Evaluation of the Longer Semi-Trailer Trial: Annual Report 2019 Update

A report for the Department for Transport

November 2020

ISSUE 1-2

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Client reference: 1-1025 P4102020

Report reference: J0083-20 (AR2019)

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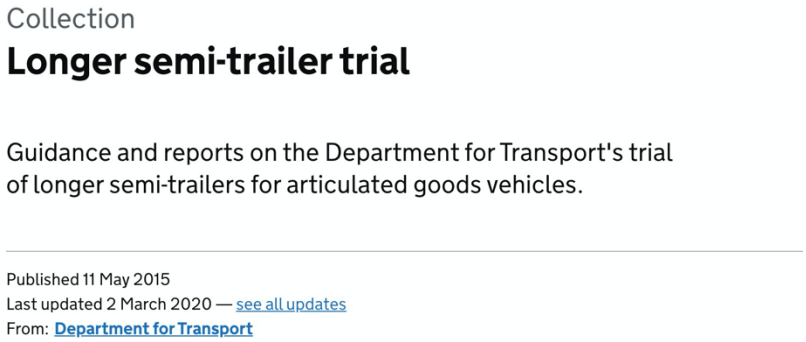
LST Trial information and contacts

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


Collection
Longer semi-trailer trial

Guidance and reports on the Department for Transport's trial of longer semi-trailers for articulated goods vehicles.

Published 11 May 2015
Last updated 2 March 2020 — see all updates
From: Department for Transport

For questions relating to the trial contact:

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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.

Report status and accessibility

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LST TRIAL EVALUATION: HEADLINES

(Rounded figures – as at 31 Dec 2019 except where stated otherwise)

Trial Take Up

2,565	LSTs registered on Vehicle Special Orders (VSOs) (Aug 2020) (90 % of revised trial maximum of 2,800 trailers)
2,473	LSTs on the road and submitted trial data (88% of revised trial target of 2,800 trailers)
228	Number of operators with trailers on the road and **due** to submit data in final period of 2019

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

5.9 million	Journey legs travelled by LSTs during the trial
739 million	km travelled by LSTs during the trial. Analysis in 2017 showed LST usage to be 85% Trunk, 13% Principal & 2% Minor Roads
54 to 60 million	Vehicle km 'saved' by LST operations (end 2019). 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

430 to 475,000	Journeys by 13.6m trailers saved by using LSTs based on 125km average journey. Upper estimate (including some return legs) is used in the saving and emissions figures that follow
1 in 12 (8%)	Average saving across all operators, 1 in 'n' journeys
1 in 8 (13%)	Highest saving achieved by individual operators, 1 in 'n' journeys

Emissions Saved

To date 2012-19 and Trial projection to 10 years

To Date	10 Years	Emission type	
48,000	71,000	CO2(e)	Tonnes of CO2(e)
241	358	NOx	Tonnes of NOX

of which 6.2% saved within 200m of 'Designated Areas' (2017 modelling estimates)

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 (2012-2019) resulting in injury*
40	51	All personal injury incidents involving an LST
4	4	Incidents/casualties judged to be 'LST Related'
54	68	Three-year average safety incident rate (ALL collisions or casualties per billion LST vehicle km, 2017-2019)
114	162	Equivalent three-year rate for all GB articulated HGVs, (per billion vehicle km 2016-2018 - 2019 not yet published)
0.47	0.42	Collision/Casualty rate ratio (LST vs All GB Artic. HGVs)

On a per kilometre basis, nationally, we estimate LSTs have been involved in around 53% fewer personal injury collisions than GB articulated HGV average.

Injury Incidents – Road Type Comparison

URBAN	MINOR	*Collisions / Casualties where LST on public highways or public access areas (2012-2019) resulting in injury*
4	3	Personal injury incidents involving an LST (All – regardless of any 'LST Related' judgement)
41	203	Safety incident rate (collisions per billion LST vehicle km)*
518	935	Equivalent rate for all GB articulated HGVs over whole trial period, 2012-2018 (per billion vehicle km)
0.08	0.22	Collision rate ratio (LST vs All GB Artic. HGVs)

On a per kilometre basis, compared with the average for all GB articulated HGVs, LSTs on the trial have been involved in 92% fewer personal injury collisions per km when operating on roads in urban areas and 78% fewer when on minor roads.

Injury Incidents – Vulnerable Road Users *(Regardless of whether it was "LST related)"*

Collisions	Casualties	*LST collisions on public highways or public access areas (2012-2019) that resulted in one or more injury to a pedestrian or cyclist*
3	3	All LST personal injury incidents and casualties where a pedestrian or cyclist was involved
4.06	4.06	LST collision and casualty rates (per billion vehicle km) over whole trial period, 2012-2019
10.82	11.26	Equivalent rates for all GB articulated HGVs 2012-2018
0.38	0.36	Rate ratios (LST vs All GB Artic. HGVs)

The LST injury incident rate for vulnerable road users in all locations, appears to be lower than that for the GB HGV fleet, but the difference in rates does not pass a classical statistical significance test.

Damage Incidents – Comparison within sample of operator fleets

LST	NON-LST	*2018 data from 92 operators for LSTs and Non-LSTs in the same fleet*
0.87	6.7	Mean number of incidents expected for an LST fleet and a non-LST fleet after 1 million vehicle km exposure.

On a per kilometre basis, the average number of damage incidents for non-LSTs is greater than that for LSTs by a factor of about 8.

Executive Summary to 9th GB LST trial Annual Report

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). In 2017, the DfT extended the trial, adding a further 1000 trailer allocations and 5 years. At the time of writing (August 2020) 2,565 trailers are on VSO and are expected to be on the road during 2020.

Evaluation scope

A reduction in emissions may be expected from using LSTs because when operated efficiently they allow the same quantity of goods to be transported in fewer journeys. We need to evaluate whether the emissions can be reduced, without a detrimental effect on safety or 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?

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.

Progress against evaluation questions

This report updates our analysis of the data to the end of 2019 and we are pleased to report that **we believe we now have sufficient quantitative data and other evidence to provide a robust evaluation response to all seven key evaluation questions.**

In addition to the quantitative results, we have collated industry insights covering the issues considered and measures taken by real operators when adopting LSTs, in particular focusing on establishing an efficient and safe operation. The complete document is shown in **Annex 6: "Introducing and Managing LSTs: An Industry-led Summary of Good Practice"**

LST Trial 2019 Annual Report Summary

The results to the end of 2019 are summarised in Chapter 10 of this document, but for an overview of the whole trial, readers may refer to the 2019 Annual Report Summary designed to meet the interest from public sector leaders, haulage industry, and civil society groups who have a valid interest in the key results of the trial, and the evidence supporting them, but do not necessarily have the resources to study the main report.

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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 1,800 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 legally as they exceed the standard length. 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 1,000 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 and references are provided throughout the report. (Note: references are given in the form AR20nn, for example AR2018 refers to the 2018 trial report published in 2019. A link to each report is provided the first time the report is referred to. Links to all the reports are provided in Annex 1.)

1.7 Clicking on the report title links to the web page on the DfT web-site where the report, and any accompanying published project notes (PNs) can be downloaded

1.8 The primary objective of the trial is set out in the 2010 impact assessment of LSTs (IA no. DfT 00062). 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.

1.9 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.

1.10 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.

1.11 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.

1.12 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, and to September 2021 by a further direct award.

1.13 The trial was set to run for a long period to ensure it generated a sufficient volume of reliable data in order for a decision to be made whilst also allowing participants to recover the costs of investing in LSTs.

1.14 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 and details of the data collection requirements can be found on the DfT website.)

1.15 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.

1.16 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.

1.17 The new 2018 data format also required operators to provide details about non-LST incidents and vehicle-kilometres for their comparable non-LST fleet, just for 2018.

1.18 Finally, from mid-2019, operators with more than a full year of consecutive, acceptablepast data submissions, are being migrated to a short-format data submission which collects only the total number of legs and distance for each trailer, as well as any incident data. Details of the updated data collection processes can be found in Annex 3.

About this report

1.19 This is the 9th GB LST Trial Annual Report and it covers the performance of the LST fleet on the road up to the end of 2019.

1.20 As in 2018, it presents 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.

1.21 Terminology used in the trial and data collation is also defined in those earlier reports. Major terms appear in the glossary.

1.22 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).
- Sections 7, 8 and 9 present new work carried out in 2019 and early 2020 as follows:
  - Section 7 completes the reporting on a consultation with a selected group of operators to collate industry insights covering the issues considered and measures taken by real operators when adopting LSTs, in particular focusing on establishing an efficient and safe operation. The resulting document is published in full in **Annex 6: "Introducing and Managing LSTs: An Industry-led Summary of Good Practice".**
  - Section 8 – Scaling-up, describes the work carried out to map the trial savings in journeys, emissions and injuries to the freight carriage data for the whole GB fleet of articulated HGVs expressed in the Continuing Survey of Road Goods Transport (CSRGT). Once mapped, this then generates a model to provide long term projections of the potential impact of LSTs under different scenarios.
  - Section 9 – Additional analysis, introduces two small pieces of further analysis that are ongoing in 2020, which we believe will provide useful further insights, but which are not expected to change the overall conclusions of the trial to date.
- Section 10 contains a complete progress summary and next steps provides the cumulative response to the seven evaluation questions in a single location.

Table 1: New analysis and research introduced in this report

Operator Conversations (Interview and workshop) Section 7, Annex 5 and Annex 6
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: 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. • Output: Annex 6: "Introducing and Managing LSTs: An Industry-led Summary of Good Practice"
Scaling up Section 8 and Annex 4A and Annex 4B
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 sheet in the data submission file, completed by each trial participant, usually in their first data period, or by all existing operators in an update requested in 2018.

Number of trailers allocated to the trial and on the road

2.3 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 2,473, with around another 50 on VSO.

2.4 At the time of writing (August 2020), the total number of LSTs on VSO has grown slightly and is now 2,565, but we would note that this includes a larger number of additional registrations, but balanced by a number of trailers being withdrawn from VSOs, many of which are in the second hand market and so not currently included in these figures.

Table 2: LSTs on the road and on VSO

	On the road At end 2019	On VSO At end 2019	On VSO At Aug 2020
Number of LSTs	**2,473**	**~2,524**	**2,565**
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 2019 will not be included in the current dataset although they may already be included on a live VSO.

2.5 Figure 1 shows the growth of the LST fleet from the start of the trial to the end of 2019.

2.6 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)

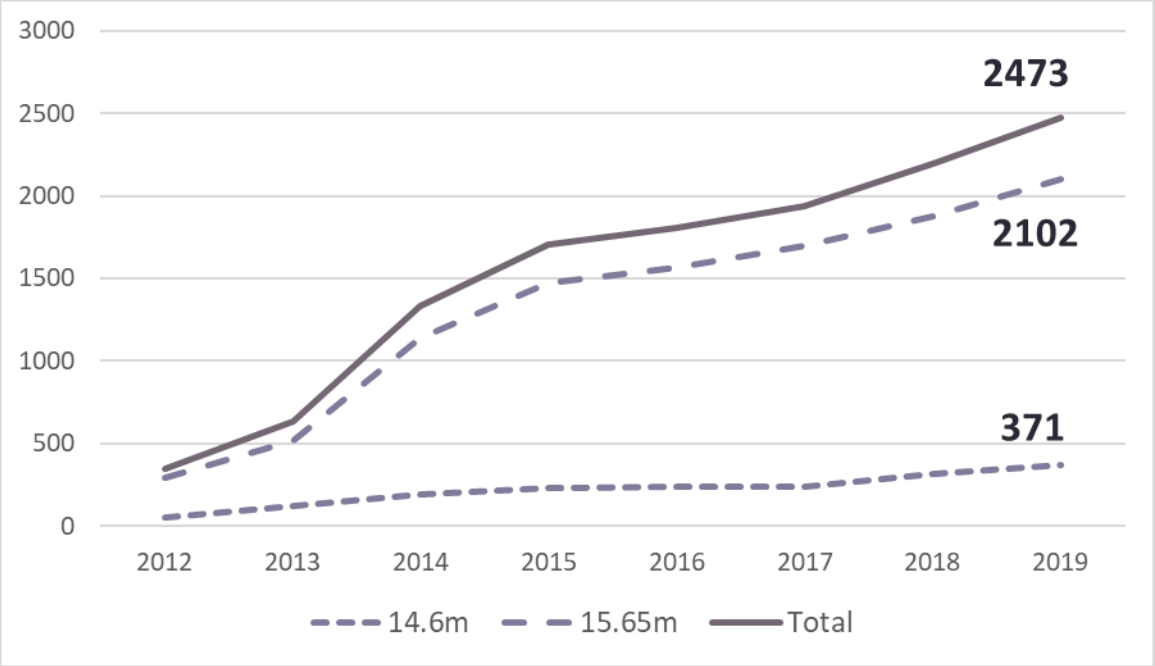
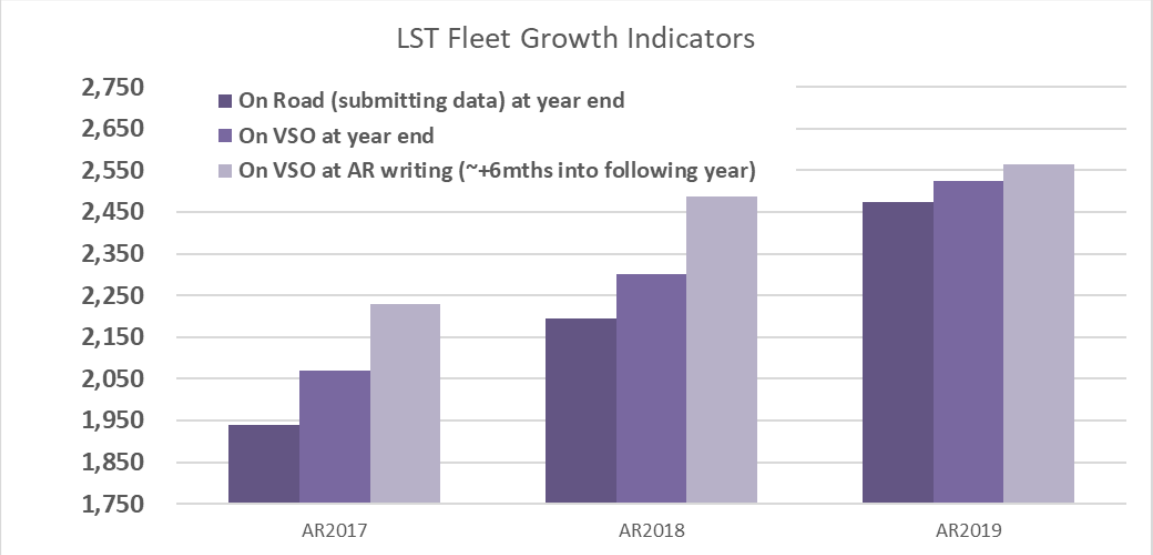


Figure 2: Trial Fleet Recent Growth Trend



Annual Report	AR2017	AR2018	AR2019
On Road (submitting data) at year end	1,939	2,194	**2,473**
On VSO at year end	2,070	2,300	**2,524**
On VSO at AR writing (~+6mths into following year)	2,229	2,486	**2,565**

2.23 Figure 2 shows the same data as Table 2: LSTs on the road and on VSO, but expanded to show the figures for the most recent three years. Looking at the fleet growth rate, it is clear that it is slowing down as we have entered 2020.

2.24 In 2017 and 2018 there is a clear spacing between the number of trailers on the road and submitting data at the year end, the number of trailers on VSO at the year end (soon to submit data) and the number of trailers on VSO at the time the report was being

written – about 6 months into the subsequent year. This cascade of figures published each year shows the funnel of new trailers coming into the fleet.

2.25 In 2019, the spacing between the figures has almost disappeared, with the number of trailers on VSO at end of 2019 and even now in August 2020, being very similar to the number of trailers reporting data at the end of 2019.

Reasons for reduced trial fleet growth

2.26 While we have not conducted a formal survey of operators on the topic of fleet growth or reductions, we have sought to communicate with operators who have released trailers and also those entering the trial for the first time, to get insight into the factors influencing their decisions. We also had the opportunity to speak to a sample of operators privately about their thinking on future LST investment, at a workshop in November 2019 (see work reported in Section 7). We can also see some evidence emerging in the data submissions.

LSTs reaching end of lease / end of life

2.27 During 2019 we began to see instances of operators removing LSTs from their fleet for a number of reasons:

- The original lease agreements from 2012/2013 were reaching their 7 year term and the trailers were returned to the leasing company. We have had verbal confirmation of at least one case where a lease was extended by a year, but leasing companies are generally reluctant to extend leases further. Leasing companies have then sold, or are in the process of selling, the trailers into the second hand market rather than leasing them to a new operator.
- Purchased trailers were reaching the end-of-life or the normal renewal date for the company and they were either sold into the second hand market or sent for dismantling by the original owner.

Delayed or deferred LST investment decisions

2.28 Operators selling or returning the trailers to lease have in some cases replaced some or all of the trailers, but we know of at least two operators who have between them released 70-80 trailers who in discussion of their plans have stated that their decision to re-invest and replace the trailers is being delayed by a combination of:

- The focus of management resources on BREXIT impacts in 2019
- The focus of all resources on COVID19 issues in early 2020
  and also,
- The uncertainty around the DfT's future plans for the trial or longer term use of LSTs

2.29 While we cannot provide evidence that these same issues might also be limiting the flow of new operators coming forward to take up large allocations of LSTs during the same time period, it would be reasonable to consider that this might be the case (see also next).

Reduced size of requests for allocations by new operators

2.30 Finally, we note that during the second half of 2019 and so far in 2020, while we have seen a continuing flow of new operators joining the trial, they have mostly been small operators buying one to three trailers (some of them from the second hand supply noted above) for a specific purpose. A significant number of these have been operators taking on LSTs to transport straw to power stations, where the clients have discovered that they can unload a single LST more easily than a Rigid+Drawbar combination carrying

the same sized load.

Tracking LSTs released by an operator

2.31 When trailers are released, operators should apply immediately to VCA to remove them from their VSO. In the DfT database that tracks the trailers on the trial, the Vehicle Identification Numbers (VIN numbers) associated with these trailers are then either marked as:

- Scrapped
- OR
- Not attached to a live VSO

2.32 However, there is sometimes a delay in this process and so there is no easy way to obtain an accurate figure for the number of trailers that have entered these states.

2.33 At the time of writing, there are about 126 trailers 'Not attached to a live VSO', although we believe this may include a batch of VINs issued by a manufacturer for a VSO, but where the trailer was given a new VSO when built. We are communicating with the manufacturer to resolve this issue.

2.34 **The increase in trailers being released by operators and then purchased on the second hand market continues in 2020. We are currently working with the DfT and VCA to update their process to track trailers entering these intermediate states, before they then appear on a new VSO once a new owner takes them on.**

Operators on the trial

2.35 One of the DfT's stated intentions was that the trial should be accessible to operators of all sizes – not just large operators. Figure 3 summarises the range of companies (based on their data submissions) by size, Figure 4 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.)

2.36 Figure 3 shows that the trial does include a significant number of small and very small operators. Figure 4 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.

2.37 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.

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

Figure 3: LST trial participants by fleet and company size (source LST Trial data)

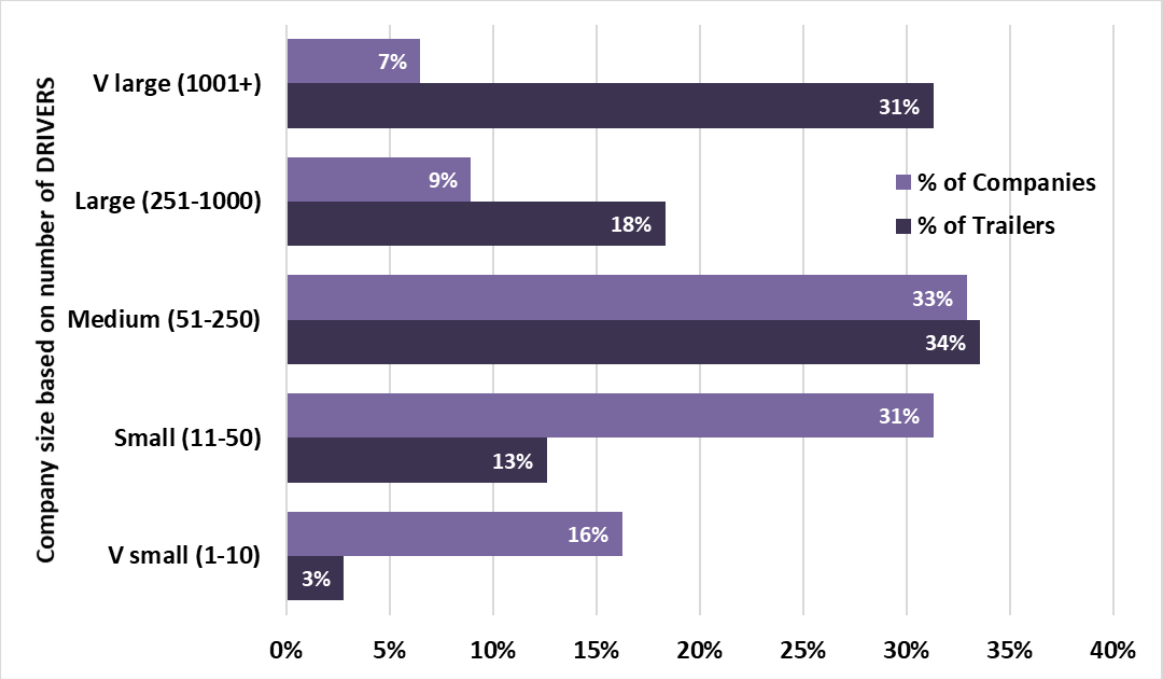
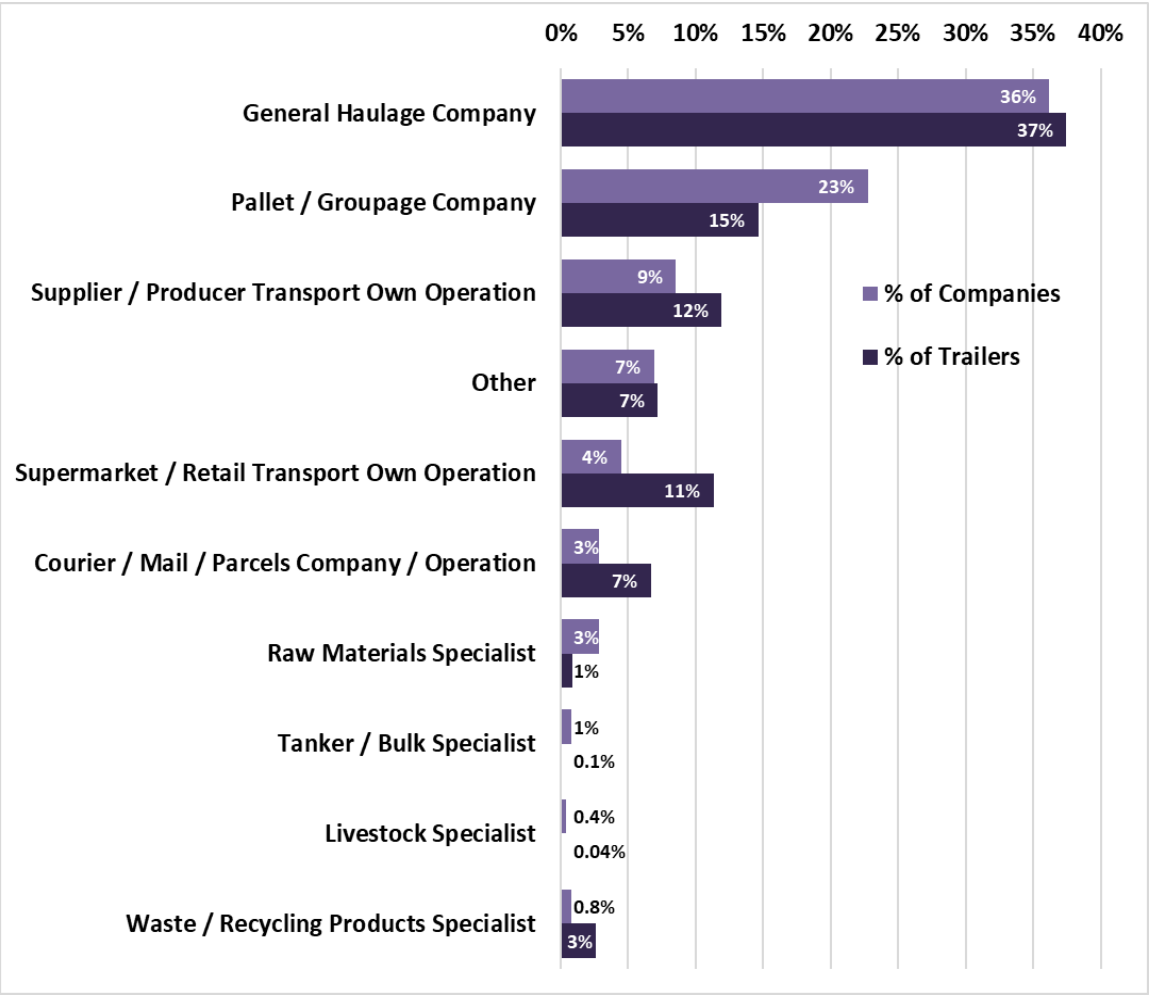


Figure 4: LST trial participants by nature of operation (source LST Trial data)



LST designs in operation

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

2.40 Most LSTs are box or curtain sided designs with a single deck. Figure 5 to Figure 8 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 5: LST body design mix (source LST Trial data)

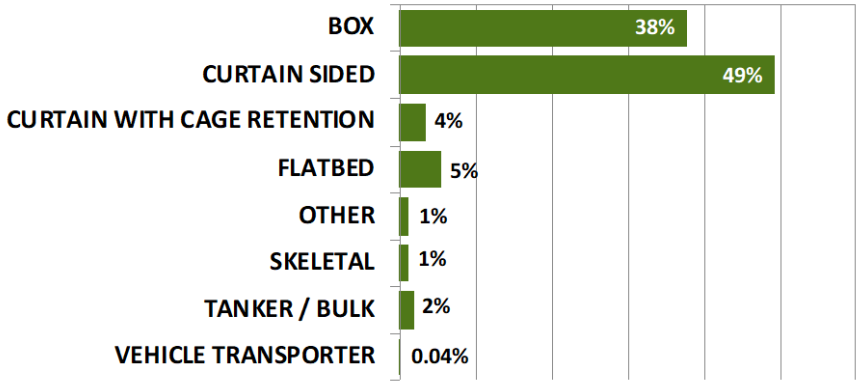


Figure 6: LST deck layout mix (source LST Trial data)

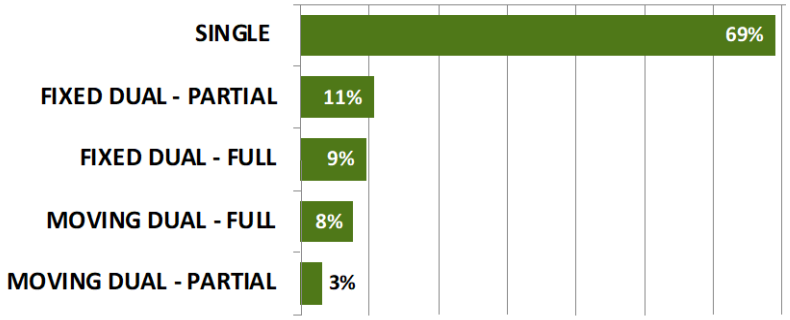


Figure 7: LST steering design mix (source LST Trial data)

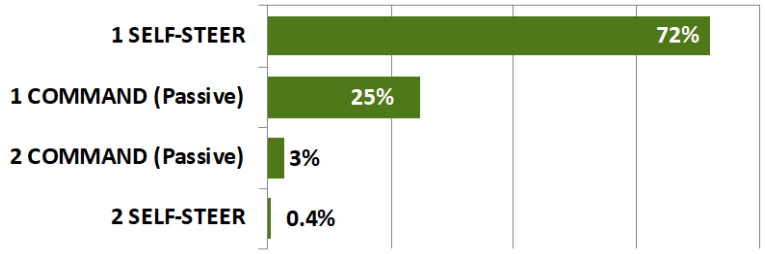
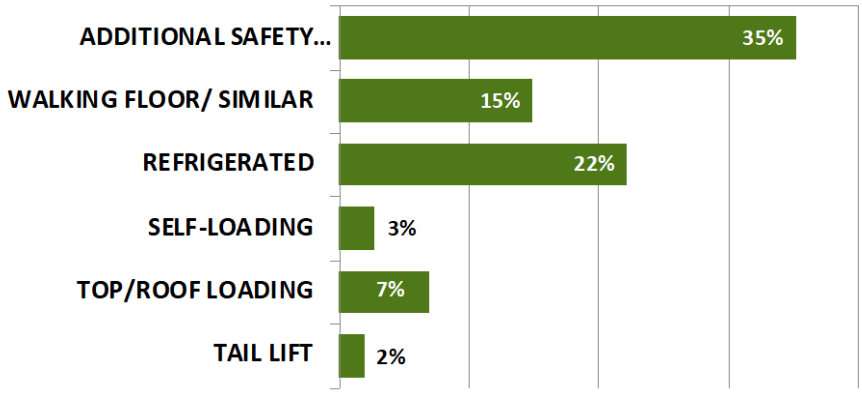


Figure 8: LST other features mix (source LST Trial data)

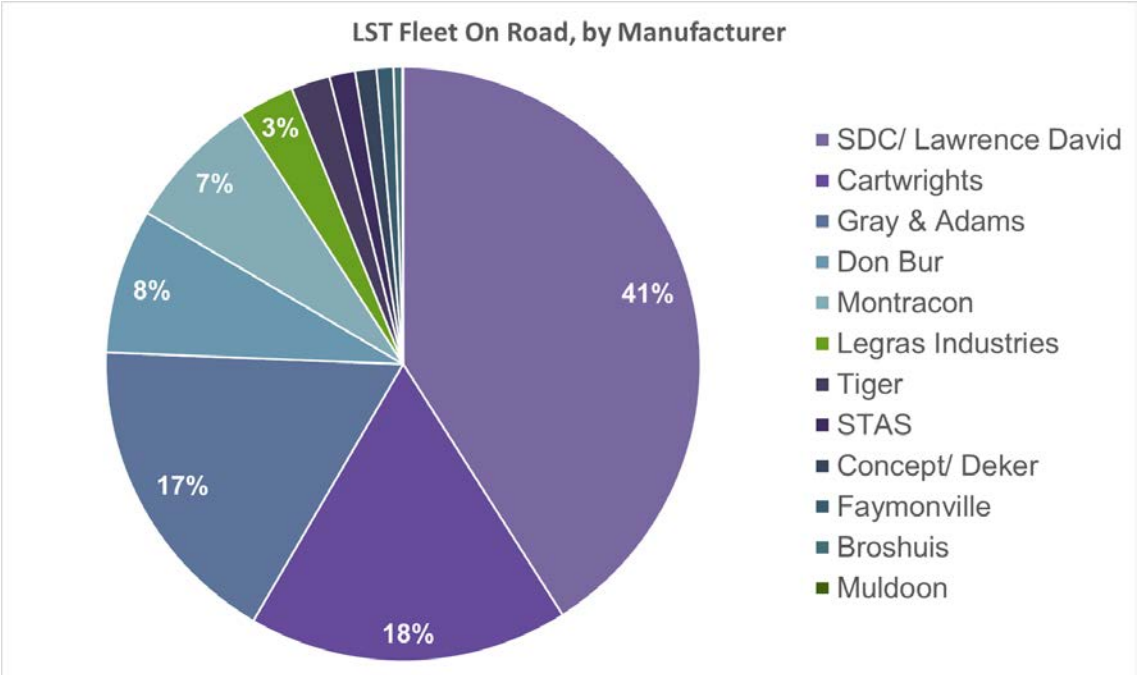


Manufacturers

2.41 By the end of 2019, 12 manufacturers had designed LSTs and had them cleared by VCA for use on the trial (Figure 9).

2.42 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.

Figure 9: LST fleet by manufacturer (to end 2019) (source LST Trial data)



Operational data

Note on methods and sources of data

2.43 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 we introduced a new simplified journey summary sheet) which only requires an aggregated view of the operations of each trailer for each permutation of leg type, goods type and MOA on which that trailer was used. In 2019, an even simpler format was introduced for operators who had already met a threshold of continuous accepted data. These changes in the data collection framework are summarised in Annex 3.

2.44 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 is no longer recorded.

Distance covered by LSTs

2.45 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)

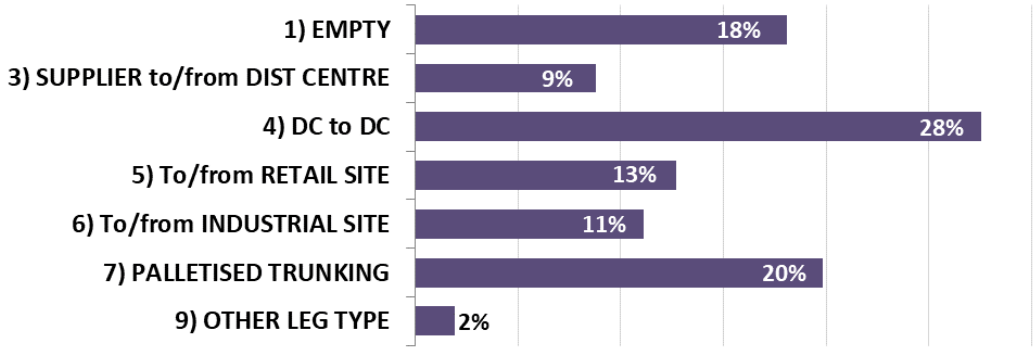
LST distance & leg count totals	To end 2019	To end 2018	To end 2017	To end 2016	To end 2015
Total vehicle km recorded	739 million	587 million	443 million	319 million	202 million
Number of recorded legs	5,870,664	4,691,852	3,589,290	2,647,018	1,727,559
Average leg distance	126 km	125 km	124 km	121 km	117 km

2.46 We note that the figures given for each year are the values cited in the relevant annual report, based on the dataset frozen for analysis in that year. Past years totals are not updated here to show additional data submitted too late to be included in the relevant annual report. So, for example, the change in the cumulative total between 2018 and 2019 is largely due to data for LSTs operations in 2019, but ALSO includes delayed 2018 data for 15 companies. This represents approximately 10,000 legs and 1 million km of delayed data from 2018 appearing in the 2019 cumulative total, which is not a significant proportion of the totals shown above. If the updated 'data-in-year' figures are required later for a particular analysis, we can provide them on request.

Operation by nature of operation and MOA

2.47 Figure 10 shows that the primary uses of the LSTs continues 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 distribution centre (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.)

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



Journey types 2) and 8) only appeared in the pre-2017 trial data framework

Figure 11: LST km by goods type (source LST Trial data)

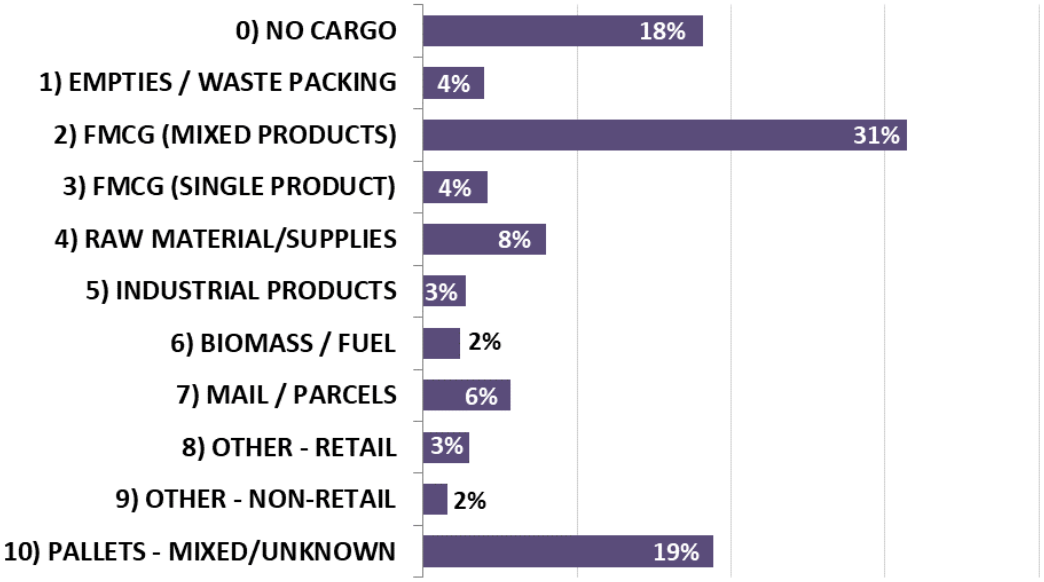
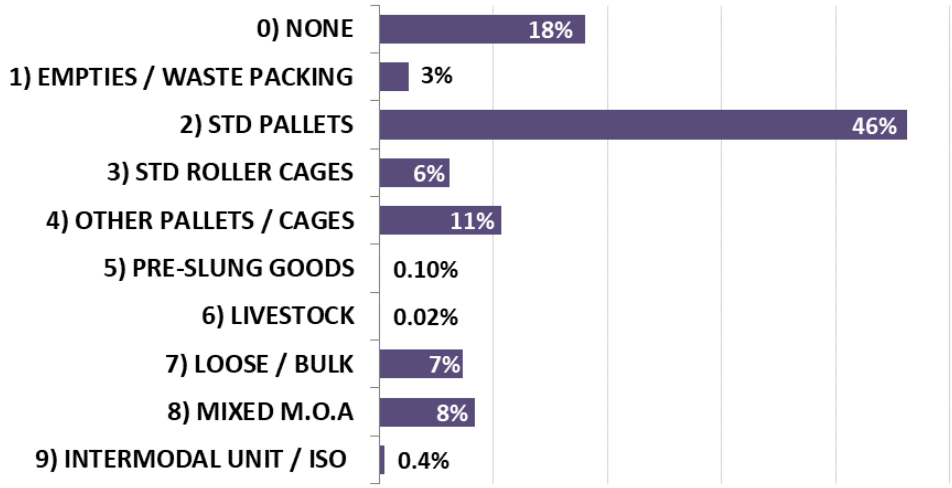


Figure 12: LST km by mode of appearance (MOA) (source LST Trial data)



2.48 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 68% of all loaded distance covered and, we can assume, a proportion of all the empty distance

2.49 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.

2.50 The nature of the transported goods is shown in Figure 11 and the mode of appearance (MOA) is shown in Figure 12. These are dominated by fast moving consumer goods (FMCG) and other goods moved in cages or on pallets.

Empty running

2.51 The LSTs ran empty for around 18% of the total distance they covered, considerably lower than the figure of around 30% for all GB articulated HGVs in 2019.

2.52 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 the 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.

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

Utilisation measures

2.54 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 noted when a journey was ‘weight limited’ so that we could identify 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.)

2.55 With the new aggregated format, we do not produce an overall Deck% histogram, but the overall performance can be seen later, in the operator savings chart - Figure 13. Where operators have been moved on to the 2019 ‘Short-DSF’ their total leg and distance figure for each trailer is used as a reference value which is then expanded pro-rata to create 2018-style complete data for full/empty legs etc, using the proportions found in their last year of full format data. (See Annex 3).

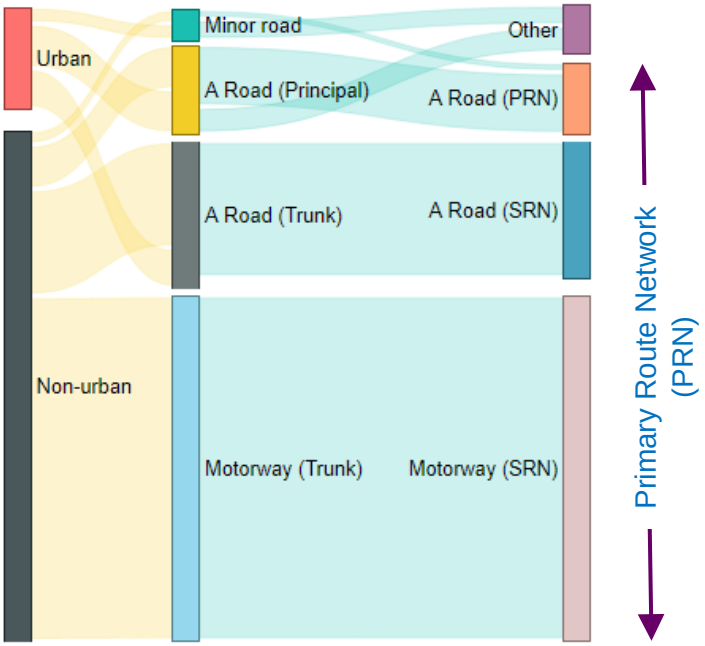
LST patterns of movement

2.56 During 2015 through to 2017 we developed a method of modelling routes, using the start and end postcodes provided by operators for 2017. We validated the model route selection using a large sample of GPS data for a mix of LST and non-LST operations by trial participants (DfT judged it would be unreasonable to ask operators to fit GPS equipment as a condition of the trial, as it would limit participation to larger companies. While GPS use is now more common, our research suggests fewer than

50% of the trailers are fitted with GPS tracking).

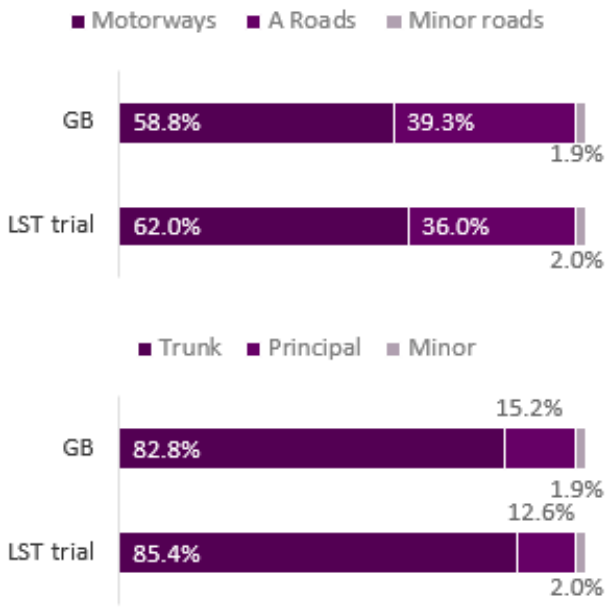
2.57 From this work we were able to generate estimated patterns of LST movement by each of the major GB road classification systems, as show in the chart here.

Figure 13: LST distances by different road classification systems



2.58 A key result of this 2017 work was the comparison of the LST use of different road types to that published for the GB Articulated HGV fleet as a whole. As the chart above shows, the split of road types used by the LSTs is very similar to that of the standard length trailers.

Figure 14: LST comparison with national HGV fleet by road class and road type



2.59 This is an important conclusion of the trial since it shows that contrary to some pre-trial

assumptions, the LSTs operations are not any more weighted towards Motorways and SRN A Roads than the standard GB artic fleet. This aligns with the major use of LSTs by the retail sector to deliver to large stores, rather than solely for trunking between national distribution centres.

2.60 In the 2018 Annual Report we presented two additional analyses of LST movement patterns:

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.

2.61 The results can be found in the full 2018 annual report.

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 are taken into account, as with the new data format these would be difficult to estimate and they 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 and journey savings results: trial to date

3.7 Table 4 shows the cumulative vehicle kilometres saved during the trial.

3.8 Since the start of the trial, **the use of LSTs has removed between 54 and 60 million vehicle kilometres of freight traffic from the roads of Great Britain.**

Table 4: Cumulative vehicle km saved by using LSTs (source LST Trial data)

Distance saved (million vehicle km)	At end 2019	At end 2018	At end 2017	At end 2016	At end 2015	At end 2014	At end 2013
Loaded Legs Only	53.8	41.1	29.3	20.9	12.3	6.0	2.1
Loaded Legs plus 'matched' empty return legs	59.9	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 126km average leg length recorded by vehicles in the trial and rounding the results (Table 3, page 24).

3.10 On this basis, **we estimate that 430,000 to 475,000 journeys were removed from GB roads as a result of the trial to the end of 2019** (rounded figures).

Distance and journey savings results by operator and by trailer

3.11 Figure 13 shows the distribution of percentage distance savings by operators participating in the trial for 2018 and 2019.

3.12 Figure 14, shows the same data, but weighted to show the number of *trailers* owned by the operators in each savings group.

3.13 The savings percent indicates the km savings as a percentage of the total km that would have been required had 13.6m trailers been used to deliver the same cargo:

Savings % = km saved divided by (Total LST km + km saved)

3.14 Note that the mean of the savings values for each operator are not quite the same as the mean across the whole trial. Also, these charts are not based on the entire trial as:

- the data is for 2018 and 2019 only – the change in data gathering format making a cumulative calculation with pre 2018 data, problematic
- the basis of the calculation for 2018 and 2019 is slightly different than for previous years due to differences in the data template and the approach to identifying empty return legs.

3.15 This has some merit, since it means for this detailed view we are looking at the most current operations of the LSTs and their efficiency.

3.16 Further details of the utilisation calculation can be found in Annex 3.

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

3.17 We can also express the saving in the form '1 in X' (km or journeys), which we have found useful in articulating the benefit gained from operating LSTs to a wider audience.

3.18 Over the whole fleet and across the trial we estimate **that the average percentage distance saving by operator including empty return legs is 8.3%, which equates to 1 in 12 journeys.**

3.19 The most efficient operators achieve the maximum **percentage distance saving by operator including empty return legs of 13.5%, which equates to 1 in 7.5 journeys.**

3.20 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.

Figure 15: Distribution of % distance saved using LSTs with and without return empty savings (2018 and 2019) – COUNT OF OPERATORS (source LST Trial data)

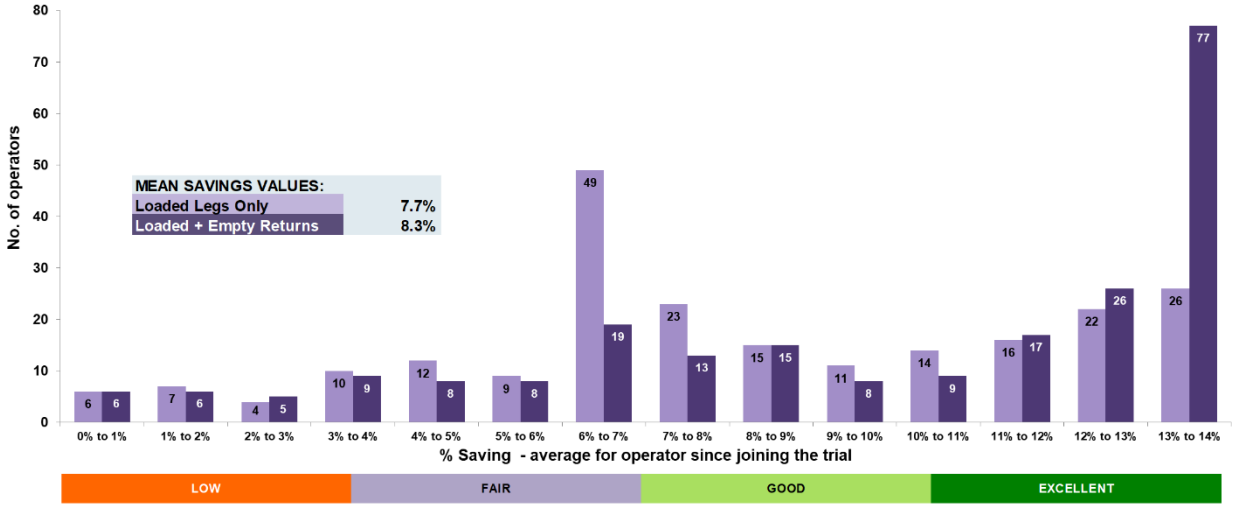


Figure 16: Distribution of % distance saved with and without return empty savings included (2018 and 2019) – COUNT OF TRAILERS IN OPERATOR FLEET (source LST Trial data)

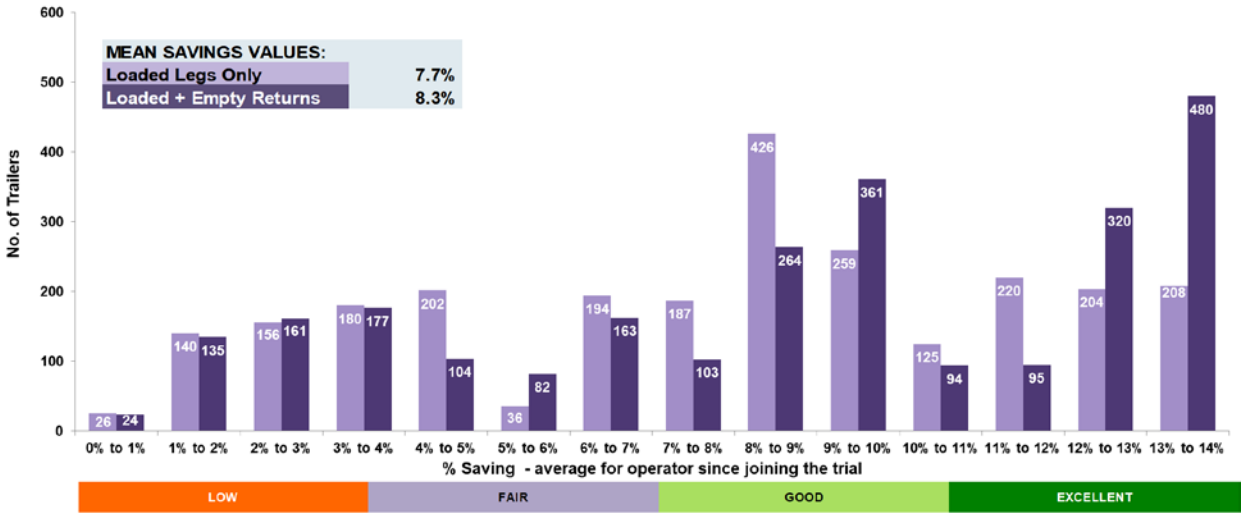


Figure 17: 2019 Savings bands by operator (source LST Trial data)

LST savings performance summary by operator (2019)	Lowest Savings Group (0-5% Saving)	Average Savings Group (>5-10% Saving)	Highest Savings Group (>10-14% Saving)
% of operators	15%	28%	57%
% of trailers	23%	38%	39%

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

3.21 In Figure 15 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 129 operators on the trial operating 989 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 34 operators (15%), operating 601 trailers (23%). 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 retail sector fleets on the trial are operating within the 7-9% efficiency range according to our calculations (see Figure 14), reflecting the highly variable demand for cargo movement in their business. For these large fleets, 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.

3.22 In Figure 14, 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 1-5% efficiency bands, with many journeys being operated without, apparently, using the extra length.

3.23 A more detailed study of the business types of 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 empty-return 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 trailers were 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 (both reports are available on the DfT website). 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 actual LST designs that have been adopted and the 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 5. These results are reproduced from the 2018 annual report, with the exception of the last row. The final row gives emissions savings expressed as kg (of emissions) per million trailer km SAVED by using LSTs in place of standard trailers, calculated from the 2017 data. This allows us to derive emissions savings from the distance saving for any year of the trial.

Table 5: 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 standard (13.6m) trailer km SAVED*	***459***	***774,030***	***3,882***	***41***	***89***

Notes: This is based on the routing and emissions modelling dataset only, not the whole trial to date. The key values in 2017 were:

***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.*

Some figures above are rounded.

4.6 In 2017 and 2018, the savings factors were applied inside a version of the original emissions model. The factors have now been integrated into the trial Scaling Model

(which is designed to provide long term projections of the potential impact of LSTs under different scenarios- see Section 8). The Scaling Model was developed during 2019 and the results presented here are generated from that model. The calculation performed is unchanged.

4.7 Two types of results are generated:

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 of the latest trial year
   b. Projected savings to end 2021 – the final year of the original 10-year trial period
   c. Projected savings to end 2026 – the final year of the trial as extended in 2017.

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, once the first 1-2 trial data periods were completed.

Engine class assumptions

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 to explore the impact of the introduction of EURO VI engines to some fleets in the later years of the trial is possible. This option is discussed further in Section 10, but for now, the results using the existing factors have been updated to incorporate the 2019 LST operations.

LST Trial fleet growth assumptions

4.11 A projection of the growth of the trial LST fleet over future years of the trial is needed for both the emissions model and the Scaling Model mentioned above.

4.12 We estimate the growth by looking at both the number of LSTs added to the trial in the most recent year and also the number of allocations which are already on live VSOs at the time we do the modelling. The difference between these two provides an indication of the broad rate of growth as the VSO figure is a reasonable predictor of trailers likely to join the trial in the coming year.

4.13 In addition, we look at whether the DfT has made any changes to the allocation system or other announcement to the industry that might lead to a higher or lower growth rate in coming years.

4.14 In Section 2 we discussed the fact that the rate of growth of the LST fleet appears to have reduced significantly since late 2019 (see Figure 2 in page 18). On this basis we

have adjusted the anticipated fleet growth for the remaining trial years slightly, although with the total fleet already being at 90% of the 2,800 ceiling, this has had a marginal effect on the overall emissions savings projections.

2019 Emissions savings results

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

Table 6: Total LST trial emission savings projection

A. TRIAL OPERATIONS

Trial operational parameter	Unit	To End 2019 (actual)	10 year Trial end 2021	Extended Trial end 2026
LSTs on road	number	2,473	**2,800**	2,800
Total journey	millions	5.9	**8.4**	15.1
Total distance covered	million kms	739	**1,066**	1926

B. EMISSIONS SAVINGS

Emission	Unit: tonnes	To End 2019	10 year Trial end 2021	Extended Trial end 2026
Carbon Monoxide	CO	28	**42**	79
Carbon Dioxide equivalent	CO2e	48,169	**71,495**	132,820
Oxides of Nitrogen	NOx	241	**358**	666
Particulate Matter (Exhaust)	PM Exhaust	2.6	**3.8**	7.1
Volatile Organic Compounds	VOC	5.5	**8.2**	15.3

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. Figures 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.

4.16 **The total emissions saving from LSTs from the start of the trial to the end of 2019 is estimated as 48,000 tonnes of CO2e and 241 tonnes of NOx** (rounded figures).

4.17 **The projected saving in CO2e, if the trial were to run to 10 years (2021) or 15 years (2026) are around 71,000 tonnes and 132,000 tonnes respectively. The figures for NOx are 358 and 666 tonnes respectively** (rounded figures).

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 trends or contributory factors to risk to be analysed in a statistically meaningful way, to inform future 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 739 million vehicle kilometres and have removed between 54 and 60 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 7 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 8 to 9 injury collisions with a reduction of 11 to 12 casualties** (rounded figures).

Table 7: Estimated collisions and casualties removed from GB roads over the trial period through reduction in vehicle km operated

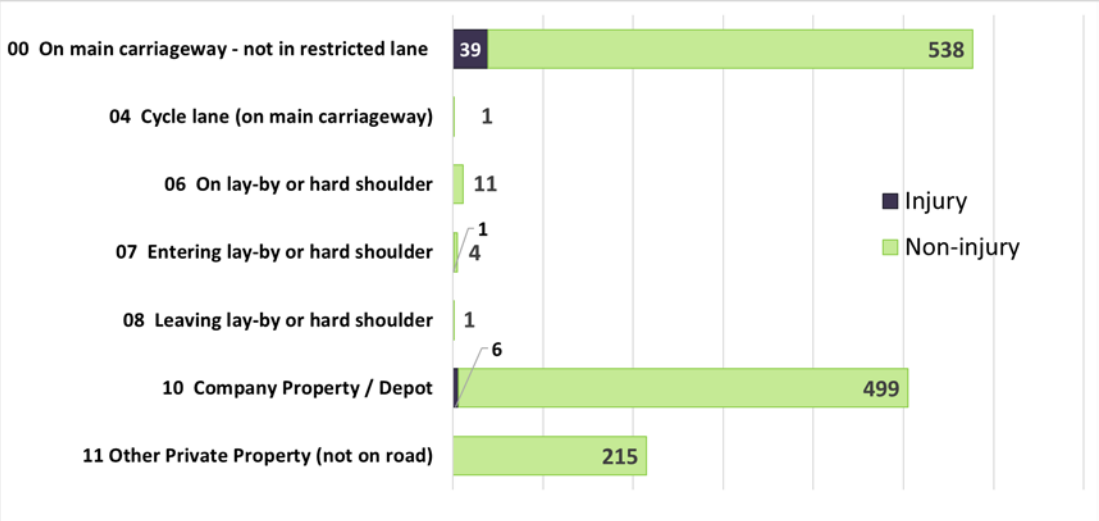
Injury incidents Public access locations	GB Artic HGV rate 2012-2018 per million vehicle km	Million vehicle km removed from operation by LST use	Calculated incident reduction
Collisions	**0.143**	**53.8 to 59.8**	**7.7 to 8.6**
Casualties	**0.204**	**53.8 to 59.8**	**11.0 to 12.2**

- Sources: LST utilisation and vehicle km reduction from trial data. GB Arctic rate from STATS19 and TRA3105 2012-2018.

LST Safety Outcomes 2: Incidents involving LSTs

5.9 There have been 46 injury incidents involving an LST reported of which 40 took place on the public highway. Figure 16 provides a summary of these incidents involving LSTs, by the road location reported by the operators.

Figure 18: Incidents reported involving LSTs (Summary to end 2019 – source LST trial data)



Note: The injury events are marked in dark purple. There were 39 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 For the events that occurred on the public highway or in other public locations, 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 9).

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 vehicle km 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 46 injury incidents involving LSTs since the trial began. Table 8 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 8: Casualties from incidents involving LSTs reported to the trial: 2012-19

Injury Collisions from Trial Logs	Total Collisions	Total Casualties	Fatal	Serious	Slight
All Injuries (including depots etc.)	**46 (39)**	**57 (49)**	2 (0)	11 (11)	44 (38)
All Injuries in Public Road/Place	**40 (33)**	**51 (43)**	2 (0)	10 (10)	39 (33)
All Injuries judged LST related (any location)	**9 (9)**	**9 (9)**	0 (0)	1 (1)	8 (8)
All injuries LST related AND in public place	**4 (4)**	**4 (4)**	0 (0)	0 (0)	4 (4)

Figures in (brackets) show the totals at the end of 2018. 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 shaded box).

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

- **There have been 7 additional personal injury incidents involving LSTs in public locations during 2019, resulting in 8 casualties.**
- **Two of these casualties were fatalities, the first recorded during the trial.**
- **None of the 2019 incidents were judged to have been LST related**

Fatal incidents in 2019

5.17 There have been two fatal incidents in 2019. Given the serious nature of these events, we have provided the DfT with the incident report received from the operator, along with further emails and documents where available. There was nothing in the documents Risk Solutions have seen to indicate that the LST contributed to the incident in a way that would have been different to a standard 13.6m trailer.

5.18 The DfT have taken responsibility for further investigation of these events, using their access to the police forces that attended the incidents. We have consulted with the Department for Transport to further assess whether there was any LST specific contribution to the event.

5.19 The DfT 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 to see 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

5.20 The personal injury incidents in public locations are summarised in Table 9. Note that:

- Locations are identified by 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 2019 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.
- **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.

Events judged to be not LST related

5.21 **3rd Party Errors:** In incidents 3, 4, 6, 13, 16, 34, 36, 37 and 38 - a **3rd party vehicle ran into the trailer (or the tractor pulling it)** 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.

- The two fatal events (36 and 38) fall broadly into this category in that they have both been attributed to the actions of a third party.
- In event 36, a 3rd party vehicle cut-in on and struck the LST. The incident developed as the driver of the LST was unable to recover the vehicle and he died when the vehicle left the road.
- In event 38, the LST was overtaking the cyclist, who fell off into the side of the vehicle and was killed.

5.22 **LST Driver Errors:** In incidents 11, 12, 14, 15, 18, 20, 21, 24, 26, 29, 31, 39 and 40 where the **LST driver ran into the rear or side of another vehicle**, often in slow moving traffic and there is no effect from the trailer length. Event 40 is slightly different in that the LST driver lost control of his vehicle while moving downhill at speed and

accepted it was driver error, not a problem with the trailer. Operators, so far, have not reported any issues with braking or slowing instability when pulling LSTs compared to other trailers.

5.23 **LST Driver incapacitation:** In incidents 7, 9, 10, 19, 22, 23, 25, 28, 30, 35 the **cause was driver fatigue / error / illness / 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.

Potentially LST Related Events:

5.24 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, even if this was not completely clear.

5.25 **None of the 7 events added in 2019 were judged to be LST related**

5.26 In earlier years, events 8 and 17 were classified as LST related, with events 2 and 32 noted as having the LST possibly contributing to the event.

5.27 In event 32 the driver 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’.

Table 9: 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.**
[34] 2019	Principal (rural)	**0**	**0**	**1**	LST was pulling out of a layby at the side of an A Road. Third party vehicle approaching from behind braked but was struck by a following vehicle and shunted into the side of the LST tractor unit. **Not LST related.**
[35] 2019	Motorway	**0**	**0**	**1**	LST was travelling on the motorway when the driver suffered a medical incident. Tractor unit and trailer ran off road on nearside and came to a stop in a field. **Not LST related.**
[36] 2019	Motorway	**1**	**0**	**0**	LST was travelling on a raised section of motorway when it was struck by third party vehicle. Tractor unit and trailer overturned, slid across carriageway, went through the bridge barrier and dropped over the edge. **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
[37] 2019	Motorway	**0**	**0**	**1**	LST collided with a third party vehicle as both vehicles attempted to merge onto a motorway main carriageway from a motorway link road. **Not LST related.**
[38] 2019	Trunk (urban)	**1**	**0**	**0**	LST was travelling along a straight section of A road, overtaking a cyclist. As the LST moved past, the cyclist fell from his bike into the side of the vehicle. **Not LST-related.**
[39] 2019	Motorway	**0**	**0**	**2**	LST was travelling on a motorway, indicated left to move into inside lane, did not see third party vehicle travelling at faster speed in inside lane. Collided with the third party vehicle, causing it to spin into barrier. **Not LST related.**
[40] 2019	Motorway	**0**	**0**	**1**	LST travelling downhill on a motorway, lost control overtaking another vehicle, causing the tractor unit and trailer to overturn and collide with a third party vehicle in the outside lane. **Not LST related.**

Sources: LST data, Operator communications and STATS19 data for validation (except 2019 – 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

LST Safety Outcomes 3: Comparison of national injury incident rates

5.28 **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.**

5.29 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

5.30 There have been 40 personal injury incidents involving an LST in public locations in 739 million vehicle km travelled from when the trial began in 2012 to the end of December 2019.

5.31 Of these 40 public personal injury incidents, only 4 events (resulting in 4 slight injuries) were determined to be, or possibly be, LST-related.

5.32 This equates to:

- **1 injury event in a public place for every 18.5 million vehicle km travelled by the LSTs**
- **1 LST related injury event in a public place, in every 185 million vehicle km travelled**.

GB Articulated HGVs summary

5.33 Table 10 summarises the number of collisions, vehicle km and casualties for the period 2012-2018 for the GB Articulated HGV fleet.

5.34 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.

5.35 Table 11 then summarises the data in Table 10 as a three-year average for the period 2016-18. 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 10: Number of collisions, vehicle km and casualties for the period 2012-2018 for the GB Articulated HGV fleet

Number of Collisions		2012	2013	2014	2015	2016	2017	2018	Total
Motorways		723	741	831	795	625	521	482	**4,718**
Non-motorways by Major-A & Minor roads	Major A-roads (Trunk & Principal)	1,189	1,187	1,250	1204	1,090	933	809	**7,662**
	Minor roads	310	265	286	265	236	213	219	**1,794**
Non-motorways by Rural & Urban roads	Rural roads	1,025	1,027	1,077	994	921	736	671	**6,451**
	Urban roads	474	425	459	475	405	410	357	**3,005**
Total Collisions		**2,222**	**2,193**	**2,367**	**2,264**	**1,951**	**1,667**	**1,510**	**14,174**

Vehicle Kilometres (billions)		2012	2013	2014	2015	2016	2017	2018	Total
Motorways		7.5	7.8	8.1	8.3	8.5	8.7	8.8	**57.7**
Non-motorways by Major-A & Minor roads	Major A-roads (Trunk & Principal)	5.2	5.2	5.4	5.6	5.8	6.0	6.2	**39.4**
	Minor roads	0.3	0.3	0.3	0.3	0.2	0.3	0.3	**1.9**
Non-motorways by Rural & Urban roads	Rural roads	4.7	4.7	4.8	5.1	5.2	5.4	5.6	**35.5**
	Urban roads	0.8	0.8	0.8	0.8	0.8	0.9	0.9	**5.8**
Total Vehicle Kilometres (billions)		**13.0**	**13.3**	**13.7**	**14.2**	**14.5**	**15.0**	**15.3**	**99.0**

Number of Casualties	2012	2013	2014	2015	2016	2017	2018	Total
Fatalities	116	117	111	125	133	124	132	**858**
Serious injuries	355	443	410	430	394	374	382	**2,788**
Slight injuries	2,650	2,547	2,878	2,733	2,232	1,942	1,528	**16,510**
Total Casualties	**3,121**	**3,107**	**3,399**	**3,288**	**2,759**	**2,440**	**2,042**	**20,156**

Source STATS19 and TRA3105 2012-2018 (2019 STATS19 not yet published).

Further notes to Table 10

Rural roads (Excluding motorways) include one incident where its STATS19 code for rural/urban status is 3 (=unknown). It has been allocated to rural for the purposes of this calculation, to maintain equal numbers of total non-motorway events when split between Major/Minor and Urban/Rural segmentations of the data. The event was on a road which is predominantly rural.

The rural event count is, in any case, only a balancing figure in this table - without which the sub-totals would not match for the two non-motorway road split types. It does not affect any later calculations.

Table 11: Three-year averages (2016-18) for collisions, casualties and vehicle km for the GB Articulated HGV population, public locations

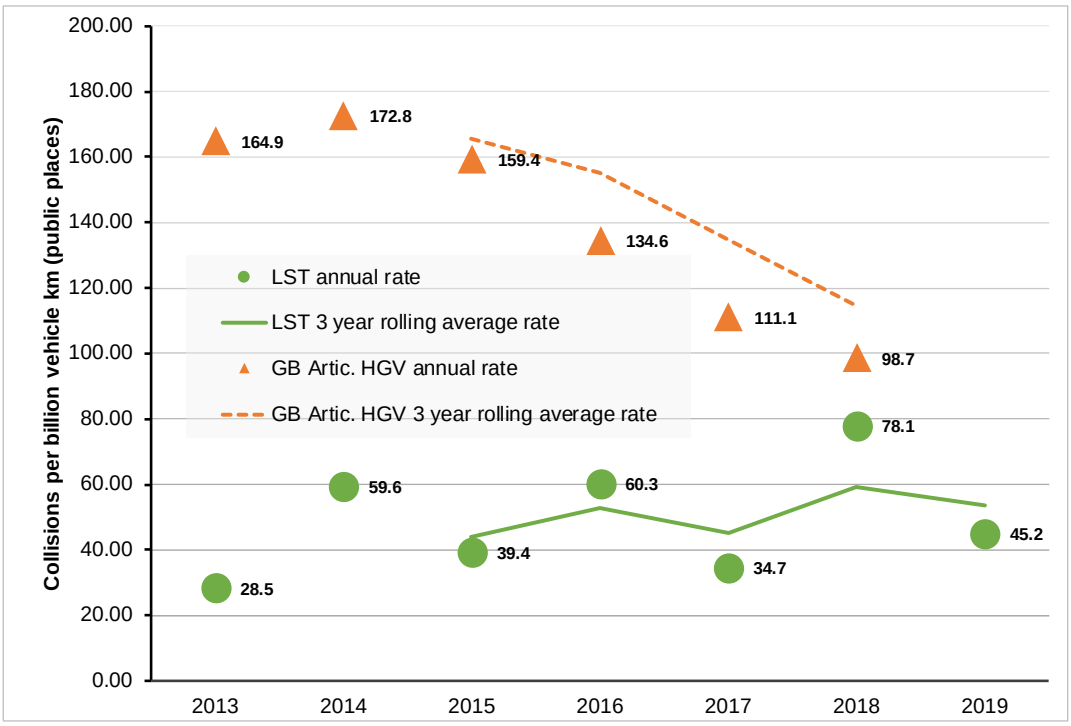
GB Articulated HGV three-year averages 2016-2018	Collisions per year	Casualties (All killed or injured) per year	Billion vehicle km per year
1) Motorways	543	807	8.7
2) Major A-roads (Trunk and principal)	944	1,331	6.0
Minor roads	223	275	0.3
3) Rural roads (excluding motorways)	776	1,121	5.4
Urban roads (excluding motorways)	391	485	0.9
Total *(1) Motorway + (2) or (3) rounded figures*	**1,709**	**2,414**	**14.9**

Source STATS19 and TRA3105 – annual average 2016-2018 (2019 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

5.36 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 10) and the GB fleet (calculated from Table 11), which helps to smooth out any natural variation in the data from year to year. This is shown in Figure 17 below.

Figure 19: Annual incident rate and three year rolling averages, 2013-2019



5.37 The LST incident rate has decreased since last year, and the three-year rolling average rate has also reduced. The GB articulated HGV rate has also continued its downward trend.

5.38 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

5.39 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.

5.40 Table 12 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.

5.41 **For the public access location comparison, per km operated, LST incidents are occurring at a rate of 47% of the GB articulated HGV fleet.**

5.42 The difference in incident rates has narrowed over time due to the downward trend in the background data. However, the difference in rates is still statistically significant.

Table 12: Summary comparison of LST public road collision and casualty three year rolling average rates (2017-19) vs. GB articulated HGVs (2016-18)

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	54	114	**0.47**
Casualties	68	162	**0.42**

Sources: LST from trial data. GB from STATS19 and TRA3105 – all 2016-2018 (2019 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 AND key vulnerable user groups

5.43 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.

5.44 In this section, we update the analysis by road type. A separate analysis – new this year at the DfT's request – of the actual statistics for pedestrians and cyclists is covered in the next section.

Injury incidents by Road Type

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

5.45 The detailed data for the injury incidents noted in Table 9 and taken from trial data have been analysed and the incidents classified in Table 13 using the tailored data splits highlighted above.

Table 13: Number of personal injury collisions for LSTs (whole trial to end 2019)

Number of collisions in each location type		Public & private locations	Public locations only
Motorways		26	26
Non-Motorway – by Road Type	Major A-roads (Trunk and Principal)	11	11
	Minor roads	3	3
	Depots etc.	6	0
Non-Motorway – by Urban or Rural	Rural roads	10	10
	Urban roads	10	4
Total		**46**	**40**

The source for LST vehicle kilometres split

5.46 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.

LST incidents involving vulnerable road users (pedestrians and cyclists)

5.47 Vulnerable Road Users (VRU) are defined by EU Intelligent Transport Systems as "non-motorised road users, such as pedestrians and cyclists as well as motor-cyclists and persons with disabilities or reduced mobility and orientation". We would also include horse riders in this group.

5.48 VRU are considered an important group for analysis because they are disproportionately represented in statistics on injuries and road traffic casualties and we have added an analysis of the risk posed to this group from LSTs to the report this year.

5.49 Since the trial began there have been three incidents where pedestrians or cyclists have been involved, including one fatality in 2019. They are events 8, 12 and 38 in Table 9.

Pedestrian standing at edge of curb [Event 8]

5.50 In 2015 an LST on a driver assessment route making a turning manoeuvre in an urban location, was reported (by a member of the public) to have hit a pedestrian with the tail end of the trailer.

5.51 The pedestrian self-reported as slight injury. Police did not attend the scene but gathered information from the pedestrian's report and interviews with the operator involved.

5.52 **The fact that the trailer was an LST was a part of the cause of this incident,** since the manoeuvre being performed involved a very high turn angle (almost 120 degrees). The route is no longer used for driver assessment.

5.53 A more detailed assessment of this incident drawing on the police record and the operator's internal event investigation can be found in AR2015, on page 26.

Cyclist hit from behind on dual carriageway [Event 12]

5.54 In 2016 an LST hit a cyclist from behind when moving from the slip road to a dual carriageway, which forms part of a bypass around a major town.

5.55 The driver reported checking mirrors before moving forward but was dazzled by the evening sun and so only saw the cyclist when they were about 2 metres in front of the vehicle. The driver braked as hard as possible but collided with the cyclist from behind. The Police and Ambulance attended the scene; the cyclist was taken to hospital with serious injuries.

5.56 **The fact that the trailer was an LST was not part of the cause of this incident.**

5.57 A more detailed assessment of this incident drawing on the police record and the operator's internal event investigation can be found on page 40 of AR2016.

Cyclist fell from bicycle as HGV overtook [Event 38]

5.58 The incident took place as the LST overtook the cyclist on a straight road, and the cyclist fell off. Being a fatal incident, the DfT engaged directly with the operator.

5.59 **The fact that the trailer was an LST was not believed to be part of the cause of this incident.** The full DfT statement based on their further investigation was provided in the discussion earlier at paragraph 5.19.

Vulnerable Road User data and analysis

5.60 The tables below summarise the collisions recorded on public roads where an articulated HGV was involved and where one or more pedestrians or cyclists was killed or injured, between 2012 and 2019 (2018 for STATS19 data).

Table 14: Injury incident and distance data for vulnerable road user analysis

A. All articulated HGV incidents

Parameter	2012	2013	2014	2015	2016	2017	2018	2019	Total
Pedestrians involved	93	124	93	95	100	105	95		705
Cyclists involved	77	52	70	70	44	47	50		410
Total casualties	**170**	**176**	**163**	**165**	**144**	**152**	**145**		**1115**
Total collisions	**168**	**161**	**158**	**159**	**137**	**149**	**139**		**1071**
Billion vehicle km	13.0	13.3	13.7	14.2	14.5	15.0	15.3		99.0
Casualties per billion vehicle km	13.08	13.23	11.90	11.62	9.93	10.13	9.48		11.26
Collisions per billion vehicle km	12.92	12.11	11.53	11.20	9.45	9.93	9.08		10.82

B. LST incidents

Parameter	2012	2013	2014	2015	2016	2017	2018	2019	Total
Pedestrians involved				1					1
Cyclists involved					1			1	2
Total casualties				1	1			1	3
Total collisions				1	1			1	3
Billion vehicle km	0.0083	0.0351	0.0671	0.1016	0.1160	0.1153	0.1409	0.1551	0.7394
Casualties per billion vehicle km				9.84	8.62			6.44	4.06
Collisions per billion vehicle km				9.84	8.62			6.44	4.06

C. Summary comparison of LSTs and all articulated HGVs

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
Casualties	4.06	11.26	**0.36**
Collisions	4.06	10.82	**0.38**

Sources: LST from trial data. GB Articulated HGVs from STATS19 and TRA3105 – all 2016-2018 (2019 not yet published) – Some figures rounded.

Further Notes to Table 14 – applicable also to Tables 15a and 17 that follow: The calculation method used here (and in past Annual Reports) includes ALL casualties injured in any incident where an articulated HGV was one of the vehicles involved, not just the HGV occupants, or parties who's injuries could be related to the HGV role in the accident. The calculation normalises the number of incidents in each case using the vehicle km estimated for the LSTs/Articulated HGVs alone and does not make any attempt to take into account the vehicle km of any other vehicles involved in the accidents. This a general approach applied to both the LST incidents and the STATS19 Articulated HGV incidents and provides a general metric for comparison between the two populations of trailers. This approach could not be directly expanded to address a wider set of cases – for example such as comparing LST incident rates to Cars, as this would risk either comparing unalike populations, or if multiple vehicle types were analysed and then totalled up, double counting or the same vehicle in more than one sub-group of the analysis, where more than one vehicle was involved

5.61 The LST casualty and collision rates each year appear to be lower than the corresponding articulated HGV fleet average accident rates and the mean rate ratio is less than one in each case. However, this is based on a very small sample size. To determine if the difference is statistically significant, a statistical significance test must be carried out, this is described in the following section.

Statistical comparison of injury incident rates by road type and for vulnerable road users

5.62 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.

5.63 When we presented this analysis in the 2016, 2017 and 2018 Annual Reports examining the differences in injury incident rates by road type, the tests were statistically significant in most cases, confirming that the data sets were now large enough to reach valid conclusions. As we show below, the addition of the 2019 data has not changed the conclusions compared with the 2018 report.

5.64 In this report we have also presented an additional analysis looking at injury incidents involving vulnerable road users, this new analysis is included in the testing presented below.

Injury incident analysis – classical statistics

5.65 The results in Table 15 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.

5.66 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.

5.67 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.

5.68 **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.**

5.69 **There is not yet enough data for incidents involving vulnerable road users to determine whether the incident rates are different.**

5.70 We will continue to monitor and report on the urban and minor road incident rates, as well as vulnerable road users, separately as the risk of injury events in these subsets of the data will remain an area of concern for the trial.

5.71 Once the 2019 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 2012-2019 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 15: Injury incident rate analysis by different road types

A. GB Articulated HGV fleet average collision rate (STATS19 data for 2012-2018)

Data item	Urban roads (excluding motorways)	Minor roads	A-roads (trunk & principal)	Motorways	Pedestrians & cyclists (all road types)
No. of collisions	3005	1794	7662	4718	1071
Billion vehicle km travelled	5.8	1.9	39.4	57.7	99.0
Mean collision rate per billion vehicle km	518	935	195	82	10.82

B. Trial LSTs (trial data for 2012 to 2019)

Data item	Urban roads (excluding motorways)	Minor roads	A-roads (trunk & principal)	Motorways	Pedestrians & cyclists (all road types)
No. of collisions	4	3	11	26	3
Billion vehicle km travelled	0.097	0.015	0.266	0.458	0.739
Mean collision rate per billion vehicle km	41	203	41	57	4.06

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

Comparison measure	Urban roads (excluding motorways)	Minor roads	A-roads (trunk & principal)	Motorways	Pedestrians & cyclists (all road types)
Mean rate ratio	0.08	0.22	0.21	0.69	0.38
95% confidence limit of rate ratio	0.02 – 0.20	0.04 – 0.63	0.11 – 0.38	0.45 – 1.02	0.08 – 1.10
p value that mean rate ratio equals 1.0	< 0.001	0.001	< 0.001	0.06	0.09
Statistical interpretation	Significant	Significant	Significant	Not 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

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

5.73 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.

5.74 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 Minor roads.

5.75 The results in Table 16 shows that there is a less than 0.1% chance that the urban and minor road incident rates are higher for the LST population than for the background population and only a 2.6% chance that the vulnerable road used rate is higher for the LST population than for the background population.

5.76 **The Bayesian approach strongly supports our conclusion from the classical statistical analysis that the LST fleet does not have a higher incident rate than the average for GB articulated HGVs on urban roads and minor roads. It is also likely that the LST incident rate for vulnerable road users is no higher than the average for the GB HGV fleet.**

Table 16: LST Injury incident rate - Bayesian Analysis

Road type	Urban roads (excluding motorways)	Minor roads	Pedestrians & cyclists (all road types)
Median Collision Rate Ratio (LST / GB HGV rate)	**0.08**	**0.23**	**0.40**
Credible range	0.03 – 0.20	0.07 – 0.61	0.12 – 1.10
Probability that the LST (injury) incident rate is **HIGHER** than the background rate for all large GB articulated HGVs	**< 0.1%**	**< 0.1%**	**2.6%**
Probability that the LST (injury) incident rate is **LOWER** than the background rate for all large GB articulated HGVs	**> 99.9%**	**> 99.9%**	**97.4%**

Conclusion: Comparison of LST and other trailer injury incident rates

Statistical comparison

5.77 **At the end of 2019, 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).**

5.78 **The LST injury incident rate on motorways, and for vulnerable road users in all locations, were also lower than that for the GB HGV fleet, but the difference in rates does not pass a classical statistical significance test.**

Safety impact outcomes expressed as 1 in ‘n’ kilometres

5.79 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 17 we present a summary of the safety incident data using this format.

5.80 The information in Table 17 relates only to incidents involving an LST, operating in a public location.

5.81 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 17: Summary of LST injury incident outcomes vs. all GB Articulated HGVs

Summary of LST-related injury incidents and outcomes after 739 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	**7.0 million km**	**19 million km**	**185 million km**
Urban only (excl. Motorways)	1.9 million km	24 million km	97 million km
Minor roads only	1.1 million km	4.9 million km	15 million km
All locations - where a pedestrian or cyclist was involved	**92 million km**	**246 million km**	**n/a**

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. 2012-2018 (TRA3105) = 99.0bn km of which 5.8bn urban non-motorway and 1.9bn minor roads. Injury incidents from STATS19 2012-18: Total collisions = 14,174 (3,005 urban and 1,794 minor roads).
- LST Involved: 40 collisions (of which 4 occurred on urban and 3 on 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 9. 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.
- These figures are mean values – based on analysis that concludes that the comparisons between LST incident rates shown here are statistically robust at a 95% confidence level, with the exception of the rate comparison for vulnerable road users.

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. This included asking operators to provide data on injury and damage only incidents not just for their LSTs, but also summary figures for incidents involving their comparable non-LST fleet (those running on similar work and roads to their LSTs).

6.4 In the 2018 annual report, we presented an analysis of the data collected, including:

- A simple overview of LST related incidents.
- A statistical comparison of incident data for the LST and non-LST fleets.
- Damage Incidents – Comparison within sample of operator fleets.

6.5 In this section we have summarised the findings of the work. The detailed numbers differ a little to those presented in AR2018 because during the analysis of the 2019 data we found a small number of data records had been duplicated in the 2018 data. These duplicates have been removed during the 2019 analysis and so the results in this report, being largely cumulative trial-to-date, has corrected any errors. The damage incident analysis however was a single-year snapshot, rather than trial-to-date, so we have presented an updated version here. This is being done solely for completeness and consistency in the data analysis.

6.6 **The amendment does not alter any of the conclusions made in AR2018**.

Overview of LST-related incidents

6.7 There were **117 incidents in 2018 involving LSTs where some damage was recorded** (either to the vehicle or public/private property) where this occurred in a publicly accessible location. For **46** of these, **the trailer's design was not explicitly ruled out as a contributory factor**.

6.8 **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 2.9 million km travelled by the LSTs**
- **1 reported damage event for every 23,000 journey legs operated by LSTs.**

6.9 We found that:

- Of the 46 events of interest – meaning where the trailer being an LST may have contributed to the event:

  - a little over half (57%) were events where the vehicle was turning where one might anticipate the trailer kick-out would be a factor.
  - Damage to **public** property was only recorded in 9 events.
  - 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 21 of the 117 events the only damage was to the operator's own vehicle. This leaves 96 events where an asset owned by another party was damaged.
- **In around 90% of these incidents the owner was aware of the incident and which operator was involved, or was made aware of it by the operator.**
- In a small number of cases (less than 10%) the property owner was unknown, and in two incidents, both involving roadside furniture or motorway crash barriers, it was unclear from the operator's submission whether the owner was aware or not.

Comparison of LST and non-LST damage incident rates

6.10 Damage events, where there has been no injury, are not routinely reported for HGVs. To obtain comparable datasets we asked operators in 2018 to report damage incidents for both their LST and non-LST fleets, where the non-LST trailers were carrying out similar operations. Ninety two operators were able to provide credible data for both their LSTs and Non-LSTs.

6.11 For this analysis we focused 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).

6.12 For the LSTs, we included 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.

6.13 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. 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.

6.14 We then carried out a series of statistical tests to compare the two distributions. The methods applied are explained further in Annex 8 of AR2018 (with the original results).

6.15 We concluded that the **mean incident rate for non-LSTs in our sample of 92 operators was greater than the mean incident rate for LSTs in our sample by a factor of 7.8**.

6.16 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:	**0.86 incidents**
Non-LST fleet:	**6.7 incidents**

6.17 **We concluded that for the paired data sample from 92 of our trial participants in 2018, LST fleets had a much lower incident rate than non-LST fleets of the same group of operators. We therefore saw no indication that the LSTs on the trial are causing more damage than other semi-trailers.**

7 TRIAL OUTCOMES: INDUSTRY INSIGHTS

7.1 One of the seven key evaluation questions listed at the beginning of this report was "Might any special operational requirements be appropriate for LSTs?"

7.2 This question is vitally important, since the overall conclusion we have made in terms of utilisation and especially safety is that when operated under the trial conditions, operators have shown that they can operate LSTs safely and with resulting reductions in journeys made. However, the trial conditions included:

- **explicit requirements** such as special LST training for drivers
- **broad requirements** that operators take appropriate measures to ensure LSTs were operated safely, with extensive discussion throughout the trial of the importance of only sending the trailers on appropriate routes
- **extensive monitoring** with an emphasis on efficient utilisation and a special focus on all incidents, even minor ones.

7.3 The DfT approach to the trial was not to presume that the special conditions required for safe and efficient operation could be pre-determined and expressed entirely in explicit requirements, but that the industry, operating under close scrutiny, would be best placed to develop good practice based on experience using the trailers.

7.4 Having established that the trailers were indeed being operated acceptably, we proposed (in AR2017) a process to formally 'harvest' that industry-led good practice. The work was carried out during 2019.

Part 1: Operator Interviews

7.5 Part 1: During 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.

7.6 The interviews took place at operator's own sites so that they could involve multiple members of their team and each took at least half a day. They focused on four main areas of interest, reflecting some key questions first articulated in the 2017 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.**

7.7 The original interviews responses were synthesised summarised in AR2018.

Part 2: Industry workshop and industry insights development

7.8 Part 2: Having studied the themes emerging from the interviews in Part 1, we drew together a group of 15 operators, together with other specialists, for a workshop to develop an initial set of summary industry insights to operators and others who may be involved in introducing LSTs into an existing operation.

Workshop objectives

7.9 The workshop objectives were:

1. To present an initial document summarising all the main issues that operators have actually implemented, or, from their trial experience, they believe will be important in future
2. To provide a starting point for further consultation with industry to refine the issues into an agreed document as the basis for a range of potential uses.

Workshop topics

7.10 From the Part 1 interviews, we knew that two areas of particular interest would be:

- **Driver Management** – including but not limited to training
- **Operational Management –** including but not limited to the assessment of routes in terms of their suitability for LSTs.

7.11 In developing the design for a workshop, we realised that while the Driver Management topic was fairly well bounded, the Operational Management discussion contained a number of subsidiary areas that would need to be separated out – probably based on the stakeholders of interest. We therefore expanded the workshop focus to include:

- **'Upstream' decisions** – relating to the business case/ROI for adopting LSTs – without which the market for the trailers will never develop
- **Whole sector adjustments** - relating to supply chain processes and software and long-term warehousing sector issues.

7.12 The workshop (in November 2019) involved 25 industry representatives – mainly from LSTs operators - working in groups looking at the topics above.

Workshop discussion dimensions

7.13 For each topic we explored three dimensions:

1) **Nature of the issue:** WHAT was done and WHY
2) **Stakeholder Interests** – specifically
   a) Driver management
   b) Operational management
   c) Logistics and supply chains
3) **Impact area**
   a) Emissions reduction – based on efficiency of trailer utilisation
   b) Safety management
   c) Other issues

7.14 More detail on the process used in this work and the industry partners involved can be found in Annex 5. The annex also discusses why we have used a qualitative industry led approach to developing the industry insights, as opposed to a formal quantitative analysis to attribute the trial outcomes to specific contributions from individual measures.

Output

7.15 Risk Solutions processed the workshop results and structured them into a preliminary document that was circulated to workshop attendees, who provided some further comments and suggestions. **The current version is presented in full here as Annex 6.**

7.16 The industry insights is set out in sections designed to address the issues of different stakeholder interests in the industry or a large company.

The stakeholder areas are:

A) Business Decisions / ROI
B1) Training and Awareness – Drivers
B2) Training and Awareness – Other Roles
C1) Operational Processes – Routing
C2) Operational Processes – Depot Assessment
C3) Operational Processes – Warehousing / Supply Chain
D) Equipment and Maintenance
E) Depot Infrastructure
F) Specifying LSTs – Design Choices

7.17 Smaller operators – especially SMEs – will find that some issues are not applicable to their situation or are simpler to address because of the size of their operation.

7.18 A company of any size using a single LST design for a highly uniform type of work, will find it will be straightforward to apply the document, a company working across diverse sectors, perhaps with several LST designs in their fleet, will need to address more of the issues raised.

Issues

7.19 Within each stakeholder AREA the document sets out a set of issues, detailing:

- An issue ‘name’ and a description of the issue and why it matters
- Applicability to LST steering axle types (ALL, SS or CS)
  - **ALL** indicates that the issue is broadly the same for all steering designs
  - **SS** indicates the issue only applies to Self-Steer designs
  - **CS** indicates the issue only applies to Command-Steer designs
  - **SS/CS** indicates the issues applies in different ways for the two designs

Impacts

7.20 Issues are marked with icons to indicate the primary area of benefit or risk they influence. Some groups of issues are given a single set of icons as they apply across that whole group.

 **Safety / Damage**

 **Efficiency (journey savings) / Emissions**

 **ROI (Return on Investment)**

Further refinement of the content

7.21 This document is not a 'finished product' – nor at this stage has the DfT determined exactly how it will be used. The purpose of this initial version is to provide the foundation of a set of issues that could potentially form the basis of any of the following as the DfT and the industry deems would be most valuable and effective:

1. A guidance or good practice guide to potential LST operators
2. The core of future training content for drivers and other staff in relation to LSTs
3. Awareness raising for company owners, directors and other stakeholders
4. A starting point for any policy makers, industry or government stakeholder charged with defining or executing any regulatory role in relation to LST operations
5. A source for freight sector analysts and researchers interested in the issues and parameters affecting the operation of LSTs - and potentially any other high-volume 'special designs' as part of an overall system.

7.22 This list of potential uses appears in the preface to the document (Annex 6) so that it can act as a stand-alone document for further discussions around its refinement and use.

Conclusion and recommendations

7.23 The document as it stands is presented as an output of the trial evaluation, without any presumption of how it should be used beyond publication here.

7.24 What we do want to emphasise is that operators, who have hands on experience with LSTs, have told us that it is a combination of the advice and approaches described in Annex 6 that have formed the basis of their safe and efficient adoption of LSTs.

7.25 We therefore want to be clear that while much of the evaluation work performed on the trial has necessarily focused on the quantitative assessment of the efficient and safe use of the trailers, the document presented here should be seen as an equally important output from the trial. **In terms of any future operation of LSTs, we believe that this document, based on real world operational experience of the trailers, forms one of the most important tangible outputs from the trial as a whole**.

Recommendation 2019-01: Refinement and publication of industry insights

We recommend that Annex 6: "Introducing and Managing LSTs: An Industry-led Summary of Good Practice", be used as the foundation for further DfT and industry led discussion with the aim of:

(a) refining the content based on input from a wider selection of relevant stakeholders

(b) adding prioritisation of measures, where possible, based on industry experience and consensus

(c) agreeing the most appropriate format(s) for publication (where and by which body)

7.26 While policy decisions lie outside the scope of this evaluation, we recommend that any policy or regulatory system should include some reference to guidance on good operational practice to be used by operators and any other relevant industry representatives or regulatory bodies. We believe that the draft document (in Annex 6) provides a sound basis for the development of such guidance.

8 SCALING-UP

Purpose and place in wider project

8.1 This workstream was first identified as a next step in AR2017 and the early work was started at the time AR2018 was being written. The task was to create an initial scaling model that would use the results of the trial, and other appropriate data, to estimate the likely take-up and impact of LSTs over the long term, if they were made widely available to the whole of the GB freight industry.

8.2 This work lies at the boundary between our work as the independent trial evaluators and the DfT's role in applying the evaluation evidence to their policy thinking, specifically:

- The DfT need a method for scaling up the trial data and reporting the results in a format suitable for input into the development of policy options in relation to the future use of LSTs and the economic analysis that would be required to support any associated regulatory impact assessment.
- Risk Solutions' role at this stage is to ensure that where any policy or impact argument the DfT seeks to support from trial evidence, the claims made correctly reflect the data and information generated during the trial and do not exceed it. We may also respond to the DfT requests for additional analysis of the trial data in response to emerging policy thinking or economic analysis.

Model development

8.3 The model uses a reference year of data from the Continuing Survey of Road Goods Transport (CSRGT) and models what that same year of freight movements might have looked like, if relevant segments of the work had been carried out using LSTs in place of standard 13.6m trailers, reducing the distance travelled for the same outcome. Savings in vehicle km, emissions and safety are estimated using scaling factors derived from trial data.

8.4 The model only applies the LST saving to segments of the CSRGT data where LSTs might be usable. The current exclusions are that savings are only applied to:

- **Vehicle Configuration**: Three axle trailers and Rigid+Drawbar combinations
- **Cargo Weight** (as a proxy for density): Standard trailer cargo weight < 25.22t
- **Haul Type**: The model allows for an exclusion of short haul trips, but on the basis of the trial evidence – where we have seen LSTs used effectively on trips of all lengths – we have currently set this to allow all haul types.

8.5 The model is then set up to provided two sets of results:

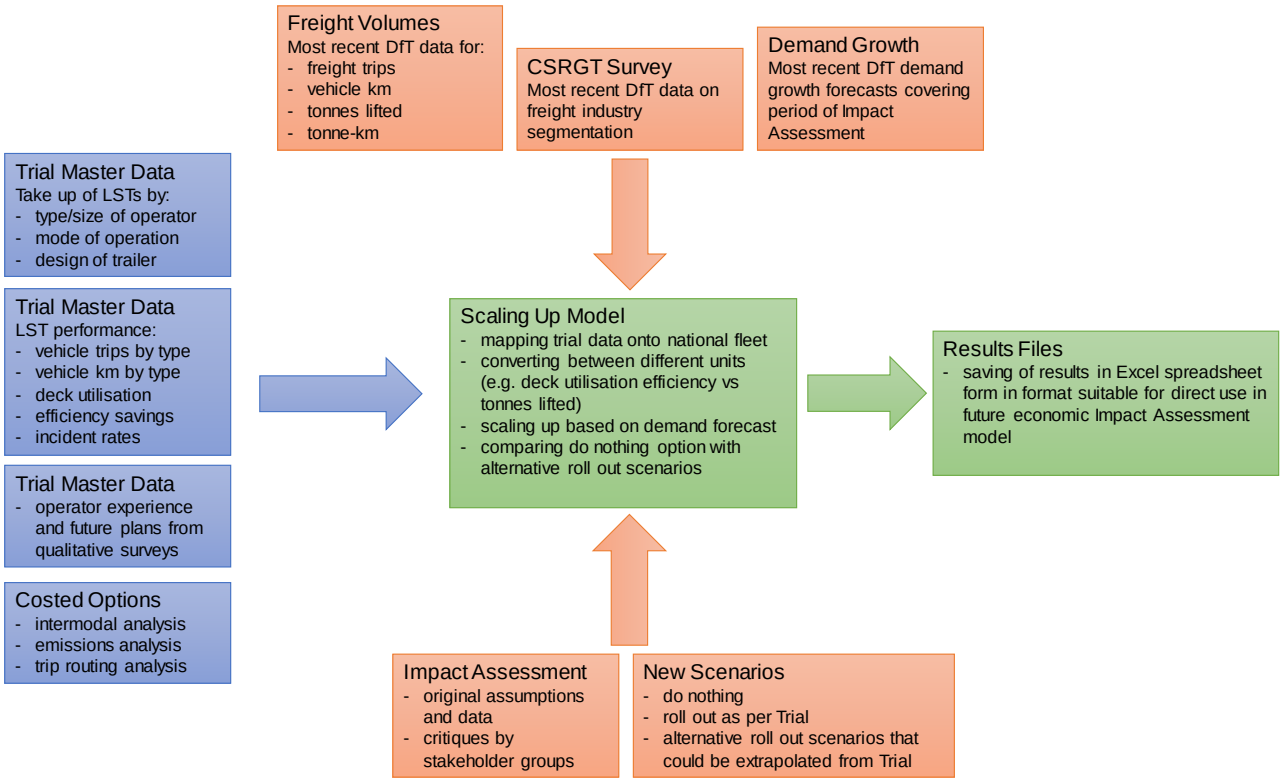
- **In Year**: Distance and emissions savings that would have been made in the CSRGT reference year, has LSTs been used on the identified data segments.
- **Future Projection**: Distance, emissions and injury savings that might be made in future years, taking into account estimates of future LST take up and overall freight demand growth. This part of the model also provides for sensitivity analysis based on variation of the savings and take up assumptions.

8.6 The model is a macro-enabled Excel spreadsheet designed to:

- Contain all the key scaling factors derived from the trial data by Risk Solutions
- Be suitable for further enhancement by DfT economists.

8.7 Figure 20 shows the main input data sources considered, in developing the model.

Figure 20: Scaling model concept and data sources



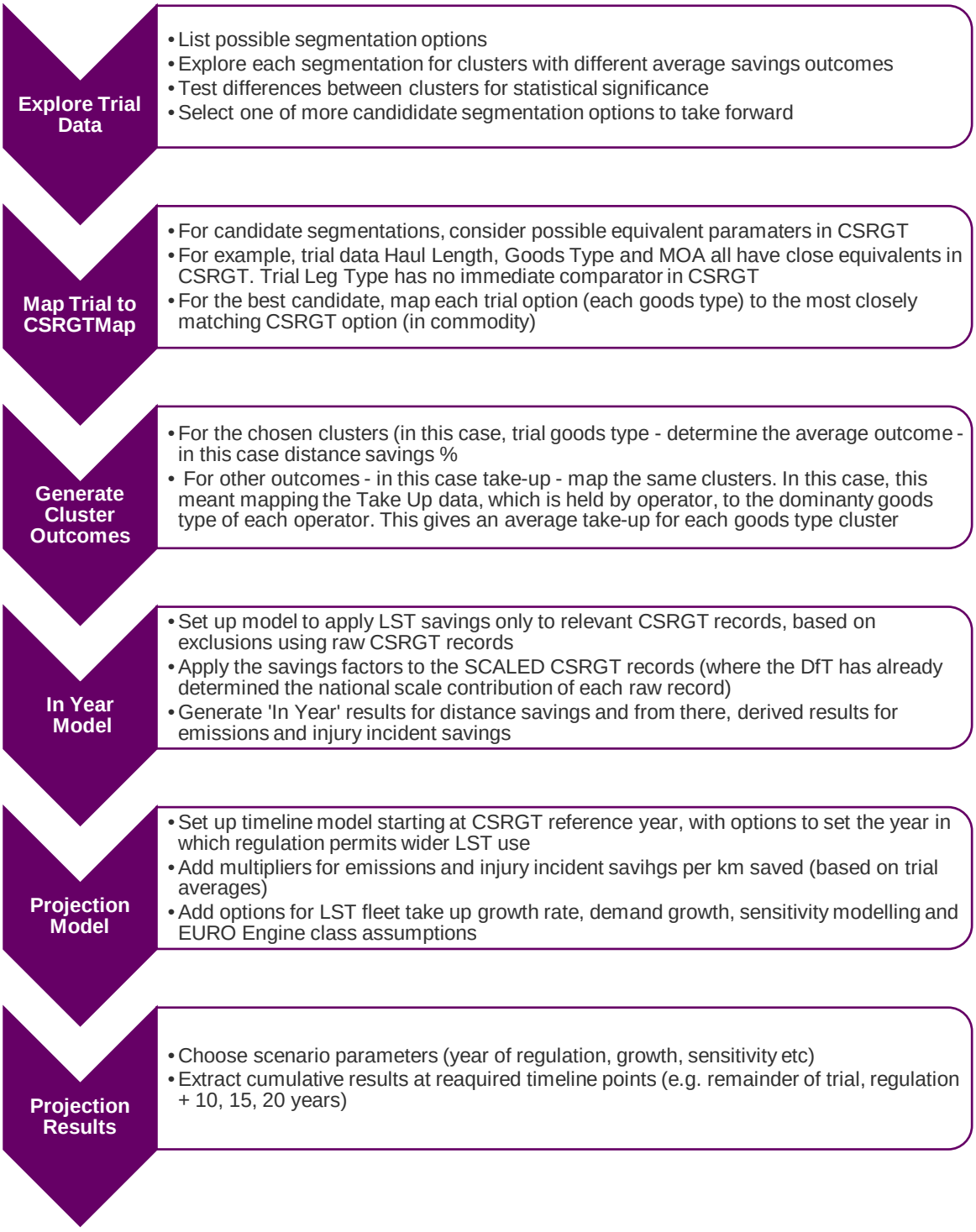
8.8 The model and its results files are represented by the green boxes. The model is designed to take its input from trial data (represented by the blue boxes) along with data from other DfT sources (the orange boxes).

8.9 The model inputs and set-up assumptions, such as the savings clusters, CSRGT exclusions and other parameters, allow a user to explore a variety of scenarios.

8.10 The model development steps are summarised in Figure 19. The crucial step is the cluster analysis which is used to characterise segments of the trial data that exhibit different savings characteristics. This is explained further in in the sections that follow.

8.11 A more detailed description of the model and development process are given in Annex 4A, along with further development options. Technical discussion of the cluster analysis is provided in Annex 4B.

Figure 21: Scaling Model development steps



Mapping the trial data to the CSRGT data

8.12 As has been noted in previous annual reports, the distribution of the LST trial fleet by operator size, goods type or any other parameter, was never intended to be a statistically representative sample of the GB freight industry. In setting up the trial, DfT identified that to achieve this would be immensely challenging and would have restricted access to the trial. It would also have meant deciding before the trial, the most dominant parameters that would determine where LSTs would be used, rather than discovering the dominant parameters as an outcome of the trial.

8.13 Instead, the plan was always to maximise the range of operators and industry sectors that could join the trial and explore the use of LSTs. Working in this way would then require a mapping exercise to map the trial data onto real-world operations. This begins with a **cluster analysis** of the trial data.

8.14 In the cluster analysis we explore the trial data and look for a suitable **segmentation of the trial data into clusters with statistically different distance savings profiles.** The clusters could be, for example: by operator type, leg type or goods type, or a combination of these.

8.15 We also look for suitable parameters for predicted LST take-up - ideally based on the same clusters as above both:

- in the short term (with today's depot and road infrastructure) and
- longer term (allowing for upgrade of infrastructure over time).

These clusters and their savings profiles are then applied to the national CSRGT freight flow data by mapping the field defining the cluster in the trial data to the best comparable field in CSRGT. The model then estimates potential national impacts of a wider use of LSTs, by comparing the original CSRGT results with those obtained by applying the trial savings profiles.

Savings clusters applied in final model

8.16 The cluster analysis suggested the most usable segmentation of the data would be on the Goods Type in the trial data, mapped to the Commodity types in CSRGT.

8.17 The trial data clusters are shown here in Table 18. The mapping of trial goods types to CSRGT commodity types is given in Annex 4A in Table 23.

Table 18: Scaling model - Goods type clusters

Trial Data 'Goods Type'	CLUSTER NAME
0) EMPTY / NO CARGO	EMPTY
1) EMPTIES / WASTE PACKING	LOW
7) MAIL / PARCELS	LOW
2) FMCG (MIXED PRODUCTS)	MID
3) FMCG (SINGLE PRODUCT)	MID
8) OTHER - RETAIL	MID
9) OTHER - NON-RETAIL	MID
10) PALLETS - MIXED/UNKNOWN	MID
4) RAW MATERIAL/SUPPLIES	HI
5) INDUSTRIAL PRODUCTS	HI
6) BIOMASS / FUEL	HI

Table 19: Scaling model - Distance saving factors associated with each cluster

CLUSTER NAME	Average distance Saving %
EMPTY	0%
LOW	6.8%
MID	9.7%
HI	12.7%
AVERAGE ACROSS ALL LOADED LEGS	**9.7%**

8.18 The differences in average distance savings between the goods type clusters were shown to be statistically significant. Note that in this approach, the parameter on which the cluster is based is not necessarily being claimed to be the determinant of the savings. The inference is that the sum of all factors behind not only the goods type (density, packaging etc) but also the types of operation that predominantly move those goods types, have some similarities that distinguish them from another cluster. One may or may not be able to identify exactly what mix of factors creates the coherence in the cluster, but we would expect there to be some logic to the groupings. Our full exploration of this logic can be found in Annex 4, but in summary we see:

8.19 **LO-saving cluster**: Empties and Waste-Packaging loads are often not created as planned loads to maximise capacity, but whatever load is ready when the trailer departs. In the case of empties, the load is often just the return leg of a loaded run. In the case of mail and parcels, three are many cases where the trailer departs on a fixed schedule to meet delivery time commitments, whether or not the load space is full.

8.20 **MID-savings cluster**: Dominated by the retail sector where load size is partly amendable to planning to maximise efficiency, but is primarily determined by a just-in-time demand led system, with the specific intention of avoiding the build-up of on-site surpluses.

8.21 **HI-savings cluster**: Containing goods types where the operation is either based on full loads (biomass to power stations) or is controllable by the suppliers or has more time flexibility, allowing more cases where the trailer is consistently 100% full.

8.22 Finally, note that these clusters are averages. **There will of course be cases where a specific operation would fall in a different cluster**, but on average, across the trial data, these cluster differences have been proven to be valid for modelling purposes.

Scaling – next steps

8.23 The scaling model has now been shared with the DfT for use in their internal discussions of possible regulatory policy options for LSTs.

8.24 Risk Solutions continue to provide advice and support to the DfT team where requested, to ensure that the application of the model results reflects the underlying trial evidence.

9 ADDITIONAL ANALYSIS

9.1 There are two ongoing programme tasks addressing further analysis or process changes.

Model Report digitisation

9.2 Each new LST chassis design must be presented (by the manufacturer) to the Vehicle Certification Authority (VCA) for testing before it can be delivered to the end user and operated on the trial. The testing covers a range of measurements and driving tests to ensure the design is fully compliant with the requirements set down for LSTs at the start of the trial.

9.3 The test results are recorded in a **Model Report** produced by VCA in Word and PDF format for each new design. When VCA then grant a Vehicle Special Order (VSO) to an operator for specific trailers (listing the VINS covered) that document cites the Model Report number under which the design has been passed.

9.4 Model Report documents have been held by VCA alone and only in Word and PDF format, which limits the ability of the DfT and Risk Solutions to answer questions such as:

- how many trailers have been built of each model
- how many trailers have a specific feature, such as self-steer axles with locking
- if an issue was noted on a specific model, which trailers would it apply to.

9.5 We are working to:

- Create a complete digital record of the Model Report data
- Enable the DfT to link the Model Report data to their VINS database
- Enable Risk Solutions to link Model Report data to the wider trial analysis datasets.

9.6 We have created a process for taking PDF Model Reports, transcribing the contents into a raw Excel data table, a manual process to check and correct each record to make it internally consistent, checking the final version with VCA and the report author, and uploading the data to a Database (MS Access).

9.7 Our initial analysis of the data so far includes:

- A gap analysis showing that around 25 Model Reports are missing (not yet supplied by VCA) and as a result around 755 (30%) trailers cannot yet be matched to their Model Report data.
- Two sample analyses using the data in combination with the DfT VINS dataset, bearing in mind that the results do not include 30% of trailers on the trial.
  - Comparing the trailer steering type from the Model Report to that stated by the trailer operators (and used for all trial analysis to date)
  - An analysis of the proportion of self-steer axles fitted with the lock-at-speed option (at the time of manufacture).

Trial processes to manage second-hand LST trading

9.8 We are working with the DfT and VCA (with input from DSVA) to adjust the processes for bringing new operators into the trial and for granting VSOs, to better track the passage of trailers from their original owner into the second hand market (sometimes via a leasing company).

10 PROGRESS SUMMARY AND NEXT STEPS

10.1 This section summarises:

- progress against the seven key evaluation questions
- progress against recommendations from previous reports
- options for further analysis for discussion with the DfT

10.2 The section provides a complete summary of progress on the trial and so where work was completed in earlier years, the text is repeated from past Annual Reports.

Progress against evaluation questions

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

10.4 With this latest report, we believe we now have sufficient quantitative data and other evidence to provide a robust evaluation response to these key evaluation questions.

10.5 Evaluation work led by Risk Solutions is now therefore substantially completed.

Q1 What do operators use LSTs for?

10.6 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.

10.7 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.

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

10.9 In AR2018 we presented 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?

10.10 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.

10.11 Since the start of the trial the use of LSTs over 739 million miles of operation has removed between 54 and 60 million vehicle kilometres of freight traffic from GB roads.

10.12 With an average journey distance of 125km, this equates to 430,000 to 475,000 journeys removed from GB roads as a result of the trial to the end of 2019.

10.13 The average saving achieved by operators is 8.3% (1 in 12 journeys) with the most efficient operations saving 13% (1 in 8 journeys).

Q3 What are the resulting reductions in emissions?

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

10.15 Since the start of the trial, we estimate that emissions of 48,000 tonnes of CO2e and 241 tonnes of NOx have been avoided by the use of LSTs.

10.16 The report also gives figures for Particulates and Volatile Organic Compounds.

Q4 What about safety – will LSTs cause more injuries?

10.17 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.

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

10.19 For the first measure, on the trial to date, the benefit from making fewer journeys may have eliminated 8-9 injury collisions with a reduction of 11-12 casualties.

10.20 For the second measure, at the end of 2019, 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.

10.21 Operators, with hands on experience with LSTs, have told us that it is a combination of the advice and approaches described in Annex 6 that have formed the basis of their safe and efficient adoption of LSTs. This is discussed further under Q6.

10.22 There were no fatal accidents involving LSTs to the end of 2018, but there were two in 2019. This equates to two in 739 million km of operation by the end of 2019.

10.23 The two events have both been assessed to see whether the fact that the trailer was an LST contributed to the incident in any way, either to its occurrence or the outcome. The initial report of each event was assessed by Risk Solutions based on the submission from the operator. The DfT has then conducted deeper investigation through the police forces involved in each event and no link to the LST as a cause has been found. The department will continue to check to see if there are issues related to either incident which require further consideration in the context of the trial.

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

10.24 During 2018 we undertook 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.

10.25 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.

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

10.27 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 cases 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.

10.28 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.

10.29 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.

10.30 If the work to digitise the Model Reports in Section 9 delivers an adjustment to the data on steering types, we plan to revisit the steering related aspect of the damage only analysis, to confirm that the conclusions remain valid.

Q6 Might any special operational requirements be appropriate for LSTs?

10.31 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.

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

10.33 The first phase of this work, reported in AR2018, reported the outcomes of 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 awareness for loaders, managers, depot designers and other company roles.

10.34 The second phase is reported here in Section 7, with more detail on the workshop process used, provided in Annex 5.

10.35 The key output from all this work is the document published in full as **Annex 6: "Introducing and Managing LSTs: An Industry-led Summary of Good Practice"**

10.36 The document provides a summary of issues that might be considered by a wide range of stakeholders in the freight and logistics sector, when deciding whether to introduce Longer Semi-trailers (LSTs) into their operation.

10.37 **This document is not speculative or theoretical. It is a summary of what LST operators found actually worked or was necessary in real world operations. These are the issues on which companies using LSTs have either committed money and resources already, or anticipate they will need to do so in future.**

10.38 We want to be clear that while much of the evaluation work performed on the trial has necessarily focused on the quantitative assessment of the efficient and safe use of the trailers, the document presented here should be seen as an equally important output from the trial. **Specifically, in terms of any future operation of LSTs, we believe that this document, based on real world operational experience of the trailers, forms one of the most important tangible outputs from the trial as a whole**.

10.39 This document is not a finished product – nor at this stage has the DfT and industry determined exactly how it will be used. The purpose of this initial version is to provide the foundation of a core-guide which could potentially form the basis of any of the following:

1. A guidance or good practice guide to potential LST operators
2. The core of future training for drivers, fleet managers and others in relation to LSTs
3. Awareness raising for company owners, directors and other stakeholders
4. A starting point for any policy makers, industry or government stakeholder charged with defining or executing any regulatory role in relation to the operation of LSTs
5. A source for freight sector analysts and researchers interested in the issues and parameters affecting the operation of LSTs - and potentially any other high-volume 'special designs' as part of an overall system.

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

10.40 We have previously published estimates that 10-20% of standard 13.6m trailers might be replaced by LSTS, depending on the type of operation, based on our 2016-17 survey of operators 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.

10.41 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. We have made a small number of amendments to the projection estimates to reflect this.

10.42 These take-up figures have been used in the initial scaling model. They can be updated at a later stage if further data becomes available from industry.

Progress against actions in previous reports

10.43 Specific actions and recommendations, notably from the 2016 and 2017 Annual Reports has now been completed, as summarised in Annex 2.

10.44 AR2018 proposed three options for action, two of which have been completed. The remaining option is that of re-running the emissions model to cover EURO VI engines – we discuss this below.

Recommendations and options for further use of trial data presented in this report

10.45 We have made one recommendation in this report.

Recommendation 2019-01: Refinement and publication of industry insights

We recommend that Annex 6 of this report be used as the foundation for further DfT and industry led discussion with the aim of:

(a) refining the content based on input from a wider selection of relevant stakeholders

(b) adding prioritisation of measures, where possible, based on industry experience and consensus

(c) agreeing the most appropriate format(s) for publication (where and by which body)

10.46 While policy decisions lie outside the scope of this evaluation, we recommend that any policy or regulatory system should include some reference to guidance on good operational practice to be used by operators and any other relevant industry representatives or regulatory bodies. We believe that the draft document (in Annex 6) provides a sound basis for the development of such guidance.

Further Work

10.47 We note two areas where further analysis could be carried out, subject to discussion with the DfT regarding the additional value they would deliver.

Emissions model re-run for future projections

10.48 This is carried over from AR2018.

10.49 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.

10.50 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.

10.51 Options for accommodating this in future projections of emissions savings include re-running 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 the emissions calculations should be adjusted and if so, the most appropriate way to do this.

10.52 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 is 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 in AR2018 (Annex 7).

10.53 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.

Reverse engineering scaling model outputs for other uses

10.54 In 2013-14, an emissions savings model was developed for the UK Climate Change Committee (CCC) by the Centre for Sustainable Road Freight (cSRF). This model included input modules for a range of freight carbon reduction measures, both engineered (alternative fuels, aerodynamics etc) and external (such as larger trailers)

10.55 We reviewed the model to see whether we could make the scaling model operate in a way that would allow our results to be compared with the other freight adaptation options they considered, or perhaps feed into any future projections by cSRF or CCC using this or any other model. The DfT were already aware of this wider modelling.

10.56 While this link with the CCC model has not been fully explored, we believe it could still be useful and it might be worth discussion with Defra and cSRF.

10.57 The 2013-14 CCC model was also based on a CSRGT sample dataset, but used different data segmentations, as shows in Table 20. In both cases the models overlay these data segments with savings factors and take-up factors over a long time period.

Table 20: LST and CCC emissions models data segmentation

Model	CSRGT Segmentation by:
2013-14 CCC freight emissions reduction model	**Vehicle Config** - Size and rigid vs Artic **Haul Type** - Urban, Regional, Long – based on distance **Business Sector** – aggregated version of full CSRGT business types
2019 LST Trial scaling model	**Vehicle Config** - Size and rigid vs Artic **Haul Type** - Urban, Regional, Long – based on distance **Commodity** – an aggregated version of full CSRGT business types

10.58 In the CCC model, the introduction of higher capacity vehicles was once measure considered, although in the published papers on the model, what is modelled appears to be the very large vehicles (for example, 25m / 60 tonne GVW) in use or on trial in some EU countries rather than LSTs.

10.59 Having produced a modidied CSRGT dataset which contains the savings effect of LSTs, we could now re-run the analysis to re-segment the dataset using the CCC Business Sector mapping and it would generate an LST input set for the CCC model, based on the LST trial scaling model.

10.60 The same 'reverse engineering' of our model could be done for any emissions or other modelling which uses CSRGT as its reference dataset. For example, this approach could

be taken by the DfT to consider the potential impact of LSTs over time on any of the major statistics produced from CSRGT.

10.61 **While not a formal recommendation, since this falls outside the main scope of evaluation of the LST trial, we would suggest DfT consider the potential wider application of the LST scaling model and results to other contexts.**

GLOSSARY

Item	Definition
DfT	The 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.
RHA	Road Haulage Association
RST/Standard	Regular or Standard 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 chassis for mounting of an intermodal trailer.
Steering: **Self-** **Command-** **Active-**	**Self-Steer:** The wheel turns on a kingpin built into the assembly at each end of the axle and the angle of steer is controlled solely by the interaction of forces between the road/tyre and the axle springs/dampers. There is no physical or electronic connection to the angle of turn between the tractor and at the 5thwheel. *Some manufacturers refer to this as "Passive" steering*

Item	Definition
	Command-Steer: The angle of steer is controlled by a direct mechanical or hydraulic link to the angle of turn at the 5thwheel. In the most common system the whole axle is mounted on a turntable under the rear of the trailer. *Note - some trailer vendors simply classify steering as "Passive" (meaning self-steer) and "Active" (meaning Command-steer). The use of the term "Active" on the trial is reserved for computer controlled steering (see category below)* **Active-Steer:** The wheels of the steering axle are controlled by a computer and the angle of steer is adjusted to make the rear of the trailer closely track the path of the tractor unit as well as other variables detected by the software. *Also called Active Command Steer by some vendors but that terminology not used on the trial to avoid confusion with the Command Steer category*
VCA	The Vehicle Certification Agency is an Executive Agency of the United Kingdom's Department for Transport and is 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 the internal DfT Project Notes. Updated in AR2014 and AR2015
Statistical method for analysis of injury incidents: Update for Urban/Rural split	AR2015
Statistical method for analysis of injury incidents: 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
Qualitative Survey Results: 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
Damage event analysis: 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	AR2019 Annex 4 and internal PN E4
Operator conversations	Part 1: AR2018 Annex 5 and internal PN E5 Part 2: AR2019 Annex 5 & 6 and internal PN E8
Trip end / flow analysis	AR2018 and internal PN E6
Special Issue: Course correction at speed	AR2017
Special Issue: Kick-Out vs Axle Design	AR2016 and AR2017
Special Issue: Model report digitisation	AR2019 and internal PN E7

List of Annual Reports

Clicking on the report title links to the web page on the DfT web-site where the report, and any accompanying published project notes (PNs) can be downloaded.

Longer semi-trailer trial evaluation: annual report 2018

2 March 2020

Longer semi-trailer trial evaluation: annual report 2017

19 September 2018

Longer semi-trailer trial evaluation: annual report 2016

21 September 2017

Longer semi-trailer trial evaluation: annual report 2015

6 September 2016

Longer semi-trailer trial evaluation: annual report 2014

30 July 2015

Longer semi-trailer trial evaluation: interim report 2014

24 March 2015

Longer semi-trailer trial evaluation: annual report 2013

19 June 2014

First year evaluation of the high volume semi-trailer trial

31 May 2013

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 in seven questions, published in the 2016 and 2017 Annual Report Summary.

A2.2 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.

As noted below – we are now in a position to state that we have sufficient evidence to provide an appropriate response to all seven evaluation questions.

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? Q5 What about damage and the associated costs – will LSTs cause more damage on the roads?	**Q1 to Q5: 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.
Q6 Might any special operational requirements be appropriate for LSTs?	**Q6: READY: COMPLETED IN 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 in Autumn 2019, produced a first draft 'agreed' list of issues relating to driver training and wider company operational awareness themes for operators of LSTs.
Q7 What proportion of the existing GB fleet of semi-trailers might be replaced by LSTs, were numbers not restricted?	**Q7: READY: COMPLETED IN 2019** Initial estimates from the operators on the trial are available and have been used in developing the scaling up model. As part of the interviews with operators during 2019 for the industry good practice document, we also checked whether they still agreed with their likely take-up projections made in 2016, as reported in AR2018. In all cases they either confirmed or increased their projection. The values have been used as described in the Scaling Up work in Section 8 and Annex 4A.

Progress on previous recommendations

A2.3 The table below lists the outstanding recommendations made in previous LST Trial Annual Reports. **They are all now completed**

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 who determined no further investigation was required
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 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 include 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 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.	Modelling completed in 2019 and provided to DfT for use in support of policy explorations
2016-8 Preliminary exploration of possible post-trial requirements or industry insights 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 and reported in AR2018 Part 2 completed in early 2020 and reported here Additional data may be available to dft from their own consultations with stakeholders

ANNEX 3: THE DATA COLLECTION FRAMEWORK

2012-2017: DSF + CIF + QSF

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 AR2018.

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 (CIF) on joining the trial and occasional Qualitative Surveys (QSF).

A3.3 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.

2018-P1 onwards: Single summary DSF with additional incident detail

A3.4 Changes were made to the data collection template for 2018 - for reasons put forward in the 2016 Annual Report - which may be briefly summarised as:

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

A3.5 Information was still submitted every four months, but the format changed as follows:

- Separate Company Information Forms (CIF) and Qualitative Survey Forms (QSF) were replaced with a cut-down version of the original CIF, as well as some key qualitative questions, incorporated into the main data collection template (the DSF)
- The trailer reference information sheet, which captures basic information relating to each trailer was reduced in scope and reformatted for ease of completion.
- The detailed leg-by-leg journey log was replaced by **a summary of journeys 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 narrative descriptions of damage, as well as a summary of overall incident (including damage) rates in the comparable non-LST fleet.

2019-P2 Onwards: Summary DSF + New Short DSF

A3.6 As reported in AR2018, early in 2019 the DfT agreed that we should implement a further revision of the data framework, aimed at reducing the journey detail collected by LST

operators for whom we already hold sufficient detailed data to enable us to understand their operations and establish baseline figures for their most common types of work.

A3.7 For 2019-P2, we issued a new 'Short DSF' (SDSF) template to 165 operators who had submitted acceptable files for the past four consecutive periods (All of 2018 plus 2019-P1). The new SDSF has no journey record data sheet. Instead, for each trailer, a simple total count of legs and total distance travelled is recorded in the trailers data sheet which significantly reduces the work required by these operators.

A3.8 Existing operators and new operators are now monitored and once they have submitted acceptable files for three consecutive periods they are moved over to the SDSF format.

A3.9 At the time of writing – during submissions of data for 2020-P1 – there are 192 operators now using the SDSF, with 67 working with the 2018 format DSF (including some who will only submit their first data in 2020-P2).

Revised utilisation and savings calculation

A3.10 The changes in the templates after 2017 mean that 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.

A3.11 This discontinuity in analysis arising from the changes of data collection framework was anticipated and agreed with the DfT before each framework change was made.

A3.12 All the utilisation and savings results present in this report now use a combination of data as follows:

- 2012-2017 'Full DSF' data based on leg by leg journey records for each trailer including utilisation levels for each leg
- 2018 Onwards 'DSF' data per trailer including dominant leg, goods and MOA types, with details of Full, Empty and Partially-Loaded legs counts and total distance and an estimate of average utilisation level for partially loaded legs
- 2019 Onwards 'SDSF' data based on per trailer total leg count and distance only.

A3.13 The 2012-2017 dataset was frozen at the start of 2018 and the other two data types are treated individually to produce key utilisation and savings results on a comparable basis so that it can then be combined, where possible, into a single total. The approaches for this are below.

Handling 2018 Summary DSF Data

A3.14 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.

A3.15 Analysis of utilisation is 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.

A3.16 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%.

A3.17 As noted in AR2018, 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 estimated it to be 98% or 99%, which in real world terms, would be effectively full.

Handling 2019 SDSF Data

A3.18 This data contains only a total count of legs and distance for each trailer.

A3.19 These two totals are pro-rated up to generate data in the same format as the 2018 summary DSF, based on the last year of data in that format, to generate values for Leg Type, Goods Type, MOA, Full legs/Distance, Empty Legs/Distance and Partially Loaded Legs/Distance – along with the average utilisation on part loaded legs. This is done by creating a 'past data' table or pro-rating factors for each trailer based on the last year of data submitted in the 2018 format. This trailer past data record is then static and is applied to all future periods of data for that trailer while it remains in the fleet of that operator.

A3.20 The pro-rating calculation handles a number of cases as follows:

- Existing trailer with a single Leg/Goods/MOA type combination
  - Past Leg/Goods/MOA type assumed to continue.
  - Full/Empty/Part-Loaded leg and distance figures calculated pro-rata based on the ratio of the new data total leg/distance to the past data leg/distance.
- Existing trailer with two or more Leg/Goods/MOA type combinations
  - As above, but with a further pro-rata split between the different Leg/Goods/MOA type combinations present in the past data for the same trailer.
- New trailer added to existing fleet
  - In a few cases, an existing operator already using the SDSF has been permitted by the DfT to take on additional LSTs. There is of course then no past data for these trailers which we can use to carry out the pro-rating calculation described above.

- For these trailers, the calculation considers the Leg/Goods/MOA types across all the past data for all existing trailers in the same operator fleet and creates a pro-rating table from these. For each record in that table, the proportion of legs and distance for each Leg/Goods/MOA type is calculated and applied to the total legs and distance operated by the new trailer.
- This approach is applied both to newly built trailers and to trailers sold by an original operator and which then enter a new fleet.

ANNEX 4A: SCALING MODEL

Introduction

Purpose and place in wider project

A4.1 This workstream was first identified as a next step in AR2017 and the early work was started at the time AR2018 was being written. The task was to create an initial 'scaling up' model that would use the results of the trial, and other appropriate data, to estimate the likely take-up and impact of LSTs if they were rolled out across the whole of the GB freight industry.

A4.2 This work lies at the boundary between our work as the independent trial evaluators and the DfT's role in instigating the trial and, once it is complete, applying the evaluation evidence to their policy thinking. Our distinct roles in relation to this mode are:

- The DfT need a method for scaling up the trial data and reporting the results in a format suitable for input into the development of policy options and the economic analysis that would be required to support any associated impact assessment.
- Risk Solutions role at this stage is ensure that any policy or impact argument the DfT seek to make supported by evidence from trial is correctly reflecting the data and information generated during the trial and does not seek to make claims beyond what can be supported.

The scope

A4.3 The summary scope for the task was to:

- Produce an initial scaling model that can generate results for emissions and safety projections for scenarios where LSTs are made available beyond the trial conditions
- Validating evidence from the trial regarding savings being made with LST operators
- Gathering information about likely future take-up, re-segmented to fit the modelling
- If possible, gather data on marginal weight and costs of LSTs as input to relevant elements of our modelling, or later exploration of scenarios by the DfT, using the model.

A4.4 While we were carrying out this task, we also reviewed an emissions' saving model developed in 2013-14 by the Centre for Sustainable Road Freight – cSRF to see whether we could either use it in our analysis, or generate new inputs to this or future cSRF models to capture LST savings.

Deliverables

A4.5 The deliverables included:

- An Excel spreadsheet scaling up model:
  - Containing all the key scaling factors derived from trial data by Risk Solutions
  - Suitable for further enhancement by DfT economists.
- A final project report (unpublished) describing the model, the results, and addressing the other task objectives described above.

A4.6 Version 1.0 of the model and the report were delivered to the DfT in early 2020, using the data published in AR2018. That data has been used in further model development.

A4.7 Annex 4A and 4B contain all the material from that final project report so that it will be published in full. The key difference is that here we have updated key numeric factors that drive the model with the latest 2019 values from this report, including:

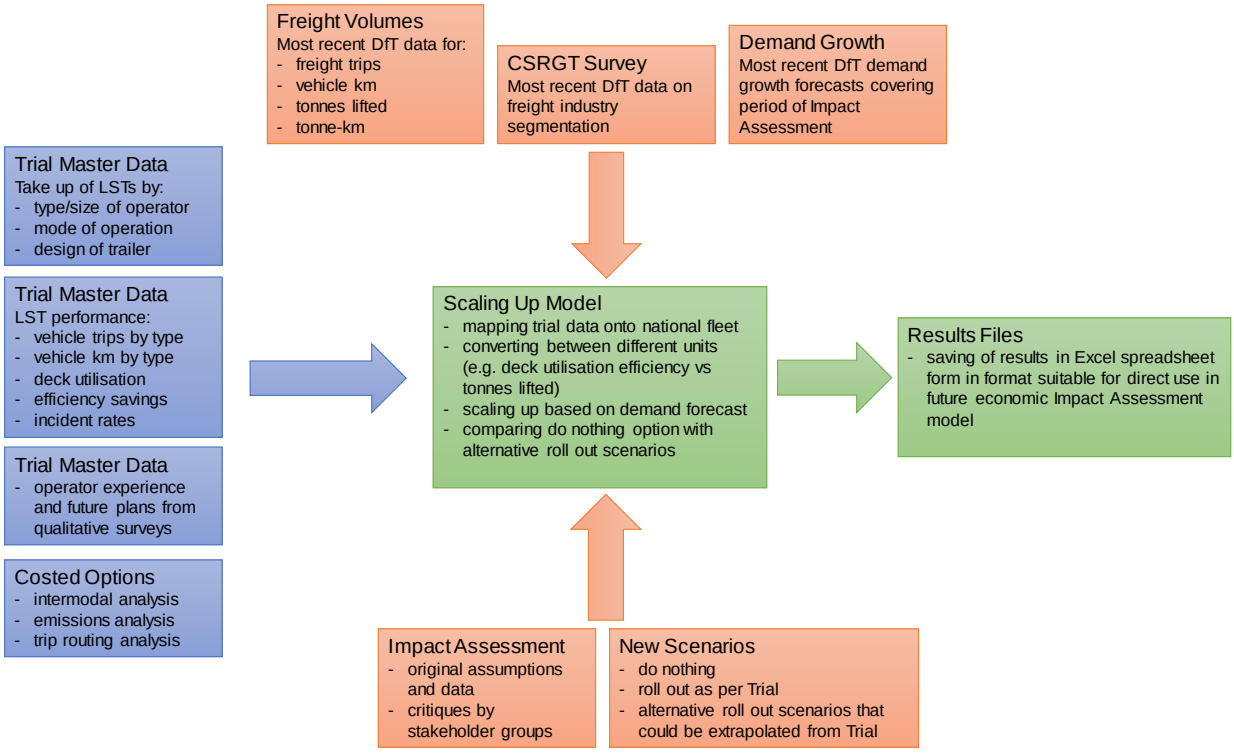
- The current and projected fleet size
- The average distance savings rates

A4.8 At the same time, we have moved the calculation of some results – notably the emissions savings into the latest model for existing trial years as well as future projections, and the results presented in Section 4 were in fact generated from the scaling model.

Model development

A4.9 The model has been implemented in Excel. Figure 20 shows the main input data sources considered, in developing the model.

Figure 22: Original scaling model concept and data sources



A4.10 The model and its results files are represented by the green boxes. The model is designed to take its input from trial data (represented by the blue boxes) along with data from other DfT sources (the orange boxes).

A4.11 In summary the model allows the user to estimate savings in journeys, and from these, savings in emissions and the impact on safety, based on predictions of take-up of LSTs by the industry derived by reference to experience on the trial and any broader consultation the DfT may undertake around potential LST take-up.

A4.12 As take-up of LSTs and distance savings is expected (based on the trial results) to differ depending on the nature of operations, a key initial task was to derive:

- A suitable segmentation of the data into clusters with statistically different distance savings profiles. The clusters could be, for example: by operator type, leg type or goods type, or a combination of these.
- Suitable parameters for predicted LST take-up - ideally based on the same clusters as above both:
  - in the short term (with today's depot and road infrastructure) and
  - longer term (allowing for upgrade of infrastructure over time, especially in depots).

A4.13 These clusters and their savings profiles are then applied to the national CSRGT freight flow data by mapping the field defining the cluster in the trial data to the best comparable field in CSRGT. The model then estimates potential national impacts of a wider use of LSTs, by comparing the original CSRGT results with those obtained by applying the trial savings profiles.

A4.14 The model development steps were:

Data Segmentation

1. Explore cluster analysis and segmentation options - identify candidate indicators of distance savings in the trial data and generate and test cluster hypotheses to show the statistical significance of any difference in saving between the clusters. This shows that the clusters can be treated as having 'predictive power' when applied in the model.
2. Develop an initial mapping of clusters on to CSGRT data categories.

Modelling Savings

3. Generate cluster saving and take-up profiles - for validated clusters (where cluster difference is confirmed as statistically valid) calculate average distance savings and take-up factors.
4. Develop the model to calculate CSRGT 'in year' savings: application of cluster savings profiles to a single year of CSRGT data assuming full LST take-up (i.e. without any ramp up).
5. Future projection over time - Expansion of the single year model to a 10-20 year projection incorporating take-up over time and changing freight demand.
6. Use the journey distance saved to calculate greenhouse gas emissions saved and safety benefits. Application of trial results on greenhouse gas, air quality and safety (injury) to the single year and future projection models to provide indicators of savings in these factors from the introduction of LSTs.

A4.15 These steps and the data used are described below.

Data Segmentation

A4.16 In this section we describe:

- Our analysis of the 2017 trial data sample to see whether there are any identifiable 'clusters' in the data that have distinctly different distance savings outcomes.
- The distance savings and take-up projections derived for the clusters, and
- Mapping of the selected clusters to CSRGT groupings.

Distance savings segmentation

Basis of the leg-by-leg distance savings contribution

A4.17 We have reported distance savings for the trial in the annual reports – with the full explanation of this savings calculation being given in AR2014.

A4.18 They are calculated by looking at the loading on any individual leg and the amount of the LST's additional deck space that was utilised. We then calculate the % of a 13.6m trailer that would be taken up by those additional goods, operated over the same distance. Summed over a large dataset, this gives a savings figure as the additional distance that would have been covered using 13.6m trailers to carry the same goods.

A4.19 A further analysis examines the sequence of legs by their start and end locations and where a clear A>B>A or A>B>C>A pattern is found. If (and only if) the first or last leg is empty, then the same saving is claimed for that empty leg as for the loaded part of the journey. The leg type of the associated loaded leg is also noted for use in later analysis.

Data segmentation options exploration

A4.20 Previously savings were only analysed in total across the whole trial and by company – showing the range of savings being achieved by companies on the trial.

A4.21 The task here was to see whether savings profiles could be created for distinct groups of freight operation with particular characteristics, that can then be applied to relevant segments of the national freight data. The potential mapping of our selected data segments to data types in the national CSRGT data is discussed later.

A4.22 We looked at a number of characteristics that might be used to segment the data as shown in Table 21 assessing each on the basis of several criteria:

- Does an analysis of the 2017 trial dataset indicate any difference in the savings made by operations segmented by the relevant trial data field i.e.
  - Does the average percentage distance saving across all records with e.g. goods type 'x' appear to differ from the saving across those with goods type 'y'
  - If so – is the apparent difference in savings between these two 'clusters' proven to be statistically significant?
- Could a mapping be made between a relevant CSRGT data field and an equivalent or related trial data field? If so – what degree of human expert judgement (and hence uncertainty) would be involved in that mapping.

A4.23 Our early tests considered a wide range of possible segmentations on single prameters, and for combinations of parameters, as illustrated in Annex 4B.

Table 21: Trial data segmentation options considered

Segment by trial data field:	Discussion
1. Company Primary Operation (CPO)	Every company participating in the trial completes a 'Company Information Sheet' soon after joining the trial. A large proportion of the sheets from early trial years were refreshed during 2018. This data includes their declared 'Primary Operation' from a list defined at the start of the trial. A 'modified' CPO list has been developed in this task, filling in gaps where the company info was not clear or where from other discussions with the operator we know that the LSTs are operating in a specific division of the company better represented by a CPO other than that for the company as a whole. (For example, LSTs operating in a sub-fleet of a 3PL company dedicated to retail delivery is reclassified to retail).
2. Leg Type	A trial data field capturing the nature of the work (DC to DC, To/From Retail etc) that while not directly paralleled in CSRGT, may have some correlation to company types.
3. Goods Type	A trial data field similar to the CSRGT 'Commodity' field, but with fewer classes.
4. Mode of Appearance (MOA)	A trial data field very similar to the CSRGT 'MOA' field.
5. Haul Type	A set of haul length categories originally proposed by AEA Ricardo in 2011/12 in work for the Committee on Climate Change and adopted in later work, including that by the Centre of Sustainable Road Freight (See Greening 2015 CfSRF "An assessment of the potential for demand side fuel savings in the HGV-sector") – being: URBAN <25 km but in our work, renamed LOCAL REGIONAL 25-100 km LONG HAUL 100+ km
6. Pre-Trial Segmentation	The pre-trial segmentation used to predict savings on the trial, was based on a combination of CSRGT haul type and weight / volume limited flags, to identify CSRGT records that might have LST savings applied to them. While the Volume and Weight limited flags still appear on the operator survey form, they are no longer migrated through to the CSRGT grossed data and so this segmentation approach is no longer possible in its original form.

Segmentation choice

A4.24 We concluded that the **most promising option was to segment the data by 'goods type'**, which appeared to provide three distinct groups of data – each with a different average saving. We also considered it likely that the trial goods types could be mapped relatively straightforwardly to the CSRGT 'Commodity' field.

Cluster hypothesis

A4.25 Our 'cluster hypothesis' was that there were three segments as shown in Table 22.

Table 22: Scaling model - Cluster Hypothesis

A) Hypothesis: grouping of goods type by savings cluster

Trial Data 'Goods Type'	Proposed Savings Cluster
1) EMPTIES / WASTE PACKING	LOW
7) MAIL / PARCELS	LOW
2) FMCG (MIXED PRODUCTS)	MID
3) FMCG (SINGLE PRODUCT)	MID
8) OTHER - RETAIL	MID
9) OTHER - NON-RETAIL	MID
10) PALLETS - MIXED/UNKNOWN	MID
4) RAW MATERIAL/SUPPLIES	HI
5) INDUSTRIAL PRODUCTS	HI
6) BIOMASS / FUEL	HI

B) Hypothesis: Average saving for cluster

Proposed Savings Cluster	Avg % Saving
LOW	6.5%
MID	9.2%
HI	12.8%

A4.26 Note that this analysis is based on a very specific view of the 2017 LST data, designed to highlight potential clusters. This is the data included:

1. Only 15.65m trailer data, so it excludes any potential variation in saving peculiar to the shorter, 14.6m trailers, which are a small segment of the total LST fleet
2. Only loaded legs and any matched empty return legs, to ensure we were looking at only the data for which we knew the goods type, for two reasons:
   - It avoids the diluting effect of empty legs where the goods type (or any related loaded leg) is unknown, in locating potential clusters
   - It is necessary to create savings percentage factors that can be applied directly to loaded legs in the CSRGT dataset, since there is no method of locating CSRGT empty-return legs that would be avoided when use of LSTs saves a loaded leg. The effect of empty return savings needs to be embedded in a savings factor applied to the loaded legs.

3. All the haul types (Table 21 and next section)

A4.27 We explored the three haul type categories based on length of haul (Table 21 item 5) and found that while overall savings were dominated by the longer distance haul types, it was not a strong determinant of savings percentage. Some operators on the trial are running LSTs efficiently over short distances, sometimes making many trips in a day.

A4.28 As a result, we did not use length of haul as part of the segmentation. However, we have provided a user option in the scaling model to include or exclude different length of haul types, to enable the comparison of baseline model results with alternative scenarios, e.g. that assume no savings are made in the short haul category (which was the assumption in the original impact assessment).

A4.29 This selective shaping of the data was designed to improve the possibility of finding a valid cluster hypothesis. In reading the table, it is important to note that the percentages here are only relevant to this process of locating clusters. They cannot be compared with the overall trial savings percentage, which averages at around 7-8% because:

- some data points are excluded, and
- here the overall trial saving value represents a weighted average across all recorded trial legs, but applied only to loaded legs and those with matched empty returns.

A4.30 In making a cluster hypothesis it is important to find not only an apparent numerical difference between the segments of the data, but also some possible rationale for why such a difference might exist.

A4.31 In making the case for the goods type clusters shown here, there are a number of potential supporting arguments:

1. Logically, goods type should be correlated with LST savings potential because it has a natural link to goods density - a key factor in considering the potential for using LSTs. Also, the goods type is a common factor in determining the wider nature of the operation in terms of the types of trailers, destinations and patterns of full, part-full and empty running.
2. The LOW group in Table 22 covers two goods types – ‘Empties and Waste packaging’ and ‘Mail and Parcels’. The common factor in these two types of operation may be that the quantity of goods loaded is often not determined by a process designed to fill trailers to the maximum level, but by other factors:
    a. Empties/Waste packing is very often a backhaul load and so the cargo is whatever is at the site to be taken back to a home depot.
    b. Mail and Parcels - for which we have five of the major GB operators on the trial – can be an operation based on precisely timed vehicle departures to meet operational deadlines driven by customer commitments, such as next-day-delivery. In such an operation the fill level of vehicles is determined by the demand for cargo on a given route.
    c. Mail and Parcels operations - at least the larger ones – may also operate a ‘national fleet’ with trailers not returning to a specific depot each night and rarely involving any completely empty running. Compared to other goods types, our algorithm for claiming savings in empty returns will not claim much benefit in this goods type group, and therefore while the points above may lead to low loading efficiency overall, there may also be some degree of under-estimating the savings for this group.
3. The HI group is almost the opposite of the LOW group, covering raw materials, industrial products and biomass/fuel – the latter being almost exclusively the carriage of straw or wood pellets to power stations. In this segment, the operator will

often ship goods in full loads only, to a large warehouse/distribution centre/power station. It will also commonly be a simple 'Full-Out – Empty-Back' loop so it is possible to identify most of the empty return legs as 'saved'.

4. The MID group has a mixture of factors driving the savings. It includes all the retail sector, where the cargo sizes – even in the trunking part of the operation, are largely driven by just in time delivery to the store of exactly what is demanded – there being little or no stock held at stores.

A4.32 The slight surprise in the cluster was the placement of goods type 10) Pallets (Mixed Unknown) in the MID group. We might have expected it to fall in the HI cluster as much of the palletised goods sector involves trunking full loads between large hubs. We have no specific rationale for why the average for this part of the fleet is not higher. Further analysis of the underlying data could be carried out if the DfT wishes.

Cluster hypothesis confirmation

A4.33 Statistical analysis of the hypothesis of three clusters based on goods type was tested and **the results confirmed that the difference in average savings between these clusters is statistically significant.** The statistical analysis and results are described in more detail in the section "**Cluster hypothesis**" below.

CSGRT Mapping

A4.34 The next key step in building the model was to define the mapping of each CSRGT Commodity code, to the most appropriate trial 'Goods Type'. This is not to say the actual goods are the same, but there is an underlying similarity that supports a judgement that the savings seen in the cluster for that goods type would be likely to be appropriate to the related CSRGT commodity code.

A4.35 Our initial mapping - for the purposes of this project note - is shown in Table 23.

A4.36 If necessary, we can review this mapping with DfT specialists, so an adjusted mapping might be used for later work on an impact assessment.

Exclusions from CSRGT mapping

A4.37 It is necessary to exclude certain records in the CSRGT data from having any saving applied to them, on the basis that it is unlikely that LSTs would be used for the work represented by those records in the database.

A4.38 The model contains three exclusion functions:

1. **Vehicle Configuration**. LSTs are presumed to only be used to replace other tri-axle semi-trailers and draw-bar combinations so the savings model is only applied to vehicle configuration codes 323,333 and 223,233.
2. **Cargo Weight**. LSTs are only likely to be used where the cargo densities being carried on 13.6m trailers are such that increasing the cargo volume by 15% would not exceed the 44 tonne GVW limit. Given the removal of the 'weight limited' flag from the CSRGT final data, we applied a reverse logic. The maximum cargo weight found on LSTs in 2017 was 29,000kg, giving a maximum cargo weight for a 13.6m trailer (at the same goods density) of 25,217kg. CSRGT records with cargo weight above this are excluded.
3. **Haul Type** (Length) The model allows the user to include or exclude all CSRGT legs on the basis of the LOCAL/REGIONAL/LONG-HAUL type, to reflect possible policy options or expectations about where the LSTs would be used. However, as noted earlier, trial data shows that large trailer - short distance work can be amenable to savings and all haul types have therefore been included in the baseline model runs.

Table 23: Scaling model – baseline CSRGT commodity mapping

CSRGT CODE	CSRGT COMMODITY DESCRIPTION	LST GOODS TYPE MAPPING	SAVINGS CLUSTER
1	01 Products of agriculture, hunting, and forestry; fish and other fishing products	3) FMCG (SINGLE PRODUCT)	MID
2	02 Coal and lignite; crude petroleum and natural gas	4) RAW MATERIAL/SUPPLIES	HI
3	03 Metal ores and other mining and quarrying products; peat; uranium and thorium	4) RAW MATERIAL/SUPPLIES	HI
4	04 Food products, beverages and tobacco	2) FMCG (MIXED PRODUCTS)	MID
5	05 Textiles and textile products; leather and leather products	3) FMCG (SINGLE PRODUCT)	MID
6	06 Wood and products of wood and cork (except furniture); articles of straw and plaiting materials; pulp, paper and paper products; printed matter and recorded media	6) BIOMASS / FUEL	HI
7	07 Coke and refined petroleum products	4) RAW MATERIAL/SUPPLIES	HI
8	08 Chemicals, chemical products, and man-made fibres; rubber and plastic products; nuclear fuel	5) INDUSTRIAL PRODUCTS	HI
9	09 Other nonmetallic mineral products	4) RAW MATERIAL/SUPPLIES	HI
10	10 Basic metals; fabricated metal products, except machinery and equipment	4) RAW MATERIAL/SUPPLIES	HI
11	11 Machinery and equipment n.e.c.; office machinery and computers; electrical machinery and apparatus n.e.c.; radio, television and communication equipment and apparatus; medical, precision and optical instruments; watches and clocks	5) INDUSTRIAL PRODUCTS	HI
12	12 Transport equipment	5) INDUSTRIAL PRODUCTS	HI
13	13 Furniture; other manufactured goods n.e.c.	8) OTHER - RETAIL	MID
14	14 Secondary raw materials; municipal wastes and other wastes	6) BIOMASS / FUEL	HI

CSRGT CODE	CSRGT COMMODITY DESCRIPTION	LST GOODS TYPE MAPPING	SAVINGS CLUSTER
15	15 Mail, parcels	7) MAIL / PARCELS	LOW
16	16 Equipment and material utilized in the transport of goods	10) PALLETS - MIXED/UNKNOWN	MID
17	17 Goods moved in the course of household and office removals; baggage and articles accompanying travellers; motor vehicles being moved for repair; other non market goods n.e.c.	9) OTHER - NON-RETAIL	MID
18	18 Grouped goods: a mixture of types of goods transported together	10) PALLETS - MIXED/UNKNOWN	MID
19	19 Unidentifiable goods: goods which for any reason cannot be identified and therefore cannot be assigned to groups 01-16	10) PALLETS - MIXED/UNKNOWN	MID
20	20 Other goods n.e.c.	10) PALLETS - MIXED/UNKNOWN	MID
EM	EM Empty	0) NO CARGO	EMPTY

Modelling savings

A4.39 This section described savings and take-up factors derived from the trial data for each of the selected clusters and demonstrates the use of the model to estimate savings for a single year (the 'in year' model) and for future projections (the multi-year model).

Savings and take-up factors for selected clusters

Distance savings

A4.40 Savings percentage factors for ALL loaded legs in the 2017 data (not just the sample selected for the purpose of identifying clusters) are applied in the model to the CSRGT dataset. These are calculated as follows:

For each Cluster – totalling all data for legs with goods types in that cluster the **Loaded Leg % Savings Factor =**

The sum of:

the total distance saved on loaded legs +

the Distance saved on matched empty return legs

divided by:

the total distance travelled on all loaded legs.

A4.41 The final savings factors for the clusters are shown in Table 24.

Table 24: Scaling model - Goods type clusters and distance saving factors

A. Goods type clusters

Trial Data 'Goods Type'	CLUSTER NAME
0) EMPTY / No CARGO	EMPTY
1) EMPTIES / WASTE PACKING	LOW
7) MAIL / PARCELS	LOW
2) FMCG (MIXED PRODUCTS)	MID
3) FMCG (SINGLE PRODUCT)	MID
8) OTHER - RETAIL	MID
9) OTHER - NON-RETAIL	MID
10) PALLETS - MIXED/UNKNOWN	MID
4) RAW MATERIAL/SUPPLIES	HI
5) INDUSTRIAL PRODUCTS	HI
6) BIOMASS / FUEL	HI

B. Distance saving factors associated with each cluster

CLUSTER NAME	Average distance Saving %
EMPTY	0%
LOW	6.8%
MID	9.7%
HI	12.7%
Average across all loaded legs	**9.7%**

Take-up Assumptions

A4.42 The data gathering on the trial has included two rounds of operator qualitative surveys (QSF1 and QSF2). In particular, the 2016 QSF2 survey asked operators:

- whether they expected to continue to use LSTs in the future and if so, how many (including their trial trailers) might they require (Take-up scenario A)
- whether they had plans to increase or decrease their fleet size by take-up of LSTs
- what was their likely trailer replacement cycle
- how their uptake projection might change if - over time – depot and other infrastructure were to develop to be more LST compliant (Take-up scenario B).

A4.43 The responses included both quantitative estimates and comments on their reasoning.

A4.44 We reported estimated take-up values in AR2017, showing the average take up projections for operators on different leg types based on a survey of 126 LST operators.

A4.45 In our conversations with a small selection of operators early in 2019, we asked whether their take-up projections had changed since the 2016 survey. In most cases they had not, but a few companies said they would now increase their potential take-up.

A4.46 For this new analysis we have returned to the same dataset and attempted to map it to Goods Type, to fit in with the distance saving clusters reported above.

A4.47 For each operator we calculated an overall fleet average take-up projection for the Take-up A and Take-up B scenarios. We then multiplied the distance travelled in 2017 for each operator and each goods type, by the operator's fleet average take-up projection, to give a distance-weighted take-up for each operator-goods type combination. Summing these distance weighted values over all operators, gave a weighted take-up factor for each goods type.

A4.48 Using the approach described and the available data we generate the take-up values by goods type and cluster shown in Table 25.

Table 25: Scaling Model - Take-up factors

Cluster	Goods Type	Weighted Take-up A	Weighted Take-up B
LOW	1) EMPTIES / WASTE PACKING	26%	31%
	7) MAIL / PARCELS	14%	22%
	Cluster weighted average	**18%**	**26%**
MID	2) FMCG (MIXED PRODUCTS)	23%	33%
	3) FMCG (SINGLE PRODUCT)	14%	20%
	8) OTHER - RETAIL	39%	63%
	9) OTHER - NON-RETAIL	3%	7%
	10) PALLETS - MIXED/UNKNOWN	21%	35%
	Cluster weighted average	**22%**	**33%**
HIGH	4) RAW MATERIAL/SUPPLIES	28%	35%
	5) INDUSTRIAL PRODUCTS	21%	28%
	6) BIOMASS / FUEL	10%	22%
	Cluster weighted average	**22%**	**31%**

A4.49 There are a number of points in this calculation were the data and the assumptions are less than perfect – the main one being that the weighting assumes that the types of goods being moved on the operator's LSTs are similar to the mix of goods types the operator carries in general. This will be true for most of the operators, but not for all. We cannot obtain data on the full distances and goods types for the operators entire non-LST fleet, so this is the best calculation possible with the data available. This weakness is, however, mitigated by the later step in the model where the take-up values are only applied to CSRGT data rows with the matching goods type (mapped through the CSRGT commodity field) so the model will not take these values and then apply them to an entirely unrelated movement of goods. The forward projection model also includes an ability to conduct sensitivity analysis on the estimated take-up values.

A4.50 **The 'cluster-weighted averages' are applied in the scaling model**.

A4.51 The DfT may decide to adjust these assumptions further in the light of their 2019 gathering of stakeholder views, which goes beyond surveying just current trial participants.

The scaling model

A4.52 The scaling model applies the savings factors from using LSTs to relevant loaded legs in a sample year (2017) of CSRGT data.

A4.53 The model then produces two results:

- An 'in-year' result – showing what the savings might have been in the sample year, if the full take-up of LSTs is presumed to have already happened
- A future projection – which takes the in-year result and uses it to generate year by year savings taking into account the time taken for the LSTs to be taken up following a hypothetical change in regulation that removes the cap on how many LSTs are available.

A4.54 The projection model can then be used to explore a range of scenarios with variations in the start year, speed of take-up, the point at which it is assumed the higher Take-up B figures can be applied, as well as other sensitivity factors.

A4.55 The point of providing the DfT with the model in this form is that they can then consider how different policy options would affect assumed take-up etc and hence examine a range of outcomes.

The 'In Year' model – illustrative scenario

A4.56 Figure 21 shows a set of results for a scenario based on the cluster savings percentage and take-up percentages presented in Table 24 and Table 25 above, along with the CSGRT exclusion assumptions presented earlier.

A4.57 Two sets of take-up assumptions are included:

- **Take-up A** where depots and infrastructure are similar to now
- **Take-up B** where depots and other infrastructure were developed to be more LST compliant.

A4.58 Under this scenario, had LSTs been in common use in 2017 (the year of the CSRGT data sample) with Take-up A, then the model estimates that 112 million km of large semi-trailer HGV operation might have been avoided, representing a saving of 1.08% of all such operations. With Take-up B, the saving is 165 million km, or 1.58% of all large semi-trailer operations.

A4.59 In addition – a further 4.5 to 6.4 million km of draw-bar combination operations would have been avoided, if replaced by LSTs.

Figure 23: Scaling model - 'In-Year' results (Illustrative)

LST SAVINGS RESULTS IN BASE CSRGT YEAR (2017) at for Take Up A and B

CSRGT DATA FOR 2017		LOCAL	REGIONAL	LONG HAUL	TOTAL	%
CSRGT RAW DATA SUMMARY		<25 km)	<=100 km)	>100 km)		
RECORDS						% of records
Rigid		12,843	14,504	10,056	37,403	50%
Rigid and Trailer		429	828	950	2,207	3%
Articulated Semi-Trailer		5,442	12,902	17,407	35,751	47%
	TOTALS	18,714	28,234	28,413	75,361	100%
GROSSED DISTANCE (millions of km)						% of total GD
Rigid		335	2,002	5,211	7,548	41%
Rigid and Trailer		10	101	454	564	3%
Articulated Semi-Trailer		143	1,583	8,760	10,486	56%
	TOTALS	488	3,686	14,425	18,599	100%
LST SAVINGS (Records and km) SUMMARY						
RECORDS ELIGIBLE FOR SAVINGS CALCULATION (Not excluded)						% of records in vehicle group
Rigid		-	-	-	-	0%
Rigid and Trailer		218	534	439	1,191	54%
Articulated Semi-Trailer		4,522	10,018	12,378	26,918	75%
	TOTALS	4,740	10,552	12,817	28,109	37%
GROSSED DISTANCE SAVED (millions of km)		TAKE UP A				% of distance for vehicle group
Rigid		-	-	-	-	0.00%
Rigid and Trailer		0.1	0.9	3.5	4.5	0.79%
Articulated Semi-Trailer		1.2	14.1	97.5	112.8	1.08%
	TOTALS	1.3	15.0	101.0	117.3	0.63%
		TAKE UP B				% of distance for vehicle group
Rigid		-	-	-	-	0.00%
Rigid and Trailer		0.1	1.3	5.0	6.4	1.13%
Articulated Semi-Trailer		1.7	20.7	142.9	165.3	1.58%
	TOTALS	1.8	22.0	147.9	171.7	0.92%

BASE SETTINGS					
	Run Ref:	SAVINGS RUN: 06/08/2020 22:23:10			
	User Info:	paulbrand			
Vehcile (Axle) Configs included (Fixed):	323, 333, 223 and 233			CSRGT Yr:	2017
Haul Types Included:	LOCAL	<25 km)	Yes	MAX kg:	25,217
	REGIONAL	<=100 km)	Yes	(Goods Wt)	
	LONG HAUL	>100 km)	Yes		

SAVINGS APPLICATON TO CSRGT - SUMMARY (NOTE this version is counting all records to show the excluded data	RECORDS	GROSS DIST	TAKE UP A SAVED DIST	% of Take Up A Saving	TAKE UP B SAVED DIST
CLUSTER	Count	Million km	Million km	% of Saving	Million km
EXCLUDED	47,252	11,216	0	0.0%	0
EMPTY	12,134	2,267	0	0.0%	0
LOW	749	260	3	2.7%	5
MID	9,793	3,267	70	59.4%	105
HI	5,433	1,588	44	37.8%	63
TOTALS	75,361	18,599	117	100%	172

Modelling future projections – illustrative scenario

A4.60 The future projection model allows for a range of input assumptions. Table 26 shows the settings for the scenario illustrated here.

Table 26: Scaling model - Set up

A: SCENARIO SET UP

Parameter	Values Illustrative	Definitions
CSRGT base year	**2017**	year of CSRGT survey data loaded into model
Projection base year	**2019**	year 0 in projection model
LST Regulation / Quantity Cap Removed	**2027**	year in which regulation is presumed to be enacted lifting the quantity cap on LSTs *For this illustration, the trial has been assumed to run to its current end date before regulation takes place*
Trailer renewal cycle	**5**	number of years for the natural replacement cycle to replace eligible standard trailers with LSTs
Take-up A/B transition date	**2037**	first year in which infrastructure has been sufficiently modified that Take-up changes to scenario B *For this illustration, the transition in infastructure is assumed to happen only 10 years after regulation*
Freight km demand growth per yr	**1.1%**	annual percentage growth factor to apply to CSRGT base year freight vehicle km
Savings modifier	**1.00**	factor to apply to base savings data, for sensitivity analysis
Take-up modifier	**1.00**	factor to apply to base take-up data, for sensitivity analysis
Collision rate GB Artic Fleet	**0.114**	collisions per million vehicle km (3 yr moving avg)
Casualty rate GB Artic Fleet	**0.162**	casualties per million vehicle km (3 yr moving avg) *Collison and Casualty rates from Table 12*

B: EMISSIONS SAVINGS FACTORS

Emission	Euro 5 emissions savings factors (kg saved per million vehicle km saved)
CO	**459**
CO2e	**774,030**
NOx	**3,881**
PM exhaust	**41**
VOC	**89**

Source of emissions savings factors:

The factors are derived from 2017 trial data routing analysis & emissions model, assuming 100% Euro V. Factors for EURO VI require a further run of the whole emissions model.

A4.61 The projection model then produces savings in a time-line out to 2040 with a summary in the form shown in Figure 22.

A4.62 The projection model goes beyond the distance savings results of the in-year model, using the emissions savings factors from the 2017 emissions modelling to provide an indication of the potential emissions avoided over 10-20 years. These savings are still based on the original factors for all EURO V engines.

A4.63 At the time of writing this annex, we had not agreed with the DfT whether we need to re-run the whole emissions model for EURO VI engines to generate new emissions factors, or whether these can be generated through a simple scaling-down from EURO V, based on known relative emissions of the two engine classes).

A4.64 Finally - the future projection model estimates the avoided collisions and casualties arising solely from the reduction in distance operated. **No benefit is claimed for any restriction placed on LSTs that would mean they continue to operate at a lower collision rate per km than the general GB fleet.**

A4.65 The results presented here give an indication of the potential benefits that might arise from introducing LSTs more widely across the GB HGV fleet, but we would emphasise that these are illustrative only. They represent only one scenario, based on one set of assumptions. We believe it is a credible scenario, based on fairly prudent assumptions and so the results can be used as a rough estimate.

A4.66 These results are only illustrative and cannot be taken to indicate any actual projections of future benefits from LSTs.

Figure 24: Scaling model - future projection result (illustrative)

FUTURE PROJECTION SUMMARY	TRIAL YEARS		Transition Year	REGULATED YEARS (NOT INC TRIAL)		
SCENARIO: REGULATION IN: 2027	**LST Trial 2012-18**	**Later Trial Years**	**Regulation / Transition Year**	**Regulation + 10 years**	**Regulation + 15 years**	**Regulation + 20 years**
up to year:	2018	2019-2026	2027	2037	2041	2041
REDUCTION IN LARGE ARTIC HGV JOURNEYS						
Millions of VEHICLE KM avoided	45.8	123.4	18.2	1,054	1,932	1,932
Millions of JOURNEYS avoided (125km avg)	0.37	0.99	0.15	8.43	15.46	15.46
SAFETY BENEFITS						
Colisions / Casualties avoided by LSTs making fewer trips to deliver the same quantity of goods						
Collisions avoided from fewer km	5.2	14.1	2.1	120	220	220
Casualties avoided from fewer km	7.4	20.0	2.9	171	313	313
Casualty counts include all STATS19 injuries - Fatal, Serious and Slight						
Note: these figures do not include any factor for safer operation per km arising from regulation of LSTs						
EMISSIONS BENEFITS						
Total emissions avoided by using LSTs travelling fewer km for same quantity of goods						
CO tonnes	22	57	8	484	887	887
CO2e tonnes	**37,333**	**95,487**	**14,075**	**815,647**	**1,495,704**	**1,495,704**
NOx tonnes	**187**	**479**	**71**	**4,090**	**7,499**	**7,499**
PM Exhaust tonnes	2	5	1	43	79	79
VOC tonnes	4.3	11	2	94	172	172

SCENARIO VARIABLES:		MODEL VERSION INFO:			
CSRGT base year	2017	Version:	v1-9		
Projection base year	2019	Issue Date:	tba		
LST Regulation / Quantity Cap Removed	2027	Issue By:	P BRAND		
Trailer renewal cycle	7				
Take up A/B transition date	2037	Freight km demand growth per yr			1.1%
Take Up A % Min / Max for loaded legs	18% to 22%	Savings modifier			100%
Take Up B % Min / Max for loaded legs	26% to 33%	Take up modifier			100%
		Reg Yr	**Reg+10**	**Reg+15**	**Reg+20**
Fleet mix in Regulation year and future:	**Profile**	**2027**	**2037**	**2041**	**2041**
Fraction of fleet ZERO EMISSIONS (manual entry or prof	0	0%	0%	0%	0%
Fraction of fleet Euro VI (manual entry or profile)	0	0%	0%	0%	0%

NOTE - EURO VI SAVINGS FACTORS NOT YET LOADED 25/7/19

Model description

Model user description

A4.67 Version 1-0 of the model will be passed to the DfT with this project note and a meeting with DfT analysts is scheduled at which we will take them through the worksheets and functions. The notes below provide a simplified summary of the elements of the model. More detail can be found in the sheet notes within the model workbook.

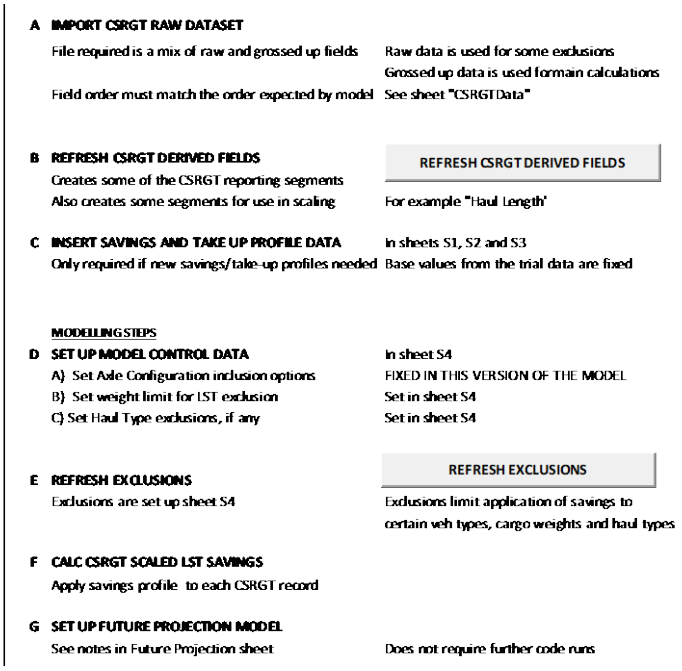
A4.68 At the time of writing the model has been further developed (now at v1-9) in conjunction with the DfT to meet their requirements for further exploration of policy options, while ensuring that the modelling continues to adequately reflect the underlying trial evidence on which it is based.

Dashboard

- The model is set-up by choosing parameters in sheets S1-S4, and Future Projections as described in sections below.

- Runs of the model are then controlled from the Dashboard sheet, which also contains the summary results

Figure 25: Scaling Model Dashboard Controls



- The model can be refreshed at 3 levels – using the three control 'buttons' shown on the left side of the dashboard - depending on which setups have been altered (see below):
  - If any values in S1-S3 are altered, the user must run "REFRESH CSRGT DERIVED FIELDS
  - If any values in S4 are altered, the user must run "REFRESH EXCLUSIONS"
  - If either of the above refreshes are made, the user must then run "CALCULATE SAVINGS IN YEAR" – which also then updates the FUTURE PROJECTION model
  - The charts shown in Figure 21 and Figure 22 are from the dashboard.

Future Projection

- This model sheet enables future projections from the present day out to 2040.
- The Future Projection model has its own user defined scenario parameters set inside the sheet, each of which is explained in the sheet notes. One of the key settings is the year in which the scenario assumes the trial ends and regulation removes the cap on the number of LSTs that can run nationally.
- Updating the IN YEAR savings in any way as noted above, changes the values used from that model in the future projection.
- The model is designed with the expectation that DfT analysts may wish to:
  - Run scenarios based on different parameters reflecting different policy options being considered, since those options might lead to higher or lower take-up of LSTs or cover different profiles in the growth of demand for road freight
  - Explore sensitivity of the results to different input assumptions
  - Expand the functionality of the future projection sheet to cover economic impact, which is beyond the remit of the Risk Solutions evaluation of the trial.

Set-Up sheets

S1 – Cluster Profiles

- The profiles based on goods type that we have tested and found to be statistically robust are fixed in this sheet in the top rows of the table.
- The model can be used to explore other savings profiles – but only at this version based on Goods Type – by adding new rows with unique cluster names.
- Additional profiles would be speculative as they would not have been tested by cluster analysis to confirm they are robust.

S2 – Map Goods Type

- Select the cluster savings profile from S1 to be applied to each trial goods type.
- The default mapping – on which the default cluster settings were based – are retained on the right-hand side of the sheet so that they can be pasted back in at any time.

S3 – Map CSRGT Commodity

- Select the Trial Goods Type - and hence cluster savings profile – to be applied to CSRGT records of each given commodity type.
- The default values chosen by Risk Solutions (retained on the right-hand side of the sheet) are based on a cross check of the underlying descriptions of each CSRGT commodity code and an assessment of the most appropriate trial goods type to map to each one.
- This is a judgement (rather than a statistically tested result) and so alternative mappings might be explored by the DfT.

S4 – CSRGT Exclusions

- The model excludes certain records of the CSRGT data from the savings calculation
    A. VEHICLE CONFIGURATION: This is hard coded into the model – all rigid vehicle configurations and any articulated trailers with fewer than 3 axles are excluded.
    B. CARGO WEIGHT: As described in the project note text, CSRGT records with a cargo weight over a given threshold are excluded as representing loads that would weight-out at LST capacity. The default settings are LST max cargo weight = 29,000kg and the scaling factor from 13.6m to 15.65m = 15%
    C. HAUL TYPE EXCLUSION: As described in the project note text, the user can exclude one or more of the distance based Haul Types shown here.

Model technical description

Model input files

- There are no external input files required. The CSRGT data sheet can be updated if required by pasting in the same data fields on the left side of the sheet. However, note that the model calibration and mapping from the trial was based on 2017 trial data.

Model coding

- The model has been tested in Office 365 version of MS Excel for use under both Windows and MAC OSX (Mavericks) operating systems.
- Based on our knowledge of the changes to MS Excel and the embedded Visual Basic coding system, we would expect the model to be compatible with Excel 2010 onwards.

Model outputs

- There are no output files from the model. The actual CSRGT modelled savings can be read directly from the CSRGT worksheet. The annualised outputs for each result parameter can be read from the Future Projection sheet.
- We understand DfT economists have now developed their own tools which read results from scenarios in our model and use them for their own analysis.

Future development options

A4.69 We develop the model further to incorporate

- Emissions Savings Factors for EURO VI engines
- Updated marginal weight figures.

A4.70 We also noted our slight surprise in the cluster analysis was the placement of goods type 10) Pallets (Mixed Unknown) in the MID group. We might have expected it to fall in the HI cluster as much of the palletised goods sector involves trunking full loads between large hubs. We have no specific rationale for why the average for this part of the fleet is not higher. Further analysis of the underlying “goods type 10)” data could be carried out if the DfT wishes. The question of interest would be to explore whether the average saving we see in the data is simply a facet of the way the savings algorithm works, or something related to a real limitation on the efficiency of LSTs in the palletised trunking sector.

ANNEX 4B: Segmentation and cluster analysis

A4.71 Although integral to the model development process described in Annex 4A, the detail of the data segmentation and cluster analysis have been separated out into this separate section as they are quite technical and we judged they might only be of interest to specialists in this area of mathematics and data analysis.

Preliminary exploration of the data

A4.72 The exploration of possible segmentation choices involved some early visual study of each option using a simple 'Box-and-whiskers' plot in Excel (as shown in Figure 24 and Figure 25), to obtain some initial indications of where the best segmentation option might lie. We considered Company Type, Leg Type, Goods Type and Mode of Appearance.

A4.73 After this initial work, a more complex set of matrix plots produced in 'R' were studied. These plots allow you to look at combinations of parameters fairly quickly.

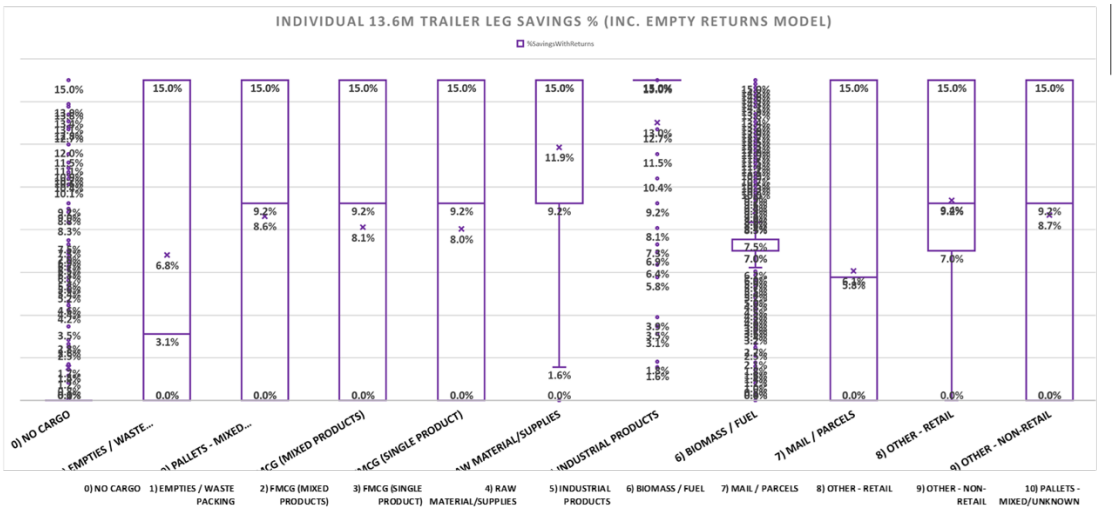
A4.74 There are too many of these matrix plots (covering various combinations) to present in full here, but an example is shown in Figure 25

A4.75 From a visual review of these plots, we then moved to review key statistics for promising options – essentially a table of the numbers behind the matrix plot.

A4.76 From this we developed two possible cluster hypotheses, based on

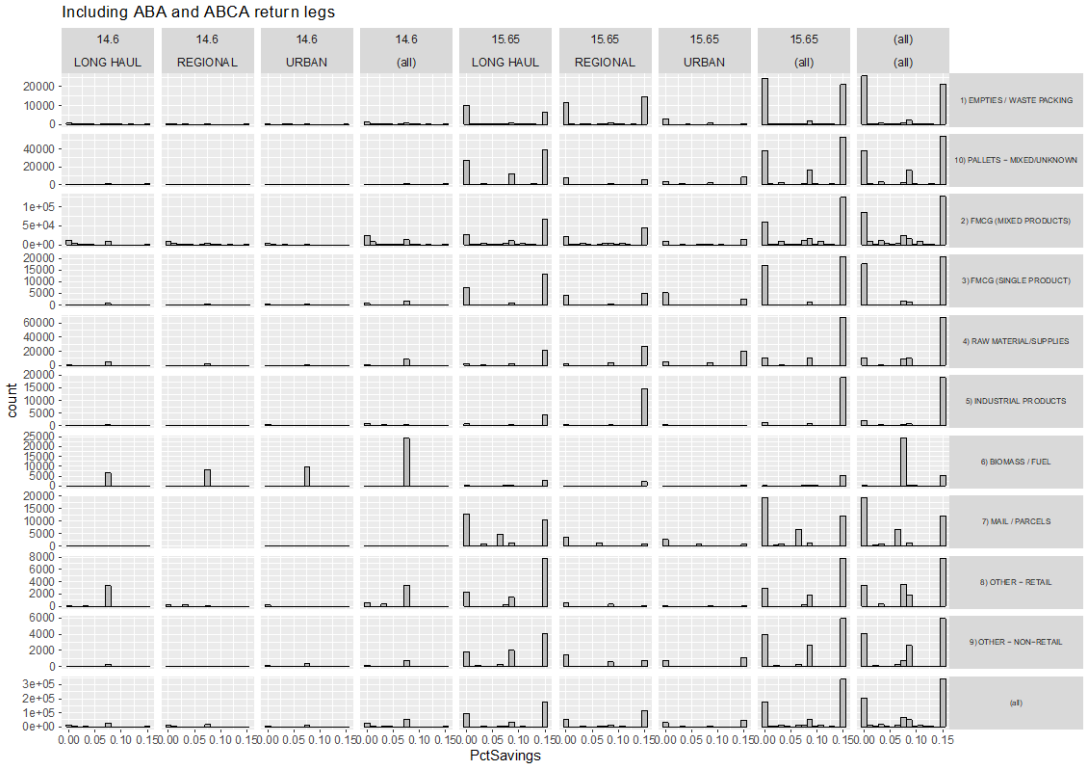
1) Goods type alone
2) Goods type in combination with haul type (LOCAL, REGIONAL, LONG HAUL)

Figure 26: Early exploration of 2017 trial data segmentation



	0) NO CARGO	1) EMPTIES / WASTE PACKING	2) FMCG (MIXED PRODUCTS)	3) FMCG (SINGLE PRODUCT)	4) RAW MATERIAL/SUPPLIES	5) INDUSTRIAL PRODUCTS	6) BIOMASS / FUEL	7) MAIL / PARCELS	8) OTHER - RETAIL	9) OTHER - NON-RETAIL	10) PALLETS - MIXED/UNKNOWN
MAX	15.0%	15.0%	15.0%	15.0%	15.0%	15.0%	15.0%	15.0%	15.0%	15.0%	15.0%
75th	0.0%	15.0%	15.0%	15.0%	15.0%	15.0%	7.5%	15.0%	15.0%	15.0%	15.0%
MEDIAN	0.0%	3.1%	9.2%	9.2%	15.0%	15.0%	7.0%	5.8%	9.2%	9.2%	9.2%
25th	0.0%	0.0%	0.0%	0.0%	9.2%	15.0%	7.0%	0.0%	7.0%	0.0%	0.0%
MIN	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
AVERAGE	1.5%	6.8%	8.1%	8.0%	11.9%	13.0%	8.9%	6.1%	9.4%	8.7%	8.6%

Figure 27: Example matrix plot



(Note URBAN is referred to as LOCAL in the main body of the report; PcT = percentage)

Cluster hypothesis development

A4.77 The figures below show the 2017 LST dataset split into possible segments by Goods Type and then combinations of Goods Type and Haul Type (the latter using the types found in work for the Climate Change Panel, referred to here as 'CCC Haul').

A4.78 Both options were then analysed in 'R' to see whether the differences between the average savings percentages were statistically significant.

A4.79 The result was that while the simpler 'Goods Type Only' cluster shown Figure 26, was confirmed as statistically significant. The results for the combined approach (Goods type with haul type) were less clear.

Figure 28: Cluster analysis - Goods type only

GoodsType	Cluster	Count	Sum n	Sum Weight	Wtd Mean
1) EMPTIES / WASTE PACKING	LOW	3	48,850.0	3,432.8	7.0%
2) FMCG (MIXED PRODUCTS)	MID	3	239,409.0	22,822.7	9.5%
3) FMCG (SINGLE PRODUCT)	MID	3	39,615.0	3,274.8	8.3%
4) RAW MATERIAL/SUPPLIES	HI	3	89,868.0	11,265.7	12.5%
5) INDUSTRIAL PRODUCTS	HI	3	21,379.0	2,957.5	13.8%
6) BIOMASS / FUEL	HI	3	6,325.0	869.4	13.7%
7) MAIL / PARCELS	LOW	3	41,676.0	2,441.8	5.9%
8) OTHER - RETAIL	MID	3	12,830.0	1,363.9	10.6%
9) OTHER - NON-RETAIL	MID	3	13,101.0	1,150.8	8.8%
10) PALLETS - MIXED/UNKNOWN	MID	3	115,837.0	9,933.6	8.6%
ALL		**30**	**628,890.0**	**59,513.3**	**9.5%**

Figure 29: Cluster analysis - Goods type with haul type

Average of mean	Column Labels		
Row Labels	LONG HAUL	REGIONAL	LOCAL
7) MAIL / PARCELS	6.60%	3.60%	3.80%
1) EMPTIES / WASTE PACKING	5.80%	8.40%	3.20%
8) OTHER - RETAIL	11.20%	4.30%	6.40%
3) FMCG (SINGLE PRODUCT)	9.50%	8.20%	5.00%
9) OTHER - NON-RETAIL	9.70%	6.10%	8.80%
10) PALLETS - MIXED/UNKNOWN	8.70%	6.80%	9.80%
2) FMCG (MIXED PRODUCTS)	9.90%	9.30%	8.60%
5) INDUSTRIAL PRODUCTS	12.50%	14.60%	3.40%
4) RAW MATERIAL/SUPPLIES	12.80%	13.20%	11.50%
6) BIOMASS / FUEL	13.10%	14.80%	14.70%

Cluster hypothesis confirmation

A4.80 The hypothesis is that when segmented by 'Goods Type', the 2017 trial data falls into three clusters with different distance savings profiles as shown in Table 22.

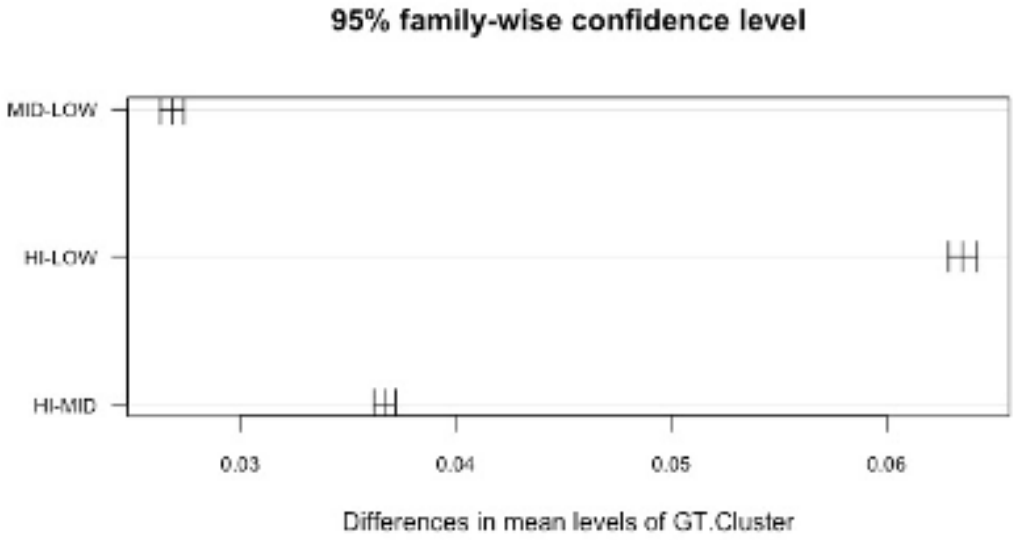
A4.81 The data was analysed in the statistical package 'R' using the describeBy function to determine cluster means and the aov function and tukey.test function to conduct an ANOVA analysis and Tukey Test of the difference between clusters. The number of data records in each cluster, along with the mean and median percent saving and standard deviation are show below.

Figure 30: Cluster analysis - statistical robustness test results

Cluster	n	mean	median	sd
LOW	90526	0.065	0.03	0.069
MID	420785	0.092	0.15	0.066
HI	117572	0.128	0.15	0.047

A4.82 The Tukey test results are plotted below. The test performs a pairwise comparison of each cluster with each other cluster to determine if the difference in the mean percent savings between clusters is statistically significant.

Figure 31: Cluster analysis - Tukey plot



A4.83 The plot confirms that all the 95% confidence interval bars do not span the “difference in means = zero” line. We can be confident that the clusters are all different to each other, i.e. there is sufficient evidence to say that the difference in mean savings between all the clusters is greater than zero.

ANNEX 5: DEVELOPING PRELIMINARY INDUSTRY-LED LST GOOD PRACTICE INSIGHTS

A5.1 Part 1: During 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.

A5.2 Part 2: Having studied the themes emerging from the interviews in Part 1, we drew together a group of 15 operators, together with other specialists, for a workshop to develop an initial set of summary industry insights to operators and others who may be involved in introducing LSTs into an existing operation.

A5.3 The main topics emerging from Part 1 interviews were reported in the (AR2018 Section 7 and Annex 5). Here we present:

- the methodology for the project
- comments on the results of Part 2 and (in a separate Annex)
- the summary industry insights document based on the evidence from this work

A5.4 The industry insights document resulting from this work is presented in Annex 6**.**

Method

Topic areas

A5.5 We had four main areas of interest, reflecting some key questions first articulated in the 2017 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

A5.6 We approached a total of 13 companies, described in outline in Figure 30 and successfully arranged meetings with 11. The others were willing to meet but a suitable date was not available within the timescales for this piece of work.

A5.7 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 30)
- a range of size, from family run businesses to national groups (Figure 30)
- those with operations supplied by a range of manufacturers / builders (Figure 31)

Figure 32: Operators interviewed, by size and main axle choice

Phase	Visit number	Characteristics	Axle Choice	Date
Pilot study Each interviewer carried out one initial visit to pilot the topic 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 33: Manufacturers of trailers owned or leased by companies represented in the sample

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

Part 1 Interview team and guide

A5.8 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.

A5.9 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

A5.10 The original interview notes remain confidential to Risk Solutions.The contents were synthesised using an internal team workshop and the results summarised in AR2018.

A5.11 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.

Part 2 Workshop Development

A5.12 As part of the early 2019 interviews, we asked whether operators would be willing to take part in a more in-depth workshop to develop the core of this document, with two areas of particular interest:

- Driver Management – including but not limited to training
- Operational Management – including but not limited to the assessment of routes in terms of their suitability for LSTs.

A5.13 In developing the design for the workshop we realised that while the Driver Management topic was fairly well bounded, the Operational Management discussion contained a number of subsidiary areas that would need to be separated out – probably based on the stakeholders of interest. We also saw the potential value in expanding the bounds of the discussion slightly wider to take into consideration:

- 'Upstream' decisions – relating to the business case/ROI for adopting LSTs – without which the market for the trailers will never develop
- Whole sector adjustments - relating to supply chain processes and software and long-term warehousing sector issues.

A5.14 The workshop scope was finalised and the event took place on 18 November 2019.

Workshop design

A5.15 The workshop was designed and delivered by an independent facilitator so that the project leaders from Risk Solutions could participate fully in the content of the day, drawing on their knowledge of the earlier stage of interviews and the wider insights from the trial to date.

A5.16 We agreed the formal objectives of the workshop as:

- To draw together real-world experience of the management, training and operational practices that operators using LSTs have found effective to ensure safe and efficient use of the trailers
- To produce a structured list of themes covering WHAT has been done by operators and WHY.

A5.17 We agreed that we wanted the group to explore three dimensions of each issue:

4) **Nature of the issue:** WHAT was done and WHY (from the objectives)
5) **Stakeholder Interests** – specifically
    a) Driver management
    b) Operational management
    c) Logistics and supply chains
6) **Impact area**
    a) Emissions reduction – based on efficiency of trailer utilisation
    b) Safety management
    c) Other issues

Workshop participation and topics

A5.18 We invited fifteen companies to the workshop, including all those who took part in the earlier round of one-to-one interviews and a number of additional companies who we believed had a strong interest in contributing.

A5.19 Companies were permitted up to three participants (one for each stakeholder view).

A5.20 On the day, 25 people were involved in the workshop, from the following organisations:

Gregory Distribution ltd	WM Morrison	Pladis Global
Bibby Distribution Ltd	Wincanton Group Ltd	Metcalfe Farms
C M Downton	Royal Mail Group	WSP (Freight & Logistics Team
Eddie Stobart Ltd	Culina Logistics Ltd	

A5.21 The morning session was spent generating lists of issues in three groups, each focusing on one of the stakeholder areas listed in dimension B (above). The discussion was then expanded to explore the other two dimensions (What/Why and Impact), along with the range of management actions companies had adopted to address each issue.

A5.22 In the afternoon session groups selected specific topics from the list to explore in more depth. The topics were:

1) **Driver Training**
   a) what are the most important training issues?
   b) what is the diversity of topics and training input (time) across the companies?
2) **Return on Investment** – what are the key issues to consider?
3) **Choice of LST design** – length and steering options.
4) **Timescales** - the likely speed of any wider roll-out of LSTs and constraints.

Workshop output processing

A5.23 Risk Solutions processed the workshop results and structured them into a preliminary document that was circulated to workshop attendees, who provided some further comments and suggestions. The current version is presented in Annex 6.

Issues not within the scope of the document

A5.24 Three issues were raised at the workshop were of interest or concern to the companies but fall outside the stated scope of the document and so do not appear in the document. They are noted here for completeness.

A5.25 To respect the input of those raising these issues, we committed to include them in the report to the DfT to take forward as they deem appropriate. They are all issues that the industry has raised with the DfT in other forums.

1. Uncertainty is limiting commitments

A5.26 Companies are now reluctant to invest further in LSTs until there is certainty about whether the DfT is going to make LSTs generally, or at least much more widely, available for the long term.

A5.27 The tone of comments suggested that the length of the trial to date was already causing companies to hesitate about further investment and causing problems as many trailers are now reaching (or have reached) end of life or the end of their lease agreement.

2. Future Regulation

A5.28 If LSTs are to be permitted more widely, what if any special conditions or regulation would be put in place:

1) Will they continue to be 'on trial' (and whether there will be continued data submission requirements)?
2) Will the DfT impose limits on the numbers that can be owned (as % of fleet)?
3) Will the DfT introduce any regulatory requirements beyond that for standard trailers (under the 'O' licence) and if so – what will those requirements be?
4) If there are special regulations or requirements, how will they be enforced?

A5.29 Note: The views of operators in the workshop (and in earlier interviews) range from a broad acceptance that some LST specific conditions will be required to ensure safe and efficient operation, through to the view that there is no need for any additional regulation beyond that already present in the 'O' licence system.

3. Weight Limits (Gross vehicle weight [GVW] Max 44t)

A5.30 Some operators noted that they would be able to migrate more work to LSTs – reducing numbers of HGV journeys – if a special GVW uplift were applied to their operation, even if for a restricted set of journey types.

Status of industry insights document

A5.31 The document itself is presented as a stand-alone annex to give an idea of what a future guidance document might look like and in the expectation that the next step will involve some further consultation with industry stakeholders.

A5.32 Version 1 of the document was circulated to all the operators involved in the main workshop described in the text. The version presented here incorporates a small number of comments received from two large operators who participated in the original workshop, one of whom stated that they were happy with the entire annex.

Objectives

A5.33 To present an initial document summarising all the main issues that operators have actually implemented, or, from their trial experience, they believe will be important in future.

A5.34 To provide a starting point for further consultation with industry to refine the issues into an agreed document as the basis for a range of potential uses.

Further refinement of the content

A5.35 This document is not a 'finished product' – nor at this stage has the DfT determined exactly how it will be used. The purpose of this initial version is to provide the foundation of a set of issues that could potentially form the basis of any of the following as the DfT and industry deems would be most valuable and effective:

1) A guidance or good practice guide to potential LST operators – perhaps produced in conjunction with industry trade associations
2) The core of future training content for drivers and other staff in relation to LSTs
3) Awareness raising for company owners, directors and other stakeholders
4) A starting point for any policy makers, industry or government stakeholder charged with defining or executing any regulatory role in relation to LST operations

5) A source for freight sector analysts and researchers interested in the issues and parameters affecting the operation of LSTs - and potentially any other high-volume 'special designs' as part of an overall system.

A5.36 This list of potential uses appears in the preface to the document (Annex 6) so that it can act as a stand-alone document.

A5.37 **The document as it stands is presented as an output of the trial evaluation, without any presumption of how it should be used beyond publication here.**

A5.38 **What we do want to emphasise is that operators, who have hands on experience with LSTs, have told us that it is a combination of the advice and approaches described in the document that have formed the basis of their safe and efficient adoption of LSTs.**

A5.39 **We believe further industry led discussion to prioritise the items in the document, or otherwise help operators identify the most relevant issues for their context, would be beneficial both for future LST operators and any group charged with a regulatory role.**

More precise attribution

A5.40 It is not possible to attribute precisely how much each specific element of industry practice has contributed to the overall trial performance using trial statistics or data. To do such a granular attribution process would have been very difficult requiring for example:

1. A trial design with a formal counterfactual group of LSTs, operated with no special management measures and then, periods of time during which different groups of trailers were operated with different combinations of measures, to establish the contribution of individual measures. Each of these sub-groups would need to have been operated for sufficient time to generate statistically significant results on key safety measures – something that took around 4-5 years of the full trial.
   OR
2. The existing trial would have required a much deeper intervention into each operator's business, to monitor the combination of measures in place in each fleet and the rigour with which each measure was applied. The evaluation would then have required a complex differential analysis of measures and outcomes between operators to estimate the contribution of each measure. This would have been further complicated by the fact operators would develop their approach to LST management over time, so the process would be observing a moving system, not a static one. Finally, as with the first option, the trial would have needed to generate sufficient data for each sub-group of measures to generate statistically robust results for each group.

A5.41 The existing trial has (we believe) been one of the largest and most in depth live operations evaluation by the DfT, and the commitment by both the department and industry has been substantial. To have conducted the trial at an even greater depth to provide numeric attribution of the results to individual LST management measures would have been impractical.

ANNEX 6: "INTRODUCING AND MANAGING LSTS: AN INDUSTRY-LED SUMMARY OF GOOD PRACTICE"

ABOUT THIS DOCUMENT

This document provides a summary of issues that might be considered by a wide range of stakeholders in the freight and logistics sector, when deciding whether to introduce Longer Semi-trailers (LSTs) into their operation. The issues included here are drawn directly from the experience built up over the first seven years of the GB Longer Semi-trailer trial coordinated by the Department for Transport. Specifically:

- the core of the list was developed at a workshop held in November 2019 with a group of 25 representatives of companies participating in the trial
- the workshop built on an earlier series of on-site interviews with 12 companies around their overall experience of adopting LSTs.
- the process was designed using the much wider experience of speaking to operators and data provided in 'Company Information' for each company.

Prior to the LST trial, there was a list of speculative issues that would be faced by LST operators, containing many of the points listed here.

This document is not speculative or theoretical. It is a summary of what LST operators found actually worked or was necessary in real world operations. These are the issues on which companies using LSTs have either spent money and resources already or anticipate they will need to do so in future.

This document is not a 'finished product' – nor at this stage has the DfT determined exactly how it will be used. The purpose of this initial version is to provide the foundation of a set of issues which could potentially form the basis of any of the following:

- A guidance or good practice guide to potential LST operators – perhaps produced in conjunction with industry trade associations
- The core of future training for drivers, fleet managers and others in relation LSTs
- Awareness raising for company owners, directors and other stakeholders
- A starting point for any policy makers, industry or government stakeholder charged with defining or executing any regulatory role in relation to operations of LSTs
- A source for freight sector analysts and researchers interested in the issues parameters affecting the operation of LSTs - and potentially any other high-volume 'special designs' as part of an overall system.

Assumptions about context

The document presumes a context where LSTs are permitted by the Department for Transport on an unlimited basis or in very large numbers in a future scenario. However, publication of this work should not be taken as an indication of future DfT policy decisions on LSTs or, for example national road design to make roads and junctions suitable for LSTs.

STRUCTURE

The document is set out in sections designed to address the issues of different stakeholder interests in the industry.

Larger companies, may find they need to address all these issues, which may fall into multiple individual areas of responsibility.

Smaller operators – especially SMEs – will find that some issues are not applicable to their situation or are simpler to address because of the size of their operation.

A company of any size using a single LST design for a highly uniform type of work, will find it easier to address all relevant issues than a company working across diverse sectors, perhaps with several LSTs designs in their fleet.

The stakeholder areas of interest:

A) Business Decisions / ROI
B1) Training and Awareness – Drivers
B2) Training and Awareness – Other Roles
C1) Operational Processes – Routing
C2) Operational Processes – Depot Assessment
C3) Operational Processes – Warehousing / Supply Chain
D) Equipment and Maintenance
E) Depot Infrastructure
F) Specifying LSTs – Design Choices

Issues

Within each stakeholder AREA the document sets out a set of issues, detailing:

- An issue ‘name’ and a description of the issue and why it matters
- Applicability to LST steering axle types (ALL, SS or CS)
  - **ALL** indicates that the issue is broadly the same for all steering designs
  - **SS** indicates the issue only applies to Self-Steer designs
  - **CS** indicates the issue only applies to Command-Steer designs
  - **SS/CS** indicates the issues applies in different ways for the two designs
- **AS** would indicate that an issue applies to ‘Active Steer’ designs, but there are no **AS** trailers on the trial. However, issues tagged as **ALL** would apply to **AS** designs

Impacts

Issues are marked with icons to indicate the primary area of benefit or risk they influence. Some groups of issues are given a single set of icons as they apply across that whole group.

 **Safety / Damage**

 **Efficiency (journey savings) / Emissions**

 **ROI (Return on Investment)**

These impact icons are only indicative of a primary link. The three areas are closely related, and every issue affects all three areas to some degree. The journey savings being dependent on efficient use of the additional trailer length, which then delivers the emissions benefits and justifies the ROI without which the trailers will not be built.

A) BUSINESS DECISIONS and RETURN ON INVESTMENT

Benefit or Risk	Area or issue	Description	Axle type
	**Customers Demand LSTs**	Some customers (internal or external) may demand, request or expect LSTs for a job. The trailer operator, manufacturer, 3PL or fleet manager may need to advise on benefits, but also on constraints to work patterns to ensure they result in fewer trips and safe operation	**ALL**
	**Customers Averse to LSTs**	Customers (internal or external) may be hesitant about adopting LSTs if they are unsure of the potential savings or overly concerned about the potential limitations on use, additional resources required or safety implications. Major issue for smaller fleets or companies who may be less able to afford to trial the use of LSTs.	**ALL**
	**Estimating ROI**	The return on investment of adopting LSTs is a complex issue, especially if the real-world average utilisation of the additional length is not predictable (e.g. driven by variable demand or just in time supply chains with timetabled departures). ROI may be reduced if rental companies cannot supply temporary LST trailers when needed to cover peak demand or trailers being repaired, as the operator then has to hold 'spare' LSTs in the fleet.	**ALL**
	**Benefit Estimates**	The commercial benefits - required to justify the investment - depend on the % of journeys saved by using LSTs, seen in lower costs of fuel, standing costs (drivers etc) and time saved. The emissions benefits also depend on the % of journeys saved, as well as the engine technology being used to pull both the LSTs and the trailers that would be used if LSTs were not available	**ALL**
	**Benefit Sharing**	Reduced emissions provide a societal shared benefit. Outside of 'Own-Operation' fleets the cost benefits derived from LSTs may need to be shared contractually between the client and operator to justify the investment and deliver the journey savings. There is also a potential perverse incentive for reward-for-hire hauliers NOT to use LSTs if the contracts do not share the benefits with the haulier and remain a fixed payment 'per trip', since making fewer trips becomes less attractive. Benefit sharing may require a commitment to longer-term contracts for work to ensure the investment can be recovered at limited risk.	**ALL**
	**Whole Life Cost**	A full assessment of ROI involves the up-front marginal capital cost, plus any marginal maintenance costs and residual value	**ALL**

Benefit or Risk	Area or issue	Description	Axle type
	**Infrastructure costs**	A true assessment of value must take into account some portion of any of the other adjustments listed here to operations or depots	**ALL**
	**Residual Value**	Value at disposal is zero unless there is a viable second-hand LST market and adequate demand to sustain prices. Otherwise LSTs must be presumed to run until scrap value is realised, which may then lead to increased maintenance costs and lower use in later life	**ALL**
	**LST Design Decisions:** **a) Length** **b) Steering** **c) Lock at speed**	Chosen combination of length and steering drives cost and potential return and influences all other factors (routes, maintenance) (see F) a) Length can be up to 15.65m – Length choice trades off the quantity of extra cargo space vs. route and site access constraints b) Steering choice at present is **Self, Command** or **Active** Steer. c) Self-steer choice of whether to lock-at-speed or not	**ALL**
	**Operational Flexibility**	**General:** LSTs cannot be used on ALL routes, limiting flexibility **Specific Designs:** A chosen length and steering design may offer optimal savings in one contract or route but not for others.	**ALL**

EXAMPLE MANAGEMENT ACTIONS:

- Review operations and only introduce LSTs if sustainable benefits are predicted
- Develop lists of the potential savings and constraints, presentations & case studies of real operations for different types of work
- Demonstrations of site-access, adequacy of temperature control, specialist case benefits (e.g. extra spacing between cargo items, reducing risk of product damage)
- Robust whole-life costing calculation based on real world data
- Contractual terms relating to risk/benefit sharing and duration

B1) TRAINING AND AWARENESS – DRIVERS

Benefit or Risk	Area or issue	Description	Axle type
⚠	**Turning**	Steering Axle functionality – especially CS – shorter wheelbase and added length increases kick-out vs 13.6m trailers in turns on road in depots (especially docking and undocking between other trailers), potential damage	**SS/CS**
⚠	**Driving Line**	Shorter wheelbase allows tighter cut-in, reducing effect of extra kick-out at rear – varies between designs	**SS/CS**
⚠	**Lane Positioning**	Taking account of other road users, including cyclists, command of lanes, negotiating road hazards	**SS/CS**
⚠	**Length**	Extra length when changing lanes, parking, on bay, reversing	**ALL**
⚠	**Trailer Switching**	Drivers pulling mix of 13.6m and LST trailers need to change driving behaviour – especially when off trunk network – need reminder when change what they pull	**ALL**
⚠	**Weight**	When below 44T limit – trailer is heavier than 13.6m with same cargo due to chassis, steering axle and maybe extra fridge units	**SS/CS**
⚠	**Loading / Distribution**	Drivers aware that 44T overall limit still applies and the need to check axle loading, load stowage	**ALL**
⚠	**Ride Height**	Where driver can adjust ride height manually it must be re-set before driving or it can affect behaviour of some LSTs	**SS (CS)**
⚠	**Self-steer Axle Locking**	Drivers aware of (a) procedure for lock-in-reverse and (b) behaviour at speed (locked or not depending on design)	**SS**
⚠	**Route / Site Awareness**	Drivers aware of the specific route risks and issues noted in route assessment (see OPS) and of conditions they can expect at sites	**ALL**
⚠	**Route Adherence**	Drivers need to be aware of the reasons for LST route assessment and adhere to assessed route.	**ALL**
⚠	**Dynamic Risk Assessment**	Drivers need to be sufficiently aware of LST issues and risks to make appropriate dynamic risk assessments (e.g. diversions)	**ALL**
⚠	**Retaining skills**	Training only effective if drivers use LSTs regularly	**ALL**
⚠	**Trial**	If the LSTS continue to be operated under some other form of trial, drivers need to know some background to the trial, need for data collection and record keeping, relevant paperwork, agencies involved, benefits of the longer trailers	**ALL**

EXAMPLE MANAGEMENT ACTIONS:

- Driver training on specific LST design used in company on all issues:
  - Classroom, Video and On Road (Driving LST and observing following from behind)
  - Training on one specific LST design may not be a ‘universal’ qualification for all LSTs, if drivers use more than one design, move to another fleet, or are from an agency

    - Internal research by a large operator showed that it may not be duration of the training that makes the difference (they compared 2 vs 8 hrs) but the quality and content, along with tailoring the training to the complexity of the task and skill level of each driver.
- Driver training a requirement before using any specific LST design
- LST training restricted to more experienced and high performing drivers
- Process to ensure awareness of route and site assessment
- Driver reminder of LST being pulled (e.g. Specific LST identifier in Trailer IDs, job sheet flags, visual on trailers like corner pillar markings viewed in mirror, coloured headboards)
- Built in protection (e.g. Auto ride height reset)
- IT-based protection (where fitted) e.g. reminders from cab systems
- Driver rostering for regular LST use by drivers to retain skills
- Refresher training
- Driver retention programmes (embed the experience, reduce retraining)
- Promotion of qualification for LSTs as a professional developmental step for drivers
- Driver £ incentive to train for and operate LSTs? One company did this – most do not

B2) TRAINING AND AWARENESS – OTHER ROLES

Benefit or Risk	Area or issue	Description	Axle type
⚠ £ ☁	**Fleet & Driver Managers, Planners, Safety, Health and Env Lead, Sales Staff, Accounts Staff, Directors and Executives, Owners, Driver Trainers**	All levels of management – especially in larger organisations – need to be aware of the LST issues in this document as it applies to their area of responsibility. Without such awareness, they may make inappropriate decisions or issue instructions that will • reduce realisation of LST benefits, • introduce potential safety risks • reduce ROI. As companies, operators also need to consider their statutory Duty of Care to all staff in the operation of LSTs	**ALL**
⚠	**Fleet & Driver Managers**	While training is essential, many operators suggest the underlying quality and experience of the driver matters and so they only allow their most trusted and experienced drivers to operate their LSTs	**ALL**
⚠	**Fleet Managers**	Availability of LSTs for driver training	**ALL**
⚠	**Shunters**	Shunters need suitable training including LST behaviour and swept path when subjected to turning in confined spaces	**ALL**
⚠	**Loading staff**	Loading staff may need special guidance for LSTs	**ALL**

EXAMPLE MANAGEMENT ACTIONS:

- Incorporate LST element into driver training programme (appropriate to company size)
- Incorporate LST ‘qualification’ requirement into process that allocates drivers to jobs.

C1) OPERATIONAL PROCESSES – ROUTING

Benefit or Risk	Area or issue	Description	Axle type
⚠	**Road Route Assessment and Approval**	Safe operation of LSTs requires that the dimensions and swept area (when turning) must be considered along the route to consider risk posed by ingress into other lanes, interaction with pedestrians, roadside asset damage. May include variables such as presence of parked vehicles at certain times of day. May need to consider route approval for specific LST designs not just all LSTs.	**SS/CS**
⚠	**a) Desktop**	GIS, Tracking system or 'public' tools (e.g. Google Maps) or consult with LST driver who is familiar with route using non-LSTs	**SS/CS**
⚠	**b) Non-LST test**	Experienced LST driver tests route with 13.6m trailer or car	**SS/CS**
⚠	**c) LST Test**	Experienced LST driver tests route in LST (perhaps accompanied)	**SS/CS**
⚠	**Road Changes**	Reassessment required when roads and routes change over time	**SS/CS**
⚠	**Road Route Adherence**	Any measure to check whether LSTs are using the assessed route i) Planner observation ("planners know what is going on") ii) Aggregate measures e.g. total km actual vs expected iii) Exact – some telematics providers are able to provide measures of deviation from a planned route	**SS/CS**
⚠	**Diversion / Emergency Protocol**	Any measure to manage the case of diversion off assessed route: i) Un-anticipated events – incidents, emergency works ii) Anticipated events – planned period of road works	**SS/CS**
£	**Temporary Replacement Trailers**	Planning for operations when LST is not available: i) Unplanned – at time response (damage, breakdown) ii) Planned unavailability (Service, MOT etc.) NB: Leasing companies may not guarantee a replacement trailer for LSTs as until the market grows, they may not hold spare trailers	**SS/CS**

EXAMPLE MANAGEMENT ACTIONS:

- A route assessment and LST approval process, appropriate to the size of the fleet and the diversity of routes on which LSTs might be used.

- A format (paper or electronic) for communicating the assessed route and key problem areas
- Measures to ensure drivers have the route information in a format they can easily use, and understand the importance of adhering to the route (See B1)
- Possibly, measures to discourage drivers from deviating onto their personal choice of route. May involve work to understand why drivers might make such a choice.
- Planned process for diversions or emergencies that require route deviation.
- Planning process for operations where LST loads must be carried using other vehicles.
- Ensure that route assessments are updated when there are changes to the conditions on that route and periodic checks to ensure any such changes are being picked up.

C2) OPERATIONAL PROCESSES – DEPOT ASSESSMENT

This section of the document relates to the need for a suitable assessment process. Sections C3, D and E contain more detailed descriptions of factors that might need to be considered in designing or modifying a site to accommodate LSTs. The same list of factors would be relevant in assessing a site's suitability for LST operations.

Benefit or Risk	Area or issue	Description	Axle type
⚠ £	**Site or Depot Assessment and Approval**	As for Road Route assessment above, but within sites where additional assessment may need to consider much tighter turns, bay access, space to drive straight to lock SS axles before reversing and parking for LSTs. In addition, factors in sections C3, D and E could all form part of a site assessment.	**SS/CS**
£	**Pre-contract Assessment**	Where work is being contracted, the assessment of all sites involved needs to be carried out before commissioning or bidding for work to determine whether LSTs can be used.	**ALL**
⚠	**Mixing LSTs / other trailers**	When mixing LSTs and other trailers interactions need to be considered (e.g. can regular trailers turn if there is an LST on bay)	**ALL**
⚠ £	**Compliance Over Time**	Ensuring assessed conditions remain valid if depots or sites are upgraded (e.g. turning space for LSTs not reallocated to other use formally or by 'custom and practice')	**ALL**

EXAMPLE MANAGEMENT ACTIONS:

- Review of current and future requirements to likely need to accommodate specific LST designs in a given site or on a specific piece of work / contract
- Consider assessment of all sites (clients) to establish how close they are to being LST-ready – could be joint client and operator assessment of potential value of site upgrade
- Ensure that depot assessments are updated when there are changes to the conditions at that depot and periodic checks to ensure any such changes are being picked up.

C3) OPERATIONAL PROCESSES – WAREHOUSING / SUPPLY CHAIN

Benefit or Risk	Area or issue	Description	Axle type
☁ £	**Load Consolidation**	Sub-optimal loading of LSTs reduces the emissions saving benefit. Business processes and software may need re-optimising to take available LSTs into account in making consolidation decisions both for the additional load space and the issue of matching outbound and inbound loads to make best use of LSTs.	**ALL**
☁ £	**IT Systems**	IT systems managing jobs, load collation in warehouse and pallet and item tracking may need optimising or even redesigning	**ALL**
£	**Warehouse Layout**	Warehouse staging areas for consolidated loads may need to be assessed and redesigned to accommodate LST load sizes	**ALL**
£ ⚠	**Load Lock / bay Allocation**	Processes – paper or IT – that finalise a load and allocate a bay may need adjustment if LSTs only permitted at designated bays.	**ALL**
£	**Loading time**	Assumptions for loading-time needed to manage LST loads	**ALL**

EXAMPLE MANAGEMENT ACTIONS:

- Review of current and future requirements to accommodate loads for relevant LST designs
- Forward plan for LSTs in:
  - Immediate changes that can be made to systems at minimal cost
  - Medium term plans for more major changes to existing systems
  - Long term planning for future systems before commissioning
- Industry response – discussion of issues with warehousing systems and IT provide.

D) EQUIPMENT AND MAINTENANCE

Benefit or Risk	Area or issue	Description	Axle type
£ ⚠	**Facilities**	Any operator, client or service provider running maintenance and repair facilities will need to consider additional requirements for the LSTs or perhaps equipment an operator has added to LSTs that is not fitted on the rest of a fleet (e.g. tracking, cameras etc).	**ALL**
£ ⚠	**a) Space**	Will LSTs fit inside the facility and can they access the site?	**ALL**
£ ⚠	**b) Skills**	Do the technicians have the relevant training – for example, from steering axle suppliers? (Skills may be LST design specific)	**SS/CS**
£	**c) Spare Parts**	What spare parts only required for LSTs need to be held and where?	**SS/CS**
£	**d) Flexibility**	If LSTs can only be repaired and maintained at a sub-set of sites in a larger organisation – what operational constraints does this impose?	**ALL**

EXAMPLE MANAGEMENT ACTIONS:

- Review of current and future requirements for specific LST designs
- Business decision on whether to upgrade all or existing facilities to accept LSTs
- Amend existing processes, training, spares holdings, spares purchasing
- If LSTs are only to be maintained at limited sites, consider business constraints and plans for the event of an LST becoming immobilised at a non-designated site

E) DEPOT INFRASTRUCTURE

Benefit or Risk	Area or issue	Description	Axle type
£ ⚠	**LST Bays**	It may be necessary to direct LSTs to a designated group of bays: i) Which have special adjustments (list below) ii) To avoid shorter trailers having to pull out between LSTs	**ALL**
£ ⚠	**Additional Space**	LSTs may require additional space to manoeuvre on to and away from the bay, or at depot entry and exit points, or parking areas	**SS/CS**
£ ⚠	**Canopies**	May be designed around 13.6m trailers leaving exposed section of LST during loading (e.g. in rain) affecting safety and working conditions of loading teams as well as potential damage to cargo	**ALL**
£ ⚠	**Yard Markings: Vehicle**	Some yards provide turning markings for vehicles based on a 13.6m trailer. Alternative markings needed for each LST design	**SS/CS**
£ ⚠	**Yard Markings: Pedestrian**	Other safety features – notably walkway markings – may need to be painted or re-painted to accommodate LSTs of specific lengths	**ALL**
£	**Leg Landing Points**	Leg landing plates need may need to be moved or duplicated to accommodate 13.6 trailers and one or more LST length	**ALL**
⚠	**Levels and Gradients**	Significant changes in level or gradient, especially on turns, could affect behaviour of trailers or steering axles (for example, because of the increased axle spacing compared to standard triaxle trailers)	**ALL**

EXAMPLE MANAGEMENT ACTIONS:

- Review of current / future requirements to accommodate relevant LST designs
- Forward plan for LSTs in:
  - Immediate changes that can be made to facilities at minimal cost
  - Medium term plans for more major changes to existing facilities
  - Long term planning for future depots to be built, leased or purchased
- Industry response – discussion of issues with warehouse and site designers or architects and those commissioning or purchasing new developments.

F) SPECIFYING LSTs – DESIGN CHOICES

Benefit or Risk	Area or issue	Description	Axle type
⚠ £ ☁	**Which Length?**	Almost 80% of all LSTs commissioned during the trial were at or close to the maximum length permitted (15.65m) to allow the maximum potential saving in journeys. Operators choosing shorter LSTs stated it was because either: i) they already knew longer LSTs would not fit their sites OR ii) they doubted they would fill the longer option enough of the time to justify the expense OR iii) they saw the shorter LST as being easier to integrate into their existing fleet for use on a wide range of routes Some use extendable trailers, with set stops at LST lengths	**ALL**
⚠ £	**Which Steering?**	The common choice on the trial was between Self-Steer (SS) or Command-Steer (CS) and for a few companies, single vs. dual CS. Active-Steer (AS) options were available from axle manufacturers, but no operator or trailer builder chose this option during the trial. A number of factors listed below (including some conflicting perceptions) influenced the choices operators made. In addition to these issues, operators also stated that they were influenced as much by 'what my usual trailer supplier offered me' as by any formal assessment of pros and cons. *This information taken from operator 1:1 interviews in early 2019 – not from the Nov 2019 workshop. These are a mix of experience and perceptions that influenced operator design choices*	**ALL**
⚠ £	**Self (SS)**	**Pros:** Lighter than CS. Cheaper up-front cost than CS (though not always reflected directly in overall trailer cost). Smaller measured tail kick-out than CS. Perception (by some) of being simpler to run and maintain than CS. Can be locked at speed (optional) **Cons:** Must lock to reverse – requires space and does not have benefit of steering in reverse. Experience (of a few) of additional maintenance frequency as axles age	**SS**
⚠ £	**Command (CS)**	**Pros:** Added manoeuvrability when reversing. Perception (by some) of being simpler to run and maintain than SS **Cons:** Heavier than SS. More expensive up-front cost than SS (though this may not always be reflected in overall trailer price). Larger measured tail kick-out than SS. Cannot be locked at speed	**CS**

Benefit or Risk	Area or issue	Description	Axle type
⚠ £	**Active (AS)**	*Perceived* **Pros:** Better corner tracking and smaller kick-out than SS or CS. Added manoeuvrability when reversing. *Perceived* **Cons:** Significantly more expensive up-front cost than SS/CS. More complexity, leading to unknown reliability and maintenance implications. Unfamiliarity. Not offered by supplier. *This information based on interviews with operators, few of whom had any experience of active steering systems in their fleets*	**AS**

EXAMPLE MANAGEMENT ACTIONS:

- Before purchasing – review the pros and cons of each design in relation to the nature of the work anticipated for the LSTs. Consider consulting with industry peers re: their experience.
- Consider monitoring whole-life costs of chosen designs to inform future decisions.
- Industry response – consider how sector-wide experience of whole life costs and performance of different designs could be collated to inform future designs.