Evaluation of the Longer Semi-Trailer Trial: Annual Report 2018 Update

A report for the Department for Transport

July 2020

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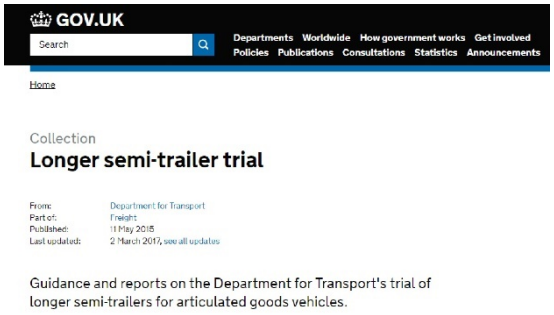
LST Trial information and contacts

The latest information regarding the trial, including participation criteria and data collection requirements, are always available from the DfT website.



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The project is sponsored by the DfT Freight Policy Group. All communications should, in the first instance, be directed to the project manager/sponsor.

Acknowledgements

Risk Solutions and the Department for Transport (the DfT) would like to record thanks to all operators on the trial, especially the individual data contacts, for their continued positive cooperation and hard work in collating, cleaning and submitting data in keeping with the operator undertaking. Without this effort evaluation of the trial could not take place.

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LST TRIAL EVALUATION: HEADLINES

(Rounded figures – as at 31 Dec 2018)

Trial Take Up

2,486	LSTs registered on Vehicle Special Orders (VSOs)
(89%)	(% of revised trial target of 2,800 trailers)
2194	LSTs on the road and submitted trial data
(78%)	(% of revised trial target of 2,800 trailers)
201	Number of operators with trailers on the road (submitting data)

A Vehicle Special Order (VSO) grants permission for a specific operator to operate specific special trailer(s) on GB roads for the duration of the VSO. All LSTs require a VSO from the Vehicle Certification Authority (VCA) before the trailers go on the road.

Utilisation and km saved

4.7million	Journey legs travelled by LSTs during the trial
587million	km travelled by LSTs during the trial. Analysis in 2017 showed LST usage to be 85% Trunk, 13% Principal & 2% Minor Roads
41.1 to 45.8million	Vehicle km 'saved' by LST operations (end 2018). Lower - Upper estimates (Upper includes matched empty return legs)

Journeys saved

Estimates of equivalent 'standard trailer' journeys saved across the whole trial period and all operators

330,000 to 365,000	Journeys by 13.6m trailers saved by using LSTs based on 125km average journey. Upper estimate (includes some return legs)
1 in 13	Average saving across all operators, 1 in 'n' journeys
7.5%	Average percent distance saved
1 in 8 (13%)	Highest saving achieved by individual operators, 1 in 'n' journeys
13%	Highest percent distance saved

Emissions saved

Estimates for LSTs on the trial compared to the emissions from delivering an equivalent quantity of cargo on 'standard trailers'

To date	To 10 yrs	
37,000	**70,000**	**CO2(e)** Tonnes of CO2(e) 2012-2018 (Rounded).
187	**350**	**NOx** Tonnes of NOx 2012-2018 of which 6.2% saved within 200m of 'Designated Areas'

Carbon dioxide equivalent" or "CO2e" is a term for describing different greenhouse gases in a common unit. For any quantity and type of greenhouse gas, CO2e signifies the amount of CO2 with an equivalent global warming impact. Savings of CO, PM (Exhaust) and VOC are also calculated in the report.

Injury incidents – National Comparison

Collisions	Casualties	***Collisions / Casualties where LST*** *on public highways or public access areas* ***(2012-2018) resulting in injury***
33	**43**	All personal injury incidents involving an LST
4	**4**	Incidents/casualties judged to be 'LST Related'
59	**72**	Three-year average safety incident rate (ALL collisions or casualties per billion vehicle km, 2016-2018)
135	**194**	Equivalent three-year rate for all GB articulated HGVs, (per billion vehicle km 2015-2017 - 2018 not yet published)
0.44	**0.37**	Collision/Casualty rate ratio (LST vs All GB Artic. HGVs)

On a per kilometre basis, nationally, we estimate LSTs have been involved in around 55% fewer personal injury collisions and casualties than GB articulated HGV average.

Injury Incidents – Road Type Comparison

URBAN	MINOR	*Collisions / Casualties where LST* ***on public highways or public access areas*** *(2012-2018) resulting in injury*
3	**3**	Personal injury incidents involving an LST (All – regardless of any 'LST Related' judgement)
39 (per billion km)	**255** (per billion km)	Safety incident rate (collisions per billion vehicle km) over whole trial for distance est. of 13.1% Urban and 2.0% Minor
540 (per billion km)	**949** (per billion km)	Equivalent rate for all GB articulated HGVs over whole trial period, 2012-2017 (per billion vehicle km)
0.07	**0.27**	Collision rate ratio (LST vs All GB Artics)

On a per kilometre basis, compared with the average for all GB articulated HGVs, LSTs on the trial have been involved in 93% fewer personal injury collisions per km when operating on roads in urban areas and 73% fewer when on minor roads.

URBAN = ONS Urban areas - excluding motorways - MINOR = Operations OFF Motorway/Trunk /Principal roads

Damage Incidents – Comparison within sample of operator fleets

Based on 91 operators able to provide credible 2018 data for both LSTs and Non-LSTs in the same operator fleet, occurring on roads, resulting in damage.

LST	NON-LST	
0.91 incidents	**6.8** incidents	Mean number of incidents expected for an LST fleet and a non-LST fleet after 1 million vehicle km exposure, that is, after completing a million vehicle km as a fleet

The average number of incidents per million vehicle km for non-LSTs is greater than that for LSTs by a factor of about 7.4.

Executive Summary

Background

The Department for Transport (DfT) is evaluating the impact of the operation of longer semi-trailers (LSTs) on Great Britain's (GB) roads. These trailers are up to 2.05m longer than the standard 13.6m units commonly seen on the roads in this country. The DfT launched the 10-year trial in 2012, permitting up to 1,800 to operate under Vehicle Special Orders (VSOs) granted by the Vehicle Certification Agency (VCA). Following a consultation process during 2016, the DfT announced an extension to the trial with a further 1000 trailer allocations being offered from 1 April 2017. At the time of writing (October 2019) 2,486 trailers are on VSO and expected to be on the road during 2019.

The trial is designed to evaluate the impact of LST operations on efficiency, emissions and safety. A reduction in emissions may be expected because the increased trailer length should allow the same quantity of goods to be transported in fewer journeys. Evaluation of the trial will determine whether this potential reduction in emissions is realised, without a detrimental effect on safety. The trial is also considering the issue of non-injury incidents resulting in asset damage.

We have expressed these aims in terms of seven evaluation questions:

1. What do operators use LSTs for?
2. What are the savings realised in HGV journeys?
3. What are the resulting reductions in emissions?
4. What about safety – will LSTs cause more injuries?
5. What about damage and the associated costs – will LSTs cause more damage on the roads?
6. Might any special operational requirements be appropriate for LSTs?
7. What proportion of the existing GB fleet of semi-trailers might be replaced by LSTs, were numbers not restricted?

Annual reports on the progress of the trial evaluation have been published since 2013 and are available on the DfT website. This report contains the updated analysis of the data to the end of 2018.

Evaluation approach and methods

The design of the evaluation and the methods used to collect and analyse the trial data are summarised in this report. Full explanations of the approaches used, where these have not changed from previous years, can be found in previous annual reports and published project notes. A route map to these is provided in Annex 1.

LST Trial 2018 Annual Report Summary

The results to the end of 2018 are summarised in Chapter 8 of this document, but for an overview of the whole trial, including the most up to date results from this report, readers should refer to the "**2018 Annual Report Summary**" published in parallel with this report, and also authored by Risk Solutions.

This accessible summary version of the report has been produced since 2016, in response to increased interest from individuals in public sector leadership, haulage industry, and civil society groups who have a valid interest in understanding the key results of the trial, and the evidence supporting them, but do not necessarily have the resources to study the main report in depth.

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1 INTRODUCTION

The LST trial

1.1 The Department for Transport (the DfT) has been running a trial of the operation of longer semi-trailers (LSTs) on roads in Great Britain (GB) for the past seven years. These trailers are permitted to be up to 2.05m longer than the standard 13.6m units commonly used in this country. Details of the trial can be found on the DfT website.

1.2 The trial was created to gather evidence about the operational performance of LSTs in terms of safety, environmental impact and economics. In order to participate in the trial, hauliers sign an 'Operator Undertaking' which included a commitment to data collection.

1.3 The trial was originally scheduled to last for 10 years from its launch in 2012 and allowed up to 1800 LSTs to be built and operated. The first semi-trailers were granted Vehicle Special Orders (VSOs) early in 2012 and data collection began on 1 May 2012. (Note: A VSO grants permission for a specific operator to operate specific special trailer(s) on GB roads for the duration of the VSO. All LSTs require a VSO to operate. The operator must apply to the Vehicle Certification Authority (VCA) for a VSO before the trailers are used on the road, citing all the trailer Vehicle Identification Numbers (VINs). This is often done as soon as the VINs are fixed by the manufacturer during build.)

1.4 In January 2017 the DfT agreed to extend the number of semi-trailers in the trial by 1000 trailers and extended the prospective trial length by 5 years to 2026/7. This followed an industry consultation during 2016. In March 2017 the DfT invited operators to bid for a share of this additional allocation. The first LSTs from this new allocation entered service from 1 May 2017. View details of the trial extension on the DfT website.

1.5 The outputs from the trial will feed into a decision about whether to permit an increase in the length of semi-trailers authorised for operation on roads in GB beyond the trial.

More broadly, subject to acceptable outcomes in terms of safety and property damage, the trial will contribute to the DfT's work to:

- identify de-regulatory measures to reduce burdens on business; and
- identify measures to reduce carbon emissions from HGVs.

The trial evaluation

1.6 Fuller details about the design of the evaluation and methods used can be found in previous annual reports. A route map to the detailed description of methods used for each aspect of the evaluation can be found in Annex 1.

1.7 The primary objective of the trial is set out in the 2010 impact assessment of LSTs (IA no. DFT00062). It is to provide evidence to the DfT to support long term policy decisions on **"…. the most socially beneficial length of Heavy Goods Vehicle semi-trailers"**. The detailed evaluation questions are listed in Annex 2 along with an assessment of the progress made in answering them.

1.8 The DfT commissioned Risk Solutions to:

- Design a process to collect data to support the evaluation of LST performance
- Set up the initial systems for data collection
- Initiate the process and support participants during the first year of the trial (2012)
- Report on progress achieved during the year.

1.9 Having an independent evaluator serves two purposes:

- The raw operational data remains confidential – it is not seen by or available to the DfT or any party other than the originating company and Risk Solutions. Without this arrangement many companies would not have been willing to participate or would have only agreed to provide summary data.
- The analysis of the data and the conclusions are made independently of the DfT.

1.10 Trial data is analysed and reported on annually, and recommendations are made regarding the conduct of the trial where appropriate. View all of our Annual Reports and a number of supporting documents. Annex 2 sets out progress on outstanding actions raised in previous evaluation reports.

1.11 Risk Solutions was re-commissioned to continue in the role of independent evaluation consultant for the trial in 2013, 2015 and 2017. The company was re-appointed for the period 1 January 2018 to 31 December 2019, via a competitive process.

1.12 The trial was set to run for a long period to ensure it generated reliable decision data and to allow participants to recover the costs of investing in LSTs.

1.13 For the first six years of the trial the data collection requirement was quite onerous, with details of each journey made by each trailer reported and analysed in detail. Details of the data collection requirements and processes can be found in the early trial annual reports (2012-14) and in the guidance given to operators. The datasets collected have provided a rich picture of the performance of LSTs. (Note: Annual Reports can be found at this web page, details of the data collection requirements: can be found at this web page.)

1.14 The stability of the datasets generated in this way, and the level of detail collected, enabled the DfT to reduce the burden of data collection on operators at the end of 2017.

1.15 From the start of January 2018 (2018-P1) a new data collection framework was introduced. This framework requires only summary data on overall trailer operation but captures an increased level of detail on any incidents that have occurred.

1.16 The new 2018 data format also required operators to provide a set of details about non-LST incidents and vehicle-kilometres in the period for their comparable non-LST fleet. We will likely collect this data for a limited timeframe (until the analysis is completed).

1.17 Details of the updated data collection requirements and processes can be found on the DfT website, a summary is provided in Annex 3. Annex 3 also sets out the processes we use to ensure that the data submitted is of adequate quality and summarises the status of the returns for 2018.

About this report

1.18 This report concerns the performance of the LST fleet on the road up to the end of 2018 and draws on data reported under the old and new data frameworks.

1.19 It adopts a simpler format to that seen in previous years, presenting updates to existing key results tables and charts without repeating the related detailed method statements. New pieces of work (see Table 1 below) are presented in full. Details of methods, unchanged from previous years, can be found in previous annual reports as listed in Annex 1, or for new methods, in the annexes to this report.

1.20 Terminology used in the trial and data collation is also defined in those earlier reports. Major terms appear in a glossary at the end of this report.

1.21 The remainder of this report presents the summary of results as follows:

- Section 2 presents data concerning:
  - Trial trailers and participants, and

  - Operational data – distance covered by LSTs, nature of use, and how well the extra capacity has been utilised.
- Section 3 presents findings in terms of key trial outputs – most notably the savings in distance and number of journeys from the operation of the trial LSTs.
- Sections 4,5 and 6 present the resulting trial outcomes, in terms of emissions saved (4), safety impact (5) and collisions resulting in damage (6)
- Section 7 describes further analysis and research in progress during 2019 including a series of face-to-face conversations with a selected group of operators, and modelling to scale-up the trial results to hypothetical impacts if LSTs were made available more widely, outside trial conditions.
- Section 8 presents our latest evaluation conclusions and recommendations.

Table 1: New analysis and research introduced in this report

Journey end and flow analysis – Section 2 and Annex 4
An analysis of geographical LST movements in 2017, showing the number of stops in trips passing through each local authority, and then the overall region-to-region flows. This work was suggested by stakeholders at the launch of the last annual report.
Operator conversations – Section 7 and Annex 5
A series of evidence-based conversations with a small selection of operators: • Part 1: Jan-Mar 2019: Individual company site interviews covering all aspects of their experience of specifying, purchasing, introducing and running LSTs and the potential future take-up if they were permitted more widely, beyond the trial. • Part 2: Autumn 2019: Planned group discussions of good practices adopted by operators on the trial, especially in terms of training content, which might be replicated outside of the trial conditions.
Marginal weights and costs – Section 4 and Annex 7
An analysis of sample information supplied by a selection of operators and manufacturers on the marginal weights and costs LSTs, compared to data for similar 13.6m trailers. The weight data is for comparison with estimates made before the trial. The cost data is to assist the DfT in their economic impact assessment.
Comparison of reported damage incident rates – Section 6 and Annex 8
Analysis of rates of collisions resulting in damage for LSTs and non-LSTs within fleets where operators could provide comparable data for both trailer types.
Scaling up model – Section 7
Summary description of work being carried out to build a scaling model that will enable the DfT to build profiles of journey savings by different groups of trailers and operators in the trial and apply those savings to national semi-trailer data from the Continuing Survey of Road Goods Transport (GB) (CSRGT).

2 TRIAL PARTICIPANT AND OPERATIONAL DATA

2.1 In this chapter we present the key charts and statistics concerning:

- Trial trailers and participants – the number and nature of trailers and operators
- Operational data – distance covered by LSTs, nature of use, and how well the extra capacity has been utilised, and
- LST patterns of movement – analyses of journey end points by Local Authority and the flows of LSTs/goods within and between regions.

Trial trailer and participant statistics

Note on method and data sources

2.2 Most of the data presented here is drawn from the data returns submitted by operators three times a year (see Annex 3). The data on the size of companies and the nature of their operations is drawn from the company information form (CIF) completed by each trial participant, usually in their first data period. As part of the updated data collection framework we requested an update of this data. The information requested, and the current status of returns, is presented in Annex 3.

Number of trailers allocated to the trial and on the road

2.3 At the time of the last Annual Report, around 80-90% of the additional batch of 1000 LSTs announced in 2017 had been allocated, with around 70 new operators among those taking up these newly available trailer options. At the time, proof of order was still required to confirm the take up of those allocations.

2.4 Table 2 shows that a portion of those allocations were not yet taken up by the end of 2018 – the total number of LSTs at the year end being just under 2,200, with around 2300 on VSO. So, at that point, around 400 of the 1000 extra trailers were in service and another 100 on order.

2.5 At the time of writing, the total number LSTs on VSO is now 2,486.

Table 2: LSTs on the road and on VSO

	On the road At end 2018	On VSO At end 2018	On VSO At Oct 2019
Number of LSTs	**2,194**	**~2,300**	**2,486**
Source	*LST Trial Data*	*DfT/VCA Data*	*DfT/VCA Data*

* Note that the 'on the road' figure is an underestimate as it counts only those trailers for which we had data submitted. A small number of operators had not submitted data for all their trailers and some new operators were waivered from submitting data. Any trailers on the road after 31 December 2018 will not be included in the current dataset although they may already be included on a live VSO.

2.6 There have been some transfers of LSTs between companies on the trial, including:

- Movements where there was already a relationship, as subsidiaries of a parent company, or between a client and their contract haulier already operating the LSTs

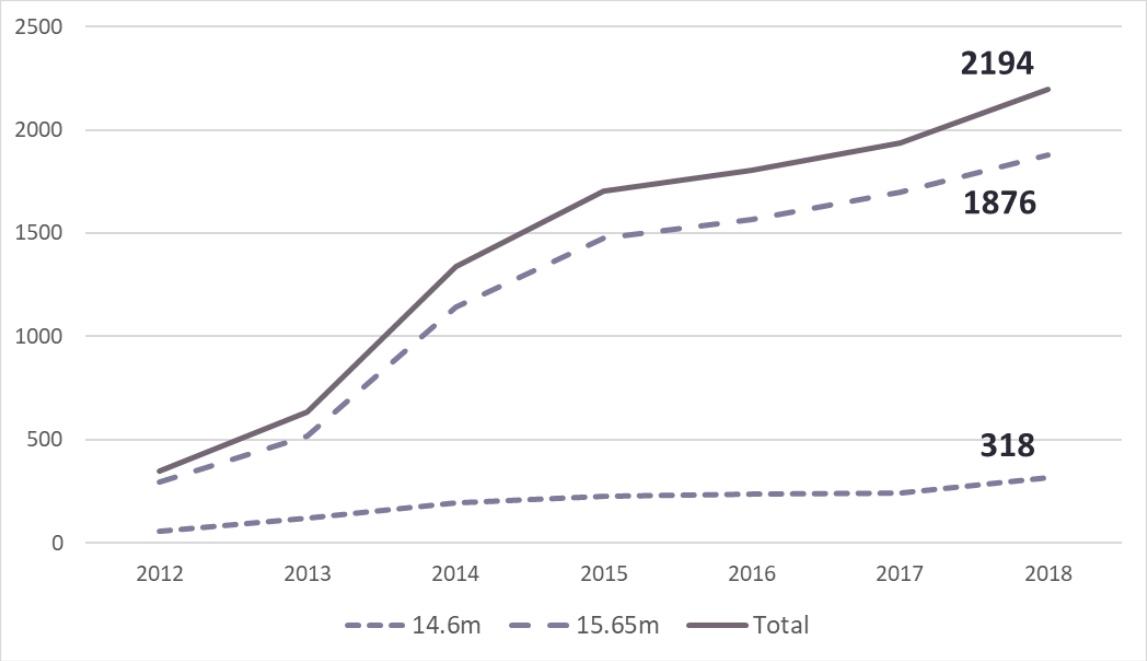
- Transfers of whole fleets – including LSTs – as part of company takeovers
- Individual sales between companies
- A small number of sales of manufacturers' demonstration trailers to hauliers.

2.7 A small number of trailers have been taken out of service due to manufacturing faults, or damage through incidents that was beyond repair.

2.8 Figure 1 shows the growth of the LST fleet from the start of the trial to the end of 2018.

2.9 Of the trailers put into operation during the trial to date 85% have been 15.65m length. As has been noted in earlier reports – once it was proven, early in the trial, that a 15.65m LST with a self-steer axle could be built to comply with the turning circle requirements, this rapidly became the most popular design. That said – some operators choose the 14.6m LSTs to fit their loads, or for access to a greater variety of locations.

Figure 1: Growth of the LST fleet 'On the Road' (source LST Trial data – from data logs)



Operators on the trial

2.10 One of the DfT's stated intentions was that the trial should be accessible to operators of all sizes – not just large operators. Figure 2 summarises the range of companies (based on their data submissions) by size, Figure 3 by the nature of their primary operations. (Note: Further details of the categorisation of companies and all other data gathering in the CIFs can be found in earlier trial annual reports.)

2.11 Figure 2 shows that the trial does include a significant number of small and very small operators. Figure 3 shows the balance between a small number of own operation fleets (retailers, parcel companies) with larger numbers of LSTs, and a large number of general hauliers with fewer LSTs each.

2.12 We note that while a large proportion of the companies are general hauliers, some of their operations are associated with long term contracts for major retailers.

2.13 The 'Other' category includes cases with very few data points, or specialist trailers.

Figure 2: LST trial participants by fleet and company size (source LST Trial data)

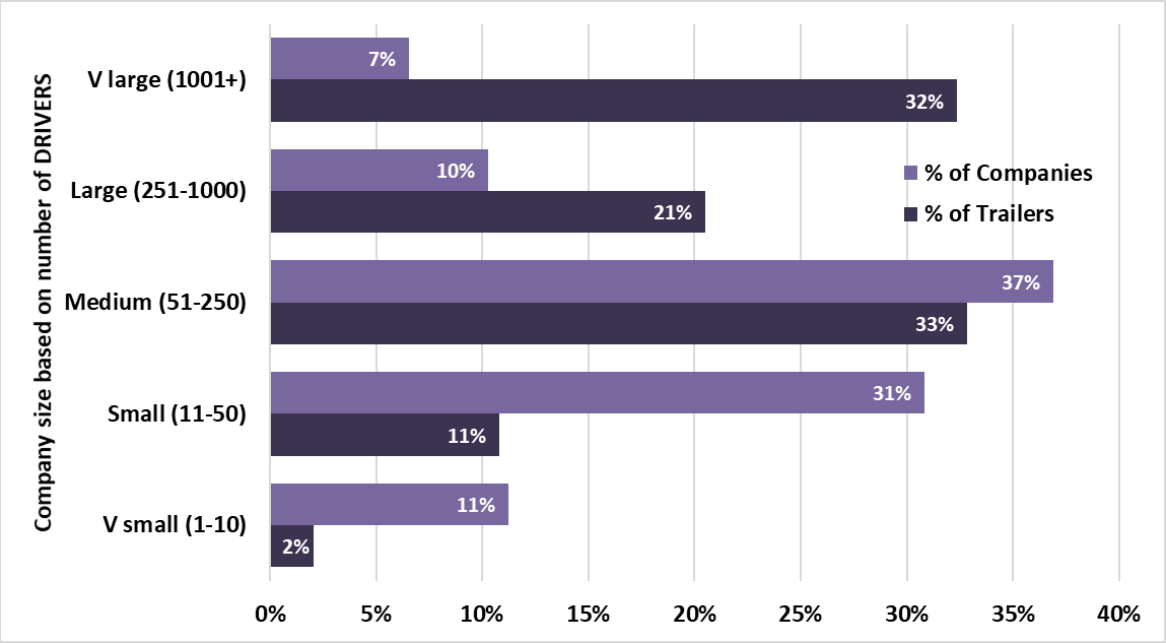
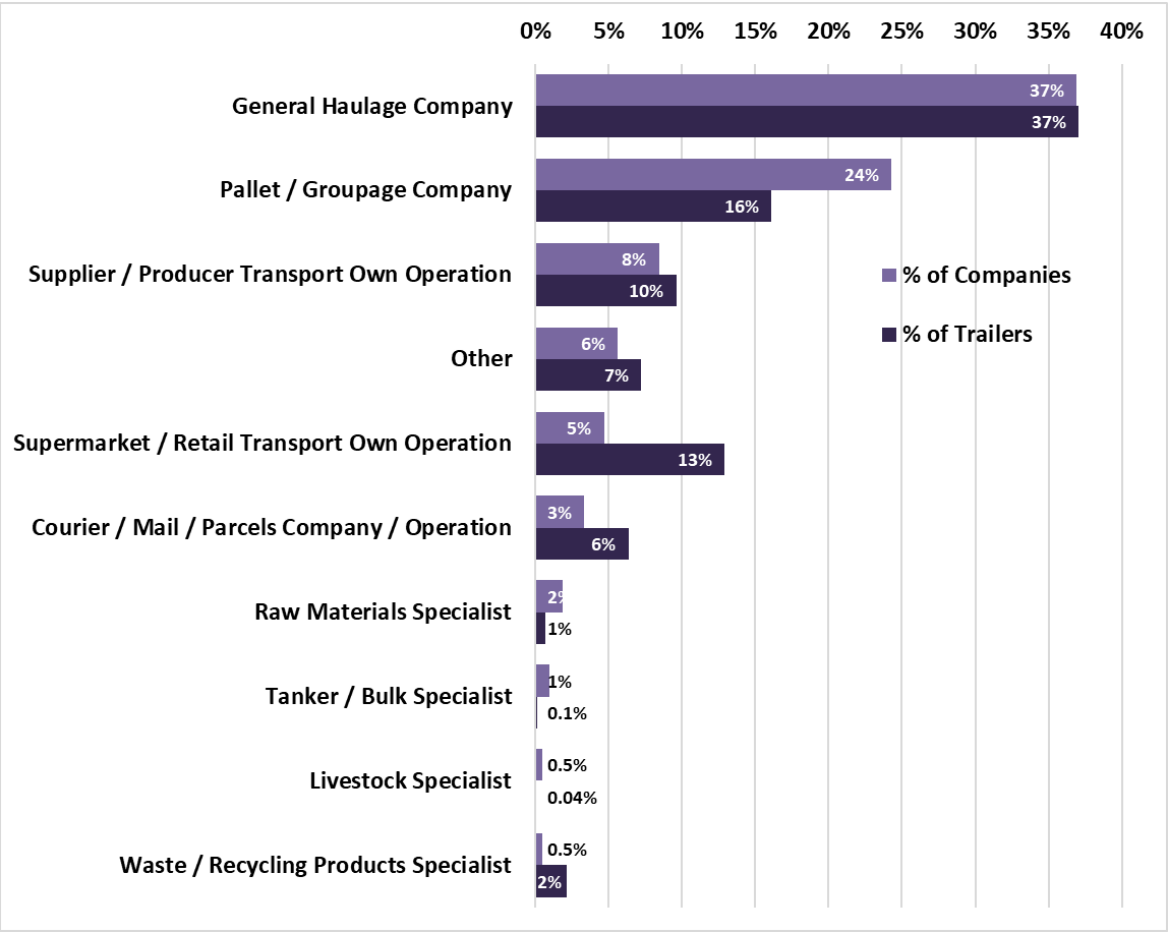


Figure 3: LST trial participants by nature of operation (source LST Trial data)



LST designs in operation

2.14 LST designs have emerged from manufacturers or bespoke requirements of users. The numbers of each design have been driven by market demand.

2.15 Most LSTs are box or curtain sided designs with a single deck. Figure 4 to Figure 7 show a summary of the LST fleet mix by major design features. (Note: Further details of the design mix categorisation and the history around the choices of steering arrangement can be found in earlier trial annual reports.)

Figure 4: LST body design mix (source LST Trial data)

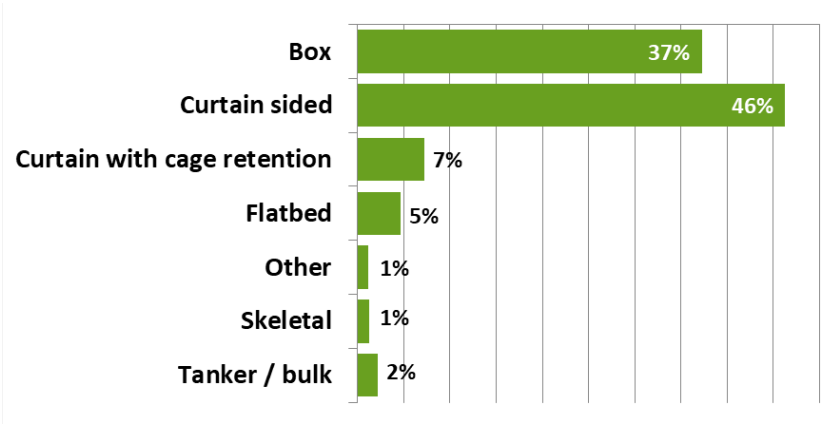


Figure 5: LST deck layout mix (source LST Trial data)

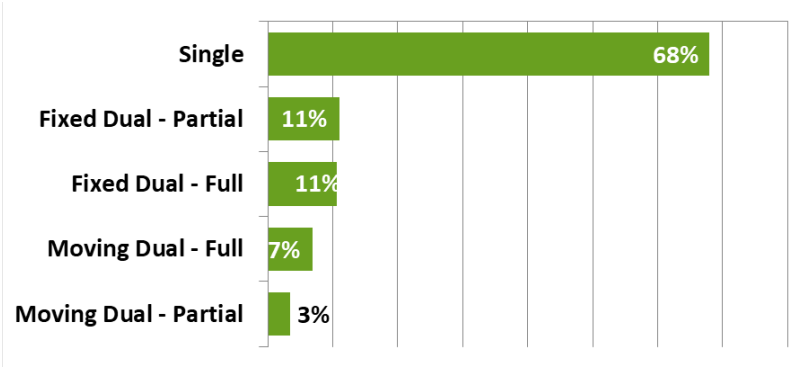


Figure 6: LST steering design mix (source LST Trial data)

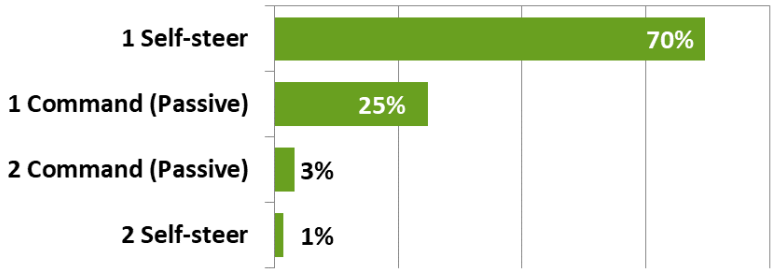
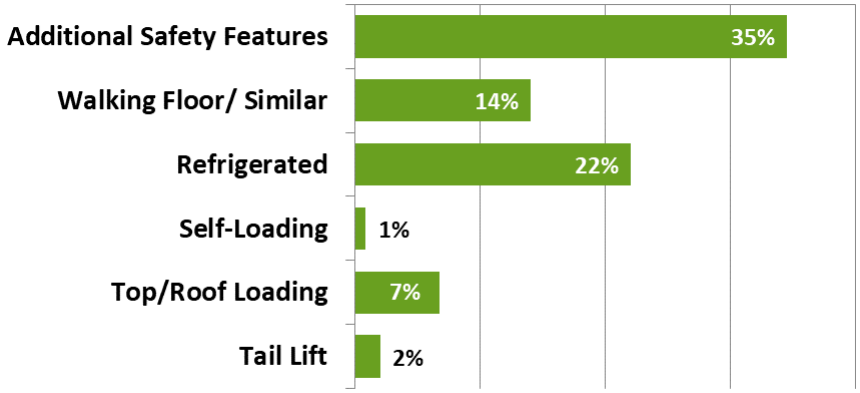


Figure 7: LST other features mix (source LST Trial data)



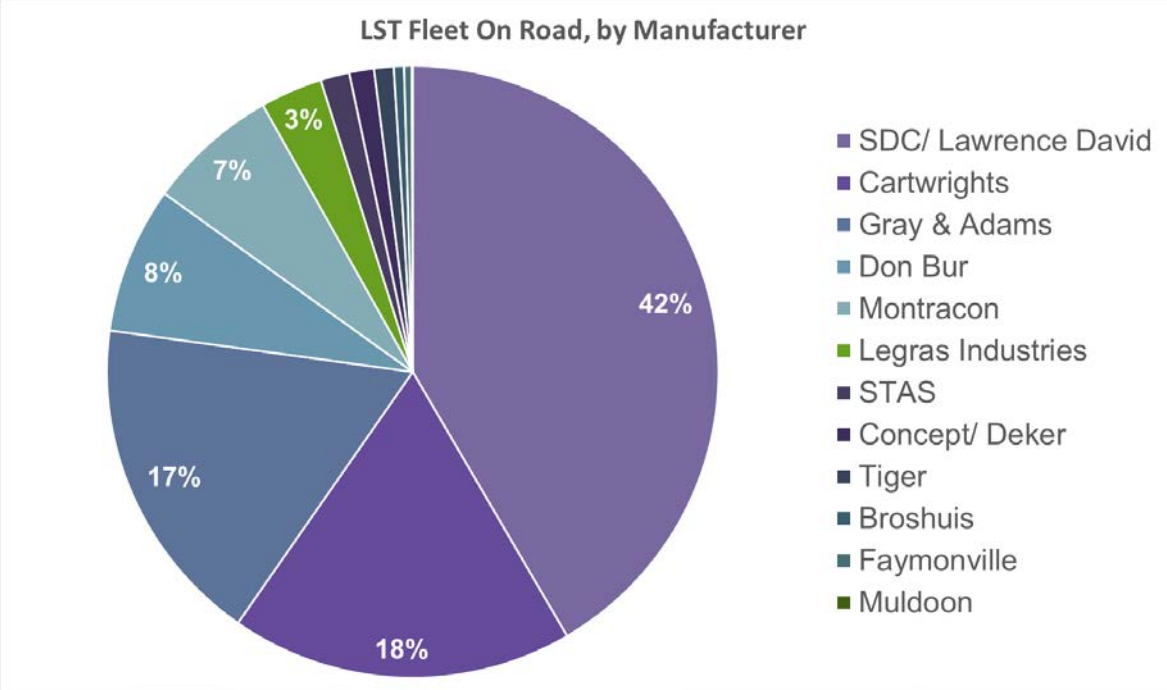
Manufacturers

2.16 At the time of writing, 12 manufacturers have designed LSTs and had them cleared by VCA for use on the trial (Figure 8).

2.17 The main UK manufacturers have been responsible for construction of most LSTs. As the fleet has grown, some other EU and smaller manufacturers have introduced LST designs. Often these offer specialist features such as walking floors.

2.18 At the end of 2017, thirty one LSTs trailers in the fleet ca me from manufacturers who have built fewer than ten trailers. As the smaller producers have developed their sales, this figure is now just 10 trailers.

Figure 8: LST fleet by manufacturer (at end Dec 2018) (source LST Trial data)



Operational data

Note on methods and sources of data

2.19 The outputs below are derived from data submitted by operators every four months. Prior to 2018 this was based on the detailed journey leg data submitted by operators. During 2018 it has been taken from the new simplified journey summary sheet (see Annex 3). It gives an overview of the operations carried out by LSTs from the start of the trial to the end of 2018.

2.20 Journeys are expressed as legs in the data, meaning a single point-to-point trip without loading or unloading stops *en route*. Any multi-drop journeys with fewer than five loading/unloading points are recorded as individual legs for each part of the journey. Prior to 2018, where there were five or more drops, the journey was recorded as a single record in the data, with the number of drops noted. Post 2018 the detail on number of drops would no longer be recorded.

Distance covered by LSTs

2.21 Table 3 shows the total distance recorded in the data for LSTs at the end of each year.

Table 3: LST total km and legs (source LST Trial data)

LST distance & leg count totals	To end 2018	To end 2017	To end 2016	To end 2015
Total vehicle km recorded	587 million	443 million	319 million	202 million
Number of recorded legs	4,691,852	3,589,290	2,647,018	1,727,559
Average leg distance	125 km	124 km	121 km	117 km

Operation by nature of operation and MOA

2.22 Figure 9 shows that the primary uses of the LSTs continue to be largely in the areas anticipated in the DfT Impact Assessment. This is a direct comparison of the percentage swaps since the table relates to assumed transfers of loads across the entire market. Although DC to DC trunking dominates the operations, as predicted before the trial, we do note the significant use of LSTs in delivery both to larger retail sites and also in industrial goods movements from suppliers. (Note: Page 31 and Page 40, Table 5 of the impact assessment lists the categories of journeys which were assumed to see transfer of loads from regular 13.6m trailers to LSTs, were the longer trailers to be generally available.)

2.23 The categories ‘3) Supplier to Distribution Centre (DC)’, ‘4) DC to DC’, ‘6) To/from industrial site’ and ‘7) Palletised trunking’ all relate to journeys between sites that might be considered industrial - based on site access and the location of such sites in areas with lower public movement or limited public access. These legs represent 66% of all loaded distance covered and, we can assume, a proportion of all the empty distance.

2.24 In contrast, ‘5) To/from Retail Site’ is the only leg type where we might expect operations in areas of high public movement and potential public access (on entry routes to the site). This leg type represents 13% of the loaded distance, but by the nature of retail delivery operations, many of the return legs will be empty.

2.25 The nature of the transported goods is shown in Figure 10 and the mode of appearance (MOA) is shown in Figure 11. These are dominated by fast moving consumer goods (FMCG) and other goods moved in cages or on pallets.

Figure 9: LST km by journey type (source LST Trial data)

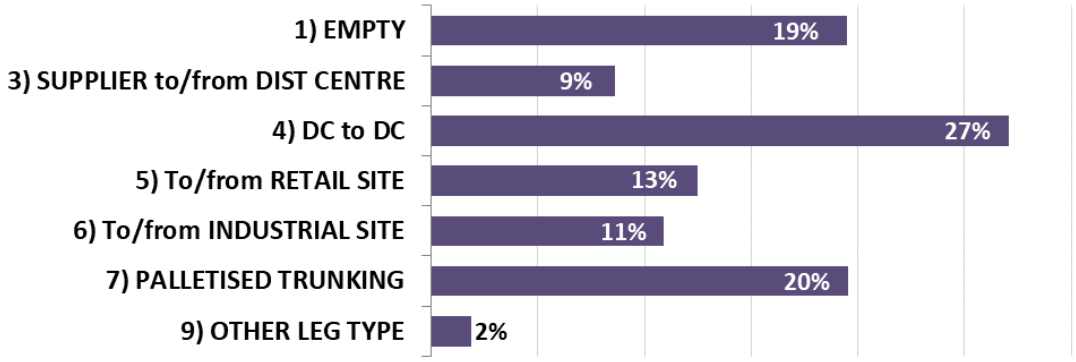


Figure 10: LST km by goods type (source LST Trial data)

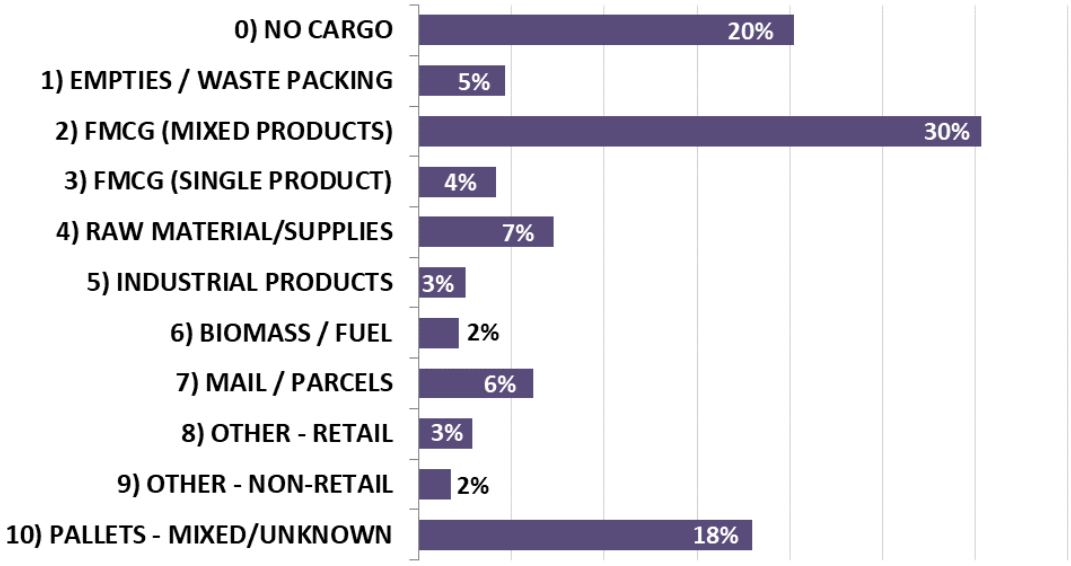
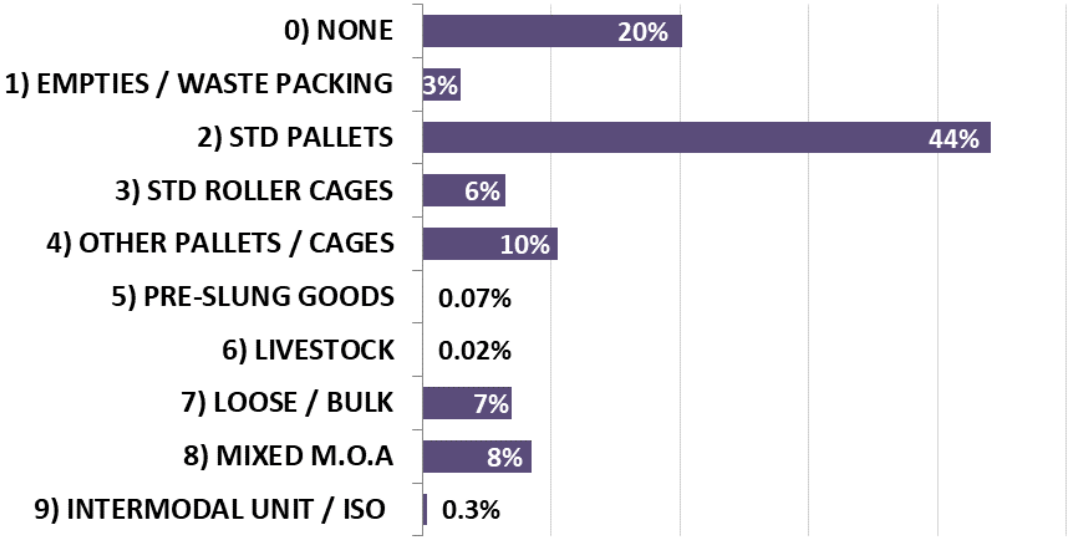


Figure 11: LST km by mode of appearance (M.O.A.) (source LST Trial data)



Empty running

2.26 The LSTs ran empty for around 19-20% of the total distance they covered, considerably lower than the figure of around 29-30% for all GB articulated HGVs in 2018.

2.27 The level of empty running has been steady across the years of the trial and reflects the extent to which the trial participants are placing the LSTs on operations where they know they have good utilisation and hence see the opportunity to make best use of the LSTs. These are often operations where the routes are familiar to the planners and drivers, are most easily pre-assessed as being suitable for LSTs, and where the return on investment for the additional cost of an LST can be most clearly demonstrated.

2.28 This pattern is evidence that many of the trial operators have suitable work available where they can deploy the LSTs efficiently, making use of the additional length on both outbound and return legs.

Utilisation measures

2.29 In the new 2018 data format, utilisation data is gathered only by deck % by trailer, grouped into legs/distance run (a) 100% Full (b) Empty and (c) Part-Filled. For the Part-filled legs an average Deck% is estimated by the operator. (Note: Prior to 2018, data was gathered for every leg by both Deck% and Volume%. We also gathered data on whether a journey was 'weight limited' so that we could identify legs in that data where the deck or volume was not being fully used because no additional weight could be added, rather than because no further goods were available. In the trial to end 2017, only 2.6% of legs were noted as being weight limited, which is consistent with the view that LSTs are primarily of interest to those hauling lower density – higher volume goods.)

2.30 With the new aggregated format, we do not produce an overall Deck% histogram, but the overall performance can be seen in the operator savings chart - Figure 17 - in the trial outputs section of this report.

LST patterns of movement

2.31 A new piece of work carried out during 2019 explored geographical patterns of movement of LSTs. The analysis sought to provide information on the locations and routes being used by the LSTs on the trial, which would be of interest and value to trial stakeholders, without going into a level of detail that would breach confidentiality commitments.

2.32 Two analyses were carried out:

1. **An analysis of journey end point activity by Local Authority (LA), reported in the form of heatmaps and tables of values, and**
2. **An analysis of the flow of LSTs and goods within and between regions (NUTS1), reported in the form of a table of values.**

(Note: An 'end point' is where a stop is recorded in the journey data submitted for each LST by the operator in their Data Submission File, this may be for a number of reasons but is principally to deliver or pick up cargo.

Nomenclature of Territorial Units for Statistics, or NUTS, is a geocode standard, developed and regulated by the European Union, for referencing the subdivisions of countries for statistical purposes. The NUTS1 level in the UK consists of Wales, Scotland, Northern Ireland, and nine regions in England.)

Note on methods and source of data

The work built on the platform of the 2017 LST routing model, which already contained part of the data and functionality required for this analysis. A full description of the routing modelling work can be found in the 2017 Annual Report and the project note published at the same time. As with the routing work, this pattern of movement analysis was performed on the full operational dataset of journeys made in 2017.

2.33 The work made use of the data sources shown in Table 4.

2.34 The analyses include all those journeys in the year 2017 for which we had complete data, which is around 816,000 journeys, ~95% of the total of 861,000 LST legs. Details of the analytical approach are summarised in Annex 4.

Table 4: Data sources for LST movement pattern analysis

Data	Source
Local Authority Boundaries	ESRI LA area shape file (Local_Authority_Districts_December_2017_Generalised_Clipped_Boundaries_in_Great_Britain)
UK Region Boundaries	ESRI NUTS Level 1 area shape file (NUTS_Level_1_January_2018_Full_Clipped_Boundaries_in_the_United_Kingdom)
LST start and end point data	Start and end locations (postcodes) in 2017 provided by operators through their Data Submission File returns (816,000 journeys with valid data)
LST Journey Information	Risk Solutions' LST modelled journeys from all start/end locations (postcodes) in 2017 with valid data
Road Network	Ordnance Survey (OS) MasterMap Integrated Transport Network (ITN) (Extracted Nov 2015)

Results: LST Activity by Local Authority

2.35 For each local authority we present data for the values shown in Table 5.

2.36 The data is presented in the form of heat maps generated using the open source Geographic Information System (QGIS) using the 'NATURAL' option to define the data bands. This approach uses the Jenks natural breaks clustering algorithm, in which bands are based on natural groupings inherent in the data. This approach was selected because it gives a mapping that more clearly shows differences between the areas; the reader must however carefully note the band sizes in the key.

2.37 The detailed data supporting the maps can be found presented in Table 22 in Annex 4.

Table 5: LST movement patterns: data fields presented

Data Field	Description
LST Stopping journeys (count)	Number of journeys involving a stop within the LA to e.g. deliver or collect cargo
LST Pass-through (Count)	LST Journeys passing through the LA without stopping
Estimated Savings	Estimated savings in terms of stops / pass-through journeys by 13.6m trailers saved by using LSTs to carry the same cargo (measured by deck % used)
LST Distance Operated	The total distance covered by LSTs in the LA, with a breakdown of the % on each road type
% TRUNK	SRN in England and the equivalents in the devolved nations
% PRINCIPAL	A-roads that are not TRUNK - managed by local authorities
% MINOR	B and other road classes

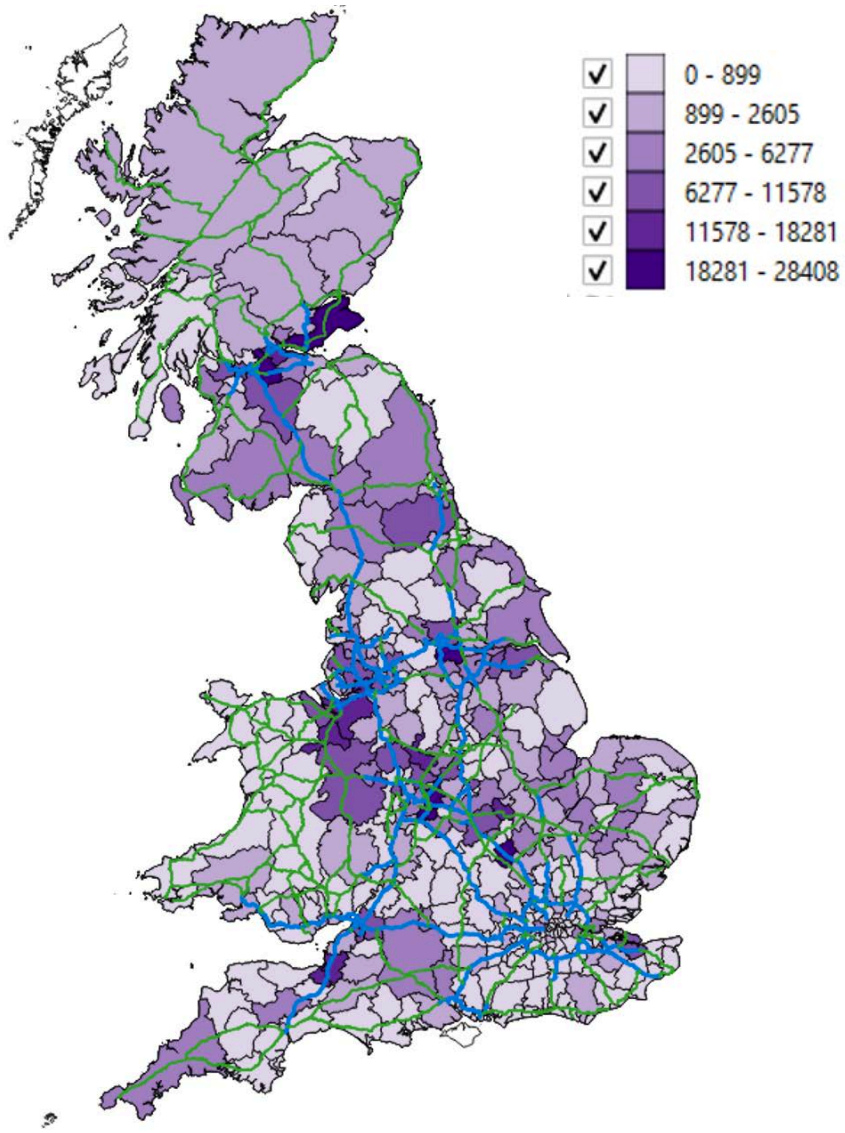
Note: the road class division used is that found in the DfT national traffic statistics (TRA table series). This clearly highlights the division between the Trunk roads (operated by Highways England and the equivalents in the devolved nations) and the Principal/Minor roads, managed by local authorities.

Results for Stopping journeys

2.38 The heat map for Stops (Figure 12) shows the operations in and out of the major logistics estates in the country (Midlands around Rugby, NW near Warrington, Glasgow/Edinburgh corridor etc.) and delivery out to major centres of population.

2.39 Adjusting for the 5% of legs that could not be mapped, **the lowest band represents 0-18 LSTs 'visits' a week, and the highest band 370-575 a week.**

Figure 12: LST Stops (2017) by LA [Scale: NATURAL] (source LST Trial data)

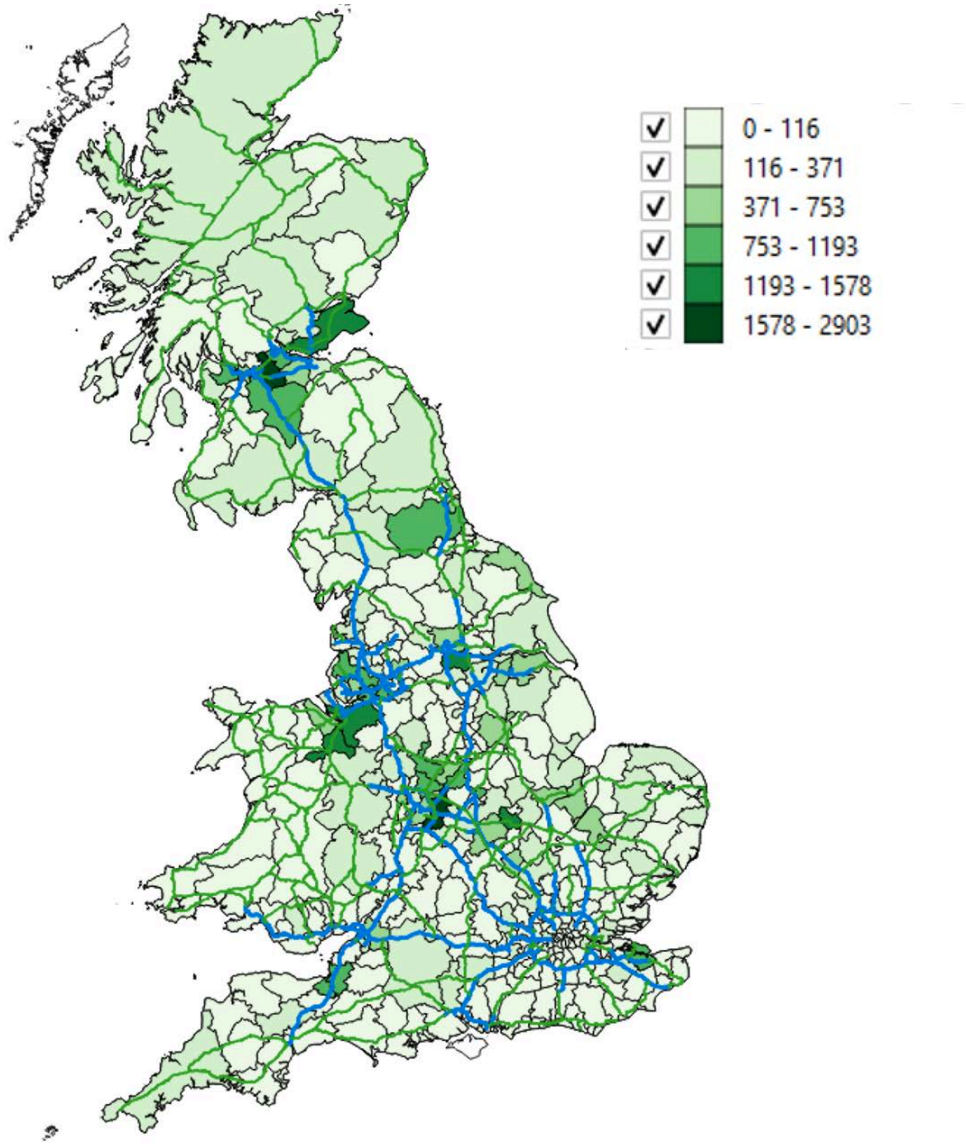


2.40 The heatmap for Stops saved (Figure 13) is derived from the now standard calculation used on the trial which converts the Deck% values into an estimate of the number of journeys saved in each local authority compared to delivering the same total deck space of goods using 13.6m trailers.

2.41 This therefore represents the number of large articulated HGV journeys starting/ending in each LA that were not needed because of the use of LSTs. (Note this does NOT include journeys passing through the LA – discussed later.)

2.42 Adjusting for the 5% unmapped legs, **the lowest band represents 0-2 standard articulated HGV visits saved per week by using LSTs instead of standard trailers, and the highest band 32-59 a week.**

Figure 13: Standard Trailer Stops Saved (2017) by LA [Scale: NATURAL] (source LST Trial data)



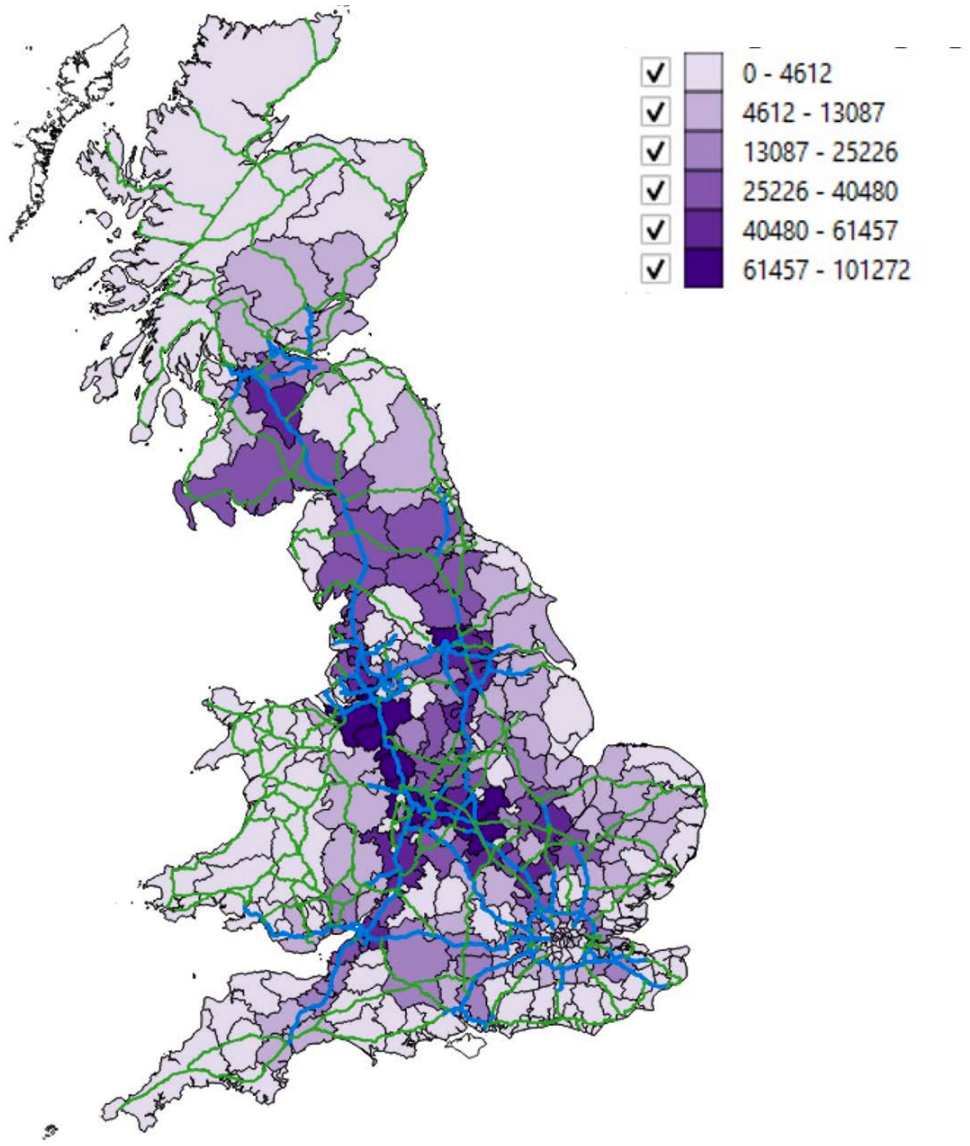
Results for Pass-through journeys

2.43 The heatmap for Pass-through journeys (Figure 14) shows the activity of LSTs passing through each LA, but not stopping to pick up or deliver goods.

2.44 Not surprisingly, this map is dominated by movements on the national road network and between the major centres of population.

2.45 Adjusting for the 5% unmapped legs, **the lowest band represents 0-93 LST Pass-Through journeys each week, and the highest band 1,244-2,050 a week.**

Figure 14: LST Pass-through Journeys (2017) by LA [Scale: NATURAL] (source LST Trial data)



2.46 What may be of more interest for any individual local authority, is the level of Pass-through activity that comes OFF the Trunk Network, but this is much more difficult to assess, since the routing model assumes that for the long-distance part of most journeys, the drivers are routed along the Trunk Network.

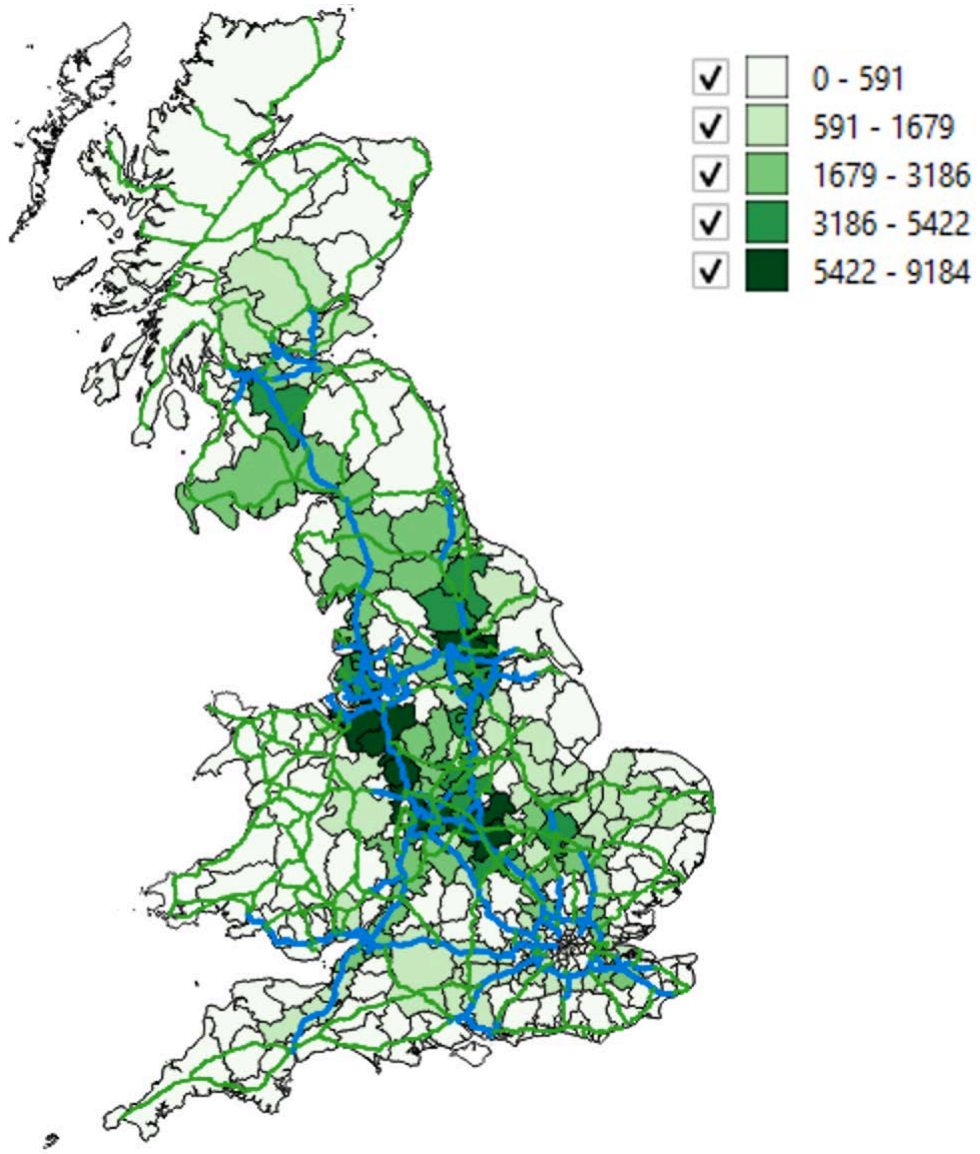
2.47 This preference for trunk routing reflects what operators tell us they choose and advise as a route for drivers, but it will not cover cases where the driver chooses their own route. This issue was discussed in the 2017 routing work and cannot be easily resolved

unless real-world GPS data was available for all trailers.

2.48 The heatmap for Pass-through journeys saved (Figure 15) is derived from the now standard calculation used on the trial which converts the Deck% values into an estimate of the number of through journeys saved in each local authority compared to delivering the same total deck space of goods using 13.6m trailers.

2.49 Adjusting for the 5% unmapped legs, **the lowest band represents 0-12 Standard trailer Pass-Through journeys saved each week, and the highest band 110-186 a week.**

Figure 15: Standard Trailer Pass-through Journeys Saved (2017) by LA [Scale NATURAL] (source LST Trial data)



Results: LST activity within and between regions

2.50 The UK uses the international Nomenclature of Territorial Units for Statistics (NUTS) codes for all national economic analysis. NUTS has three levels of detail, the largest scale being NUTS1 areas as shown in Figure 16.

Figure 16: UK NUTS1 Regions

2.51 NUTS1 regions are used by the DfT for their national statistics of movements of goods based on the CSRGT data. We analysed the 2017 LST data using the same regions.

2.52 The results, based on only fully valid records, are shown as regional matrices with the starting location in the rows and destinations in the columns, in Annex 4 for:

- Journeys between regions in 2017
- Journeys between regions **saved** in 2017
- Tonnes lifted between regions in 2017.
- Note: this analysis is of the 816,000 'Valid' data records and so slightly underestimates the overall figures for the year, but as the intention is simply to show pattern, we have not adjusted them.

2.53 The detailed matrices can be collapsed to show a summary of the movements **IN** region, to an **ADJ**acent region and **FAR**ther afield, as show in Table 6. While the table does show the extensive use of the LSTs for region to region movements, it also highlights the substantial in-region LST activity indicating more localised usage, even allowing for the variation in region sizes.

Table 6: Regional flows: localisation (source LST Trial data)

Region	No. Journeys IN region	No. Journeys to ADJacent region	No. Journeys FARther afield	Journeys IN region saved	Journeys to ADJacent region saved	FARther afield Journeys saved	Tonnes Lifted Journeys IN region	Tonnes Lifted to ADJacent region	Tonnes Lifted FARther Afield
UKC North East*	**12%**	40%	48%	**6%**	39%	55%	**7%**	44%	50%
UKD North West*	**54%**	42%	4%	**49%**	46%	4%	**47%**	48%	5%
UKE Yorkshire & The Humber	**49%**	32%	19%	**36%**	42%	23%	**34%**	43%	24%
UKF East Midlands*	**28%**	51%	21%	**24%**	53%	23%	**25%**	51%	24%
UKG West Midlands*	**40%**	44%	16%	**49%**	35%	16%	**36%**	45%	18%
UKH East of England	**40%**	32%	27%	**48%**	21%	31%	**31%**	31%	37%
UKI London	**10%**	33%	57%	**1%**	12%	88%	**9%**	14%	77%
UKJ South East*	**53%**	43%	4%	**49%**	46%	5%	**40%**	53%	7%
UKK South West*	**46%**	33%	20%	**37%**	41%	21%	**35%**	40%	24%
UKL Wales	**41%**	48%	11%	**49%**	37%	14%	**33%**	50%	17%
UKM Scotland	**83%**	8%	10%	**82%**	7%	11%	**78%**	9%	13%

* Region of England (Regions are the highest tier of sub-national division in England)

3 TRIAL OUTPUTS: DISTANCE AND JOURNEYS SAVED

3.1 **The analysis of potential savings in journeys and distance travelled being realised in real operations is central to the trial, as this is what drives potential societal benefits in terms of safety gains and emissions savings.** Beyond the trial, these savings are also what would determine the economic case for operators adopting LSTs.

Methods and source of data

3.2 The fundamental measurement in the analysis of how efficiently the LSTs are operating is whether the additional length is being used, based on the declared 'Deck%' data reported by operators in their data submissions. The deck% data is adjusted to reflect the individual trailer length when calculating potential savings from using LSTs.

3.3 The distance and journey savings calculation process is described in detail in our previous Annual Reports (specifically, the 2014 report, Annex E). The distance saving is estimated by comparing the actual distance travelled by the LSTs to an estimate of the distance that would have been travelled if the same quantity of goods (measured by the Deck% utilised) had been transported on standard 13.6m trailers making more journeys. Savings are 'claimed' only for legs where some/all of the extra trailer length is used.

3.4 As in previous years, we have estimated two values for the savings:

- The upper estimate takes account of some empty return journeys also being saved due to saving of whole round trips – loaded out and empty returns – but only where we have data to match the empty returns to the loaded leg data.
- The lower figure considers only loaded legs and is a more conservative estimate.
- Prior to 2018, the matching was performed by checking the sequencing of start-end locations of individual legs in the journey log. From 2018 onward, the matching is done using those legs where all legs of the same combination of Leg Type, MOA and Goods Type are either 100% full or entirely empty, usually accompanied by narrative of "full out/ empty back" or similar. This is an underestimate as no empty running returns for part-loaded legs that use the longer length are taken into account, but with the new data format these would be difficult to estimate and are a small part of the data

3.5 Although we continue to cite both the upper and lower estimates, we have reviewed the process for detecting 'empty-returns' related to loaded legs and our view is that the inclusion of these savings is justified and may still be a slight underestimate of the true figure. **On this basis, later modelling (emissions etc.) uses the upper estimate data, including empty return legs as the more realistic of the two.**

3.6 To help validate the findings on savings, we asked operators to consider whether our estimates of their savings from use of the longer trailers agreed with their own experiences and expectations. This work, reported in the 2016 Annual Report and continued through the operator conversations reported here (see Section 7 and Annex 5) has confirmed that in calculating savings in this way, we do not appear to be over-estimating the savings compared to the operator's own experience or analysis.

Distance/journey savings results: trial to date

3.7 Table 7 shows the cumulative vehicle kilometres saved during the trial.

3.8 Since the start of the trial, **the use of LSTs has removed between 41 and 46 million vehicle kilometres of freight traffic from the roads of Great Britain.**

Table 7: Cumulative vehicle km saved by using LSTs (source LST Trial data)

Distance saved (million vehicle km)	At end 2018	At end 2017	At end 2016	At end 2015	At end 2014	At end 2013
Loaded Legs Only	41.1	29.3	20.9	12.3	6.0	2.1
Loaded Legs plus 'matched' empty return legs	45.8	32.9	23.5	14.2	7.1	2.4

Journeys saved – trial to date

3.9 The vehicle kilometres saved shown in the tables above can be converted into a simple estimate of the number of journeys saved by dividing by the 125km average leg length recorded by vehicles in the trial and rounding the results (Table 3, page 17)

3.10 On this basis, **we estimate that 330,000 to 365,000 journeys were removed from GB roads as a result of the trial to the end of 2018** (Rounded figures).

Proportion of distance and journeys saved by using LSTs – trial to date

3.11 The analysis above calculates total distance savings. We also analyse savings as a percentage of distance operated and from this calculate an expression of the number of journeys saved compared with using standard length trailers to deliver the same goods.

3.12 Expressing the results in this form is, we have found, useful in articulating the benefit gained from operating LSTs to a wider audience.

3.13 Over the whole fleet and across the trial we estimate that the average percentage distance saving by operators is 7.5%, which equates to 1 in 13 journeys.

3.14 We arrive at this figure by dividing the distance saved from Table 7 by the total distance travelled by LSTs from Table 3. The lower and upper estimates give 7% and 8% respectively, so an average of 7.5% has been quoted.

3.15 Behind this average figure there are considerable differences in efficiency of operation and levels of loading across the range of operators taking part in the trial, so we also look at the savings for each operator.

Distance/journey savings results by operator – 2018 results

3.16 Figure 17 shows the distribution of percentage distance savings by operators participating in the trial for 2018 only.

3.17 Figure 18, shows the same data, but weighted to show the number of *trailers* owned by the operators in each savings group.

3.18 Note that the mean of the savings values for each operator are not quite the same as the mean across the whole trial, and the chart differs from the equivalent in past reports, as

- the data in the Figure are for 2018 only – the change in data gathering format making a cumulative calculation with pre 2018 data, problematic
- the basis of the calculation for 2018 is slightly different than for previous years due to differences in the data template and the approach to identifying empty return legs

3.19 Further details of the revised utilisation calculation, based on the new 2018 format data, can be found in Annex 3.

Figure 17: Distribution of % distance saved using LSTs with and without return empty savings (2018) – COUNT OF OPERATORS (source LST Trial data)

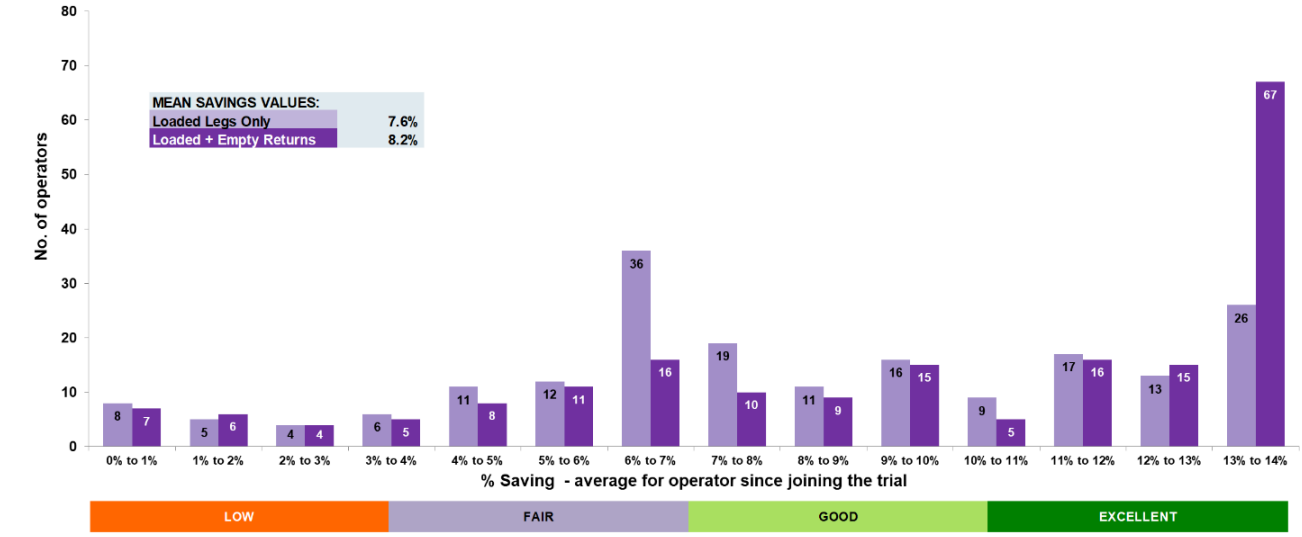


Figure 18: Distribution of % distance saved with and without return empty savings included (2018) – COUNT OF TRAILERS IN OPERATOR FLEET (source LST Trial data)

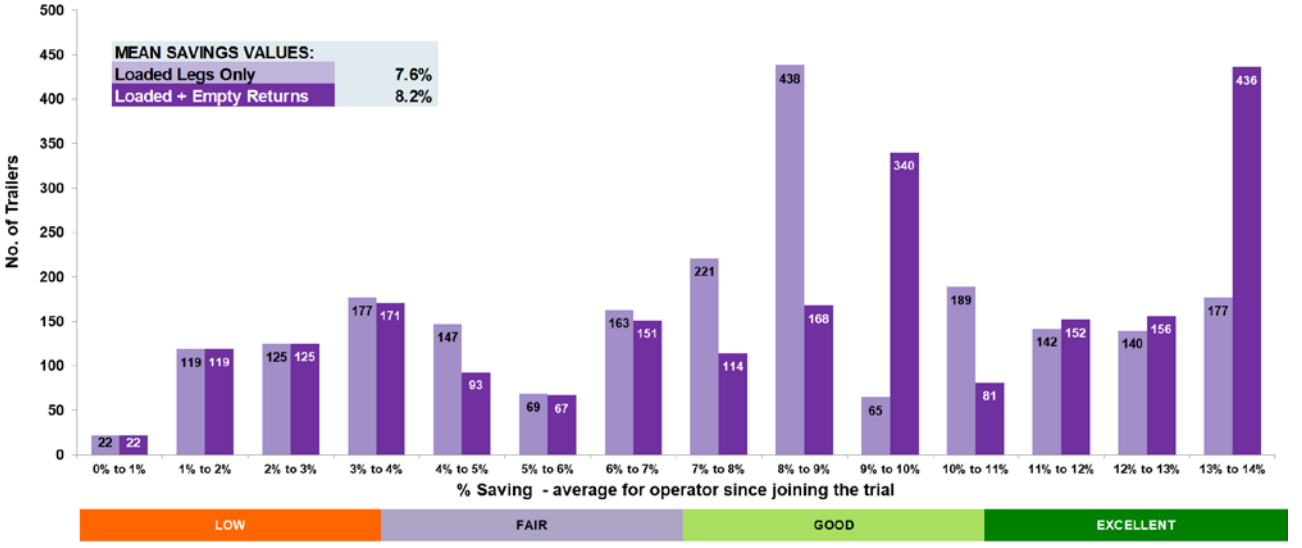


Figure 19: 2018 Savings bands by operator (source LST Trial data)

LST savings performance summary by operator (2018)	Lowest Savings Group (0-5% Saving)	Average Savings Group (>5-10% Saving)	Highest Savings Group (>10-14% Saving)
% of operators	16%	31%	53%
% of trailers	24%	38%	38%

Notes: Based on the savings % for each operator INCLUDING any matched empty return legs. % of trailers based on the number of trailers registered to the operators falling into each savings group

3.20 In Figure 19 we identify three savings groups:

- ***Highest savings group:*** **More than 50% of operators are making savings of over 10% from using LSTs**. If we consider the top 5% of savings bands (the "Excellent" segment) as being the operation of trailers at or near their maximum efficiency, then there are 103 operators on the trial operating 825 trailers, at this level of performance. This accounts for over 50% of the operators on the trial, and almost 40% of all the trailers.
- ***Lowest savings group:*** **About 16% of operators are making savings of less than 5% from using LSTs**. At the other end of the chart, in the lowest 5% of savings bands, we find a group of 30 operators (15%), operating 530 trailers (24%). These operators would appear to be making little or no quantifiable benefit from using the LSTs. Indeed, once the additional capital cost of trailers and any fuel use penalty (estimated before the trial at 1.8%) – some of these operators may have a net disbenefit from running their LSTs.

  That said, we are aware that some of the operators in this group have had disruptions in their contracts which have meant they have not seen the benefits they originally planned from using LSTs or they find less easily quantified benefits from having their LSTs available. Overall, outside of trial conditions and with a more active open market for LSTs, we would question whether these operators would have held on to their trailers.
- ***Average savings group:*** **About a third of operators are making savings of 5-10% from using LSTs**. It is also notable some of the largest fleets on the trial are operating within the 7-9% efficiency range according to our calculations (see Figure 18), reflecting the highly variable demand for cargo movement in their business. In both cases, a large portion of their business is moving retail goods either from national to regional depots or onward to larger retail stores. In both cases, there is an inherent 'retail' flow effect, where goods are predominantly being moved 'one way' and the fill level of vehicles is substantially dependent on a demand led supply chain working on fairly short turn-around times.

3.21 In Figure 18, the uneven distribution of trailers across the intervals can be explained by the distribution of larger and smaller fleets amongst the operators within the trial. There are a small number of larger fleets operating within the 3-4% and 4-5% efficiency ranges, with many journeys being operated without, apparently, using the extra length

3.22 A more detailed study of the operators appearing at the lower half of the range of savings (not just the 0-5%) shows that there are possibly two groups:

- **Operators with complex operational patterns**: where the operation involves large numbers of 'out-full/back-empty' movements but we have not been able to include these in our upper savings calculation as they are part of more complex operational patterns and are not picked up by the algorithm. A more refined analysis of the operational patterns of operators could allow the upper estimate calculation to be applied to these operators.
- **Operators unable to operate the trailers efficiently in some periods**: operators who do not appear to be making use of the additional length of their LSTs often had periods of efficient operation, with gaps in between where the trailer was not used at all, or were being used with low loading levels. Where we have spoken to operators this has commonly been due to loss of a contract for which the LST were originally purchased (and on which they were used efficiently), with a period of time passing before another contract could be found on which the additional trailer length could be used effectively

4 TRIAL OUTCOMES: EMISSIONS SAVED

4.1 **The possibility of reducing the emissions contribution from large HGVs by replacing them with LSTs was a primary focus of the LST trial.**

4.2 In this section we report the updated results of the 2017 emissions modelling, carried out to estimate the potential emissions savings from using LSTs in place of standard length trailers when carrying the same cargo over the same duty cycle, particularly in terms of carbon dioxide (CO_2e) and oxides of nitrogen (NOx), important environmental pollutants.

Note on methods and sources of data

4.3 The estimate of emissions is based on modelling described in the 2017 Annual Report (AR2017, Chapter 6), and described in full in Project Note E2: LST Emissions Savings. That work showed the individual results for emissions by road class and proximity to areas of special interest.

4.4 The modelling estimated emissions based on the real LST designs that have been adopted and the actual duty cycles recorded in the trial data during 2017, for which we have the greatest detail in terms of locations and modelled routes for the LSTs.

4.5 The modelling results are shown in Table 8 (reproduced from last year's annual report, with an update to the format of the final factors in the bottom two rows.)

Table 8: LST Emissions savings factors (2017 data - uncongested flow and Euro V)

2017 [tonnes emissions]	CO	CO2e	NOx	PM Exhaust	VOC
LST	49.8	81,278	412	4.44	9.60
Non-LST	53.7	87,772	445	4.79	10.35
Emission Saving	**3.9**	**6,494**	**32.6**	**0.38**	**0.744**
% Emission Saving	*7.2%*	*7.4%*	*7.3%*	*7.3%*	*7.2%*
*Emission saving **kg** per million LST km TRAVELLED*	***38***	***63,565***	***319***	***3.4***	***7.3***
*Emission saving **kg** per million LST km SAVED*	***459***	***774,030***	***3,882***	***41***	***89***

*Notes: This is based on the routing and emissions modelling dataset only, not whole trial to date. The key values are: **LST km travelled** 102,163,128 / **Non-LST km to move same cargo** 110,552,411 and hence **non-LST km saved** 8,389,284. Figures above are rounded.*

The reason for citing two options for the emission factor is a matter of timing. When the emissions work was originally completed in 2017, the first factor (per km TRAVELLED) was used in the modelling of emissions by various geographical regions. In developing a model for scaling the trial results up to a national projection - work being carried out in parallel with the drafting of this report, the second factor - by km SAVED was required)

4.6 The 2017 sample year savings factors were used to estimate:

- Emissions savings in previous years and in 2018, based on the number of trailers and distances covered recorded by the trial – to give results up to the end of 2018.
- Projections of emissions savings into the future based on a range of fleet growth scenarios – the fleet projections used are presented in Annex 6.

4.7 Two types of results have been produced:

1. Total savings as a percentage of the emissions that would be produced if the same goods were carried in standard length trailers
2. Total emissions savings for the trial in tonnes:
   a. Actual savings to end 2018
   b. Projected savings to end 2021 – the original 10-year trial period
   c. Projected savings to end 2026 – the notional end of the 2017 trial extension.

4.8 The modelling makes two key assumptions:

- We have assumed vehicles are travelling at speeds consistent with uncongested flow. This is because, for the specific purpose of this modelling, it is the prudent choice. The absolute emissions impact for a vehicle is higher in congested traffic, but here we are interested in the comparison between the emissions from an operation running LSTs and one moving the same goods using 13.6m trailers.
- This approach assumes that previous and future years have operational patterns that are not grossly different to 2017. Risk Solutions' wider analysis of the trial data provides assurance that this is a reasonable assumption, based on the fact that key indicators such as the average journey leg length, loading percentages and calculated savings have been relatively stable for all years, at least once the first 1-2 trial data periods were completed.

4.9 The results are currently modelled assuming EURO V engines across the fleet, to provide results that are comparable to the pre-trial impact assessment, where the same assumption was made.

4.10 Note that a re-analysis of the emissions savings on the trial would now be possible, incorporating updated estimates of LST marginal weights – discussed later in this report – and to explore the impact of the introduction of EURO VI engines to some fleets in the later years of the trial. These options are discussed in Section 8, but for now, the results using the existing factors have been updated to incorporate the 2018 LST operations.

Emissions savings results

4.11 The final two rows of Table 8 gives the emissions savings expressed as a single factor in kg (of emissions) per million LST km TRAVELLED and an alternative factor of kg (of emissions) per million LST km SAVED, calculated from the 2017 data.

4.12 The total emissions at the three key time points in the trial described above, are shown in Table 9. They are derived by applying the factors above, pro-rata, to the total LST distances covered in each year from the total fleet distance curve in Annex 6.

4.13 On this basis we estimate **a total saving to date in CO2e of 37,000 tonnes and NOx of 187 tonnes, since the start of the trial**. (Rounded figures)

4.14 The projected savings to the end of the original 10 year or extended 15 year trial are not quite a simple pro-rata uplift of the projection made last year, as we have downgraded the estimate of 'new LSTs on the road in each new period' from 114 to 85, reflecting the actual experience during 2018 and the early indications in 2019. On the other hand, the average leg length has increased slightly.

4.15 **On this basis, the projected saving in CO2e if the trial were to run to 10 years (2021) or 15 years (2026) are around 70,000 tonnes and 130,000 tonnes respectively. The figures for NOx are 350 and 645 tonnes respectively.** (Rounded figures)

4.16 Estimates for other air quality emissions are noted in the table.

Table 9: Total LST trial emission savings projection

FLEET SCENARIO: EURO V, S2: WHOLE FLEET TO 15 Year

Assumed addition rate - trailers per future trial period: **85**

Resulting projection - period at which all 2,800 trial LSTs on road: **2021-P2**

(All figures are rounded)

A. TRIAL OPERATIONS

Trial operational parameter	Unit	To Date End 2018 (actual)	10 year Trial end 2021	Extended Trial end 2026
LSTs on road	number	2,194	**2,800**	2,800
Total journey	millions	4.7	**8.6**	15.6
Total distance covered	million kms	587	**1,098**	2,017

B. EMISSIONS SAVINGS

Emission	Unit: tonnes	To Date End 2018 (actual)	10 year Trial end 2021	Extended Trial end 2026
Carbon Monoxide	CO	22	**41**	76
Carbon Dioxide equivalent	CO2e	37,333	**69,786**	128,190
Oxides of Nitrogen	NOx	187	**350**	643
Particulate Matter (Exhaust)	PM Exhaust	2.0	**3.7**	6.9
Volatile Organic Compounds	VOC	4.3	**8.0**	14.7

Note: “Carbon dioxide equivalent” or “CO2e” is a term for describing different greenhouse gases in a common unit. For any quantity and type of greenhouse gas, CO2e signifies the amount of CO2 with an equivalent global warming impact. Figure here are based on EURO V Engine emissions data to provide a direct comparison to the pre-trial emissions projections. Emissions modelling for LSTs looking at future years will need to account for migration to EURO VI engines.

5 TRIAL OUTCOMES: SAFETY IMPACT

5.1 The analysis of personal injury incidents is vital to establish whether there are any indications that LST operations are increasing safety risk (relative to traditional trailers), particularly to other road users and vulnerable groups.

5.2 The primary focus of incident data analysis throughout the trial is to assess whether there is any emerging evidence about the relative safety risk performance of LST operations compared with standard length trailers.

5.3 The low incidence of road traffic collisions involving LSTs on the public highway (both anticipated and actual) is one of the reasons the DfT planned that the trial would need to collect data for an extended period. This is necessary to allow analysis of trends or contributory factors to risk in a statistically meaningful way, to inform policy decisions

5.4 Most of this section of the report deals with the quantitative and qualitative analysis of the incidents that have been reported on the trial and the comparison to the equivalent rate of injury incidents in the national fleet of semi-trailers. However, before addressing those questions, we first need to note the inherent positive effect on safety of taking fewer HGV trips by operating LSTs.

LST Safety Outcomes 1: Benefits from saved journeys

5.5 As described in Section 3, the additional capacity of the LSTs has been calculated to have travelled 587 million vehicle kilometres and have removed between 41.1 and 45.8 million vehicle kilometres from GB roads.

5.6 These vehicle kilometres would have otherwise been operated by the standard length HGV articulated fleet. It is therefore reasonable to calculate the additional incidents and casualties that would have been expected to occur if the trial had not taken place, by considering how many incidents and casualties the standard length fleet would have incurred over those additional vehicle kilometres.

5.7 This saving is independent of any difference in the actual incident rate per km of LSTs vs standard trailers, addressed in the next report section.

5.8 The results in Table 10 show that **the elimination of large HGV trips by the operation of the relatively small fleet of LSTs on the trial to date may have eliminated 6-7 injury collisions with a reduction of 9-10 casualties**.

Table 10: Collisions and casualties removed from GB roads over the trial period 2012-2018 through reduction in vkm operated

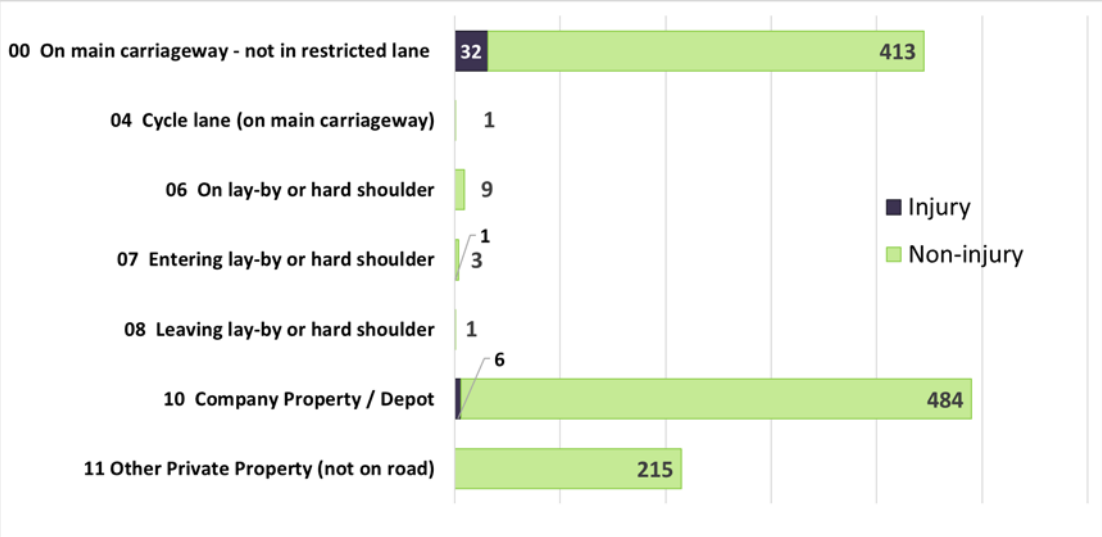
Injury incidents Public access locations	GB Artic HGV rate 2012-2017 per million vehicle km	Million vehicle km removed from operation	Calculated incident reduction
Collisions	**0.151**	**41.1 to 45.8**	**6.2 to 6.9**
Casualties	**0.216**	**41.1 to 45.8**	**8.9 to 9.9**

Sources: LST utilisation and vehicle km reduction from trial data. GB Arctic rate from STATS19 and TRA3105 2012-2017.

LST Safety Outcomes 2: Incidents involving LSTs

5.9 There have been 39 injury incidents involving an LST reported of which 33 took place on the public highway. Figure 20 provides a summary of these incidents involving LSTs, by the road location reported by the operators.

Figure 20: Incidents reported involving LSTs (Summary to end 2018 – source LST trial data)



Note: The injury events are marked in dark purple. There were 32 on main carriageways + 6 events on private land, there is then 1 further injury in category 07 – Entering or leaving a layby or hard shoulder which has been counted as occurring on the public highway.

5.10 A detailed analysis of the incident data and resulting casualty figures is reported in this section, along with a review of the circumstances of each injury incident (Table 12).

Note on analysis methods and terms

5.11 As in past reports, we analyse the safety impact of the LSTs in the trial by:

- Estimating the absolute saving in injuries arising from the reduction in journeys
- Comparing the per km incident and casualty rates for LSTs with that published for the GB fleet of articulated HGVs as a whole. We analyse the incident rates nationally and then also for 'urban operations' and by road type.

5.12 In calculating the road type urban/rural and motorway/major/minor splits, we have assumed that the 2017 vkm percentage splits from the detailed route analysis carried out for the 2017 annual report apply in 2018.

5.13 We present the data on injuries that occurred in all locations, whether on the road or on private land (depots etc.). However, the primary analysis focuses on incidents which took place on the public highway or in areas with public access, such as service stations.

5.14 We also review the LST injury incidents qualitatively. We examine not only the narrative given by the operator in their submission file, but in many cases, we ask for further information or documents from the operator to ensure we understand the circumstances of the incident. We use this to form a view on the degree to which the incident may have been related to the trailer being an LST. However, this judgement is purely used for discussion – events that may not have been related to the presence of an LST are still included in all the primary analysis and statistical significance checks.

Injury incident and casualty numbers

5.15 Above we noted that there have been 39 injury incidents involving LSTs since the trial began. Table 11 expands on this to show the casualties associated with these events, classified by injury severity, the nature of the location, and whether the event was judged to be LST-related - a judgement discussed later in this section. (Note: An incident is marked as LST-related if it is judged that the incident occurred, or might have occurred, because the trailer was an LST and would not or might not have occurred had the trailer been a standard length.)

Table 11: Casualties from incidents involving LSTs reported to the trial: 2012-18

Injury Collisions from Trial Logs	Total Collisions	Total Casualties	Fatal	Serious	Slight
All Injuries (including depots etc.)	**39 (27)**	**49 (36)**	0 (0)	11 (10)	38 (26)
All Injuries in Public Road/Place	**33 (22)**	**43 (31)**	0 (0)	10 (10)	33 (21)
All Injuries judged LST-related (any location)	**9 (7)**	**9 (7)**	0 (0)	1 (0)	8 (7)
All injuries – LST-related AND in public place	**4 (3)**	**4 (3)**	0 (0)	0 (0)	4 (3)

Figures in (brackets) show the totals at the end of 2017. The injury incident analysis in this report is based on all public incidents, i.e. the figures in the second row of data (outlined in the dashed red box).

5.16 From this table and the data that underpins it, we can note the following findings:

- **There were no fatal accidents involving LSTs in 587 million km of operation by the end of 2018.**
- **Since the last annual report, there have been 11 additional personal injury incidents involving LSTs in public locations, resulting in 12 slight injuries. One of these may have been LST related. There has also been 1 serious injury incident in a depot.**

Fatal incidents in 2019

5.17 There have been two incidents in 2019. While these do not fall in the reporting period of this document and do not appear in the results presented here, we have consulted with the Department for Transport who have provided this statement.

"In May 2019, there was a fatal accident involving a longer semi-trailer resulting in the death of the lorry driver. Investigation by the DVSA found that this incident was unrelated to the condition or extra length of the longer semi-trailer.

There was a second fatality in August 2019 which resulted in the death of a cyclist. With the evidence the Department currently possesses, it is not believed that this was related to the longer length of the trailer.

The department will continue to check if there are issues related to either incident which require further consideration in the context of the trial."

All injury incidents in public locations - discussion

5.18 The personal injury incidents in public locations are summarised in Table 12. Note that:

- Locations are identified the operator and checked manually using Google Maps.
  - Casualty severity is determined by the operator, based on the STATS19 (police data) injury classes but are reviewed by Risk Solutions and, on occasion, adjusted based on further information provided by the operator.
- Whether the incident is LST-related or not is a judgement made initially by the operator. Where appropriate, we have reviewed specific event records with the operator and adjusted the original classifications upwards i.e. classified an incident as LST-related where the operator had formerly identified it as not LST-related. No incidents have yet been reclassified 'down' to be not-LST related.
- The incident summary shown here is a simplified and cleansed version of events designed to convey the main points without identifying the operator.
- In around 70% of cases, for events up to the end of 2017, the STATS19 record for the same event can be identified from the event details the year after it occurs, allowing us to further inform our understanding of the events and to compare incident locations to the STATS19 location data.
- The national STATS19 data for 2018 had not been published by the DfT at the time the incident analysis was performed and so our formal process of matching the LST injury events to STATS19 incidents was not completed. Note: A shortened form of this matching has been carried out during the writing of this report and for the seven LST injury events in 2018 where the police attended, we can see probable matches in STATS19 for five of them.

5.19 **All statistical analysis is based on all events listed in the table above, whether or not they are judged to be LST-related**. This is a prudent approach adopted because whether an incident would have occurred at all, or whether it would have developed in the same way if the trailer had not been an LST, is a matter of judgment. For example:

- In incidents 3,4,6,13 and 16 - a **3rd party vehicle ran into the back of the trailer** due to poor judgement by the 3rd party driver. The LST length is probably not relevant and the incident would almost certainly have happened with a 13.6m trailer.
- In incidents 11,12,14,15, 18, 20, 21, 24, 26, 29 and 31 where the **LST driver ran into the rear of another vehicle**, usually in slow moving traffic, the operators see no effect from the trailer length. Operators, so far, have not reported any issues with braking or slowing instability when pulling LSTs compared to other trailers.
- In incidents 7,9,10, 17, 19, 22, 23, 25, 28, 30 and 32 the **cause was driver fatigue / error / loss of concentration**, which would not be related to trailer length, unless it is argued that the trailers might be less stable when the driver makes a sudden steering or braking adjustment as a result of the lapse. Operators have not, so far, reported any increased braking instability related to LSTs compared to other trailers. The only incident where it might have been raised as an issue was [32], but in that event the driver was not braking heavily at speed, but was on a roundabout and misjudged his turn, locked up the trailer brakes, resulting in a trailer sideways slide. The slide may not have been materially different with a fixed tri-axle13/6m trailer, but we have prudently marked the event as 'Maybe LST Related'.
- In general, if the LST was manoeuvring and the impact is with the rear corner of the trailer, the default assumption has been to classify it as LST-related.

Table 12: Description of all reported LST injury incidents in public locations (source LST Trial logs)

The allocation to fatal, serious or slight injury is based on STATS19 police category definitions

[Incident No.] and Year	Road type & urban or rural	No. of Fatalities	No. of Serious injuries	No. of Slight Injuries	Incident summary including the judgement of whether the incident was LST-related or not
[1] 2012	Minor (urban)	**0**	**0**	**1**	LST driver turning left on mini-roundabout. A taxi entered the roundabout during the LST manoeuvre and struck the trailer. Taxi driver slight injury. **Not LST-related.**
[2] 2012	Trunk (rural)	**0**	**0**	**1**	Early in the trial, LST being delivered from manufacturer to VCA for testing, before delivery to operator. Agency driver misjudged roundabout at motorway junction and overturned trailer. Driver slightly injured - no other vehicles involved. Agency drivers generally not used on the trial. **Maybe LST-related.**
[3] 2013	Motorway	**0**	**1**	**0**	LST slowing down on motorway. Driver behind failed to brake and hit back of trailer and was injured. **Not LST-related.**
[4] 2014	Trunk (rural)	**0**	**0**	**1**	LST travelling on rural section of A-Road at night. Another road user ran into rear of the LST at high speed and was injured. **Not LST-related.**
[5] 2014	Motorway	**0**	**1**	**0**	LST encountered previous incident on motorway that had resulted in a jack-knifed vehicle partially blocking lane 1. It was night, motorway section unlit and damaged vehicle was unlit. LST driver was unable to avoid hitting it and was injured. **Not LST-related.**
[6] 2014	Motorway	**0**	**1**	**0**	LST travelling in lane 1 of motorway at night. Car driver approached from behind and hit the trailer. Car driver injured. **Not LST-related.**
[7] 2014	Trunk (rural)	**0**	**0**	**1**	LST travelling on rural section of A-Road when he lost control - vehicle left the road and overturned, injuring the driver. No other vehicles involved. Investigation attributed event to driver fatigue resulting from stress factors outside work. **Not LST-related.**
[8] 2015	Minor (urban)	**0**	**0**	**1**	LST on driver assessment route making a turning manoeuvre in an urban location reported to have hit a pedestrian with the tail end of the trailer. Police did not attend scene but gathered information from pedestrian report and interviews with operator involved. The route is no longer used for driver assessment. **LST-related (see discussion in 2015 Annual Report page 27 para 5.12-5.18)**
[9] 2015	Motorway	**0**	**0**	**1**	LST travelling on motorway in middle of the day. Vehicle left the road on nearside but did not overturn. No other vehicle involved. Investigation attributed event to driver fatigue. **Not LST-related.**

[Incident No.] and Year	Road type & urban or rural	No. of Fatalities	No. of Serious injuries	No. of Slight Injuries	Incident summary including the judgement of whether the incident was LST-related or not
[10] 2015	Motorway	**0**	**0**	**1**	LST travelling on motorway mid-morning. Vehicle left the road on offside and overturned. No other vehicle involved. Investigation attributed event to driver fatigue. **Not LST-related.**
[11] 2015	Motorway	**0**	**1**	**5**	LST travelling on motorway in middle of the day. Traffic congestion resulted in a stationary queue. LST driver failed to react quickly enough and collided with the rear stationary vehicle. There were 1 serious and 5 slight injuries. **Not LST-related.**
[12] 2016	Principal (urban)	**0**	**1**	**0**	Driver hit cyclist from behind when moving from slip road to dual carriage way. **Not LST-related.**
[13] 2016	Motorway	**0**	**0**	**1**	LST travelling on inside lane of motorway when a third-party vehicle crossed from outside lane and hit rear offside of the trailer at speed. **Not LST-related.**
[14] 2016	Motorway	**0**	**0**	**1**	LST travelling on motorway, collided with rear of another vehicle which then ran into a second vehicle. **Not LST-related.**
[15] 2016	Motorway	**0**	**1**	**0**	LST following another HGV in roadworks on motorway. The HGV made an emergency stop to avoid another vehicle swerving across the lanes. LST unable to stop in time and collided with rear of HGV. **Not LST-related.**
[16] 2016	Motorway	**0**	**1**	**0**	3rd party vehicle collided with rear of LST on motorway. Near side right under-run bar snapped. **Not LST-related.**
[17] 2016	Motorway	**0**	**0**	**1**	LST travelling on inside lane of motorway, drifted onto rumble strip and just over hard shoulder line. Driver observed a vehicle parked in hard shoulder. Steered to right to avoid the vehicle, but rear of trailer hit offside of parked vehicle. Although the role of the steering axle in this event is not clear, we have treated it as **LST-related (see discussion in 2016 Annual Report, page 40, para 6.24 onwards)**

[Incident No.] and Year	Road type & urban or rural	No. of Fatalities	No. of Serious injuries	No. of Slight Injuries	Incident summary including the judgement of whether the incident was LST-related or not
[18] 2016	Motorway	**0**	**0**	**1**	LST travelling on motorway, driver did not react in time to changing road conditions and collided with rear of another vehicle. **Not LST-related.**
[19] 2017	Principal (rural)	**0**	**1**	**0**	LST travelling on A road, approaching split with another major A road, skidded and hit central reservation. Investigation recorded that driver lost control of his vehicle (cause unknown). Nothing indicating trailer design contributed. **Not LST-related.**
[20] 2017	Trunk (rural)	**0**	**1**	**4**	LST travelling on major A road, collided with rear of one vehicle and then a side impact (tractor unit and then trailer) with a second vehicle. Full company investigation report provided to the DfT/Risk Solutions. Conclusion was driver error (following too closely) but nothing to indicate trailer design was a contributory factor. **Not LST-related.**
[21] 2017	Motorway	**0**	**1**	**0**	LST travelling on motorway, collided with rear of two HGVs that had been involved in a previous accident and had not cleared their vehicles from Lane 1. Detailed report and photos from Operator suggest simple driver inattention. Judged to be **Not LST-related.**
[22] 2017	Trunk (rural)	**0**	**0**	**1**	LST travelling on major dual A road at night. Driver reported that he swerved to avoid an animal possibly a deer and lost control. Contact was made with the LH and RH barriers causing the vehicle to land on its side, causing extensive damage to the trailer. No other vehicles involved. **Not LST-related.**
[23] 2018	Motorway	**0**	**0**	**1**	LST travelling on motorway, infringed soft verge at left hand edge of inside lane. Driver steered away to the right but lost control and collided with central reservation. Trailer overturned, and ruptured fuel system caused a fire that engulfed tractor and trailer. **Not LST-related.**
[24] 2018	Motorway	**0**	**0**	**1**	LST travelling on motorway, did not see slower moving third party vehicle ahead when changing lanes to the left. Skidded and collided with rear of the vehicle, spinning it into the path of a third vehicle. **Not LST-related.**
[25] 2018	Trunk (rural)	**0**	**0**	**1**	LST travelling on major A road, approaching slight right-hand bend when nearside front wheel infringed soft verge. Lost control of vehicle, which overturned onto its left-hand side and slid off the road down an embankment. **Not LST-related.**
[26] 2018	Motorway	**0**	**0**	**1**	LST travelling on motorway, changed lanes to overtake a slower vehicle and collided with rear of a third vehicle which then spilled some of its load. Two further vehicles involved attempting to avoid the spilled load. **Not LST-related.**

[Incident No.] and Year	Road type & urban or rural	No. of Fatalities	No. of Serious injuries	No. of Slight Injuries	Incident summary including the judgement of whether the incident was LST-related or not
[27] 2018	Minor (rural)	**0**	**0**	**1**	Third party claimed that LST hit his car while it was reversing into a lay-by for overnight parking, causing a minor injury. LST driver is disputing that a collision occurred, referred to the insurers. **Not LST-related.**
[28] 2018	Motorway	**0**	**0**	**2**	LST exiting motorway on a slip road, travelling too fast on approach to roundabout due to driver error. Trailer overturned on nearside. **Not LST-related.**
[29] 2018	Motorway	**0**	**0**	**1**	LST travelling on motorway approaching exit, rear end collision with third party vehicle. **Not LST-related.**
[30] 2018	Motorway	**0**	**0**	**1**	LST travelling on motorway when the driver blacked out at the wheel. Vehicle collided with crash barrier and came to rest. **Not LST-related.**
[31] 2018	Motorway	**0**	**0**	**1**	LST travelling on motorway, indicated left to move into inside lane, did not see third party vehicle travelling at faster speed in inside lane (undertaking). Collided with rear offside corner of the third-party vehicle. **Not LST-related.**
[32] 2018	Principal (rural)	**0**	**0**	**1**	LST approached major A road roundabout too fast due to driver error. Driver braked hard and the brakes locked, then the rear of the trailer swung out hitting a vehicle on the other side of the carriageway. The trailer was empty at the time. A standard- length trailer might have behaved in a similar manner. **Maybe LST-related.**
[33] 2018	Motorway	**0**	**0**	**1**	Third party vehicle hit by another vehicle causing vehicle to spin and hit the LST following behind in heavy motorway traffic. **Not LST-related.**

Sources: LST Data, Operator communications and STATS19 data for validation (except 2018 – at the time of writing the STATS19 data has not been released.) The Road Type definitions adopted here are the same as those used in the DfT table TRA3105 (the source for the vehicle km data for the GB artic. Population):

Motorway = all roads with road class M or A(M).

Trunk = all major A roads managed by Highways England and their equivalents in Wales and Scotland

Principal = all other A roads managed by local authorities

Minor = all other road classes

Injury incidents of special interest

5.20 As in the past Annual Reports, we want to highlight any incidents that are of special interest. The incident numbers in the discussion refer to the table above.

5.21 This part of the discussion focusses on the qualitative nature of these incidents and the possible further questions or areas for further study they pose for the DfT in regard to LSTs. **The quantitative analysis in the subsequent sections treats all 33 of the public injury incidents equally, regardless of whether they were nominally judged to be LST-related or not.**

5.22 Although there were more injury incidents in 2018 (eleven) than in any earlier year, there are fewer incidents of particular concern. Eight of the events were on motorways or motorway roundabouts and few, if any of them were clearly related to the presence of the longer trailer.

- Incident 23 was the most serious in terms of the physical damage (loss of the trailer) but resulted only in a slight injury to the driver. A very detailed investigation by crash investigation experts concluded that the trailer design was not a specific contributory factor to the event. Risk Solutions has had the opportunity to review the root cause report for this event and, subsequently, to discuss the circumstances directly with the fleet engineer. Following their investigation, the engineer's view is that the lateral forces derived from the extreme steering input and resulting roll-over moment would have far exceeded any minor effect arising from any further behaviour of the steering axle
- Incident 32 involved the driver locking the brakes after misjudging a roundabout entry. The rear of the trailer swung out hitting a vehicle on the other side of the carriageway. The trailer was empty at the time. A standard- length trailer might have behaved in a similar way, but we have no further details of this event. We have treated the event as possibly LST-related.

5.23 There was also one serious injury that happened in the depot, which is not in Table 12 as it is on happened on private land. The event was complex in that it involved two drivers working near to a bay entrance, who had communicated their intentions prior to making the manoeuvre, but one driver hit the cab door of the other, as the 2nd driver was entering the cab, crushing him with the door. Investigation by a senior manager with previous experience in crash investigation for the police, concluded that "*…irrespective of the LST and its rear steering axle had the driver been towing a conventional standard length trailer the same outcome was highly likely to have occurred although the degree of swing may have been reduced resulting in a less severe impact."*

LST Safety Outcomes 3: Comparison of national injury incident rates

5.24 **Aside from the review of LST incident patterns and causes, a key outcome required from the trial was analysis of the incident data to assess whether the LST operations posed an additional risk to other road users, when compared with the GB articulated HGV fleet (which includes the LST fleet) on a per km basis.**

5.25 Our analysis focuses on the comparison of LST incidents in **public locations** (public highway, services areas etc.) as the best comparison to the background STATS19 data published for all personal injury road traffic collisions that take place on the public highway.

LST Incident Summary

5.26 There have been 33 personal injury incidents involving an LST in public locations in 587 million km travelled over 4.7 million journey legs from when the trial began in 2012 to the end of December 2018.

5.27 Of these 33 public personal injury incidents, only 4 events (resulting in 4 slight injuries) were determined to be, or possibly be, LST-related.

5.28 This equates to:

- **1 injury event in a public place for every 18 million km travelled by the LSTs**
- **1 LST-related injury event in a public place, in every 147 million km travelled**.

GB Articulated HGVs summary

5.29 Table 13 summarises the number of collisions, vehicle km and casualties for the period 2012-2017 for the GB Articulated HGV fleet.

5.30 Collision and casualty data is taken from STATS19 for all personal injury collisions involving articulated goods vehicles of 7.5 tonnes and over. Vehicle km data is taken from the DfT statistics table TRA3105 for articulated goods vehicles with 3 or more axles.

5.31 Table 14 then summarises the data in Table 13 as a three-year average for the period 2015-17. This allows us to compare the rates of incidents and casualties for the GB fleet with the rate for the LST trial fleet, as described in the next section.

Table 13: Number of collisions, vehicle km and casualties for the period 2012-2017 for the GB Articulated HGV fleet

Number of Collisions	2012	2013	2014	2015	2016	2017	Total
Motorways	723	741	831	795	625	521	**4,236**
Major-A and Minor roads:							
Major A-roads (Trunk and Principal)	1,189	1,187	1,250	road	1,090	933	**6,853**
Minor roads	310	265	286	265	236	213	**1,575**
Rural and Urban roads:							
Rural roads (Excluding motorways)	1,025	1,027	1,077	994	921	736	**5,780**
Urban roads (Excluding motorways)	474	425	459	475	405	410	**2,648**
Total Collisions	**2,222**	**2,193**	**2,367**	**2,264**	**1,951**	**1,667**	**12,664**

Vehicle Kilometres (billions)	2012	2013	2014	2015	2016	2017	Total
Motorways	7.5	7.8	8.1	8.3	8.5	8.7	**48.9**
Major-A and Minor roads:							
Major A-roads (Trunk and Principal)	5.2	5.2	5.4	5.6	5.8	6.0	**33.1**
Minor roads	0.3	0.3	0.3	0.3	0.2	0.3	**1.7**
Rural / Urban roads:							
Rural roads (Excluding motorways)	4.7	4.7	4.8	5.1	5.2	5.4	**29.9**
Urban roads (Excluding motorways)	0.8	0.8	0.8	0.8	0.8	0.9	**4.9**
Total Vehicle Kilometres (billions)	**13.0**	**13.3**	**13.7**	**14.2**	**14.5**	**15.0**	**83.7**

Number of Casualties	2012	2013	2014	2015	2016	2017	Total
Fatalities	116	117	111	125	133	124	**726**
Serious injuries	355	443	410	430	394	374	**2,406**
Slight injuries	2,650	2,547	2,878	2,733	2,232	1,942	**14,982**
Total Casualties	**3,121**	**3,107**	**3,399**	**3,288**	**2,759**	**2,440**	**18,114**

Source STATS19 and TRA3105 2012-2017 (2018 STATS19 not yet published).

Table 14: Three-year averages (2015-17) for collisions, casualties and vehicle km for the GB Articulated HGV population, public locations

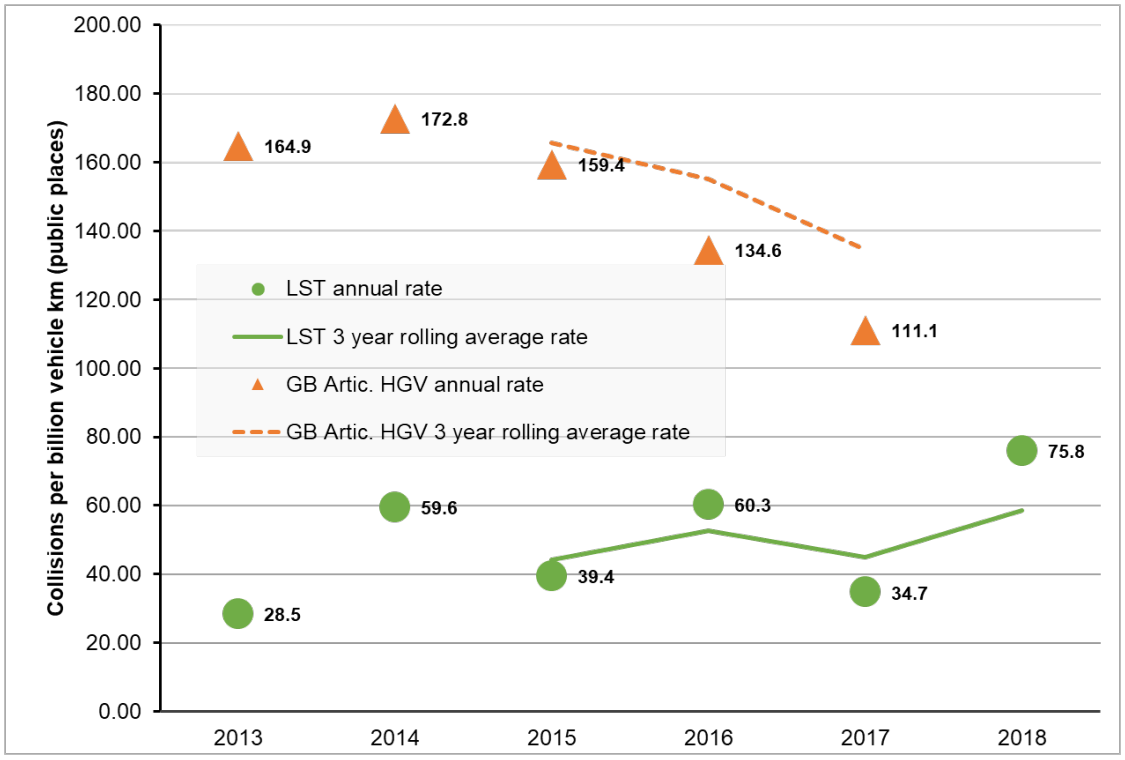
GB Articulated HGV three-year averages 2015-2017		Collisions per year	Casualties (All killed or injured) per year	Billion vehicle km per year
1)	Motorways	647	995	8.5
2)	Major A-roads (Trunk and principal)	1076	1528	5.8
	Minor roads	238	306	0.3
3)	Rural roads (excluding motorways)	884	1292	5.2
	Urban roads (excluding motorways)	430	543	0.8
Total	*(1) Motorway + (2) or (3) rounded figures*	**1961**	**2829**	**14.6**

Source STATS19 and TRA3105 – annual average 2015-2017 (2018 STATS19 not yet published). Slight difference in totals for different non-motorway groups due to rounding in the 3-year averages

LST comparison to the GB articulated HGV 3-year rolling average

5.32 In the early annual reports, we compared figures for individual years of data. Once the trial had been running for over four years, we also included the trend in annual incident rate and a three-year rolling average for LSTs (calculated from Table 13) and the GB fleet (calculated from Table 14), which helps to smooth out any natural variation in the data from year to year. This is shown in Figure 21 below.

Figure 21: Annual incident rate and three year rolling averages, 2013-2018



5.33 The LST incident rate has increased since last year, but all of the 2018 incidents resulted in only minor injuries and the STATS19 data for 2018 had not yet been published at the time of the statistical analysis, so the comparison for that year was not possible. An updated analysis may be produced at a later date if required by DfT.

5.34 Subject to a positive statistical significance test, the overall incident rates for LSTs appear to continue to be significantly lower than those of the GB articulated HGV fleet as a whole. Significance testing is the subject of the next section.

Statistical significance testing

5.35 To establish whether the difference between the LST and GB Artic. Injury rates per km are real, rather than due to normal statistical 'noise' in the data, we calculate the **mean rate ratio.** This is defined as the LST incident rate (per billion vehicle km) divided by the incident rate for the background population of all GB articulated HGVs. If the mean rate ratio is equal to 1.0, then the rates are the same. If the ratio is not equal to 1.0, we apply a statistical test to determine if the difference from 1.0 is statistically significant. More details on the tests used can be found in past annual reports and the detailed analysis by road type is discussed later in this section.

5.36 Table 15 shows that the national incident and casualty rates for LSTs are substantially lower than those of the standard fleet. The ratios in the table are less than 1.0 and are statistically significant.

5.37 **For the public access location comparison, per km operated, LST incidents are occurring at a rate of 44% of the GB articulated HGV fleet.**

5.38 The difference in incident rates has narrowed since 2017 due to the increase in motorway incidents in 2018 for LSTs, to be more in line with the background data. However, we do not yet have 2018 data for the GB articulated fleet so we cannot yet say if this represents a trend. We will continue to monitor this key safety statistic.

Table 15: Summary comparison of LST public road collision and casualty three year rolling average rates (2016-18) vs. GB articulated HGVs (2015-17)

Injury incidents Public access locations	LST Rate per billion vehicle km	GB Artic HGV Rate per billion vehicle km	Mean Rate Ratio LST to GB-HGV
Collisions	59	135	**0.44**
Casualties	72	194	**0.37**

Sources: LST from trial data. GB from STATS19 and TRA3105 – all 2015-2017 (2018 not yet published) – all figures rounded. Both ratios shown to be statistically significant at the 5% confidence level.

LST Safety Outcomes 4: Comparison of injury incident rates by road type

5.39 There is a valid question over whether LST operations in urban locations or on minor roads, where LSTs would be expected to perform most high angle turns, could pose a threat to vulnerable road users such as pedestrians, cyclists and powered two-wheeler users, as well as to other drivers. The analytical question is whether such an effect might be 'hidden' by the dominance of motorway and trunk road operations in the national average calculations given above.

The source for LST injury incidents on urban roads and minor roads

5.40 The detailed data for the injury incidents noted in Table 12 and taken from trial data have been analysed and the incidents classified in Table 16 using the tailored data splits highlighted above.

Table 16: Number of personal injury collisions for LSTs (whole trial to end 2018)

Number of collisions in each location type	Public and private locations	Public locations only
Motorways	21	21
Non-Motorway – by Road Type		
Major A-roads (Trunk and Principal)	9	9
Minor roads	3	3
Depots etc.	6	0
Non-Motorway – by Urban or Rural		
Rural roads (excluding motorways)	9	9
Urban roads (excluding motorways)	9	3
Total	**39**	**33**

The source for LST vehicle kilometres split

5.41 The trial data submissions do not contain detailed data on LST journeys by urban or rural environments or by road type. We therefore made an estimate of LSTs distance travelled on different road types in 2017 using route mapping (see the 2017 annual report for details). From the mapping work we produced breakdowns of the LST distance operated, using the different approaches used in the DfT national statistics:

- LSTs ran on roads in urban areas (excluding motorways) for 13.1% of their total operating distance, as against 86.9% on rural roads and motorways.
- LSTs spent 62.0% of their operating distance on motorways; 36.0% on major A-roads; and 2.0% on minor roads.
- LSTs spent 85% of their operating distance on Trunk Roads (the motorways and A roads on the SRN), 13% on Principal Roads and 2% on minor roads.
- In the analysis that follows we assume that the same percentages apply to all years during the trial period.

Statistical comparison of injury incident rates by road type

5.42 The number of safety incidents involving LSTs in some segmentations of the data is low, so as with the national statistical analysis presented earlier, it is important to test whether differences in collision rates observed between the LST fleet and the GB fleet of articulated HGVs (which includes LSTs) are 'real' (statistically significant), or are just the result of natural variation (noise in the data). We do this using both a classical Poisson rate ratio test and a Bayesian comparison. The details of this approach were given in some detail in the 2015 Annual Report

5.43 When we presented this analysis in the 2016 and 2017 Annual reports the tests were statistically significant in most cases, indicating that the data sets were now large enough to reach valid conclusions.

5.44 As we show below, the addition of the 2018 data has not changed the conclusions apart from for motorways, where the difference in collision rates between LSTs and the GB fleet is now not statistically significant (although the LST rate is still lower). However, as noted earlier, this reduction in statistical significance may be a facet of the difference 3 year periods applied to the LSTs and GB fleet, as well as the inclusion – conservatively – of all the 2018 LST Motorway incidents, a number of which were almost certainly unrelated to the presence of the longer trailer.

Injury incident analysis – classical statistics

5.45 The results in Table 17 summarise the incident rate calculations for our different road type splits. In each case, we calculate a key indicator - the mean rate ratio. This is the ratio of LST collision rate to the background (GB articulated HGV fleet) collision rate. So, a mean rate ratio >1.0 would imply that the LST collision rate is higher, a value <1.0 implies that the LST collision rate is lower.

5.46 We then test whether we can be confident that any apparent difference between the two collision rates is significant (and not just noise in the data). We use the Poisson rate ratio test for all such comparisons.

5.47 In all these cases apart from for motorways the analysis shows a mean rate ratio less than 1 across the confidence interval range so we can state with a high degree of confidence that the LST incident rate is lower than the background population.

5.48 **We can conclude that the use of national averages to compare LST incident rates to the general national fleet are not masking an underlying problem of higher injury rates in urban areas or on minor roads.**

5.49 We will continue to monitor and report the urban and minor road incident rates separately as the risk of injury events in these locations will remain an area of concern for the trial.

5.50 Once the 2018 GB Fleet statistics and STATS 19 data are available we will, if required, be able to re-run the significance testing based on the years 2015-2018 for both LSTs and the GB Fleet and see whether the mean rate ratio for motorway events then passes the test of statistical difference.

Table 17: Injury incident rate analysis by different road types

A. GB Articulated HGV fleet average collision rate (STATS19 data for 2012-2017)

Data item	Urban roads (excluding motorways)	Minor roads	A-roads (trunk and principal)	Motorways
No. of collisions	2648	1575	6853	4236
Billion vehicle km travelled	4.9	1.7	33.1	48.9
Mean collision rate per billion vehicle km	540.4	949.1	206.8	86.6

B. Trial LSTs (trial data for 2012 to 2018)

Data item	Urban roads (excluding motorways)	Minor roads	A-roads (trunk and principal)	Motorways
No. of collisions	3	3	9	21
Billion vehicle km travelled	0.077	0.012	0.21	0.36
Mean collision rate per billion vehicle km	39.0	255.3	42.6	57.7

C. Comparison of LST versus GB Articulated HGV fleet average collision rate

Comparison measure	Urban roads (excluding motorways)	Minor roads	A-roads (trunk and principal)	Motorways
Mean rate ratio	0.072	0.27	0.21	0.67
95% confidence limit of rate ratio	0.015 – 0.21	0.055 – 0.79	0.094 – 0.39	0.41 – 1.02
p value that mean rate ratio equals 1.0	< 0.001	0.01	< 0.001	0.06
Statistical interpretation	Significant	Significant	Significant	Not significant

Significant here means significant at the 5% level. There is sufficient evidence for these road types and locations to accept the hypothesis that the rates are different.

Not significant here means not significant at the 5% level. There is insufficient evidence for these road types and locations to reject the hypothesis that the rates are the same.

Injury incident analysis – Bayesian statistics

5.51 Given the importance of the safety conclusions from the trial, we have always supplemented our classical statistical testing with a Bayesian analysis.

5.52 A Bayesian statistical analysis estimates the probability that the LST injury incident rate is higher or lower than that for the background population. This is different from the classical Poisson Test described above, which just gives a pass/fail indication at a given confidence level. In simple terms, the Bayesian analysis gives an insight into how far away from, or inside, a robust statistical test the result falls.

5.53 We have used the Bayesian approach to consider the two data segments of most interest in terms of risk to vulnerable road users, the Urban operations and those on Minor roads.

5.54 The results in Table 18 shows that there is a less than 0.1% chance that the urban incident rate is higher for the LST population than for the background population and only a 0.4% chance that the minor roads incident rate is higher for the LST population than for the background population.

5.55 **The Bayesian approach strongly supports our conclusion that the LSTs are being operated on the trial with a lower injury incident rate than the average for GB articulated HGVs**.

Table 18: LST Injury incident rate - Bayesian Analysis

Road type	Urban roads (excluding motorways)	Minor roads
Median Collision Rate Ratio (LST / GB HGV rate)	**0.077**	**0.29**
Credible range	0.023-0.21	0.085-0.77
Probability that the LST (injury) incident rate is **HIGHER** than the background rate for all large GB articulated HGVs	**< 0.1%**	**0.2%**
Probability that the LST (injury) incident rate is **LOWER** than the background rate for all large GB articulated HGVs	**> 99.9%**	**99.8%**

Conclusion: Comparison of LST injury incident rates versus other trailers

Statistical comparison

5.56 **At the end of 2018, based on the confirmed injury incidents, we find that the trial LSTs were operated with a significantly lower rate of injury incidents per vehicle km in public locations than the average for GB articulated HGVs, for three of the location types that we have studied (urban locations, A-roads and minor roads).**

5.57 **The LST injury incident rate on motorways was also lower than that for the GB HGV fleet, but the difference in rates is not statistically significant,** although this result may be updated once the GB fleet statistics for 2018 become available.

Safety impact outcomes expressed as 1 in 'n' kilometres

5.58 For communication with the general, non-technical reader, it is also useful to summarise the key incident impact results in terms of "1 event in every n km" to convey a sense of the scale of the incidents being observed with LSTs, compared with existing semi-trailers in common use in the country. In Table 19 we present a summary of the safety incident data using this format.

5.59 The information in Table 19 relates only to incidents involving an LST, operating in a public location.

5.60 The data is presented at the national level, to be consistent with other published results. The urban operations (excluding motorways) analysis has concluded that these national results do not appear to be concealing an underlying problem of LST operations in urban areas.

Table 19: Summary of LST injury incident outcomes vs. all GB Articulated HGVs

Summary of LST-related injury incidents and outcomes after 587 million km travelled, compared with those for all GB Articulated HGVs (>7.5T)

Collisions in all public locations	GB Artic HGVs 1 in every …	LST Involved 1 in every …	Incident judged LST Related 1 in every …
All locations	**6.6 million km**	**18 million km**	**147 million km**
Urban only (exc Motorways)	1.9 million km	26 million km	77 million km
Minor roads only	1.1 million km	3.9 million km	12 million km

Table Notes

- 'All public locations' covers all public roads and also private land where there is public access.
- 'Urban' here defined as all roads, excluding motorways, in ONS defined urban areas
- 'Minor' Roads are all roads that are classified below the level of A-Road
- GB Articulated HGVs: Based on the DfT National data for all articulated HGVs > 7.5T. 2012-2017 (TRA3105) = 83.7bn km of which 4.9bn urban non-motorway and 1.7bn minor roads. Injury incidents from STATS19 2012-17: Total collisions = 12,664 (2,648 urban and 1,575 minor roads).
- LST Involved: 33 collisions (3 urban and 3 minor roads). Any injury event in which an LST was involved, even if the trailer being an LST was not relevant – data from latest annual report table - Table 12. Non-injury (damage only) incidents are covered separately.
- LST Related: 4 collisions. Events involving an LST where the fact that the trailer was an LST rather than a standard length was considered to be at least part of the cause. ***This judgement was not used in the headline figures for trial injury rates – which includes all collisions regardless of whether or not the incident was considered LST related.***
- These figures are mean values – based on analysis that concludes that the comparisons between LST incident rates shown here are all statistically robust at a 95% confidence level

6 TRIAL OUTCOMES: DAMAGE INCIDENTS

6.1 Comparison of LST performance in terms of damage incidents with non-LSTs is difficult because data on non-injury incidents is not collected nationally. We could not be sure therefore if the LSTs good safety performance in terms of injury collision incident rates was matched by an equally good performance in terms of damage-only incidents or conversely whether LSTs were actually disproportionately responsible for property damage incidents compared with non-LSTs.

6.2 The LST 2017 Annual Report recommended that the new data framework (applied from January 2018) should:

"…include details of location of incidents, injuries or damage only, and causes including whether LST-related or not. The aim is to produce a statistical comparison of the safety and incident levels of LSTs in comparison with the standard semi-trailers."

6.3 As part of the revised data framework launched on 1 January 2018, we therefore sought to improve the reporting of damage events, especially those involving public property, by introducing:

- A clearer statement of the requirement to report any and all damage to property
- Narrative data fields for damage to property, separate from that for damage to the operator's vehicle – with specific guidance to elicit some statement of the severity of damage resulting from the event
- A requirement to report whether the property **owner** is aware of the damage.

6.4 We also asked operators to provide data on injury and damage only incidents involving those non-LSTs in their fleets that were running on similar roads to their LSTs – their comparable non-LST fleet.

6.5 This data would enable us to carry out more robust comparisons of LST fleet safety and incident performance with non-LST fleets.

6.6 A year of data is now available. In this section we summarise work carried out to:

- explore the emerging data from the new incident log and set up an analytical approach to the statistical testing of the damage only events.

6.7 In this section we present two analyses:

- A simple overview of LST-related incidents, and
- A statistical comparison of incident data for the LST and non-LST fleets.

Road surface damage

6.8 The analysis here is focused on the damage to roadside assets and other vehicles. We have not been asked to study any impact on the road surface itself.

6.9 Pre-trial work suggested that road surface damage would not be an issue since the overall weight limit or number of axles/tyres for an LST is no different to standard trailers. The only change would be the that the empty weight of the LSTs was slightly greater than standard trailers, but this would be more than offset by making fewer journeys. Indeed, the argument was made that the reduction in tyre scrub by the use of a rear steering axle would mean reduced road surface damage.

Overview of LST-related incidents from the 2018 trial incident logs

6.10 Our focus for this analysis is on events that:

- occurred in 2018 and resulted in injury or some damage
- were located on the public highway (or in a publicly accessible area)
- were assessed as being related to the fact the trailer was an LST.

6.11 We have chosen to focus only on LST-related events here, whereas in the injury incident analysis data presented we treated all incidents as 'relevant' and hence produced the most conservative result possible, to ensure the final outcome (a low incident rate per km) was itself conservative. In looking at injury and damage events we have a much larger dataset and a broader range of event types, and there would be a real concern that including all incidents would result in an inconclusive outcome, with any underlying LST/non-LST difference being 'lost' in the noise.

6.12 Each event is classified by the operator with their judgement of whether it was LST-related or not, using the options shown. The operator judgements are checked by Risk Solutions and, where necessary, amended.

Injury and damage incidents by location

6.13 Table 20 shows a summary of the breakdown of the **125 incidents in 2018 where some damage was recorded** (either to the vehicle or public/private property) where this occurred in a publicly accessible location.

6.14 If we conservatively treat events with a judgement of 'Yes', 'Yes – partly' or 'Maybe', or 'unclear' as potentially LST-related, we have **52 "events of interest**" in 144 million km travelled over 1.1 million legs during 2018 (deduced from Table 3, deducting figures to end 2017 from that to end 2018)

6.15 **This gives estimates of damage events where an LST was involved and the trailer's design has not been explicitly ruled out as a contributory factor:**

- **1 reported damage event for every 2.8 million km travelled by the LSTs**
- **1 reported damage event for every 21,200 journey legs operated by LSTs.**

6.16 Of the 52 events of interest, half were events where the vehicle was turning (highlighted in the table with purple shading) where one might anticipate the trailer kick-out would be a factor.

6.17 Third party property damage was reported in 41 of the events. Damage to **public** property was only recorded in 8 events, damage to **private** property was reported in 33 incidents.

6.18 Damage associated with these events was generally minor or moderate and included, for example, minor scrapes and dents to vehicles, and damage to traffic lights and road signs. In a small number of these events severe damage was reported (about 12% of the 41 third party damage events), or the extent of damage was unknown, or insufficiently described for us to make a judgement of the severity (again around 12%).

Table 20: LST injury and property damage incidents by location (source LST Trial data)

Location of LST property damage incidents recorded in 2018	LST related	Partly or Maybe LST related	Unclear whether LST related	Not LST related	Total
00 Total on main carriageway	**11**	**23**	**4**	**68**	**106**
Broken down by …					
01 Reversing	0	1	0	1	**2**
02 Parked	0	0	0	5	**5**
03 Waiting to go ahead but held up	0	0	0	3	**3**
04 Slowing or stopping	0	1	0	0	**1**
05 Moving off	0	1	1	3	**5**
06 U turn	*0*	*3*	*0*	*0*	***3***
07 Turning left	*5*	*6*	*0*	*2*	***13***
08 Waiting to turn left	0	1	0	0	**1**
09 Turning right	*5*	*5*	*1*	*4*	***15***
10 Waiting to turn right	0	2	0	0	**2**
11 Changing lane to left	0	0	0	5	**5**
12 Changing lane to right	0	0	0	1	**1**
13 Overtaking moving vehicle on its offside	0	0	0	2	**2**
16 Going ahead left hand bend	0	1	0	0	**1**
17 Going ahead right hand bend	1	0	0	4	**5**
18 Going ahead other	0	2	2	36	**40**
19 Unknown	0	0	0	2	**2**
06 On lay-by or hard shoulder	**0**	**0**	**1**	**2**	**3**
07 Entering lay-by or hard shoulder	**0**	**0**	**0**	**1**	**1**
10 Company Property / Depot	**0**	**1**	**0**	**0**	**1**
11 Other Private Property (not on road)	**1**	**9**	**2**	**2**	**14**
GRAND TOTAL	**12**	**33**	**7**	**73**	**125**

The shaded areas in Incident location types 06 U turn, 07 Turning left, and 09 Turning right, denote events involving turning with some possible LST-related contribution identified in the event details

Awareness of damaged asset owner

6.19 As part of the revised 2018 data format we included a specific question about whether the owner of any asset that had been damaged was aware, or was made aware, of how the damage had occurred. This was in response to concerns that even where operators were declaring a damage event on the trial, the party suffering the loss might still not be aware of the involvement of the operator's vehicle.

6.20 In around 85% of the incidents the owner (or owner's representative) was aware of the incident or was made aware of it by the operator. In a small number of cases (around 10%) the owner was unknown, and two incidents, both involving roadside furniture or motorway crash barriers, the operator responded 'other' to the question as to whether the property owner was aware of the damage.

Comparison of LST and non-LST damage incident rates

A note on data and methods

6.21 Our focus for this analysis is on events that:

- occurred in 2018 and resulted in injury or some damage
- were located on the public highway (or in a publicly accessible area)

6.22 In this case we were interested in all events, regardless of whether they were assessed as being related to the fact the trailer was an LST, because we wished to compare LST incident rates with non-LST incident rates.

6.23 Not all trial participants had relevant non-LSTs in their fleet, and some were unable to provide the requested data for their non-LSTs. These participants were excluded from the comparison. For those included in the comparison (91 operators in total), we looked at LST incidents in public areas only, to match the data available for relevant non-LST fleets.

6.24 To calculate incident rates for each operator, we divided the total of injury and damage-only incidents reported for a fleet by the number of vehicle km covered by that fleet.

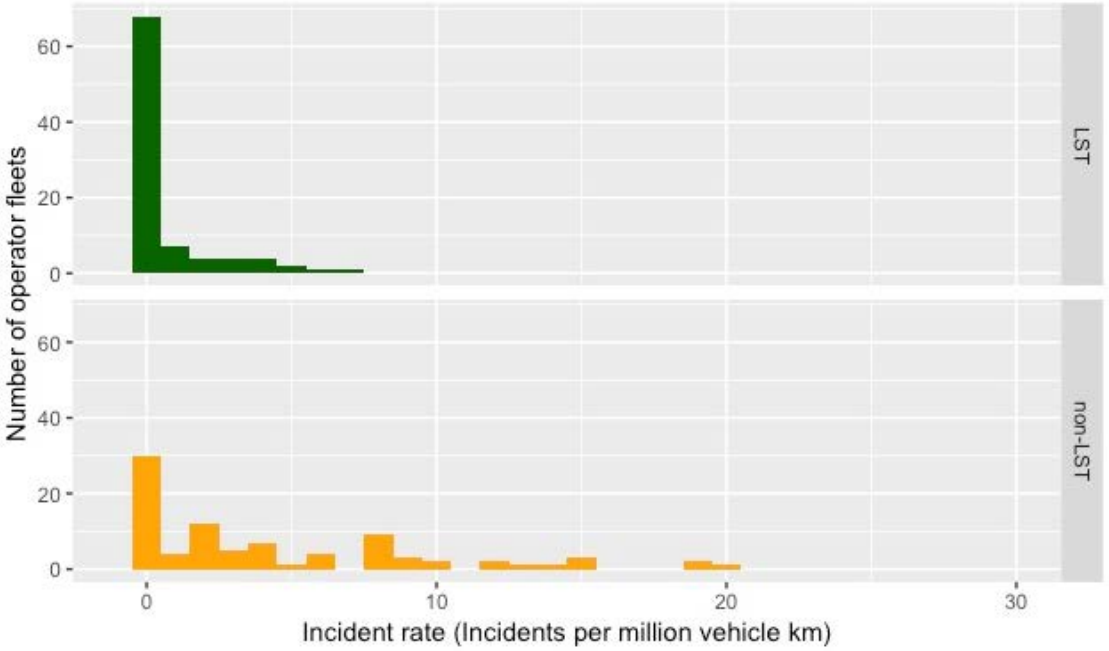
6.25 Over all the operators in our sample this generated two distributions of the total number of incidents per million vehicle km in 2018 that occurred on the public highway or in a public area. One for LSTs and one for relevant non-LST fleets.

6.26 We then carried out a series of statistical tests to compare the two distributions. These are explained further in Annex 8.

Incident rate comparisons

6.27 Figure 22 shows that distribution of incident rates for the LST and non-LST operator fleets.

Figure 22: Histograms of LST and non-LST incident rates (source LST Trial data)



6.28 We selected a statistical analysis method appropriate to the nature of the distributions and which we found gave a good fit to the data (more details are provided in Annex 8).

6.29 We concluded that the mean incident rate for non-LSTs in our sample is greater than the mean incident rate for LSTs in our sample by a factor of 7.4.

6.30 Our method allowed us to predict the mean number of incidents expected for an LST fleet and a non-LST fleet after 1 million vehicle km exposure, that is, after completing a million vehicle km as a fleet. This results in the following predictions:

LST fleet:	**0.91 incidents**
Non-LST fleet:	**6.8 incidents**

6.31 **We concluded that for the paired data sample from 91 of our trial participants, LST fleets have a much lower incident rate than non-LST fleets of the same group of operators. We therefore see no indication that the LSTs on the trial are causing more damage than other semi-trailers.**

7 2019 WORK IN PROGRESS / UNDER DISCUSSION

7.1 We have an ongoing programme of work during 2019, alongside the continued collection of data from the trial. In this section we outline the programme and report results from parts of the work that have already been completed.

7.2 The task references (E'n') relate to the trial programme management plan.

LST evaluation activities in 2019

Task E5/E8: Operator Conversations

7.3 Following publication of the previous Annual Report (AR17), we approached 10-15 operators to ask them to take part in a series of evidence-based conversations, in two stages.

7.4 Part 1: Jan-Mar 2019: (Task E5)
Individual company site interviews covering all aspects of their experience of specifying, purchasing, introducing and running LSTs and the potential future take up if they were permitted more widely, beyond the trial.

7.5 The key themes from these discussions have already been collated in an internal project document and shared with the DfT. **A summary is given later in this section** and the detail is in Annex 5.

7.6 Part 2: Autumn 2019 (Task E8)
Planned group discussions of good practices adopted by operators on the trial, especially in terms of training content, which might be replicated outside of the trial conditions.

Task E7: Digitising LST Model Reports

7.7 We plan to work with the DfT to digitise the data contained in the VCA Model Reports, which are currently only available as PDF documents, to support further analysis of the design mix in the LST trial fleet.

Task E4: Scaling Up

7.8 The trial results relate solely to the LSTs already built and operated on the road under the trial conditions, not to a hypothetical inclusion of large numbers of LSTs in the GB national fleet.

7.9 As part of any future formal impact assessment, the DfT will need to 'scale up' the trial results appropriately to provide projections of the impact of operating LSTs were they to be permitted more widely on GB roads, under a variety of possible regulatory scenarios.

7.10 While any such modelling would be performed by the DfT, the evaluation team at Risk Solutions need to produce the foundations of such scaling, to enable the DfT to carry out modelling that is soundly based on the trial results.

7.11 At the time of writing, the core model has been developed and an initial presentation made to the DfT analysts and economists.

Operator conversations : Part 1 Results

7.12 The emerging outcomes from the operation of LSTs on the trial are confirming positive results in terms of journey savings, without any evidence of an increase in safety risk during the trial operations.

7.13 Discussions with operators and the DfT along with responses to both trial qualitative surveys and company information submissions, suggest that the reason for the good performance in terms of both journey savings and injury collisions per km can be attributed to the special treatment of LSTs by the operators on the trial.

7.14 As part of the 2018-19 evaluation programme of work we have sought to refine the quality and depth of information about exactly what those special treatments are:

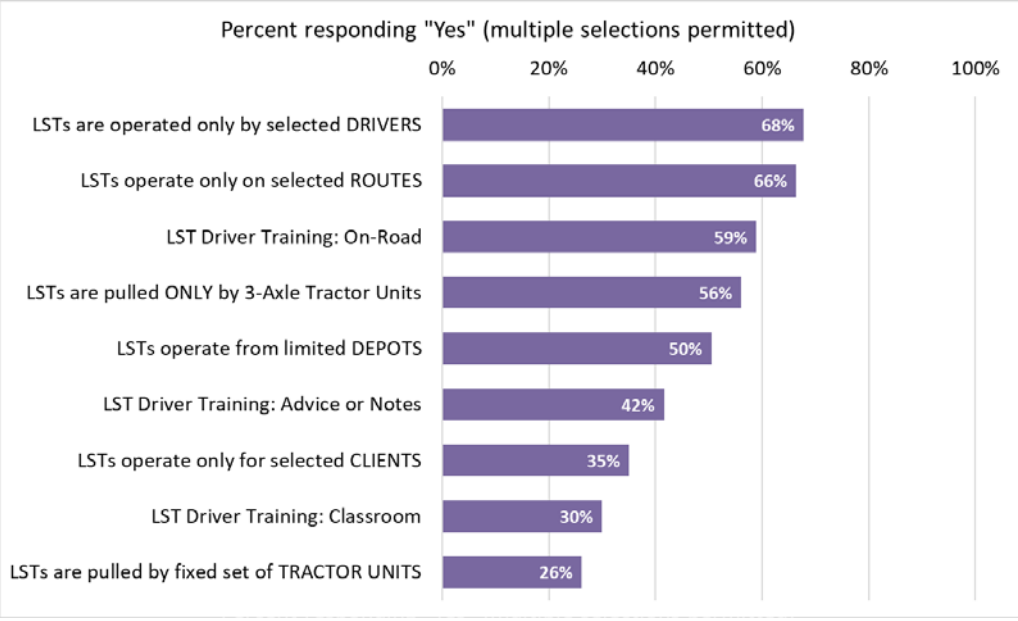
- We refreshed the information about operator practices in the new Company Information sheet submitted by all operators in 2018, including those who would have provided equivalent information much earlier in the trial.
- We began a series of evidence-based conversations with a small selection of operators to:
  - Start exploring whether the good practices adopted by operators on the trial can be replicated outside of the trial conditions, and
  - Provide other information to support scaling up (on issues such as take up).

7.15 Here, we draw together some of the refreshed company information and also the themes from the Part 1 of the operator conversations.

Operations data from the Company Information sheet

7.16 Figure 23 shows the special arrangements made by operators for LST operations, taken from the Company Information submitted by operators.

Figure 23: Special arranagments for LSTs declared by operators (source LST Trial data)



7.17 As in previous years, this confirms that:

- Many operators restrict LST operations to set routes, where:
  - they can maximise utilisation of the extra length
  - they have assessed the route to be suitable for LSTs
  - the delivery points have been assessed as suitable for LSTs
- Operators have adopted a range of different approaches to drivers' LST training
- Many operators seek to ensure that LSTs are operated by drivers who do so regularly, and in some cases, on repeated routes.

On-Site Interviews

Approach

7.18 Between December 2018 and March 2019, we interviewed a small selection of the LST operators to discuss, four main areas of interest, reflecting some key questions noted in the most recent trial Annual Report, published in September 2018:

- LST Design Choices and Impacts - their thinking behind key choices they made in selecting their LST design options, and whether this would change in light of their experiences
- LST Take-Up - their experience of introducing LSTs into their fleet and through one interview a decision not to take up LSTs
- LST Operational Constraints - their practices for driver and route selection now, including whether any changes were made as a result of the trial
- LST Performance and Incident Data – although this was largely a check of whether the operator recognised and broadly agreed with the aggregated results our analysis showed for their company

7.19 We focused mainly on operators with significant LST experience and aimed to cover a mixture of operator sizes, operational types, trailer builders, geographical regions and most importantly, length and axle designs (SS-Self-Steer, CS-Command Steer or AS-Active Steer). Fifteen companies were considered, thirteen were approached and we met with eleven.

7.20 Interviews were semi-structured, took place at the operator's own premises and lasted between 2-3 hours. To ensure consistency of approach, the interviews were based around topic guides and a briefing note sent to participants to explain the rationale for our interest in each area. Full details are provided in Annex 5. The key observations are summarised below.

Key observations

Design choices

- Factors such as cost, volume, perceived manoeuvrability and maintainability, were the major influence on the initial design choices, but the choice was also often influenced by the offering and preferences of their favoured manufacturer
- The differing kick-out measurements of different steering options were not considered by most operators in their choice of trailer design. In many cases they were not even aware of the kick-out difference between the two options
- None of the operators had considered, or been offered, active-steer options.

Impact of design choices

- Some operators had changed their choice of preferred steering during the trial, both from CS to SS and from SS to CS. One major operator moving from SS to CS cited their experience of having to retrofit lock-at-speed to a fleet of self-steer axles and a doubling of the SS maintenance frequency.
- We also started or continued conversations around:
  - safe failure modes of steering axles
  - the contribution of steering axles in cases of transient off-tracking.
- The overall impression given by operators is of the LSTs being no harder to drive at speed than standard trailers, with operators noting that they 'follow well' in cornering.

Take-up

- The future take-up projections articulated by operators in the 2016 survey were, in most cases, confirmed (and so will be used as the foundation of the scaling up work referred to earlier)
- In a few cases, operators now anticipate a larger future potential for LSTs in their business than they did when we asked in 2016. In particular, one large operator currently using LSTs for their trunking operations, had not previously considered using them for regional delivery, but would probably do so if LSTs were more widely available.

Operational constraints

- The key operational constraints articulated by the operators in our sample were:
  - Route assessment – both the roads required and especially the pick-up and drop-off locations – with a view to confirming suitability for LST access.
  - LST specific driver selection and training and, in some cases, special awareness raising for other staff roles
- On route assessment, the operator's approaches included:
  - On screen/map assessment
  - Site visits – including the local roads – at each end of the route
  - Route assessment by an experience LST driver using standard trailers.
  - Discussion about / knowledge of the depot/site constraints at either end of the route including the approach roads.
- On training, there was a wide range of approaches in terms of the balance of:
  - Classroom / on road time.
  - LST training as separate from / integrated into wider driving training.
  - Extent of driver training on LSTs (how much of the driver group was trained).
- Almost all the operators interviewed agreed that it would be valuable to the trial to do some assessment of the key training content themes and approaches developed by operators and expressed a willingness to either share materials, take part in a discussion or both.

7.21 **Part 2 of the work will involve a group discussion with many of the same set of operators to develop a set of general LST Training and Awareness Themes, that should be considered essential for any future operators of LSTs.**

8 PROGRESS SUMMARY AND NEXT STEPS

8.1 In this section we summarise progress against the evaluation questions and against recommendations from previous reports.

8.2 We also present a number of options for further analysis, for discussion with the DfT to establish their potential value to the overall evaluation.

Progress against evaluation questions

8.3 Since 2016, we have been assessing progress against seven evaluation questions.

Q1 What do operators use LSTs for?

8.4 We continue to see LSTs in use for a wide range of work rather than just trunking, including, where route assessment permits: store delivery and movement of industrial products to and from production facilities and depots.

8.5 While the largest category of goods being moved remains FMCG (and the related supply chain), pallet network cargo and mail/parcels, we also see movements of bulk materials to power stations (wood chip and straw), industrial parts and some specialist large loads.

8.6 Operators continue to report LST-specific driver training and specific route planning/assessment as the key special operational arrangements made to ensure safe and efficient integration of LSTs into their business.

8.7 In this report we have presented, for the first time, LST activity levels by LA - both stopping in the LA and passing through - and also flows between GB regions.

Q2 What are the savings realised in HGV journeys?

8.8 The savings are the additional distance that would have had to be operated if the same quantity of goods had been moved using standard 13.6m trailers.

8.9 Since the start of the trial the use of LSTs over 587 million miles of operation has removed between 41 and 46 million vehicle kilometres of freight traffic from GB roads.

8.10 With an average journey distance of 125km, this equates to 330,000 to 365,000 journeys removed from GB roads as a result of the trial to the end of 2018.

8.11 The average saving achieved by operators is 7.5% (1 in 13 journeys) with the most efficient operations saving 13% (1 in 8 journeys).

Q3 What are the resulting reductions in emissions?

8.12 The savings in emissions reflects the reduction in distance, calculated as the additional emissions that would have occurred using standard 13.6m trailers.

8.13 Since the start of the trial, we estimate that emissions of 37,000 tonnes of CO2e and 187 tonnes of NOx have been avoided by the use of LSTs.

8.14 The report also gives figures for Particulates and Volatile Organic Compounds

Q4 What about safety – will LSTs cause more injuries?

8.15 There are two measures of safety to consider:

- The reduction in incidents arising from making fewer journeys
- The rate of safety incidents per km travelled, compared to other semi-trailers.

8.16 The first measure is an intrinsic benefit of using LSTs – the second is not.

8.17 For the first measure, on the trial to date, the benefit from making fewer journeys may have eliminated 6-7 injury collisions with a reduction of 9-10 casualties.

8.18 For the second measure, at the end of 2018, we find that the trial LSTs continued to be operated with a significantly lower rate of injury incidents per vehicle km in public locations than the average for GB articulated HGVs. This is being attributed to the effects of the special treatment of LSTs on the trial.

8.19 There were no fatal accidents involving LSTs in 587 million km of operation by the end of 2018, the period covered by this report.

8.20 At the time of writing, there has been one incident in early 2019 which resulted in the death of the driver of the HGV pulling the LST. This event does not appear in the quantitative analysis in this report as it falls outside the year being reported. At this stage there is no indication that the fact an LST was being pulled was a contributory factor in the occurrence of the incident or the resulting outcome.

Q5 What about damage and the associated costs – will LSTs cause more damage on the roads?

8.21 During the past year we have undertaken a special study of damage incidents using data from 91 operators who were able to provide both LST and non-LST damage event figures for their fleets on a comparable basis.

8.22 We concluded that for the paired data sample from 91 of our trial participants, LST fleets have a much lower incident rate than non-LST fleets of the same group of operators. The results were found to pass tests for statistical significance.

8.23 We therefore see no indication that the LSTs on the trial are causing more damage than other semi-trailers in the same fleets.

8.24 We also looked at the specific issue of whether the owners of assets damaged by LSTs were commonly aware of who was responsible for the damage. We found that in 85% of cases the owner was either present or was made aware of the incident by the operator. In 5% of case it was unclear. In only 10% of events the owner was marked as ‘unknown’ and will not have been aware of how the damage occurred.

8.25 The analysis has focused on the damage to roadside assets and other vehicles. We have not been asked to study wear and tear impact on the road surface itself.

8.26 Pre-trial work suggested that this would not be an issue since the overall weight limit or number of axles/tyres for an LST is no different from standard trailers. Indeed, the argument was made that the reduction in tyre scrub by the use of a rear steering axle would mean reduced road surface damage.

Q6 Might any special operational requirements be appropriate for LSTs?

8.27 The DfT’s approach to the trial, from the start, was to set a high-level requirement on operators to demonstrably operate the LSTs safely and efficiently, and to ensure drivers were adequately trained, rather than to impose a pre-determined set of detailed conditions designed to achieve those goals.

8.28 Having established that overall the operators have met these requirements, we have then sought to understand the most common operational conditions they have adopted, based on their experience of what works.

8.29 We have reported the outcomes of our most recent interviews with a cross-section of operators, which as in earlier surveys, emphasises the key elements of specialist

driver training and special route planning and assessment, along with wider issues of awareness for loaders, managers, depot designers and other company roles.

8.30 With a view to better defining the main themes and issues operators have sought to include in their driver (and other) training programmes and route planning and assessments, we are scheduling a further qualitative engagement with operators in the Autumn to go deeper into these two areas. The planned outputs from this discussion are succinct summaries of themes and points that have been embedded in the training and planning on the trial, which might then be considered as the foundation of some form of good practice reference or syllabus guide.

8.31 The more difficult factor to evaluate is the effect of the additional scrutiny of being on the trial, beyond noting that this will have had some effect. Clearly the present detailed data gathering process cannot be expected to continue indefinitely, or with a much increased size of national LST fleet. However, from our interviews with operators, we do hear an expectation that LSTs should always be treated by operators as 'special equipment'. This is already the case for double-deckers, ISO carriers and other less common designs, which are subject to some special treatment within the fleet management.

Q7 What proportion of the existing GB fleet of semi-trailers might be replaced by LSTs, were numbers not restricted?

8.32 We have previously published estimates in the range 10-20% replacement of standard 13.6m trailers, depending on the type of operation, based on our 2016-17 survey of operator on the trial. This range is extended up to 30% for some types of operation if they assume that, over time, depots and loading bays become more widely LST compliant, either by modification or just the natural cycle of replacement.

8.33 In more recent interviews with a small sample of operators, some have indicated they would now increase that projection based on their longer experience with the trailers.

8.34 At the time of writing, we are aware that DfT have written to a wide range of industry stakeholders inviting views and evidence on the possible future expansion of LST use, including any projection of future take up from operators not involved in the trial.

Progress against actions in previous reports

8.35 Progress against specific actions and recommendations, notably from the 2016 and 2017 Annual Reports has been good and is summarised in Annex 2.

Options for further work

8.36 We have proposed three possible areas where further analysis or changes to the trial arrangements could be carried out, subject to discussion with the DfT regarding the additional value they would deliver. One of the changes has already been agreed during the drafting of this report.

8.37 These are in addition to the planned engagement with operators in Autumn 2019.

2019-1 Emissions model re-run for future projections

8.38 The current emissions results are evaluating the trial to date, during which period most of the tractor units pulling LSTs have been EURO V engines, as was the modelling assumption in the pre-trial work.

8.39 Since the introduction of the EURO VI standard as a requirement for all new HGVs in 2014, some of the LST operation will of course have been carried out with these engines and gradual replacement of EURO V tractors with EURO VI will continue.

8.40 Options for accommodating this in future projections of emissions savings include rerunning the model, or carrying out a simple pro-rata scaling down of the relevant emissions to reflect the approximate ratio of EURO V to EURO VI outputs. Other options may also exist. At the time of writing, the DfT are considering whether adjustments should be made to the emissions calculations and if so, the most appropriate way to do this.

8.41 If the emissions model were being re-run for the reasons above, we would also suggest we take a look at the sensitivity of the emissions results to the assumptions of LST marginal weight. If it shown to be material to the outcomes, we would adjust the marginal weight assumptions in the light of the recent, albeit limited, data on LST weight factors, reported here.

8.42 Finally – any re-run of the model could also include the addition of a 'fuel-used' estimate (based on the CO2e), which would be of use in any future economic assessment of the potential savings arising from use of LSTs.

2019-2 Core scaling model

8.43 As part of our work in 2018-19, Risk Solutions have developed a core scaling model, including mapping the trial data onto CSRGT data, for use in scaling up the trial results to create future projections for LST use and benefits.

8.44 Once the scaling model is complete, we will transfer the model to the DfT's analysts for them to use in exploring possible future policy scenarios and informing a future Impact Assessment.

8.45 Our role will then be limited to commenting on whether their use of the model – including any assumptions made – remains valid, in the sense of being supported by the trial evaluation data.

2019-3 Simplified reporting requirement for longstanding operators

8.46 In March 2019, the DfT asked Risk Solutions to explore options for reducing the complexity of the data gathering at this point in the trial with the following objectives:

1. Allow more operators onto the trial
2. Avoid collection of data beyond what is now required for the trial evaluation
3. Reduce the burden of data collection on longstanding LST operators
4. Focus trial support time on new participants, or less effective (on data) operators
5. Focused trial support time on value-adding analysis
6. Be operable alongside the existing Full DSF processes with minimal duplication
7. Manage the scale of data collection in any future trial years.

8.47 We put forward a proposed solution in which a cohort of operators, where we have a sufficient history of detailed data submissions, would submit less detail on each trailer (just number of legs and total distance), but with the same level of detail on incidents.

8.48 **This proposal has been agreed with the DfT and the plan has been implemented for 165 longstanding LST operators starting with the 2019-P2 submissions (being submitted in September-October 2019).**

GLOSSARY

CIF	Company information form - the MS Excel workbook developed to capture background information about the operator's company and standard operations prior to the trial.
DfT	Department for Transport
Double deck/ dual deck	A specialised trailer with two floors covering all or part of its internal length to allow for more cargo to be loaded.
DSF	Data submission file - the MS Excel workbook developed to allow operators to submit all trial data in the required format for analysis.
Flatbed	A flat trailer with no enclosure or doors. Can be loaded/unloaded from the sides or above and does not require elevated access for forklifts.
FMCG	Fast Moving Consumer Goods - products that are sold quickly and at relatively low cost. Examples include non-durable goods such as soft drinks, toiletries, over-the-counter drugs, processed foods and many other consumables.
FTA	Freight Transport Association
ISO	Containers meeting the international specification for intermodal transport.
Leg	A single journey from A to B.
LST	Longer Semi-Trailer - a trailer exceeding the standard length of 13.6m, towed by a tractor unit (as opposed to standard length trailers).
LST-related	A judgement (on scale of options) of whether or not an incident involving an LST would have happened had the trailer been a standard length.
MOA	Mode of appearance - the physical form of the load, for example standard pallets, loose/ bulk, livestock.
Model Report	A document specifying the conformance criteria for a specific model to be licensed for use on the road, created by the VCA after testing new vehicle types.
PLM	Programme logic model - a diagrammatic representation of the structure of a process for the purposes of evaluation.
QSF	Qualitative survey form - the MS Excel workbook developed to capture qualitative information from operators about their trial experience.
RHA	Road Haulage Association
RST	Regular Semi-Trailer – i.e. up to a maximum length of 13.6m (not requiring a VSO) – sometimes use to refer to a GB standard length HGV trailer.
Skeletal	A skeletal trailer composed of a simple chassis for the mounting of an intermodal trailer.
VCA	The Vehicle Certification Agency is an Executive Agency of the United Kingdom Department for Transport and the United Kingdom's national approval authority for new road vehicles, agricultural tractors and off-road vehicles.
VIN	Vehicle Identification Number - a unique 17-digit identifier required on all vehicles, stamped on the chassis on manufacture.
VSO	Vehicle Special Order - a certificate provided by the VCA to allow vehicles that do not conform to standard legislation in terms of dimensions to operate on roads in Great Britain under specially licensed conditions.

ANNEX 1: ROUTE MAP TO DESCRIPTION OF METHODS

Details of methods, where these have not changed from previous years, can be found in previous annual reports and published project notes as below. AR – Annual Report.

Method / Explanation	Source
Evaluation / Trial Theory of Change (ToC) Programme Logic Model	Not developed before trial, so implied ToC presented in AR2013
Data Framework	AR2012 Original format: Annexes A1-A6 ALSO Published user guide on the DfT website AR2017 – Proposal for revised data framework from 2018
Formal submission compliance (missing/late) process including escalation steps	AR2014
Statistical method for analysis of injury incidents (Classical and Bayesian)	AR2013 Annex C1 and C2 and internal the DfT Project Notes Updated in AR2014 and AR2015
▪ Update for Urban/Rural split	AR2015
▪ Update by road type	AR2017
Distance savings (percent) calculation	First version AR2014 Annex E Refined in subsequent years
Percent savings by operator (chart)	AR2014
Qualitative Survey Results:	
QSF 1 – early qualitative experience	AR2014
QSF 2 – update and take-up estimates	AR2016 (+ summary in 2017)
Full format injury incident table and formal definition of ‘LST-related’	AR2015
Damage event analysis:	
▪ Initial small sample	AR2016
▪ Trial scale estimates	AR2018
Route modelling	AR2017 and published PN E1
Emissions modelling	AR2017 and published PN E2
Intermodal effects	AR2017 and published PN E3
Scaling Up	AR2018 and internal PN E4
Operator conversations	Part 1: AR 2018 and internal PN E5
Trip end / flow analysis	AR2018 and internal PN E6
Special Issues:	
▪ Course correction at speed	AR2017
▪ Kick-Out vs Axle Design	AR2016 and AR2017

ANNEX 2: EVALUATION PROGRESS

Progress against the seven evaluation questions

A2.1 As the trial has progressed, the nature of the questions the Department has wanted addressed has changed slightly and in 2016 we re-articulated the issues above in seven questions, published in the 2016 and 2017 Annual Report Summary. They are shown in the table below, with a summary of the status of the trial in terms of generating sufficient evidence to inform a future impact assessment in each area.

Evaluation question	Status
Q1 What do operators use LSTs for? Q2 What are the savings realised in HGV journeys? Q3 What are the resulting reductions in emissions? Q4 What about safety – will LSTs cause more injuries?	**Q1 to Q4: READY** While the trial continues to gather data in other areas, we believe the evidence we have already gathered in this area would be sufficient to inform a future impact assessment.
Q5 What about damage and the associated costs – will LSTs cause more damage on the roads?	**READY THIS YEAR** The work completed in 2018 has shown that the LSTs in a sample of 91 fleets on the trial are being operated at a lower damage rate per km than the standard length trailers in the same fleets.
Q6 Might any special operational requirements be appropriate for LSTs?	**COMPLETION EXPECTED 2019** The first stage of a series of conversations with operators has been completed, providing an initial list of considerations for future LST good practice and/or regulation. A second stage of this work is planned for Autumn 2019, aiming to produce a first draft 'agreed' list of issues relating to driver training and wider company operational awareness themes for operators of LSTs. In parallel with this work, the DfT wrote to a wide range of industry stakeholders (not just trial operators) inviting their general views on LSTs and potential future regulatory options. We anticipate all this work being completed by Christmas 2019.
Q7 What proportion of the existing GB fleet of semi-trailers might be replaced by LSTs, were numbers not restricted?	**COMPLETION EXPECTED 2019** Initial estimates from the operators on the trial are available and have been used in developing the scaling up model. The DfT's engagement with stakeholders in 2019 is expected to give further insights in this area.

Progress on previous recommendations

A2.2 The table below lists the outstanding recommendations made in previous LST Trial Annual Reports. They are all now either completed or in progress as part of work being carried out in 2019

Area of work recommended	Progress
2016-1 Industry Engagement We recommend that the DfT liaise with FTA, RHA and other stakeholders to arrange a further LST Trial industry forum, ideally during 2017, to communicate with the operators and retain participant engagement, as the trial enters its sixth year and the trial community is extended.	REPLACED BY OPERATOR CONVERSATIONS WORK IN 2019 AND THE DfT DIRECT LETTER TO STAKEHOLDERS (JULY 2019) SEE OTHER ACTIONS BELOW
2016-2 Understanding low efficiency use of LSTs Once the Qualitative Survey (QSF2) analysis is completed, the scope of work for 2017-18 should include further enquiry with operators whose results suggest limited benefits from using LSTs, to better understand the range of factors involved.	COVERED IN OPERATOR CONVERSATIONS EARLY 2019 – SEE OTHER ACTIONS BELOW
2016-3 Technical appraisal of LST 'course correction at speed' The DfT / VCA should consider the questions raised in this report relating to the likely response of an LST using a self-steering / command steered axle to a sudden course correction 'at speed' (e.g. 50 mph).	ACTION PASSED TO THE DfT
2016-4 Understanding the underlying basis for LST design variation The DfT / VCA should consider working with the industry, including manufacturers, to better understand the design and operational choices or requirements that have led to the variety of LST designs with different kick-out measurements.	COVERED IN CONVERSATIONS WITH OPERATORS IN EARLY 2019 SEE ACTION 2017-8 BELOW
2016-5 Increasing data on the relative rate of LST damage incidents to those of all trailers in the fleet of each operator the DfT should consider working with the industry and/or amending the data framework, to assess how many operators experience a difference in damage only incident rates between their LSTs and standard length trailers. This should include work to better understand the impact of route familiarity and equipment awareness, especially on non-trunking operations, on the ability of drivers to operate LSTs without an increased risk of collisions resulting in property damage.	COMPLETED IN THIS REPORT AR2018

Area of work recommended	Progress
2016-6 Increasing data on the nature and severity of damage incidents involving LSTs If the DfT wishes to assess the impact of damage only incidents in more detail, then operator in-house incident severity data for both LSTs and ideally standard length trailers would need to be gathered as part of the standard trial submissions. To achieve this, we would recommend that the incident log template be revised to incorporate including at least narrative evidence of the severity of damage to the trailer and any objects hit in the collision and, potentially, a simple damage impact ranking. This recommendation is subject to the DfT determining whether the value of this additional data justifies the additional reporting requirement on operators.	COMPLETED IN THIS REPORT AR2018
2016-7 Preliminary assessment of future impact of LSTs – scaling up and emissions assessment The DfT should consider including an initial scaling up analysis in their 2017-19 plans for the trial evaluation, to begin assessing the potential future impact of LSTs. This would include work to translate the current distance/journey saving results into measures of reduced emissions/air pollution.	INITIAL MODEL COMPLETED IN PARALLEL WITH THIS REPORT
2016-8 Preliminary exploration of possible post-trial requirements or guidance for operating LSTs The DfT should consider conducting evidence-based conversations between the DfT, the haulage industry and other interested parties such as Local Authorities and civil society groups, regarding what guidance or regulation might be required to maintain the positive results seen on the trial under post-trial conditions.	PART 1 COMPLETED EARLY 2019 PART 2 SCHEDULED FOR AUTUMN 2019 ADDITIONAL INFORMATION BEING COLLECTED BY THE DfT IN RESPONSES TO LETTER TO STAKEHOLDERS JULY 2019

ANNEX 3: THE DATA COLLECTION FRAMEWORK

A3.1 The original data framework for the trial was created by Risk Solutions in early 2012 based on an outline specification developed by the DfT. This original data framework was used, almost unchanged, until the end of 2017, and provided the foundation for much of the analysis presented in the annual reports prior to this one.

A3.2 The framework consisted of a main 'Data Submission File' (DSF) in which operators recorded details of each trailer, information about every individual journey leg undertaken and specific data on any incidents where an LST was being pulled. In addition, operators submitted a separate Company Information Form on joining the trial and occasional qualitative surveys.

A3.3 Changes were made to the data collection template made for 2018 - for reasons put forward in the 2016 Annual Report - which may be briefly summarised as:

- The DfT is satisfied that good information has been received from the individual journey data collected to date to establish patterns and extent of journey savings
- There has been continued good performance on injury incidents
- A small piece of work with a subset of operators has raised questions about damage-only incidents which has indicated that there may be more questions to answer in this area.

A3.4 Information is still submitted every four months, but the nature of the data requested has changed in the following key ways:

- Separate Company Information Forms (CIF) and Qualitative Survey Forms (QSF) are no longer required - a cut-down version of the original CIF, as well as some key qualitative questions, were incorporated into the main data collection template (the DSF) and complete by ALL participants to refresh the company information of all operators at a single point in time.
- The trailer reference information sheet, which captures basic information relating company Trailer IDs to their Vehicle Identification Number (VIN), basic design details and numbers of days 'off the road' in the period, has been reduced in scope and reformatted for ease of completion.
- The detailed leg-by-leg journey log was replaced with a trailer journey summary sheet, requiring data on all journeys on the public road network in the period to be reported in summary form on a per-trailer basis. This is a significantly reduced requirement compared with previous leg-by-leg data collection.
- A more detailed incident log was included; this covered all LST incidents on the public highway and certain types of incident on private property (e.g. in depots, at client sites), with expanded space to provide narrative descriptions of damage, as well as a summary of overall incident rates in the comparable non-LST fleet, including damage-only incidents.

A3.5 Raw data submitted by operators remains confidential. All datasets submitted by trial participants contain commercially sensitive data and are held securely on Risk Solutions' servers or the encrypted computers of the project team. The data files are only accessible by members of the team who have a project-related reason to do so. Risk Solutions does not make raw data available to the DfT or any third parties.

A3.6 The DfT have now agreed that during 2019 we will implement a further revision of the data framework, reducing the detail collected from long-standing LST operators.

Revised utilisation and savings calculation

A3.7 The new data template no longer records leg by leg data and so the previous approach to utilisation calculations, which were done on an individual leg basis using the utilisation provided by operators for each leg, could no longer be used for data collected after 1 January 2018 using the new template.

A3.8 This discontinuity in analysis arising from the change of data collection framework was anticipated and agreed with DfT before the framework change was made.

A3.9 The 2018 template records total number of legs and distance operated either 100% full, 100% empty or, if part full, then the legs and distance with an average fill for that goods type/ leg type/ MOA combination for the particular trailer. Operators running regular operations can typically fill in a single row of data per trailer and are encouraged to complete a comment describing their operation with that trailer, which often includes phrases such as “Full out, back empty”. So although we have slightly less refined numerical information about the loading on individual legs, we have this new qualitative indicator of the journey patterns.

A3.10 Analysis of utilisation has therefore been carried out as follows:

- Legs and distance run 100% full – these are treated as previously, full utilisation of the trailer for the distances and legs recorded.
- Legs and distance run partially full – these are treated as previously - where the % fill level would utilise any part of the additional trailer length, a calculation is carried out to attribute savings proportional to the amount of additional length used, and the distance operated at that fill level.
- Legs run empty – for the return legs calculation, where legs are run empty as part of a trailer operation where some of the legs are also run 100% full, the amount of distance run empty up to the maximum of the 100% full amount is attributed to the empty legs from the same rows (goods type/ leg type/ MOA) as the 100% full legs. No additional amount has been allowed for any almost-full return leg backhauls.

A3.11 Utilisation has been calculated at the trailer level, rather than the leg level, and then averaged over each operator’s operation. Since the fill levels are all expressed as percentages, the length of the trailer (14.6 or 15.65) is also taken into account. The same basic principle to calculate the savings has been used as previously:

- For a 15.65m trailer the percentage saving for each journey is assumed to be:
- 0.15*(([Actual Utilisation]-0.87)/0.13)
- For a 14.6m trailer the percentage saving for each journey is assumed to be:
- 0.07*(([Actual Utilisation]-0.91)/0.09)
- The total percentage saving is then given by:
- Distance saved/(Distance saved + Distance operated)
- The maximum saving for a 15.65m trailer is 13% and for a 14.6m trailer is 9%.

A3.12 It should be noted that with the simplification of the data collection template, it appears that more operators are recording a simpler operating pattern of full out and empty returns for their trailers where in the previous system, an individual leg loaded might not have been treated as full if the calculation had estimates it to be 98% or 99%, which in real world terms, would be effectively full.

ANNEX 4: JOURNEY END AND FLOW ANALYSIS

Introduction

Background

A4.1 At the September 2018 event held by the DfT to launch the 2017 Trial Annual Report, some stakeholders asked for publication of more detailed information on the locations and routes being used by the LSTs on the trial.

A4.2 The DfT explained that detailed GIS data on LST delivery points could not be published as that information was provided to Risk Solutions under very strict confidentiality agreements.

A4.3 Two suggestions were made by stakeholders that the DfT agreed might provide information of interest and value to trial stakeholders, without going into the level of detail that would breach the confidentiality commitments. These were:

1. **An analysis of journey end point activity by local authority (LA)**
2. **An analysis of the flow of LSTs within and between regions (NUTS1 level)**

Note: An 'end-point' is where a stop is recorded in the journey data submitted for each LST by the operator, this may be for a number of reasons but is principally to deliver or pick up cargo. Nomenclature of Territorial Units for Statistics or NUTS is a geocode standard, developed and regulated by the European Union, for referencing the subdivisions of countries for statistical purposes. The NUTS 1 level in the UK consists of Wales, Scotland, Northern Ireland, and nine regions in England

A4.4 The DfT and Risk Solutions considered the possible range of approaches to this work and in April 2019 and the DfT included it in a package of further activities on the trial.

Scope of work

A4.5 The scope of work was to produce **publishable** analysis covering the two topics suggested by stakeholders, as noted above.

Methodology

A4.6 The work built on the platform of the 2017 LST routing model, which already contained part of the data and functionality required for this analysis. As with the routing work, this analysis was performed on the full operational dataset of journeys made in 2017.

A4.7 The key tasks required were:

- Map all road network links from the 2017 Route Modelling work to the LA and NUTS1 GIS layers to:
  - geo-locate all LST start/end points
  - identify all 'pass-through' LST movements.
- Generate meta-data for mapping analysis to allow mapping to be explored by activity, distance savings and tonnes lifted.
- Perform analysis of all LST stopping and pass-through activity, distance and tonnes lifted by LA and NUTS1 region.
- Explore visualisation options for LA journey end points and pass-through activity and NUTS1 region flow results.

- Select best visualisations and refinement for report.
- Draft Project Note E6 and finalise following the DfT comment.

Data sources

A4.8 The work made use of the data sources shown in Table 4.

Table 21: Data sources for LST movement pattern analysis

Data	Source
Local Authority Boundaries	ESRI LA area shape file (Local_Authority_Districts_December_2017_Generalised_Clipped_Boundaries_in_Great_Britain)
UK Region Boundaries	ESRI NUTS Level 1 area shape file (NUTS_Level_1_January_2018_Full_Clipped_Boundaries_in_the_United_Kingdom)
LST start and end point data	Start and end locations (postcodes) in 2017 provided by operators through their DSF returns (816,000 journeys with valid data ~95% of the total of 861,000 LST legs)
LST Journey Information	Risk Solutions' LST modelled journeys from all start/end locations (postcodes) in 2017 with valid data
Road Network	Ordnance Survey (OS) MasterMap Integrated Transport Network (ITN) (2016-17)

Note that the road network data source is the map available in 2016 when the routing model was first developed. It would still be largely correct for the 2017 data sample. To upgrade the model to use the upgraded MasterMap issued later in 2016 would have required further work without commensurate added value for this specific task

Detailed mapping and analysis

A4.9 Every LST modelled route consists of a list of OS ITN road links. We mapped all the links, which the 2017 Route Modelling work concluded were used for at least one LST journey, to the local authority area and NUTS1 GIS shape files. With this mapping we were therefore able to identify every local authority and NUTS1 region included in each LST route.

A4.10 This provided a dataset aggregating all the LST journeys in 2017 by local authority area and NUTS1 region to give:

- the number of journey stops in each area (departures from origin and arrivals at destination)
- the number of journeys that pass-through each area (without stops)
- the sum of:
  - weight of goods moved
  - aggregate equivalent 13.6m trailer loads moved (from Deck%), and
  - vehicle km driven.

A4.11 From this, we calculated the implied savings for each local authority area and NUTS1 region, in terms of stop counts, pass-through journeys, goods moved, and vehicle km driven – all as totals in the sample year (2017).

A4.12 These aggregate datasets were explored using a number of visualisation options.

Heatmap visualisation options

A4.13 In producing the heatmaps, we considered a number of ways of grouping data into bands for each heat colour, conscious that the data being presented is not homogeneous, in that:

- The operators have diverse sizes of LST fleet from 1 to 160 or more – skewing the operations naturally towards high LST activity near the locations of the home depots of the larger fleets
- The local authorities differ in geographical size, but also the length of trunk, principal and minor roads in their area, and different populations exposed to the LST activity.

A4.14 Mapping the data in QGIS, we reviewed the data banding approaches offered, and narrowed our choice down to the three options illustrated in Figure 24.

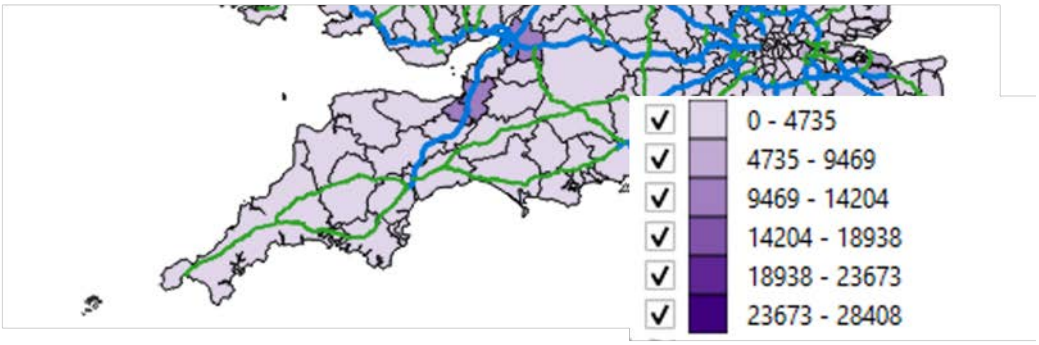
A4.15 The simplest choice is ‘EQUAL’ bands, in which each band is the same size, with ‘PRETTY’ being a similar approach, but with the band thresholds rounded. While these choices present the data simply, they provide very little insight into the contrast between LAs, because of the dominance of the data from the very large fleets in the higher bands.

A4.16 The ‘NATURAL’ option uses the Jenks natural breaks clustering algorithm, in which bands are based on natural groupings inherent in the data. Band breaks are identified that best group similar values and that maximize the differences between bands. The effect is to give a mapping that more clearly shows differences between the areas, but for which the reader must carefully note the band sizes in the key.

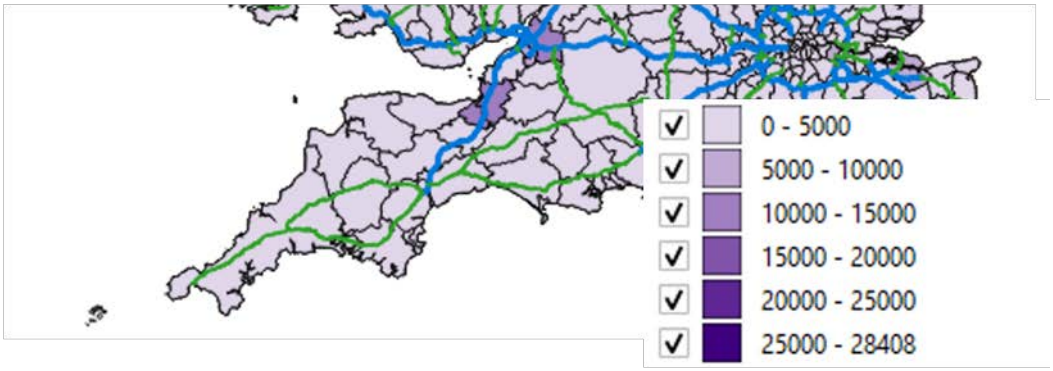
A4.17 Our recommendation to the DfT was to use a single option for clarity of communication in this Annual Report and that the NATURAL banding approach should be used as it most clearly conveys differences in LST activity levels between local authorities.

Figure 24: Heatmap scale options illustration (LST Stops by LA)

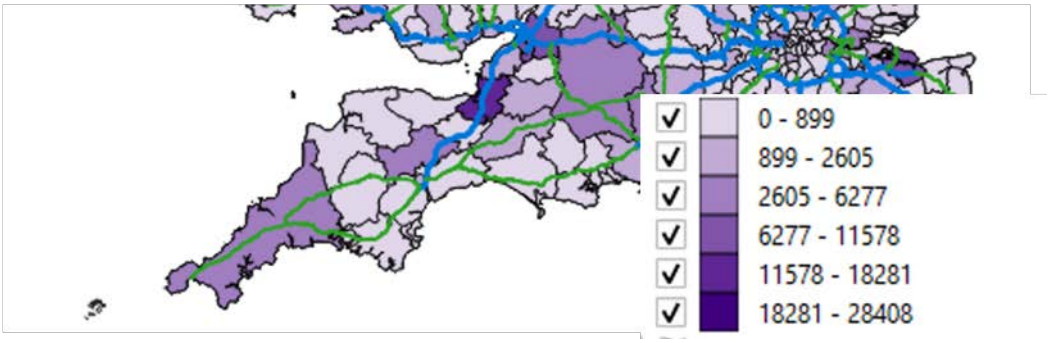
SCALE: EQUAL



SCALE: PRETTY



SCALE: NATURAL



Results: Detailed tables of values

A4.18 The heatmaps and summary tables of results are presented in the main body of this report. Here we present the detailed tables of values and matrices that underpin the summary results.

LST activity by local authority

A4.19 Table 22 is based on the 2017 journey data for which we had complete data, which is around 816,000 journeys - ~95% of the total of 861,000 LST legs.

A4.20 The data fields in Table 22 are defined as follows:

Data Field	Description
LST Stopping journeys (count)	Number of journeys involving a stop within the LA to e.g. deliver or collect cargo
LST Pass-through (Count)	LST Journeys passing through the LA without stopping
Estimated Savings in stops and pass-through journeys	Estimated saving of stops / pass-through journeys by 13.6m trailers by using LSTs to carry the same cargo (measured by deck % used)
LST Distance Operated	The total distance covered by LSTs in the LA, with a breakdown of the % on each road type
% TRUNK	SRN in England and the equivalents in the devolved nations
% PRINCIPAL	A-Roads that are not TRUNK - managed by local authorities
% MINOR	B and other road classes

Table 22: LST Activity by Local Authority

AUTHORITY	Stops (Count)	Pass-through (Count)	Stops SAVED (Count)	Pass-through SAVED (Count)	Total Distance [km]	% Minor	% Princi-pal	% Trunk
Aberdeen City	2,883	2,842	208	201	69,830	6%	33%	61%
Aberdeenshire	4,458	2,331	297	205	322,258	1%	9%	89%
Adur	20	696	0	86	5,220	0%	2%	98%
Allerdale	727	96	29	4	29,954	10%	52%	38%
Amber Valley	2,252	16,670	162	1,415	301,519	1%	2%	98%
Angus	2,101	6,085	153	491	302,208	1%	6%	93%
Argyll and Bute	11	117	1	5	6,075	1%	4%	95%
Arun	320	467	38	12	7,667	3%	59%	38%
Ashfield	1,427	30,650	65	2,945	202,727	1%	7%	91%
Ashford	108	666	4	82	16,885	0%	10%	89%
Aylesbury Vale	510	5,339	20	270	53,073	1%	76%	23%
Babergh	4,195	3,522	373	242	141,870	3%	44%	54%

AUTHORITY	Stops (Count)	Pass-through (Count)	Stops SAVED (Count)	Pass-through SAVED (Count)	Total Distance [km]	% Minor	% Princi-pal	% Trunk
Barking and Dagenham	805	5,476	31	353	30,014	3%	97%	0%
Barnet	65	8,099	1	501	96,454	0%	37%	63%
Barnsley	5,881	19,511	366	1,468	401,542	2%	10%	88%
Barrow-in-Furness	3,237	0	298	0	26,170	5%	35%	59%
Basildon	4,341	966	363	106	31,493	12%	89%	0%
Basingstoke and Deane	3,162	15,344	248	1,284	349,332	1%	10%	89%
Bassetlaw	4,248	12,460	250	814	402,456	1%	12%	87%
Bath and North East Somerset	138	2,141	6	120	34,880	1%	46%	53%
Bedford	5,840	9,685	264	703	162,690	2%	8%	91%
Bexley	9,862	1,880	464	148	57,469	9%	91%	0%
Birmingham	9,466	92,337	882	9,184	1,114,915	1%	43%	56%
Blaby	1,391	45,784	113	4,120	441,322	1%	7%	93%
Blackburn with Darwen	1,796	2,902	113	223	31,244	5%	55%	39%
Blackpool	144	650	1	67	1,739	1%	92%	7%
Blaenau Gwent	516	537	50	49	8,971	6%	13%	81%
Bolsover	1,155	50,665	42	4,537	591,487	0%	3%	97%
Bolton	6,178	5,984	556	420	129,291	5%	25%	70%
Boston	6,940	1,952	504	143	229,692	5%	95%	0%
Bournemouth	387	1,561	9	195	8,029	0%	100%	0%
Bracknell Forest	3,013	420	352	26	20,036	9%	92%	0%
Bradford	7,492	1,475	342	56	87,601	4%	81%	16%
Braintree	2,085	11,544	187	344	92,704	6%	12%	82%
Breckland	5,851	5,321	573	636	207,935	6%	9%	85%
Brent	2,033	2,297	77	268	18,194	13%	87%	0%
Brentwood	455	24,034	24	2,125	145,032	0%	20%	80%
Bridgend	636	3,911	13	259	74,921	1%	5%	94%
Brighton and Hove	210	1,657	9	141	15,833	1%	4%	95%
Bristol City of	13,836	35,699	547	2,447	280,307	7%	14%	79%
Broadland	1,296	3,073	95	445	42,852	2%	6%	92%
Bromley	28	2,730	1	29	8,017	0%	97%	2%
Bromsgrove	2,430	46,910	190	3,328	735,100	0%	9%	90%
Broxbourne	517	539	12	6	5,154	14%	86%	0%
Broxtowe	870	30,183	181	2,846	367,791	0%	4%	96%
Burnley	1,560	1,733	219	93	17,945	5%	19%	75%
Bury	1,568	29,484	195	2,292	231,841	4%	4%	92%

AUTHORITY	Stops (Count)	Pass-through (Count)	Stops SAVED (Count)	Pass-through SAVED (Count)	Total Distance [km]	% Minor	% Princi-pal	% Trunk
Caerphilly	917	736	54	77	18,280	6%	81%	14%
Calderdale	1,687	25,088	113	2,054	371,060	0%	6%	93%
Cambridge	927	14,947	89	973	12,217	4%	32%	64%
Camden	37	5,871	4	325	14,019	0%	100%	0%
Cannock Chase	3,282	18,108	281	2,023	82,114	4%	2%	94%
Canterbury	961	631	113	44	24,911	5%	30%	65%
Cardiff	3,851	9,136	140	627	189,011	3%	24%	73%
Carlisle	10,129	37,972	574	3,179	1,130,947	1%	8%	91%
Carmarthenshire	1,808	528	154	38	58,450	4%	13%	83%
Castle Point	1,332	90	180	3	5,226	4%	97%	0%
Central Bedfordshire	4,634	42,339	284	2,917	1,096,078	1%	2%	97%
Ceredigion	807	16	62	1	21,801	2%	15%	82%
Charnwood	209	37,395	10	3,914	226,980	0%	13%	86%
Chelmsford	1,075	4,456	89	404	97,086	1%	10%	89%
Cheltenham	634	67	35	2	1,242	45%	55%	0%
Cherwell	718	12,520	15	913	413,682	0%	2%	98%
Cheshire East	6,115	101,272	401	8,954	2,623,574	0%	9%	90%
Cheshire West and Chester	37,136	88,517	3,132	7,675	1,618,544	2%	24%	74%
Chesterfield	4,121	48,082	306	4,456	236,002	1%	8%	91%
Chichester	1,734	34	45	1	21,111	11%	2%	87%
Chiltern	116	12,931	4	696	34,572	0%	1%	99%
Chorley	7,234	46,725	734	4,050	539,477	1%	2%	97%
Christchurch	72	18	1	0	290	48%	52%	0%
City of Edinburgh	6,840	20,359	487	1,802	276,521	1%	28%	70%
City of London	5	2,735	0	32	4,396	0%	100%	0%
Clackmannanshire	7,858	219	716	10	64,405	7%	69%	24%
Colchester	177	5,187	7	371	77,062	1%	2%	97%
Conwy	38	2,179	2	158	77,126	0%	0%	100%
Copeland	142	4	5	0	2,167	15%	31%	55%
Corby	2,169	2,507	129	294	29,247	3%	97%	0%
Cornwall	5,867	1	398	0	313,890	3%	9%	87%
Cotswold	415	3,536	16	325	94,770	1%	27%	72%
County Durham	16,222	26,930	1,730	2,339	1,020,558	1%	6%	93%
Coventry	1,186	71,406	69	6,237	306,744	2%	12%	86%
Craven	1,080	1,316	54	75	47,992	0%	100%	0%
Crawley	999	2,206	48	194	31,141	4%	19%	77%
Croydon	79	320	2	26	3,297	5%	95%	0%

AUTHORITY	Stops (Count)	Pass-through (Count)	Stops SAVED (Count)	Pass-through SAVED (Count)	Total Distance [km]	% Minor	% Princi-pal	% Trunk
Dacorum	4,293	34,284	508	2,405	166,928	3%	1%	95%
Darlington	3,023	23,059	186	2,040	203,021	2%	3%	95%
Dartford	5,493	17,173	529	1,560	204,905	1%	13%	87%
Daventry	19,774	70,660	1,144	5,944	1,619,795	1%	1%	98%
Denbighshire	1,042	2,192	78	159	47,051	3%	11%	87%
Derby	1,311	17,461	65	1,482	160,128	0%	5%	94%
Derbyshire Dales	253	26,359	8	2,531	258,586	1%	28%	71%
Doncaster	7,824	49,794	370	4,335	1,320,999	1%	4%	95%
Dover	655	21	36	0	5,688	13%	6%	81%
Dudley	250	18,426	6	1,373	101,847	1%	24%	75%
Dumfries and Galloway	7,745	33,627	640	2,680	2,609,870	1%	1%	98%
Dundee City	2,045	7,932	154	641	98,420	2%	7%	91%
Ealing	7,040	4,042	493	251	66,896	14%	86%	0%
East Ayrshire	2,588	8,289	131	539	228,786	2%	24%	74%
East Cambridgeshire	10,781	10,891	955	974	296,302	2%	31%	67%
East Devon	832	8,011	46	572	98,573	0%	4%	96%
East Dorset	90	2,186	6	210	22,490	2%	49%	48%
East Dunbartonshire	1,341	4,988	120	245	7,995	44%	56%	0%
East Hampshire	1,398	2,093	42	100	93,750	2%	1%	97%
East Hertfordshire	195	467	3	20	8,638	3%	97%	0%
East Lindsey	1,212	137	97	5	36,272	8%	92%	0%
East Lothian	2,356	3,249	95	233	123,125	2%	4%	94%
East Northamptonshire	3,703	29,561	430	2,511	537,973	1%	49%	50%
East Renfrewshire	562	13,484	42	944	150,575	0%	0.2%	100%
East Riding of Yorkshire	6,162	7,120	449	470	271,291	5%	23%	73%
East Staffordshire	26,005	28,231	2,293	2,671	724,785	6%	14%	79%
Eastbourne	812	0	94	0	1,950	23%	77%	0%
Eastleigh	4,018	7,224	178	620	70,818	6%	11%	83%
Eden	9,157	35,757	674	3,111	2,272,553	0%	0.7%	99%
Elmbridge	171	8,318	2	797	32,706	0%	1%	99%
Enfield	2,469	17,060	88	1,520	227,155	1%	13%	86%
Epping Forest	2,502	22,266	129	1,933	377,670	1%	2%	97%
Epsom and Ewell	10	12	0	0	100	22%	78%	0%
Erewash	1,631	44,693	82	4,192	279,940	1%	1%	98%
Exeter	2,494	6,178	87	512	34,727	5%	5%	90%

AUTHORITY	Stops (Count)	Pass-through (Count)	Stops SAVED (Count)	Pass-through SAVED (Count)	Total Distance [km]	% Minor	% Princi-pal	% Trunk
Falkirk	25,320	15,709	1,720	1,370	514,376	4%	15%	81%
Fareham	396	2,169	9	103	22,543	1%	29%	70%
Fenland	12,403	7,332	1,457	1,079	177,567	6%	31%	64%
Fife	30,317	10,648	2,223	1,048	833,856	11%	26%	64%
Flintshire	15,293	9,245	1,467	711	190,401	10%	28%	61%
Forest Heath	1,051	14,577	46	1,197	231,744	0%	3%	96%
Forest of Dean	1,030	6,575	44	524	90,620	6%	15%	79%
Fylde	810	2,345	72	268	47,180	1%	6%	93%
Gateshead	2,155	12,551	240	865	127,275	2%	36%	62%
Gedling	1,117	87	66	3	3,235	34%	66%	0%
Glasgow City	13,782	42,221	856	3,321	556,708	3%	11%	87%
Gloucester	2,134	1,381	120	94	22,592	10%	85%	5%
Gosport	1,731	0	94	0	3,550	33%	67%	0%
Gravesham	2,356	9,716	220	1,041	101,762	2%	3%	96%
Great Yarmouth	1,499	942	42	112	11,185	5%	8%	88%
Greenwich	864	5,613	65	198	45,977	1%	99%	0%
Guildford	390	10,956	5	914	108,796	0%	4%	96%
Gwynedd	1,706	1,259	114	106	50,342	4%	13%	83%
Hackney	307	5,286	41	226	10,808	6%	94%	0%
Halton	9,426	22,284	498	2,095	240,547	3%	48%	49%
Hambleton	6,875	37,542	591	3,662	900,154	3%	1%	96%
Hammersmith and Fulham	19	5,629	1	399	11,724	3%	97%	0%
Harborough	9,683	80,643	581	6,685	614,459	2%	10%	89%
Haringey	42	2,280	1	2	5,802	1%	99%	0%
Harlow	503	4,916	23	326	12,845	15%	43%	42%
Harrogate	1,933	40,480	102	3,938	1,341,893	0%	2%	98%
Harrow	368	6,281	47	308	11,072	1%	18%	81%
Hart	523	13,049	61	1,141	156,435	0%	7%	93%
Hartlepool	1,894	8,908	143	1,165	71,254	2%	16%	82%
Hastings	499	22	66	0	2,689	5%	83%	12%
Havant	268	2,890	4	116	29,591	0%	1%	99%
Havering	1,335	27,954	49	2,419	298,157	0%	11%	89%
Herefordshire County of	5,495	4,991	327	444	281,526	5%	29%	66%
Hertsmere	893	25,226	97	1,925	226,735	0%	2%	98%
High Peak	1,498	2,181	86	236	54,199	5%	82%	12%
Highland	2,675	30	284	2	239,196	2%	1%	97%
Hillingdon	847	21,286	29	1,160	103,975	2%	30%	69%

AUTHORITY	Stops (Count)	Pass-through (Count)	Stops SAVED (Count)	Pass-through SAVED (Count)	Total Distance [km]	% Minor	% Princi-pal	% Trunk
Hinckley and Bosworth	3,687	45,608	226	4,624	431,735	2%	33%	65%
Horsham	231	654	10	49	22,396	2%	98%	0%
Hounslow	2,474	6,900	49	402	48,013	2%	50%	47%
Huntingdonshire	3,972	47,075	267	4,222	1,356,925	1%	8%	91%
Hyndburn	2,418	3,285	184	312	35,388	2%	11%	86%
Inverclyde	124	6	5	1	1,732	7%	18%	75%
Ipswich	997	2,636	72	200	4,566	50%	17%	33%
Isle of Anglesey	461	0	43	0	14,434	1%	2%	97%
Islington	16	5,268	1	226	19,916	0.1%	100%	0%
Kensington and Chelsea	12	5,336	1	395	12,204	1%	99%	0%
Kettering	31,369	21,712	2,481	2,099	829,591	2%	9%	89%
King's Lynn and West Norfolk	2,397	6,276	200	917	253,656	2%	43%	55%
Kingston upon Hull City of	1,110	624	48	80	16,105	2%	52%	46%
Kingston upon Thames	24	537	1	48	3,026	2%	98%	0%
Kirklees	1,073	31,109	63	2,381	503,773	0%	9%	91%
Knowsley	2,924	8,124	357	673	42,721	5%	62%	33%
Lambeth	6	2,834	0	106	8,282	4%	96%	0%
Lancaster	5,837	34,132	490	2,986	913,944	0%	2%	98%
Leeds	15,287	79,875	1,228	6,701	1,698,002	0%	13%	87%
Leicester	23,119	3,845	2,170	416	91,383	23%	75%	2%
Lewes	23	1,028	1	56	15,649	0%	1%	99%
Lewisham	11	5,545	1	137	26,953	0%	100%	0%
Lichfield	19,997	29,963	2,092	2,792	863,737	3%	22%	75%
Lincoln	750	6,170	34	591	15,154	6%	61%	33%
Liverpool	4,617	1,231	401	50	21,021	18%	81%	2%
Luton	3,289	32,120	48	2,471	63,111	1%	27%	72%
Maidstone	5,580	15,722	550	1,951	208,867	5%	34%	61%
Maldon	620	0	79	0	3,347	25%	75%	0%
Malvern Hills	283	43,090	17	3,082	550,153	0%	5%	95%
Manchester	5,431	14,041	227	1,228	150,243	1%	27%	72%
Mansfield	2,768	528	129	34	16,396	7%	93%	0%
Medway	3,016	9,589	252	1,101	75,601	2%	9%	89%
Melton	88	956	4	79	2,754	4%	29%	67%
Mendip	2,523	1,486	125	96	55,887	5%	71%	24%
Merthyr Tydfil	52	747	1	77	7,598	1%	0%	99%

AUTHORITY	Stops (Count)	Pass-through (Count)	Stops SAVED (Count)	Pass-through SAVED (Count)	Total Distance [km]	% Minor	% Princi-pal	% Trunk
Merton	2,144	650	132	10	10,703	34%	66%	0%
Mid Devon	9,744	8,963	352	783	348,177	3%	17%	80%
Mid Suffolk	2,657	5,290	114	435	201,175	5%	26%	69%
Mid Sussex	81	1,895	2	154	43,571	2%	1%	98%
Middlesbrough	919	10,161	38	1,260	62,735	0%	10%	90%
Midlothian	3,204	5,206	257	337	70,201	1%	21%	78%
Milton Keynes	26,525	31,635	1,095	2,266	831,075	4%	22%	73%
Mole Valley	156	7,800	1	749	107,092	0%	8%	92%
Monmouthshire	1,068	18,036	59	1,259	303,377	0%	1%	99%
Moray	124	24	7	1	4,027	6%	23%	71%
Neath Port Talbot	1,023	3,987	36	298	91,283	1%	4%	95%
New Forest	2,299	2,049	148	216	53,285	15%	24%	62%
Newark and Sherwood	9,912	18,236	985	1,359	518,068	1%	8%	91%
Newcastle upon Tyne	267	9,035	12	461	64,161	0%	39%	61%
Newcastle-under-Lyme	3,483	81,063	275	6,795	1,176,088	0%	8%	92%
Newham	1,303	4,612	1	363	24,455	0.1%	100%	0%
Newport	3,024	14,602	229	955	339,309	0%	5%	95%
North Ayrshire	8,033	6	492	0	86,118	13%	57%	30%
North Devon	1,521	1,121	96	136	101,026	5%	95%	0%
North Dorset	611	1,507	60	78	34,479	2%	89%	10%
North East Derbyshire	1,778	51,078	76	4,697	496,922	0%	6%	93%
North East Lincolnshire	6,071	744	553	41	83,645	11%	20%	68%
North Hertfordshire	1,092	6,534	38	450	129,903	3%	29%	67%
North Kesteven	1,445	10,437	181	843	264,644	2%	64%	35%
North Lanarkshire	50,941	34,587	3,770	2,942	1,131,520	6%	4%	89%
North Lincolnshire	14,549	5,223	907	565	433,722	5%	25%	69%
North Norfolk	2,683	46	382	5	30,772	5%	95%	0%
North Somerset	2,511	35,486	178	2,363	1,065,299	0%	1%	98%
North Tyneside	7,296	1,745	328	129	23,894	13%	63%	24%
North Warwickshire	46,008	91,318	5,674	7,509	1,803,524	4%	5%	91%
North West Leicestershire	19,684	37,668	2,133	3,576	959,350	2%	10%	88%
Northampton	8,997	2,715	582	164	80,965	10%	44%	46%
Northumberland	8,311	6,592	718	428	519,182	1%	22%	76%
Norwich	637	387	36	52	6,104	5%	95%	0%

AUTHORITY	Stops (Count)	Pass-through (Count)	Stops SAVED (Count)	Pass-through SAVED (Count)	Total Distance [km]	% Minor	% Princi-pal	% Trunk
Nottingham	1,539	8,067	57	700	76,832	1%	62%	36%
Nuneaton and Bedworth	5,868	61,457	567	5,116	181,430	3%	29%	68%
Oadby and Wigston	75	690	6	137	2,333	5%	95%	0%
Oldham	2,001	5,392	135	261	60,134	4%	39%	57%
Oxford	29	1,459	1	90	8,659	0%	100%	0%
Pembrokeshire	614	0	38	0	16,305	6%	2%	92%
Pendle	960	1,200	25	68	21,208	2%	56%	43%
Perth and Kinross	4,983	11,572	282	1,020	910,534	1%	2%	97%
Peterborough	6,826	31,488	1,109	3,034	543,506	3%	51%	46%
Plymouth	1,507	878	29	48	17,640	10%	43%	46%
Poole	777	1,407	47	162	14,109	4%	96%	0%
Portsmouth	625	1,671	8	85	8,608	1%	1%	98%
Powys	439	975	35	69	85,824	4%	5.6%	91%
Preston	9,091	39,299	666	3,478	527,363	3%	1%	96%
Purbeck	1,031	664	152	20	13,088	12%	85%	3%
Reading	490	11,273	31	750	32,112	1%	10%	89%
Redbridge	91	3,173	1	176	23,006	0%	86%	15%
Redcar and Cleveland	1,254	27	47	2	6,038	12%	88%	0%
Redditch	993	1,504	39	109	5,960	26%	74%	0%
Reigate and Banstead	338	7,869	11	743	76,195	0%	3%	97%
Renfrewshire	18,608	1,374	1,713	97	175,063	12%	11%	78%
Rhondda Cynon Taf	4,163	5,256	312	344	73,872	3%	12%	85%
Ribble Valley	881	1,859	48	136	17,217	6%	94%	0%
Richmond upon Thames	8	3,007	0	51	7,373	9%	91%	0%
Richmondshire	448	32,444	26	2,789	731,758	0%	0%	100%
Rochdale	18,815	22,723	1,489	1,777	457,413	4%	5%	91%
Rochford	76	242	3	13	747	27%	73%	0%
Rossendale	1,766	2,660	171	269	26,243	1%	2%	97%
Rother	262	1,004	25	140	22,741	15%	18%	67%
Rotherham	3,513	50,035	223	4,569	785,934	0%	3%	96%
Rugby	9,890	69,100	570	6,048	1,194,984	1%	3%	95%
Runnymede	178	17,390	3	1,317	167,951	0%	1%	99%
Rushcliffe	1,164	8,871	129	785	256,376	0%	8%	92%
Rushmoor	421	11,975	48	1,078	40,243	1%	5%	94%
Rutland	3,601	14,495	477	1,122	291,596	2%	17%	82%

AUTHORITY	Stops (Count)	Pass-through (Count)	Stops SAVED (Count)	Pass-through SAVED (Count)	Total Distance [km]	% Minor	% Princi-pal	% Trunk
Ryedale	298	6,932	11	966	327,927	0%	0.4%	99%
Salford	3,633	42,030	355	3,489	570,646	1%	7%	92%
Sandwell	5,174	57,691	488	4,283	368,065	1%	11%	89%
Scarborough	7,445	28	1,045	1	43,447	34%	21%	45%
Scottish Borders	3,303	2,959	294	237	177,048	1%	22%	77%
Sedgemoor	25,366	15,879	1,617	1,053	956,484	2%	10%	88%
Sefton	793	1,117	40	36	12,781	3%	29%	68%
Selby	2,635	57,360	117	5,661	405,446	1%	4%	95%
Sevenoaks	208	9,902	4	950	210,151	0%	11%	89%
Sheffield	2,510	18,918	118	1,385	238,014	1%	14%	84%
Shepway	465	256	57	25	8,345	2%	12%	86%
Shropshire	17,406	10,605	493	959	637,523	2%	54%	44%
Slough	4,786	19,067	40	1,131	97,303	7%	12%	82%
Solihull	41,712	53,232	4,992	4,012	808,418	10%	17%	73%
South Ayrshire	1,947	424	102	37	71,888	9%	7%	84%
South Bucks	181	23,967	6	1,291	243,124	0%	3%	97%
South Cambridgeshire	3,601	29,089	265	1,944	1,020,044	0%	21%	79%
South Derbyshire	7,887	37,578	817	3,458	661,156	0%	8%	91%
South Gloucestershire	19,171	46,426	1,302	2,982	1,396,275	3%	6%	91%
South Hams	731	1,687	15	65	61,203	1%	2%	97%
South Holland	4,743	9,257	267	1,141	202,746	4%	90%	6%
South Kesteven	4,211	17,310	190	1,435	534,955	2%	7%	91%
South Lakeland	3,968	33,203	290	2,946	1,189,346	0%	1%	98%
South Lanarkshire	20,385	43,229	1,830	3,405	2,315,344	1%	1%	98%
South Norfolk	2,201	6,722	136	731	212,613	1%	45%	54%
South Northamptonshire	261	54,166	5	3,904	877,615	0%	1%	99%
South Oxfordshire	1,403	4,586	46	276	114,441	1%	10%	89%
South Ribble	10,278	46,117	789	4,088	420,597	3%	6%	92%
South Somerset	2,113	1,066	93	68	66,400	5%	40%	55%
South Staffordshire	2,842	73,311	243	5,749	1,324,262	0%	2%	98%
South Tyneside	72	4,190	3	507	7,708	0%	33%	67%
Southampton	1,079	5,036	72	299	9,997	8%	37%	56%
Southend-on-Sea	26	59	0	3	534	13%	87%	0%
Southwark	20	5,553	1	138	23,130	0%	100%	0%
Spelthorne	117	11,941	4	685	38,926	0%	0.2%	100%
St Albans	1,438	37,653	144	2,810	514,565	0%	25%	75%

AUTHORITY	Stops (Count)	Pass-through (Count)	Stops SAVED (Count)	Pass-through SAVED (Count)	Total Distance [km]	% Minor	% Princi-pal	% Trunk
St Edmundsbury	9,652	5,820	235	554	170,914	2%	49%	49%
St. Helens	15,477	57,350	1,264	5,422	516,950	2%	18%	80%
Stafford	15,121	73,206	467	6,481	1,571,111	1%	2%	97%
Staffordshire Moorlands	3,139	22,095	313	2,170	173,515	1%	19%	80%
Stevenage	107	6,923	5	452	38,134	0%	2%	98%
Stirling	4,444	10,570	228	853	322,488	1%	7%	91%
Stockport	3,084	6,091	291	457	91,134	2%	31%	67%
Stockton-on-Tees	1,886	10,063	80	1,261	168,204	0%	3%	96%
Stoke-on-Trent	7,364	23,011	819	2,252	291,391	2%	4%	93%
Stratford-on-Avon	979	27,027	53	1,805	362,424	1%	3%	96%
Stroud	301	35,197	16	2,391	1,003,164	0%	0%	99%
Suffolk Coastal	773	72	59	2	12,156	16%	28%	56%
Sunderland	8,377	1,795	949	154	116,952	7%	46%	46%
Surrey Heath	121	13,087	3	1,184	174,450	0%	4%	96%
Sutton	874	533	32	49	1,412	94%	6%	0%
Swale	16,502	597	2,087	38	171,534	16%	2%	82%
Swansea	2,346	1,996	128	179	48,635	6%	21%	73%
Swindon	6,543	10,570	285	685	220,143	5%	9%	86%
Tameside	1,686	4,302	107	253	42,609	6%	10%	84%
Tamworth	2,179	3,993	194	356	31,611	1%	1%	97%
Tandridge	159	8,570	2	882	128,047	0%	24%	76%
Taunton Deane	1,600	17,363	93	1,116	389,492	0%	3%	96%
Teignbridge	823	6,554	59	480	165,832	0%	1%	99%
Telford and Wrekin	6,792	8,606	634	339	175,730	4%	83%	13%
Tendring	2,598	2,545	197	178	27,449	11%	15%	74%
Test Valley	7,522	9,956	527	862	204,500	3%	9%	88%
Tewkesbury	2,543	42,141	170	2,998	847,936	0%	1%	99%
Thanet	116	7	11	0	1,502	6%	94%	0%
Three Rivers	177	19,539	5	1,045	203,010	0%	0%	100%
Thurrock	7,857	17,403	443	1,679	201,052	4%	19%	77%
Tonbridge and Malling	3,327	17,158	185	2,038	202,389	1%	10%	89%
Torbay	28	0	1	0	161	19%	81%	0%
Torfaen	885	57	55	2	4,810	37%	16%	47%
Torridge	2,211	4,563	222	339	38,485	8%	20%	72%
Tower Hamlets	26	5,553	0	267	22,959	0.0%	100%	0%
Trafford	16,471	1,940	1,648	213	90,164	14%	35%	51%
Tunbridge Wells	141	2,237	2	273	32,633	10%	87%	3%

AUTHORITY	Stops (Count)	Pass-through (Count)	Stops SAVED (Count)	Pass-through SAVED (Count)	Total Distance [km]	% Minor	% Princi-pal	% Trunk
Uttlesford	167	9,745	4	627	287,249	0%	0%	100%
Vale of Glamorgan	1,094	5,233	62	293	28,870	11%	33%	56%
Vale of White Horse	1,230	8,117	68	585	268,636	1%	15%	84%
Wakefield	42,810	47,693	2,682	4,389	1,230,923	3%	7%	90%
Walsall	5,275	74,556	419	6,115	539,535	1%	9%	90%
Waltham Forest	632	2,380	53	125	11,147	3%	97%	0%
Wandsworth	13	2,218	1	92	15,784	0%	100%	0%
Warrington	28,635	86,863	1,951	7,990	1,339,047	2%	13%	85%
Warwick	5,800	9,187	683	680	193,585	3%	8%	89%
Watford	332	6,281	40	308	18,785	1%	10%	88%
Waveney	4,640	14	531	1	17,243	34%	47%	19%
Waverley	172	3,000	4	174	40,048	0%	4%	96%
Wealden	2,093	778	170	94	60,552	5%	69%	26%
Wellingborough	1,041	5,393	100	296	78,782	1%	71%	28%
Welwyn Hatfield	3,760	6,397	257	461	107,649	2%	13%	85%
West Berkshire	984	15,080	12	1,041	581,480	0%	2%	98%
West Devon	1,495	4,247	31	395	211,147	1%	15%	84%
West Dorset	147	111	6	4	9,218	9%	25%	66%
West Dunbartonshire	1,620	843	134	79	26,961	5%	45%	50%
West Lancashire	21,366	39,904	2,477	3,542	271,489	12%	9%	78%
West Lindsey	3,383	4,789	250	463	169,836	7%	93%	0%
West Lothian	12,702	18,874	1,062	1,567	478,210	4%	15%	81%
West Oxfordshire	458	620	48	28	19,948	8%	92%	0%
West Somerset	542	1	55	0	14,454	5%	95%	0%
Westminster	16	6,903	0	415	38,960	0%	100%	0%
Weymouth and Portland	0	5	0	0	25	22%	78%	0%
Wigan	20,223	52,727	2,271	4,945	843,274	3%	16%	80%
Wiltshire	5,858	16,346	486	957	678,533	1%	19%	80%
Winchester	1,825	14,205	140	1,126	299,059	2%	3%	95%
Windsor and Maidenhead	158	21,415	6	1,267	156,385	0%	0%	100%
Wirral	3,127	464	324	18	44,396	8%	37%	55%
Woking	573	10,016	54	791	27,140	1%	6%	92%
Wokingham	1,208	10,913	94	716	154,016	1%	6%	92%
Wolverhampton	14,021	3,102	1,149	366	66,784	10%	90%	0%
Worcester	61	2,346	1	129	4,598	4%	95%	1%
Worthing	1,057	42	91	1	5,093	23%	44%	33%

AUTHORITY	Stops (Count)	Pass-through (Count)	Stops SAVED (Count)	Pass-through SAVED (Count)	Total Distance [km]	% Minor	% Princi-pal	% Trunk
Wrexham	21,596	2,442	1,927	129	306,046	26%	33%	41%
Wychavon	1,874	43,170	105	3,084	1,042,509	0%	2%	98%
Wycombe	2,500	4,008	258	210	105,704	2%	5%	93%
Wyre	4,406	36,816	487	3,186	555,134	1%	0%	99%
Wyre Forest	888	437	79	21	12,697	5%	95%	0%
York	1,596	7,935	130	1,057	187,099	2%	9%	89%

Flow analysis by region

A4.21 The request from stakeholders was for data on the regional movements of goods by LSTs on the trial, including an indication of the usage of LSTs on relatively local journeys entirely inside a region, as opposed to journeys to adjacent regions or farther afield.

A4.22 The results, based on only fully valid records, are shown as regional matrices with the starting location in the rows and destinations in the columns. Note: that this analysis is of the 816,000 'Valid' data records and so slightly underestimates the overall figures for the year, but as the intention is simply to show pattern, we have not adjusted them.

A4.23 Full matrices are shown in the following pages for:

- Number of journeys between regions in 2017
- Number of journeys between regions saved in 2017
- Tonnes lifted between regions in 2017.

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Figure 25: LST Regional flows (2017): Journey count

START \ END	UKC North East (England)	UKD North West (England)	UKE Yorkshire and The Humber	UKF East Midlands (England)	UKG West Midlands (England)	UKH East of England	UKI London	UKJ South East (England)	UKK South West (England)	UKL Wales	UKM Scotland	% FROM THIS START	TOTAL FROM THIS START
UKC North East (England)	2,856	3,801	3,252	6,069	3,832	62	7	28	12	1,243	2,502	2.9%	23,664
UKD North West (England)	3,807	72,024	7,972	12,943	17,288	1,482	180	1,663	2,378	7,188	7,085	16.4%	134,010
UKE Yorkshire and The Humber	2,149	8,010	34,770	12,697	5,291	3,712	190	1,013	805	328	2,533	8.8%	71,498
UKF East Midlands (England)	4,938	8,811	10,937	25,983	16,642	10,174	4,236	6,637	3,078	1,716	551	11.5%	93,703
UKG West Midlands (England)	5,189	15,605	5,243	14,506	49,384	7,691	1,503	4,455	10,093	3,962	5,311	15.1%	122,942
UKH East of England	48	1,301	3,948	10,220	8,975	24,107	2,074	6,887	1,177	362	530	7.3%	59,629
UKI London	27	71	103	6,064	1,471	1,824	1,732	3,762	1,502	174	262	2.1%	16,992
UKJ South East (England)	27	1,146	828	6,857	4,083	7,511	4,427	32,937	3,663	460	98	7.6%	62,037
UKK South West (England)	23	2,335	802	5,897	11,426	1,166	1,617	3,447	27,932	5,256	520	7.4%	60,421
UKL Wales	1,248	8,132	264	1,178	4,177	611	169	214	6,150	15,935	739	4.8%	38,817
UKM Scotland	3,634	6,332	2,337	496	7,780	412	146	85	510	869	110,230	16.3%	132,831
% FROM THIS END	2.9%	15.6%	8.6%	12.6%	16.0%	7.2%	2.0%	7.5%	7.0%	4.6%	16.0%		**816,544**
TOTAL TO THIS END	23,946	127,568	70,456	102,910	130,349	58,752	16,281	61,128	57,300	37,493	130,361	**816,544**	

Figure 26: LST Regional flows (2017): Journeys saved

START \ END	UKC North East (England)	UKD North West (England)	UKE Yorkshire and The Humber	UKF East Midlands (England)	UKG West Midlands (England)	UKH East of England	UKI London	UKJ South East (England)	UKK South West (England)	UKL Wales	UKM Scotland	% FROM THIS START	TOTAL FROM THIS START
UKC North East (England)	123	413	249	725	345	4	0	2	0	108	175	3.4%	2,143
UKD North West (England)	356	5,576	560	1,234	1,523	141	7	136	192	990	572	18.0%	11,288
UKE Yorkshire and The Humber	222	745	1,891	1,250	377	413	9	52	49	32	268	8.5%	5,308
UKF East Midlands (England)	529	825	554	1,872	1,848	994	229	553	234	127	30	12.4%	7,795
UKG West Midlands (England)	481	1,105	401	836	5,262	592	73	329	717	354	571	17.1%	10,721
UKH East of England	3	80	375	435	768	2,079	103	375	82	28	34	7.0%	4,362
UKI London	3	3	7	399	42	48	6	30	113	7	18	1.1%	677
UKJ South East (England)	1	97	71	432	355	561	452	2,122	198	45	6	6.9%	4,341
UKK South West (England)	1	171	35	376	780	82	89	206	1,360	530	29	5.8%	3,659
UKL Wales	113	501	8	94	324	36	6	16	161	1,305	96	4.2%	2,660
UKM Scotland	222	450	221	16	658	18	5	4	19	101	8,015	15.5%	9,730
% FROM THIS END	3.3%	15.9%	7.0%	12.2%	19.6%	7.9%	1.6%	6.1%	5.0%	5.8%	15.7%		**62,684**
TOTAL TO THIS END	2,052	9,965	4,374	7,669	12,282	4,969	981	3,825	3,125	3,629	9,813	**62,684**	

Figure 27: LST Regional flows (2017): Tonnes lifted

START \ END	UKC North East (England)	UKD North West (England)	UKE Yorkshire and The Humber	UKF East Midlands (England)	UKG West Midlands (England)	UKH East of England	UKI London	UKJ South East (England)	UKK South West (England)	UKL Wales	UKM Scotland	% FROM THIS START	TOTAL FROM THIS START
UKC North East (England)	13	47	15	43	30	1				21	23	2.2%	193
UKD North West (England)	41	709	56	146	220	24	3	18	26	133	121	17.4%	1498
UKE Yorkshire and The Humber	33	126	276	192	59	63	1	9	9	7	47	9.5%	823
UKF East Midlands (England)	39	103	69	247	210	120	73	73	31	21	7	11.5%	994
UKG West Midlands (England)	45	161	71	126	514	98	29	57	153	68	89	16.4%	1410
UKH East of England	1	16	27	103	144	181	15	63	14	6	7	6.7%	578
UKI London	1	1	1	97	26	12	19	18	26	2	5	2.4%	207
UKJ South East (England)		12	9	54	47	49	22	157	36	5	2	4.6%	393
UKK South West (England)		30	7	72	159	12	24	39	227	59	10	7.4%	638
UKL Wales	21	95	3	14	63	12	2	1	40	133	15	4.6%	399
UKM Scotland	37	104	37	4	113	5	2	1	8	19	1156	17.2%	1485
% FROM THIS END	2.7%	16.3%	6.6%	12.7%	18.4%	6.7%	2.2%	5.1%	6.6%	5.5%	17.2%		**8618**
TOTAL TO THIS END	231	1405	572	1098	1584	576	191	437	569	475	1482	**8618**	

ANNEX 5: THE OPERATOR CONVERSATIONS

A5.1 In early 2019 we conducted a series of conversations with selected operators designed to get deeper into:

- their experience of introducing LSTs into their fleet
- their thinking behind key choices they made in selecting their LST design options, and whether this would change in light of their experiences
- their practices for driver and route selection now, including whether any changes were made as a result of the trial.

Topic areas

A5.2 We had four main areas of interest, reflecting some key questions noted in the last trial Annual Report (AR2017), published in September 2018.

1) **LST Design Choices and Impacts**
2) **LST Take-Up**
3) **LST Operational Constraints**
4) **LST Performance and Incident Data.**

Operator selection

A5.3 We approached a total of 13 companies, described in outline in Figure 28 and successfully arranged meetings with 11. The others are willing to meet but a suitable date was not available within the timescales for this piece of work.

A5.4 The choice of operators for the visits was made to ensure a balance of operators were seen and where we believed we would find evidence relevant to questions. We also ensured there was representation from:

- a mix of operators using Self steer (SS) / Command steer (CS) axles (Figure 28)
- a range of size, from family run businesses to national groups (Figure 28)
- those with operations supplied by a range of manufacturers / builders (Figure 29)

Interview team and guide

A5.5 These conversations were face-to-face discussions at the operator's own sites (with one exception completed by conference call). Each interview was carried out by one of three experienced members of our project team.

A5.6 The interviewers used a topic guide to provide a common framework for the discussions, but with flexibility to also follow up on any interesting areas raised by the operators – including ones we had not considered previously

Use of the interview data

A5.7 The original interview notes will remain confidential to Risk Solutions. Their contents have been used to generate the discussion in this Annex and have been used to inform the summary that appears the body of this Annual Report.

A5.8 At a later date we may want to produce some case studies for the trial, but that would be a separate exercise which would only take place with the operator's permission at the time and the text of any such case study would be subject to their approval.

Figure 28: Operators interviewed, by size and main axle choice

Visit number	Characteristics	Axle Choice	Date
Pilot study	Each interviewer carried out one initial visit to pilot the user guide, after which it was refined before the main study.		
01	Large (>1000 trailers) contract haulier - multiple depots	**1/3 SS 2/3 CS**	**25/01/2019**
02	Large (>1000 trailers) contract haulier - multiple depots	**2/3 SS 1/3 CS**	**22/01/2019**
03	Small (10-100 Trailers) own operations industrial products	**CS**	**24/01/2019**
Main study			
04	Large (>1000 trailers) contract haulier - multiple depots	**CS**	**18/03/2019**
05	Small (10-100 trailers) - refrigerated specialist	**CS**	**26/02/2019**
06	Large (>1000 trailers) retail own operation – multi-depot	**SS**	**28/02/2019**
07	Small (10-100 trailers) own operation – farm produce	**SS (1 CS)**	**07/03/2019**
08	Small (10-100 trailers) contract haulier – single depot	**CS**	**07/03/2019**
09	Very Large (>2500 trailers) contract haulier	**SS (1 CS)**	**Deferred**
10	Very Large (>2500 trailers) contract haulier	**SS**	**Deferred**
11	Very Large (>2500 trailers) own operation – Courier	**CS**	**11/03/2019**
12	Very Large (>2500 trailers) own operation 3PL	**1/2 SS 1/2 CS**	**06/03/2019**
Phone			
13	Large operator who applied to trial but then withdrew	**n/a**	**13/02/2019**

(Note: Size categories are those used in the wider trial evaluation, the Axle types are: SS = Self Steer, CS = Command Steer)

Figure 29: Manufacturers of trailers owned or leased by companies represented in the sample

- Cartwright
- Don Bur
- Gray & Adams
- Lawrence David
- Montracon
- SDC
- Tiger

Structure and nature of this Annex

A5.9 This Annex sets out the details of the process we applied, our initial findings, and finally, some next steps planned for later in 2019.

A5.10 In summarising the results we have sought to be consistent in the use of terms such as many, most etc. However, in line with good practice in qualitative research it is important not to ascribe an undue importance to the number of operators putting forward a particular view, given the very small sample that, while selected to give a broad set of perspectives, is not a representative sample of the total population of operators on the trial.

Process

Selection of operators

A5.11 We created a full LST operator list with geolocation based on their landline phone number (where available). This excluded some operators, who use only mobile numbers, from the initial shortlist. However, we judged that we could get a suitable mix of operators from this subset.

A5.12 The geolocation allowed us to select our sample to be within a reasonable travel distance of the offices of our interviewers, which are in different parts of the country, enabling us to cover a range of regions.

A5.13 We selected three pilots on which to test the process in January 2019. These pilots tested the topic guide and also gave an insight into on how long each discussion should take and how many we would do within the budget available.

A5.14 The full shortlist of target operators was created after the pilots, and visits scheduled in February and early March.

A5.15 We also interviewed an operator considering LST operations serving the retail sector, who has twice considered joining the trial but both times then decided not to do so.

Invitation

A5.16 The initial invitation, including a letter provided by the DfT to support the initiative, and outlining the purpose of the visits, was sent to operators and followed up by phone.

Liaison by visiting team member and briefing

A5.17 The interviewer liaised with the contact in the operator to establish who needed to be involved from the company to cover the four areas of interest and to finalise dates, location, timing and so on.

A5.18 We then sent out a briefing note and some of the operators' recent data (if available):

- QSF2 - their response to a qualitative survey from 2016, dealing with some of the same questions being posed here (if they responded) and
- Their latest accepted DSF (Data Submission File – submitted 3 times a year).

Visits and capture

A5.19 Some visits were with a single representative of the operator, while others were with several people representing different roles in the company. This was documented.

A5.20 Interviewers used the topic guide to structure the conversation and to take notes. .

- The notes were not a verbatim record – their purpose was only to be sufficient for checking back with the operator that they were factually correct and suitable to use in the synthesis of this summary.

A5.21 After each visit, the operator interviewed was asked to check our notes for factual accuracy

Synthesis

A5.22 The team of three interviewers met on 20 March 2019 and reviewed the responses to each question, extracting both common themes and interesting outliers.

Initial findings

LST design choices and impacts

Original design choices

A5.23 The most common drivers of the operators' choices of trailer length and steering design were:

- Initial capital cost.
- Manoeuvrability including steering when reversing (when selecting CS)
- Perceived maintainability – noting that their original expectations differed on this, with some operators perceiving SS as the more easy-maintenance option, while others believed it was CS.

A5.24 While all interviewees knew kick-out would be greater on LSTs than 13.6m trailers:

- The common view was that this would be manageable with good driver training and route selection.
- Before their original purchase, no operator interviewed knew that, for a given trailer length, a CS axle might have a greater kick-out than an SS axle and so it was not a factor in making their original choice.

A5.25 Operators with previous experience of SS axles on other fleet vehicles chose CS for their LSTs – a decision that appears to have been related to maintenance and operational issues with their past SS axles.

A5.26 The weight difference between CS and SS was not noted as an issue by any operator interviewed, as most of them were working with low density cargos.

- It would seem that the weight difference was not a big enough factor to drive axle choice, even for operators who later expressed the view that an increased GVW limit for LSTs would be helpful in widening the use of LSTs to denser products.

A5.27 The lack of focus on kick-out is perhaps understandable for those operators who joined the trial in the first year, when there were only a few LST base designs and the difference in SS vs. CS kick out (illustrated in AR2017 Figure 34, which was first published in the 2016 Annual Report) would not have been known.

A5.28 Finally, although not initially noted by operators, the conversations also confirmed that most operators:

- Have established relationships with one or two manufacturers and so their design choices were influenced strongly by the offerings and preferences of those suppliers, rather than by a completely open assessment of all models available on the market.
- Ordered the same design for later orders, unless they had a poor experience which caused them to re-consider their options (as was the case for two operators already and one considering a change for the future).

Steering axle design choice impacts

A5.29 Experience with initial design choices has led to changed views, including moving to a preference for CS over SS and vice versa. Reasons cited included:

- safety concerns around CS relating to kick-out on the part of a key decision maker

- issues apparently related to SS axles operation at speed leading to increased costs of upgrades, inspection and maintenance.

A5.30 The interviews revealed a case of an incident that would not have appeared in the trial submission logs, since it did not result in any form of accident. An event in which the 5th wheel link for a CS axle became disconnected did not appear to adversely affect performance for the single round-trip the driver undertook before it was pointed out to him.

A5.31 We have raised some questions with the operator involved, around whether the axle manufacturer would expect the design to 'fail safe' in such an event. As we get further information it may be that this will warrant further discussion.

Transient off-tracking (following rapid steering input)

A5.32 We make here a special observation about the issue of transient off-tracking during relatively sudden lane changes/corrections at speed, given the questions raised about this issue in the 2016 and 2017 Annual Reports. Although not an area we specifically focused on in these conversations, we were 'listening' for any indication of it being an issue these operators had become concerned about. There was no indication that this was the case except for the single 2016 incident leading to the interest in this issue in the trial evaluation.

A5.33 The overall impression given by operators is of the LSTs being no harder to drive at speed than standard trailers, with operators noting that they 'follow well' in cornering.

A5.34 In the one case where an operator had come across some concerns about stability, the issue was not around transient off-tracking, but a confluence of several factors, the full details remain confidential between the company and the DfT.

A5.35 One of the companies interviewed was the operator involved in the two events on the trial that raised the issue of transient off-tracking in the 2016 and 2017 Annual Reports. Our specific interest was whether the fact that the trailer was an LST with a CS axle made the outcome of these events different from what might have happened with either an LST on an SS axle or, perhaps most importantly, a 13.6m fixed tri-axle trailer. We interviewed the head of fleet engineering and were able to explore his views on the details of the two events further. He noted that:

- In the first event – where the vehicle collided with a car on the hard shoulder – the CS axle might have made a difference to the outcome, but without a technical analysis it would be hard to be sure.
- In the second event – where the vehicle drifted onto a soft-verge and then overcorrected, resulting in over-turning – his view was that of the mix of large forces involved from the event, any additional force introduced by the axle steering would have been marginal.

A5.36 We made the operator aware of the DfT's developing plans for some form of research, which would include discussion of transient off-tracking and noted that we or the DfT might want to discuss this further with the fleet engineer.

LST Take-Up

A5.37 The future take-up projections articulated by operators in the 2016 survey were, in most cases, confirmed.

A5.38 In a few cases, operators now anticipate a larger future potential for LSTs in their business than they did when we asked in 2016.

A5.39 We also interviewed an operator who had considered LST operations serving the retail sector, who then decided not to do this. An early decision near to the start of the trial was not taken forward based on cost, but more generally this operator has not taken up LSTs for several reasons:

- The corporate strategy of the end user company includes an objective to minimise mileage and empty running between their DCs and delivery sites using a network of regional DCs.
- They also actively seek to integrate backhaul operations to bring goods in from suppliers to the Regional Distribution Centre (RDC) rather than the supplier delivering those goods as a separate supply process. LSTs are seen as inflexible for this backhaul integration since not all supplier sites can accommodate them due to either the trailer length or the load sizes.
- The past history of these store deliveries showed an average 33t cargo load on standard-length trailers, suggesting that LSTs would frequently 'weight out'.

A5.40 A more recent decision revisited the issue, looking at using LSTs to move garments to store preloaded onto rails (reducing handling time in store) as the density would be lower. This was ultimately rejected in favour of an alternative supply mode of appearance that had a higher load density, which favoured standard length trailers.

LST Operational Constraints

A5.41 The key operational constraints articulated by the operators in our sample were:

- **Route assessment** – both the roads required and especially the pick-up and drop-off locations – with a view to confirming suitability for LST access.
- **LST specific driver selection and training** and, in some cases, special **awareness raising for other staff** roles.

A5.42 On route assessment, the operators' approaches included:

- On screen/map assessment
- Site visits – including the local roads – at each end of the route
- Route assessment by an experience LST driver using standard trailers
- Discussion about / knowledge of the depot/site constraints at either end of the route including the approach roads.

A5.43 On training, there was a wider range of approaches in terms of the balance of:

- Classroom / on road time.
- LST training as separate from / integrated into wider driving training.
- Extent of driver training on LSTs (how much of the driver group was trained).

A5.44 Almost all the operators interviewed agreed that it would be valuable to the trial to do some assessment of the key training content themes and approaches developed by operators and expressed a willingness to either share materials, take part in a discussion or both.

LST Performance (savings) and Incident Data

Performance - % saving in overall km compared to using 13.6m trailers

A5.45 All of the operators interviewed were confident they were seeing benefits from the LST operations they currently had, but we should note that this will have been inherent in our selection of this set of trial participants. However, a few of these

operators considered themselves to already be at the limit of the number of LSTs they could effectively use in their operation, while others saw room for further growth.

A5.46 Most of the operators agreed that the sort of % savings we reflected back to them in their 2016 survey data looked about right.

A5.47 A few thought their gains might be slightly greater than that shown in their 2016 data, but could not identify where the 2016 results (generated from their own data) would be incorrect. The only issue discussed could be that where their operational patterns were very complex their gains in terms of empty legs saved might not be being reflected in our calculations, which only detect empty legs that are part of a clear A>B>A or A>B>C>A pattern.

Incident data

A5.48 The discussion on these questions affirmed our overall view that,

- Most operators do not have their incident reporting set up to clearly identify LSTs vs other trailers – this is something for which they have to do a special analysis, often manually, for the purposes of the trial.
- While operators do gather information on damage-only events where there is a resulting need for repair or a possibility of insurance claims, this data is not analysed in house for patterns and – as noted above – it would be hard to analyse the LST results vs the fleet as a whole without additional work (which they are currently all having to do in a limited form, for the trial data submissions).

A5.49 However, this may be changing over time since:

- at least two of the largest operators said their current asset management and tracking systems could, in principle, be used to look at whole life costs on a per trailer basis, including costs of damage repair, and so an LST vs non-LST whole-life cost analysis would be theoretically possible.
- one of the small operators on the trial noted that they were about to adopt asset management software that would allow them to do this in future.

Next steps

A5.50 A workshop is planned for November 2019 to develop an initial document laying out the key themes in driver training and wider company awareness / preparation that need to be understood by future operators of LSTs.

A5.51 This work might then be used as the basis of some form of industry good practice guide and also as the basis for the DfT thinking on regulatory policy options.

ANNEX 6: ESTIMATING TRIAL EMISSIONS SAVINGS

A6.1 Full details of the approach developed and used to estimate emissions in the 2017 Annual Report are provided in Project Note E2. For this report, these estimates have been updated to reflect changes in assumptions regarding fleet growth. This annex describes these changes, and also describes additional changes that we recommend are addressed in future estimates of emissions.

Fleet growth and fleet distance growth during remainder of trial

A6.2 To extend the modelling to future years, we need first to estimate the number of LSTs likely to be on the trial in each year. The figures below update the equivalent charts from AR2017. All the changes derive from two adjustments:

1. Values for the number of trailers, legs and distance travelled in 2018 are now actual values rather than projections
2. The data is produced annually, rather than by period (owing to the change in data framework at the start of 2018) and then smoothed across the 3 periods of that year (in past years it could be done period by period).

A6.3 The charts still refer to 'scenarios' as in the original 2017 model we considered three options for the length of time existing trial allocations and trailer VSOs would remain valid. This has now been resolved, with all existing trial VSOs being confirmed by VCA as being valid to the end of the extended trial (15 years from 2012) which was scenario S2. S2 is therefore the only scenario shown in these charts.

Figure 30: Projections of numbers of LSTs

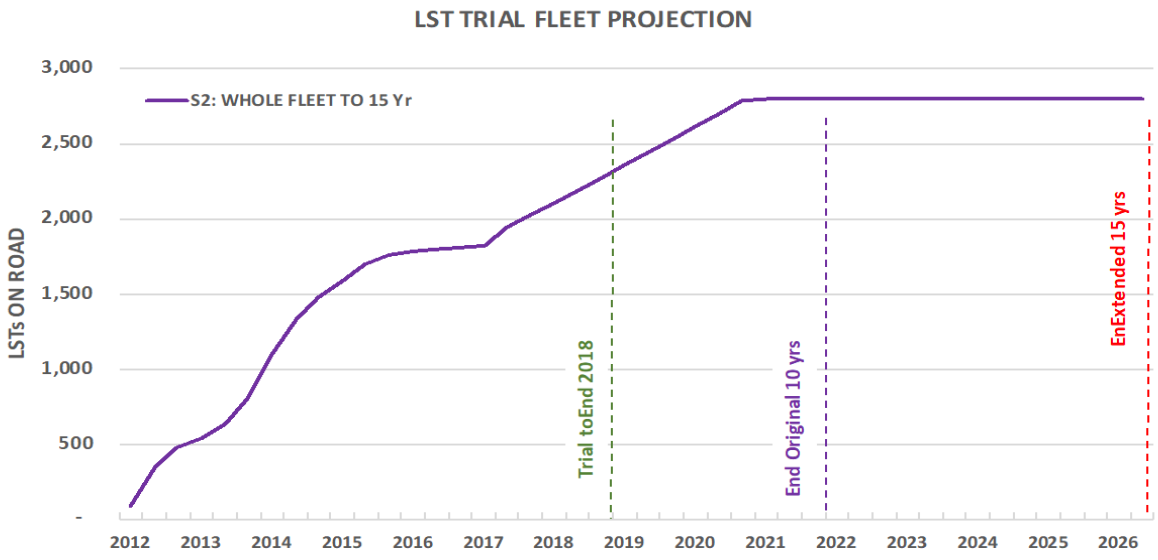


Figure notes: ***Extended fleet growth***

Assumed addition rate, trailers per period	**85** actual trailers added in 2018-P3
Resulting projection, period all on road	**2021-P2**
In 2017, we expected higher addition rates in 2018	
Rate for 1000 on road by 2019-P1 would be	**225**

Figure 31: Projections of LST vehicle km

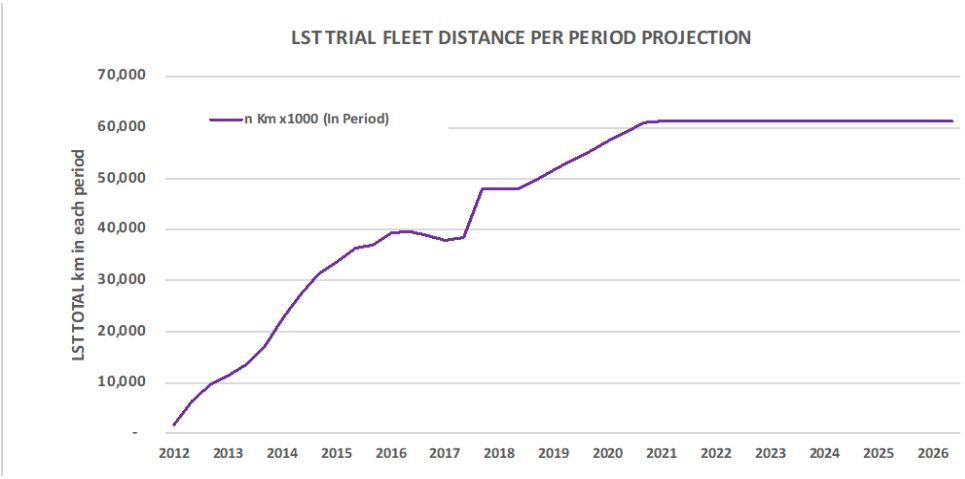


Figure notes: *Extended fleet growth*

Assumed addition rate, trailers per period	**112** actual trailers added in 2017-P3
Resulting projection, period all on road	**2021-P2**
Rate for 1000 on road by 2019-P1 would be	**225**

Future adjustments

A6.4 In future, as well as updating fleet growth estimates, the modelling may need to be adjusted to take account of engine size and potentially vehicle weight.

Engine sizes

A6.5 The engine parameters used in this report are currently still those used in AR2017, that is, all EURO V tractor units, so as to provide a direct comparison between the figures here and those presented in the pre-trial Impact Assessment (IA).

A6.6 The gradual introduction of EURO VI will reduce the carbon emissions across all fleets and hence the absolute savings would be reduced in proportion to the uptake of the newer engines replacing older equipment

A6.7 We are in discussion with the DfT about whether they require a rerun of the whole 2017 model based on EURO VI tractor units to allow them to then create a blended emissions/savings projection based on the DfT's most up to date projection of the likely GB tractor fleet engine mix over the next 10-15 years.

A6.8 Thinking further ahead, DfT may of course need to consider the possibility that a much wider use of hydrogen, hybrid or electric tractors units will also be in service in the later part of that time period.

Vehicle weights

A6.9 The gross vehicle weights used in the underlying emission modelling are currently still those used in AR2017, derived from the estimates of the additional weight for various LST design components, estimated prior to the trial.

A6.10 Annex 7 shows more recent analysis of the marginal weight factors of different LSTs designs and the issues to be discussed before a decision is made to use these in the emissions model. The key issue is whether the pre-trial data slightly underestimated the additional LST weight for single self-steer trailers and some refrigerated designs.

ANNEX 7: THE MARGINAL WEIGHTS AND COSTS SURVEY

A7.1 This annex presents the results of an analysis of sample information supplied by a selection of operators and manufacturers on the key additional weight and cost components of an LST, compared to a similar 13.6m trailer data (the marginal weights and costs).

Background

Rationale

A7.2 As part of the pre-trial feasibility studies, a number of manufacturers, axle providers and one trailer design consultancy were consulted regarding the trailer design options, including estimates of the marginal weight of the key additional weight components of an LST, compared to a similar 13.6m trailer. These were included in the 2010 pre-trial impact assessment.

A7.3 At the time these values were generated, there were only one or two demonstration LSTs in existence, so these were expert judgement estimates of each component:

- **Base weight** for an 'average' 13.6m trailer for different deck layouts
  - Single
  - Fixed Dual – Partial
  - Fixed Dual – Full
  - Moving Dual – Partial
  - Moving Dual – Full
- **Additional axle weight** for each of the axle design options considered in the pre-trial work – based on the presumption that all LSTs (or at least the longest class) would require a steering axle in order to meet the turning circle requirements
  - 1 Self-Steer (pre-trial only applied to 14.6m class of LST)
  - 2 Self-Steer
  - 1 Command (Passive)
  - 2 Command (Passive)
  - Active (Any More complex)
- **Additional body weight (kg per additional metre)** for a series of body designs (below) combined with relevant deck options to give an additional weight for each permutation:
  - Single Deck
  - Double-Deck

A7.4 The original work acknowledged that estimating additional costs for the body work on Double Deck trailers is challenging as it depends heavily on whether the deck is fixed or moving. The pre-trial work did not attempt to quantify this variation in dual deck design weights.

A7.5 The pre-trial values were used in the LST Emissions Savings modelling carried out in 2017 and reported in Annual Report 2017, where the trailer type of every 2017 LST journey was used to generate a nominal vehicle weight for input to the emissions modelling. For that work, the estimates for body designs were expanded to include

the full range of deck designs, and also other overall trailer types seen on the trial, such as skeletal, curtain-siders and bulk carriers

2019 Sample Data

A7.6 We have obtained some sample information on real marginal weight data from a selection of operators and manufacturers.

A7.7 A more comprehensive survey could be undertaken, but it would require substantial resources and a significant negotiation with the trial participants.

Data from Operators

A7.8 During 2018-19 we conducted a series of on-site interviews with a sample of operators across a range of topics (see Annex 5):

1. **LST Designs**
2. **LST Take Up**
3. **LST Operational / Regulatory Issues**
4. **LST Data beyond the trial**

A7.9 As part of that round of interviews – under the question on LST Designs, we included an enquiry about the marginal weight and cost of their LSTs, compared to a similar 13.6m trailer, and invited the companies involved to submit some simple data about the main designs of LST in their fleet.

A7.10 Of 11 operators interviewed, five submitted data.

Data from manufacturers

A7.11 We sent the same data request to all seven of the major UK manufacturers of LSTs either via SMMT or through direct contacts. We received data from four manufacturers.

Samples

A7.12 From the two sources, we ended up with data for 29 trailer designs.

A7.13 Of these, a number were not used in this analysis for different reasons:

- three contained incomplete weight information
- two were for 14.6m LSTs
- six were for comparisons with 13.6m trailers which also had a steering axle and therefore represented a comparison to a non-standard 13.6m trailer design with a likely different cost and weight from standard 13.6m trailers).

A7.14 This gave us 18 examples for which we had complete data, summarised in the left-hand columns of Table 23. The last three columns of the table are then:

- **Design# AxleDeck:** A code grouping the samples by the key variations consider in the pre-trial weight estimates:
  - 1 Single Self-Steer designs
  - 2 Single Command-Steer designs
  - 3 Two Command-Steer designs

  And then by deck type:
  - n.0 Single Deck
  - n.2 Dual Deck - FIXED

    - n.3 Dual Deck - MOVING
- **2019 Examples:** The marginal weights from the 2019 survey
- **Pre-Trial Estimate for Same Design:** A calculated marginal weight for the same design, built up from the elements estimated in the pre-trial work.

A7.15 In the table we have also shown whether the design was a simple flat deck or a step-frame trailer, and also whether it was refrigerated – two elements not presumed to be key drivers of marginal weight in the pre-trial work, perhaps because it was presumed that their contribution to overall trailer weight would be similar to that on a 13.6m trailer.

A7.16 What can be seen from the table here is that while the frame design may not make a major difference, the fridge design does.

A7.17 We discussed this in some detail with one of the manufacturers and he noted that compared to an equivalent 13.6m fridge trailer, an LST often requires a larger capacity chilling system and might even be designed with an additional chill compartment compared to the 13.6m design. This is in addition to the simple effect of insulated body panels being heavier than standard box van panels, making the marginal weight per metre of body higher for fridge vans.

Table 23: 2019 LST Marginal Weight Survey Samples (15.65m LSTs Only)

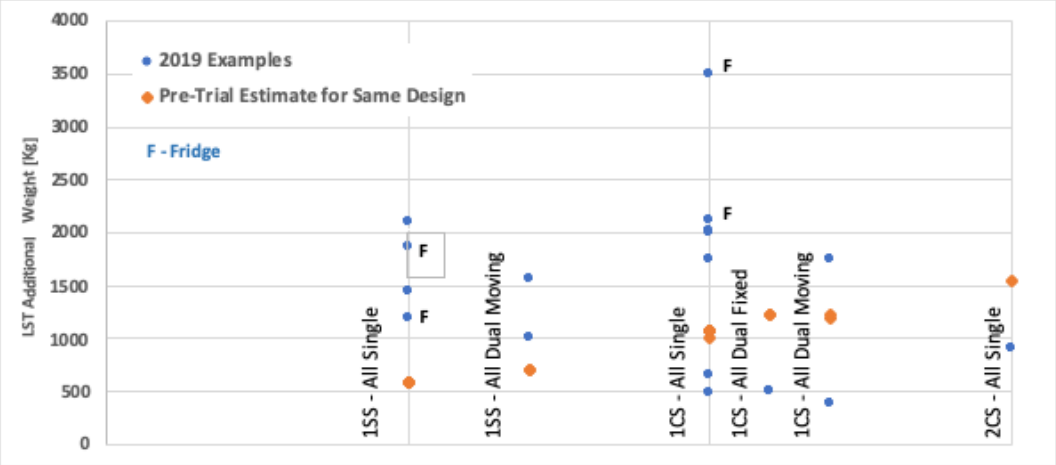
Length (m)	Axle	Frame	Single or Dual deck	Body	Fridge	Design# AxleDeck	2019 Examples Marginal weights (kg	Pre-Trial Estimate for Same Design* Marginal weights (kg)
15.65	1 Self Steer	Flat	Single	Box	Fridge	1	1200	584
15.65	1 Command Steer	Flat	Single	Box	Fridge	2	2020	1082
15.65	1 Command Steer	StepFrame	Moving-PartDual	Curtain Sider	None	2.4	1750	1196
15.65	1 Command Steer	Flat	Single	Box	None	2	1750	1082
15.65	1 Command Steer	Flat	Single	Box	Fridge	2	3500	1082
15.65	2 Command Steer	Flat	Single	Box	None	3	900	1539
15.65	1 Command Steer	StepFrame	Fixed-PartDual	Curtain Sider	None	2.2	500	1227
15.65	1 Command Steer	StepFrame	Fixed-PartDual	Curtain Sider	None	2.2	500	1227
15.65	1 Command Steer	Flat	Single	Curtain Sider	None	2	650	1082
15.65	1 Command Steer	Flat	Single	Curtain Sider	None	2	2000	1082
15.65	1 Command Steer	Flat	Single	Flatbed	None	2	480	1004
15.65	1 Self Steer	Flat	Single	Box	Fridge	1	1860	584
15.65	1 Command Steer	Flat	Single	Box	Fridge	2	2110	1082
15.65	1 Command Steer	Flat	Moving-FullDual	Box	None	2.4	380	1227
15.65	1 Self Steer	StepFrame	Moving-PartDual	Curtain Sider	None	1.4	1560	698
15.65	1 Self Steer	StepFrame	Moving-PartDual	Box	None	1.4	1000	698
15.65	1 Self Steer	Flat	Single	Curtain Sider	None	1	1440	584
15.65	1 Self Steer	Flat	Single	Curtain Sider	None	1	2100	584

* Pre-trial weight components for additional trailer length and steering axles – as updated and expanded in the 2017 LST emissions modelling.

Comparison of 2019 results to pre-trial estimates

A7.18 Figure 32 shows a summary comparison of the example data from this 2019 survey to the marginal weight that would have been predicted using the pre-trial weight component estimates.

Figure 32: Marginal LST Weights: 2019 Survey Results vs. Pre-Trial Estimates (15.65m LSTs only)



KEY: *n-SS/CS indicates the number of steering axles and the steering type (Self or Command). Single/Dual Moving, Dual Fixed refer to the number of decks and, for dual decks, the design. Further subclasses of design, such as whether the dual deck is partial or full length are subsumed into the relevant wider category.*

A7.19 We can see that for this sample:

1. Using the mean pre-trial estimates for additional weight components, would underestimate the marginal weight of single self-steer designs for 15.65m trailers. (Note: The mean additional weight for a single self-steer axle in the pre-trial work was 190kg, with a min of 140kg and max of 250kg.)
2. The marginal weight effect of a design being refrigerated – a factor not taken into account in the pre-trial work – can be significant, especially for LST designs with an additional cooling unit.

However, we need to remember that in the pre-trial phase, there was significant uncertainty about whether a single-self steer would meet the turning circle requirements for a 15.65m trailer and so the only single self-steer design included in the pre-trial work was at 14.6m (see Table 3.3 Page 15 of that document). Even the maximum pre-trial estimate of the axle marginal weight would not account for all of the higher weights being seen in these actual 2019 weights. Longer designs were assumed to need two steering axles to meet the requirements, with a commensurate increase in predicted marginal weight. More widely, the pre-trial estimates were based on expert judgement and in only one case, the design of a single demonstration LST which was, we believe, a 15.65m 2-command-steer (2CS) single deck unit.

Implications of the results

A7.20 There may be a case for re-running the full 2017-18 emissions model using revised weight component values, including a new factor for refrigeration, to see whether it changes the resulting emissions savings factors reported on the trial.

A7.21 We have not, at this stage, repeated the complete emission modelling exercise as:

1. Doing a full re-run is not a simple task
2. It would require us to determine what the revised factors ought to be, and the only data we would have to do so would be this small sample. Having said that, this sample is probably slightly more robust than the pre-trial expert estimates.
3. It is not clear whether applying new factors would materially alter overall emissions results, taking into account the fact that the trailer weight is only one part of the overall estimate of vehicle weight and not the largest component. For example:
   - Tractor weight 8000-9000 kg
   - Trailer weight 6000-12,000 kg
   - Cargo weight Zero to 25,000-29,000kg

Next steps

A7.22 There are further options for analysis, to be discussed with the DfT:

1. Repeating the existing AR2018 analysis of emissions using the factors established in the 2017 studies – updating the AR2017 analysis – without changing the estimated trailer weights – this can be done without repeating the whole modelling exercise
2. Considering a sensitivity calculation to determine whether it is likely that changing the input factors would result in a significant change in the overall emissions results
3. Discussing, with the DfT, whether a full re-run is worth doing for their work on any planned impact assessment.

A7.23 These options are discussed further in Section 8 of the main report.

ANNEX 8: COMPARISON OF DAMAGE INCIDENT RATES

A8.1 In this annex we describe how operators' data about their LST and non-LST incidents (involving injury or property damage) was analysed for comparison purposes.

The data

A8.2 Since 2018-P1 we have been collecting information on non-LST incident rates from trial participants. We asked participants to provide information on incidents for non-LSTs in their fleets that were running on similar roads to their LSTs – their relevant non-LST fleet.

A8.3 We asked them to submit information on incidents that took place on the public highway or in public areas (such as a car park or motorway service area, so not in depots), and to provide:

- The number of incidents involving injuries
- The number of people injured in those incidents
- The number of damage-only incidents
- The number of km covered by the vehicles in their relevant non-LST fleet.

A8.4 Not all trial participants had relevant non-LSTs in their fleet, and some were unable to provide the requested data for their non-LSTs. These participants were excluded from the comparison. For those included in the comparison (91 operators in total), we looked at LST incidents in public areas only, to match the data available for relevant non-LST fleets.

A8.5 To calculate incident rates for each operator, we divided the total of injury and damage-only incidents reported for a fleet by the number of vehicle km covered by that fleet.

A8.6 Over all the operators in our sample, this generated two distributions of the total number of incidents per million vehicle km in 2018 that occurred on the public highway or in a public area. One for LSTs and one for relevant non-LST fleets.

Findings

A8.7 At first glance, the means of the two distributions appear to differ by approximately one order of magnitude (see Table 24).

A8.8 The LST data include a large number of operator fleets with zero incidents (67 of the 91 datapoints). Neither the LST dataset nor the non-LST dataset have a normal distribution shape (see Figure 33). Thus, a t-test would not be a suitable test for determining whether the two samples have the same mean. We considered using a log-transformed paired dataset, but again the number of zero values in the LST dataset is too high for this to produce a meaningful normal distribution.

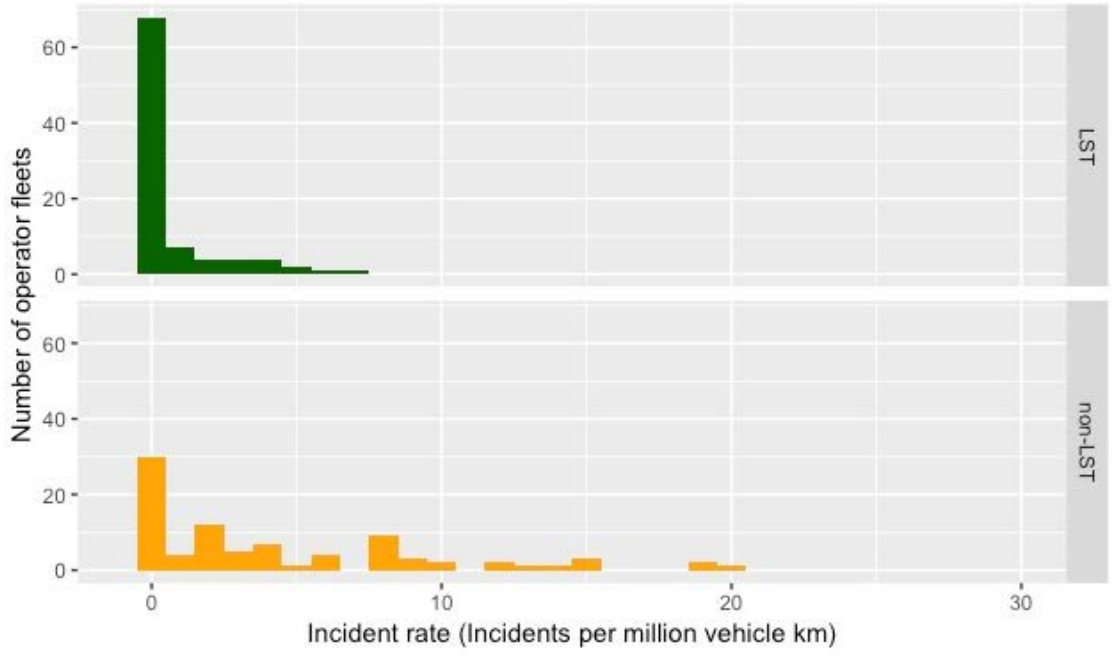
Table 24: Descriptive statistics for LST and non-LST incident rates in public areas for 2018 (incidents per million vehicle km)

Descriptive statistic	LSTs	Non-LSTs
Mean (Note 1)	0.723±0.318	6.689±2.587
Standard Error	0.160	1.302
Median	0.000	2.470
Mode	0.000	0.000
Standard Deviation	1.527	12.422
Sample Variance	2.331	154.303
Kurtosis	4.991	15.342
Skewness	2.333	3.712
Range	6.873	74.781
Minimum	0.000	0.000
Maximum	6.873	74.781
Count	91	91

Note 1: range of mean values for a 95% confidence interval

A8.9 Figure 33 shows that the distribution of incident rates for the LST and non-LST operator fleets look like they might follow a Poisson type distribution, which is typical for count data of relatively rare events. However, the non-LST data in particular show evidence of 'over-dispersion' – a wide spread of data – that is not a good fit to a basic Poisson distribution.

Figure 33: Histograms of LST and non-LST incident rates



A8.10 Over-dispersion can be counteracted by using a negative binomial distribution, which is a modification of the basic Poisson distribution. We therefore analysed the data using the glm regression procedure in the R statistical analysis package with a negative binomial model and found this to be a good fit.

A8.11 The regression model is of the form:

Log(Mean incident rate) = a + b * x where x = 0 for LST and x =1 for non-LST

Parameter 'a' = -0.09 (close to zero) with a standard error of 0.22, while parameter 'b' = 2.00 with a standard error of 0.26 and is highly statistically significant ($p<0.001$).

We can conclude that the mean incident rate for non-LSTs in our sample is greater than the mean incident rate for LSTs in our sample by a factor of exp(2.00) = 7.4.

A8.12 We used the negative binomial model to predict the mean number of incidents expected for an LST fleet and a non-LST fleet after 1 million vehicle km exposure, that is, after completing a million vehicle km as a fleet. This results in the following predictions:

LST fleet:	0.91 incidents
Non-LST fleet:	6.8 incidents

A8.13 We conclude that for the paired data sample from 91 of our trial participants, LST fleets have a much lower incident rate than non-LST fleets.

A8.14 From operator surveys and interviews we already know that trial participants are taking one or more of a number of steps that would be expected to result in a low incident rate, whether resulting in injury or damage:

- Providing training and refresher training on LSTs
- Allowing only selected, experienced, drivers to drive LSTs
- Selecting either
  - a set of repeated routes that have been pre-assessed for LSTs, so that the routes are well-known and likely to present relatively few difficulties for LSTs. OR
  - where new, or infrequent routes are used, applying specific route planning, perhaps combined with use of their 'best' drivers

A8.15 The LST fleets have also generally accumulated fewer vehicle km than the non-LST fleets, which results in more operators reporting zero incidents in their LST fleets. This is taken into account in the model fitting process.