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How Highly Does The Freight Transport Industry Value Journey Time Reliability – And For What Reasons?

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Abstract

Delays to road freight vehicles impose a very high cost on the nation. Delayed arrival time can occur for a variety of reasons. This paper presents the findings of a Highways Agency funded study, which has investigated the user valuations of three different kinds of delay:

- A delay resulting from an increased journey time, with fixed departure time
- An increase in the spread (or range) of arrival times for a fixed departure time
- A schedule delay where the departure time is effectively put back.

The paper summarises the findings of the study, which centred on an interview survey of forty shippers, hauliers and third party logistics operators. Respondents were asked to consider one of their freight flows on the trunk road network in detail. Various reasons why respondents value a high degree of predictability of journey times on the trunk road network are identified and discussed. The paper then moves on to present and discuss user valuations of each kind of delay, estimated using the Leeds Adaptive Stated Preference (LASP) methodology.

Keywords: Freight transport; journey time reliability; stated preference survey

Introduction

This paper presents results from a project on *The Evaluation of Delays to Freight on the Trunk Road Network*. The research was commissioned by the Highways Agency as part of its 'Understanding Travel Behaviour' programme which is managed by TRL Ltd.

This paper considers three types of delay. The first of these was due to increased free-flow journey times. The second was due to increased spread of actual arrival times, and the third was schedule delay in undertaking the journey. The research has centred on an interview survey of forty shippers, hauliers and third party logistics operators. Respondents were asked to consider in detail one of their freight flows using the trunk road network. The first section of the paper discusses the sampling procedures, the characteristics of the survey respondents and the freight flows selected for investigation. The paper then identifies and discusses the various reasons why respondents value a high degree of predictability of journey times on the trunk road network. User valuations of each kind of delay, estimated through an innovative application of the Leeds Adaptive Stated Preference (LASP) methodology, are then presented and discussed. In the final section, conclusions are drawn and discussed on the basis of both the attitudinal findings and the results from the LASP analysis.

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The Survey

Sampling Methodology

In designing the survey, the intention was to cover a range of dimensions of interest whilst keeping the total sample size to manageable proportions. Sample size was driven by the decision to undertake an Adaptive Stated Preference experiment using the University of Leeds 'LASP' methodology. Previous LASP experiments have utilised between 30 and 50 successful responses. Because LASP calibrates models for each respondent, larger sample sizes are not required for statistical accuracy in each dimension. It is however important to ensure that the sample covers all dimensions of interest.

Accordingly, forty interviews were conducted between November 2000 and March 2001. Few companies declined to participate, and the only difficulty encountered in achieving sufficient responses across the various dimensions of interest was in finding sufficient numbers of short distance movements. The first part of the interview collected information on the company concerned and the nature of its operations. The interview then focused on one particular flow of freight on the trunk road network, in order to identify the time sensitivity of the freight concerned and to conduct the computerised Adaptive Stated Preference experiment.

Characteristics of Freight Flows Surveyed

Traffic flows in the sample encompassed a wide range of commodity types, but food and drink and grocery distribution (15 respondents) and chemicals, chemical products and paint (8 respondents) were particularly well represented. Distribution activity (both primary and secondary) accounted for 25 out of the 40 respondents, with inbound materials flows, interplant movements and a variety of other flows accounting for the remainder. Flows categorised by respondents as Just-in-Time (J.I.T) and Quick Response (Q.R) accounted for 27 cases out of the 40. Eleven interviews were conducted with own account operators and 10 with shippers using third party services for the flow in question. The remaining 19 were conducted with hauliers undertaking third party work.

The vast majority of flows used articulated vehicles, and only two used containerised handling methods. Only one interviewee had a rail connection suitable for the traffic at either the origin or the destination, although 13 respondents indicated some positive degree of feasibility of using rail or intermodal transport for the flow selected. These included the two containerised movements and the one movement with a rail connection.

A shortcoming in the sampling was the failure to find a sufficient sample of flows travelling less than 100 kilometres, only four such flows being found. Some short distance operations were found, but these tended to form part of multi-drop operations, which do not fit easily into LASP experiments designed for A to B movements. Twenty-six of the flows travelled more than 250 kilometres. These 26 had an average distance of 362 kilometres, the overall average being 282 kilometres. It is clear therefore that the sample contained flows of much greater distance than the average traffic mix on trunk roads.

The vast majority of sample flows operated solely during the daytime. Only three flows were described as night trunking. Five could run day or night depending on circumstances, or were 24-hour operations. Interviews were divided between researchers based at Huddersfield (22 interviews) and an interviewer based in North-East England (18 interviews). Whilst in the majority of cases the selected freight flows had at least one end in the region in which the interview was conducted, the lengths of haul discussed above ensured a very wide coverage of the national trunk road network.

The Perceived Need for Travel Time Predictability

Reasons for the Need for Travel Time Predictability: A Broad Classification

Discussions with respondents as to the nature of the flows they had selected for investigation revealed that in many instances effective operation depended on a high level of certainty as to the expected arrival time of the vehicle, either for loading or unloading. On further investigation, a wide range of reasons for this certainty requirement emerged. These reasons can be divided into two broad groups – those related to the nature of the demand for freight transport, and those concerned with supply-side issues.

Demand considerations
During discussions on the importance of highly predictable journey times, survey respondents identified various reasons related to the nature of the freight concerned or to conditions stipulated by customers. These are discussed below.

Just-in-Time: The survey covered consignors and shippers responsible for J.I.T deliveries of components into manufacturing or assembly processes, or materials into other processing operations. In some cases these involved highly transport intensive operations, with several loads per day. Delivery times were specified very precisely in certain cases. It was clear that continuity of production processes would be jeopardised in the event of late arrival.

Quick Response: Other survey respondents were handling deliveries of food, drink or manufactured goods into the retail trade. These included:
- manufacturers or other suppliers delivering direct to individual retail outlets
- more commonly, manufacturers or other suppliers delivering into regional distribution centres (RDCs). Some of these were 'Quick Response' deliveries with little or no product stock being held at RDCs by the retailers concerned
- logistics operators working under dedicated contract for major retailers, responsible for deliveries of consolidated loads from RDCs to individual retail outlets.

It was common for deliveries to be time sensitive in all three of these scenarios. Most notably, modern practice at retail RDCs is for deliveries to be 'booked in' for unloading at an agreed time. A small window of variability is built around this booked time, with varying penalties for late arrival. In some cases, late arrivals are sent to the back of the queue. A number of respondents noted that in the run-up to the survey, a major grocery retailer had imposed penalty payments for late arrival.

A related issue is that consignors may be given very late notice of the precise content of orders. For example, a retailer might transmit the order electronically at midnight, for delivery to their RDC by mid-morning. In such cases the time available to the supplier to undertake order processing, picking of goods, checking, loading, documentation and despatch may be very tight, placing considerable strain on the warehousing system, as well as on the transport movement.

Port deadlines: Deadlines for arrival at ports were found to exert a strong influence on journey scheduling in a number of instances. Clearly if there is a low level of predictability of arrival times at ports, vehicles must be scheduled to start their journeys earlier to maintain a reasonable degree of certainty of achieving their preferred or booked sailing. This has cost implications for the operators concerned.

'Hub and spoke' operations: Express parcels operations are by their very nature time-sensitive. National network operators use 'hub and spoke' networks. Depots throughout the UK collect parcels and other urgent consignments during the afternoon. These are shipped during the evening to a central 'hub'. All sortation at the hub must be achieved in a narrow time window so that vehicles can return to their home depots loaded with the parcels for their region. Unpredictable arrival times at the hub will reduce the efficiency of its operation and may delay the sortation of parcels, forcing vehicles to depart late on their return journey. Further delay on that return journey may cause late deliveries to consignees, and possible refunds to customers under the terms of service guarantees. Other companies were found to operate similar 'network' operations (typically overnight) across the UK, for example to exchange products between sites depending on their place of manufacture. Again, a high level of certainty of travel time is required.

Supply Side Issues
The key issue on the supply side is that (regardless of the nature of the freight being moved) highly predictable journey times allow operators to maintain the efficiency of their transport and logistics operations and to meet statutory obligations. Some examples are discussed briefly below.

Two-way loading: A number of flows examined during the survey involved two-way loading. In some cases, both loads would be related to the same industrial operation (eg outbound product distribution linked to inbound transport of materials or components). In other cases, hauliers link together work for different customers in order to reduce the amount of empty running. Such operations often depend on a high level of journey time predictability, especially when the return load has to be collected within an agreed narrow time window.

Consolidation of deliveries: Certain respondents indicated that they consolidated deliveries to improve efficiency. For example, a food manufacturer in the North of England might despatch several consignments on one vehicle, perhaps for various smaller retailers in the South, or for different RDCs for a large retailer. This allows efficient operation of a large articulated vehicle for the trunk haul. Faced with the possibility of less certain journey times, manufacturers may lose this ability to consolidate, for two reasons. Firstly, they may miss their booked unloading time at the second or subsequent call. Service levels to customers may therefore be jeopardised. Secondly, delays on such schedules may lead to problems with respect to driving time regulations, raising the prospect of expensive double manning.

Driving hours implications: A number of respondents expressed concern about the driver cost implications of greater journey time variability. In a number of cases, delivery schedules had been calculated on the basis of effective use of the driver's working shift. Delayed journey starts, longer travel times and greater journey time variability would all lead to problems in such cases. Respondents were concerned both about the implications for maintaining legal operations and about the broader cost implications, such as reduced scope for using drivers for other work at the end of the driving day. These concerns seemed most significant in the own account sector. Another example related to the scope to exchange drivers en route. In some cases, vehicles heading in opposite directions are scheduled to exchange drivers at a convenient point en route. The scope to do this effectively is reduced if travel times are more variable, because a delay to one of the vehicles is likely to delay the other one as well.

*Scope for round the clock operation***:** Various operations were identified in which vehicles are operated round the clock, but where the daytime work differs from the night-time work. In one such example, articulated tractor units were used during the daytime coupled to small trailers suited to urban deliveries. The same tractors were used with larger trailers on overnight inter-depot trunking operations. A delayed return to the depot either in late afternoon or early morning would delay the next operation (although the delay could be minimised by having trailers preloaded). Parcels carriers also tend to use vehicles day and night. Drawbar combination vehicles are highly efficient for the night time operations to and from the sortation hub. During the daytime, the trailer can be detached and the resulting rigid vehicle can undertake collection and delivery work.

Order management and warehousing regimes: Other respondents expressed concern about the impacts of journey time variability on the effectiveness of their order processing and warehousing operations. Extended journey times or other factors enforcing earlier departure times would place greater pressure on already tight order processing, picking, loading, checking and despatch deadlines. The fear was expressed that earlier or later shifts might have to be introduced in warehouses.

In summary, against a background of rising transport costs (eg of fuel and drivers), it is apparent that many sectors of the freight transport industry have become used to operating on narrow margins and have devised many and varied strategies for improving operating efficiency as a means of survival. Critically, many of these strategies depend on a high degree of certainty as to journey times on the trunk road network. It is hardly surprising that consignors and operators stressed the importance of travel time predictability in their survey responses. What this initial stage of the survey was not able to do, however, was to estimate values of travel time delays, or to compare the valuations of the three different types of delay under consideration. One can surmise that J.I.T and Q.R flows would exhibit high values of predictability. One might also suspect that consignors using third party logistics services (having opted out of the problems of transport operation) might have lower valuations than own account operators or hauliers. Shippers with a rail alternative might also be less concerned about delays than those shippers totally locked into road transport. To investigate these and other issues in a more quantitative manner, the Adaptive Stated Preference experiment was conducted.

The LASP experiment

Basic Methodology

The nature of Adaptive Stated Preference experiments and the method of estimation have been described elsewhere (Fowkes and Shingal, 2001) and will not be repeated in this paper, which will be concerned primarily with presentation and discussion of results. The experiment needed to consider three different types of delay. These related to:

- delay time (DT) (i.e. an increase in free flow time for a given departure time)
- an increase in the spread (SP) of arrival times
- a schedule delay (SH) in the initial departure time.

For DT, respondents were asked for the departure time (T) for the movement in question, and the earliest possible arrival time (EA) if everything went perfectly. DT is the difference (EA-T). Respondents were then asked by what time 98% of deliveries could be expected to arrive. This was denoted A98 (unless it was within 10 minutes of EA, in which case a 10-minute difference was forced). The difference between A98 and EA was called spread (SP). Having determined when the movement currently departs, some delays were then imposed on departure time. These were referred to as schedule delays (SH) as they relate to the inability to depart at the preferred time. Such a delay might arise if planned roadworks were either going to completely block the journey or add so much delay that it was not thought worth starting out until the works were completed, or if the vehicle was waiting for a tolling period to end.

The other attribute in the LASP experiment is cost (C). This is expressed for most purposes as a percentage of the current cost (or freight rate), although actual monetary costs are displayed to respondents during the experiment.

In recent versions of LASP, options are presented to the interviewee on a laptop computer. Details of the selected freight flow are discussed and input, to form the basis of the options to be presented. LASP displays these options using a four-column format. The leftmost column (depicting Alternative 1) resembles the current position regarding the typical flow, but at twice the cost. This remains unchanged throughout the exercise. Columns 2, 3 & 4 represent three hypothetical alternatives to the service shown in column 1. However, each of columns 2 to 4 has one attribute set worse than in column 1. Initially, an attempt is made to get the respondent to prefer these alternatives to that in column 1, by offering a reduced cost. The base alternative (column 1) is given a rating of 100 and the respondent is asked to give ratings for each of the three alternatives as compared to the base option. Once these ratings have been input, LASP modifies the attribute levels and proceeds through a series of further iterations, each time with the attribute levels modified on the basis of the ratings given in preceding iterations. The data collected in this procedure is stored and subsequently subjected to statistical analysis.

For the study in question, 40 interviews were conducted. However, two of these yielded a regression equation with a wrong sign cost coefficient. In one of the two cases use of a weighting remedied this situation. Where there are positive cost coefficients the data for that respondent cannot be used. Hence the results presented in this paper are effectively based on 39 respondents.

Results

Table 1 presents results from the statistical analysis undertaken, for the entire sample and also for various groupings of survey respondents. Several different methods of analysis were tried, and Table 1 is based on the most robust results. Good t ratios were obtained, indicating that (reductions in) all three types of delay are significantly positively valued.

Looking first at results for the whole sample, the value of delay time (VDT) has the highest estimate of 107p/min, followed by value of spread of journey time (VSP) (85p/min) and then schedule delay (VSH) (66p/min). The average distance is just over 280 kilometres, and the average cost per kilometre is just over £1. Standard errors of difference are about 7-9p/min, so the gap between adjacent values is about 2 standard errors. Accent Marketing & Research and Hague Consulting Group (1996) recommended an evaluation value of time of 40p/min (in 1994 prices) for freight vehicles, or roughly 50p/min in 2001 prices. The estimate of VDT obtained here should be higher, since respondents were not given the option of rescheduling their journey earlier (in order to use the cheaper, slower, route and still arrive on time).

Table 1: Valuations of Delay Time (VDT), Arrival Time Spread (VSP) and Schedule Delay (VSH) expressed as pence per minute, end-2000 prices (t ratios in brackets)

	n	Cost (£)	Distance (km)	VDT (p/min)	VSP (p/min)	VSH (p/min)
Whole sample	40	285.8	281.6	107.1 (15.7)	85.3 (13.7)	65.8 (26.3)
Own account	11	227.3	237.2	169.3 (15.4)	89.5 (10.0)	126.0 (25.0)
Third party (haulier interviewed)	19	298.2	286.8	155.1 (9.2)	167.6 (8.3)	86.8 (15.7)
Third party (shipper interviewed)	10	326.8	320.6	37.2 (3.7)	61.5 (6.5)	31.3 (9.3)
Distribution	25	310.2	281.0	183.6 (14.4)	128.7 (13.0)	104.2 (23.6)
Not distribution	15	245.3	282.7	76.2 (9.5)	56.9 (7.1)	47.7 (15.7)
J.I.T / QR	27	277.9	279.1	128.6 (15.6)	101.8 (13.7)	75.9 (26.3)
Not J.I.T / QR	13	302.4	286.8	61.0 (5.1)	46.8 (4.1)	35.6 (7.2)
Articulated	33	306.8	291.6	98.4 (12.0)	90.2 (11.2)	63.4 (22.8)
Not articulated	7	186.8	234.7	126.6 (10.2)	78.1 (8.1)	74.7 (13.4)
Distance less than 250 km	14	179.4	132.9	89.9 (9.5)	93.8 (11.3)	59.0 (17.5)
Distance greater than 250 Km	26	343.2	361.7	125.0 (12.9)	74.5 (7.9)	74.1 (19.8)
Chemicals, chem. products, paint	8	397.3	285.0	224.7 (6.1)	126.6 (6.5)	94.3 (10.0)
Food, drink, grocery	15	288.7	298.0	90.9 (11.6)	77.5 (10.6)	48.4 (15.6)
Other commodities	17	230.9	265.6	145.7 (9.8)	93.3 (6.2)	97.0 (20.9)
Rail possible	13	301.4	300.5	77.9 (6.4)	60.4 (5.4)	56.3 (12.2)
Rail not possible	27	278.3	272.6	120.5 (14.6)	96.2 (12.9)	69.6 (23.5)
Daytime movement only	32	283.7	268.2	97.3 (14.0)	72.0 (10.6)	61.4 (15.7)
Some night time movement	8	294.7	325.5	431.5 (10.7)	159.0 (10.0)	173.9 (13.7)
North East based interviewer	18	321.1	275.8	50.5 (4.1)	104.7 (7.5)	49.2 (13.4)
Huddersfield based interviewers	22	257.0	286.4	131.4 (16.1)	80.3 (11.6)	80.0 (23.5)

The first disaggregation divided respondents into own account and third party. Here it emerged that the third party valuations varied according to whether the shipper or the haulier was interviewed. The values to the shipper were low, reflecting an interest in the cost to the load, but no interest in what happens to the lorry or driver. Hauliers were found to have higher values, particularly for spread, where uncertainty of arrival time is presumably highly detrimental to the operation of the business. Own account operators are less worried than hauliers about spread, but more worried about journey time and schedule delay. This may reflect the shorter distances recorded in the own account operations surveyed, which might mean that an hour's delay involves more disruption than for the longer distance third party movements.

The next disaggregation was into (primary or secondary) distribution movements and all other flows. Distribution movements were costing much more per kilometre and their valuations were also much greater. When disaggregation between J.I.T / Q.R and other flows was undertaken, it was found valuations were much higher for J.I.T / Q.R, although this time the per kilometre freight rate was lower for J.I.T / Q.R than for other flows. Type of vehicle used had little effect on the valuations, though it was noticeable that articulated vehicles were used for the longer distance journeys.

With respect to journey distance, it was stated earlier that insufficient numbers of journeys below 100 kilometres were found to allow reliable estimates to be generated. When the total sample was disaggregated into journeys less than and more than 250 kilometres, it was found that long distance journeys had higher values of delay time but lower values of spread. This echoes the earlier point that (an absolute amount of) uncertainty is more disruptive for shorter, as opposed to longer journeys, and in the case of shuttle operations may call for an extra vehicle in the circuit.

With respect to commodities moved, sample sizes were too small to permit much disaggregation. Chemicals related flows were travelling an average distance, but at a cost greatly above average, presumably reflecting the specialist equipment involved and lack of opportunity to obtain suitable return loads (avoiding contamination or cleaning of tanks). They had high valuations. Grocery flows, on the other hand, went further than average, slightly more cheaply than average and had lower than average valuations.

Flows where rail was a (usually remote) possibility were longer than average and had lower valuations than average. Only one fifth of flows involved night-time movement. These were found to have high valuations, suggesting that once the decision to operate at night has been taken, any form of delay is greatly disliked.

Other dimensions were also investigated, but did not yield insightful results. A particularly unfortunate case was value per load. It appeared that high value loads produced very low value of delay time, zero value of spread and low value of schedule delay. In fact it proved difficult to reconcile value of goods to the value of the vehicle load. Small vehicles loaded with high value goods and large vehicles loaded with average value goods could well have loads of equal value.

Lastly, Table 1 presents the results from the two interview bases, as a way of stressing that the above results are in no way meant to be representative of the mix of traffic on trunk roads. Very different results can arise depending on which area is surveyed, and it is likely that this reflects the mix of product and traffic types in each area.

Concluding Remarks

This paper has presented findings from a project into *The Evaluation of Delays to Freight on the Trunk Road Network*. Data for the study was obtained from a set of interviews held with consignees and decision-makers in the road freight transport industry. These interviews have provided a wealth of information on the factors affecting freight transport decisions in the face of journey time uncertainty. The survey has also yielded 39 interviews suitable for obtaining estimates of the valuation of delay using the LASP survey methodology. This paper has therefore focused on two main themes:

- A discussion of the many varied factors identified during the course of the interviews as important influences on freight decision-making
- A brief description and discussion of the LASP methodology and a presentation of estimates for the valuation of three distinct types of delay:

- A delay resulting from an increased journey time, with fixed departure time
- An increase in the spread (or range) of arrival times for a fixed departure time
- A schedule delay where the departure time is effectively put back.

The valuations of the three types of delay are referred to as VDT, VSP and VSH respectively. The LASP analysis has produced plausible valuations for these, given the composition of the survey sample. This sample was not intended to be representative of any particular population (e.g. the commodity distribution in the sample will not reflect the population). However, an attempt was made to obtain sufficient responses in each dimension of interest, and disaggregated results have been presented across these dimensions so that any desired re-weighting can be performed. One caveat is that (in the event) very few short distance flows on trunk roads were sampled, and therefore it is not possible to re-weight in this instance.

A particular objective was to investigate the difference between J.I.T and non-J.I.T movements. Discussions with survey respondents strongly suggested that delays would be valued relatively highly in the case of J.I.T flows. This was indeed substantiated by the LASP analysis, which found estimated valuations for J.I.T movements group to be always at least twice as high as for the group of non-J.I.T movements. A significant number of survey respondents in the distribution sector were trying to achieve very strict time windows for deliveries, particularly to retailers. This is reflected in relatively high valuations for all three types of delay, in comparison to those for non-distribution flows.

Another strong impression gained from the interviews was that whilst many respondents expressed concern over the impact of delays, those impacts would differ between shippers using third party services and those actually responsible for transport operations. The LASP analysis confirmed that shippers using third party services tended to have much lower valuations. This may be because they do not consider the costs to the haulier of increased journey times, which (as has been discussed) may be considerable. Own account operators appear to consider both the costs (a) to the load and (b) to the driver and the vehicle, and so sum the values of VDT and VSH. This does not apply to VSP, where the own account operator is less inconvenienced by unplanned delays than the haulier.

Results in this paper are presented as one-dimensional splits, this being all that the sample size will permit. It should be borne in mind that correlations will exist between the various attributes. For example, there is some correlation between operator type and journey distance, with third party journeys being on average some 30% longer than own account journeys. Consequently, what might be taken to be an 'own account effect' could be a 'distance related effect' (or vice versa).

Notwithstanding this and a number of other caveats, there is a consistent picture from both the information provided by survey respondents and the LASP analysis that in certain sectors of the freight transport market at least, there are relatively high valuations of all three types of delay under investigation. This reflects on the one hand the increasing demand for J.I.T / Q.R services from consignors, and on the other hand the pressure on hauliers and own account operators to implement more efficient methods of operation.

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