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Department for Transport

National Evaluation of E-scooter Trials

Technical Report

December 2022

This report takes into account the particular instructions and requirements of our client. It is not intended for and should not be relied upon by any third party and no responsibility is undertaken to any third party.

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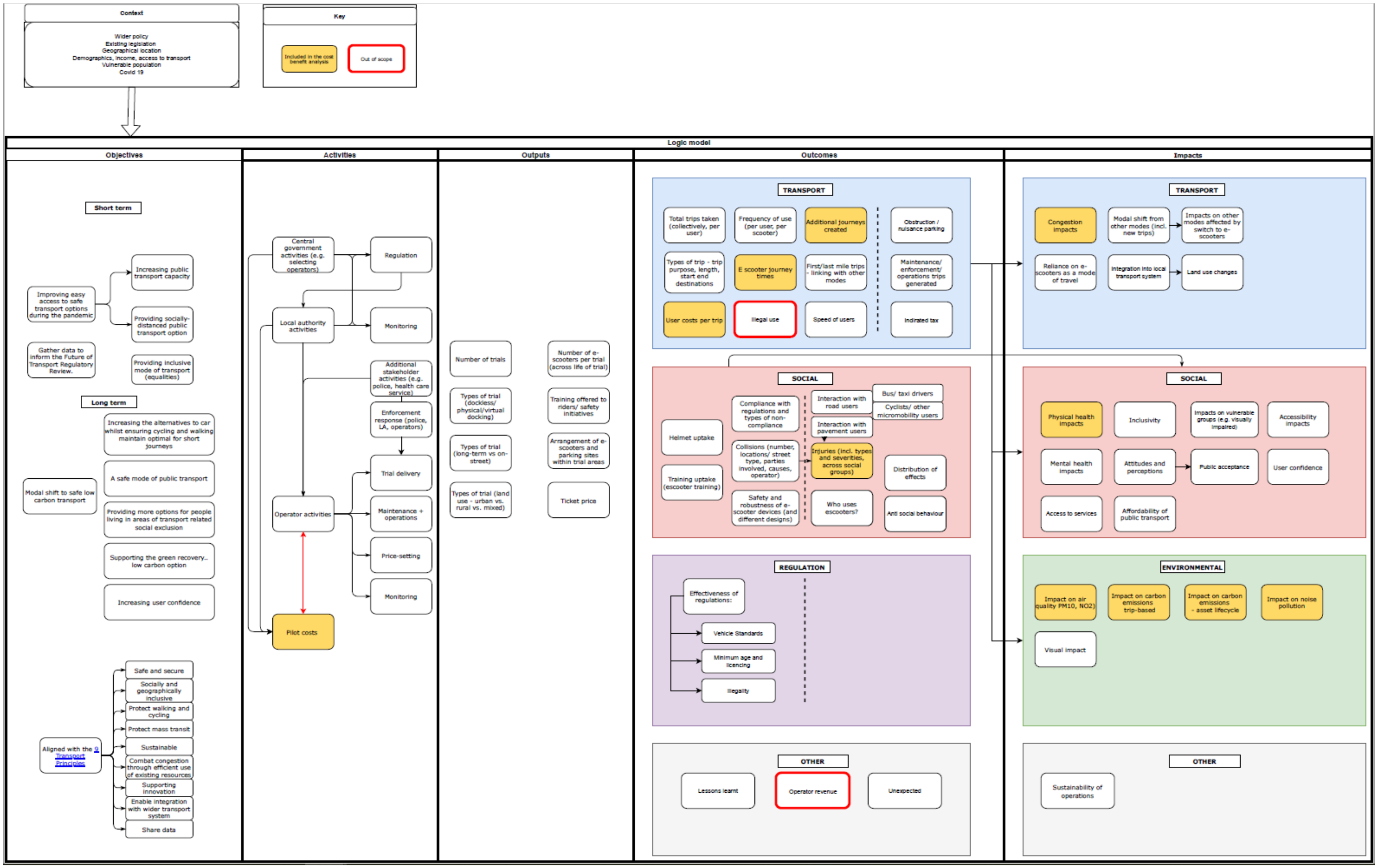
1. Theory of change and research questions

1.1 E-scooter trial logic map

The theory of change for the e-scooter trials was developed, with input from DfT, in the form of a logic model which sets out the context, objectives, activities and desired outcomes of the trials. The theory of change underpins the evaluation framework. It provides the theoretical basis for the evaluation and draws on government guidance including HM Treasury's Magenta Book and Logic mapping.

Below is the logic map developed for the evaluation, with an explanation provided below.

Figure 1: E-scooter trials logic map



1.1.1 Activities

The activities undertaken as part of the trials, and outlined in the trial logic map above, have been separated according to three main responsible parties: central government, local authorities and the trial operators. There is some overlap between each party's activities.

- Central government is responsible for the regulatory framework of the trials and for monitoring and evaluating them as the trials progress. They are also responsible for setting out the parameters of the overarching trial ecosystem.
- Local authorities are also responsible for both regulation and monitoring of trials but are focused on the trials within their constituencies.
- Operators are chosen by the local authorities and are responsible for a range of activities relating to the delivery of trials such as maintenance / operations.

The overall costs behind each trial are an additional input arising from all other activities.

1.1.2 Outputs

The outputs of the trials represent what gets delivered on the ground directly after implementation. Some of the activities, for instance the number of e-scooters per trial, are subject to change over time as trials are adapted to better suit local needs. The direct outputs arising from activities defined in the logic model include:

- The total number of trials carried out and identified for evaluation
- The number of e-scooters available in each trial
- Types of device docking across trials (dockless/ virtual docking/ physical docking)
- Rental models being offered to trial participants (long-term rental, on-street rental)
- Training offered to riders and other safety initiatives being undertaken (e.g. helmets)
- The distribution by operators of e-scooters across docking locations within trial areas, and the distribution of docking locations across trial areas
- The price of renting and riding e-scooters (ticket price).

1.1.3 Outcomes

Outcomes generally have short-to-medium term implications arising directly from the activities and outputs. They have been separated into four key categories as follows:

- Transport: Outcomes relating to trips and travel demand (e.g. number, frequency, types, speed, distance).
- Social: Outcomes relating to safety, demographic characteristics of e-scooter users and other road users, and distribution of impacts.
- Regulation: Outcomes relating to the effectiveness of regulations.
- Other: Miscellaneous or unexpected outcomes.

1.1.4 Impacts

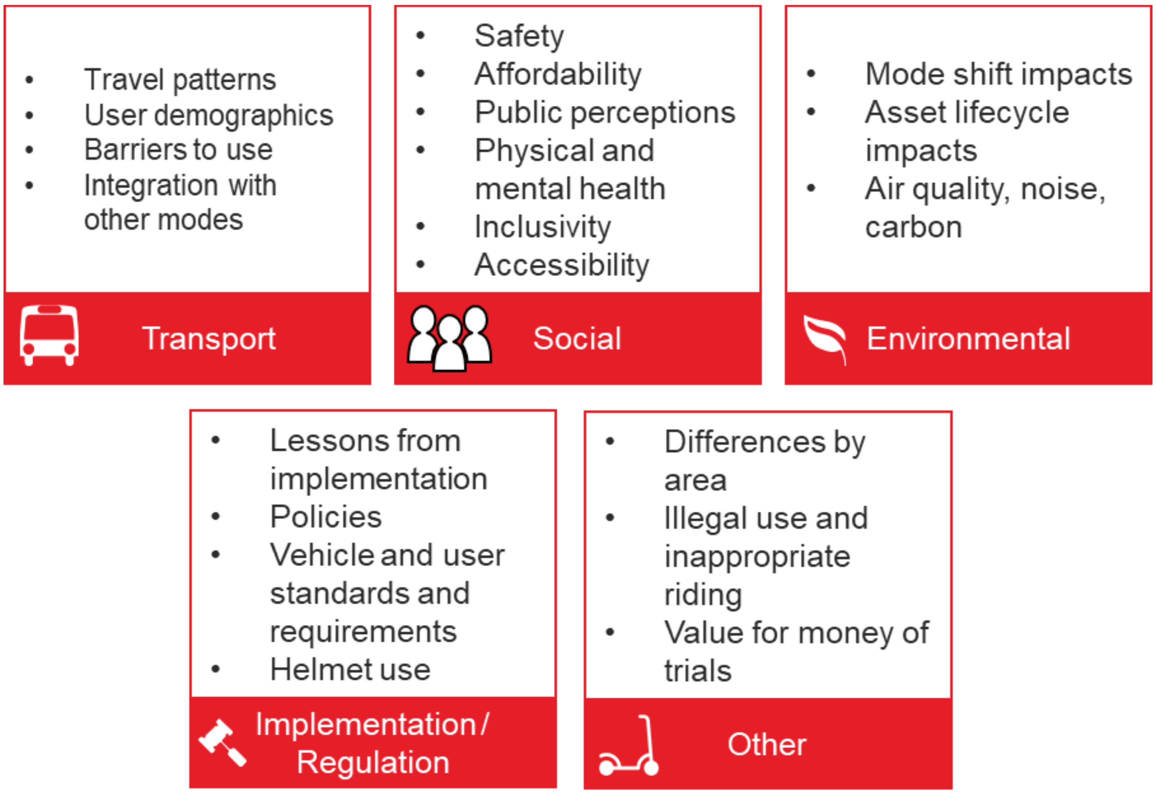
Impacts relate to longer-term implications which arise from activities, outputs and outcomes. They have also been separated into four key categories (with one variation from the outcome categories listed above):

- Transport: Long term impacts on travel behaviour and the transport network resulting from the amount and type of e-scooter uptake, including impacts on other modes, integration with the wider transport system, reliance on e-scooters and land use changes.
- Social: Long term impacts on health (both physical and mental), safety, user confidence, public perceptions, impacts on underprivileged/ vulnerable social groups, access to opportunities and the affordability and inclusivity of transport.
- Environmental: Impacts relating to the overall sustainability of e-scooters in relation to mode shift, including air quality, carbon emissions, noise pollution and visual impact. These impacts are strongly linked to transport outcomes and impacts.
- Other: Miscellaneous or unexpected impacts (e.g. long-term sustainability of operations, operator revenue).

1.2 Research questions

This section presents the full list of research questions to be addressed as part of the national evaluation of e-scooter trials. Based on this list, the evaluation team identified specific research themes to focus on (see Figure 2).

Figure 2: Key evaluation research themes



1. How safe are e-scooters? (for users and non-users)

- What is the accident / injury rate for e-scooter users per million vehicle miles (or per trip or per hour of use) compared to:
  - cycling
  - the mode that riders have shifted from?
- How do e-scooters impact on the safety of other road/pavement-users?
- How safe are e-scooters perceived to be by users and non-users? And how safe are they perceived to be compared to other modes, e.g. cycling?
- What factors are perceived or shown to contribute to safety?
- How do streetscapes affect safety or perceptions of safety?

- Do users feel they have the skills to ride safely?
- Does frequency of use enhance perceived skill and safety?
- What makes helmet use more or less likely?

2. Who is using e-scooters, how, and why? (All of these to be split by long and short-term rental, and analysed by different groups and demographics where not stated)

- What proportion of registrations/journeys are made up by different demographic groups?
- What are the barriers to use by different demographics, including vulnerable groups?
- What types of trips are being taken? (length, purpose, start-end destinations)
- How often do people use e-scooters?
- Why are e-scooters chosen? What do users state are the barriers and drivers? What affects a good or bad experience?
- How does use change over time for individuals?
- How much do covid-19 circumstances appear to be affecting use and uptake, and what does this imply about future use?
- What was the trend in take-up and use over the trial (and how can this be explained)? What do the customer journeys look like?

3. What is the impact on the transport system?

- What is the mode-shift (Including impacts on active travel)?
- How many additional journeys are estimated to have been enabled in the trial that wouldn’t have happened otherwise?
- Have any journeys enabled connections to other modes?
- What level of use/additional journeys is implied if the trial is made permanent?
- How are e-scooters integrated into the local transport system?
- How well have e-scooters been integrated into the local transport system (infrastructure)?
- Are there any other unexpected outcomes?

4. What are public perceptions of e-scooters?

- How acceptable are they to different road and pavement user groups?
- Does public acceptance increase over time with increased exposure?

- Do e-scooters create access issues for pedestrians?
- Do e-scooters create access issues for vulnerable groups (e.g. through poor parking)?
- What is the visual and practical impact of e-scooters on public space?
- What is the visual impact of e-scooters in heritage areas?
- How well have e-scooters been integrated into the local transport system (including journey planning and payment options)?

5. How do outcomes differ between areas? (Including, but not limited to, current urban design, transport infrastructure, population density, physical characteristics, (e.g. hilly), heritage areas, other socioeconomic characteristics)

- How do characteristics of areas affect outcomes?
- How, if at all, do implementation approaches affect outcomes?

6. How well are specific policy aspects working?

- Vehicle Standards:
    - Are vehicles perceived to be visible enough?
- What is user-feedback on aspects of vehicle standards?
- Do design features affect outcomes?
- Speed of users: What are perceptions of suitability of speed limits?
- Where they are used (cycle-lanes/roads/tracks/bus lanes):
    - Can we estimate journey length for cycle lanes vs road use?
    - What are the benefits/challenges of each location of use?
    - Is any illegal use on pavements occurring?
    - Is any inappropriate riding taking place? (e.g. on A roads)
    - Is there any difference in outcomes for provisional versus full license holders?
    - How does the impact of training affect use? Do different forms of training have different impacts?
    - What might influence better parking behaviour? E.g. user incentives, infrastructure (physical and digital).
- Helmet use:

    - How often and in what circumstances are helmets worn?
    - What can encourage more wearing? And what are the barriers to helmet use?

7. Illegal e-scooter use

- Are people using private e-scooters illegally during the trial and why?
- How does this group differ to the population of rental users?
- How do outcomes differ between legal and illegal use?

8. What lessons are there about implementation? This could include:

- What lessons are there from local authorities around good practice and challenges in implementation?
- What controls do LAs think are necessary to manage this scheme adequately?
- What lessons are there from operators around good practice and challenges in implementation (including lessons learned about effective deployment and geofencing)?
- What challenges have the police faced?
- What do stakeholders (including users and non-users, including vulnerable groups) suggest about improvements that could be made to the service and product?
- What communications are necessary to inform the general public about e-scooters?
- Would widespread adoption increase awareness and safety?
- What adaptations to land use and transport infrastructure are needed if e-scooters are to be accommodated optimally?

9. What are the overall costs and benefits (using Green Book methodology)?

- What is the effect on: journey time savings; new journeys; health outcomes; safety, environmental impact, inclusivity, accessibility, enforcement costs, obstruction/nuisance parking[1], and congestion.

[1] Some of these impacts were covered qualitatively as part of the overall evaluation.

2. Overview of data sources

An overview of the data that fed into this report is presented below, including which output, outcome or impact category each data source provided information on.

Table 1: Overview of evaluation data sources included in this report

	Type of data	Data included in this report	Sampling	Transport	Social	Environmental	Other (including regulation)
Monitoring data from operators (including post-ride and demographic survey)	Quantitative	Data collected up to the 31st December 2021	All 32 trials	Trip data User data	-	Mode shift data	-
Surveys with users and residents	Quantitative	User survey (Wave 1 and Wave 2) Resident survey (Wave 1 and Wave 2)	Ten trials	Trip data User data	Safety data Wider social impacts	Mode shift data	Lessons from implementation / views on regulation
Local interviews and focus groups with users, residents and stakeholders	Qualitative	2 waves of interviews including: • 105 user interviews • 109 resident interviews • 21 local stakeholder interviews • 10 focus groups (5 with users and 5 with residents)	Five trials	Trip data User data	Safety data Wider social impacts	Mode shift data	Lessons from implementation / views on regulation
Engagement with national stakeholders	Qualitative	Ten Interviews One Focus group	Organisations agreed with DfT	Travel patterns	Safety issues related to e-scooters	Environmental impacts	Future implementation
Secondary data	Quantitative	High level analysis of National Travel Survey and Census data,	n/a	Travel patterns for other modes	Safety data Illegal use	-	-

		and STATS-19 data. Published reports such as the report by PACTS.		Demographic data			
Previous studies, literature and global case studies	Qualitative and quantitative	Rapid review of literature	n/a	International evidence on travel patterns and users	International evidence on safety and wider social impacts	International evidence on environmental impacts	International lessons from implementation

More information on each data source is provided below.

2.1 Monitoring data

A key source of data for the evaluation was the monitoring data, consisting of data for all trips made across the trials collected by all operators participating in the trials. The data also included information from users collected through two different types of short surveys:

- a post-ride survey distributed via operators' apps. This survey popped up after each trip on the users' app, downloaded on to their phones. It contained, on average, two questions asking about either: alternative mode used if an e-scooter had not been available (or whether the user would have made the trip at all), perception of safety while riding or journey purpose.

- a short demographic survey hosted by DfT and distributed by operators to registered users asking about key socio-economic characteristics. All this data was combined into a database and analysed. For the purposes of complying with GDPR, user data has been anonymised.

DfT put data sharing agreements in place with the operators and procured a third party to build the technical infrastructure required to receive and store operator data.

Operators were required to provide trip-level data covering the following:

- Name of operator
- User details (non personally-identifiable[2], grouped by operator)
- User trips – since this could be personally identifiable information, this data was received at an aggregated level to ensure anonymity (i.e. instead of route waypoints and timestamps, we receive start LSOA, day of week, month of year, and duration in minutes)

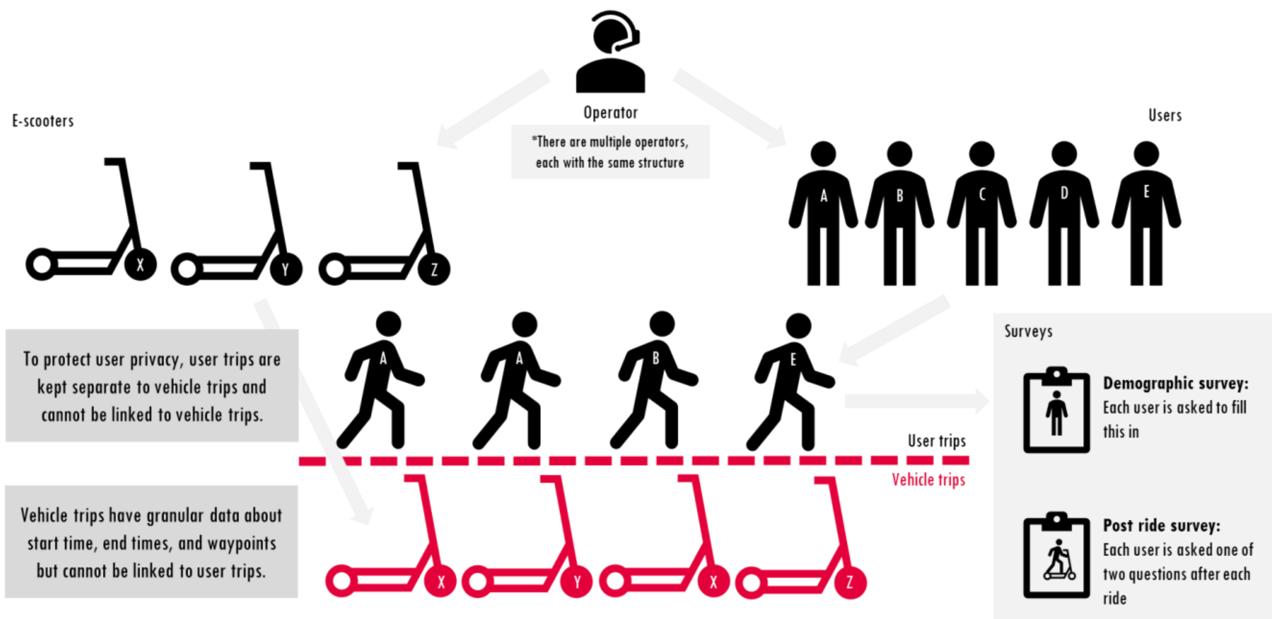
[2] Includes age bracket, gender, income, ethnicity and health conditions

- Post-ride survey response(s) for each user trip (on trip purpose, perceptions of safety and mode shift)
- Vehicle details and status grouped by operator
- Vehicle trips and waypoints (this data is not linked to an individual user)

As part of the evaluation, user demographic data was also collected through the demographic survey, which users were linked to via operators' apps.

The diagram below shows the overall structure of the data received from operators. This dataset is what is referred to as 'monitoring data'. Each operator holds a number of vehicles and has a number of users registered (those that signed up to use rental e-scooters). A user can rent a vehicle for a trip. To comply with data protection laws, user trips and vehicle trips are kept separate and cannot be linked.

Figure 3: Overview of operator data



This data was received via the DfT eScooters API (web feed) and stored in a database within DfT's Data Ingestion Environment on Google Cloud Platform (GCP). The data was then fed into the Analysis Environment (also in GCP) where Arup validated, transformed and analysed the data.

The data collected included all historic data collected by operators (including early trial data collected before the evaluation started) and was updated on a monthly basis during the evaluation.

2.2 Survey data

To complement and validate the monitoring data, the evaluation included additional surveys as part of primary research. This research consisted of surveys with both users and residents in ten out of the 32 trial areas (referred to as the 'user survey' and the 'resident survey' in the main report). The ten trials chosen for surveying users and residents were identified so that the evaluation covered a range of operators, regions, and trial sizes. This number was considered sufficient to provide robust findings at a national level representative of all trials. Out of these ten, five were selected as case study trials for in-depth interviews with users and residents.

Table 2: The ten trial areas selected for surveys and interviews, and the five areas selected for case studies

Trial area	Operator	Region	Selected for case study?
Essex	Spin	South East	Yes
Newcastle	Neuron	North East	Yes
West Midlands	Voi	West Midlands	Yes
West of England	Voi	South West	Yes
London / TfL	Lime, Tier and Dott	London	Yes
Cambridge and Peterborough	Voi	East of England	
Liverpool City Region	Voi	North West	
Milton Keynes	Spin	South East	
Northamptonshire	Voi	Midlands	
York	Tier	Yorkshire and the Humber	

The evaluation included two waves of surveys in total. The purpose of the user survey was to collect information on user demographics, motivations for using e-scooters, barriers to use, user experiences, mode shift, trip characteristics and lessons from implementation.

The purpose of the resident survey was to collect information on the impact of e-scooters on the trial areas and residents, and to establish an understanding of public perceptions of e-scooters in the areas where the trials are taking place. This included views relating to acceptability, safety, visual impact and other impacts related to the implementation of the trials.

The following table below summarises the key details for each survey.

Table 3: Data source review

Dataset	Survey description	Survey timings	Sample characteristics	Data availability		
				Understanding e-scooter user journey	Experience and integration of e-scooters	Safety
User Survey	Wave 1 online survey of new users within ten trial areas	April –May 2021 (non-London trials) August – September 2021 (London trial)	3,193 surveys completed (between 88-399 responses per trial area) with a response rate of 6% overall	The survey allows profiling of e-scooter users, profiling of journey type by reason, recentness, frequency and type. Data collection on accessing e-scooters, onward journeys and alternative modes as well as perceived value for money.	Reasons for choosing an e-scooter, impact of COVID-19, rating of last journey, barriers to use and opinion on illegal use.	Feelings of safety & helmet use, experience of training, confidence and knowledge of e-scooters, experience of collisions.
User Survey	Wave 2 online survey of new users within ten trial areas	August – October 2021 (non-London trials) October – November 2021 (London trial)	4,115 surveys completed (between 88-766 responses per trial area) with a response rate of 5% overall	Similar to the Wave 1 survey with additional questions on safety		Additional questions on the factors contributing to collisions
Resident Survey	Wave 1 online quota-based non-probability panel survey of residents	June 2021 (non-London trials) August 2021 (London trial)	1,901 surveys completed[3] between 156-1,084 responses per trial area)	Exploring awareness and experiences of e-scooters and the trials.	Reasons for and against choosing an e-scooter, barriers to use and illegal use. Understanding residents' perceptions of e-	Feelings of safety around e-scooters, experience of collisions.

[3] Response rate for resident survey cannot be calculated as a panel sample was used

	within ten trial areas				scooters including impact on local environment.	
	Wave 2 online quota-based non-probability panel survey of residents within ten trial areas	October 2021 (non-London trials) November 2021 (London trial)	1,913 surveys completed between 99-497 responses per trial area)	Similar to the Wave 1 survey with additional questions on safety		Additional questions on collisions experienced

2.3 Case study interviews

To gain additional insights and qualitative findings, the primary research programme for this evaluation also included interviews with local users, residents and stakeholders in five case study areas. A first wave of interviews with local users and residents was undertaken in four case study areas (Newcastle, Essex, WECA and West Midlands) between April and June 2021 and in a fifth case study area (London) in September 2021[4]. A second wave of interviews with users, residents and local stakeholders was undertaken in September and October 2021 for the initial four case study areas and in London in November 2021.

The second wave of user interviews included new users as well as users who had already participated in Wave 1 interviews. These interviews aimed to understand changes in riding habits and perception of e-scooters over time.

Table 4: Wave 1 user interviews sample composition

Primary criteria	Characteristics	Achieved sample
Trial area	Essex	9
	Newcastle	9
	West Midlands	9
	West of England	9
	London	9
Gender	Female	18
	Male	27
Age	16-34	25
	35-54	15
	55+	5
Ethnicity	White British	32
	Ethnic Minority	13
Income	Less than £21,000 per year	16
	More than £21,000 per year	26
	Prefer not to say	3
Frequency of use	At least once a day	7
	At least once a week	10
	At least once a month	13
	At least once a year	13
	Not answered	2
Rental type	Short term	42
	Long term	3

[4] Fieldwork for the London trial began later than other areas as the trial started later.

Parking	Docked / both	15
	Dockless	30
Training / safety	Involved in an accident on an e-scooter	6
	Uses helmet	16
	Received training on e-scooter use	20

Table 5: Wave 2 user interviews sample composition

Primary criteria	Characteristics	Achieved sample
Trial area	Essex	12
	Newcastle	12
	West Midlands	12
	West of England	12
	London	12
Gender	Female	28
	Male	32
Age	16-34	24
	35-54	27
	55+	9
Ethnicity	White British	40
	Ethnic Minority	20
Income	Less than £21,000 per year	17
	More than £21,000 per year	32
	Prefer not to say	11
Frequency of use	At least once a day	8
	At least once a week	18
	At least once a month	18
	At least once a year	16
Rental type	Short term	50
	Long term	10
Parking	Docked / both	20
	Dockless	40
Training / safety	Involved in an accident on an e-scooter	8

	Uses helmet	22
	Received training on e-scooter use	44

Table 6: Wave 1 resident interviews sample composition

Primary criteria	**Characteristics**	**Achieved sample**
Trial area	Essex	12
	Newcastle	16
	West Midlands	8
	West of England	10
	London	12
Gender	Female	28
	Male	30
Age	16-34	15
	35-54	22
	55+	21
Ethnicity	White British	47
	Asian or Asian British	4
	Black or Black British	4
	Other[5]	3
Income	Less than £21,000 per year	23
	More than £21,000 per year	35
Health condition	Mobility	6
	Hearing or vision	9
	Combination of mobility, hearing or vision issues	6
Main mode of travel	Cycling	11
	Walking	15
	Driving (cars including taxis)	18
	Driving (LGVs / HGVs / buses / coaches)	8
	Other (Public transport)	1
Experience of e-scooter interaction	Positive	15

[5] Includes any other White background; mixed or multiple ethnic groups and other

	Neutral	23
	Negative	20

Table 7: Wave 2 resident interviews sample composition

Primary criteria	Characteristics	Achieved sample
Trial area	Essex	7
	Newcastle	11
	West Midlands	15
	West of England	9
	London	9
Gender	Female	27
	Male	24
Age	16-34	13
	35-54	21
	55+	17
Ethnicity	White British	35
	Ethnic Minority	16
Income	Less than £21,000 per year	25
	More than £21,000 per year	26
Health condition	Mobility	8
	Hearing or vision	9
Main mode of travel	Cycling	8
	Walking	12
	Driving (cars including taxis)	17
	Driving (LGVs / HGVs / buses / coaches)	7
Experience of e-scooter interaction	Positive	13
	Neutral	18
	Negative	20

2.4 Local Stakeholder interviews

The primary research programme for this evaluation also included interviews with Local Stakeholders for all five case study areas. These interviews were held between October and November 2021. These aimed to get a better understanding of the situation locally, observe best practice and understand challenges unique to these trials.

Table 8: List of local stakeholders interviewed across five case study areas

Trial Area	Organisation
Essex	Essex County Council
	SPIN (Operator)
	Essex Police
Newcastle	Newcastle City Council
	Neuron (Operator)
	Northumbria Police
West Midlands	West Midlands Combined Authority
	Voi (Operator)
	West Midlands Police
West of England[6]	West of England Combined Authority
	Voi (Operator)
London[7]	Transport for London
	Metropolitan Police
	Lime (Operator)
	Dott (Operator)
	Tier (Operator)
	London Borough of Howslow (non-participating borough)
	London Borough of Richmond upon Thames (participating borough)
	London Borough of Hammersmith and Fulham (participating borough)
	London Councils (participating borough)
	City of London (participating borough)

2.5 Engagement with national stakeholders

A total of ten in-depth interviews were conducted with national stakeholders from transport campaign groups and road safety organisations, vulnerable user groups and retailers. These interviews were conducted at the start of the evaluation in February and March 2021. The same organisations were invited to workshop on the 10th of February 2022. Both the interviews and the workshop sought to explore stakeholders' views about the trials and their thoughts on future e-scooter policy and regulation. The list of organisations consulted is presented below:

[6] It was not possible to obtain a police contact for WoE.

[7] Additional local stakeholders were interviewed in London to account for the increased complexity of London governance arrangements which included 11 participating boroughs and Transport for London, who jointly managed the trial.

Table 9: List of national stakeholders interviewed

Sector	Organisation
Transport campaign groups/road safety organisations	Collaborative Mobility UK (COMO UK)
	Sustrans
	Motorcycle Action Group (MAG)
	Bicycle Association
	Royal Society for Prevention of Accidents (ROSPA)
	Campaign for Better Transport (CfBT)
	Urban Transport Group[8]
Vulnerable user groups	Disabled Persons Transport Advisory Committee (DPTAC)
	Royal National Institute of Blind People (RNIB)
	Guide Dogs
E-scooter retailers	Pure Electric
	Halfords

2.6 Secondary data

High-level analysis of secondary data has been used to provide relevant context for interpreting the findings obtained through the analysis of monitoring data and primary research. This included comparing e-scooter trip and user characteristics to other modes based on data from the National Travel Survey 2020, DfT Road Traffic Statistics (2021) and Census 2011 from the ONS.

[8] Urban Transport Group were unable to take part in an interview and instead provided the team with policy documents for analysis.

3. Approach to counterfactual analysis

Two approaches were used to estimate journey time savings and changes in distance travelled as part of the analysis of impacts across the five case study trial areas. One approach was based on the journey times and distances reported by e-scooter riders in the user survey, and a second approach was based on a counterfactual analysis undertaken using Google Directions API.

3.1 Method 1: Analysis of the User Survey results

For Method 1, journey times were sourced from the user survey. E-scooter users were asked whether they had a change in journey time by using an e-scooter in their most recent journey, compared to the alternative mode they would have used instead of an e-scooter, and if so the size of the change.

Whilst there was a mix of responses, the majority of respondents indicated that they had saved journey time by using an e-scooter and hence the weighted average time saving per trip was positive for each mode, except motorcycles and the tube (see Table 10). Intuitively it seems correct that the highest time saving was for pedestrians, since walking is usually slower than other modes of transport. There is also a relatively high time saving for rail, although this could be because it reflects a reduction to the overall journey time, including waiting for a train and walking to the station.

The results in Table 10 reflect the average across all the five case study trial areas. The average time savings from the user survey across all areas was used to compare against time savings in Method 2 for each trial area[9]. This was considered to be the most appropriate approach because it is based on a larger sample size; applying survey results for each case study area only would mean that the time saving applied for individual modes would be based on a very low number of responses in some cases.

[9] Method 2 provided enough sample to enable results to presented at case study area level.

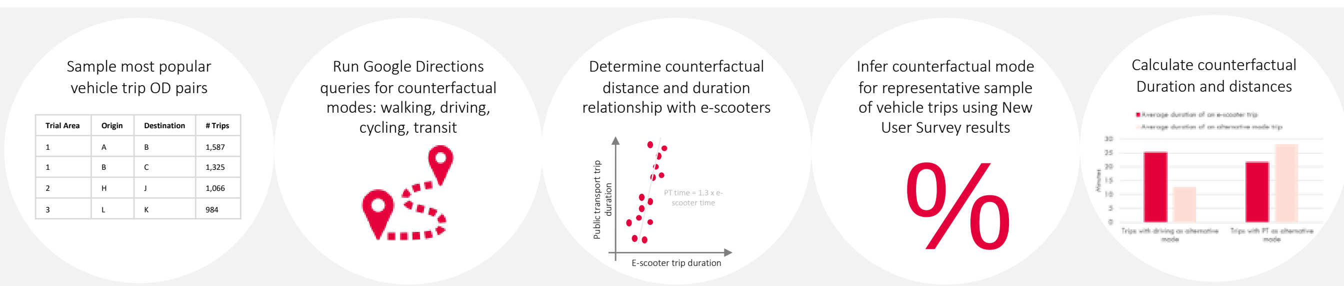
Table 10: Average time saving per trip from using e-scooter, by alternative mode

Alternative mode used	Average time saving per trip (minutes)
Car driver	3.6
Car passenger	4.0
Taxi / Minicab passenger	2.3
Rail passenger	3.3
Tube	-1.3
Pedestrian	11.1
Cyclist	2.0
Motorcyclist	-5.8
Bus	8.6

3.2 Method 2: Using Google Directions as a proxy for counterfactual mode

For Method 2, a novel, data-driven methodology (shown in Figure 4) was developed to estimate the duration and distance of an e-scooter trip for counterfactual modes: walking, driving, cycling and public transport (transit)[10]. Google Directions API was used to determine the duration and distance of popular e-scooter routes on all counterfactual modes. Combined with the mode shift findings from the user survey, the Google Directions API results were then used to predict the counterfactual mode and associated distance and duration for all e-scooter trips in each case study area.

Figure 4: Data-driven methodology for performing counterfactual analysis



Google Directions provides estimated journey times and physical distances for all transport modes for any origin-destination (O-D) pair. About 2,500 queries per case study trial were run for the purposes of this analysis. The analysis focuses on trips made up until the end of December 2021 and in the case study trial areas.

The analysis used waypoints (intermediate points along a route – rather just origin and destination), provided in the vehicle trip data by operators, to identify which route e-scooter users were following. Based on analysis of operator data using waypoints, e-scooter users often did not tend to take the most direct route.

A series of filters were implemented to isolate trips made for specific purposes and to exclude those trips made to go for 'just a ride' (viewed as less relevant for time savings). This enabled a comparison with trips reported in the user survey. Applying these filters, the following trips were excluded:

[10] Covering bus and train

- trips that start and end in the same place (roundtrips are assumed to have multiple purposes)[11]

- trips that are very short i.e. false starts (cancelled rentals) and trips that are very long (assumed to have multiple purposes)

- trips with a very low average speed (lots of stationary time and therefore likely to have multiple purposes) or very high average speed (erroneous records[12]).

The results are presented in Table 11.

Table 11: Time savings in minutes (Google API Directions analysis)

Time savings (mins)	West Mids	WoE	Newcastle	Essex	London	Weighted average
Car driver	-7.4	-6.5	-6.8	-9.1	-0.9	-6.6
Car passenger	-7.4	-6.5	-6.8	-9.1	-0.9	-6.9
Taxi / Minicab passenger	-7.4	-6.5	-6.8	-9.1	-0.9	-6.5
Rail passenger	-1.2	1.4	0.6	0.0	-3.9	-0.4
Walker	6.8	13.0	11.6	10.1	19.9	11.8
Cyclist	-0.9	-6.1	-7.6	-8.6	-6.9	-5.6
Motorcyclist	-7.4	-6.5	-6.8	-9.1	-0.9	-6.4
Bus	-1.2	1.4	0.6	0.0	-3.9	0.5

3.3 Comparison of counterfactual methods

The comparison of results based on both methods is discussed below.

Walking

Walking trips are estimated to be approximately similar in duration for both counterfactual methods, showing in both methods time savings. This is expected due to average walking speed (3-4 mph) being slower than average rental e-scooter speed (12 mph).

Public Transport (bus and rail)

E-scooter trips replacing public transport trips were estimated to result in time benefits for bus and rail travellers in the user survey but showed in some case study areas disbenefits for Method 2 (Google API). In reality, these benefits might depend on the local transport network and congestion.

Driving

On average, users reported time savings from switching from cars to e-scooters (based on Method 1), however Method 2 showed the opposite results. Both results could be plausible. On the one hand, there is a reasonable expectation that cars would offer quicker trips because cars are able to travel at much higher speeds while e-scooters are limited to a maximum speed of 15.5 mph. On the other hand, e-scooter trips could be quicker if made on cycle lanes on

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[11] An analysis of trips in case study areas found that 30% of vehicle trips start and finish in the same LSOA.

[12] These were assumed to wrong given e-scooter speed limits.

congested roads where car travel might be slow, which could explain users' perceptions (Method 1).

Cycling

Cycling trips, which are often most closely compared to e-scooter trips, were estimated to take less time than e-scooter trips using Method 2, despite users reporting small time savings in the survey (Method 1). This may be because bicycles are not limited in speed, while rental e-scooters are. In addition, rental e-scooter trips are more restricted due to geo-fencing of their operational areas, which may have impacted route choices as well as their average speed.

A similar approach was followed to estimate counterfactual distances, but differences across both approaches were minimal and therefore results are not examined here. Approach to case study impacts analysis

3.4 Calculation of car km saved

A key input into the estimation of environmental impacts of the trials included calculating the number of car km saved as a result of modal shift to e-scooters. This was estimated as follows:

- The total number of trips by e-scooter for each case study area was taken from the monitoring data up to the end of December 2021.
- The number of e-scooter trips was multiplied by the proportion of trips switching from car (driver) to e-scooter taken from the post-ride survey for each case study area.
- This was then multiplied by the average distanced travelled by car from both the user survey and Google API Directions analysis by case study area.

Table 12: Calculation of car km saved (source: user survey and Google API analysis)

	Total e-scooter trips up to Dec 2021	Proportion of trips switching from car	Car km saved	
			User survey	Google API
London	548,000	6%	75,899	151,919
West Midlands	1,108,000	8%	141,617	215,169
West of England	3,443,000	10%	795,682	1,040,614
Newcastle	404,000	4%	32,632	41,624
Essex	616,000	10%	197,721	156,140
Total	**6,119,000**		**1,243,551**	**1,605,466**

4. Casualty rates calculation

This appendix provides more detail on the calculation of indicative casualty rate for rental e-scooters.

4.1 Reported road casualties in Great Britain (STATS19)

STATS19 provides the basis for the Department for Transport's published road casualty statistics. Information on casualties involving e-scooters has been captured from 2020, relying on recording using the 'other vehicle' code and accompanying free text field. This includes both private and rental e-scooter collisions that have been reported through the STATS19 reporting system to the police[13].

As mentioned in Section 5 of the evaluation report, police-reported data on e-scooter casualties for 2021 supplied through the STATS19 reporting system was used to calculate rental e-scooter casualty rates in six trial areas. In these trials, police forces were able to record whether e-scooter casualties related to rental or private e-scooters and therefore the analysis is limited to these areas[14].

Despite limitations outlined alongside the figures included in Section 5 of the main findings report (in particular it is known that a considerable proportion of non-fatal collisions are not captured in STATS19), this presents a basis to calculate a casualty rate with some advantages including:

- Some data on both trial and private e-scooters, enabling trial casualty data to be analysed separately
- Ability to compare with other modes, particularly cyclists, using a broadly comparable source
- Relatively good detail of collision circumstances e.g. involvement of other parties

This analysis was carried out by DfT in parallel to the evaluation and relied on the reporting police officer to explicitly mention rental e-scooters in the free text field. **In six large trial areas – Northampton, WECA, Liverpool, Nottingham, Hampshire and Dorset – police forces were able to identify trial e-scooters.** A casualty rate was therefore estimated based on reported casualties, number of trips and average distance travelled per trip in these three areas. The table below shows the number of reported rental e-scooter user casualties in 2021 in these areas combined.

[13] The STATS19 database is a collection of all road traffic collisions that resulted in a personal injury and were reported to the police within 30 days of the collision.

[14] DfT (2022), Reported road casualties Great Britain: e-scooter factsheet 2021. Calculations were based on unpublished underlying data which is related to the published data.

Table 13: E-scooter user casualties in selected trial areas (Unpublished STATS19 data: 2021)

	Avon and Somerset	Merseyside	Northamptonshire	Nottingham	Dorset	Hampshire	Total
Trial	34	32	19	25	6	13	**129**
Private	22	22	9	34	14	22	**123**
Unknown	24	0	0	0	1	23	**48**
Total	80	54	28	59	21	58	**300**

As the use of e-scooters in trial areas is known (i.e. number of trips and average distance travelled), a casualty rate can be calculated. Based on combined mileage of around 11.5 million (from operator monitoring data), an indicative e-scooter casualty rate of 13 **casualties** per million miles was estimated for the e-scooter trials. In Avon and Somerset, Dorset and Hampshire, where some casualties were identified as unknown, these were apportioned pro-rata to the known records.

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