvo, Iveco, and DAF recommend VDO Siemens to their customers as a wayfinding GPS system. VDO Siemens systems have the capability for routing and monitoring any type of vehicle but because of the mapping data supplied by Navteq and Tele-Atlas, they are unable to route HGV's on appropriate routes.

For dynamic fleet management in the freight industry, the PC5510pro and PC5400pro are widely used, as these two systems allow interaction between control centre and driver. With this, the control centre can manage vehicles and jobs can be forwarded directly to the navigation system.

The potential benefits according to Siemens of the VDO Siemens PRO systems (PC5510pro and PC5400pro) to the freight industry are:

- Precision tracking: the control centre knows exactly where its vehicles are, so can allocate jobs appropriately;
- Safe communication; information is exchanged with the driver via text messages. This cuts out telephone costs hence, lowering communication costs and increasing safety;
- Efficient routing: the control centre manages navigation and the system finds the best route to the next destination, enabling the driver to focus on doing their job; and
- Cost saving: based on VDO Siemens experience, the investment in such a system is paid off in a year, as this system saves money through fleet tracking, better communication and more relaxed and efficient drivers.

3.3.2

Clarion

Truck manufacturers such as MAN/ERF and Isuzu Trucks recommend Clarion's navigation systems to their customers. Clarion navigation systems can be fitted into any vehicle type, but the recommended navigation system for the freight industry is their DVD-ROM navigation system (NAX943DV).

The DVD-Rom navigation system (NAX943DV) according to Clarion's website costs £1,299.00 and has to be fitted by the truck manufacturer or dealer, which costs extra. Mapping covers Western Europe and turn-by turn voice and map guidance is provided. A menu driver touch screen and remote control is supplied for ease of use.



Clarion use Navteq as its mapping software supplier, therefore navigation is limited for car or light goods vehicle use. This product also provides information on points of interest and allows drivers to choose their preferred routes (e.g. avoid toll roads, etc.). This system can also display two different maps at the same time (the normal 2D view or 3D view), which helps avoid confusion when approaching intersections.

3.4

Satellite Navigation and Vehicle Management Systems

Over many decades road transport has proved to be by far the most efficient and cost effective means of moving the majority of freight from manufacturers to consumers. Urban centre's are now becoming increasingly congested. Lorries/vans which distribute goods can be delayed by congestion, accidents and road works. This in turn disrupts delivery schedules and cause problems in relation to the drivers' hours' rules which would result in consequences such as customer dissatisfaction, higher operating costs, more stress for drivers and a decline in profitability.

Research was carried out in August 2005 on satellite navigation and vehicle management systems. The information in the following sections was provided by the fleet management companies and has been reported in this report in good faith. Freight Best Practice cannot be held responsible for any inaccuracies as these are the views of the contributing companies and not those of the programme.

Below are some examples of companies who provide fleet management/telematics solutions combined with satellite navigation systems.

3.4.1

Fleet Finder

FleetFinder claim to be a market leading Internet based fleet management and telematics solution provider. The company's advanced vehicle tracking and reporting solution provides detailed reports on all vehicle fleet. The vehicles' location, speed and direction are displayed on street-level mapping to provide live updates as well as an extensive range of detailed and summary management reports.

Fleetfinder offer solutions from vehicle tracking and mobile data to satellite navigation. The reports available from the Fleetfinder will help an operator monitor the efficiency of their fleet, view the mileage of each vehicle and provide other information including the idling times of vehicles.

The Fleetfinder Mobile Data Terminals would also allow operators to communicate with their fleet, enabling two-way texting. The unit allows unlimited text messages between the operator and the driver. Job details, directions or messages to drivers can be sent via the data terminals which will reduce an operators communication costs.

3.4.2

Microlise

Microlise are in the industry for helping their customers improve the execution of their supply chain through the innovative application of best of breed technology. An innovative element of Microlise's Opus Fleet and Distribution portfolio is a low-cost satellite navigation system option. The solution goes hand-in-hand with Microlise's in-vehicle electronic Proof of Delivery (POD) solution. This normally consists of a rugged Mobile Data Terminal (MDT) or a lower cost personal digital assistant style terminal, with mobile communications - predominantly GPRS.

Particularly in ad hoc collection and delivery or multi-drop environments, such as courier services or home delivery, customers have found significant operational value by providing the driver with real-time navigation guidance. Microlise use TomTom products to make this solution attractive. According to the company's website, last mile satellite navigation can be provided for about a fifth of the cost of 'stand-alone' satellite navigation hardware and with no additional vehicle fitting. The addition of satellite navigation provides a more rapid return on investment on the often significant outlay made on the mobile data terminal in the vehicle.

The satellite navigation application provides both visual and audible turn-by-turn instructions. Microlise have designed the controls such that visual communication options can be configured to be displayed only below certain speeds or when idling or stationary.

3.5

Traffic Message Channels

With congested roads, demanding customers and costly fuel, fleet and logistics companies need up to the minute traffic information to make their operations run as efficiently as possible. Below are some useful traffic message channels to inform drivers of congestion in advance and provide re-routing guidance.

Combining satellite navigation with real-time traffic information helps traffic managers and drivers regain control of delivery schedules disrupted by unforeseen events such as road traffic accidents. iTIS Holdings and Trafficmaster are the two companies who provide real-time traffic data in the UK.

3.6

Digital Mapping for Satellite Navigation Systems

With the advent of GPS satellite technology, the accuracy and speed of establishing basic mapping control networks has greatly improved, enabling a position to be pinpointed within centimetres and ensuring the projections used to present the map data are of the correct size, orientation and position to the Earth. While this is crucial, the positioning of the satellite is also vital if features on the ground are to be pinpointed accurately.

As digital mapping accuracy improves it will be possible to provide a vast range of services. For instance, tracking systems utilising GPS technology have become essential for the transport industry, particularly when dealing with valuable or hazardous loads. The ability to accurately locate a vehicle enhances security and is important for optimising loads. If a company can pinpoint their vehicles when an urgent load becomes available, it becomes possible to divert an empty vehicle to pick up that load. It also enables freight companies to optimise the routing and calculate probable driving hours to avoid exceeding the limits set out in the imminent Working Time Directive for mobile workers.

While consistency of data is crucial, it is also important to consider its usability. All applications need both usability and consistency to succeed. Imminent regulations and facilities affecting road transport across Europe have made the joint issues of consistency and reliability an issue of concern for Great Britain's transport industry.

Based on our research into satellite navigation and digital mapping, the quality of any route planner depends primarily on the map material it uses. This is why continuous updates and upgrades are important.

Mapping data can be used and supplied in various ways for the use in satellite navigation systems. Mapping can be saved on a CD or DVD that can be downloaded onto the satellite navigation system. Mapping software can also be saved on a SD memory card that is located on the side of a satellite navigation unit.

According to Garmin, complete and accurate digital mapping information is either not available or is expensive. Garmin provide their customers with the most complete and accurate cartography that is available at a reasonable cost. Whether mapping information is supplied on CD, DVD or SD memory cards, there is no difference in the quality or depth of detail in the map information. However, mapping information and the amount of detail depends on mapping suppliers.

Many suppliers of mapping and routing software will sell updates of electronic maps as part of their package to operators. These maps increasingly contain far more information than is normally found on a traditional printed map. Data on, for example, nearby hotels, petrol stations, parking facilities and height or weight restrictions may be stored and made available when required. Below are mapping information suppliers to the vehicle and GPS navigation systems manufacturers:

3.6.1

Navteq

Navteq is one of the companies that is a mapping supplier feeding a new generation of important navigation services, including Internet websites, Enterprise/Fleet/GIS solutions and Location Based Services (LBS). Navteq provides applications for automotive, internet/wireless, government, and enterprise/fleet sectors, and has a growing array of products and services throughout the expanding digital navigation industry.

Navteq digital map data features road geometry and contains dozens of road attributes for every kilometre, everything from speed restrictions to lane configurations in more than 40 countries. Navteq digital map database also enables turn-by-turn directions to millions of Points of Interest (POIs).

With over 500,000 POIs throughout Europe, the maps make navigation easy. Petrol stations, service stations, ferry landings, exhibition centres, hotels, industrial parks and airfields are shown on the map. Mapping information also accounts for one-way streets and turning restrictions during route planning.

3.6.2

Tele-Atlas

Tele-Atlas offers digital maps and dynamic location content for a variety of automotive, personal navigation, location-based services, geospatial products and database solutions. Tele-Atlas has created a database that enables turn-by-turn route guidance and a whole range of points of interest (e.g. service stations, airports, parking facilities, etc) on the vast majority of European, U.S. and Canadian roads.

To help deliver powerful solutions to consumers, Tele-Atlas offer dynamic, content-enabled digital maps that provide location-specific road and travel information right to the driver via live incident feeds. Turn-by-turn directions, dependable rerouting, and reliable drive-time estimates can all be dynamically created based on real-world driving situations.

3.6.3

Ordnance Survey Mapping

The vision of the Integrated Transport Network (ITN) Layer of Ordnance Survey Master Map is to provide a detailed overview of Great Britain's transport infrastructure. The first two themes released are:

- **The Roads Network** – a network representing the roads in Great Britain for those who require increasingly sophisticated geographical data to support their applications; and
- **Road Routing Information (RRI)** – extending data functionality with features that may affect

a driver's choice of route including height and vehicle type restrictions, traffic calming, turn restrictions and one-way roads.

According to Ordnance Survey, the ITN layer will help to underpin telematics, making vehicle navigation a reality for both the transport industry and the everyday motorist. When coupled with real-time traffic congestion information, this cuts down journey times, reducing vehicular wear and tear and decreases environmental impact. ITN data, together with that of other OS MasterMap layers, lay the foundations for location-based services and assist:

- Haulage companies; Route and track their vehicles to help cut delivery times and reduce costs, plan resources with greater insight and reduce the cost of deploying more staff or vehicles than needed, boosting productivity. A typical haulage vehicle spends 97 minutes a day being unproductive; this adds up to more than eight hours in a five-day week (Source: www.ordnancesurvey.co.uk); and
- Courier and express companies; Calculate the fastest and most economical routes for drivers. Combined with the address layer, drivers can be routed from door to door without confusion or delay; ensuring goods are delivered on time to exactly the right places.

Road Routing Information (RRI) describes restrictions, permissions and other information relevant to drivers. The restriction information is not applied to the base network, but is referenced. This allows the range of information collected to be extended in the future and minimises the impact on customers not concerned with routing information.

The network features and attributions currently available are:

- **Road link classifications;**
Motorway, A road, B road, minor road, local street, alley, pedestrianised street, private road - publicly accessible and private road - restricted access;
- **Road link types;**
Dual carriageway, single carriageway, slips road, roundabout, traffic island, traffic island at junction and enclosed traffic area;
- **Ferry network;**
Ferry terminals, ferry link and ferry node; and
- **Routing information;**
No turn, mandatory turn, no entry, access prohibited to (specified vehicle types), access limited to (specified vehicle types), height restrictions, mini-roundabouts, traffic calming, gates, tolls, bridge over road, firing range, through route, severe turn.

Organisations such as the Freight Transport Association (FTA) are campaigning for the creation of a standardised in-vehicle application with known interfaces. This will ensure both consistency and usability of the devices. At the core of the FTA's solution are five key functions:

- Digital tachography;
- Lorry road user charging/congestion charging/toll collection;
- On-board management systems covering driver performance, vehicle diagnostics and vehicle security;
- Fleet management information (including tracking); and
- Network performance information including routing and real-time traffic.

Fundamental to each of these functions is the integrity, accuracy and consistency of the data. For those functions involving tracking, routing or real-time traffic feeds, the core requirements are accurate geographic data together with accurate positioning. When coupled with the appropriate application, such a solution provides the user with the geographic intelligence required in today's ever more demanding environment.

The use of telematics in the form of GPS technology for helping drivers find their way about is undoubtedly one of the most important benefits. Systems exist which can guide a driver across Europe and pinpoint a collection or delivery address at street level. Some programs update drivers on their position, including known danger spots and speed cameras, and can issue

appropriate warnings. Others will advise a driver that they are approaching the four and a half hours' driving time limit and a break should soon be taken.

3.7 Low Bridge Warning Systems for Freight Vehicles

Bridge strikes can mean a substantial cost for the vehicle operator. For the road haulier, there is also the cost of damaged goods and reputation. A bridge strike can also lead to the delay of other road users through diversions and queues, and recovery, reloading, and replacing damaged goods add costs.

Bridgeclear has developed a product, based on Global Positioning Systems (GPS), which warns drivers of high vehicles of the proximity of low bridges, thus enabling them to stop safely before hitting bridges and ideally, which would give prior warning so as to enable the driver to divert on to a safe route well before it was difficult to turn round. The availability of a database of low bridges is key to the product.



3.7.1 The Bridgeclear System

The Bridgeclear unit is a square box containing all the electronics for the system. The base product is a panel unit (145mm square box, 40mm deep), which can fit on the instrument console or on the heading of the cab of a vehicle. It is powered from the vehicle's electrical system. The other component is the GPS antenna, which provides the current location of the lorry and which fits on the roof of the vehicle.



The electronics compares the vehicle's height and location with a database of locations and heights for low bridges in the UK. The driver inputs the current height of the vehicle and the nearest low bridge, which would otherwise be hit, appears on the display showing the distance to it and the road affected. The direction of that bridge relative to the moving lorry is also indicated.

On the front panel is a display of the height of the vehicle, in Feet & Inches (up to 16'6") or Metres (up to 5.03 metres). There is an indication at the left of the main display as to which units are shown. There are buttons for adjusting the displayed height of the vehicle to that which it is at time of use. If the vehicle is a fixed height vehicle, e.g. a double-decker bus or rigid van, then this is set into the panel unit during the initial sequencing and is then fixed for that vehicle. Alternatively 'variable height' can be selected on installation.



3.7.2 The Advantages of Bridgeclear

- Bridgeclear gives a warning in the cab, in the driver's own environment. The BBC TV South West programme Inside Out on 16 September 2002 examined the whole subject of Bridge Strikes, notably at the A30 Tregoss Moor Bridge in Cornwall, which is hit about 10 times a year. Cris Burgess, a psychologist from Exeter University, who took part in the programme, is clear that hazard-warning road signs at the side of the road do not seem to have the impact that is needed to prevent Bridge Strikes. Only something which is within the cab and which warns drivers in their own environment will make an impact. That is precisely what Bridgeclear has been developed to do;
- Ideally, because the driver is reminded of a bridge, which is too low, well before they reach it, the driver can take a diversionary route and can avoid turning round where it may be very difficult and time consuming. Bridgeclear does not depend on any roadside or bridge based hardware that can otherwise be damaged or fall off, or if powered by batteries, fail. Bridgeclear bleeps if the GPS signal is lost;
- The Bridgeclear database can be updated through a socket that is part of the front display on the unit. Options can be chosen in terms of warnings to suit each company's needs and can be set on installation; and
- There is no national database for low bridges. Bridgeclear now has the most accurate database and have a contract with the AA to provide a base database, which is converted into Latitude and Longitude from Grid references. There are at least 5,100 bridges under 16'6" on UK roads and the Bridgeclear database includes these.

3.7.3

Future Potential

The Freight Transport Association and the Road Haulage Association have given Bridgeclear the opportunity to contact their members as they support the Bridgeclear product. The Department for Transport has a Bridge Strike Prevention Group, which meets twice a year to review the position. Network Rail has been supportive in giving details of their bridges and would welcome, together with train operators, a reduction in their costs by reducing bridge strikes.

Network Rail HQ and their regions have taken much interest in promoting the Bridgeclear product. Some Local Authorities have also been keen to support Bridgeclear, particularly Transport for London, who have been quick to see the benefit of:

- Less damage;
- Less disruption; and
- Less cost for both road and rail operations.

Leasing and insurance companies have also begun to see the advantages of their clients not hitting bridges, and are starting to support the fitting of Bridgeclear. Lorry manufacturers want to fit Bridgeclear to add value for their customers. Several companies have trialed the units and the general reaction has been very positive.

By fitting Bridgeclear, road hauliers can reduce the possibility of bridge strikes, and therefore provide an even more consistent service to their customers, and this may well contribute to reducing costs of their insurance, as well as contributing to road and rail safety.

This chapter reported on the types of satellite navigation systems available and the preferred systems that truck manufacturers would recommend to potential customers who purchase their trucks. Digital mapping information and its relevance to the freight industry has also been discussed in this section. The following chapter looks at how some freight companies currently use satellite navigation systems and the benefits/problems they experience by using such systems. Articles from the press have been reported to display current drawbacks of the system in the freight industry.

4 Market Review

4.1 Companies Currently using GPS Satellite Navigation

As with any other industry, technology has had a huge impact on logistics. In vehicle satellite (GPS) systems for vehicle tracking and management are now well established in the freight market.

By way of illustration as to the growing popularity of satellite navigation sales, particularly of the portable “ready to go” units, which are ballooning in the car market, currently running at 100,000 a month. A feature on Channel Five’s motoring programme “Fifth Gear” on December 12th 2005 revealed that the TomTom Go 300 is currently the market leader with approximately a 50% market share. However, they have recently released the TomTom One (pictured) which is said to have a faster processor, a more sensitive aerial for picking up GPS signals better and is cheaper than the other TomTom units. Plus a user can enter a full postcode to get directions. The system calculates routes quickly, and there’s still the built-in Bluetooth so you can hook up your phone to access TomTom Plus and their traffic information service.



Other products featured on the television programme included the Garmin i3 (pictured) which is currently being advertised heavily on billboards everywhere. It’s tiny and hence, very portable but according to the programme presenters the screen is probably too small. The Navman 520, which is the slimmest unit on sale and costs about £280 was also featured. It’s got nice looking maps, but unfortunately you can’t enter a full postcode so have to go through the tedious business of typing out the full street name. The size means it can usefully pop into a pocket when leaving the vehicle to avoid theft.



Thefts of these portable units are running at a high level. Recent figures from South Yorkshire Police (December 2005) showed that about 132 wayfinding units were stolen from vehicles in their county each month. This shows there is a ready market for these units this year.

The following are examples of companies who have already invested in satellite navigation technology in their vehicle fleet as a means of reducing vehicle mileage, improving road safety and helping reduce company operating cost. The views expressed in the following sections are entirely those of the contributing companies and are not necessarily those of Freight Best Practice.

4.1.1

ACR Logistics (Marks & Spencer large item home delivery)

ACR Logistics is one of Europe’s leading 3rd party supply chain providers, serving blue-chip clients in the retail, consumer goods, automotive/industrial and telecom/technology sector. ACR Logistics provides home delivery services on behalf of retailers operating in the home furnishings sector. Home Delivery solutions enable retailers to improve inventory management while at the same time offer a premium service that reflects positively on their brand.

ACR Logistics operates the Marks & Spencer large item home delivery using 14 tonne vehicles. In a trial to reduce delivery time and improve fuel efficiency by improved navigation, a selection of in-vehicle features were installed (vehicle tracking, satellite navigation, electronic Proof of Delivery (POD)).

The in-vehicle system was developed by Microlise and a Microlise In-Vehicle Computer (IVC) was installed into the delivery vehicles. The IVC incorporated GPS for vehicle tracking and GPRS modem for communication with the transport management centre. A handheld unit was also installed for satellite navigation and proof of delivery.

4.1.2

Ocado Home Delivery

Ocado was launched in partnership with Waitrose in January 2002. Ocado's service is now available to over 8 million households across the South East, the Midlands and more recently, the North West, enabling them to deliver to key postcodes and in new areas such as Cheshire and Lancashire.

Ocado's demountable-body delivery van fleet is seen as a key strength. Not all the advanced technology specified by Ocado has yet been implemented. Some underlying technology is already proving invaluable, and Ocado particularly singles out the Siemens VDO satellite navigation system that has been fitted in all the vans.



Satellite navigation is the key to timely deliveries. The company offers consumers very demanding one-hour delivery windows, so there's very little margin for the drivers to waste time trying to find addresses. For routing and scheduling Ocado is using a system from Descartes, for gathering accurate drive time and stop time data as it is a key to efficiency. The scheduling system will be linked to the navigation system, although currently drivers simply type in the required address themselves.

Feedback:

- Ocado do not use wayfinding in HGV's because they do fixed routes;
- Satellite navigation is used in all customer delivery vans, and the drivers could not do the job without these systems;
- Any cost and fuel savings are from eliminating vehicles getting lost/wayward drivers rather than any other inherent benefit;
- Ocado have never run the fleet without satellite navigation so they can not give any efficiency or mileage savings; and
- Occasionally the systems are out of date for changes to one way systems or new junction controls and over time a driver can identify routes/roads or crossings that are not exactly what a driver thinks the system thinks they are!

4.1.3

Sainsbury's Supermarkets

Sainsbury's has fitted 400 of its home delivery vehicles with Trafficmaster's advanced satellite navigation system - SmartNav. The contract signed between Trafficmaster's partner Cybit and Sainsbury's Supermarkets Limited also includes Cybit's Fleetstar-Online fleet management solution. The integration of the SmartNav and Fleetstar-Online solutions on one platform delivers cost and management efficiencies and provides Sainsbury's with a comprehensive telematics solution that supports its 'Sainsbury's to You' home delivery service.

SmartNav will provide Sainsbury's home delivery drivers with an easy to use navigation system that uses Trafficmaster's traffic data to calculate the best route around traffic jams. Sainsbury's will also be installing SmartNav's Touch Screen, which allows drivers to quickly select their next destination by simply entering the postcode.



The integrated SmartNav and Fleetstar-Online solution was chosen after a comprehensive analysis of the solution against competitive offerings. The assessment proved that the integrated Cybit and Trafficmaster solution would support Sainsbury's high customer service levels, ensuring the drivers made deliveries on time and at the correct addresses. The agreement also includes a programme of implementation and training services and future collaboration between all parties for further technology developments.

However, in order to achieve operational efficiencies in Sainsbury's home delivery fleet, SmartNav and Cybit's telematics technology plays an important part in achieving this. Feedback for using satellite navigation:

- Delivery drivers find satellite navigation very useful and they feel they can not operate without it;
- In terms of cost savings, due to the recent start of using satellite navigation, it is too early to tell;

- Sainsbury's have seen a significant reduction in late deliveries; and
- Sainsbury's do have problems with drivers having to re-route because the system has sent them towards a low bridge or a road not wide enough. This is because the solution has not been bespoke for the 3.5t home delivery van. However with the very effective implementation and change management tools Sainsbury use, most drivers understand that this sort of technology will never be perfect.

4.1.4

Eddie Stobart Ltd

Companies like Eddie Stobart are investing heavily in in-cab technology comprising of Personal Digital Assistants (PDA) which have the benefits of satellite navigation for better routing of the vehicle. The latest vehicles are fitted with on-board computers using GPS and RDS technology to provide drivers with vital operating data. Route, fuel and engine diagnostics are also combined in these units, which ultimately lead to more efficient use of the vehicle, generating greater cost savings for the customer as well as the Company.



4.1.5

Stan Robinson (Stafford) Ltd

Stan Robinson (Stafford) Limited provides a range of transport and logistics services to its blue chip client base. The company operates approximately 150 trucks from its four operating bases, Stafford, Glasgow, Teeside and Devon, each of which have vehicles equipped with VDO Dayton satellite navigation systems.

"Initially, we began installing VDO Dayton MS 3200 monochrome systems to assist new drivers on multi-drop operations to navigate their way," says the company's Managing Director Stan Robinson. "However, by the time we had installed ten of these systems they were proving themselves to be so efficient – not only with new drivers but with our regular drivers too – that we decided to upgrade to the full-colour MS 5400 unit. Currently, we have 55 of these in service."



"Our multi-drop drivers spend five or ten minutes before starting off programming in their day's drops, which we find is time well spent. The principal benefits we gain are a reduction in time wasted spent driving round looking for destinations and an according saving in fuel. As there is now no need to rely on maps, our drivers are free to concentrate on their driving, which I believe potentially enhances our safety in operation."

Stan Robinson Ltd installed the VDO Dayton MS5400 systems to assist new drivers on multi-drop operations to navigate their way. Having had these systems installed, the company felt that these systems were proving themselves to be so efficient not only with the new drivers but also with their regular drivers. The company currently has 55 of these in service.

Stan Robinson (Managing Director) quotes:

- "We have many new drivers and agency drivers and they don't know where they are going. Satellite navigation has helped us eliminate wasted mileage as drivers spend very little time searching for locations".
- "Now our drivers do not have to stop and ask for directions. This is saving us a lot of time and money and potentially enhancing road safety for both driver and general road users".
- "Drivers do not have to buy A-Z maps of the different areas now. With satellite navigation, our drivers do not need to refer to manual maps".
- "Satellite navigation systems are more useful and are of higher priority compared to tracking systems".
- "Our drivers are less stressed now, as the system makes the job less onerous. By providing drivers with such systems, has helped aid driver retention as the drivers do not leave the company".

David Lean (Workshop Manager) quotes:

- “The drivers in general find it a god-send”.
- “Even the two most reluctant drivers have changed their minds about the system and have had them fitted in their cabs”.
- “We have saved time and fuel, and we feel satellite navigation has made driving safer as our drivers do not have to keep referring to manual maps in their cabs”.
- “They help cause less congestion because there is no need to stop and ask for directions on busy roads”.
- “On multiple drop work, even the most experienced drivers tend to have several new drops everyday”.
- “Drivers have been told to use their own common sense in conjunction with satellite navigation, and don’t turn down inappropriate routes”.
- “I am not aware and have not heard of any of our lorries using inappropriate routes”.
- “We are approved dealers for tachograph systems and Siemens VDO satellite navigation systems, so we fit the units into the cabs ourselves. It takes us 3 hours to fit a system, and each system is wired into the electrics of the vehicle, therefore it’s less likely to be stolen”.
- “If Stan Robinson was not saving money, Stan would have not bothered putting the systems into the cab. All our new lorries are now fitted with satellite navigation systems”.
- “Reliability of these systems has been good. They have never broken down and have not yet given our drivers any problems”.

4.1.6**TNT Logistics**

TNT Logistics has been pioneering some high-tech systems in its drive to stay ahead of the market. For instance, it has been particularly active in vehicle tracking and in-cab technology, and in its use of the web for consignment tracking and visibility.

TNT’s regular partner for in-vehicle systems is Microlise. TNT is using its Opus Distribution system to manage proof of delivery and collection and Opus Fleet to provide vehicle and consignment tracking. However, many aspects of the solution are unique to TNT’s operation.



As part of its move to add delivery and collection management to tracking, TNT Logistics worked with Microlise to develop the Portapod "plug-in" telematics system, in which all the components are housed in a case that sits secured on the passenger seat and simply attaches to the 12 volt power socket.

Symbol handheld terminals are used with this system and run bespoke applications for capturing signatures to confirm proof of collection and delivery. GPS and receipt printing are also included to provide a complete mobile solution. This capability can be fully integrated with the customer’s own systems if required. In the case of Rolls-Royce, for instance, the data is linked automatically to its SAP system, as well as to an LIS warehouse management system.

TNT Logistics is also devoting attention to home delivery. The company has a substantial and growing business in this market, especially in the field of brown consumer electrical goods, furniture and other bulky or heavy goods demanding two-man crews. TNT’s objective has been to develop a system that can encompass all the key issues in this complex market, from customer contact to route planning and stock management.



TNT Logistics has taken a confident lead in the pioneering use of the BridgeClear system, in which a device is mounted in the cabs of tall vehicles and warns the driver whenever he or she is in the vicinity of a low bridge. An inbuilt GPS unit tracks the position of the vehicle and an internal database holds details of all the country’s low bridges and similar obstructions. When there is a potential conflict, visual and audible alarms are triggered, alerting the driver to a possible incident.

The system has now been rolled out to over 80 high vehicles in the TNT Logistics fleet, and Court says it’s working well. "When you consider that the average physical cost of a bridge-bashing incident is approximately £30,000, in addition to the human distress and operational disruption, you can see the attractions."

4.1.7

Westminster Waste Collection

Westminster City Council has installed satellite Global Positioning Systems (GPS) on its waste disposal trucks as part of a £32m a year project to clean up London's streets. More than 90 refuse lorries and 10 caged vehicles have been fitted with GPS tracking systems, allowing Westminster and its contractor Onyx to identify where each vehicle is and change schedules accordingly.

After increasing delays to collections - caused by road works, traffic accidents and public events in the capital - the council asked Onyx to install the technology to improve schedules and provide better updates to residents and businesses in the area. Information is sent wirelessly over O2's GPRS mobile data network. And with the trucks transmitting their location to the office every 45 seconds, the council is able to see their position on a computer screen, using a geographic database from supplier ESRI.



4.1.8

Queens Motors in Croydon

This south London based vehicle recovery company has not only saved fuel and improved fleet management control of its 60 vehicles, but has improved response time to call-outs by 25% with an on-board satellite navigation unit system from Siemens VDO.

4.1.9

Home Delivery Company in Warrington

A local home delivery driver reported that all their vans have SatNav systems. He uses the system occasionally because he knows his way around the local delivery area which is done from the local superstore. The SatNav systems are used all the time by a couple of drivers that do not have a good sense of bearings. The home delivery market is expanding and a fifth van is coming to the local store soon. The customers are offered a choice of 2 hour delivery windows from 10am until 10pm (although few deliveries are done after 9:30pm). The driver said SatNav helped particularly when he first started, but he now has regular customers.

4.1.10

P&H Food Distribution

P&H Food Distribution are now getting HGV drivers from Poland due to the shortage of HGV drivers in the UK. These drivers are being recruited from a driver agency in the UK who provides them with living accommodation.

P&H gives their polish drivers TomTom navigation units for wayfinding purposes so that the drivers do not have to worry about finding collection and delivery points. The company provides the polish drivers with a TomTom unit for 1 month which enables them to learn their routes. After a month, the TomTom unit is passed on to another new polish driver so that they can become familiar with their routes.

Polish drivers find satellite navigations very useful as it gives them the confidence to work and drive anywhere in Europe. These drivers are able to remember their routes within a month so satellite navigation is extremely useful for new drivers/agency drivers.

4.2

Taxi Company Views on Satellite Navigation Systems

One of the first transport industry sectors to see the benefits of satellite tracking and help in wayfinding were many taxi businesses. The use of live tracking enables the taxi controller to monitor the whereabouts of a large fleet of cars and to allocate incoming jobs in a much more cost effective way. It reduces the need for telephone or car radio communication and shows the status of each car as to whether they are available for hire or not, by using green or red cars on an electronic map.

A comment from Allens Taxis of Coventry, which run over 200 cars in the city, was that Global Positioning Systems have revolutionised the taxi business, making it more efficient, it is better for the cabbies as they get more fares per day, there is less empty running and customers get a quicker response. Although most taxi drivers know their way around Coventry, the mapping helps when on journeys outside the local area.

A 'cabbie' from Station Taxis of Hull said that the "autocab" wayfinding system with a small visual display unit in each cab is useful when you are not sure where the road is and it does save a lot of time. He also said that a GPS system allows a controller to run many more cars effectively. Using



manual systems a controller can only really run about a dozen cars properly, beyond that inefficiencies creep in.

However not every taxi company uses this type of system yet, a cab driver from 57-57 taxis also in Hull, said that driver knowledge is what is required and he didn't think there was a need for this type of system.

4.3

Freight Vehicle Driver Views on Satellite Navigation Systems

During the research stage of this study, the project team felt that it would be very useful to have views on satellite navigation systems that are already used by freight vehicle drivers. Below are quotes by HGV drivers who have used and are using satellite navigation for wayfinding:

- “TomTom is pretty much OK except it doesn't have any HGV friendly options like avoid narrow turns, etc. You can set the road speeds to prefer major highways - those tend to have wide turns. CoPilot Live has a special "RV" mode that takes this into account. In any case the navigation system is merely an aid so you don't get lost. You have to keep judging road quality and suitability yourself”.
- “TomTom doesn't really have a HGV routing mode. Other GPS programs like CoPilot and Garmin do have HGV routing mode though. Don't forget that none of the systems on the market are 100% foolproof. From time to time, it may also tell you to do a u-turn on a dual carriageway, go the wrong way down a one-way street or make an illegal turn. It's up to the driver to decide if they want to do it or not. If it does direct you down an unsuitable road then ignore the direction and the software will calculate a new route for you when you miss the turn. If you use 'Fastest' routing rather than 'Shortest' then you will get routes based on major roads which would suit larger vehicles”.
- “You will have to take care when driving and if it tries to take you down a weight limit then carry on and let it find another route. As for low bridges, download the low bridge POI from the database. The list is not complete but it's getting there. The best thing you could do as well as using the TomTom is to get an AA truckers atlas. This has all low bridges on most main roads and also get a good London A to Z there are so many weight, height and width restrictions.”

(Source: www.pocketgps.co.uk – Forum on navigation for LGV's and HGV's).

4.4

Articles in the Press regarding the use of Satellite Navigation

The following articles about SatNav usage in the freight industry appeared in the national press when this report was written:

Example 1: Satellite navigation is blamed for heavy lorries being redirected through a historic wool town in Suffolk and causing damage to buildings. Some navigation systems used by lorry drivers from overseas designate use the A1141 road through historic Lavenham as an acceptable route across East Anglia. However, the road runs along Water Street in the Suffolk wool town, a road originally designed for two carts. Conservationists are trying to get the navigation systems changed. Suffolk Preservation Society wants the databases to show the sensitivity of the route.

Richard Ward, from the society, said: "It is a major worry because the drivers see this as the quickest route and go through the town at significant speeds. They also get very close to the historic buildings, some of which have overhanging jetties. Drivers just tap their destination on an east-west journey into a satellite navigation system and it gives them an acceptable route through the centre of Lavenham. The narrow streets get congested and the heavy lorries damage the buildings. We now need to get these databases changed."

(Source: www.bbc.co.uk – Satellite Navigation blight Lavenham).

Example 2: Satellite navigation may soon consign paper maps to the great waste bin of history. The sooner the better, many will say. Maps are bulky, difficult to fold, and somehow destinations always seem to be right on the edge.

The good news for the cartophobic is that satellite navigation systems are becoming cheaper and better than ever. These neat little devices - which display maps or directions on a small screen and announce when to make a turn - used to be £1,000 optional extras on luxury cars, but new portable systems cost as little as £370 - and have the advantage that they are not built into the vehicle, so they can be taken on holiday and used in rental cars.

According to Laurent De Hauwere, of digital map-maker Tele-Atlas, the dramatic fall in prices has led to an explosion in satellite navigation (SatNav) sales, with the market for handheld units growing at about 300% a year. "About a quarter of buyers get the devices to take on holiday," he says, "while about 20% are "comfort seekers" - people who don't like getting lost or trying to navigate for themselves wherever they go."

Driving in unfamiliar places is stressful and can lead to stinking rows between driver and map reader. How much more relaxing to enter an address or just a postcode, and let the SatNav plan the route. The reason is that making digital maps is a huge and time consuming job, involving satellite photography, paper maps and even driving around in special vans.

There are other drawbacks as well. Just as mobile phones mean no one can be bothered to remember phone numbers anymore, so SatNav could mean we eventually surrender our sense of direction to these boxes of gadgetry. In other words, if you throw away your A-Z and come to rely too much on satellite navigation, you'll be well and truly lost without it.

(<http://news.bbc.co.uk/1/hi/magazine/4124760.stm>).

Example 3: Concerns of using satellite navigation for lorry use have also been raised recently by residents in Dorset. According to a recent article 'Shock finding of SatNav mapping' in Dorset, delivery vehicles using satellite navigation systems are being routed along some of West Dorset most unsuitable roads to reach commercial centres. Satellite navigation systems are based on virtual computer maps that bear no relationship to the suitability of the routes. There must be some law about selling misleading information, and or the damage to the freedom to enjoy ones property relevant to the dissemination of this software.

(Source: 'Shock finding of sat-nav mapping' – www.thisisdorset.net).

Example 4: Electronic navigation yet to overtake local knowledge, say delivery firms. More than 9 out of 10 delivery firms rely fundamentally on their drivers' local knowledge rather than electronic navigation systems, research from Ordnance Survey reveals today.

Despite the availability of computerised route planning, 94% of heavy goods and express parcel delivery firms said they still depended above all on their drivers' familiarity with the road layout. Of the 272 firms who took part in the national opinion poll (NOP), only around a fifth use in-cab navigation aids of one kind or another.

"There appears to be significant resistance to some kinds of new technology," says Andy Embling, Ordnance Survey's Transport Marketing Manager. "Firms are still heavily reliant on drivers despite the consequent drop in productivity when they move to another job, or a contract driver is used during sickness or holidays."

However, more firms are now beginning to look to electronic help to complement first-hand human knowledge. Those already using in-cab navigation are mostly the larger firms investing in infrastructure improvements and so putting further competitive pressure on smaller operators such as local couriers. These in turn are increasingly going for online systems such as free-to-use Internet services.

Only a few of the firms questioned could immediately name their supplier of electronic mapping. After prompting, the top three organisations named were Trafficmaster, AA and Ordnance Survey. Mr Embling says: "We found this intriguing as although we supply the data that underpins routing, scheduling and navigation, it is our Licensed Partners rather than us who actually supply those commercial applications."

The NOP found that vehicle tracking was one of the key benefits of geographic information for transport along with a greater ability to monitor performance, efficiency improvements and the currency of information. Indeed, Minorplanet and Tracker – both firms with vehicle tracking products – were only just behind Ordnance Survey in terms of awareness.

Mr Embling says: "We will see further pressure on transportation companies to reduce costs as the Working Time Directive is applied to mobile workers, and as further attempts are made to manage congestion via charging and tolls. We believe more companies will look to optimise schedules and improve efficiency through geographic information such as our new standard in digital data, OS MasterMap, and transport applications from our commercial partners."

The NOP is one of a number of Ordnance Survey activities designed to highlight the benefits of intelligent geographic information for the transport sector. Ordnance Survey has recently sponsored a Road Haulage Association conference and a Transport Manager seminar series run by the Freight Transport Association. The mapping agency also sponsored one of the Institute of Logistics and Transport's annual awards.

(Source: Ordnance Survey; 03/08/2004).

Before trialling satellite navigation in the freight industry, it was important to understand the benefits and drawbacks of the system. The press articles featured in this chapter shows the effects of satellite navigation to local residents and local authorities. However, companies that are currently using the system have been able to achieve cost reductions and reduced mileage run due to 'lost running'. The in-fleet wayfinding trial, discussed in the next chapter looked to explore the benefits and drawbacks of such systems. Qualitative and quantitative data analysis has been used to show the effect of using satellite navigation systems in the freight industry.

5 The Trial

5.1 The Research Method
Before commencing this research study, it was important to develop a detailed understanding of the satellite navigation manufacturers, truck manufacturers, mapping suppliers and freight companies that should be approached to participate in such a trial.

As considerable research was carried out into available GPS satellite navigation systems, thought was given to deciding which companies should be invited to participate in such a trial. Company selection was based on:

- Companies already using satellite navigation systems;
- Nature of the business (e.g. home delivery food and non-food companies, skip hire companies, parcel/furniture delivery companies, car transporters and rural delivery operations);
- Market share; and
- Company environmental policies.

Selecting freight companies was fundamental for the methodology because the ultimate success of the study depended on the number and quality of participants. For this study, companies were initially contacted in writing and by phone, and if interested they were invited to a workshop where they received a more comprehensive briefing about the project. This was done to ensure the selection provided a truly representative sample.

To ensure that companies participated in this research, the project team fully explained the potential benefits to participating organisation. Benefits to participating freight companies included:

- Drivers guided direct to delivery area via postcode or address;
- Reduces the need for voice communications to secure new route planning information, saving time and money;
- Optimises journey times, increasing the available working day for more customer visits and deliveries, reducing the need for overtime and increasing driver's own free time;
- Reduces wear and tear and depreciation on vehicles as distances to each defined location are reduced, and less need for drivers to start/stop;
- Reduces driver stress;
- Reduces time on pre-journey planning for example, looking up addresses, sketching directions and receiving location maps, etc;
- Avoids drivers stopping on yellow lines to ask for directions, causing disruption to road users. Therefore better health and safety for drivers and road users;
- Good publicity for companies participating; and
- The project team did undertake much of the work and provided a high level of support throughout the trial.

Other benefits from Freight Best Practice to participating companies in this study were to:

- Help truck fleet operators save money and increase profits;
- Help improve operational efficiency;
- Reduce the impact of freight movement on the environment;
- Improve driver safety; and
- Increase business profitability.

5.1.1 *Existing Companies already using Satellite Navigation*

By referring to the companies already using satellite navigation for deliveries (e.g. Ocado, ACR Logistics, Sainsbury Home Delivery and TNT). These companies were contacted for further information regarding the usefulness of GPS satellite navigation on their organisation.

Feedback regarding benefits/drawbacks with satellite navigation was obtained from these companies as they have been using the system. As these companies are in different sectors of the freight industry, any information they provided was very useful for this research study.

Truck manufacturers recommend navigation products such as VDO Siemens and Clarion to their customers. Some freight companies therefore already use satellite navigation systems for their operations. Obtaining this information from truck manufacturers was difficult due to customer confidentiality, but any company information obtained was very useful for the study.

5.1.2 *Contacting Freight Operators*

The Road Freight Transport Industry is one of the largest “service” industries in the UK. It is a major national employer and has a major effect on all our day-to-day lives. A few statistics serve to emphasise this:

- 82% of all inland freight is moved by road;
- 97% of all goods in the Construction and Food industries are moved by road;
- 15% of all of British industry’s costs relate to the movement of freight; and
- The industry is made up of nearly 53,000 companies, ranging from one vehicle “owner - driver” concerns to multi- million pound turnover corporations.

(Source: Road Haulage Association)

The vast majority of the products we use in our daily lives do come into contact with the Road Haulage Industry. Despite the Government’s wishes to move more freight by other means of transport, for the foreseeable future the vast majority will remain tied to movement by road.

The Road Transport Industry is a varied and wide ranging one. The industry sectors below give a very general guide to the various sectors of the industry that satellite navigation could be trialled:

- Parcel/courier delivery services;
- Home delivery companies;
- Groupage/general haulage;
- Rural delivery operations (farms); and
- Special Types; for example car transporters, furniture delivery companies, home and office relocation companies, Skip collection/delivery companies.

There are many GPS navigation products that could be trialled, but this depended on the number of freight companies interested in participating in this study. In order to motivate operators to participate and collect good quality information, the project team was connected with their key business objectives.

Satellite navigation was trialled in the following sectors of the Road Haulage Industry:

1. Paper merchant distributor;
2. Drinks trunking and direct-to-store delivery;
3. Chemical manufacturer/distributor; and
4. Container distribution (Owner drivers).

5.1.3 *Pre and Post Survey Analysis*

The quality and choice of satellite navigation products have improved considerably in recent years. However, in order to promote the benefits of these systems to HGV operators a practical ‘before’ and ‘after’ trial of these systems provided an opportunity to quantify the benefits of wayfinding systems that could help guide the future development of satellite navigation systems for the freight industry.

5.1.4 *Pre-survey Analysis;*

Once we selected a number of freight companies to participate in this survey, and before we commenced with the trial, the project team examined participating company operations by:

- Reviewing driver time sheets;
- Analysing tachographs;
- Monitoring fuel consumption;
- Reviewing mileage returns; and
- Monitoring driver behaviour and driver comments.

5.1.5 *Post survey Analysis;*

Having collected and reviewed the information/data from the pre-survey analysis, the project team then conducted trials using wayfinding GPS systems. Once we began the trial using the GPS wayfinding systems, monitoring devices were used to assess examples of improved efficiency and reduced mileage. Driver behaviours and views on the wayfinding system were also captured, showing the effectiveness of such systems in the freight industry.

5.2 **Research Study Methodology**

Operational efficiency, energy consumption and fleet operating costs are affected by the ever increasing impact of road congestion and the amount of wasted mileage that occurs due to the ‘last mile’ wayfinding. The measurement tools that have been used in this research study have provided a consistent basis for measuring transport efficiency across different fleets.

As stated in the report, the quality and choice of satellite navigation products have improved considerably in recent years. In order to promote the benefits of these systems to freight transport operators a practical before and after trial of these systems has provided an opportunity to quantify the benefits of wayfinding systems that will help guide the future development of satellite navigation systems for the freight industry.

5.2.1 *Aims*

The aim of the methodology for the wayfinding research study was to devise and pilot a set of measurement tools that were appropriate to freight transport operations and which enabled us to assess the effectiveness/usefulness of satellite navigation systems in freight vehicles. The project methodology followed the phases below:

- Measurement techniques were developed to evaluate the usefulness of satellite navigation systems in the freight industry (this is explained later in this report); and
- Having decided on useful measurement criteria’s, attention was concentrated on signing up participating companies, developing the measurement data collection techniques, supervising the survey, analysing the survey results and producing the required written outputs, which in turn have helped produce and conclude the wayfinding research study.

The wayfinding research measurement criteria was addressed with the aims of providing the project team with data/information that examined:

- Effects on efficiency;
- Time saved/lost by using satellite navigation;
- Effects on fuel costs;
- Effects on vehicle wasted mileage;
- Effects on operating costs;
- Effects on customer service;
- Fleet size (if satellite navigation enables operators to carry out more drops, then there is a possibility that vehicles could be spare as an indirect effect of using satellite navigation); and
- Driver performance and attitude.

The project team devised a methodology and data collection techniques that was consistent and practical by working closely with participating companies. The trial took place at the beginning of October 2005, after an initial training period of staff in September 2005.

5.2.2

Guidelines for the Wayfinding Trial

Having decided on the measurement criteria for the wayfinding study, the project team considered the following issues when undertaking the in-fleet trial. More detailed information on guidelines for In-fleet trials can be referenced in the Best Practice guide 'In-fleet Trials for Fuel Saving Interventions for Commercial Vehicles'. The most important guidelines were:

- **Participating company culture**

The most successful in-fleet trials occur in companies with a strong culture of managing costs and performance. It is difficult to undertake an effective trial where there is limited commitment and understanding of the potential benefits. The performance management culture of a company would not only benefit the trial procedure but also the entire operation of the business, from financial management to compliance issues.

- **Participating company staff**

The project team established and maintained the interest and commitment of the management team to the project. Without this, it was unlikely that the project team would have assessed the full extent of the potential benefits. The project team set a realistic period of time for testing (eight weeks), so it was important that the participating company staff promoted the project and demonstrated belief in it.

- **Timescale**

In general, the longer the trial period, the more informative the results are. The project team established a realistic timescale (eight weeks) for the testing process in order to gain full understanding of the performance of an intervention.

- **Planning**

As with any project, an in-fleet trial must be planned. The project team established the factors to be tested, the aims, timescale, and responsibilities; hence the plan was simple. For this trial to be successful, the project team knew what had to be achieved, and as explained earlier in the report, the main aim for the wayfinding trial is to reduce mileage and fuel use by using satellite navigation systems.

In order to maintain reliability, and ensuring the processes are easily explained and understood, it was sensible to keep the trial as simple as possible. Therefore, the data collection methods set-up were easy to follow.

- **Responsibility**

The project team nominated a person who had general responsibility for the project. This 'Trial Champion' managed the project and was the main point of contact. However, for the wayfinding trial it was important to assign responsibility for various elements of the trial. For example, the drivers had responsibility for ensuring that their data collection sheets were filled in correctly, and reporting any errors of the system (discussed in more detail later in this report).

- **Participation and training**

The project team ensured that all those involved in the trial were informed of their roles and responsibilities. This was carried out through meetings and written information. The project team also felt that it was important to train everyone involved in the wayfinding trial to undertake their specific tasks. This ensured that participating company staffs were familiar with the processes and systems so they would interact with them correctly.

- **Research**

Before proceeding with the trial, considerable desk based research was carried out by the project team. The research highlighted the main satellite navigation suppliers in the market, the companies that were already using such systems in the freight industry and feedback has been obtained from such companies. This gave the project team a good idea of the nature of the market and has helped select the satellite navigation suppliers.

- **Support from suppliers**

Without the right support, the trial would be ineffective. The project team needed to ensure that satellite navigation suppliers were able to provide support needed in the trial period. The things to be considered include how the equipment works, how it can be replaced or repaired if defective and what the supplier contact process is.

- **Cost analysis**

The main reason for trialling satellite navigation systems in the freight industry is to save money. However, the project team balanced the cost against potential savings. It was also useful for the project team to obtain figures for participating company's current costs and fuel consumption.

- **Trial size**

The trial was big enough to negate chance factors that may affect results. The choice of trial size depended on participating company operations. The larger the sample, the more effort would be required to carry out the trial and the more money may be needed for the equipment. For example, the trial lasted eight weeks, of which four weeks was 'before' satellite navigation, and then after a week of getting used to having satellite navigation systems, driver runs were monitored for a further four weeks.

- **Operational factors**

The type of operation did have an impact on the trial process. Where possible, for the wayfinding trial, the vehicles were on similar operations rather than very different types (e.g. some long distance and some urban multi-drop), or in varied geographical regions. In order for the project team to gain a true impact of the use of satellite navigation systems in the freight industry, the following industry sectors/operators were targeted:

- Soft drinks company (trunking and local delivery operation);
- Stationary and printing (bulk and multi-drop deliveries);
- Containers (trunking); and
- Chemical manufacturer/distributor (multi-drop deliveries).

- **Tampering**

All those who came into contact with the trial were made aware of the process, so they did not accidentally amend or change equipment. Involving everybody positively led to an understanding of the reasons for the equipment, and less fear and concern about what it was for.

- **Feedback and data recording**

The way data was recorded was crucial to obtaining a true picture of the trial. If the data collection process was ineffective, the trial would not have been a success, so it was important to implement just one method for recording which was easy to use and hence reliable. The data collection methods have been explained in detail later in this report.

5.2.3

Measurement Areas

In the interests of consistency, the project team set out to follow as closely as possible the approach taken in previous Best Practice key performance projects. Below are the measurement categories that were looked at for the freight specific satellite navigation trial:

- Fuel consumption;
- Vehicle utilisation;
- Time utilisation;
- Delays;
- Maintenance costs;
- Increased congestion;
- Safety related incidents; and
- New staff training.

The most effective way of ensuring the suitability of an intervention was to test it in the vehicle fleets. This enabled the project team to gain better understanding of its benefits and drawbacks. Establishing our own in-fleet trial required careful thought and consideration. The process was robust but flexible. It was also necessary to obtain as much accurate information as possible.

If the testing was not thorough enough, then there could have been a decline in performance when it was introduced into the fleets. As a result, it was important for the project team and operators to understand the relative merits of fuel saving interventions and how to test their effectiveness.

The measurement tools that were chosen fulfilled a number of key requirements such as:

- Measurement of energy use;
- Relevance to operator;
- Ease of understanding by those compiling the data;
- Relevant to analysis of individual vehicles and fleets; and
- Relationship to data already collected by operators to measure effectiveness.

5.2.3.1

Fuel Consumption

Measuring fuel consumption was crucial for managing the cost of any freight distribution operation as fuel represents about 30% of operating cost. Fuel consumption in any in-fleet trial can be affected by factors such as:

- The weight of vehicle and load;
- The frequency of stop/starts;
- Age of vehicle;
- The engine size and gearbox;
- The terrain of the journey (hilly area);
- The number of drops/collections in a shift;
- The specification of the vehicle (body type, aerodynamics, wheels/tyres);
- The dominant type of road (motorway or urban);
- The nature of the driving conditions (weather); and
- Driving technique.

Fuel usage, whether it is measured in kilometres per litre or energy intensity is important. Wayfinding did have a bearing on fuel usage by reducing the slow running and stop/start looking for a destination. For this research study it was important to collect information on:

- Vehicle kilometres travelled;
- Fuel in litres; and
- Vehicle category.

It was anticipated that fuel costs will reduce as a result of reduced wasted mileage by planning more efficient routes and will improve average miles per gallon as a result of minimising time spent in searching for delivery/collection locations.

For this research, the project team collected fuel in litres per shift per day over the trial period. This data was collected by the participating company's traffic office and data was entered into the 'traffic office weekly vehicle sheet' (Form 'B') which can be viewed in the appendix.

5.2.3.2

Vehicle Utilisation

Companies participating in the trial were expected to use a wide range of unit loads due to the great diversity of products within the freight industry. The industry sectors for this research study ranged from a chemical manufacturer, a paper merchant, to a drinks distributor.

Vehicle fill is normally measured in weight, volume or deck space used and these limiting factors are related to a day or a load. Efficient operators optimise both weight and volume by mixing of loads. It must be remembered that trips involving a number of legs with multiple deliveries from the same initial load that the first leg will have the best utilisation. Wayfinding using satellite navigation may have helped vehicle utilisation indirectly in allowing a vehicle scheduler to put more drops on to the vehicle in the longer run as in theory, journey time would be saved due to lost running giving the driver more time to carry out the drops.

By using satellite navigation the participating companies did recognise the financial and environmental benefits of increased utilisation on second and subsequent legs. Vehicle fill data, as with the fuel data was collected by the participating company's traffic office and data was entered in the 'traffic office weekly vehicle sheet' (form 'B') which can be seen in the appendix.

5.2.3.3

Time Utilisation

Lorry drivers that are on the tachograph are subject to EU Driver's Hours legislation. This legally requires them to take rest breaks during the working day and have sufficient overnight rest. Although the legislation applies to rest, it does by implication affect the duty time of the driver. If a significant period of this duty time is incurred looking for destinations then the productivity of the driver and hence the vehicle is less than optimum. The more hours a day a vehicle is in use the better in terms of spreading overheads like depreciation, road tax, insurance, etc.

The finding of destinations is a cost to industry that is absorbed into normal operations. In many businesses it is a relatively small amount but in other businesses it can represent a significant part of the day. Audits were used to monitor how vehicles and drivers spent their time during the survey period as it was important to find out if the time spent was productive or unproductive. The following data was collected regarding how driver's spent their time:

- Total time (driver shift time);
- Lost time in finding delivery drop locations; and
- Hours per day in use.

In this trial, the total time for drivers (time of shift) was collected by the traffic office, and this was obtained from the driver time sheet. The total driver time was recorded on form 'B' and was then totalled at the end of each week during the trial period.

On the other hand, the driver filled their 'weekly driver record sheet' (form 'A') which can also be viewed in the appendix. On this form the driver recorded per shift and per day the following:

- The total number of time spend searching for a locations;
- The total number of deliveries and collections;
- The total number of late deliveries; and
- Drivers also specified when the satellite navigation system sent them down inappropriate routes.

The use of satellite navigation can indirectly improve vehicle efficiency, which could lead to a reduction in the sizes of vehicle fleets. This could have positive operational implications such as reduced capital investments and lower maintenance costs, but due to the nature and time scale of this trial, the project team were unable to explore these benefits.

5.2.3.4

Delays

The impact of delays on energy use is significant but it also results in increased capital investment in vehicles and higher employment costs. Measuring delays was included because instability in transport schedules can have a bearing on vehicle utilisation as it makes it more difficult for companies to plan backhauls and more complex multiple collection/delivery rounds. It also affects both the time utilisation of the vehicle and its fuel efficiency.

Survey participants (mainly delivery drop drivers) recorded significant delays affecting their delivery drops against categories such as:

- Traffic congestion;
- Delivery point problems;
- Collection point problems;
- No driver;
- Driver hours problems (needing a break);
- Missed time-slot which cause knock on delays; and
- Vehicle breakdown.

A key performance indicator that needed to be measured for this research was the time a driver spends looking for next destination. In terms of data collection, the participating company

drivers recorded the total number of late deliveries on their weekly driver record sheet (form 'A'). This enabled the project team to work out the percentage of late deliveries as the total number of deliveries and collections was recorded by the traffic office and driver on their input sheets (form 'A' and form 'B').

5.2.3.5

Maintenance Costs

There is a considerable amount of wear and tear on the vehicle "drivetrain" and braking system with low gear driving and stop/start. It was difficult for the project team to directly attribute any savings from wayfinding to this.

5.2.3.6

Increased Congestion

When drivers are looking for a delivery point they often travel at slower speeds causing following traffic to tail back. Another example is when lorries are parked in inappropriate places awaiting instructions which can cause an obstruction and can result in a bottleneck, albeit for a short time. Some new systems can alert to the live presence of congestion and this could be useful in planning evasive action on route selection. The project team were unable to directly attribute any savings from the use of satellite navigation to this as real-time traffic information was not available.

5.2.3.7

Safety Related Incidents

A number of accidents happen each year concerning vehicles stopping abruptly when a driver spots a likely member of the public or passer-by to ask for "last mile" directions. When drivers receive advice particularly if they are travelling in the wrong direction, a manoeuvre may occur to regain the correct route. Sometimes this manoeuvre may be a u-turn or reversing into side streets etc. which may be dangerous. The extent of the problem is not known but when a driver is faced with time deadline constraints they are more likely to take risks to regain the correct route.

5.2.3.8

New Staff Training

Satellite navigation systems helped to get staff up to a productive level quicker in fewer days. In addition for companies that use agency staff it meant that they were more efficient as one of the biggest problems with temporary staff is that they are unfamiliar with any of the drops.

5.2.3.9

Measuring and Collecting Data

In order to collect data/information for the wayfinding research study, it was important to have key staff of participating companies to collect information for the project team. It is understood that any data collection process imposes a significant extra workload on staff during the trial period. Therefore great emphasis was placed on ease of use of the data collection data sheets and questionnaires that were developed to address the issues.

For this research study, the involvement of the following key staff was required to assist the project team collect data, drivers, traffic office staff and transport managers. By equally distributing the data collection workload it helped to reduce the burden on staff to collect data.

5.2.4

Drivers

The project team anticipated that company drivers will comment on ease of use of their satellite navigation system, record data on the amount of time saved each day and record any problems with being routed up inappropriate roads.

To collect this information, the project team developed a 'weekly driver record sheet' (form 'A') specifically for drivers, which can be viewed in the appendix. This form required drivers to provide information on:

- Type of navigation system used;
- Vehicle type driven;
- Number of minutes spent searching for locations;
- Total number of deliveries and collections;
- Total number of late deliveries; and
- Situations when the satellite navigation system routed them down an inappropriate road.

Gathering driver views on the satellite navigation system that they used were an important aspect of the research study. In order to collect this information, it was sensible to gather data via a simple questionnaire that was filled in by drivers at the end of the trial period. An example

of the driver questionnaire (form 'C') that was developed by the project team can be seen in the appendix.

The aim of the driver questionnaire (form 'C') was to understand and gather information of what the drivers thought of the satellite navigation system they used. Once this information/data was collected, the data was tabulated and analysed to determine the most user-friendly satellite navigation system and the usefulness of navigations systems in the freight industry.

5.2.5

Traffic Office Staff

Traffic office staff of participating companies were also responsible for some data collection for this research study. For the wayfinding study, it was important to collect data on factors such as load weight, number of loads and drops, driver time of shift and fuel and vehicle kilometres travelled per shift.

The project team developed an Excel spreadsheet called 'traffic office weekly vehicle sheet' (form 'B') which can be seen in the appendix. On this form, traffic office staff collected and inputted data for each shift on:

- Number of loads;
- Total number of delivery and collections;
- Vehicle fill (weight/volume);
- Total time;
- Total kilometres per shift; and
- Fuel in litres per shift.

This information enabled the project team to carry out statistical analysis and examine the results to determine the usefulness of wayfinding systems in freight operations.

5.2.6

Transport Manager

For the wayfinding study, the project team felt it would be useful to gather general comments and opinions of transport managers on the use of satellite navigation in the freight industry. In terms of obtaining information regarding the ability to plan more work and whether new/agency staff performance improves as a result of using satellite navigation, transport managers were the best people in participating companies to provide the project team with this information.

This information was gathered via a simple questionnaire that was filled in by the transport managers at the end of the trial period. An example of the transport manager's questionnaire (form 'D') that was developed by the project team can be viewed in the appendix.

The aim of the transport manager's questionnaire (form 'D') was to understand and gather information on what transport managers thought of satellite navigation system and how they affected their operations. Having obtained this information, the data was tabulated and analysed to determine the usefulness of satellite navigation in freight operations from a transport manager's point of view.

In theory, satellite navigation could also be a solution to certain business problems such as:

- Poor vehicle MPG;
- Delays and overtime costs due to looking for local addresses on multi-drop work;
- High vehicle maintenance cost;
- If the planner gives the driver too much work, the driver could bring the work back to the depot;
- Communication costs between driver and traffic office;
- Unpredictable traffic delays frequently interrupting the schedule;
- Poor customer service due to lack of knowledge of vehicle location;
- No accurate estimated time of arrival available for customers;
- Road safety concerns; and
- Driver performance and attitude.

The above points were also part of the questionnaires where transport managers and drivers scored the usefulness of satellite navigation systems in the freight industry. This has assisted the project team to explain the benefits/drawbacks of such systems in the freight industry. With regards to the measurement of safety, the questionnaire covered this by questioning drivers

and transport managers on safety and their views on the contribution of satellite navigation to better road safety will be assessed.

5.2.7

External Factors

In an ideal world, it is sufficient to carry out comprehensive trials on interventions and simply make decisions based on the results. This makes evaluation easy and to a larger extent, designing a robust trial system with numerous processes, can certainly help. However, there were numerous external factors outside the control of the project team. The impact of these were minimised but they played an important part in the overall trial process as, if they are not taken into account, the end result would have been inaccurate.

The external factors have been discussed below, but more detailed information on external factors can be obtained from the Freight Best Practice guide on 'In-fleet Trials of Fuel Saving Interventions for Commercial Vehicles'. The main external factors considered for the in-fleet trials were:

- **Unforeseen circumstances**

Controlled tests can be affected by unforeseen circumstances. For example, if the person appointed to take responsibility for the trial becomes ill or changes job half way through, the entire trial could fail without their skills and knowledge. Therefore, consideration was given to 'chance' factors and the extent to which we were able to do this depended upon the size of operation and trial.

- **Flexibility**

A degree of flexibility in any trial procedure is essential to incorporate any unforeseen factors. This required a balance between control and adaptability. For example, the wayfinding trial has been conducted on four vehicles per company, and if one of the vehicles got damaged in operation, requiring long term repairs, there was a need to have flexibility to take this into account in the trial and bring another vehicle into the trial as a replacement.

- **Weather**

This is probably the greatest factor affecting trials. If a vehicle is subject to heavy rain or snow, its performance is likely to be affected. It was important to take into account the varied climate when establishing a timescale for a trial. If the wayfinding trial was for a longer period (one year), then the climate factors would have been considered, but in this case the trial period is eight weeks, hence weather was not an important factor to measure.

- **Informing participants**

Participation and communication are vital for the success of any trial study. If the trial was not well managed and participants were unaware of their responsibilities, mistakes could have occurred. Careful consideration was given to involving all employees whose actions may affect the results of the trial to avoid such mistakes.

- **Operational changes**

The important thing built into our measurement system was the ability to record changes. The project team was aware of any changes made to a trial vehicle's operation during the trial period. If for example, a vehicle was being used for trunking and was then used for an urban multi-drop, this was factored in. With the wayfinding trial, the participating company industry sectors have been identified, so all vehicle fleet operations will be the same.

- **Driver behaviour**

Driver behaviour does have a huge bearing on the vehicle's performance and this can affect a testing procedure. Therefore securing driver support and participation early in the trial lead to valuable feedback. The project team understood that drivers can be under pressure for a variety of reasons, which can affect driving performance and so affect the trial results.

- **Support**

The project team had little direct control over the intervention of suppliers (satellite navigation suppliers). Therefore it was important for the project team to have support from the satellite navigation suppliers during the in-fleet trial. For example, if we used a satellite navigation system that was faulty, the supplier would help resolve any faults that occurred. The better

the support, the easier and quicker it was to solve any problems and so the less impact the fault will have.

- **Vehicle loading**

Controlling a vehicle's payload is part of the 'O' licence requirements. Greater payloads will increase the energy requirements of the vehicle and so may alter any data outputs. As increased payloads were recorded, this was easily factored in.

- **Customers**

Because the trial was carried out on vehicle's operating from participating customer premises, it was advisable to let someone in charge know that the vehicles are in the trial, so equipment was not altered, damaged or tampered with.

Further information on conducting in-fleet trials can be obtained from the Freight Best Practice guide 'In-fleet Trials of Fuel Saving Interventions for Commercial Vehicles'. This guide did help design the way-finding in-fleet trial, and by referring to this guide, has helped the project team avoid some of the common mistakes that can prove costly to put right.

- **Possible Risks**

With this type of practical research there was a risk that we would not find companies interested in helping with the supply of the equipment. There was also the possibility that freight operators may not have wanted to have the equipment fitted into their vehicles. As there were no cost implications to operators, the project team were able to get interest. However, this risk was part and parcel of a true research project which could have led to the trial being inconclusive.

- In order to trial the system and estimate the benefits achieved, a small scale trial was considered to be unproductive. Typical problems and issues that may have arisen were:
 - Operational staff or drivers too busy to put effort into using a satellite navigation hence, the trial could not be taken seriously by staff;
 - A key obstacle in carrying out the survey concerns the number of companies that are both willing to take part and that can also provide suitable data;
 - The system is not used regularly by staff, so it does not form part of their normal working practices. Any training is fast forgotten and the system is not used to its full benefit;
 - A small scale trial could produce results or conclusions that may not be statistically representative; and
 - The trial could extend beyond the planned 'trial period' consuming valuable time in trying to quantify the benefits.

The research has only provided a limited comparison between different satellite navigation systems on the market. The main aim was to trial the concept of using wayfinding equipment rather than doing a comparison between different manufacturers. Trials were carried out on different fleets/vehicle types and examples of cost, mileage reductions and emission reductions have been examined. Information has been presented in a way that is clear and meaningful to operators.

5.2.8

Analysis of Information/Data after the Trial Period

Accurate measurement was the key to assessing performance and enabled the usefulness/drawbacks of satellite navigation to be monitored. By conducting these measures within this study, the project team have been able to identify the key areas for attention in satellite navigation for use in the freight industry. This research study has tried to maximise the benefits of satellite navigation and highlight areas for concern.

After the data was returned, substantial additional analysis was carried out such as:

- Aggregate calculation of the statistics based on data provided by operating companies;
- Data tables and graphs of results broken down by satellite navigation system such as, vehicle type, to allow vehicle fleet operators to make meaningful decisions when trying to select satellite navigation systems for their organisations; and
- Commentary on general issues and trends identified by the survey.

For data analysis purposes, the following fleet numbers were allocated to the participating companies as follows:

- Fleet 1: Atherton (AG Barr - Trunking);
- Fleet 2: Moston (AG Barr – Direct to Store Delivery (DSD) distribution);
- Fleet 3: Wednesbury (AG Barr - DSD distribution);
- Fleet 4: Walthamstow (AG Barr - DSD distribution);
- Fleet 5: A1 Paper Plc;
- Fleet 6: Quadralene Ltd; and
- Fleet 7: Container distribution (owner drivers).

5.3 Key Performance Indicator Analysis

5.3.1

Introduction

This report details the analysis of the data collected during the Freight Best Practice Wayfinding trial. The University of Newcastle's, Department of Freight Studies compiled and reported on fuel consumption (km/litre) and time (minutes lost/saved) as a result of using satellite navigation. The purpose of this analysis was to see whether using satellite navigation can be said to:

- Affect the number of minutes lost by a driver when finding a delivery/collection point;
- Affect the kilometres driven per litre of fuel;
- Affect the kilograms of cargo carried per litre of fuel; and
- Any other finding from the practical trial.

5.3.2

Duration and Record Count

The data has been compiled from a trial of SatNav systems in designated weeks 1-4 and 6-9. Week 1 started 5/9/2005 and week 6 started 10/10/2005. In weeks 1-4 the vehicles completed normal business activity without satellite navigation and data was recorded both by the driver and by the traffic office.

In week 5 the drivers were issued the systems and had a couple of days to get used to them before the second half of the trial began. In weeks 6-9 the vehicles were equipped with SatNav units and the drivers utilised their features to complete deliveries and collections. The data was recorded in the same fashion.

There were some issues with the traffic office record sheets for weeks 6-9, so we have a record count for the driver sheets of 210 records and 151 for traffic office record sheets. Where a vehicle was off road the records have not been entered.

5.3.3

Data recorded

The data recorded on each driver report sheet was as follows:

Registration Number of Vehicle.	
Satellite navigation system used	e.g. TomTom700 or Garmin etc.
Vehicle Type.	e.g. 3.5T, 7.5T, 18T etc.
Number of minutes spent searching for location.	Recorded by shift
Total number of deliveries and collections.	Recorded by shift
Total number of late deliveries as a result of using satellite navigation.	Recorded by shift
In how many instances was satellite navigation legitimately used?	Recorded by day

In addition the drivers were to codify any routing problems experienced when using the satellite navigation system.

The data recorded on each traffic office report sheet was as follows:

Registration Number of Vehicle.	
Vehicle Type	e.g. 3.5T, 7.5T, 18T etc.
Number of loads	The Number of times the driver has left the depot/factory per shift.
Number of delivery and collection points	Recorded by shift.
Vehicle fill (Weight in kgs or volume)	This is the amount of total load carried per vehicle per shift. (all records were taken in kgs)
Total time	This is the time of the shift of the driver (taken from driver time sheet)
Total kilometres per shift	This is the total distance travelled by the driver per shift.
Fuel in litres per shift	This is the amount of fuel used per shift for this vehicle.

5.3.4

Fleet Type and Composition

Each fleet has individual characteristics and has been identified by a fleet number to preserve anonymity. Weights are roughly in line with the vehicle capacity and delivery/collection points are detailed as kilometres travelled. All averages have been rounded off to no decimal points and all standard deviations to two decimal points. Vehicles are identified in the text with a letter where helpful for identification.

Fleet 1: A trunking fleet operating for a drinks distributor. The trial utilised a TomTom G700. It consists of four 44t articulated lorries making long journeys with high payloads and low numbers of stops.

The average number of delivery/collection points a week for this fleet was 9 with a standard deviation of 5.24. Looking at the data three vehicles averaged around 8.5 and one averaged around 12. The average shift distance was 2712 with a standard deviation of 969.82. Looking at the individual vehicle data the lorry with 12 delivery/collection points averaged around 1500 kms a week, the other three around 3000km.

Company	Average of kms	Standard deviation of kms
Fleet1	2712	969.82
Company	Average of points	Standard deviation of points
Fleet1	9	5.24

Fleet 1 delivery/collection profile

Fleet 2: A distribution fleet operating for a drinks distributor. The trial utilised a TomTom G700. It consists of four 32t vehicles. The fleet has a very high delivery/collection activity and the vehicles averaged 111 such points per week with a standard deviation of 15.24. This was quite homogenous between all four vehicles. There are data issues with the traffic office sheets for this fleet so only a modal average of around 1000km per week can be judged for the fleet.

Company	Average of points	Standard deviation of points
Fleet2	111	15.24

Fleet 2 delivery/collection profile.

Fleet 3: A distribution fleet operating for a drinks distributor. The trial utilised a TomTom G700. The fleet for the purposes of the survey consisted of a 13T (A) vehicle for the first period and a 7.5T (B) vehicle for the second period.

The characteristics of the routes, weights and distances travelled are completely different from on to the other. To compare one period to the other would not be sensible, but within an overall data analysis the data has value.

Company	Vehicle	Average of kms	Standard deviation of kms
Fleet3	A	830	56.93
Fleet3	B	934	92.80
Company	Vehicle	Average of points	Standard deviation of points
Fleet3	A	110	3.42
Fleet3	B	80	9.00

Fleet 3 delivery/collection profile

Fleet 4: A distribution fleet for a drinks distributor. The trial utilised a TomTom G700. The fleet consisted of one 3.5T vehicle, one 7.5T vehicle, one 15T (F) vehicle and one 17T vehicle. This is a multi-drop vehicle fleet with a high delivery/collection activity. The average delivery/collection points were 95 with a standard deviation of 16.86, average kilometres was 1013 per week with a standard deviation of 307.99.

Company	Vehicle	Average of kms	Standard deviation of kms
Fleet4	C	1051	212.35
Fleet4	D	1126	207.69
Fleet4	E	1224	304.47
Fleet4	F	628	138.77
Company	Reg	Average of points	Standard deviation of points
Fleet4	C	32	10.15
Fleet4	D	52	8.46
Fleet4	E	40	20
Fleet4	F	73	11.09

Fleet 4 delivery/collection profile

Fleet 5: A distribution fleet for a paper distributor. The trial utilised a TomTom GO500. Serving schools, offices and hospitals. The fleet consisted of one 3.5T, one 7.5T, one 18T and one 32T vehicle. All operated final deliveries, with no trunking or intermediate roles. The activity of the fleet was quite homogenous, with an average of 44 points per week with a standard deviation of 7.56.

Company	Reg	Average of points	Standard deviation of points
Fleet5	G	42	9.64
Fleet5	H	42	7.27
Fleet5	I	46	5.68
Fleet5	J	48	6.65
Company	Vehicle	Average of kms	Standard deviation of kms
Fleet5	G	1606	303.19
Fleet5	H	1544	190.56
Fleet5	I	1600	330.19
Fleet5	J	1434	500.43

Fleet 5 delivery/collection profile

Fleet 6: Fleet 6 consisted of three 18T vehicles and a 4.6T (N) vehicle delivering chemical products. It utilised a TomTom GO700. The average number of delivery/collection points was 15 with a standard deviation of 5.95.

The 18T vehicles had a different profile to the 4.6T vehicle, making more deliveries with less variation in the number. The 4.6T may have been used as a 'make-up' vehicle, filling gaps and smoothing peaks in activity. This can be seen below:

Company	Vehicle	Average of kms	Standard deviation of kms
Fleet6	K	1520	185.14
Fleet6	L	1573	232.20
Fleet6	M	1516	160.84
Fleet6	N	1186	520.45
Company	Vehicle	Average of points	Standard deviation of points
Fleet6	K	16	3.36
Fleet6	L	18	4.14
Fleet6	M	17	3.75
Fleet6	N	10	7.83

Fleet 6 delivery/collection profile

Fleet 7: this fleet consisted of two owner operated articulated 44T vehicles carrying container traffic to and from ports. One vehicle used a Garmin c320, the other a Siemens 5500. The operators used SatNav for the entire period so before and after analysis is not possible but the data can be used in overall analysis. The fleet operated low delivery/collection activity business with wide variety of activity, delivery addresses and routes. This is the classic sub contracting haulier.

Company	Average of kms	Standard deviation of kms
Fleet7	1530	419.38
Company	Average of points	Standard deviation of points
Fleet7	7	4.84

Fleet 7 delivery/collection profile

5.3.5

Data Notes

Fuel data was recorded on a scale that meant daily analysis would have been impossible so the data was aggregated at weekly level. Certain vehicles were off road for repairs during the period, on checking, assurances were given that the repairs would not have affected fuel consumption.

Seasonality can have an impact on business activity, as for the drinks business, the volume of activity falls through the autumn and winter but, this was static over the full period. All load data was recorded in kilograms for all fleets, and where mileage was recorded in miles it was converted to kilometres.

Having looked at both the data and feedback from drivers, vehicles were classified based on gross weight and the way road infrastructure impacts vehicles. Vehicles up to 7.5T were classified as 'light'. Drivers of the small 3.5T and 4.6T vehicles reported no problems with routing due to low bridges or weight limits or vehicle access. 7.5T vehicle drivers reported problems of access hence, were classified as 'medium'. Given the different characteristics of 32T and 44T vehicles they were slotted into a 'Heavy' category. Vehicles were classified as:

- Light <7.5T;
- Medium >=7.5T and <32T; and
- Heavy >32T.

5.3.6 *Fuel Consumption KPI Results*

One of the key questions in this report is whether using satellite navigation improves distance travelled (kms/litre) or weight (kgs/litre) carried per unit of fuel. If satellite navigation proved to reduce the amount of energy used in distribution then the take up of the systems would contribute to saving carbon emissions and the goal of sustainable distribution, a key policy objective.

5.3.6.1 Overall Fuel Consumption Analysis

The data we have from these fleets suggest that there is no appreciable difference at an aggregate level on fuel efficiency.

Sat?	Avg Points	Of	Change %	Avg km/litre	Of	Change %	Avg kg/litre	Of	Change %
N	37.00			4.87			179.25		
Y	29.93		-19%	4.92		1.11%	179.33		0.05%

Fuel Consumption KPI's, all data

Whilst the total data set shows a fall in delivery/collection points visited falling by 19% from period 1 to period 2, fuel efficiency as km/litre shows a 1.11% improvement and almost no change (0.05%) in kg/litre.

We tested the total dataset to see whether the number of delivery/collection points or satellite navigation was more significant in fuel efficiency. The number of points visited is found to be the most significant factor when comparing it with satellite navigation, with a significance of 0.8189 (1-0.1811) and as the number of points visits rise the kgs/litre fall, at a reduction of 0.685 kgs/litre per point. Satellite navigation is not significant, since its significance is only 0.0211 (1-0.9789).

When comparing delivery/collection points and distance/fuel we find that points are the most important with a significance of 0.9993 (1-0.0007). As points increase, km/litre falls at a rate of 0.022 km/litre per point. Satellite navigation is not significant, since its probability to be significant is only 0.3754 (1-0.6246).

We then postulated the question: "If you use satellite navigation does your kgs/litre rise or fall?"

The answer from the aggregate data is that they fall at a rate of 0.511 kg/litre per point, so the effect of using satellite navigation is that kgs/litre fall. To the question: "If you use satellite navigation does your km/litre rise or fall?" the answer is that they rise, at a rate of 0.118 km/litre per point, so the effect of using satellite navigation is that kms/litre rise.

We would suggest that before accepting this as a conclusion we evaluate the vehicle class split, individual fleets and the effect of time on organisational change.

5.3.6.2 Fuel Consumption by Vehicle Class

If we break down the data by vehicle class we see quite different characteristics between the groupings.

Type	Sat?	Class + Sat	Points /Wk	Change Points %	Avg Of km/litre	Change km/litre %	Avg Of kg/litre	Change kg/litre %
Light	N	Light N	41.7		8.8		45.1	
Light	Y	Light Y	35.1	-15.80%	8.9	0.60%	37.9	-15.93%
Medium	N	Medium N	46.4		4.8		74.0	
Medium	Y	Medium Y	38.4	-17.15%	5.1	6.44%	70.1	-5.22%
Heavy	N	Heavy N	20.5		3.4		396.5	
Heavy	Y	Heavy Y	17.7	-13.98%	3.2	-6.17%	365.5	-7.83%

Light = 3.5T to <7.5T

Medium = 7.5T to <32T

Heavy = >=32T

Points/Wk = average delivery/collection points per week

Change Points % = percentage change in points visited (where possible to express as a percentage)

Fuel Consumption KPI's, by vehicle class

Light vehicles show a small improvement in km/litre but a significant reduction in kgs/litre. Medium vehicles show a 6.44% improvement in kms/litre and a 5.22% deterioration in kgs/litre. Since this is combined with a fall in points visited for both classes, which we know is the more significant factor on fuel efficiency, we suspect there is a different factor such as average load weight, traffic conditions or weather effects which may be affecting this.

Heavy vehicles show a deterioration in both factors, which given the poor effects of satellite navigation on the heavy vehicles in minutes lost might not be surprising, but we are not confident enough to suggest that it is a definite factor.

5.3.6.3

Fuel Consumption by Fleet

The data on fuel consumption for some of the fleet can be seen below:

Fleet & Sat	Avg Of Points	Change %	Avg Of km/litre	Change %	Avg Of kg/litre	Change %
Fleet1 N	16.89		3.09		457.94	
Fleet1 Y	14.56	-13.8%	3.06	-1.0%	526.84	15.0%
Fleet4 N	52.67		5.17		68.15	
Fleet4 Y	51.40	-2.4%	5.90	14.2%	75.31	10.5%
Fleet5 N	45.44		6.00		83.67	
Fleet5 Y	44.75	-1.5%	5.98	-0.4%	90.94	8.7%
Fleet6 N	17.14		5.63		51.03	
Fleet6 Y	14.95	-12.8%	6.01	6.7%	45.42	-11.0%
Fleet7 Y	12.00		2.87		224.29	

Fuel Consumption KPI's, by fleet

Fleet 1 which was a trunking operation of 44T articulated lorries shows fewer points to visit, a worsening of km/litre and an improvement of kgs/litre. We suggest this is due to the fewer delivery/collection points.

Fleet 4 is a heterogeneous vehicle fleet with a high delivery/collection activity. It shows a relatively stable delivery/collection activity and an improvement in both kms/litre and kgs/litre. The satellite navigation systems were used at a high level around ten (10.3) times a week and as such the fleet may have benefited from the systems greatly.

Fleet 5 is a heterogeneous vehicle fleet performing quite high delivery/collection activity in a very homogenous fashion. With a stable number of points visited per week km/litre stayed stable and kgs/litre improved. The fleet may have benefited from the systems, noticeably they used them thirty (30.4) time a week.

Fleet 6 is a fleet with three 18T vehicles and a 4.6T vehicle, exhibiting lower end delivery/collection activity. The fleet suffered badly, with almost two (1.5) delivery failures a week caused by satellite navigation. The fleet saw km/litre improve and kgs/litre worsen. This introduces more doubt about the data and which effects we are seeing.

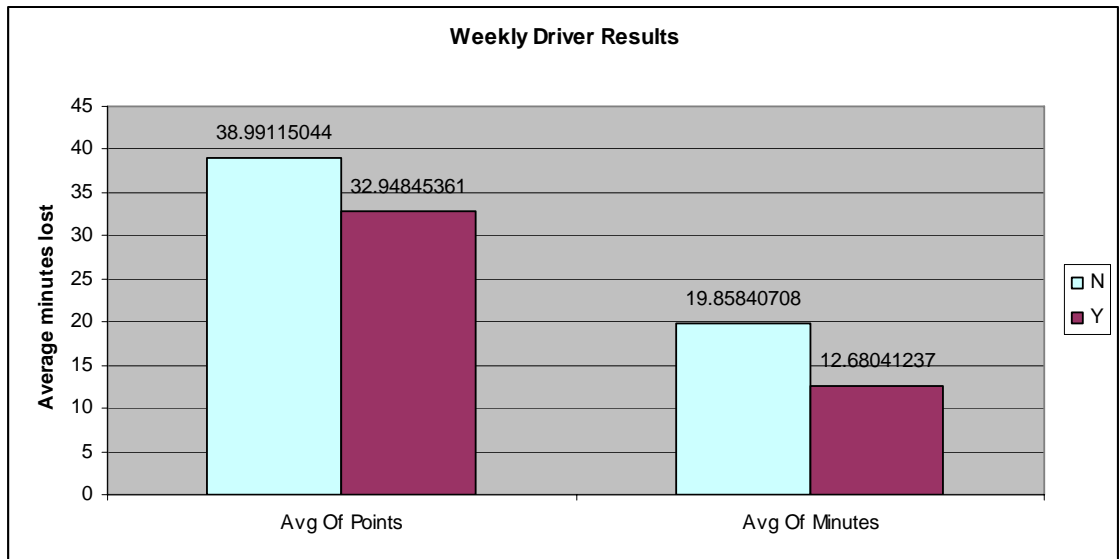
5.3.7

Minutes Lost Data Results

5.3.7.1

Minutes Lost Overall

The number of minutes lost by a driver when trying to find a delivery/collection can be a significant amount of time. We found that the average number of minutes lost per week fell from period 1 to period 2 by 36.15%. However this aggregated figure should be compared with the number of delivery/collection points visited, since logically visiting few places will result in fewer opportunities to get lost, that fell by 15.5%. This suggests that satellite navigation may have impacted on the number of minutes lost greater than the simple fall in delivery/collection.



Average minutes lost versus average points visited, all data

The total dataset was tested to see whether the number of delivery/collection points or SatNav was more significant in the number of minutes lost. It can be said that using SatNav is the most significant factor with a probability of 0.9982 (1-0.0018) as opposed to the number of points which is significant only with 0.1883 (1-0.8117).

Using SatNav implies fewer minutes lost. SatNav coefficient is 12.62, so when it is not used (the variable has a unit value) there is a contribution of 12.62min to the predicted minutes lost equation. The data suggests that for these fleets they will lose 12.62 minutes of time a week more not using the systems than if they do.

5.3.7.2

Minutes Lost by Vehicle Class

We analysed minutes lost by vehicle class to test the hypothesis that different vehicle characteristics would yield different benefits. To that end we found that light vehicles enjoyed a substantial change in minutes lost, despite seeing an increase in the number of points visited from period 1 to period 2.

Light vehicles lost 71% fewer minutes a week (27.9 minutes), despite an increase in delivery/collection of 19%. Medium vehicles saw a 31% saving in minutes lost (9.39 minutes), this did coincide with a 14% fall in the number of points visited. Heavy vehicles saw an increase in the average number of minutes lost (+48%, or 2 minutes) despite an 18% fall in points visited. This coincides with driver feedback where heavy vehicle drivers were directed as if using a car and meeting access problems. The change is great in relative terms, but we must remember that in absolute terms it is much smaller than the other vehicle classes.

The data also shows that in this trial the medium vehicle drivers used the system the greatest (16 times a week), with the heavy vehicle drivers using them least (4.8 times a week). The light category suffered no failures of delivery due to satellite navigation but the medium vehicles did. This maybe due to medium vehicles making retail deliveries and meeting access issues where a light vehicle could operate due to its near-car characteristics.

Vehicle Class	Satnav?	Minutes Lost/Wk	Change Min %	Points /Wk	Change Points %	Times Used/Wk	SatNav Failed/Wk
Light	N	39.5		28.8		0.0	0.0
Light	Y	11.6	-71%	34.4	19%	9.6	0.0
Medium	N	30.0		59.3		0.0	0.0
Medium	Y	20.7	-31%	51.2	-14%	16.0	0.8
Heavy	N	4.0		20.5		0.0	0.0
Heavy	Y	6.0	48%	16.7	-18%	4.8	0.1

Light = <3.5T to <7.5 Medium = 7.5T to < Heavy = >=32T

Points/Wk = average delivery/collection points per week

Change Points % = percentage change in points visited (where possible to express as a percentage)

MinutesLost/Wk = average number of minutes lost per week finding destination

Change Min % = percentage change in minutes lost (where possible to express as a percentage)

TimesUsed/Wk = average number of times satnav was used per week

SatNavFailed/Wk = average number of time that satnav caused a late delivery

Average minutes lost versus average points visited, by vehicle class

The data shows the light vehicles in these fleets benefited from the use of SatNav, medium vehicles also benefited but at a lower level and that heavy vehicles may have been hindered.

5.3.7.3

Minutes Lost by Fleet

Whilst analysing the data by vehicle class is useful, there is value in analysing it by fleet since the different fleets represent different types of distribution activity, trunking, small van deliveries, heavy vehicles doing final delivery, container jobbing, etc.

Company	Satnav?	Points/Wk	ChangePoints %	MinutesLost/Wk	Change Min %	TimesUsed/Wk	SatNavFailed/Wk
Fleet1	N	9.3		0.0		0.0	0.0
Fleet1	Y	8.5	-8%	4.3	n/a	0.8	0.0
Fleet2	N	113.3		16.1		0.0	0.0
Fleet2	Y	107.8	-5%	0.0	-100%	3.8	0.0
Fleet3	N	109.5		20.0		0.0	0.0
Fleet3	Y	80.3	-27%	15.0	-25%	5.0	1.5
Fleet4	N	47.8		52.6		0.0	0.0
Fleet4	Y	50.5	6%	5.7	-89%	10.3	0.0
Fleet5	N	44.5		30.1		0.0	0.0
Fleet5	Y	44.4	0%	16.8	-44%	30.4	0.0
Fleet6	N	15.1		29.3		0.0	0.0
Fleet6	Y	15.3	2%	38.0	30%	13.4	1.5
Fleet7	Y	6.9		7.0		2.8	0.0

Points/Wk = average delivery/collection points per week

Change Points % = percentage change in points visited (where possible to express as a percentage)

MinutesLost/Wk = average number of minutes lost per week finding destination

Change Min % = percentage change in minutes lost (where possible to express as a percentage)

TimesUsed/Wk = average number of times satnav was used per week

SatNavFailed/Wk = average number of time that satnav caused a late delivery

Average minutes lost versus average points visited, by fleet

Fleet 1, which was a trunking operation of 44T articulated lorries, suffered from using satellite navigation. Lorries were misdirected for the simple reason that the retail systems are programmed to direct cars and not HGV's. Despite delivery/collection points falling the lorries increased from losing no time to losing almost four (4.3) minutes per week on average whilst only using the systems once (0.8) a week.

Fleet 2, which is a high activity drinks delivery fleet of 32T vehicles, saw a significant fall in minutes lost. Sixteen (16.1) minutes a week were saved, or a 100% reduction. There were no delivery failures caused by satellite navigation. This is a fleet that is averaging around 110 delivery/collection points a week and where the drivers only had to use satellite navigation about four (3.8) times a week. This fleet seems to have greatly benefited from the systems. The drivers, however, felt differently and stopped using the systems after week 7. What acceptance issues this demonstrates should be investigated as the data may be leading to a false conclusion.

Fleet 3 switched vehicle between period 1 and period 2 and is therefore meaningless for these purposes.

Fleet 4 consists of vehicle fleets with a high delivery/collection activity. It shows an 89% reduction in minutes lost with relatively stable delivery/collection activity. The satellite navigation systems were used at a high level, around ten (10.3) times a week, and as such, the fleet seems to have benefited from the systems greatly.

Fleet 5 vehicle fleets have a high delivery/collection activity in a very homogenous fashion. With a stable number of points visited per week, minutes lost fell by 44%. This fleet appears to have benefited from the systems, noticeably they used them thirty (30.4) times a week.

Fleet 6 is a fleet with three 18T vehicles and a 4.6T vehicle, exhibiting lower end delivery/collection activity. The fleet suffered badly, with almost two (1.5) delivery failures a week caused by satellite navigation and a rise in minutes lost by 30% from an existing average of almost 30 (29.3) minutes a week.

Fleet 7 used SatNav for the full trial. Despite using the system regularly, and having a lorry specific SatNav system installed, seven (7) minutes a week were lost by this HGV fleet.

The data analysed by fleets suggests that high delivery/collection activity fleets, even those with heavy vehicles, can benefit greatly from satellite navigation. It also suggests that HGV trunking operations using retail satellite navigation unit for cars can suffer deterioration from using such units.

Summary of 'quantitative' findings:

- Analysis by vehicle class in the trial suggests that light vehicles will benefit more from the systems and that heavier vehicles will benefit less. However, the reason for this is due more to the type of work rather than vehicle size;
- Multi-drop delivery vehicles are likely to benefit more from having SatNav systems especially if they are not fixed route runs;
- Although the number of calls visited fell by 15% in the second period of 4 weeks, the average number of minutes lost per week looking for drops fell by 36%. This suggests that satellite navigation has made a significant saving on the number of minutes lost finding destinations;
- Depending on the nature of operation, multi-drop fleets saw a reduction in minutes lost of 89% (fleet 4), 44% (fleet 5), and 30% (fleet 6) depending on the type of operation. But some operations did not have any savings;
- Trunking vehicles and fixed route runs where drivers do the same run on a daily basis will benefit less from having SatNav. Indeed the trial suggests that it may have a negative effect because of the time spent programming the system and possibly incorrect routing decisions;
- New or agency drivers that are unfamiliar with the company operation and the routes stand to benefit the most from SatNav systems;
- A car focused SatNav system is likely to have a larger negative effect on heavier lorries because these systems appear to occasionally route vehicles down inappropriate roads. When this happens the larger the vehicle the worse the problem and the longer it takes to correct the situation;
- Our trial shows that fuel consumption improved at some depots as a result of using satellite navigation. One depot (fleet 4) saw an improvement of 14.2% in fuel consumption and fleet 6, saw an improvements in fuel consumption by 6.7%. However, overall fuel efficiency (km/litre) for all participating companies improved by 1.11%. This suggests that satellite navigation can improve km/litre for some fleets so when selecting the technology, companies need to assess the type of operation before investing in satellite navigation systems;
- The trial suggests that using satellite navigation saves time searching for destinations. Overall results show that on average companies lose 13 minutes of time a week when not using satellite navigation. This equates to a total of 676 minutes a year (52 weeks a year);
- Drivers of 3.5 tonne to 4.6 tonne vehicles reported no problems with routing due to freight specific mapping. Drivers of 7.5 tonne vehicles and above did report routing problems with current freight specific mapping (especially bridge heights, weights and problems of access);

- The argument for satellite navigation improving fuel efficiency is that it will improve certainty; release minutes lost in destination finding and allow greater loads to be carried for longer distances. The trial period was too short to report any meaningful changes in load planning; and
- Due to the time frame for such a trial, the data cannot tell us a great deal about overall efficiency and kilograms per drop carried 'before' and 'after' using satellite navigation. To test this more accurately, participating companies will need to change their planning parameters and a trial will need to be completed over a longer period.

5.4 Satellite Navigation Routing Problems

As detailed in the quantitative analysis of the satellite navigation wayfinding trial, the following data has been generated from information provided by both driver and traffic office experiences. The driver reports recorded any individual problems with routing such as routing unsuitable vehicles over the wrong bridges, down the wrong roads, or simply taking a longer route than necessary. This section of the report records and reports the findings of that process.

5.4.1 Weekly

The trial recorded trips in weeks 6-9 numbering circa 107,028 kilometres. From driver reports an extra 83 kilometres were generated causing an increase of 0.08% kilometres over the period. This is insignificant. We know from the minutes lost/saved analysis in the last report that in time the effect of SatNav is positive for light and medium vehicles.

	Km		Increase due to SatNav
•	• 45	• 33374	• 0.1344%
•	• 14	• 26184	• 0.0550%
•	• 16	• 28216	• 0.0567%
•	• 8	• 19254	• 0.0416%
•	• 83	•	• 0.0777%

Table 1: Extra kilometres due to SatNav by week

5.4.2 Vehicle Class

Using the classification of Light meaning all vehicles below 7.5t as light and all vehicles over 26t as heavy, we can see that heavy vehicles experienced the greatest increase in distance travelled due to SatNav problems. Light and medium vehicles lost similar amounts proportionally although light vehicles suffered by a much lower absolute number.

	Km		Increase due to SatNav
•	• 51.2	• 53963	• 0.0950%
•	• 6.4	• 10796	• 0.0593%
•	• 24.0	• 42269	• 0.0568%
•	• 81.6	•	• 0.0763%

Table 2: Extra kilometres due to SatNav by class, 1.6 km not recorded due to data recording errors

5.4.3

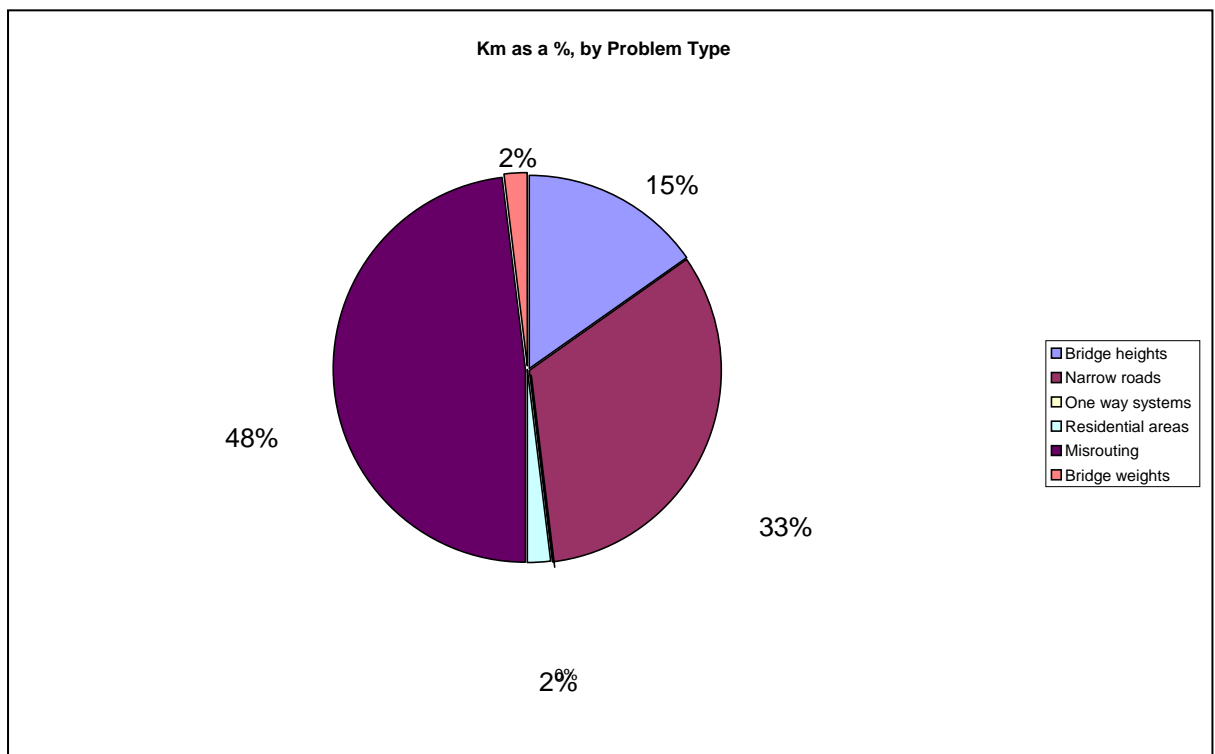
Problem Type

When we break down the unnecessary distance we see that the majority of the kilometres were caused by system misrouting at 48%, with narrow roads causing the second greatest problem at 33%. Some problems were not reported as creating additional travel, and one way systems seemed to have no effect, whilst being noted by drivers as a problem.

Problem Type	Km	Percentage
Bridge heights	12.8	15%
Narrow roads	27.2	33%
One way systems	0	0%
Residential areas	1.6	2%
Misrouting	40	48%
Bridge weights	1.6	2%
Total	83.2	100%

Table 3: Extra kilometres due to differing problem types

Figure 1: Percentage of km lost by problem type



5.4.4

Summary

Satellite navigation causes problems for large vehicles when navigating areas with unsuitable infrastructure, due to the fact that the systems used have no concept of the vehicle being driven nor of the infrastructure limitations. The amount of extra kilometres reported is so low as to be irrelevant, whilst it may still be a significant issue with regard to HGV impact on residential areas, urban centres or bridges.

5.5

Views and Opinions

5.5.1

Introduction

As the Road Transport Industry is a varied and wide ranging one, satellite navigation was trialled in a number of industry sectors which represent a broad cross section of the various sectors of the freight industry. A total of four companies participated in the trial:

- Drinks trucking and local distribution (AG Barr Plc);
- Paper merchant/distributor (A1 Paper Plc);
- Chemical manufacturer/distributor (Quadralene Ltd); and
- Container Distribution (Owner Drivers).

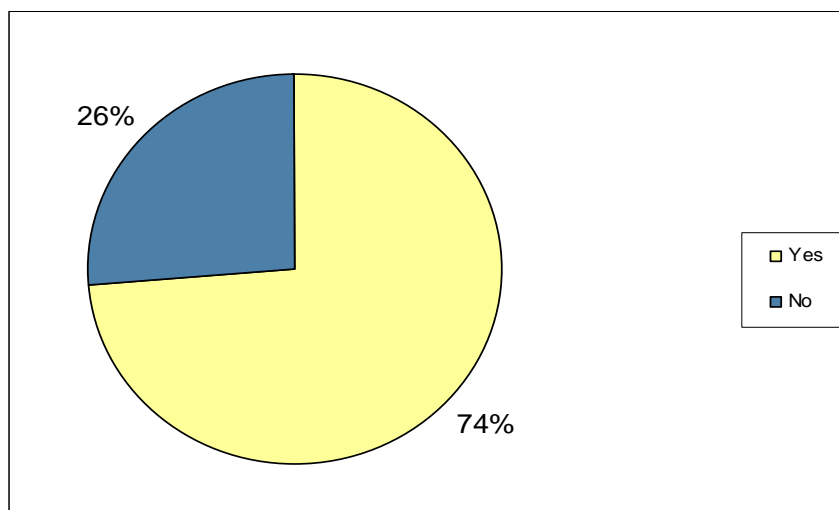
Below is a summary of all the companies drivers and transport managers analysis of the questionnaires (Forms C and D) relating to the benefits/drawbacks of satellite navigation systems and what they thought of the use of such systems in the freight industry.

5.5.2

Driver Views

Out of all the participating companies, figure 1 below shows that 74% of all the drivers who participated in the trial were using satellite navigation for the first time. 26% of the drivers have used satellite navigation systems before, and drivers have used systems developed by Siemens, TomTom and Navman.

Figure 1: Percentage of drivers who have used satellite navigation for the first time.



5.5.2.1

Usefulness of Satellite Navigation Systems

All drivers were also asked to rate the usefulness of satellite navigation systems in the following areas from 'very good' to 'very poor':

- Enables you to drive to unfamiliar locations;
- Saves time searching for locations;
- Improves driver performance and stress;
- Improves customer service by meeting delivery time slots;
- Helps you drive more safely;
- Helps reduce vehicle wear and tear; and
- Uses appropriate routes.

Figure 2 below shows that 48% of all the drivers felt that satellite navigation were ‘very good’ and that they enable them to drive to unfamiliar locations. 34% of drivers also felt that they were ‘good’ and 18% of drivers felt satellite navigation systems were satisfactory for driving to unfamiliar locations.

The systems are also useful when a driver tries to save time searching for locations. 58% of the drivers felt the system was ‘good’ and 36% of drivers felt these systems were ‘very good’ for saving time searching for destinations. 6% of drivers were satisfied with satellite navigation systems. On the whole, drivers would use the satellite navigation systems for driving to unfamiliar locations as it helps save time finding a destination.

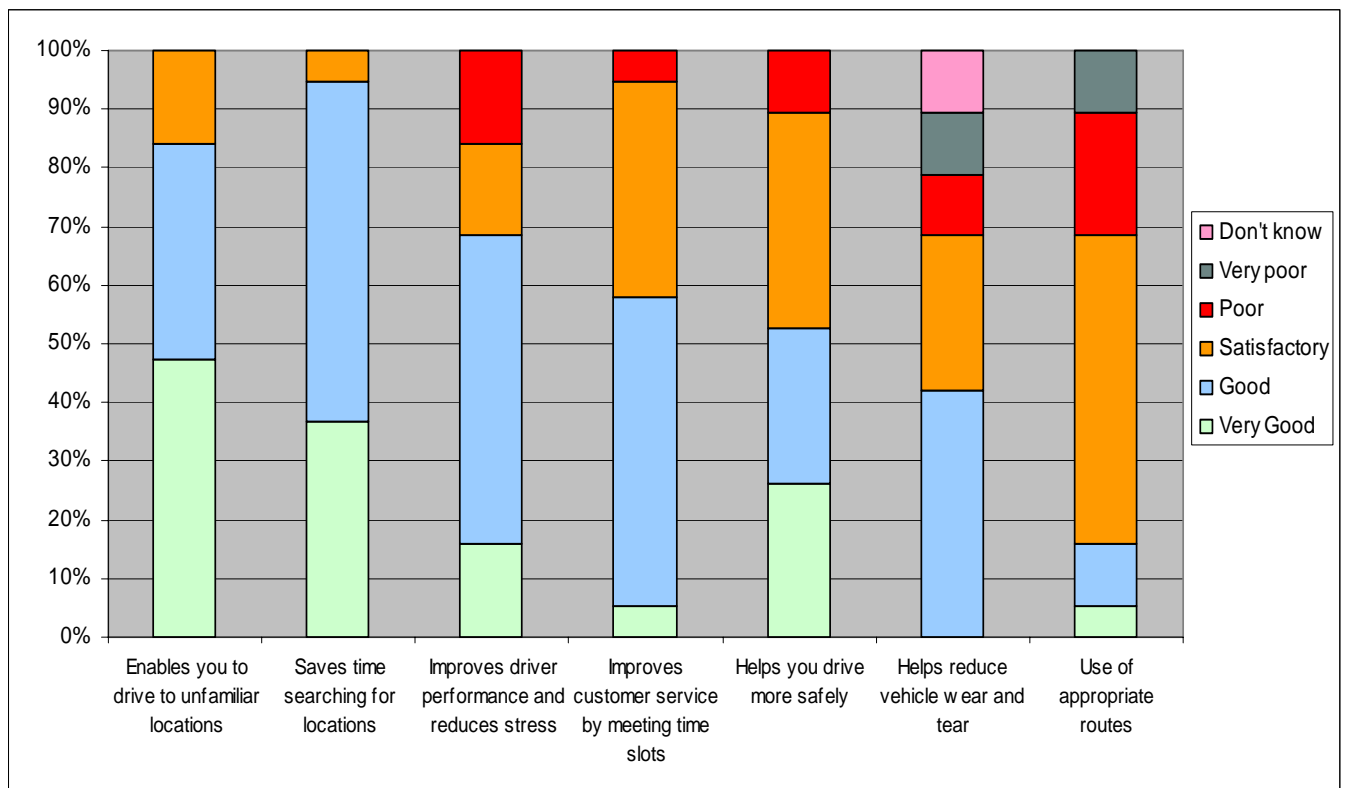
A total of 52% of drivers rated satellite navigation systems as ‘good’ and 16% rated them as ‘very good’ in improving their driving performance and reducing stress. Surprisingly 18% of drivers felt the system was ‘poor’ in terms of improving performance and reducing stress.

Amazingly, a total of 89% of the drivers mentioned that the systems are ‘satisfactory’ and help them drive more safely. Of this, a total of 52% of drivers felt the systems were ‘very good’ (26%) and ‘good’ (26%) for helping them driver more safely.

A total 20% of drivers rated satellite navigation systems as ‘poor’ (10%) and ‘very poor’ (10%) for reducing vehicle wear and tear. 42% of the drivers felt the system was ‘good’ for helping reduce vehicle wear and tear.

In terms of using appropriate routes, a total of 32% of drivers felt the routes generated were ‘very poor’ (12%) and ‘poor’ (20%), but in total 68% of drivers felt the system was satisfactory and above for taking appropriate routes (4% for ‘very good’, 10% for ‘good’, and 54% for satisfactory).

Figure 2: Usefulness of Satellite Navigation Units



5.5.2.2

Driver Rating of Satellite Navigation Systems

Drivers were also requested to rate the satellite navigation systems they used in the following areas:

- Ease of use and understanding;
- Clear direction guidance;
- Routing information provided;
- Suitability for use in trucks/freight vehicles;
- Re-routing capabilities; and
- Suitability in poor lighting.

Figure 3 below shows that a total of 84% of drivers found the system 'very good' and 'good' to use and understand. Of this, 42% drivers felt that the satellite navigation systems were 'very good'.

Clear direction guidance is an important feature as this would enhance safer driving. A total of 74% of the drivers felt the systems were 'very good' and 'good' in providing clear directions (42% thought it was very good and 32% for 'good'). 26% of the drivers rated satellite navigation as 'satisfactory' as voice guidance turned out to be different to what the visual maps showed on screen.

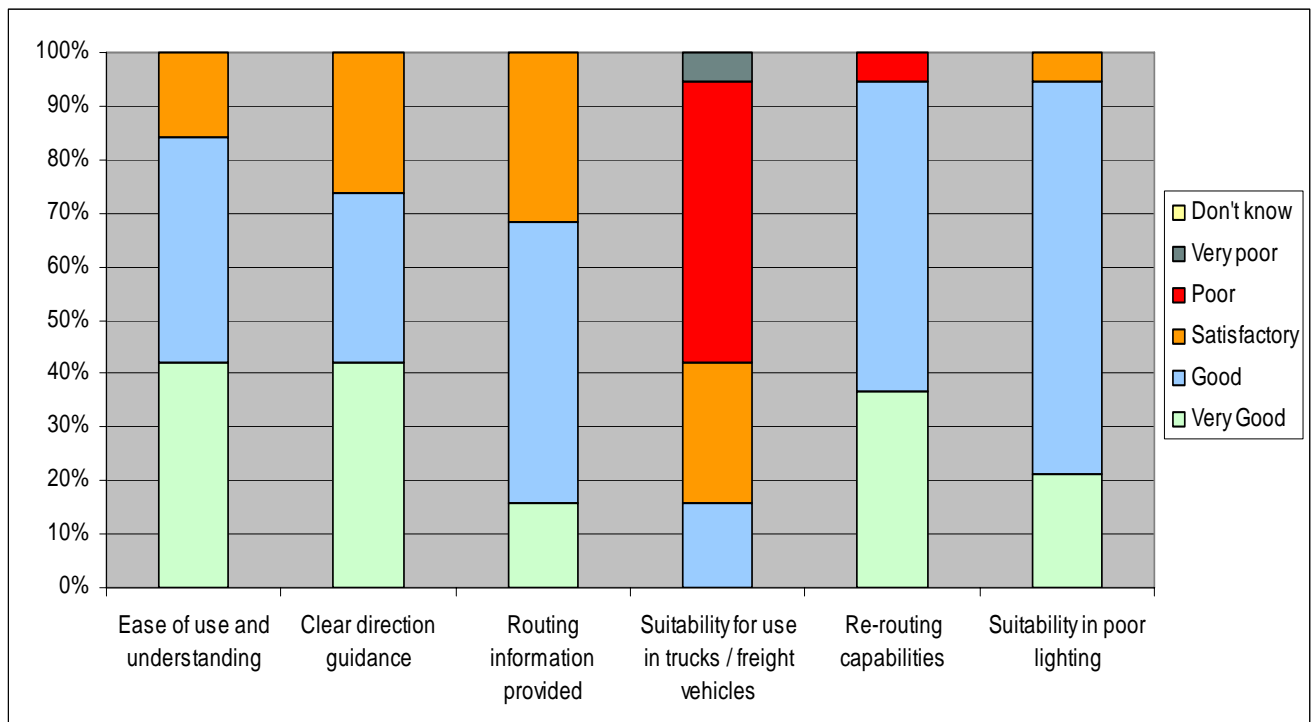
A total of 68% of drivers rated the system as 'very good' (16%) and 'good' (52%) for routing information provided. 32% of drivers rated the systems as 'satisfactory'.

Interestingly, a total of 58% of the drivers felt that satellite navigation systems were 'very poor' (5%) and 'poor' (53%) for their use and suitability in the freight industry, followed by 24% feeling the systems were 'satisfactory'. As the majority of the drivers felt these systems were not suitable for freight vehicles, 18% of drivers did rate them as being 'good'.

Visibility of maps at night is also an important factor to consider when having a satellite navigation system. 22% of the drivers felt the systems were 'very good' in poor lighting, followed by 72% rating them as 'good' for suitability in poor lighting. 6% of drivers were satisfied with their satellite navigation systems in poor lighting.

Re-routing capabilities are also an important feature and can be of benefit in the freight industry especially when drivers are experiencing congestion or road network delays. Amazingly, a total of 94% of drivers felt that the systems were 'very good' (38%) and 'good' (56%) when it comes to re-routing capabilities.

Figure 3: Driver Rating of Satellite Navigation Systems



5.5.2.3

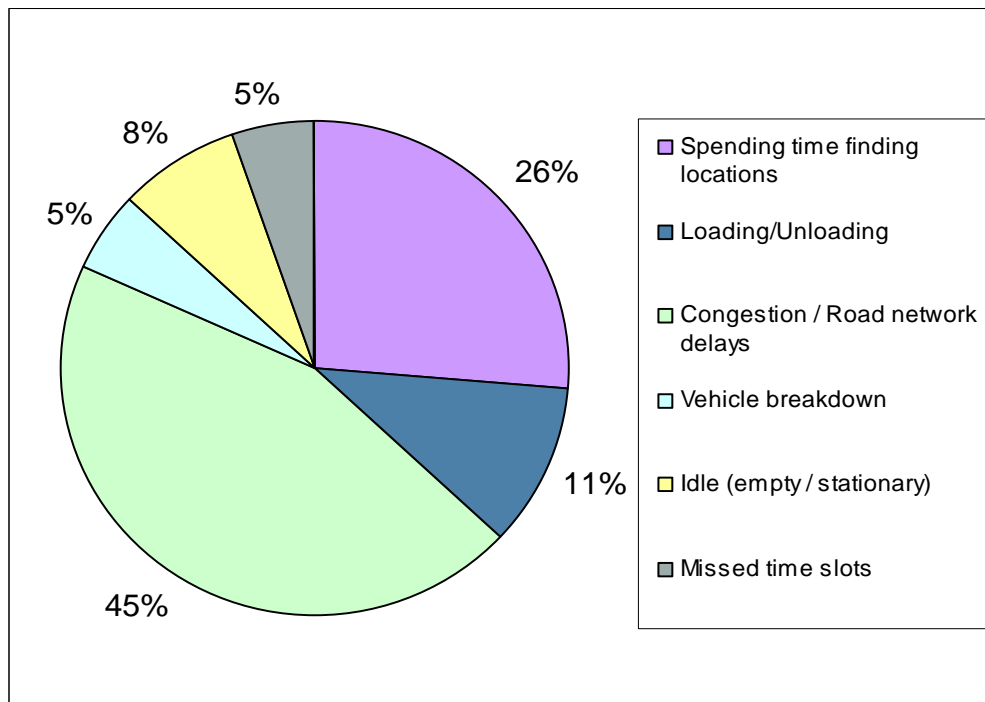
Contributing Factors to Drivers being Least Productive

With changes in driver hour regulations and the Working Time Directive, drivers do feel that some of the time they spend is unproductive. Having conducted such a trial, the project team felt it was important to recognise the issues that contribute to drivers being least productive or 'wasted' time. Drivers were asked to tick a maximum of two issues from the options below:

- Spending time finding locations;
- Loading/unloading;
- Congestion/road network delays;
- Vehicle breakdown;
- Idle (empty and stationary);
- Missed time slot; and
- Other reasons.

According to figure 4 below, 45% of drivers felt that congestion/road network delays is the main contributor to them being unproductive, followed by 26% of drivers spending time searching for locations. 11% of drivers are least productive when they are being loaded/unloaded.

Figure 4: Parts of a Day Drivers Feel is 'Least Productive'



If satellite navigation can dramatically reduce the time a driver spends searching for a location, and if live traffic information was available and re-routed drivers to avoid congestion, then this could result in huge benefits for freight operators in terms of saving time and money, and would result in a reduction in CO₂ emissions due to less 'wasted' mileage travelled and vehicles avoiding congestion.

5.5.3 Transport Manager Views

As with drivers' views on using satellite navigation systems for wayfinding, transport manager views are equally as important. Transport managers were also asked to complete a satellite navigation questionnaire. After trialling with satellite navigation systems, all transport managers would consider using satellite navigation systems in their operations in the future.

5.5.3.1 Usefulness of Satellite Navigation Systems

Figure 5 below shows that all the transport managers feel satellite navigation systems are satisfactory and above for improving driver efficiency (44% for 'very good', 41% for 'good' and 15% for 'satisfactory').

Surprisingly, with regards to improving driver attitudes, all the transport managers felt that satellite navigation systems were 'very good' and 'good'. 58% of managers felt the systems are 'very good' for improving driver attitudes and 42% of managers rated the system as 'good'.

New/agency driver performance is important for any freight operation, especially for finding delivery/collection points as these drivers will be unfamiliar with routes. 44% of the transport managers rate satellite navigation systems as 'very good' when it comes to assisting new/agency drivers for route finding, followed by 12% felt these systems were 'good'.

Satellite navigation systems are considered to be 'satisfactory' by the transport managers when it comes to improving customer service by meeting time slots. As above, 42% of managers felt they were satisfactory, while 14% of managers felt they were 'very good'.

Interestingly, in order to plan more drops by using satellite navigation systems, 14% of the transport managers rate the systems as being 'very good' in enabling them to plan more drops, but 56% of managers also felt it is too early to say.

The majority of the transport managers (58%) rate the systems as 'good' in terms of helping reduce vehicle wear and tear, followed by 42% of managers rating the system as 'satisfactory'.

According to the transport managers, 44% of them rate satellite navigation systems as ‘good’ for improving fleet efficiency, the other 28% feel the systems are satisfactory.14% of transport managers rate satellite navigation systems as ‘very good’ as they feel it improves fleet efficiency.

The suitability of satellite navigation systems in freight vehicles according to transport managers is also an important factor to consider. Surprisingly, a total of 58% of transport managers feel the systems are ‘very good’ (14%) and ‘good’ (42%). 28% of transport managers also feel that the systems are ‘very poor’ (14%) and ‘poor’ (14%) for suitability in freight vehicles.

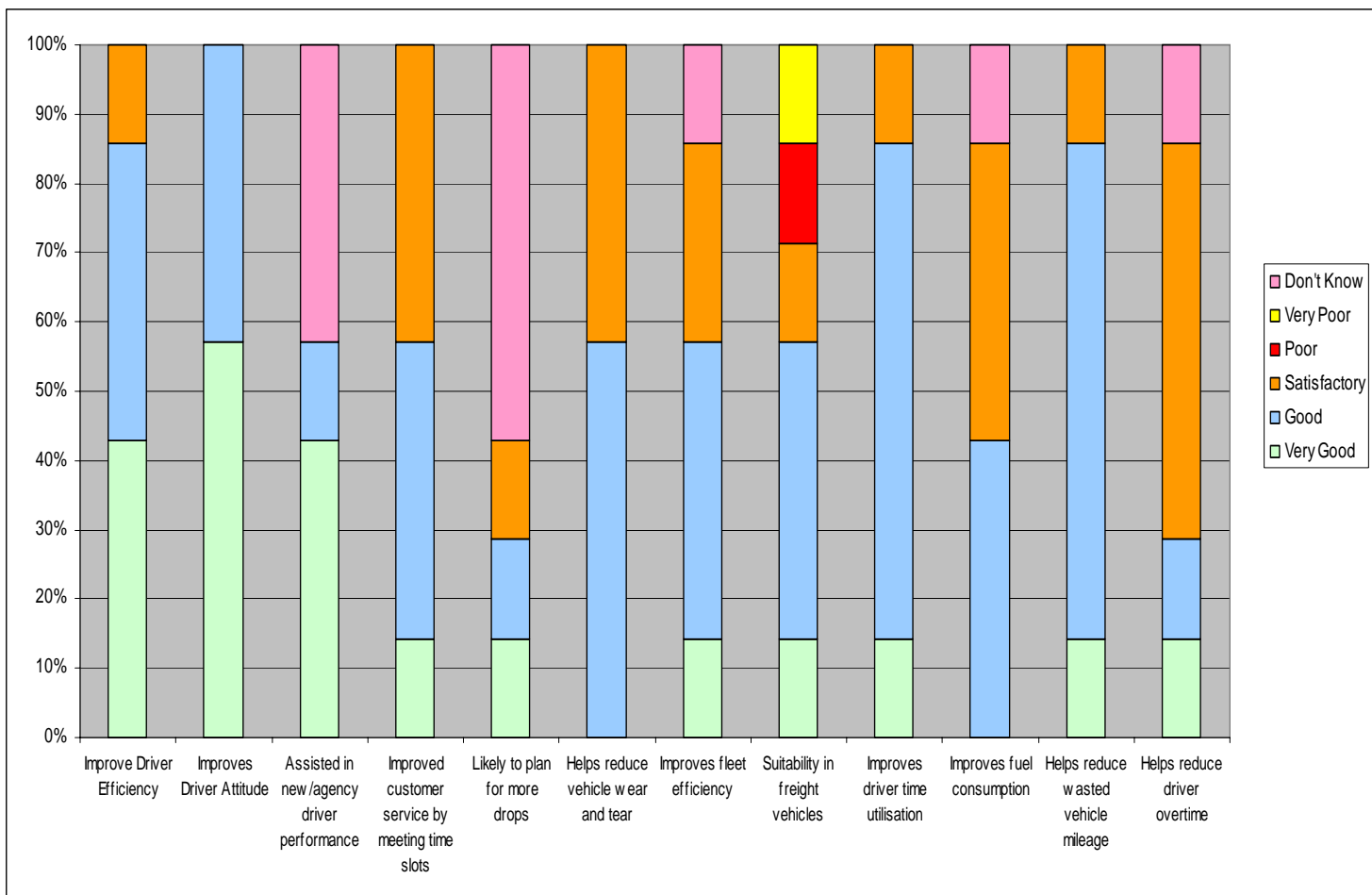
Improving driver time utilisation is vital for achieving operational efficiency. All managers rate the system satisfactory and above (14% rate the systems as ‘very good’, 72% rate as ‘good’, and 14% as ‘satisfactory’).

Improving fuel consumption, reducing wasted vehicle mileage and reducing driver overtime are crucial factors when it comes to achieving operational efficiency. 44% of transport managers rate satellite navigation systems as ‘good’, while 42% rate them as ‘satisfactory’ when it comes to improving fuel consumption.

86% of transport managers rate the systems as satisfactory and above for helping reduce wasted vehicle mileage. A total of 24% feel satellite navigation systems are ‘very good’ (14%) and ‘good’ (14%) for reducing wasted mileage due to lost running.

Finally, 58% of transport manager’s rate satellite navigation systems as ‘satisfactory’ for reducing driver overtime, while 14% felt the systems were ‘very good’. 14% of transport managers could not rate the system for reducing driver overtime as they felt it is too early to say.

Figure 5: Transport Manager Views on Usefulness of Satellite Navigation Systems



5.5.3.2

Satellite Navigation Systems Contribution to Cost Saving

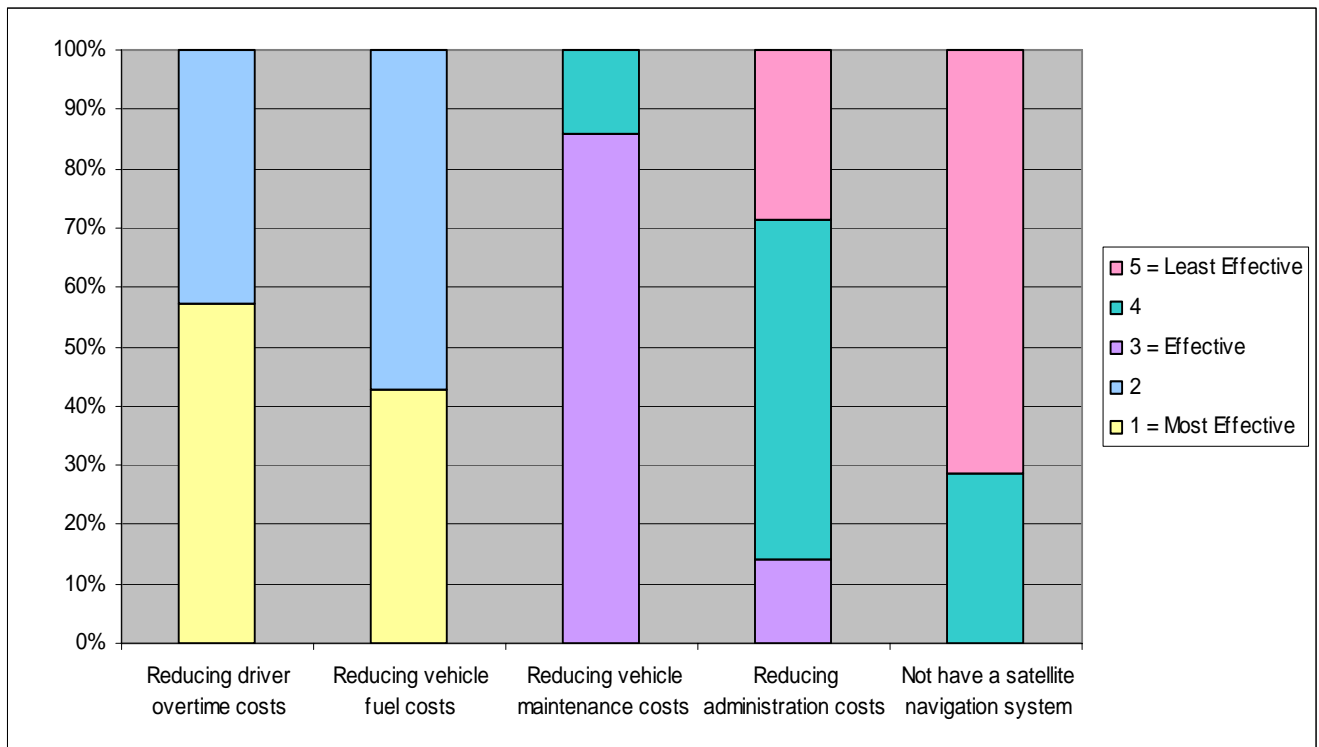
Transport managers were asked to rank the following factors from 1 (most effective) to 5 (least effective) in their relative contribution to cost savings as a result of using satellite navigation:

- Reducing driver overtime costs;
- Reducing vehicle fuel costs;
- Reducing vehicle maintenance costs;
- Reducing administration costs; and
- Not have satellite navigation systems at all.

Figure 6 below shows the effectiveness of satellite navigation when it comes to achieving cost savings. 58% of transport managers felt satellite navigation is most effective for helping reduce vehicle fuel costs, followed by 42% rating the system as most effective for helping reduce driver overtime costs.

89% of transport managers felt satellite navigation was effective (rating 3) for helping to reduce vehicle maintenance costs. For reducing administration costs, 28% of the transport managers felt the system was ‘least effective’ and 32% felt it would be least effective if they did not have a satellite navigation system at all. Hence, they would rather have satellite navigation systems in their fleet as they do in effect contribute to cost savings in the long run.

Figure 6: Rating of Satellite Navigation to Cost Savings



5.5.3.3

Summary of Satellite Navigation Systems

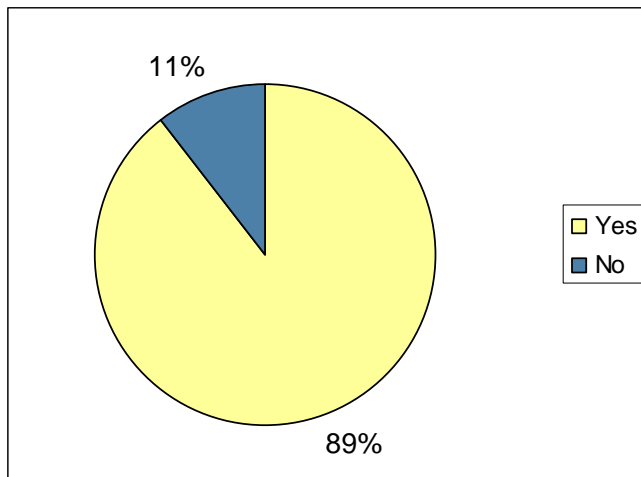
Transport manager and driver opinions on satellite navigation systems are vital before a company decides about investing in such systems and the types of systems. Most of the drivers that participated in the trial felt that satellite navigation systems are definitely worth having in freight vehicles and are of great benefit. Below is a summary analysis of what the drivers and transport managers felt about satellite navigation systems.

5.5.3.4

Is Satellite Navigation Worth Having in Freight Vehicles?

Out of all the companies who trailed satellite navigation systems, all transport managers would consider using satellite navigation systems for wayfinding in their operations. However, not all the drivers felt the same. Figure 7 below shows that 11% of the drivers feel it's not worth having satellite navigation systems in freight vehicles, but amazingly 89% of drivers do feel its worth having satellite navigation systems in freight vehicles.

Figure 7: Is it Worth Having Satellite Navigation Systems in Freight Vehicles?



5.5.4

Overall 'Usefulness' of Satellite Navigation Systems

Figure 8 below shows that 39% of drivers felt current satellite navigation systems are 'good', followed by 27% of drivers who felt the systems were 'satisfactory'. 20% of drivers felt the systems were 'very good', which is understandable as there is need for further improvement to make satellite navigation systems more suitable for freight vehicles. However, in total 12% of the drivers felt the systems were 'very poor' (3%) and poor (9%).

Figure 8: Driver's Overall Views on the Usefulness of Satellite Navigation

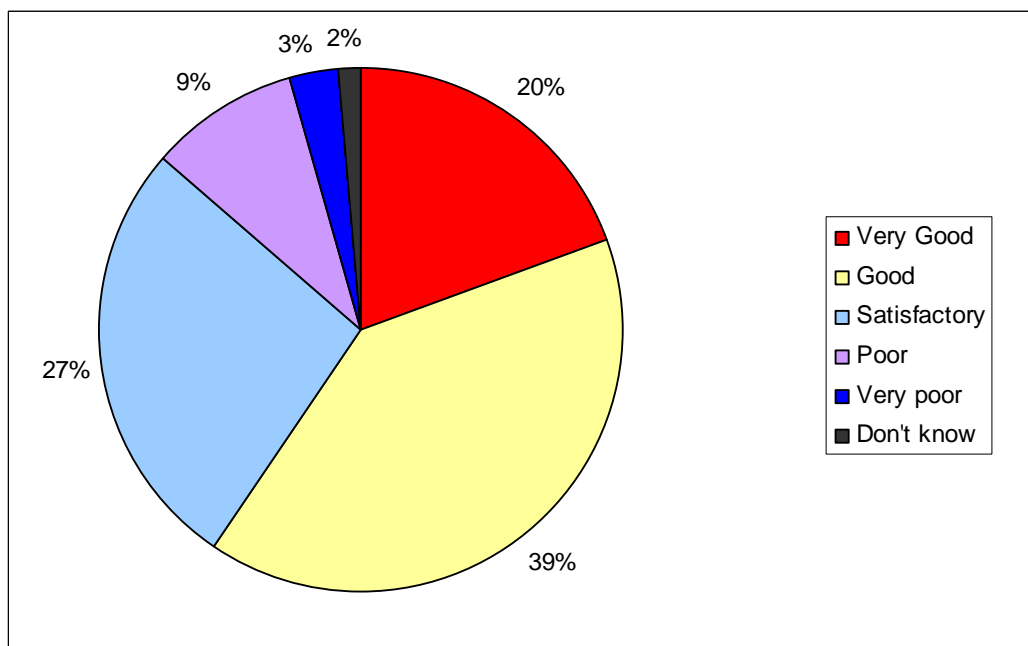
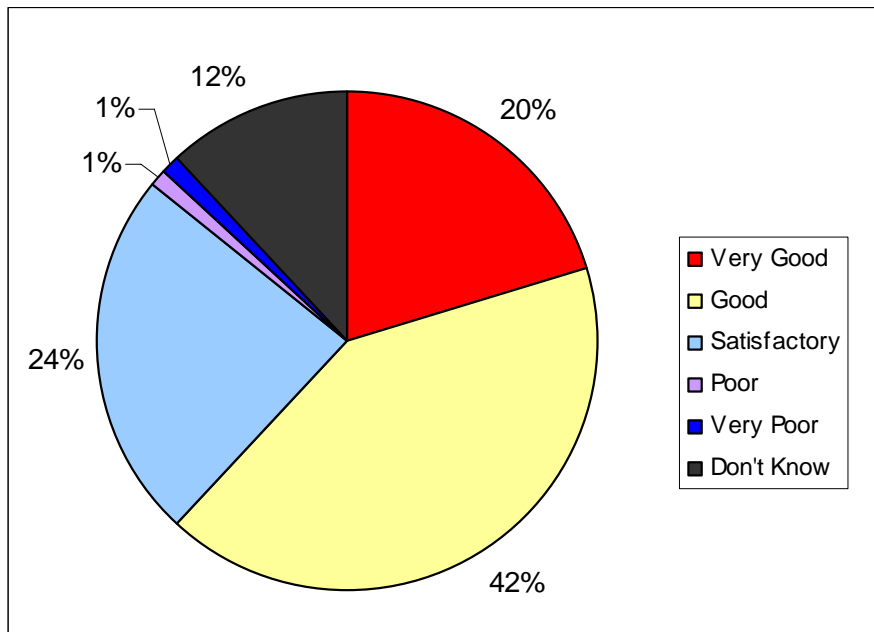


Figure 9 gives an overall view of the transport manager's views on the usefulness of the systems. As can be seen, 42% of the transport managers felt the systems are 'good', followed by 24% of managers rating satellite navigation systems as 'satisfactory'. As the drivers, 20% of transport managers felt the systems were 'very good'. Only 2% felt the current systems are 'very poor' and 'poor'.

Figure 9: Transport Manager's Overall View on the Usefulness of Satellite Navigation Systems

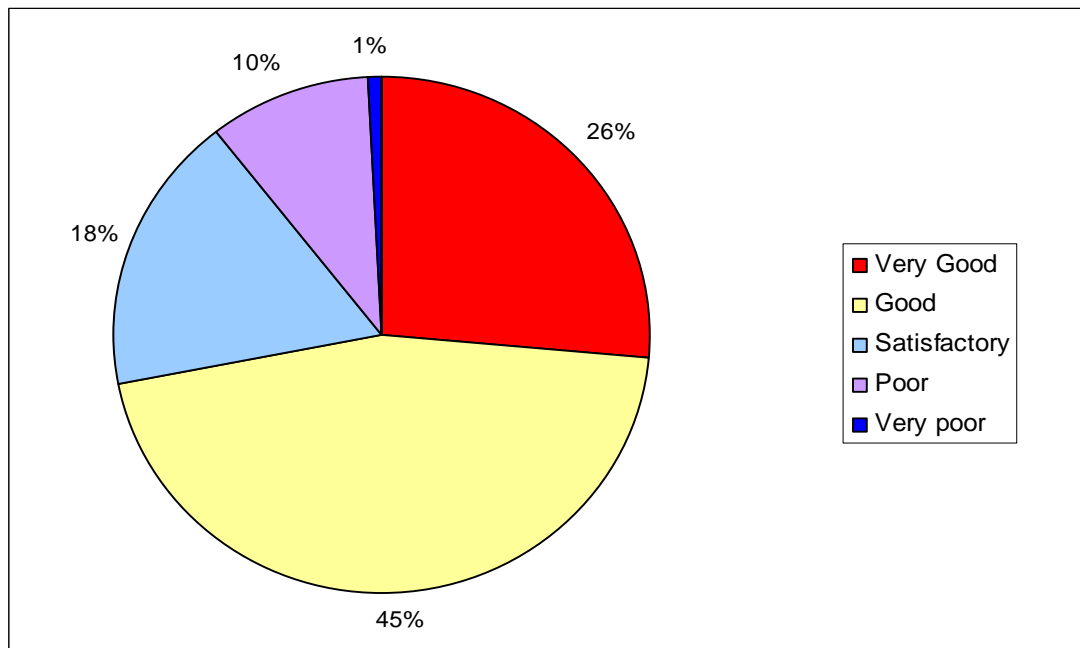


5.5.5

Overall 'Rating' of Satellite Navigation Systems

As mentioned earlier in the report, drivers were asked to rate their satellite navigation system. Figure 10 below gives an overall 'rating' view of drivers. Considering the problems with digital mapping and suitability of the systems in the freight industry, a total of 71% of drivers rated the system as 'very good' (26%) and 'good' (45%), followed by 16% of drivers who rated the system as 'satisfactory'. 10% of the drivers did feel satellite navigation systems are 'poor'.

Figure 10: Driver Overall 'Rating' of Satellite Navigation Systems



Information obtained from all the company drivers and transport managers has enabled the project team to summarise the positive and negative findings as a result of the trial:

'Positive' Findings – Drivers and Transport Managers:

- 95% of drivers feel satellite navigation saves time searching for locations;
- 59% of drivers rated the usefulness of satellite navigation systems as 'very good/good';
- Potential for saving time and fuel; 75% of drivers felt SatNav's reduce wasted mileage;
- 52% of drivers rate satellite navigation as 'very good/good' for safer driving;
- 89% of drivers mentioned its worth having satellite navigation in the freight industry;
- All participating transport managers are considering having satellite navigation;
- 62% of all the transport managers rated satellite navigation as very good and good;
- 58% of managers rate SatNav's as 'most effective' for reducing driver overtime costs;
- 42% of transport managers rated SatNav's as 'most effective' for reducing fuel costs;
- 72% of transport managers rate SatNav's as 'good' for reducing wasted vehicle mileage; and
- 43% of transport manager's rate SatNav's as 'very good' for improving driver efficiency.

'Negative' Findings – Drivers and Transport Managers:

- 32% of drivers felt the routes generated were 'very poor' (12%) and 'poor' (20%);
- 58% of drivers and 28% of transport managers feel that the system is 'very poor/poor' for use in freight vehicles due to freight mapping issues;
- Transport managers and drivers feel the systems are expensive; and
- Portable systems are very marketable resulting in high theft rates from vehicles if left unattended.

5.5.6

Comments Regarding the Use of Satellite Navigation

Both transport managers and drivers were encouraged to give feedback (positive or negative) on the use of satellite navigation in the freight industry. Some comments from transport managers are as follows:

- Satellite navigation systems should have the ability to plan a complete multi-drop load in advance and route all for best efficiency. For example, put all post codes in at once and the system should route the vehicles in the best possible order;
- There needs to be a place where the SatNav is position which is secure but which is still in a visible position for the driver of the vehicle;

- There is a need for a 'commercial' SatNav unit that shows low bridges and suitable routes for HGV's;
- It would be good to use blue tooth technology and to have real-time traffic information to see the effects this would have on the operation; and
- SatNav's deserve to succeed in commercial vehicle movements.

Drivers did also provide positive and negative comments of the systems. From a positive point of view of the systems, drivers mentioned that these systems would help them find locations easily and that the systems are simple and straightforward to follow. The drivers and the transport managers also strongly feel that satellite navigation systems greatly contribute to safer driving, especially in town/city centres as drivers do not need to refer to manual maps.

Apart from the digital mapping information issues and information on bridge heights/weight, road widths, etc, drivers also felt that satellite navigation systems will take a driver the shortest distance from 'A' to 'B', but this may not necessarily be the best way to take.

The transport managers felt that such systems are suited for all types of freight vehicles of various sizes, as long as the mapping caters for HGV/freight vehicle restrictions. Current systems are just for 7.5 tonne vehicles and below.

5.6 After Trial Results

As the Road Transport Industry is a varied and wide ranging one, satellite navigation was trialled in a number of industry sectors which represent a broad cross section of the various sectors of the freight industry. A total of four companies participated in the trial.

- Drinks 'trunking' and direct to store (DSD) distribution (AG Barr Plc);
- Paper merchant/distributor (A1 Paper Plc);
- Chemical manufacturer/distributor (Quadralene Ltd); and
- Container Distribution (Owner Drivers).

During the eight week wayfinding trial period, the TomTom GO 500 and GO 700 and the Garmin c320 was used by the participating companies as a way of assessing the usefulness of such systems in the freight industry. Our research showed that satellite navigation systems manufacturer by TomTom and Garmin are market leaders, so the best possible systems were used for trialling purposes.

5.6.1 Description of Participating Companies

The in-fleet trials were carried out in October 2005 on the use of satellite navigation in freight vehicles. The information in this section has been provided by participating companies and has been reported in good faith. Freight Best Practice cannot be held responsible for any inaccuracies as these are the views of the participating companies and not those of the programme.

A description of the participating companies is discussed below, and their comments of using satellite navigation have also been included. The detailed trial findings (quantitative and qualitative) analysis has been discussed later in the report.

Company Name:	A G Barr Plc
Industry Sector:	Soft Drinks
Vehicle Fleet Size:	Barr's have a total of 80 vehicles of various sizes from transit vans to 21 tonne (6 wheelers) to 44 tonne artics. Barr's are replacing the 21 tonne vehicles with 18 tonne (4 wheelers) in the very near future as they feel the 18 tonners are much cheaper and economical to operate.
	The delivery fleet of 70 vehicles in England only runs in the

	<p>daytime and has a mixed fleet with between 15 and 20 vehicles at each of the sites. The Wednesbury depot has a satellite depot at Bristol for the south west. Most vehicles are on regular runs but they do use agency drivers occasionally and do need drivers to do different routes for holiday cover.</p> 
<p>Details of Company:</p>	<p>A G Barr Plc is an independent, consumer led and profitable company, engaged in the manufacture, distribution and marketing of branded soft drinks.</p> <p>Being a long established company, A G Barr produces a large range of soft drinks including IRN-BRU, Tizer, and D'N'B (produced by A G Barr under licence from brand owner Cadbury Schweppes).</p> <p>The company has 4 production sites based at Cumbernauld, Mansfield, Atherton and Pitcox supported by distribution centres covering the whole of the UK. The sales of their soft drinks direct to the impulse market (small shop trade) are made through sales branches in Scotland and England. Their distribution centres deliver to supermarkets; cash and carry's and wholesale trade. A G Barr provides a high standard of service to both UK and overseas customers.</p>
<p>Freight Information:</p>	<p>A G Barr have primary distribution and direct to store delivery at different branches. Vehicle fleet varies from rigid delivery vehicles (3.5 to 18 tonnes), to artic vehicles used for trunking</p>

	<p>operations (38 and 44 tonnes).</p>
<p>Comments regarding the use of satellite navigation after the trial:</p>	<p><u>Atherton (Trunking depot):</u> “Satellite navigation is very useful for drivers in our operation, but it would be worthwhile if the system routed our vehicles based on real-time traffic information.”</p> <p><u>Wednesbury (DSD depot):</u> “The systems are a ‘god-send’ and are brilliant and valuable for agency/new drivers. I feel their performance and confidence has gone up 4 fold. I definitely would like to have 2 satellite navigation units to start off with for my depot.”</p> <p><u>Walthamstow (DSD depot):</u> “My drivers liked the systems very much. One of my drivers has actually gone out and bought a satellite navigation system, and feels they make his job much easier as he does not worry about finding delivery points now. Another driver is also considering buying a system for himself.”</p> <p>The systems no doubt have been easy to use and follow, and are very useful for our kind of operation, so I would also like to have 2 satellite navigation units to start off with until improvements have been made to freight specific information on digital mapping.”</p> <p><u>Moston (DSD depot):</u> “They are good systems and I would also like to have 2 units.”</p> <p><u>General comments from other members in the discussion:</u> “Three of our depots want the satellite navigation systems. Most probably we will get 2 satellite navigation units for our ‘Direct to Store Delivery’ depots. Congestion and road network delays account for 39% of our drivers being least productive, so if we can have a system that routes drivers based on live traffic information, no doubt there will be additional savings in journey time for the drivers.”</p> <p>“By having freight information available on satellite navigation,</p>

would be a great step forward for the technology and for the industry. If vehicle management systems and satellite navigation can be linked together, then there could be even more benefits for companies, rather than using satellite navigation on its own.”


<p>Company Name:</p>	<p>A1 Paper Plc</p>
<p>Industry Sector:</p>	<p>Stationary</p>
<p>Vehicle Fleet Size:</p>	<p>The company vehicle fleet comprises of 11 goods vehicles of which:</p> <ul style="list-style-type: none"> • 4 vehicles are 18 tonne; • 2 vehicles are 7.5 tonne; and • 5 vehicles are 3.5 tonne. 
<p>Details of Company:</p>	<p>A1 Paper Plc wholly owns A1 trade Print Services. In 1995, the company became the first fully accredited APACS printer and have been producing cheques and security products for over 30 years.</p> <p>A1 Paper Plc have the latest technology in prepress, press, and finishing departments, which has allowed the company to widen their portfolio by branching out into more specialised products as well as longer run colour, re-reel and sheet work. The company has a wealth of experience and knowledge in the security and specialised forms market.</p> <p>A1 Paper Plc is the UK's most locally focused paper merchant with a sound logistics framework. The company are able to</p> 

	<p>offer a more diverse and extensive catalogue of papers and boards than any other merchant. The sectors that the business now operates into include printers, Education/Universities, Local Authorities, Stationers and more recently the Retail sector.</p>
<p>Freight Information:</p>	<p>A1 Paper Plc has customers based all over the UK. Deliveries are carried out using the company’s own fleet. Because of the large number of customers at various locations, the use of satellite navigation would be a useful tool in minimising mileage run for the company.</p>
<p>Comments regarding the use of satellite navigation after the trial:</p>	<p>“Satellite navigation is a useful tool for drivers. Our company will be looking to get some in the future. At the moment, the systems are expensive, so the payback for our type of operation we feel will be longer. When the prices of these units fall, we are definitely going to buy some for our drivers.”</p> <p>“Our drivers had to be extra careful when they left their cabs. These units can get stolen very quickly, even if a cab is locked. If a driver leaves his cab to get his delivery notes signed off, there is a very high chance that the portable unit will go missing. Who do you blame for this as it’s not the drivers fault?”</p> <p>“Drivers need to use common sense and need to know road signs when using satellite navigation. Some of the directions generated don’t make sense. For example, the system sent a driver down the M6, then routed them on the M42, then back on the M6 incurring an extra 6 miles! Surely it should have just left the driver on the M6.”</p> <p>“If the systems worked out the routes based on 3 or more post code drops, then this will save a lot of time in our transport office.”</p> <p>“Screen colour mode should automatically adapt to day or night vision like offered in the Garmin system. If a driver has to physically change the colour vision while they are driving it is not advisable as this does not only affect safety, but also the driver will loose his map display for a while till he works out how to</p>

change the colour mode.”

Company Name:	Quadralene Limited
Industry Sector:	Chemical Manufacturer / Distributor
Vehicle Fleet Size:	<p>Quadralene fleet comprises of 5 vehicles:</p> <ul style="list-style-type: none"> ■ 4 x 18 tonne gross 2 axle rigid curtain sided vehicles, which have payloads of 8400kilos; and ■ 1 x Sprinter Van, 4600 kilos gross, 1950 kilos payload. The company also run another Sprinter Van as a sales van, which is independent of the delivery fleet.
Details of Company:	<p>Quadralene provide cleaning and hygiene solutions and are manufacturers and distributors of:</p> <ul style="list-style-type: none"> ■ Industrial cleaning chemicals; ■ Automotive valeting products; and ■ Janitorial supplies. <p>Quadralene has been manufacturing industrial cleaning chemicals since 1930 and are acknowledged worldwide as experts, particularly in the field of ultrasonic cleaning.</p> <p>The company aims to deliver innovative research and development, whilst making the best environmental use of resources supported by high-calibre logistics.</p>
Freight Information:	<p>The Quadralene logistics team ensures that customers receive their products on time and in pristine condition. Quadralene aims to deliver any order within five working days from receipt.</p> <p>Quadralene use a combination of their own fleet of vehicles and some carefully selected carriers to ensure a fast and efficient service. Their own fleet are unmarked Mercedes vehicles to ensure a confidential service, when appropriate.</p> <p>The company can make arrangements to book loads in at specific times, or accommodate customer preferred times. Special arrangements or overnight deliveries can be arranged at competitive rates.</p> <p>Quadralene are involved in Dangerous Goods by virtue as some of the products manufactured are classified as dangerous for transport. Some of the raw materials the company use in manufacture are also hazardous.</p>

<p>Comments regarding the use of satellite navigation after the trial:</p>	<p>“There are now so many satellite navigation systems on the market. I strongly feel post code driven systems are vastly superior to actually typing in the road name. Some systems on the market are address driven rather than post code driven, and this can be cumbersome to use. The ideal system has to offer six figure post codes and in some cases, for London especially, a seven figure post code would be a bonus”.</p> <p>“At times, the systems will loose GPS reception very quickly and not have a clue where it is! This can be very annoying, as a driver has to wait till the unit picks a signal before they can move. This can usually take anything between 10 minutes to 25 minutes”.</p> <p>“No doubt such technology is needed in the logistics and transport industry. Our drivers want us to buy satellite navigation now as they feel they can not do their job without them. These systems have been well liked by our drivers, but our drivers have had problems with them and they can not rely on them 100%”.</p> <p>“By using satellite navigation, our drivers are relaxed and less stressed as they do not worry about wayfinding any more. Above all, the systems definitely enhance road safety as drivers can concentrate on the roads as opposed to looking at maps”.</p> <p>“If freight specific information was available on these systems, then all freight companies would buy satellite navigation. They do reduce mileage travelled hence, reduce fuel, they are brilliant for agency drivers and they will get a driver to their delivery/collection point. However, the systems do have problems and if a driver is not careful, they can end up in a right mess”.</p> <p>“The trial has had a positive impact on our drivers and operation. Our drivers want the systems, so my company is going to invest in getting 4 satellite navigation systems to start off with”.</p>

<p>Company Name:</p>	<p>JNW Transport</p>	
<p>Industry Sector:</p>	<p>Container Distribution</p>	
<p>Vehicle Fleet Size:</p>	<p>Owner driver (operates one 44 tonne vehicle)</p>	
<p>Details of Company:</p>	<p>Neil Wilson (proprietor of JNW Transport) is an owner driver running a Volvo FH12 tractor unit. He is in the container market working for Maersk mainly out of the Stourton Terminal at Leeds. The containers mostly come up from Felixstowe to Leeds by train.</p> <p>Neil claims that he was the first operator in the UK to specify the Volvo in-cab wayfinding system. The chosen system was the Siemens VDO satellite navigation system with the option of either using Volvo’s Dynafleet or a reversing camera sharing the same visual monitor in the cab. As Neil works for himself the fleet management tool was not required so he chose the reversing camera.</p>	
<p>Comments regarding the use of satellite navigation after the trial:</p>	<p>“The systems are mainly for cars and smaller vehicles. It is very easy to find addresses, but bridge heights, weights, road widths information is needed in satellite navigation systems for it to be ideal in the freight world.”</p> <p>“Some of the routes generated are not accurate. Some junctions are not on the maps so this can get confusing. The voice guidance does not always match the map directions, so drivers do need to use common sense when using the system.”</p> <p>“PDA system screens are very small, and the maps can hardly be seen so are not really suitable for freight vehicles. The portable systems are better but these can get stolen very quickly.”</p>	

This chapter mainly looked at the trial findings, both the qualitative and quantitative analysis. Comments from drivers and transport managers who participated in the trial have also been highlighted above to show what they thought of satellite navigation systems, and how these systems had an impact on their operations.

The following chapter, conclusions and recommendations, brings together our findings from the trial and summarises how satellite navigation systems have contributed to helping companies achieve operational efficiency. The recommendation section reveals the next steps for satellite navigation applications in the freight industry, based on comments from freight operators and our findings.

6 Conclusions and Recommendations

6.1

Conclusions

Freight vehicle drivers spend a lot of time on the road. They can therefore become quickly converted not just to navigation aids, but congestion information tools. Satellite navigation with real-time traffic information will empower the driver to make decisions based on the best available information. It is hoped that the inclusion of the market review chapter makes selecting a satellite navigation system decision easier, but choosing the right system is difficult.

With a growing satellite infrastructure providing even more reliable and accurate signals, the transport and logistics sector has the largest ever range of technology options for asset management and fleet tracking. It's not the technology itself that will convince the industry, but evidence of:

- The reliability of systems;
- Ease of use;
- Integration with existing infrastructure (like computer routing systems); and
- Return on investment.

Route finding traditionally has been via a combination of the use of road atlases, local A to Z maps and word of mouth. At the present time, satellite navigation systems are improving to assist with routing and wayfinding for freight vehicle drivers. These systems have the potential of being better than the current practice carried out by drivers.

In comparison to manual maps that drivers have traditionally used, satellite navigation systems can be less stressful and safer. These systems can be a more convenient tool that would give any driver more confidence in driving and finding locations.

To be successful, satellite navigation-enabled systems need to be tailored to suit the logistics and transport industry. Freight operators then need to carefully select, install and manage systems most appropriate for their industry sector. The logistics sector is not technology oriented but will adopt solutions that deliver value and reduce costs.

Given the traditional pressures on driving time such as tight delivery windows, drivers' hours restrictions and new pressures from the latest working time rules, freight operators can not afford the time and fuel while drivers are looking for a particular destination. Unless freight drivers drive the same well-known route every time they get in the cab, satellite navigation systems can be invaluable for any freight operator and driver.

Having conducted an eight week trial in October/November 2005 to compare the 'before' and 'after' effects of using satellite navigation, it must be stated that at this stage the quantitative approach may not be suitable for a full understanding of the benefits of SatNav. Interviews with drivers and fleet managers have made a better contribution to the research, especially where the value of SatNav was in the training of new drivers or old drivers to new routes/customers.

6.1.1

Fuel Consumption

We feel that the trial cannot tell us a great deal about fuel efficiency and satellite navigation. This is simply because we believe that the time frame for change isn't long enough in the data set. Despatchers always plan with an element of slack in their daily schedules to cope with traffic, weather, accidents and other external factors. They will load a wagon to a certain weight or plan a trip to certain durations dependent on the driver, vehicle, road conditions, customer personal cautiousness and so on.

The argument for satellite navigation improving fuel efficiency is that it will improve certainty, release minutes lost in destination finding and allow greater loads to be carried for longer distances. We believe the idea that a planner, for whom customer service will be the highest criteria of success, would have changed planning patterns in the timescale of the study because untested satellite navigation systems had been fitted to cabs is unrealistic. We have not seen many changes to fuel efficiency because we haven't seen any change in planning

practice. We are probably seeing the noise from various other factors, not least being the seasonal fall off in drinks distribution business.

The way to test for satellite navigation effects on fuel efficiency will be to sample the fleets that adopt satellite navigation, and that have changed their planning parameters accordingly. High activity fleets where small incremental change is quickly translated to drops per day may be most suitable, but it needs to be done after despatcher confidence has grown.

We can dissect the data further, map activity level versus number of points versus utilisation, traffic conditions etc, but we suggest that a better solution will be to resample the fleets that adopt satellite navigation and change their planning accordingly after a few months.

6.1.2

Minutes Lost

At an aggregate level our trial suggests that satellite navigation does reduce time lost in finding destinations. It is more significant in the data than the points visited, which is the logical alternative factor. Analysis by vehicle class suggests that light vehicles will benefit most from the systems and that heavy vehicles will benefit less.

This simple conclusion is seen more subtly from the fleet analysis that suggests that it is the *nature* of fleet activity that affects time saving most. Fleet 2, with heavy vehicles, saw significant savings in time whilst Fleet 6, with medium and light vehicles, saw a worsening of performance.

Heavy vehicles seem to be disadvantaged by the car focused retail systems, which do not allow for the vehicle characteristics. At this point we suggest that: "High delivery/collection activity vehicles in an infrastructure which does not present significant access issues will benefit greatly from satellite navigation systems. Low delivery/collection activity vehicles will benefit less, and heavy vehicles and any vehicle in an unsuitable infrastructure using car-focused satellite navigation units will suffer."

6.2

Summary of Findings

Following the successful trial period all data was collected and analysed in order to present both the positive and negative findings. There are three sets of findings, quantitative from the trial data, qualitative from a questionnaire issued to drivers and transport managers following the trial and general findings obtained from desktop research and informal consultation.

6.2.1

Quantitative Data

The quantitative data collected during the trial has been analysed by the University of Newcastle to see whether satellite navigation can be said to affect the:

- Number of minutes lost by a driver when finding a delivery/collection point;
- Kilometres driven per litre of fuel; and
- Kilograms of cargo carried per litre of fuel.

Vehicle type was classified as Light (<7.5T mgw); Medium (7.5T mgw and <32T mgw); and Heavy (>32 T mgw). The findings are as follows:

Positive findings:

- **Collection and delivery work** - The type of work rather than vehicle size appears to be the more important factor in determining whether SatNavs are going to be useful to a freight operator. Vehicles used on collection and delivery work, particularly multi-drop runs to or from a wide range of new addresses are likely to benefit significantly from the use of SatNav;
- **Unfamiliar routes** - All drivers are likely to benefit from having SatNav when on unfamiliar routes;
- **New/agency drivers** - New/agency drivers are generally unfamiliar with their routes and do stand to benefit the most from SatNav;
- **Minutes lost looking for destinations** - The trial found that on average drivers would spend 13 minutes a week, or 676 minutes a year, less looking for a destination, when using a SatNav system; and
- **Reduction in the amount of time looking for destinations, "lost"** – The reduction in the amount of time drivers spent looking for a destination depended on the type of operation. Multi-drop fleets saw reductions in minutes "lost" of between 30% and 89% depending on the type of operation. However other fleets on trunking operations between small numbers of

fixed points did not report any time savings. This is mainly because little time is lost anyway in trunking fleets.

Negative Findings:

- **Fixed route runs** - Where drivers do the same journey daily, they are not likely to benefit. In fact the trial suggests that SatNav may, in fact, have a negative effect, due to the time spent programming the SatNav system and because of occasional incorrect routing decisions by the SatNav system;
- **Extra distance** – 48% of drivers reported that extra kilometres were driven caused by misrouting by the GPS systems. Misrouting occurred where a driver was directed a longer way but a shorter suitable route could have been used. Narrow road problems meant the drivers had to find a new route as opposed to following the SatNav guidance; and
- **Freight Mapping problems** - Drivers of 7.5 tonne MGW vehicles and above reported routing problems caused by freight mapping issues (especially bridge heights, weights and problems of access). In fact, the heavy vehicles experienced the greatest increase in distance due to mapping problems.

Inconclusive Findings:

- **Fuel consumption** – In theory SatNav could improve fuel consumption (km/litre), depending on the type of operation. Fleet 4 recorded an improvement of 14.2% in km/litre and fleet 6 saw improvements by 6.7%. Although these improvements were on multi-drop fleets that would stand to gain the most out of the use of SatNavs there could be other factors influencing these impressive savings. Overall fuel efficiency for all participating companies improved by 1.11%, suggesting the need for companies to assess the type of operation and likely benefits before investing in the systems;
- **Load planning** - The trial period was too short to report any meaningful changes in load planning; and
- **Kilograms of cargo carried per litre of fuel** – It was not possible in the short time period and with the types of delivery runs that tended to vary from day-to-day to obtain conclusive data on this topic.

6.2.2

Qualitative Information

The following is a summary of the qualitative information obtained from a questionnaire issued to drivers and transport managers after the trial:

Positive findings:

- **Searching for locations** - 95% of drivers in the trial felt that SatNav systems can save time;
- **The need for SatNav in the freight industry** - 89% of drivers reported that it is worth having SatNav in the freight industry. All participating transport managers were considering using SatNav within their HGV fleets permanently;
- **Driver efficiency** - 85% of transport managers rate SatNav as very good or good for improving driver efficiency;
- **Reducing driver overtime costs** - 58% of managers said that SatNav could be effective in reducing driver overtime costs;
- **Reduced wasted mileage** - 75% of drivers and 72% of managers felt SatNav systems could reduce the amount of wasted mileage incurred;
- **Reducing fuel costs** - All managers rated SatNav as potentially being effective in reducing fuel costs;
- **The current usefulness of SatNav** - 59% of drivers and 62% of all the transport managers rated the usefulness of SatNav as very good or good; and
- **Safer driving** - 52% of drivers rate SatNav as very good or good for safer driving but this percentage is not conclusive.

Negative Findings:

- **Quality of the routes generated** – A third of drivers felt that some of the routes generated were poor or very poor. There were concerns as to the appropriateness of guidance on the routes generated for freight drivers. Some of the drivers chose to disregard certain routes generated because they were inappropriate;
- **Freight mapping** - 58% of drivers and 28% of transport managers felt that the digital mapping in the systems trialed was poor or very poor for use in freight vehicles due to the lack of information on bridge heights, weight limits, narrow roads and other freight related issues not being featured on the maps. It is important to stress that it is the mapping issues where the problems lie, and not SatNav as a tool itself; and
- **Value for money of the systems** - Transport managers and drivers felt the systems are expensive, but it is recognised that prices are falling.

6.2.3

General Findings

In addition to the findings that came from the quantitative and qualitative research there are a number of other notable points that came from desk-top research or consultation.

Positive Findings:

- **Create Customer satisfaction** - The benefits of customer satisfaction following goods arriving on time and good service are difficult to quantify but lead to customer retention. It was felt that a softer benefit of SatNav is that more deliveries could be made on time;
- **Driver aid** – In the same way that having a good atlas or a local A to Z provides confidence that a destination can be found, a reliable SatNav can offer this “peace of mind”. This confidence needs to be built up over days of successful running and is not a quantifiable factor but nevertheless good systems can reduce worry;
- **Payback period** - The trial found that on average 13 minutes a week or 11 hours per unit a year would be saved. If the cost of a vehicle is approximately £25 per hour then the 11 hours per vehicle saved would equate to £275 per year. Assuming the cost of wayfinding equipment is about £400 then the payback on initial cost would take about 1.5 years. If the units are acquired in a more targeted, selective way then the payback period would be shorter. This is a shorter payback period than for many other items in the transport industry; and
- **Integration with other computer systems** – SatNav systems will really become popular when vehicle routing and scheduling systems can automatically download routes into the SatNavs and the systems also feature “real-time” traffic information that informs the driver so that alternative routes can be taken. At this point then it is likely to be a necessity for many larger fleets.

Negative Findings:

- **Last mile issues** - The systems did take the drivers to the general area of the destination however, for a proportion of journeys, some of the systems do not lead the driver to a precise enough location. This can leave a driver in the correct road but unsure of his final location. Some SatNav systems use a 6 or 7 character postcode whereas others used street names or a 4 character postcode;
- **Security Issue** – The portable systems that are mounted on the dashboard or on the windscreen are very mobile, resulting in high theft rates from vehicles if left unattended and unlocked. Indeed we had a system stolen from one of the lorries in the trial which proves the point; and
- **Freight Mapping** – The following data is required to make SatNavs “freight friendly” specifically details on:
 1. Road widths;
 2. Road weight limits;
 3. Bridge weight Limits;
 4. Bridge heights;

5. No HGV through routes except for access;
6. Severe gradients;
7. One way streets;
8. High occupancy lanes;
9. No car lanes/Bus lanes; and
10. Risk of grounding (e.g. on hump back bridges).

6.2.4

In-fleet Trial Conclusions

Although it is difficult to be sure of the precise benefits of SatNav for vehicles of 7.5 tonnes MGW and above, it is clear that in concept there are certain applications they have the potential to become an everyday tool of the trade. This is especially so where new or temporary drivers are being used and where an experienced driver is often required to travel to unfamiliar destinations.

The barriers to SatNav spreading across the road freight industry centre on the non freight specific information held in the mapping software from where the SatNav system takes its instructions.

However, if a driver is aware of the potential misrouting and takes sensible decisions it can be argued that the less familiar a driver is with the delivery address, the greater the contribution that a navigation system could make to operational efficiency. Similarly, the more locations a mobile worker has to visit each day, the greater the potential savings.

From the research team's knowledge of freight operations the following is a list of industry sectors for which satellite navigation might be particularly beneficial:

- Parcel/courier and home delivery services;
- Groupage / general haulage;
- Rural haulage operations (farms); and
- Specialist operations; for example car transporters, home/office relocation companies, skip companies, and international haulage.

With most navigation systems, mapping information is not specific to HGVs, so it does not take into account freight specific issues, such as weight or height restrictions. With the current systems on the market, freight drivers will have to judge the road quality and suitability themselves and cannot rely on the system 100%.

With a growing satellite infrastructure providing more reliable and accurate signals, the transport sector has the largest ever range of technology options for asset management. However, it is not the technology itself that will convince the industry, but rather evidence of the reliability of systems, ease of use, integration with existing infrastructure and return on investment.

To be successful, satellite navigation-enabled systems for road freight operations must be carefully selected, installed and managed. The sector is generally not technology oriented but will adopt solutions that deliver value and reduce costs. It is expected that freight specific wayfinding equipment will become readily available at affordable cost in the future and the use of satellite navigation will become more widespread across many sectors of the industry as a result.

When this report was written in 2006, it included information and guidance based on views known at the time, however, the industry is moving forward quickly and technology is changing rapidly. Portable satellite navigation equipment is becoming very popular for car users as the relative cost of the units comes down and the systems improve. It is likely that systems that download to mobile phone or other handheld pocket size units will also become popular. The downside of popularity is that the units are attractive items for thieves and they should not be left on view in cabs. If and when freight specific mapping can be provided for SatNav systems it is reasonable to predict that satellite navigation will become essential equipment in the freight industry over the next ten years.

6.3

Recommendations

The trial shows that if further enhancements were made to satellite navigation systems in the following areas they would become more attractive to road freight operators:

- **HGV specific mode for SatNav systems**
All of the different functionalities of SatNav systems appropriate for HGVs should be accessed through an HGV specific mode contained within the systems set up menu.
- **Digital mapping**
The provision of improved digital mapping to take into account HGV specific route information. This is the primary and most important recommendation.
- **Freight specific ‘points of interest’**
Alongside more general points of interest locations such as truck stops, lorry parks and HGV fuel stops might be included in the base data on SatNav systems.
- **Real-time re-routing functions**
Real-time traffic information and re-routing abilities could lead to increased benefits.
- **Multi-drop postcode functions**
This would enable a user to download ‘multi-drop’ postcode information and automatically work out the best routes.
- **Environmental routing**
A logical extension to using HGV restriction in digital mapping is to include voluntary agreements between road freight operators and local authorities on roads that are deemed environmentally unsuitable for HGV traffic.
- **Route planning download** – enabling planned routes to be downloaded from a computerised vehicle routing and scheduling system into a vehicle based SatNav system.

These actions are in the hands of the systems and software providers and it is likely to be the private sector that drives the industry forward. However, there may be an intervention that the government or public sector organisations can do to influence progress and that is to ensure that consistent information is made available to companies in the industry. Much of the freight specific information is held by Local Authorities, often only in paper form, and hence, may prove difficult to give to the digital mapping companies. Good freight mapping across the whole country would be of major benefit to the freight industry.

6.3.1 *HGV Specific Mode for SatNav Systems*

All of the different functionalities of SatNav systems appropriate for HGV’s should be accessed through an HGV specific mode contained within the systems set up menu.

6.3.2 *Freight Specific Mapping*

Having conducted the trial and consultation with various freight operators, it has revealed some problems that arise because existing satellite navigation systems are more suited for cars and smaller vehicles and do not take account of the various road restrictions that affect HGVs and other freight vehicles. This problem has been acknowledged in the media when HGVs have used inappropriate routes through small villages, etc.

According to our trial, 58% of drivers feel that the system is ‘very poor’ or ‘poor’ for use in freight vehicles. Most of the drivers mentioned that routes generated need to consider freight specific issues (for example, bridge heights/weights, road width restrictions, etc) as they had to re-route because the system routed them down inappropriate routes. 28% of transport managers feel the systems are ‘very poor’ and ‘poor’ for suitability in freight vehicles (due to freight specific mapping issues)

Satellite navigation systems are good for wayfinding but there are concerns as to the clarity of guidance and routes generated for freight drivers. More importantly satellite navigation does get a driver to their destination (in many situations within 10 to 15 foot). Whether a SatNav system is post code driven or not, none of the systems that are on the market today will get a driver to their exact point of delivery or collection point. There will still be an element of last minute wayfinding but the driver will have the benefit that they are only a very short distance away.

In the longer term, data should also be included on other restrictions that can affect HGVs, specifically:

- Road widths;
- Road weight limits;
- Bridge weight limits;
- Bridge height limits;
- No HGV through routes except for access;
- Severe gradients;
- One way streets;
- High occupancy lanes;
- No car lanes/Bus lanes; and
- Risk of grounding (e.g. on hump back bridges).

Whether satellite navigation will be a perfect tool for routing freight vehicles will ultimately depend on the depth and detail of information in the digital maps. Once freight specific mapping is available on such systems, the road freight transport industry would benefit greatly and wasted vehicle mileage could be reduced.

By looking further into digital mapping data, this will not only benefit satellite navigation systems but also other routing and scheduling packages (e.g. web-based systems, CD-ROM systems, etc).

Improving freight specific mapping has also been recommended and supported by participating companies and their quotes are as follows:

“Having freight information available on satellite navigation would be a great step forward for the technology and for the industry. If vehicle management systems and satellite navigation can be linked together, then there could be even more benefits for companies rather than using satellite navigation on its own”. Simon Reynish – Logistics Project Manager (AG Barr’s).

“If freight specific information was available on these systems then all freight companies would buy satellite navigation. They do reduce mileage travelled hence, reduce fuel, they are brilliant for agency drivers and they will get a driver to their delivery/collection point. However, the systems do have problems and if a driver is not careful they can end up in a right mess”. Kemble Turner, Head of Logistics (Quadralene Ltd).

“The systems are mainly for cars and smaller vehicles. It is very easy to find addresses, but bridge heights, weights and road widths information is needed in satellite navigation systems for it to be ideal in the freight world” (Neil Wilson – JNW Transport).

6.3.3 *Freight Specific ‘Points of Interest’*

As with freight specific road mapping information, information on points of interest such as nearest petrol station, hotel, etc. is also an important feature that is already available in the systems. If the following information is included in satellite navigation systems, it is likely to promote their more widespread use in the freight industry:

- Truck stops/lorry parks (for overnight stay); and
- HGV Fuel stops.

6.3.4 *Route Guidance and Traffic Management*

Route guidance and traffic management are already available with the ‘SmartNav’ Trafficmaster system. Further improvements on these systems will include information on weather and traffic information to make a dynamic route guidance tool, allowing the driver to avoid roads with heavy traffic. This, together with the system advising drivers of the optimum speed so that red

lights are avoided to improve fuel efficiency, have corresponding benefits in reducing CO2 emissions.

As our research found, 42% of drivers stated that congestion/road network delays were the most common factor that made their day “least productive”. Once satellite navigation systems have been developed further to include congestion avoidance, it is suggested that a further wayfinding trial for the freight industry should be conducted to investigate the potential benefits and cost savings as a result of using live traffic information.

If for example, a satellite navigation system has an in-built traffic message channel receiver that enables integrated traffic information, then the system would recalculate a new route for the driver, giving more precise information about the congestion ahead, which ideally could then be avoided. This will not only identify operational efficiency for freight operators but will also look at the reductions in CO2 emissions as drivers would be able to take alternative routes, helping them avoid traffic jams and road network delays.

Trialing using live traffic information has also been recommended and supported by participating companies and their quotes are as follows:

“Congestion and road network delays account for 39% of our drivers being least productive, so if we can have a system that routes drivers based on live traffic information, no doubt there will be additional savings in journey time for the drivers”.
Simon Reynish – Logistics Project Manager (AG Barr’s).

6.3.5 *Multi-drop Post Code Option*

Satellite navigation systems are currently used for wayfinding only. If the satellite navigation systems had the ability to route drivers in a systematic and sensible way if they have many drops, this would prove very useful and in turn reduce time spent working out the best routes for their delivery drops.

For example, if a driver has 10 drops, ideally they should be able to enter post code data for their 10 drops in any order and the satellite navigation system should work out the best route. This has also been suggested by one of the participating companies:

“If the systems worked out the routes based on 3 or more post code drops, then this will save a lot of time in our transport office”. *John Claffey, Transport Manager (A1 Paper Plc).*

6.3.6 *Environmental Routing*

Investigating further to find out if there are any plans for incorporating environmental impact on route planning/mapping algorithms in satellite navigation systems could also be vital from an environmental point of view. For example, will satellite navigation systems route drivers based on the lowest polluting journeys and will future systems report any environmental impact of a journey on the environment?

6.3.7 *Route Planning Download*

A substantial efficiency benefit could be gained if a capability was introduced to enable planned routes to be downloaded from a computerised vehicle routing and scheduling system into a vehicle based SatNav system. This would reduce the time required for repeated manual inputting of location data and integrate the use of SatNav into a driver's everyday routine. It would also have the capability to record actual against planned in order to fine tune future route plans

6.3.8 *Recommend Further Research*

The project team recommend that further research be carried out on the fleets in this trial and that they adopt satellite navigation and change their planning practices accordingly. This would enable the fleets to see if the minutes saved in destination finding can be released as greater fuel efficiency.

The project team especially recommend that greater analysis is made of the fuel efficiency data, mapping other factors, especially seasonality. The data exists but could not be processed fully in the time frame.

The project team recommend the use of retail satellite navigation for light vehicles in high delivery/collection activity fleets be encouraged. The use of retail satellite navigation may be recommended for medium vehicles in high delivery/collection activity fleets where the infrastructure is friendly to medium vehicle access.

The development of satellite navigation units which understand the access restrictions of infrastructure should be encouraged and fostered so that high delivery/collection activity fleets of all vehicle types can enjoy the advantages of satellite navigation. This is to be recommended on the basis of greater delivery accuracy and confidence allowing more efficient planning.

The project team recommend that a best practice guide, showing both the advantages and disadvantages, be written. This should be careful to avoid a 'one-size fits all' approach and maybe best preceded by further work on equipment with a better understanding of infrastructure and vehicle class.

6.3.9

Freight Best Practice Recommendations

On a more general level the following is recommended:

- Follow Up Research - Further research to be carried out on the fleets in this trial that adopt satellite navigation and change their planning practices accordingly to see if the minutes saved in destination finding can be released as greater fuel efficiency; and
- Good Practice Guide – Produce a Good Practice Guide, showing both the advantages and disadvantages of using satellite navigation systems in the road freight industry, should be produced. This guide should be careful to avoid a 'one-size fits all' approach, and may be best preceded by further work on equipment with a better understanding of infrastructure and vehicle class.

6.4

Summary

The trial found that on average 13 minutes a week or 11 hours per unit a year would be saved through the use of SatNav. If the cost of a vehicle is approximately £25 per hour then the 11 hours per vehicle saved would equate to £275 per year. Assuming the cost of wayfinding equipment is about £400 then the payback on initial cost would take about 1.5 years. If the units are acquired in a more targeted, selective way then the payback period is likely to be even quicker. It is suggested that the acquisition of a few units for the use of new or agency drivers would give a quicker payback and provide better customer service. The benefits of improved customer satisfaction and driver aid are difficult to put a value on, but are important factors that make a year's payback probably worth it.

The future for wayfinding systems for the freight industry looks bright. The availability of accurate position, time and speed from satellite navigation systems has widespread applications in the transport and logistics arena. Upgrades to GPS and the new European signals from EGNOS (European Geostationary Navigation Overlay System) and Galileo will provide enhanced capabilities in accuracy, coverage and signal integrity. These will greatly increase the range of satellite navigation based solutions available to transport and logistics management.

When this report was written it included information and guidance based on views known at the time, however, the industry is moving forward quickly and technology is changing rapidly. Portable satellite navigation equipment is becoming very popular for car users as the relative cost of the units comes down and the systems improve. It is likely that systems that download to mobile phone or other handheld pocket size units will also become popular. The downside of popularity is that the units are attractive items for thieves and they should not be left on view in cabs. It is expected that satellite navigation will become essential equipment in the freight industry over the next ten years whereas, at the moment, the take up is relatively small.

7 Appendix

7.1 Wayfinding References

7.1.1

Published Articles

- Best Practice guide; Conducting In-fleet Trials;
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7.1.2

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- www.elogmag.com (Online fulfilment and logistics site)
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7.1.3

Supporting Parties in the Study

- Quantitative and KPI analysis carried out by the University of Newcastle, Department of Freight Studies;
- Satellite navigation manufacturer; TomTom;
- Satellite navigation manufacturer; Garmin;
- Vehicle management system; Fleetfinder;
- Participating companies: (AG Barr Plc, Quadralene Ltd, A1 Paper Plc, Container Drivers (JNW Transport)).

8 Glossary of Terms

Bandwidth and 'Broadband'	The ability of a medium to transmit high speed data. It defines how much data you can send through a connection, usually measured in bits-per-second. A full page of English text is about 16,000 bits. A fast modem can move about 57,000 bits in one second. 'Broadband', can move data about 10 times quicker.
Bluetooth	Low power radio technology being developed with the objective of replacing cables currently used to connect electronic devices such as personal computers, printers and a wide variety of handheld devices such as palm top computers and mobile phones. Devices equipped with Bluetooth should be capable of exchanging data at speeds up to 720kbit/s at ranges up to 10 metres.
Dead Reckoning (DR)	A Dead Reckoning (DR) position is one based on estimating the distance and the direction you have travelled. The accuracy of the DR position depends on the accuracy of the initial position and the accuracy of your distance measuring device and heading reference. The addition of other information turns a DR position into an estimated position.
Differential GPS	A technique for overcoming GPS position determination errors, GPS receivers are placed at precisely identified control locations to measure the difference between indicated GPS positions versus actual positions. GPS systems are accurate to around 10-20 metres. Differential GPS can further increase accuracy to 1 – 5 metres.
EGNOS	The European Geostationary Navigation Overlay System (EGNOS) is a <u>satellite navigation system</u> under development by the <u>European Space Agency</u> . It is intended to supplement the GPS and <u>GLONASS</u> systems by reporting on the reliability and accuracy of the signals. It will consist of three geostationary satellites and a network of ground stations and it is planned as a precursor to the <u>Galileo positioning system</u> .
<u>Galileo positioning system</u>	The Galileo positioning system is a proposed satellite navigation system, to be built by the <u>European Union</u> as an alternative to the US military-controlled <u>Global Positioning System</u> and the Russian <u>GLONASS</u> . The system should be operational by <u>2008</u> .
Geographical Information Systems (GIS)	A computer system that contains maps and geographic information and sometimes, analysis of geographic data.
General Pack Radio Service (GPRS)	General Pack Radio Service, which has been standardised as part of the GSM Phase 2+ development, represents the first implementation of packet switching within GSM, which is essentially a circuit switched technology. Rather than sending a continuous stream of data over a permanent connection, packet switching only utilises the network when there is data to be sent. Using GPRS will enable users to send and receive data at speeds of up to 115kbit/s.
Global Positioning Systems (GPS)	GPS refers to satellite-based radio positioning systems that provide 24 hour three-dimensional position, speed and time information to suitably equipped receivers in vehicles anywhere on or near the surface of the Earth.
ITS	The Intelligent Transportation Systems (ITS) program adds <u>information technology</u> to <u>transport infrastructure</u> and <u>vehicles</u> . It aims to manage vehicles, loads and routes to improve safety and reduce vehicle wear,

	transportation times and <u>fuel</u> costs.
LAN	A group of computers and other devices dispersed over a relatively limited area and connected by a communications link that enables any device to interact with any other on the network. A computer network limited to the immediate area, usually the same building or floor of a building.
LBS	Location Based Service (LBS) is a <u>service</u> provided to a subscriber based on their current geographical location. This position can be known a <u>GPS receiver</u> that a person carries with them.
OEM	An Original Equipment Manufacturer (<u>OEM</u>) is a <u>company</u> that builds products/components that are used in products sold by another company (often called a <u>value-added reseller</u> or <u>VAR</u>). An OEM will typically build to order based on designs of the VAR.
PDA	Personal Digital Assistants (PDA) are <u>handheld devices</u> that were originally designed as <u>personal organisers</u> but which have become much more versatile over the years. A basic PDA usually includes a <u>clock</u> , date book, <u>address book</u> , <u>task list</u> , memo pad and a simple <u>calculator</u> . Many PDAs can access the Internet via <u>Bluetooth</u> technology. One major advantage of using PDAs is their ability to synchronise data with a PC or home computer.
Real-time	Transmission of information, without storage, as and when received. In reality, many telematics systems that claim to provide real-time data do not since anything but mission critical data is initially stored in memory for a period of time. True real-time data would be expensive in-fleet operations.
RDS-TMC	Radio Data System-Traffic Message Channel. The transmission of traffic condition information over the FM channels' "sub-carrier" may well revolutionise in-cab navigation systems enabling automatic re-routing in the event of traffic incidents ahead.
SatNav	Satellite Navigation systems (SatNav) use <u>radio</u> time signals transmitted by <u>satellites</u> to enable mobile receivers on the ground to determine their exact location. The relatively clear line of sight between the satellites and receivers on the ground, combined with ever-improving electronics, allows satellite navigation systems to measure location to accuracies on the order of a few <u>metres</u> in real-time.
SMS	Short Messaging Service. A popular wireless standard for transmitting text based messages. SMS is an inherent part of GSM technology. The service is a two-way "store and forward" messaging service with a maximum message size of 160 characters. SMS is widely used in commercial vehicle telematics to send both vehicle location and text message data.
WAN	A communications network that connects geographically separated areas. A network in which computers are connected to each other over a long distance using telephone lines and satellite links.
Waypoint	A point, circle or rectangle defined by geographic co-ordinates used in navigation or historic analysis reports.
WAAS	The Wide Area Augmentation System (WAAS) is a system that improves the precision and accuracy of <u>Global Positioning System</u> (GPS) signals. It uses a combination of specialised <u>satellites</u> and ground-based stations to send correction signals to GPS receivers, as well as providing integrity information for each satellite's signal.