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VEHICLE UTILISATION AND ENERGY EFFICIENCY IN THE FOOD SUPPLY CHAIN

Full Report of the Key Performance Indicator Survey

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CSDF

BEST PRACTICE PROGRAMME
ENERGY EFFICIENCY

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1. Introduction

1.1 Background

Companies have come under mounting pressure to improve the fuel efficiency of their road freight transport operations. As fuel typically accounts for 25-30% of the cost of operating a heavy goods vehicle, reductions in the fuel bill can have a significant impact on total transport costs. By economising on fuel use, companies can also make an important contribution to the national policy goal of cutting emissions of exhaust pollutants and carbon dioxide.

Through its Energy Efficiency Best Practice Programme (EEBPP), the government has been providing companies with 'impartial, authoritative information on energy efficiency techniques and technologies.' This has disseminated the results of research on fuel consumption in the road freight sector. In the 1960s and 70s, much of this research focused on engine design and performance. Later work examined the aerodynamic profiling of the vehicle chassis. In the early 1990s, efforts were made to supplement these technical measures with new management initiatives, particularly on driver training, driver incentive schemes and fuel monitoring. These were extended into broader fleet management programmes which give much greater prominence to fuel efficiency in vehicle purchase decisions, vehicle maintenance and load planning.

Up until the 1990s, most fuel efficiency measures were confined to the transport operation. By this time, however, many companies were managing their transport within a broader logistical framework with the aim of improving the co-ordination between warehousing, inventory management, production planning and customer service. A study which we undertook for the EEBPP in 1995-6 examined the effects of wider logistical trends on fuel consumption in the road freight sector and indicated how, by changing the structure and operation of their logistical systems, companies could economise not just on fuel but on their overall demand for freight transport [1]. This suggested that the objective should not simply be to reduce fuel consumption per km travelled, but also to reduce the number of vehicle-kms travelled in distributing a given amount of product. Most of the logistical measures identified by this research could be adopted by individual companies. These were publicised in an EEBPP leaflet published in 1996 [2].

It has become increasingly apparent, however, that, while individual companies can make substantial savings in fuel use, much greater gains can be achieved at a supply chain level where trading partners are prepared to work together to improve transport efficiency. After all, the efficiency with which a company operates its vehicles is inevitably constrained by the requirements of suppliers, distributors and customers above and below it in the supply chain.

With the development of supply chain management and efficient consumer response (ECR), companies at different stages in the supply chain have been trying to co-ordinate their logistical activities, primarily with the goal of minimising inventory. The aim is now to exploit this closer supply chain co-operation to achieve better utilisation of transport capacity and thereby reduce the energy-intensity of distribution operations.

The energy savings accruing from broader supply chain initiatives are likely to be greater in some sectors than others. The food and drink sector was considered to offer good potential for three reasons:

1. It accounts for almost a quarter of all the freight movement by road in the UK (measured in tonne-kms) [3].
2. It is one of the fastest growing categories of road freight traffic.
3. Around 15% of food movements require temperature-control and this proportion is steadily rising as an increasingly large share of food expenditure is going on fresh, chilled and frozen products. It has been estimated that refrigeration accounts for around 40% of total energy consumption in the frozen food supply chain. This is, therefore, a sector which is intrinsically energy-intensive.

Refrigerated trailers also cost twice as much as conventional box trailers to buy and are 15-20% more expensive to operate [4]. Concern has also been expressed about the high level of noxious emissions from vehicle refrigeration units, which are not subject to the European emission standards apply that to tractor engines and tend to use dirtier fuel.

The Cold Storage and Distribution Federation (CSDF), whose members are involved in temperature-controlled distribution at different levels of the supply chain, has actively promoted collaborative initiatives designed to improve the utilisation of refrigerated vehicles. Working in association with the EEBPP, it has sought to develop a standard set of Key Performance Indicators (KPIs) which can be used to measure transport efficiency both at company and sectoral levels. In 1997 we were commissioned by ETSU, which manages the EEBBP, to assist with the development of these KPIs and to organise a survey of the transport operations of a sample of companies in the frozen food sector to test the KPI methodology. Eleven companies participated in this pilot survey and agreed to monitor the activities of their fleets over a 48 hour period in October 1997.

The results of this survey were summarised in two earlier reports [5, 6] and discussed at length with participating companies and other interested parties. Following this consultation process, it was decided to repeat the exercise in October 1998 with a much larger sample of fleets carrying ambient and chilled food products as well as frozen. Summary results of this survey were published as an EEBPP Energy Consumption Guide earlier this year [7]. This report presents the results of a more detailed analysis of the KPI data.

1.2 Environmental Pressures

Increasing priority is being given to the reduction in noxious emissions from heavy goods vehicles, chiefly NOx and PM10s. As a result of the wider adoption of vehicles meeting higher Euro-emission standards, emissions of these pollutants are expected to fall sharply over the next 5-6 years [8]. The continuing growth of CO_2 emissions from the road freight sector is a more serious cause for concern. The Government has set a target of reducing CO_2 emissions by 20% between 1996 and 2010. Lorries account for around 5% of total CO_2 emissions in the UK and this proportion is expected to grow.

Serious concern has also been expressed about increasing traffic congestion. It has been predicted that traffic congestion on the motorway network will be roughly 20% worse in 2007 than in 1997 [9]. Such congestion can significantly inflate transport costs and reduce the productivity of production and distribution operations. Supply chain initiatives can ease the effects of congestion in several ways. By raising vehicle load factors and reducing empty running they can slacken the rate of lorry traffic growth. They can also result in the rescheduling of deliveries to off-peak periods and, through improved communication between supplier and customer, provide more information on the progress of vehicles across the road network.

1.3 Logistical Trends

While environmental pressures to cut emissions have been intensifying, logistical pressures to cut inventory, improve warehouse productivity and improve customer service have been depressing load factors and making it more difficult for companies to schedule their vehicles efficiently. Within the fast moving consumer goods (FMCF) sector, application of the quick-response principle has been of shortening order lead times, increasing delivery frequency and declining order sizes. A survey of forty-four frozen food manufacturers in the UK in 1998 showed how the move to quick-response replenishment is affecting logistical operations [10] (Table 1).

Table 1: Past and predicted trends in key logistical variables:

	1995	1998	2001
Average order lead time (days)	6.0	3.8	3.1
Average frequency of delivery (per week)	2.1	3.4	4.3
Average consignment size (pallet-loads)	11.8	10.1	8.6

In the absence of load consolidation initiatives these trends will depress load factors and vehicle productivity. Many firms have observed that there is a discontinuity in the delivery cost curve, causing unit delivery costs per pallet to rise dramatically when drop size falls below a certain threshold. Increased frequency of delivery is also straining reception facitilites at distribution centres, creating the need for tighter scheduling of inbound flows and often causing delays. These scheduling constraints can limit opportunities for return loading and the development of complex multiple collection and delivery routes which can make more effective use of vehicle capacity.

A conflict has emerged, therefore, between the desire to make distribution operations more environmentally sustainable and the drive for quick-response replenishment. Supply chain co-ordination can help to reconcile these conflicting objectives by helping to maintain or improve vehicle utilisation.

Collaboration between companies at different levels of the supply chain has traditionally been inhibited, however, by three factors:

1. The adversarial nature of the trading relationships and mutual fear that one party will behave opportunistically and capture an unfair share of the benefits.

2. The absence of an organisational framework within which companies can openly exchange views, develop joint initiatives and benchmark their operations.

3. Uncertainty about each company's current level of transport efficiency and the overall efficiency of freight movement across the supply chain.

The CSDF has successfully fostered a spirit of openness and co-operation among a large group of companies engaged in the distribution of frozen food and thus helped to overcome the first two constraints. In helping to develop a series of KPIs, it has addressed the third constraint, creating a standard yardstick against which firms can measure their performance.

1.4 Performance Measurement in Logistics

The use of KPIs to monitor the efficiency and effectiveness of logistics is discussed at length by the Nevem Workgroup [11], Caplice and Sheffi [12], and Ploos van Amstel and D'hert [13]. Long lists of possible KPIs have been compiled to assess the performance of virtually every aspect of a logistical operation.

The selection of KPIs for the present study was tightly restricted in several respects. First, they related solely to the transport function. Second, it was decided to exclude any reference to the cost of transport operations as many companies would consider this sensitive information and, as a consequence, be discouraged from participating. The KPIs were designed therefore to measure operational, rather than commercial, performance. Third, unlike many performance measurement systems which are internal to a single business and thus tailored to its requirements, the KPIs adopted for this project had to win acceptance from firms across a whole sector. They had also to relate to the wider impact of transport operations on the environment in contrast to many of the traditional metrics which are concerned only with economic efficiency.

Caplice and Sheffi have differentiated three types of logistical KPI:

Utilisation indices which measure 'input usage' and are usually expressed as a ratio of the actual input of resources to some normative value. This norm might, for instance, be the maximum carrying capacity of a vehicle.

Productivity indices which measure 'transformational efficiency' and typically take the form of input:output ratios.

Effectiveness indices which measure the 'quality of process output' as a ratio of the actual quality achieved to some norm.

Our survey employed all three types of KPIs, ensuring that the assessment was broadly-based and concerned with both inputs and outputs. Although the project had an important environmental dimension, no attempt was made to define energy or emission standards for road freight operations. Swedish research[14] has established such standards for freight transport operations which would cut the use of non-renewable energy and emissions of air pollutants to sustainable levels. The present study was concerned with the relative energy-intensity of companies' road freight operations rather than with absolute energy-efficiency targets.

Discussions were held with senior managers of manufacturing, retailing and logistics providers heavily involved in food distribution to canvas their opinions on possible KPIs. At a 'think tank' session they debated the various options and examined the practical problems they might present. The derivation of the KPIs was, therefore, a 'bottom-up' exercise involving close consultation with industry. The KPIs had to meet several requirements. They had to be:

- defined in clear and unambiguous terms so that they could be easily understood by staff responsible for data collection

- capable of direct and detailed measurement at operational level
- measurable in a consistent manner by all participating companies
- compatible with data recording systems already in place and software packages with which company staff were familiar
- correlated with operating costs and energy consumption
- of direct relevance to the management of the transport operation
- widely acceptable across the industry and of possible application in other sectors.

Our discussions with the industry led to the establishment of an agreed set of five KPIs. These were first applied in the pilot survey undertaken in October 1997. This survey highlighted a number of shortcomings in the range, definition and calculation of KPIs. These were outlined in the report of the 1997 survey [6]. Following consultations with industry representatives, several modifications were made to the KPI framework to correct these deficiencies. These modifications are listed in Annex 1.

1.5 Choice of Key Performance Indicators

The revised set of KPIs used in the 1998 survey were as follows:

1. ***Vehicle fill*** measured by payload weight, pallet numbers and average pallet height.

Most freight surveys measure load factors solely with respect to weight. In sectors such as food, where products are of relatively low density, vehicle loading is constrained much more by volume than weight. Weight-based measures of utilisation are, therefore, misleading. In the 1997 survey, volume was defined by the number of pallets carried and hence the proportion of vehicle deck area covered, giving a two-dimensional measure of utilisation. The 1998 survey extended this measurement into the vertical dimension by asking companies to estimate the proportion of trips on which average height of pallet loads fell into one of four intervals (<0.8 metres, 0.8-1.5 metres, 1.5-1.7 metres and over 1.5 metres). This permitted the calculation of cube utilisation. Data were collected on the maximum carrying capacity of trailers (by weight, pallet numbers and height) and the actual loading expressed as a proportion of these maxima.

2. Empty running: the distance the vehicle travelled empty:

Analysis of the 1997 data revealed ambiguities in companies' understanding of empty running, with some considering vehicles carrying empty roll cages to be empty. To overcome this problem, they were asked in the 1998 to monitor the return of empty handling equipment separately.

3. Time utilisation:

This was measured at hourly intervals over a period for 48 hours for all the vehicles surveyed. The survey unit was either the trailer of an articulated vehicle or a rigid vehicle. A record was made of the dominant activity of the vehicle over the previous hour. Time was classified into seven activities depending on whether the vehicle was:

1. running on the road (including legal breaks)
2. on the road but stationary during the daily driver rest-period
3. being loaded or unloaded (including time spent on manoeuvring / paperwork)
4. preloaded and awaiting departure
5. delayed or otherwise inactive
6. undergoing maintenance or repair
7. empty and stationary

Although the utilisation of tractor units was not monitored every hour, estimates could be made of the time-utilisation of tractors on activities 1 and 2, while hitched to trailers.

4. Deviations from schedule:

Companies were asked to log all delays which they considered '*sufficiently inconvenient… to be worth recording.*' These delays were attributed to six possible causes:

- problem at collection point (consigning company's responsibility)
- problem at delivery point (receiving company's responsibility)
- own company actions
- traffic congestion
- equipment breakdown
- lack of a driver

This KPI was included for two reasons:

- Delays directly affect both the time utilisation of the vehicle and its fuel efficiency.

- Instability in transport schedules can have an indirect effect on vehicle utilisation as it makes it more difficult for companies to plan backhauls and more complex multiple collection / delivery rounds.

5. Fuel efficiency: *of both the motive power unit and the refrigeration equipment.*

The fuel efficiency of the tractor units was expressed on a litres per km basis and averaged across the fleet on an annual basis. No attempt was made to estimate fuel consumption during the 48 hour survey period as this was considered impractical. These estimates would, after all, relate to tractor units, whereas the main survey unit was the trailer. The same tractor might haul several different trailers during the survey period. Annual average litres / km figures were obtained for each type of vehicle within each fleet. These were multiplied by the distances travelled during the survey period to obtain estimates of fuel consumption. In contrast, an attempt was made to measure the amount of fuel consumed by the fridge units on the trailers over the 48 hour period.

1.6 Survey Methodology

The survey took the form of a 'synchronised audit' with all companies monitoring their vehicle fleets over the same 48 hour period on the 22nd and 23rd October 1998. Discussions with logistics managers in the food industry suggested that the volume and pattern of delivery on these days would be fairly typical, giving a good indication of the average level of vehicle usage relative to both weekly and seasonal cycles.

Participating companies were asked to enter the operating data into a standard spreadsheet in accordance with an agreed set of instructions.

1. General data on the vehicle fleet
2. Data on all trips performed during the 48 hour period
3. Hourly audit of the vehicle activity during this period.

Three workshops were held around the country to advise companies on the process of data collection. They were given a manual containing instructions on how the data should be compiled. A telephone helpline was available during the week of the survey to deal with queries. Approximately a fifth of the companies took advantage of this telephone support.

Only for two of the fleets surveyed in 1998 was all the operating data routinely collected and transferable from existing data bases. Management of a third of the fleets recorded little of this information and so had to put new procedures in place to collect it. In the case of the remaining fleets, existing records had to be supplemented with other data specially collected for the KPI survey. Details of the time and effort expended by participating companies can be found in Annex 2.

1.7 Composition of the Sample

Company and fleets:

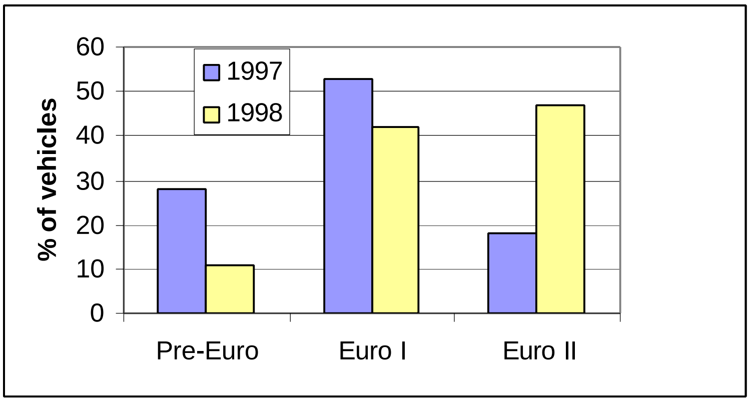
An invitation was extended to all companies engaged in food distribution to take part. Almost all the companies participating in the 1997 pilot survey agreed to join the 1998 survey. Several other companies that had attended the launch of the 1997 results or heard about the project through other channels also decided to take part. The CSDF used its extensive networking across the food industry to expand the list of participants. A total of 45 companies agreed to support the project. They are listed in Annex 3. Some of these companies outsource their transport operations. Although they were not directly involved in the data collection exercise themselves they asked their logistics contractor to provide the data. Altogether 36 separate fleets were monitored. Figure 1 shows the geographical distribution of their main bases.

Vehicle type:

Unlike the 1997 survey which was confined to articulated vehicles, the 1998 survey included rigid vehicles and a fleet of drawbar trailer units. The rigid vehicles, which were involved almost exclusively in deliveries to retail and catering outlets, accounted for only 8% of all the vehicles surveyed. In the case of articulated vehicles, the survey was primarily concerned with the use of trailer capacity rather than tractor units. Information was nevertheless collected on the numbers of tractor units in the fleet and their Euro-emission standard. This revealed that the average articulation ratio (ratio of tractors to trailers) was 1.48, significantly lower than for the 1997 sample (1.63). It also showed that a much larger proportion of the vehicles surveyed in 1998 met the Euro II emission standard (Figure 2). The 1998 sample also differed from the 1997 survey as it contained a large number of non-refrigerated vehicles. Altogether approximately 1450 tractors, 2150 trailers and 180 rigid vehicles were monitored over 48 hours (Table 2).

Figure 1: Main bases of fleets included in the survey.

Figure 2: Euro-emission standards of surveyed vehicles



During the survey period, the vehicles travelled a total of 1.16 million kilometres and delivered just over 200,000 pallets. The scale of the delivery operation monitored in 1998 was over twice as large as the 1997 survey. The larger sample size permitted more accurate estimation of vehicle utilisation and energy efficiency indices. It also provided a firmer basis for inter-company comparison and benchmarking against best-practice.

Table 2: Survey statistics

	1997	1998
Tractor units	795	1,393
Trailers	1,265	2,134
Rigid vehicles	-	182
Journeys	2,981	4,024
Journey legs	-	11,873
Pallet-loads delivered	72,801	206,202
Kilometres travelled	519,963	1,161,911

Product type

59% of the pallets-loads distributed over the 48 hour period required refrigeration (Figure 3). Roughly two-thirds of these pallets carried chilled product, the remainder frozen goods. Just under a quarter of the pallet loads had food products that could be moved at ambient temperature.

Figure 3: Composition of the pallet-loads distributed during 1998 survey

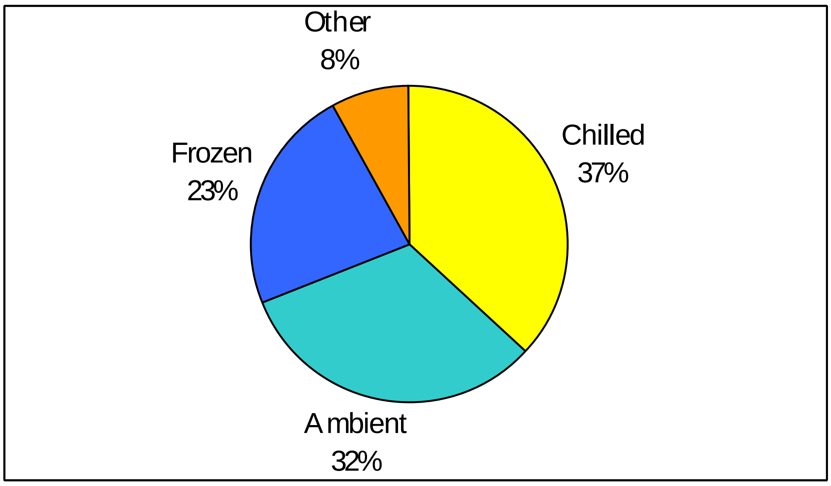
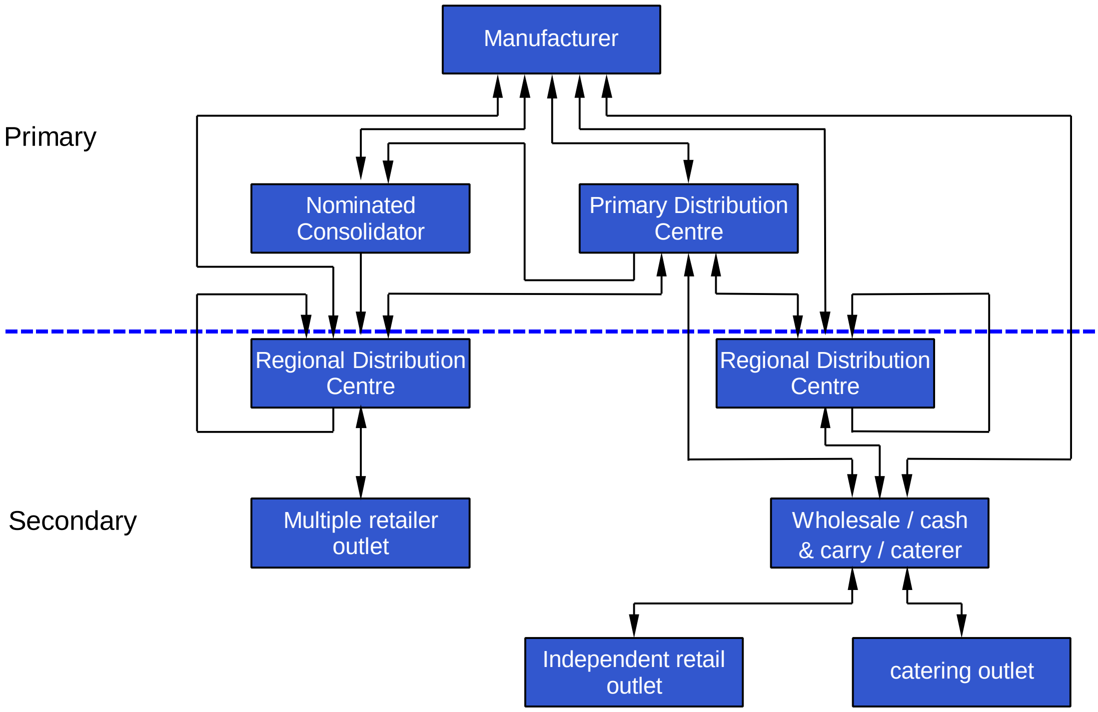


Figure 4: Distribution Channels in the Food Sector



2. Survey Results

A summary of the results were published in June 1998 in Energy Consumption Guide 76 [6]. Since then, further analysis has been done on the KPI data-base. This has included the calculation of KPI values for sub-sectors containing companies whose distribution operations are reasonably similar. By sub-dividing the full sample in this way it is possible to compare transport operations on a more consistent basis. For this purpose, the thirty-six fleets have been divided into two general categories: those engaged mainly in primary distribution, transporting products from factories to distribution centres either directly or via 'primary consolidation centres' and those handling secondary distribution from distribution centre to shop (Figure 4). In the case of primary distribution, a distinction has been made between fleets of refrigerated vehicles (P1) and those moving products at ambient temperature (P2). Secondary distribution fleets are differentiated into three categories:

- Dedicated deliveries to supermarkets (S1)
- Dedicated deliveries to other types of retail / catering outlet (S2)
- Multi-user deliveries to retail / catering outlets (S3)

It is necessary to exercise caution in comparing the sub-sectoral KPI values, for several reasons. First, it should be noted that that there is some overlap between these categories as the same fleet can be engaged both in primary and secondary distribution. Second, even within these sub-sectors there can be significant differences in the nature and scale of a distribution operations, particularly in the case of category S2. Third, there are wide variations in the numbers of companies in each sub-sample:

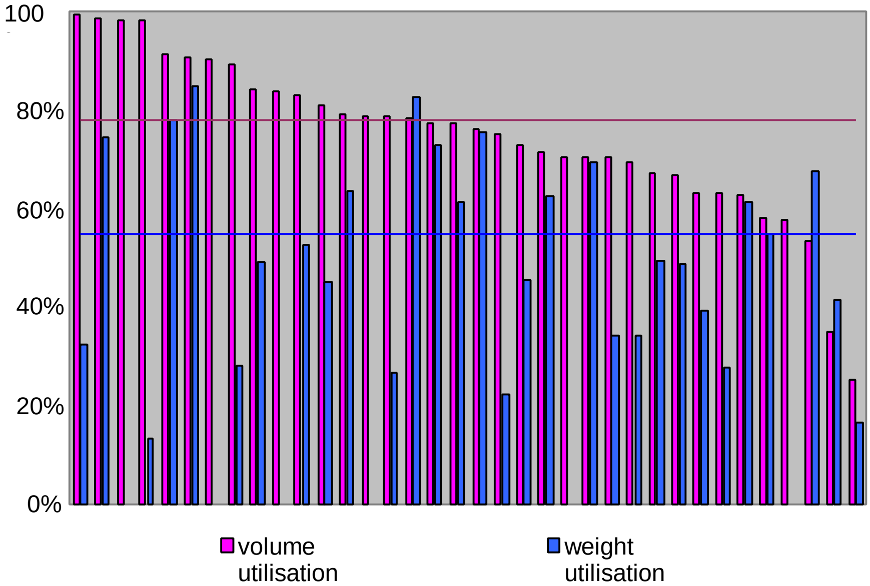
Sub-sample	Number of Companies
P1	11
P2	6
S1	9
S2	6
S3	3

2.1 Vehicle fill:

The utilisation of vehicle capacity was measured with respect to weight, pallet numbers and pallet height.

As explained earlier, most of the official road freight statistics compiled by the UK government and EU are weight-based. Vehicle utilisation is typically expressed as the ratio of the weight of goods carried to the maximum weight that could have been carried. For the fleets surveyed in 1998, the average weight utilisation was 56%, with wide variations around this mean value (Figure 5). This utilisation index can be misleading in sectors, such as the food, where most loads are of relatively low density and constrained much more by the dimensions of the vehicle that by its maximum weight limit. On only 7% of the laden trips were vehicles loaded to 90% or more of the weight limit. The survey was conducted prior to the increase in maximum lorry weights in January 1999 which increased the carrying capacity of five and six axle articulated vehicles by two tonnes. This will have partially relaxed the weight constraint on the number of pallets carried. The Commission for Integrated Transport is currently examining the case for increasing maximum lorry weight to 44 tonnes. On the basis of the KPI data, it appears that this would confer little benefit on the companies that participated in the 1998 survey. Across the total sample of laden journeys, loads on average reached only 50% of the maximum weight limit. There was, nevertheless, wide variation above and below this average, largely reflecting differences in the density of the product carried, which ranged from crisps to canned food.

Figure 5: Average weight and pallet utilisation of the fleets



When measured in terms of pallet numbers, vehicle utilisation was much higher, averaging 78% across the sample as a whole. Overall, around a third of the laden journey legs achieved a pallet utilisation level of 90% or more and were operating close to the deck-area limit. On the other hand, on approximately 47% of the laden trips 25% or more of the floor area was unused, suggesting that there was scope for improving vehicle loading.

This pallet-based measure of utilisation varied from almost 100% to under 30%, with all but five of the 36 fleets achieving values in excess of 60% (Figure 5). Sub-division of the sample revealed that ambient primary distribution operations attained the highest average utilisation at 89% (Table 3). Dedicated secondary distribution to supermarkets also recorded above average utilisation. The average for multi-user distribution to shops and catering outlets was exceptionally low, though it was based on a sample of only three fleets and depressed by one abnormal result.

Even when the fleets are sub-divided into more homogeneous groups, there are still quite wide variations in utilisation levels, as revealed by the relatively high standard deviation values. Benchmarking at this disaggregated level should give companies with relatively low pallet utilisation values an incentive to raise load factors to those achieved by similar operations elsewhere, or at least to find a justification for this apparent under-performance.

Table 3: Vehicle utilisation measured by the ratio of actual to maximum pallet numbers:

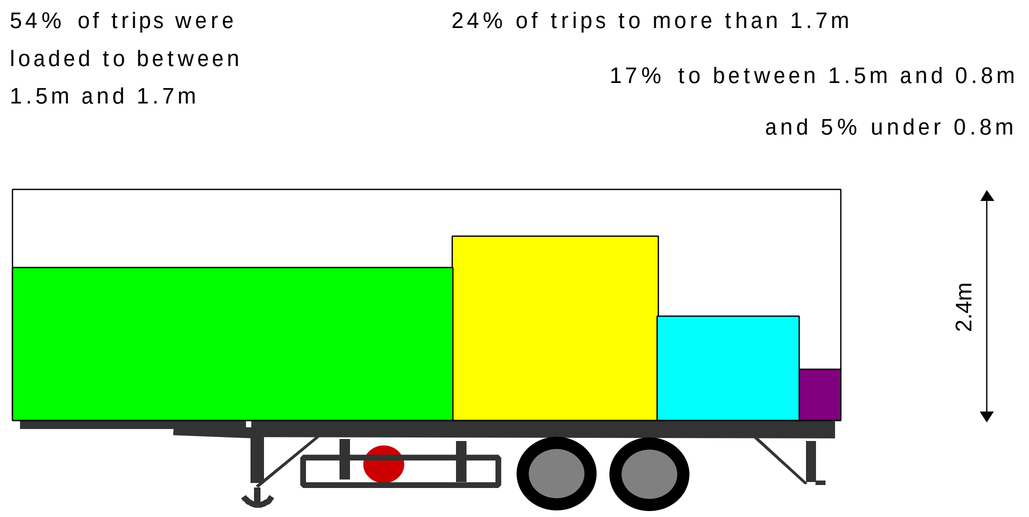
	Average	Standard Deviation
All fleets	74.5	16.32
P1 Temperature-controlled primary distribution	73.9	10.5
P2 Ambient primary distribution	89.4	8.7
S1 Dedicated distribution to supermarkets	82.0	11.6
S2 Dedicated distribution to other retail / catering outlets	70.3	9.2
S3 Multi-user distribution to retail / catering outlets	55.0	17.6

The collection, for the first time, of data on the height of pallet-loads permitted a three-dimensional analysis of the utilisation of vehicle space. Companies were asked to indicate the proportion of trips on which average pallet height fell into one of four height categories (<0.8 m, 0.8-1.5 m, 1.5-1.7 m, > 1.7 m). The majority of companies achieved average pallet heights of around 1.5-1.7 metres, close to the maximum slot height in most warehouse racking and corresponding to the typical height of the roll cages used for shop delivery (Figure 6). On approximately 22% of the trips, however, the pallet height was below 1.5 metres, indicating that there is some potential to stack loads to greater height within current space constraints. On average only around 65% of the available height in the vehicles was actually used. Multiplying this figure by the average deck-area coverage of 78% yields an estimate of 50% for the cube utilisation of vehicles on loaded trips. Companies could do several things to improve the utilisation of vehicle space:

- Increase the degree of load consolidation
- Change packaging and pallet-wrapping systems to increase stackability
- Make greater use of double-deck vehicles that can accommodate two rows of pallets /roll cages
- Reduce the height of trailers

The results of the survey indicate that, given the present pattern of loading, many vehicles are taller than they need to be. This carries a fuel penalty as it increases vehicle tare weight and impairs the aerodynamic profiling of the vehicle. A study by one of the participating retailers has indicated that by reducing trailer height by one foot it is possible to cut fuel consumption by around 10%. It should be noted, however, that in the case of refrigerated trailers there must be adequate space between the top of the load and the vehicle ceiling to permit air circulation.

Figure 6: Distribution of laden trips by average pallet-height class



2.2 Empty Running and the Movement of Returns

The definition of empty running was clarified in the 1998 survey to ensure that vehicles returning with handling equipment were not classified as 'empty'. Empty running accounted for approximately 22% of the journey legs and 21% of the total distance travelled. This average was significantly lower than the mean for the UK lorry fleet as a whole (28% in 1998 [3]). Analysis of the pattern of vehicle loading across the 36 fleets, however, revealed wide variations in empty running, with mean values spread fairly evenly over the range 0-50% (Figure 7).

When the sample was sub-divided, it was found that the average proportions of empty running for the three main sub-sectors (P1,P2 and S1) were very close to the overall mean for the 36 fleets (Table 4). The significantly lower values for S2 and S3 can be partly attributed to the fact that many of their deliveries are multi-drop, with a relatively short empty leg between the last delivery point and the depot. The standard deviation values are arguably much more significant than the means. They are surprisingly large, considering that the fleets have been grouped on the basis of similarities in their distribution operations. This wide variability in the level of empty running within all the sub-sectors, suggests that some companies could do much more to find backloads.

Table 4: Percentage of vehicle-kms run empty.

	Average	Standard Deviation
All fleets	22.0	14.3
P1 Temperature-controlled primary distribution	23.3	11.0
P2 Ambient primary distribution	20.2	15.9
S1 Dedicated distribution to supermarkets	23.0	18.8
S2 Dedicated distribution to other retail / catering outlets	13.3	16.1
S3 Multi-user distribution to retail / catering outlets	14.1	15.1

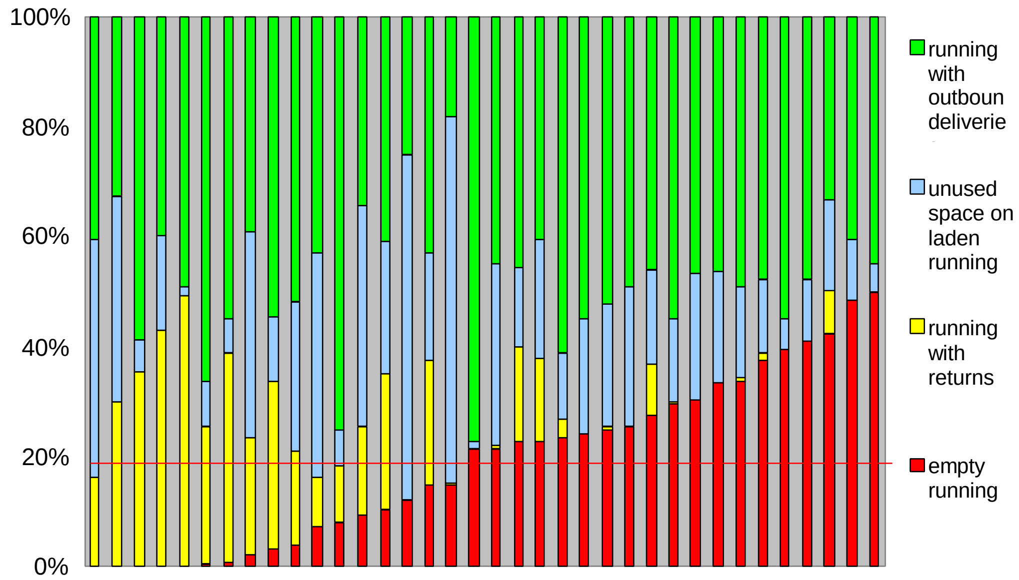
In analysing the potential for increased backloading, allowance must be made for the return of empty handling equipment. There was found to be an inverse relationship between the degree of empty running and the proportion of vehicle capacity used to bring back handling equipment, packaging and returned goods, particularly in the case of lorries engaged in secondary distribution to shops. Approximately 45% of the outbound deliveries generated a return flow of handling equipment, packaging or goods. The dominant return flow, accounting for 88% of these returns, is of empty roll cages travelling back from shop to distribution centre. (The return flow of packaging material was equivalent, in terms of pallet loads, to only 5% of the outbound flow of product). In several of the secondary distribution operations, the return of empty roll cages from shops virtually eliminated empty running. While these return movements are essential to the retail logistics operation, it would be possible for companies to consolidate them into a smaller number of trips, thereby releasing vehicle capacity for the collection of product from suppliers. It has not been possible, using the existing KPI data, to assess the potential for rationalising the return flow of handling equipment. This will require further research.

For each fleet an estimate was made of the total available freight carrying capacity over the 48 hour period measured in terms of the pallet-kilometres (taking the actual distance travelled by each vehicle as given). This available carrying capacity is divided into four categories:

1. Capacity used to carry outbound loads on laden trips
2. Capacity used to bring back empty handling equipment, packaging or returned goods
3. Unused capacity on laden trips
4. Unused capacity on empty trips

Figure 7 shows how the proportions of available carrying capacity in each of these four categories varied enormously across the thirty-six fleets surveyed. Secondary distribution operations tend be clustered on the left, reflecting the large traffic in returning roll cages, while primary distribution operations cluster on the right. Within each of the sub-sectors, however, there are quite wide variations in the overall utilisation of vehicle carrying capacity.

Figure 7: Percentage utilisation of available vehicle carrying capacity by fleet (capacity measured by pallet-kms)



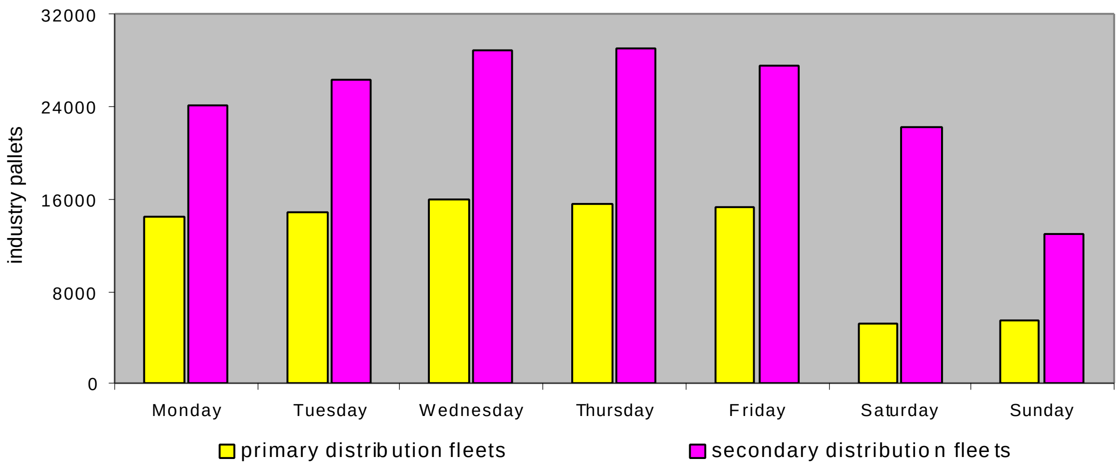
2.3 Time Utilisation

In the 1998 survey, the classification of vehicle activities was refined, mainly to permit more detailed analysis of the time that loaded vehicles spend stationary. Utilisation was analysed on a weekly, daily and hourly basis:

Weekly pattern:

The level of distribution activity, measured by the number of pallet-loads delivered, varies with the day of the week (Figure 8). Important differences emerge too between primary and secondary distribution. The volume of primary deliveries, from factory to distribution centre, is fairly constant during the working week from Monday to Friday, then drops to about a third of this level on Saturday and Sunday. Secondary distribution volumes, on the other hand, rose from around 24,000 on Monday to a peak of 30,000 on Wednesday and Thursday and then declined to roughly half this peak level on Sunday. Other things being equal, the greater weekday stability in the primary distribution system should make it easier to operate vehicles at a high level of utilisation. Partly as a result of Sunday trading, a significant amount of food is now moved at the weekend. Approximately 21% of secondary distribution volumes and 10% of primary distribution volumes were delivered were delivered on Saturday or Sunday.

Figure 8: Numbers of pallets delivered during the week of the survey.

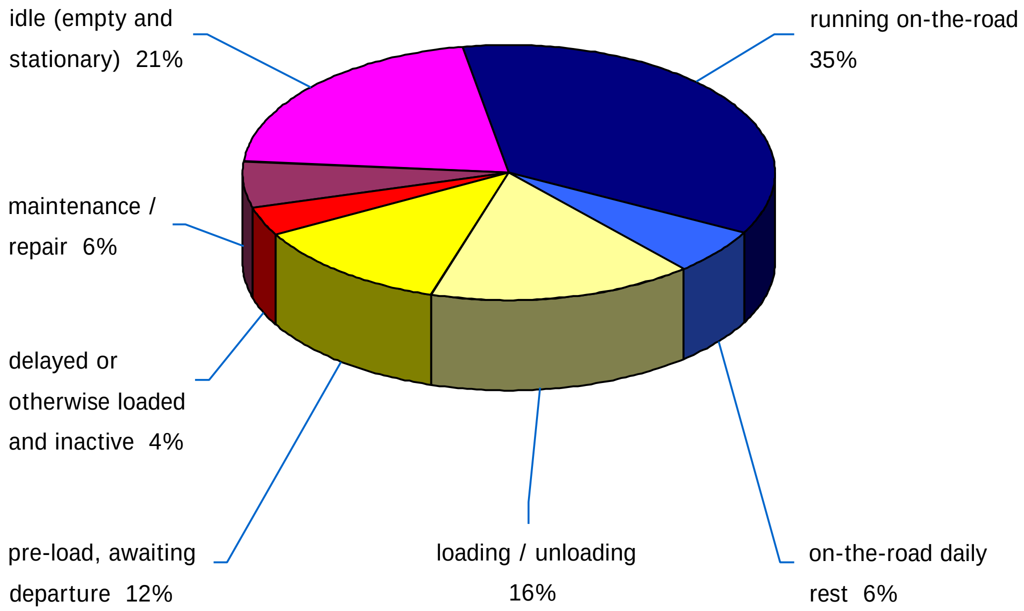


Daily breakdown:

Figure 9 shows how, for the average articulated trailer / rigid vehicle, the day was divided among seven activities.

The average vehicle spent just over a third of its time (36%) running on the road (including daily rest periods for the drivers). The average tractor unit / rigid vehicle completed an average of 3.8 journey legs per day, each of which had an average duration of two-and-half hours. As each leg had an average length of approximately 100 kilometres, the average vehicle speed (including daily rest periods) was 40 kms per hour.

Figure 9: The average day in the life of a semi-trailer / rigid vehicle:



Loading and unloading took around 4 hours each day (16%). A similar time was spent loaded and stationary. Three-quarters of this 'loaded and stationary' time was spent at the collection point, where the vehicles were, on average, pre-loaded roughly three hours prior to despatch. The 1997 KPI survey indicated that for temperature-controlled trailers the mean pre-loaded time was four and a half hours. This long pre-loading time can be attributed mainly to two factors: first, the desire to spread the workload and improve the average utilisation of staff and equipment in cold stores and, second, limited storage space in cold stores. This practice, nevertheless, has serious implications for energy consumption as the refrigeration equipment must be operating during this pre-loaded period and as the energy efficiency of vehicle refrigeration per pallet-load per hour is usually much lower than that of the typical cold store.

The results of the survey suggest that a much larger proportion of the '*loaded and stationary*' time is spent at the collection point than at the delivery point. In the case of 'primary' movements, most of which terminate at retailers' distribution centres, waiting time at the delivery point takes up around 6% of the vehicles' time (1.4 hours per day).

For a fifth of the time, the average trailer / rigid vehicle was idle and empty. This means that if equipment could be fully utilised around the clock, the vehicle fleet could be reduced by this proportion. Some of the 'excess' capacity is required, however, to meet peak flows over daily, weekly and seasonal cycles.

Hourly pattern:

Figure 10 shows the variations in vehicle activity over the 48 hour period. The proportion of vehicles running on the road rose steeply after 5am, reached a peak around 9am, gradually declined until late afternoon and then dropped quite steeply. The peak periods during which the primary and secondary fleets were running on the road broadly coincided between 0600 and 1400, though the peak for secondary distribution operations (to shops) was much higher. The coincidence of these peaks appears even more pronounced when expressed in terms of the numbers of pallets delivered at different times of day, especially in the case of chilled products (Figure 11).

Figure 10: 48-Hour audit of vehicle activity

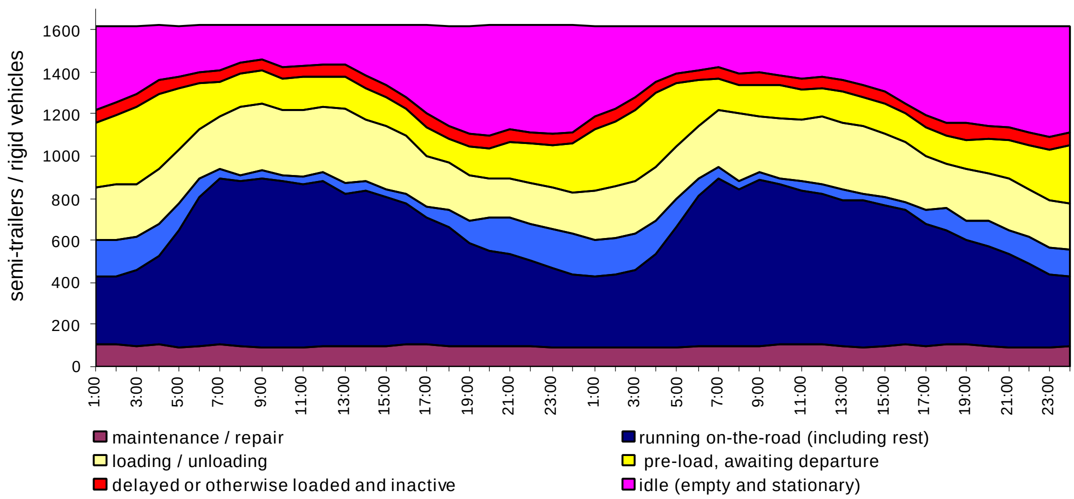
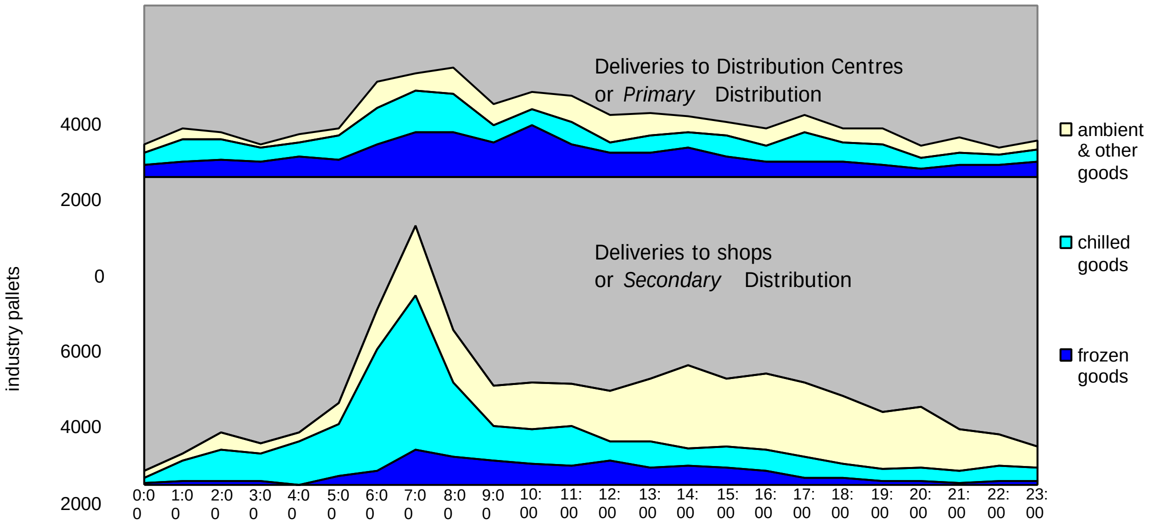


Figure 11: Primary and secondary distribution deliveries by time of day and type of product



This confirms one of the major findings in the 1997 survey. It suggests that the current scheduling of freight flows along the food supply chain limits the scope for co-ordinating primary and secondary distribution operations. While secondary distribution to retail outlets is largely constrained by shop opening hours, there may be less justification for concentrating primary deliveries in the morning peak period. Much of the vehicle capacity provided to meet the peaks is under-used at other times. By altering daily delivery cycles, particularly for the movement of supplies into retail distribution centres, it would be possible to integrate primary and secondary operations more effectively to raise vehicle load factors and improve the overall productivity of the transport operation.

Such rescheduling could also reduce the amount of time vehicles spend running on the road during congested periods. The analysis indicated that 20% of total running time occurred between 0700 and 1000 when the road network is at its busiest and fuel efficiency most severely impaired by prevailing traffic conditions. The vehicles travelled 16% of their daily mileage between 0700 and 1000. This suggests that the average speed during morning peak was around 24% lower than that achieved during the rest of the day (assuming that the incidence of driver rest periods is uniform across the day).

2.3 Deviations from Schedule

In contrast to the first KPI survey, when enquiries were only made about delays of more than 30 minutes, the 1998 survey asked companies to log all delays '*considered sufficiently inconvenient … to be worth recording*'. Approximately 25% of the journey legs were subject to a delay and these delays averaged 50 minutes. When a similar threshold of 30 minutes was applied to the 1998 data, this proportion dropped to 11% - the same proportion as in 1997, despite the enlargement of the sample and its diversification into ambient and chilled distribution.

The most common cause of delay, affecting 8% of journey legs, was an unscheduled wait at the delivery point (Figure 12). Delays due to the vehicle operating company's '*own actions*' and to hold-ups at the collection point affected, respectively, 3% and 2% of all legs. Collectively these three sources of delay, which are internal to the distribution operation, were responsible for more than twice the proportion of delays caused by traffic congestion (6%). These results help to put the problem of traffic congestion into perspective. They require two qualifications, however. First, as companies may already have allowed for congestion-related delays in their scheduling, the figure may under-estimate the true magnitude of the congestion problem. Second, the various causes of schedule deviations are inter-related. Delays originating on the road network can, for instance, be amplified by vehicles missing booking-in times and having to wait until the next available off-loading slot. Approximately 19% of the delays were considered to have '*no single cause*'.

Figure 12: Frequency of Delays by Cause

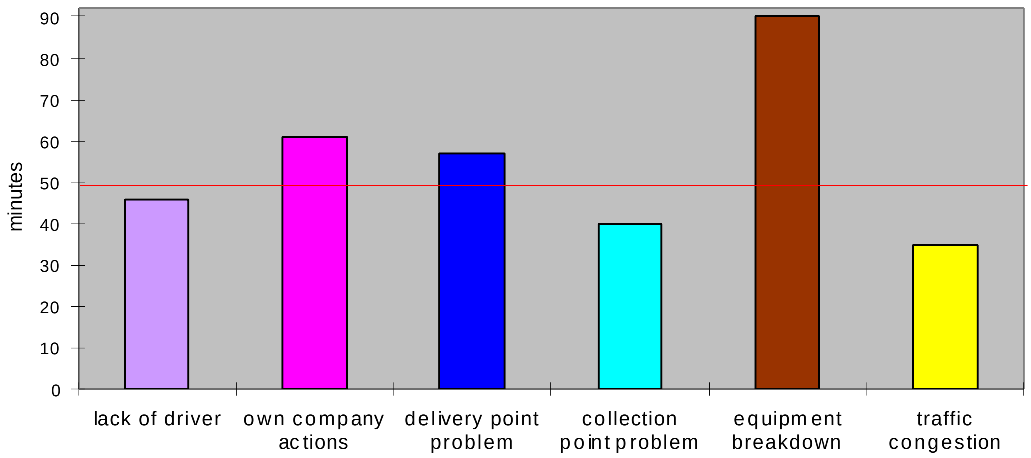


Figure 13: Average duration of delays by cause

Figure 13 shows the average length delays caused by the various factors. While equipment failures caused the greatest disruption, they are comparatively rare. The relatively long delays resulting from 'own actions' and problems at delivery points present a much more serious problem. The collection of data, for the first time in the 1998 survey, on the land use at the start and end points of journey legs permitted more detailed analysis of the incidence of delays. Figures 14 and 15 show how the frequency and duration of delays varied markedly between different types of premises. Roughly one delivery in six to retail outlets was delayed, with the average delay lasting around 30 minutes. Although only one in ten was held up at RDCs, the average delay there was more than twice as long. In the case of outbound journeys, delays occurred most frequently at factories, where delayed vehicles had to wait an average of 45 minutes to collect a load.

As in the pilot survey, therefore, it was found that most delays occurred at collection and delivery points rather than on the road network. Greater adherence to collection and delivery schedules would create a more stable framework for backloading and efficient route planning, making it easier to raise load factors and improve fuel efficiency. It would also yield more direct savings in vehicle operating costs. If one excludes the effects of traffic congestion and vehicle break-downs, approximately 14% of journey legs are subject to a delay caused by the management of operations within factories, warehouses and shops. These delays lasted an average 54 minutes and cost around £25 in vehicle / driver time. Assuming that the average vehicle makes 3.8 journeys per day and operates 300 days a year, these delays would be valued at approximately £4000 per vehicle per annum.

Figure 14: Frequency and duration of delays at collection points.

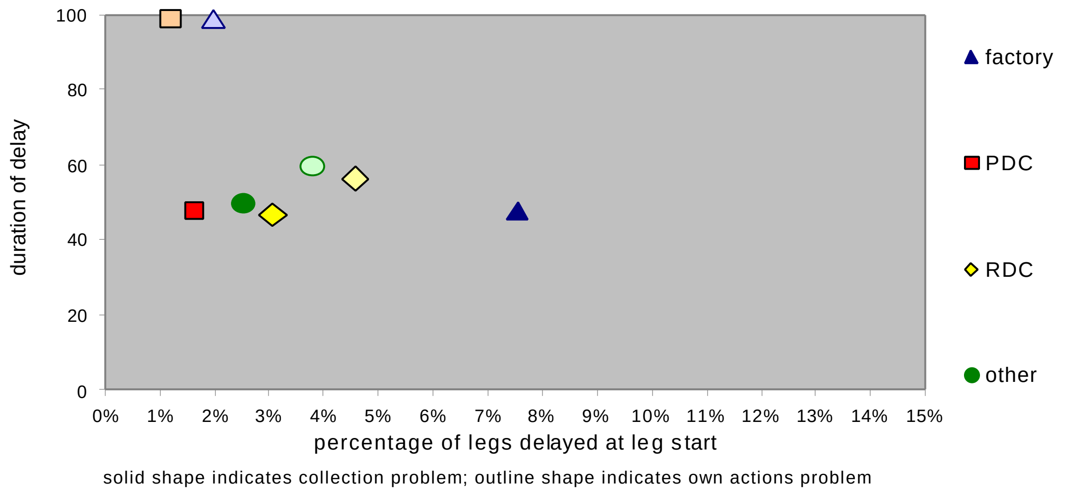
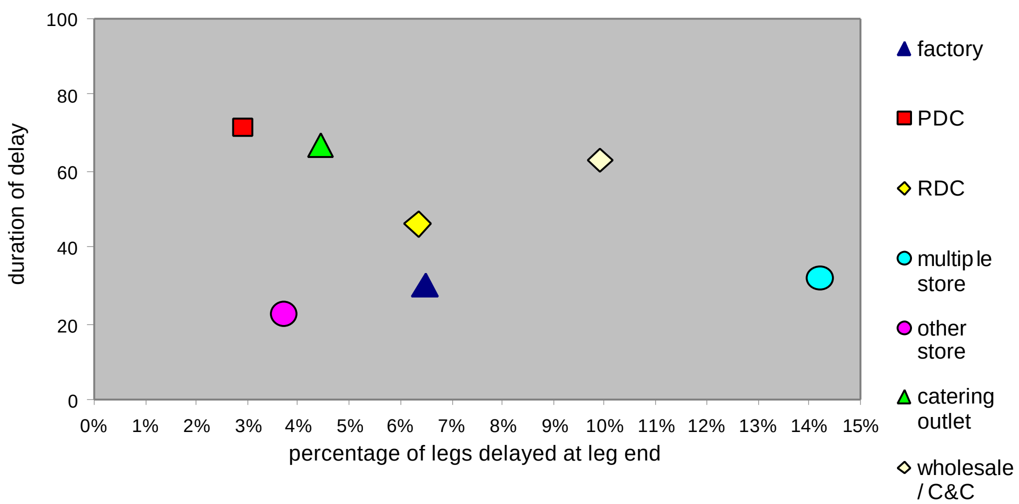


Figure 15: Frequency and duration of delays at delivery points



2.5 Fuel Efficiency

Estimates of average fuel efficiency were based on annual records and not collected during the 48 hour survey period. Separate estimates were made for seven categories of vehicle: 38 tonne articulated, 32 tonne articulated, city artic (3-axle vehicle with a gross weight of under 32 tonnes used primarily for shop deliveries in urban areas), small, medium and large rigid vehicles and drawbar trailer units. Figure 16 shows the average fuel consumption, expressed in kms per litre, for the different categories of vehicle. Inter-fleet variations in fuel efficiency were much greater for rigid vehicles than for articulated lorries. In the case of medium-sized rigids it varied from 2.5 kms per litre to 4.7 kms per litre. Across the 38 tonne artic fleet the range was 2.0 - 3.3 kms per litre. The average fuel efficiency figures for primary and secondary distribution were very similar for both 32 tonne and 38 tonne articulated vehicles and, rather curiously, indicated that vehicles in the heavier weight class were slightly more fuel efficient (Table 5). Within the general distribution categories, however, there were significant variations between companies. For a typical vehicle 38 tonne artic, running an average of 98,000 kms per annum in primary distribution, the difference in fuel efficiency between the top and bottom of the range corresponds to an extra 7300 litres of fuel consumed annually per vehicle, valued at approximately £5,000 in 1999 prices.

Table 5: Mean fuel efficiency of fleets at sub-sectoral level (kms per litre):

	32 tonne articulated		38 tonne articulated	
	mean	*range*	*mean*	*range*
Mainly primary distribution	3.03	2.9-3.2	2.90	2.65-3.30
Mainly secondary distribution	3.06	2.8-3.2	2.85	2.00-3.30

Vehicle fuel efficiency is only part of the overall energy equation, however. It is possible for a company to operate vehicles fuel efficiently but to make poor use of their carrying capacity with the net result that large amounts of energy are consumed per unit of freight moved. This latter ratio is defined as the energy intensity of a distribution operation. For the purposes of this study, energy intensity is measured by the ratio of fuel consumed (in milli-litres) per outbound pallet-km. (In the case of temperature-controlled distribution, this included a measure of the fuel consumed by the refrigeration equipment). This has been calculated as follows:

$$\frac{D_t / (F_m + F_f)}{D_l / T_l * P}$$

Figure 16: Average vehicle fuel efficiency by fleet

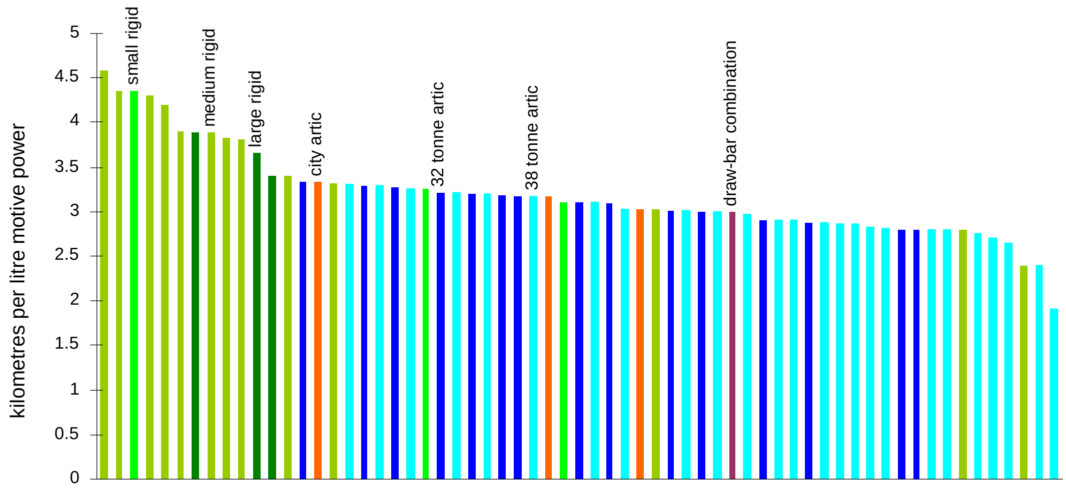
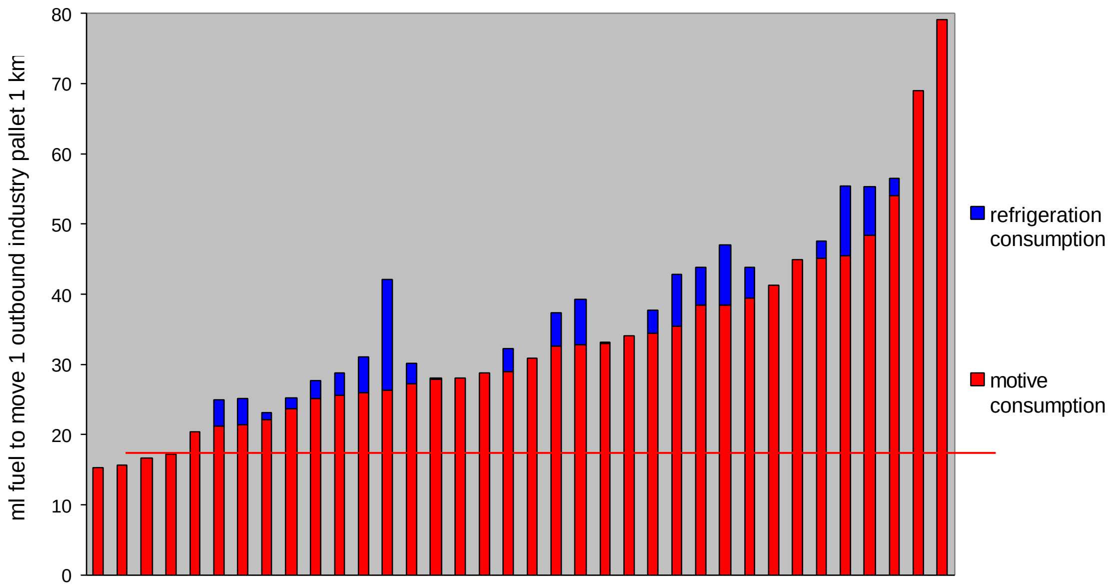


Figure 17: Average energy intensity by fleet



Where,

D_t = total distance travelled by vehicles over the 48 hour period
D_l = distance travelled with loaded pallets
F_m = average amount of fuel consumed by the tractor unit
F_f = average amount of fuel consumed by the refrigeration equipment
T_l = number of loaded trips
P = average number of loaded pallets per trip

This index was calculated for all the fleets covered by the 1998 survey. This revealed wide differences in energy-intensity, ranging from 15 ml per pallet-km to almost 70 ml per pallet-km (Figure 17). The differences are wide for energy consumed both in the tractor unit and by the refrigeration equipment. Some of the variation is likely to be attributable to differences in the nature of the distribution operation. This is confirmed by a disaggregation of the energy intensity values for 38 tonne articulated vehicles by sub-sector (Table 6). To ensure consistency between fleets with and without refrigeration, the energy intensity indices in Table 6 have been calculated solely on the basis of fuel consumed by the tractor units.

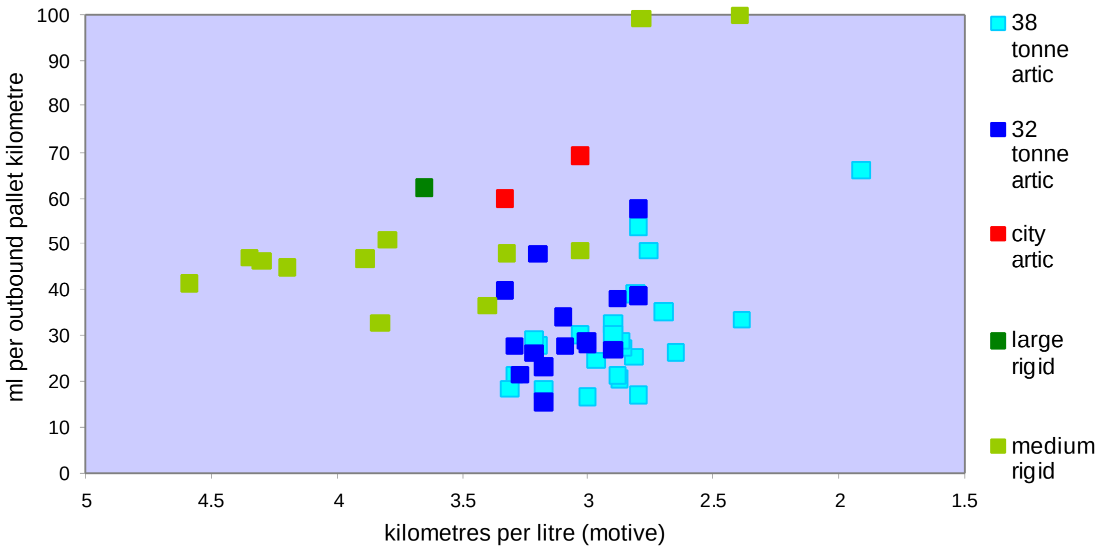
Table 6 : Average energy intensity of different types of distribution operation: (ml per pallet-km for the tractor units of 38 tonne articulated vehicles)

	Average	Standard Deviation
All fleets	33.4	12.6
P1 Temperature-controlled primary distribution	34.2	9.3
P2 Ambient primary distribution	21.4	7.8
S1 Dedicated distribution to supermarkets	34.8	12.7
S2 Dedicated distribution to other retail / catering outlets	29.1	13.9
S3 Multi-user distribution to retail / catering outlets	45.5	17.9

This disaggregated analysis revealed that there were wide variations in energy intensity both within and between the various sub-sectors. The high average value for S3 can be partly attributed to the abnormally low vehicle utilisation figures for one of the three companies in this sub-sector. At the other end of the range, the primary movement of ambient product achieved both the lowest average level of energy intensity and the lowest variability about this mean. Temperature-controlled primary distribution and dedicated secondary distribution to supermarkets recorded very similar values. Within both of the categories, however, there was a broad spread between the top and bottom of the range, with some fleets more than twice as energy efficient as others.

Across the sample as whole, some of the variation in energy-intensity is due to differences in the average fuel efficiency of the vehicles, expressed in kms per litre. This is illustrated by the horizontal spread of vehicle fleets in Figure 18. The fairly random dispersion of points on this

Figure 18: Relationship between vehicle fuel efficiency and energy-intensity



graph, even for particular classes of vehicle, indicates that there is little correlation between vehicle fuel efficiency and energy intensity measured in milli-letres per outbound pallet-km. Companies attaining similar fuel efficiency can differ markedly in the amount of energy they require to move a pallet-load of food one kilometre (excluding refrigeration). Overall energy consumption depends as much on the utilisation of the vehicle as on its fuel efficiency. This is illustrated by Table 7, which shows the combined effect of varying the vehicle load factor and fuel efficiency on the overall energy intensity of a distribution operation. The KPI survey suggests that an energy intensity value of around 15 ml per pallet-km probably represents the technical minimum that a company could achieve. The average for the 36 fleets surveyed was just over twice this value (33.3).

Table 7: Relationship between vehicle loading, fuel efficiency and energy intensity.

volume utilisation	empty / running with empty equipment	fuel efficiency		energy intensity
		km per litre	mpg	ml per pallet km
90%	10%	3.50	9.90	13.57
80%	20%	3.25	9.19	18.49
70%	30%	3.00	8.48	26.16
60%	40%	2.75	7.77	38.85
50%	50%	2.50	7.07	61.54

Using the comparative data on energy-intensity it is possible to make a crude estimate of the potential for saving energy in food distribution. Two scenarios have been analysed. The first assumes that all fleets whose energy-intensity is above the average manage to reduce it to this mean value. The second sets the more ambitious target of raising the average ml per pallet-km figure to the mean of the six companies with the best energy-intensity performance. In Scenario 1, fuel consumption would be reduced by around 10%, saving roughly £3 million per annum and cutting annual CO_2 emissions by 16,800 tonnes (Table 8). If the second scenario could be achieved, there would be a three-fold increase in these economic and environmental benefits.

Table 8: Opportunity to reduce fuel consumption, emissions and cost (annualised)

	SCENARIO 1: Fleets below mean performance achieve mean performance	**SCENARIO 2: Fleets below mean of the top third of companies achieve this mean**
Fuel savings (motive) in litres	4,670,336	14,726,121
% Fuel savings	9	29
Reduction in CO2 emissions (tonnes)	12,423	39,171
Total fuel cost savings (£)	3,269,235	10,308,285
Fuel cost saving per vehicle (£)	2,255	7,109

This calculation made no allowance for differences in the nature of the distribution operation or the composition of the vehicle fleets. As a general rule, the greater carrying capacity of the vehicle, the lower is the energy-intensity of the delivery operation (Table 9). Fleets containing smaller articulated and rigid vehicles, heavily engaged in urban delivery, will therefore tend to have higher fuel consumption per pallet-km.

Table 9: Average fuel efficiency and energy intensity by vehicle type

	fuel consumption (motive)		**outbound load**	**Average payload**	**energy intensity**
	km per litre	mpg	industry pallets	Tonnes	ml per pal km
38 tonne artic	2.87	8.13	18.5	10.2	30.4
32 tonne artic	3.08	8.71	16.9	7.8	33.2
city artic	3.18	8.99	9.5	4.3	64.6
larger rigid	3.65	10.32	8.7	5.2	52.8
medium rigid	3.66	10.34	8.6	4.4	53.9

To control for variations in distribution and vehicle type, the analysis was repeated at a more disaggregated level for 38 tonne articulated vehicles and for each of the five sub-sectors. The aim was to assess the potential fuel savings that would be achieved if all those companies with energy intensity values above their sub-sectoral mean were able to reduce their energy intensity to this mean. This would affect eight of the 25 fleets with 38 tonne vehicles. This would reduce their total fuel consumption (in 38 tonne vehicles) by 26% and the total amount of fuel used by all the 38 tonne artic fleets by 8.8%. It is interesting to note that the use of sub-sectoral averages rather than the mean for the full sample has only a modest effect on the estimated level of savings. The corresponding savings calculated using the overall sample mean were, respectively, 30% and 9.7%. This is because the variability within sub-sectors is almost as great as the variability between them, as reflected in the standard deviation values.

4. Summary

This extensive audit of vehicle utilisation in the food sector has highlighted numerous ways in which energy efficiency can be improved:

- Only around 50% of the cubic capacity of loaded vehicles is currently used. There is scope for raising both the deck utilisation and average height of pallet-loads. It would also be beneficial to reduce the height of some trailers to cut tare weight and improve aerodynamic profiling.

- As only around 7% of loads in this sector are weight-constrained, the potential savings in vehicle kilometres, transport costs and fuel from increasing maximum lorry weights are relatively small.

- While the proportion of vehicle-kms run empty is significantly lower than that for the UK lorry fleet as a whole, inter-fleet comparison suggests that there is significant potential to reduce this figure.

- Much vehicle capacity is used to return handling equipment, packaging and returned goods. This 'reverse logistics' operation could be rationalised to consolidate returns in fewer trips and release vehicles for backloading with supplies.

- Temperature-controlled trailers spend around a fifth of their time loaded and stationary, burning fuel in the fridge units. By compressing pre-loading schedules and reducing waiting times at delivery points, significant energy savings could be made.

- Although vehicles only spend around a third of their time running on the road, much of this running-time occurs in the morning when the road network is at its busiest and fuel efficiency most adversely affected by traffic conditions. The simultaneous peaking of primary and secondary movements also limits opportunities for co-ordinating distribution across the supply chain. Altering daily delivery cycles, particularly for primary flows, could improve overall energy efficiency.

- Cutting delays, especially at delivery points, would increase the degree of predictability in route planning to the benefit of vehicle loading and fuel efficiency. Only around 23% of the delays were attributable to traffic congestion. Delays internal to the distribution system (i.e. excluding traffic congestion) affect around 14% of all trips and cost approximately £4000 per vehicle per annum.

- The survey revealed wide variations in the energy-intensity of the fleets, measured in milli-litres of fuel consumed per pallet-km both within and between sub-sectors. Some of this variation is the result of differences in distribution operation and fleet composition. Much of it, however, is due to differences in the efficiency with which companies run their vehicles. This suggests that widespread adoption of current good practice in energy-efficient distribution could yield substantial economic and environmental benefits.

4. Future Development of the KPI Initiative

This project has demonstrated how it is possible for several companies at different levels in the supply chain to conduct a synchronised vehicle audit based on a standard set of KPIs. It could now be extended in several directions:

1. Repetition of surveys in the food sector: The survey could be repeated at regular intervals within the food sector to analyse trends in the KPI values and enable companies to monitor changes in their relative performance through time. It could also provide a general indication of the dissemination of best-practice and the impact of government policy measures on distribution operations. A follow-up survey found that 95% of the managers of the fleets surveyed in 1998 would be willing to take part in another similar survey. Just over half of them believed that the survey should be repeated at least once a year (Annex 2).

2. Diversification into other sectors: Most of the KPIs are generic and not specific to the food sector. Although almost all the loads surveyed so far have been palletised, it would be possible to base the survey on other units of movement. Some customisation of the KPIs and survey method may nevertheless be required to meet the requirements of companies in other sectors. The extension of the programme into other sectors would permit inter-sectoral comparisons of transport efficiency and more detailed analysis of the pattern of freight flow on the UK road network.

3. Diversification into related logistical activities: The interaction between transport and other logistical activities needs to be more fully investigated as this can impose a constraint on the efficiency of delivery operations. This might promote integrated modelling of the interface between transport and warehousing operations which could both cut the cost and improve the energy efficiency of distribution operations.

4. Expansion into other countries: It appears, from preliminary enquiries, that the KPI surveys have pioneered transport performance measurement at an industry level and that no other European countries have yet attempted to do likewise. It would be possible, in collaboration with governments and trade associations in other EU countries, to develop KPI programmes there and to apply the KPIs to cross-border freight movement.

5. More detailed analysis of the existing KPI data base: It would be possible to conduct a more elaborate spatial analysis of the existing KPI data to assess the potential for rationalising the pattern of food movement. This would require the development of an analytical tool-kit capable of interrogating the KPI data-base to explore opportunities for backloading, load consolidation, delivery rescheduling and improved routing.

6. Further refinements to the KPIs and survey method: The development of the KPI methodology has been an iterative process. In the light of feedback from the 1998 survey, additional changes could be made to improve accuracy, facilitate data collection and remove ambiguity.

7. Explore opportunities for downloading KPI data from electronic tracking and monitoring systems: Several participants in the 1998 KPI survey already employ this technology and calculate a wide range of performance indicators on a regular basis. Future development of the KPI initiative should aim to exploit these advances in information and communication technology.

8. Translating analysis into action: More work needs to be done on the use of the KPI data to foster supply chain initiatives. Companies must be encouraged to act collectively to deal with the problems of under-utilisation and inefficiency revealed by the KPI survey. This might involve the use of independently-audited demonstration projects.

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Annex 1

Main Modifications to the KPIs and Survey Method

1. Redefinition of legs and trips: The definition of 'journeys' in the 1997 survey precluded the analysis of multiple drop and collection rounds. In 1998, data were collected on individual journey 'legs', defined as the movement of a vehicle between points at which its loading changed.

2. Clearer differentiation of empty running and the return of empty handling equipment:

3. Measurement of the average height of pallet-loads:

4. Distinction between vehicle waiting time at collection and delivery points: This permitted more detailed analysis of time utilisation of vehicle capacity at different points in the supply chain.

5. Collection of post-code and land use data for the start and end of journey legs: With this data it is possible to reconstruct the pattern of vehicle movement and analyse opportunities for backloading, load consolidation and improved routing. This analysis has yet to be done.

6. Inclusion of rigid vehicles.

7. Redefinition of 'deviations from schedule': Companies were asked to log all delays '*considered sufficiently inconvenient… . to be worth recording*' unlike in the 1997 survey when only delays of more than 30 minutes were recorded.

8. Inclusion of the non-availability of drivers as a possible cause of delays.

Annex 2: Results of Follow-up Survey of Participants

Managers of the 36 fleets surveyed in October 1998 were sent a postal questionnaire enquiring about their participation in the KPI project. Two-thirds of them responded either by returning the questionnaire or providing the information by telephone.

Time and Effort Expended on the Survey

The managers were asked to what extent the KPI data were routinely collected or had to be recorded specially for the survey. On a scale of 1 (routine collection) to 5 (specially recorded), the mean score was three (Figure A2.1). 40% of the managers routinely collected much of the data.

Figure A2.1: Extent to which KPI data had to be specially collected (1 = small 5 = large)

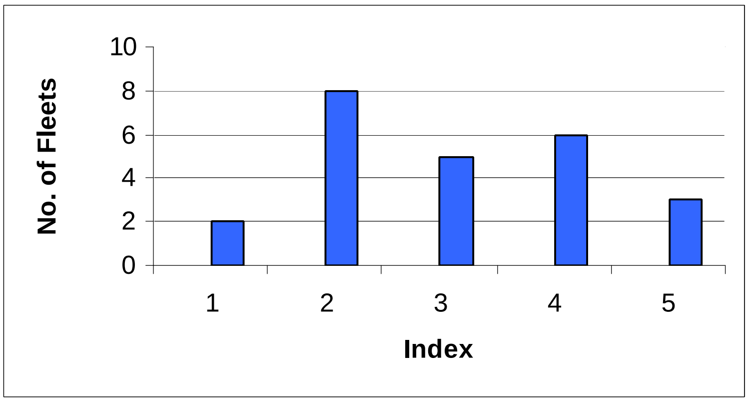
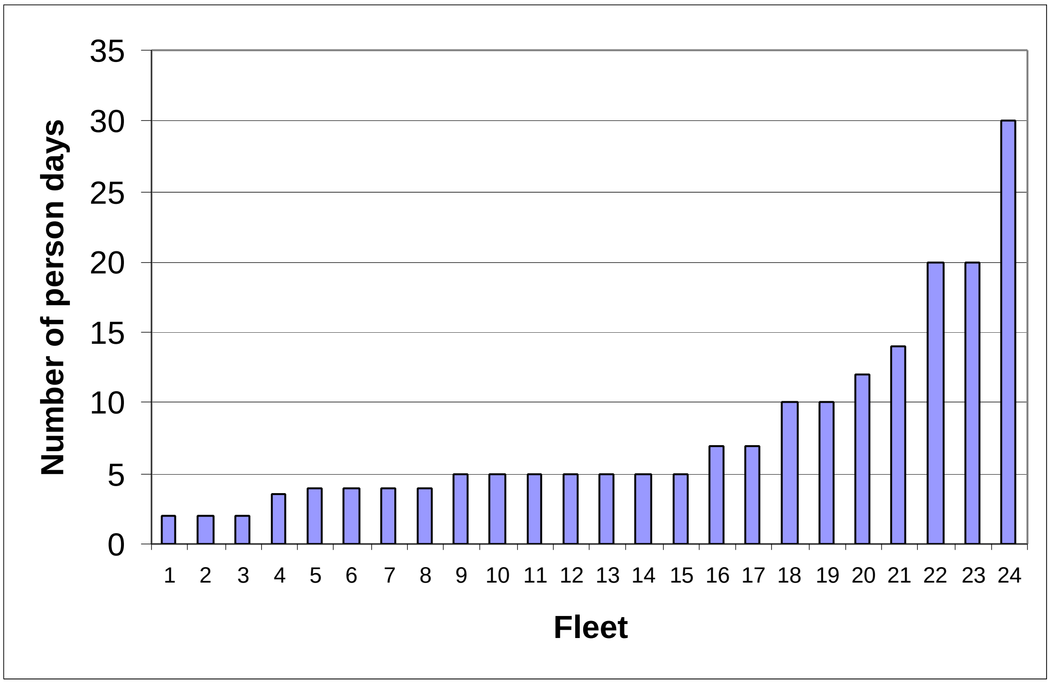


Figure A2.2 : Amount of staff time spent on the KPI project by fleet.



There were wide differences in the amount of staff time allocated to the collection and collation of the data. This ranged from 2 to 30 person-days. Two-thirds of the companies devoted 7 person days or less to the exercise. The differences are likely to be attributable mainly to three factors: the scale of the transport operation, the nature of the existing information system and experience of the 1997 KPI survey. Assuming that the median value of 5 person days is representative of the 36 fleets surveyed, a total of 9 months of staff time will have been spent on the data collection process.

Attitudes to the Survey

When asked how much value their companies had derived from the exercise most managers responded favourably. Table A3.1 shows the mean scores on a scale of 1 (no value) to 5 (extremely valuable) and the proportion of managers awarding high scores of 4 or 5. Most managers felt that the greatest benefit came from the benchmarking of their fleets. The relatively low score for 'networking with other companies' can be partly attributed to the fact that the respondent was often not the company's representative at the KPI workshops and conference.

Table A2.1: Value of Various Aspects of the KPI Project

	mean score	% of 4 or 5 scores
Collecting own company's data	3.7	56%
Own company's benchmarking results	4.3	83%
Overall survey results	4.0	78%
Networking with other companies	3	35%

The majority of the respondents were confident that the results were accurate. On a scale of 1 (no confidence) to 5 (full confidence), three-quarters of the sample awarded scores of 4 and 5 for their degree of confidence in their own benchmark results. Curiously, managers expressed less confidence in the 'overall results' implying that other companies had not collected the data so accurately.

Table A2.2: Degree of Confidence in the Survey Results

	Mean	% of 4 or 5 scores
Own benchmark results	4.1	82%
Overall survey results	3.9	64%

Approximately half the respondents (52%) said that the results broadly confirmed their suspicions and contained no particular surprises. The remainder identified one or more finding which they considered 'surprising'. Table A3.5 lists these findings:

70% of the companies did not suggest any changes. Roughly a quarter of them commented that they were happy / very happy with the KPIs and survey method.

Table A2.3: KPI findings which managers found surprising

	No. of respondents mentioning factor
Level of empty running	5
Poor vehicle time utilisation	2
High % of volume-constrained loads	1
Low average payload weight	1
Large amount of fuel used in refrigeration	1
Relatively low % of delays due to traffic congestion	1
Length of delays due to vehicle breakdowns	1
Own company performance better than expected	1
Own company performance worse than expected	1
Industry performance better than expected	1

Table A2.4: Suggested amendments to the KPI survey

	No. of companies mentioning change
simplify the spreadsheet layout	3
clarify the guidance notes	1
no need for data on land use	1
extend survey beyond 48 hours	1
enquire about engine management systems	1
replace Thursday-Friday with Tuesday-Wednesday	1
market the survey more effectively	1

Effect of the KPI Exercise on the Monitoring and Management of Transport Operations

Companies were asked if they had changed the monitoring of their transport operations as a consequence of their participation in the KPI survey. A quarter of the respondents indicated that they had changed the way that they measured time utilisation, while 21% now measure vehicle fill, fuel efficiency and deviations from scale differently. Only 13% have changed the monitoring of empty running. Several companies indicated that while they had not yet changed their data recording systems they were planning to do so and changes would be influenced by their experience of the KPI survey. Some suggested that the KPI project had caused them to rethink the process of performance measurement and recalculate existing data into new ratios.

Few of the managers indicated that involvement in the KPI project had so far led to changes in the distribution operations and / or relationships with suppliers / customers. The proportions of managers changing various aspects of operations / relationships are listed in Table A3.6. Three changes received two or more mentions: intensified efforts to reduce empty running, increasing load consolidation and rescheduling of collections / deliveries. Other measures, receiving one mention, were reducing waiting times at a distribution centre and working with breakdown firm to cut delays

Table A2.4: Changes to distribution operations / relationships following KPI survey

	% of fleets undergoing change
Internal distribution operations	12%
Links with suppliers / shippers	17%
Links with customers / receiving companies	17%

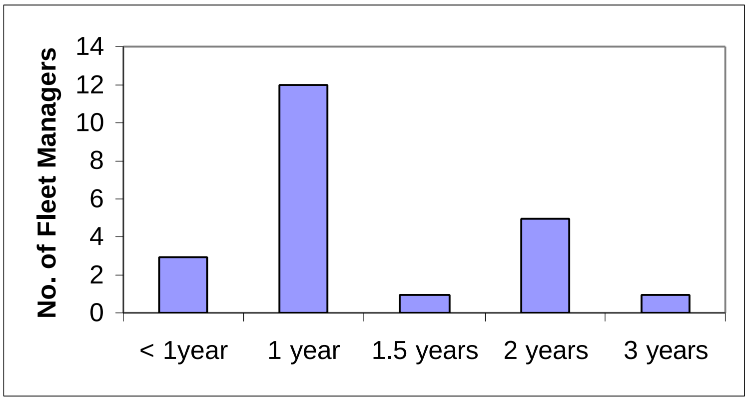
Several companies remarked that, while no tangible changes had so far resulted from their involvement with the KPI project it had influenced their thinking and would affect logistical decision-making in the future. One logistics provider believed that the large supermarket chains would increasingly press for the adoption of this type of KPI framework in contract negotiations

Willingness to Participate in Future KPI Surveys

All but one of the 24 companies responding to the survey answered yes to this question. The exception was the general manager of a distribution centre who actually believed that the company would take part again, but felt that it should be one or more of its other DCs that got involved next time. Participation in the survey could thereafter rotate around the DCs.

Respondents varied in their views on the frequency with which the survey should be repeated. Half the respondents felt that it should be rerun on an annual basis, while a quarter believed that an interval of 2 or 3 years would be more appropriate. The managers advocating more than one survey per annum argued that it needed to be repeated at difference times of the year to monitor seasonal variations, particularly for the distribution of chilled product

Figure A2.3: Recommended time intervals between future KPI surveys.



Overall, 39% of the companies indicated that they would be willing to make a financial contribution to future surveys. Several of those that indicated an unwillingness to pay argued that they were already making a valuable contribution 'in kind' in terms of the time commitment of staff. Roughly a third of the respondents were unable to answer this question, mainly because the decision on funding would not rest with them.

Table A2.5: Amounts that firms would be prepared to pay for future KPI surveys

	% of companies
Nothing	30
£500	13
£1000	9
£1500	4
Likely to pay - but unsure about amount	13
Outside the respondent's control / don't know	30

Annex 3: List of Companies Involved in the 1998 KPI Survey

ACC Distribution Ltd
Asda Stores Ltd
Associated Cold Stores & Transport
Booker Food Services
Brake Bros PLC
BOC Distribution Services
Christian Salvesen Food Logistics
Co-op Wholesale
Dairycrest Ltd
Eurocold (Severnside) Ltd
Exel Logistics
Express Daries
Farm Produce Marketing Ltd
Fresh Country Foods Ltd
Frigoscandia Ltd
Golden West Foods Ltd
Golden Wonder Ltd
Hays Distribution Services
Herbert Fletcher Transport Ltd
Iceland Frozen Foods
James Irlam & Sons Ltd
Kwik Save Ltd
Lloyd Fraser Distribution
MaCains
Marks & Spencer PLC
Mars Confectionery
McDonalds
MKG (Food Products) Ltd
N R Evans & Son Ltd
Nestle
NFT Distribution Ltd
Nisa Todays
Pedigree Masterfoods Ltd
Phil Handley Ltd
Safeway Stores PLC
J Sainsbury PLC
Snack Factory
Somerfield Ltd
Tesco Stores Ltd
TFE Euroventure Ltd.
Tibbett & Britten PLC
UB Frozen and Chilled Foods Ltd
Vandebergh Foods Ltd
W. H. Bowker Limited
Waitrose Ltd
Wincanton Logistics

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