May 2021

Assessing Sustainable Transport Solutions for Rural Mobility

Executive Summary

CATAPULT
Connected Places

Executive Summary

Rural environments are often perceived as areas of low demand for travel. Whilst urban areas are thriving in trialling more connected and digital new mobility services, rural areas struggle to attract investments in this area. The AsSeTS for Rural mobility Project improved the knowledge base around demand for new mobility services, exploring alternative data sources.

The Connected Places Catapult (CPC) Assessing Sustainable Transport Solutions (AsSeTS) for Rural Mobility project, funded by the Department for Transport (DfT) under the DfT-CPC Collaborative Programme, was developed and delivered between April 2020 and March 2021.

The project aligns with the UK Government's commitment to 'Build Back Better'[1], to support growth through significant investment in infrastructure, skills and innovation, and to pursue growth that levels up every part of the UK, enabling the transition towards Net Zero. Part of this vision to 'level up' the country includes, through improved transport services, rural and semi-rural communities having access to the same opportunities and key services as urban populations.

DfT is currently exploring options for taking a Rural Strategy forward (Future of Transport: rural strategy - call for evidence[2]).

1 Build Back Better: our plan for growth available at https://www.gov.uk/government/publications/build-back-better-our-plan-for-growth
2 https://www.gov.uk/government/consultations/future-of-transport-rural-strategy-call-for-evidence

Strategic requirement for data-driven solutions

The AsSeTS for Rural Mobility project built on research already undertaken by the DfT-Future of Transport Team. This involved a series of roundtables, during which Local Authorities, Academia and Industry across the UK identified common trends and requirements.

There was consensus among stakeholders that a data landscape for a rural context could provide better information on travel habits, public transport services and also intelligence on suppressed demand, but that such data was not currently available.

Although traditional datasets are available in rural areas, these don't reflect current mobility needs and can be too aggregated to be able to inform mobility services providers. Predicting the demand for new mobility services (NMS[3]) in rural areas is critical to design and operate them commercially. The use of new data sources, such as anonymised Mobile Network Data (MND) aggregated at trip-chain[4] level, to unveil real travel patterns has never been explored before in rural areas (due to uncertainties linked to skills, costs and methods) but, given the dispersed nature of settlements and the lower connectivity, this study is required to establish if a data-driven methodology has merit and can provide the level of fidelity and confidence required by industry to launch on-demand mobility services..

Disrupting the Rural Mobility Market Place

Connected Places Catapult is committed to the exploitation of new data sources and used its expertise in Mobile Network Data (MND) analysis to generate market analysis and actionable insights which will allow mobility services operators to develop new commercial opportunities in rural areas.

The key innovation for this project consisted of applying and adapting techniques and data used in urban settings to address rural transport issues.

The method, developed for the urban demonstrator in the DeMAND project (CPC, 2020[5]), used the concept of trip-chains from Mobile Network Data to understand door-to door travel patterns of users in rural areas. This data-driven approach is still at research and development stage and was expanded for use in a rural context. The improved knowledge base around demand for NMS in rural areas will establish new evidence for mobility service operators to adapt digitally-enabled mobility services to users' needs.

Aim

The AsSeTS for Rural Mobility project identified ways to improve accessibility and transport solutions in rural environments by improving the knowledge base around demand for new mobility services.

This was achieved by:

- Exploring alternative data sources:
  - To represent demand for travel in a rural context; and
  - To use new data sources explored in above bullet to create (beyond this project) a demand model for rural mobility.
- Exploring tailored interventions to the rural areas by:
  - Establishing the relationship between population density and travel demand; and
  - Estimating the effectiveness of different NMS solutions for meeting expectations for rural transport demand.

In doing so, the project identifies and suggests ways to remove barriers which prevent NMS being commercially viable in rural areas by:

- Using data-driven approaches to understand typical daily travel patterns; and

- Identifying new mobility services which can be deployed commercially, and those that will be likely to require on-going financial support, in order to provide socially necessary services.

Data Landscape

The success of NMS is often linked to the ability of attracting the right level of demand. To do so it is necessary to understand users' needs and their travel habits to provide the most appropriate combination of NMS.

In urban areas, tools have been developed to understand the demand for travel and users' behaviour when on-demand mobility is introduced (Franco et al., 2020). However, these tools are strongly dependent on the availability of data on travel patterns (i.e. Mobile Network data, GPS data, data collected from travel diaries either through traditional paper surveys or digital applications) to inform disaggregated demand models, namely agent-based modelling, and as such a clear data-landscape needs to be available for rural areas too.

The main requirement to inform demand for mobility services is a full understanding of door-to-door movements during 24 hours, especially with an increased focus during inter-peak (10:00 - 16:00) and off peak time (from 18:00 until 07:00) when residents are more likely to use new forms of mobility solutions. Since MND are continuously collected, data can be aggregated at the preferred time period, allowing for an increased understanding of travel patterns in the mornings, early afternoons and evenings.

Three representative case study areas (Northumberland, South Somerset and Essex) were developed. These areas have different population densities and other characteristics (place structure, road infrastructure and public transport services).

3 New Mobility Services: new modes of transport linked to the sharing economy and the development of new ways to reach customers (i.e. Ride hailing, ride sharing, car share, bike share, carpooling, micro mobility, including e-scooters) using new modes of transport.
4 A series of trips connected together and defined by location and time of travel for a specific purpose and using different modes of transport
5 DeMAND Project: https://cp.catapult.org.uk/wp-content/uploads/2021/01/DeMAND-Case-Study.pdf

The anonymised and aggregated mobile network data acquired for the project represents an average day in March 2019 at higher spatial (Lower Super Output Area) and temporal granularity[6] for the three study areas to have increased understanding for travel patterns over 24 hours. MND aggregated at trip-chain level provided information on how the journeys were connected together.

MND was enhanced using software tools developed by CPC to generate activities' travel plans, which assigns journey purpose and mode of travel to each trip in the chain using land use data, locations of interest (education settings, shopping centres, business and logistics parks), time of travel and distance travelled.

- Findings from the MND analysis showed very similar travel patterns compared to urban areas in all rural case study areas.
- In two of the case study areas (Northumberland and Essex) rural forms a close bond with nearby urban areas and demonstrates a relationship of interdependency.
- Residents tend to travel more locally and mainly for leisure activities, although those that are commuting to work tend to travel for longer to reach their usual place of work.
- When they work locally, they usually have more complex travel patterns (3- 5 trips in one day) compared to urban residents (50% of journeys are made of 2 trips in a day). Because of this, rural residents have longer and flatter peak times (either in the morning or in the afternoon) and a stable demand for travel during the day that is linked to leisure activities.
- The more rural a place is, the stronger the reliance is on deliveries to counterbalance the lack of services locally. This produces an increased number of higher count trip-chains which indicates local distribution of goods, usually sourced from the urban centre (from 12 up to 28 trips in one day).
- Travel patterns and time of travel for the long distribution of goods (defined as distribution outside the study areas) appears to be the same in all three areas.

Although the three case study areas have different population densities, the travel patterns are comparable and are also similar to what is happening in urban areas. Hence, rather than defining a minimum population density mobility services should cater for short and local trips (less than two miles) and for medium-longer distance trips, which should also integrate with the wider public transport network in order to increase frequency of services.

Community Engagement

Following a stakeholder engagement workshop, organised in June 2020, to map out the needs of rural communities across the UK, CPC organised also focus groups in July 2020 to establish criteria to be considered for the questionnaire. The questionnaire was designed to collect information on people's travel habits, attitudes towards new digitally enabled services and current barriers to travel in each rural area. Moreover, a specific element of both the focus groups and the on-line questionnaire was dedicated to exploring alternative mobility solutions; such as what rural residents would like to see in their area and their attitudes towards some of the most popular NMS in urban areas, along with how to access these types of services and ways to pay for them.

6 AM peak - 07:00 to 10:00; Inter-peak 1 - 10:00 to 13:00; Inter-peak 2 - 13:00 to 16:00; PM peak - 16:00 to 19:00; Off-peak 1 - 19:00 to 22:00; Off-peak 2 - 22:00 to 07:00)

Interviews were held between the 28th August and the 20th September 2020 with a representative sample of 1,549 respondents with 450 telephone interviews.

- Findings showed that attitudes towards transport vary with age, with older respondents being more risk averse and more aware of the impact of their transport choices on the environment. Younger respondents would like to find new ways to travel but get concerned about unfamiliar journeys.
- Amongst the three study areas, those in South Somerset are much more reliant on cars, and much less likely to use public transport. Whereas those in Essex generally have good access to train stations and a wider selection of transport options available.
- For commuters and those taking business trips, the transport mode chosen appears to either depend on convenience (favouring car), speed (favouring train) or cost (favouring bus). The commute to work and school runs are the most frequently undertaken journeys. In South Somerset and Northumberland, the commute is more likely to involve driving than in Essex, where walking and taking the train are more common. During the Covid-19 lockdown, all forms of transport have shown a decline in usage. However, in future months, assuming travel restrictions and social distancing is reduced, residents expect to walk more and to take public transport less.
- Some residents consider themselves unlikely to take up new forms of transport; especially those aged 55 and older. There are a variety of reasons why people would or would not take up these new modes of transport. The biggest barrier is preference for driving.
- However, when residents were asked about some innovative mobility solutions that could be implemented in the study areas, they showed higher interest in micro-mobility (either e-scooter and e-bikes), Demand Responsive Transport and delivery drones.

Business models for New Mobility Services in rural areas

As the data landscape revealed, mobility services should provide transport for short, medium and long distance trips. Each of the alternative mobility solutions chosen by residents during the on-line surveys could fit the requirements of all study areas, either in isolation or by combining them together.

However, for the purpose of the AsSeTS for Rural Mobility project, three towns in each area were selected to develop the calculations for the business models assigning each new mobility service (NMS) to one area only:

- Micro-mobility to Essex County Council (case study for Urban with Significant Rural);
- Demand Responsive Transport to South Somerset (case study for Largely Rural areas);
- Delivery drones to Northumberland (case study for Mainly Rural areas).

Data input for the analysis was provided by a literature review on current trials deployed around the world and from individual sessions with mobility providers operating in the UK.

A workshop organised in February 2021 by CPC provided a good overview of current business practices thanks to the participation of Local Authorities and mobility service operators, currently deploying Demand Responsive Transport (DRT), micro-mobility and delivery drones in the UK.

Following the workshop, CPC developed value propositions and business modelling analysis for the three mobility services and identified measures to adapt NMS to a rural context. When considering the deployment of a micro-mobility service in a rural location, assessing the location characteristics, and therefore the suitability for a **micro-mobility** operation, are key. For example, the use of a parking bay (rather than free floating model), and placing the bays around points of interest are key features for micro-mobility in rural areas. Moreover, engagement with the local community, both riders and non-riders, is important to the success of the service. This includes taking action to mitigate any concerns that members of the community might have.

A "hub and spoke" model for **Demand Responsive Transport**, allows operators to plan and timetable routes to be most effective and, with a semi-structured route, appears to be most likely to be commercially viable in rural areas. Having a few routes that are commercially viable could help to subsidise other routes. In addition, liaising with the local community and supporting event driven occasions is a positive way to promote the service and increase usage and trust in the service itself. This could also provide additional income to support the core DRT service.

In rural locations a single **Drone as a Service** operation serving many retailers, may become more cost effective than each retailer having a fleet of drivers or using traditional delivery services. When considering the deployment for a Drone as a Service model, there are three key elements to consider: the location of the drone hub in relation to the retailer base; the engagement with the retailer base; the engagement with the Local Authority, community, and relevant authorities.

Benefits of the Data-driven approach to Rural Mobility

The benefits of the adoption of a data-driven approach for the introduction of on-demand mobility in rural areas are to derive recent, at scale and comprehensive information on residents' travel patterns and habits. The MND at trip-chain level enables quick access to a large user base, which in turn emphasises the link between places and existing connections between the urban periphery and rural areas.

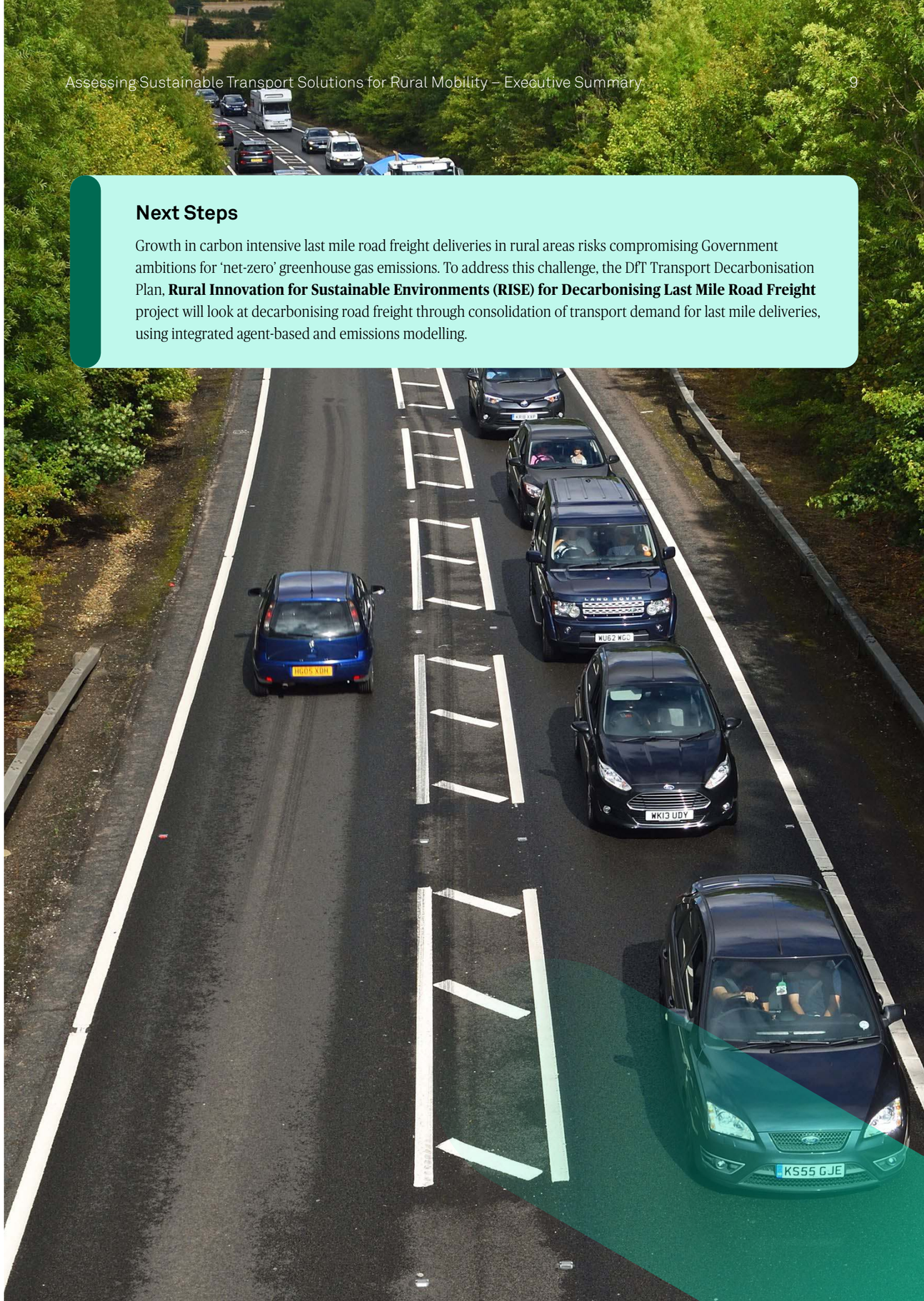
This data-driven approach will allow Local Authorities to plan flexible mobility services tailored to residents' travel needs, including when periods of uncertainties linked to Covid-19 lockdowns occur.

The transferability of the AsSeTS data-driven approach to other rural areas supports the introduction of new mobility services for people and goods and creates added value for councils and mobility providers.

Local Authorities could plan for integrated Rural Mobility services, quantifying the integration between on-demand mobility and public transport, and they can also embed the use of data for monitoring and evaluation of these services, whilst Mobility providers can exploit a new perspective in identifying latent demand for on-demand mobility and can assess their business models and value proposition against rural communities' travel habits.

During the AsSeTS for Rural Mobility project, CPC established the transferability of tools and models developed for urban areas to rural ones. This will ensure developing a holistic approach to rural mobility provision and the exploitation of agent-based and activity-based modelling for rural areas, paving the way to an integrated strategic national transport model where demand for travel arises from individual behaviours. The outputs from this project will feed into the DfT's forthcoming Future of Transport: Rural Strategy.

Furthermore, during the AsSeTS for Rural Mobility project, mobile network data analysis confirmed a rapid growth in carbon intensive last mile road freight deliveries in rural areas across the three study areas.



Next Steps

Growth in carbon intensive last mile road freight deliveries in rural areas risks compromising Government ambitions for 'net-zero' greenhouse gas emissions. To address this challenge, the DfT Transport Decarbonisation Plan, **Rural Innovation for Sustainable Environments (RISE) for Decarbonising Last Mile Road Freight** project will look at decarbonising road freight through consolidation of transport demand for last mile deliveries, using integrated agent-based and emissions modelling.

Glossary

New Mobility Services: new modes of transport linked to the sharing economy and the development of new ways to reach customers (i.e. Ride hailing, ride sharing, car share, bike share, carpooling, micro mobility, including e-scooters) using new modes of transport.

Demand Responsive Transport: is a shared mode of transportation that adapts to the demands of its user groups, often accessible via a digital platform or mobile app.

In the Community survey, DRT was described to residents as on demand transport: when you can use cars, buses or minibuses when you need to and share the lift with other people who are travelling in the same direction. It does not run on a timetable like traditional public transport. It does not have a fixed route and can be either door-to-door or corner-to-corner (when the DRT pick up is a short walk from the house).

Micro-Mobility: Refers to a range of small, lightweight devices operating at speeds below 25 Km/h (15mph) and normally is used for trips up to 10Km. Micro-mobility can be human-powered or electric, privately owned or shared. Examples include scooters, bicycles, skateboards, cargo bikes, rickshaws).

E-bike: Electric bikes that use a small motor to make cycling less strenuous although the cyclist still pedals but the journey is easier. Bikes are available to pick up from convenient locations.

E-Scooters: Electric kick scooters have grown in popularity with the introduction of scooter-sharing systems that use apps allowing users to rent the scooters by the minute. The e-scooter has generally a large deck in the centre on which the rider stands.

Delivery drone: an autonomous vehicle (often an unmanned aerial vehicle), used to transport packages, food, medicines or other goods in remote locations.

Agent Based Modelling (ABM): creates a synthetic population of agents to understand complexities in human behaviour. Agents are entities with their own behaviour, preferences and activities to fulfil. When it comes to model mobility, agents can be either the user of the service (static agent since their plan consist of a sequence of trips or activities) or vehicles (dynamic agents with no prior predefined activities). Activity Based Modelling is a specific ABM where agents have activity chains to fulfil.

Synthetic Population: Designed to resemble a real-world population with respect to sociodemographic characteristics and spatial information. In agent-based modelling, each agent in the population is associated also with daily activity plans.

Spatial Granularity depends on conventional zoning system adopted by the Office for National Statistics:

- *Output Areas (OAs)* - the smallest geography for which 2011 Census data are available, with an average resident population of approximately 300 people;
- *Lower Super Output Areas (LSOAs)* - groups of OAs, with an average resident population of approximately 1,600 people;
- *Middle Super Output Areas (MSOAs)* - groups of LSOAs, with an average resident population of approximately 7,800 people;
- *Wards* - administrative boundaries at 2011 Census, with an average resident population of 6,500, it is also available for higher level geographies such as Local Authority Districts.

Mobile Network Data: Mobile phones generate "events" as they communicate with the national cell network (made up of Local Area Cells, or LCAs). These events are collected on an anonymised basis for analysis and are aggregated at a suitable spatial granularity (LSOA, MSOA, LA district). Each event is linked to a persistent yet anonymised user ID, a timestamp and the cell ID of the cell that recorded the event.

Commercially available Mobile Network Data are normally provided at MSOA level, which is not granular enough to capture the complex travel patterns that might derive from residents. LSOA level is the smallest granularity that can be used with anonymised and aggregated MND to comply with data protection (GDPR) regulations.

Trip: a one-way course of travel with a single main purpose (National Travel Survey).

Tour: a round trip, from an origin to a destination and back to the origin.

Trip-chains: a series of one or more "links", carried out by the same person for different purposes, within a given time period, regardless of the length of pauses between trips (National Travel Survey).

Trip-chain MND dataset: retains information on the full door-to-door journeys during 24 hours. Patterns indicate how many users in the network have that specific combination of trips. All intermediate trips indicate where and when the trip occurred for an aggregated number of users. However, no purpose and mode of travel is available since trip-chains are aggregated directly from the events captured from the Local Area Cells (LACs).

Contents

1 Rural Mobility needs across communities in the UK

This first phase of the study provided insights from a workshop organised by CPC and held on the 18th June 2020. The workshop was designed to collect thoughts from stakeholders actively involved in solving problems related to rural accessibility/mobility/isolation/technologies and platforms that could be adapted to a rural context.

The workshop focused on the needs of rural communities, their perceived barriers to the uptake of on-demand mobility services and their vision for an ideal on-demand service in rural areas.

Scope

Due to restrictions on travelling during the COVID-19 pandemic, the workshop was organised on-line. Forty one participants from 14 areas across the UK joined the debate (including areas such as Buckinghamshire, Cumbria, Essex, Hertfordshire, Leeds, London, Manchester, Northamptonshire, Northumberland, Peak District, Somerset, and participants joining from Scotland and Wales). Break-out rooms with 8/9 participants, chaired by CPC project team members, were organised following a plenary session, to allow them to engage in the debate more actively.

Participants were from a wide range of backgrounds, including academia, local or transport authorities and industry actively deploying trials for New Mobility Services[7] (NMS) or technologies in support of these trials. The workshop focused on:

- Needs of the rural users and perceived barriers to the uptake of on-demand mobility services;
- What the ideal on-demand service looks like in rural areas in order to serve the residents, including the needs of those that are commuting into nearby urban areas to reach jobs and services.

Moreover, the debate concentrated on the importance of data and how data is currently used in supporting the launch and delivery of these services.

7 New Mobility Services are defined as new modes of transport linked to the sharing economy and the development of new ways to reach customers (Ride hailing, ride sharing, car share, bike share, carpooling, micro mobility, including e-scooters) using new modes of transport. New mobility services cover a variety of services typically technology driven and based on shared access to include ride hailing, ride sharing, car share, demand responsive transport, micro-mobility, bike sharing and carpooling. These services have a massive growth in urban areas in recent year without any multimodal integration with fixed scheduled public transport services (Franco, 2020)

Two case studies were presented on Northumberland and County Durham to show how well new data sources, such as Mobile Network data aggregated at trip-chain level, perform in rural contexts. The data analysis was developed using the tools created for the DeMAND project (CPC, 2020) and analysing travel patterns from the digital twin created for the North East of England.

Findings

Participants highlighted the existence of different definitions of rural areas across the country, which are then combined with different users' needs and travel behaviours. It was noted that mobility services tailored around the rural user would require a connection with local users to personalise services. This implies a lot of prior work (e.g. effort, time and money) to test viability and make it attractive for use.

Based on knowledge from previous projects conducted by CPC, the data-driven approach which uses mobile network data is considered very useful to reveal current travel patterns and for testing alternatives.

During the workshop the main perceived barriers to the uptake of on-demand mobility services were identified as:

- Lack of suitable public transport services;
- Lack of integration as a crucial point in the provision of mobility;
- Lack of reliability at interchanges and of flexibility in providing suitable alternatives.

The rise of Digital Demand Responsive Transit (DDRT) has made this flexible service rapidly available in urban areas, but many rural areas are facing digital poverty and technological barriers in booking trips of this type.

During the workshop, the idea of mobility hubs as an access point to transport and services was mentioned as a possible solution. However, funding available at the moment is too short-term to sustain the creation/ transformation of mobility hubs and there will not be enough revenue (initially) to operate without creating a burden on already over stretched Local Authority budgets. A new generation of mobility hubs should create the support required to access a wide range of new mobility services (e.g. car clubs, active travel solutions such as e-scooters and e-bike-sharing to allow rural users (especially older residents)) to tailor transport choices to their needs, but also to boost confidence in the digitalisation of services.

Real-time, app-based bookings are considered important: however, in rural areas these are limited by poor connectivity and signal coverage, whilst phone booking seems more suitable for older generations. Similarly, logistics should also be included, so that moving people and goods will establish and validate new business models.

Although the workshop was not designed to consider the transformations and impact on travel habits during the COVID-19 lockdown and the transition towards a "new normal", participants talked about the conditions and limitations experienced in rural areas. It was felt that the lockdown acted also as a catalyst to boost digital connectivity and use technologies to ease isolation and pay for services, either by phone, web or mobile apps. The shift was rapid, and people drastically changed their behaviours, being more open to new ways of fulfilling their needs.

People felt that the lockdown provided the opportunity to innovate and created a transition towards a healthier lifestyle with the discovery for high quality and local produce and a renewed appetite for active travel in communities with high car ownership. However, there is a risk that rural areas will revert to pre-lockdown travel behaviours as restrictions are lifted. Hence it is imperative to implement initiatives designed to support changes in travel patterns and introduce innovations in the way rural residents travel.

In conclusion, a holistic approach is required to look at rural mobility beyond administrative boundaries, where data-driven solutions look at residents' door-to-door travel patterns and support full integration with more traditional scheduled public transport.

1.1 Data-driven approach to support NMS

During the stakeholder engagement workshop organised for the "Assessing Sustainable Transport Solutions (AsSeTS) for Rural Mobility" project, participants joined an on-line webinar to discuss the needs of rural communities and barriers to the uptake of new mobility services in rural areas.

Two case studies were presented for County Durham and Northumberland. Data analysis using the synthetic population for the North East of England, developed under the DeMAND project, showed similar travel patterns compared to urban areas. However, as also confirmed by the National Travel Survey, people living in rural areas travel more, and for longer, to reach jobs and services. Public transport is generally inappropriate and/or inadequate to satisfy their mobility needs, so rural users rely much more on the use of private car (33% more car trips/person than national average and 66% more miles travelled per person than urban cities and towns).

Stakeholders perceived that there was very little scope for rural users to change their travel behaviour and it would be hard for any new mobility services to be introduced without the necessary support. It was felt that DRT and other on-demand services cannot compete with cars, but a more socially inclusive mobility offer can kickstart a virtuous circle and serve the unmet needs of different segments of rural communities that do not have access to a car.

Different segments of the population come with different drivers when choosing a mode of transport. In order to maintain social inclusion (e.g. young adults fully reliant on parents or elderly with no car available) and support an ever-increasing aging population, the integration between public transport and new mobility services is welcome as a step change in rural communities.

This vision integrates existing public transport services with flexible door-to-door services, which can be delivered through different modes and schemes.

The pivotal change to allow rural users to access a new range of modes is the re-establishment / creation of mobility hubs that will provide a range of services for people (e.g. e-bikes, e-scooters, DRT, car clubs) and goods (lockers and consolidation centres for door-to-door deliveries).

However, hubs should be personalised and tailored on the community needs, rather than be a standard offering across the very different rural areas.

1.1.1 Perceived Barriers

Among the main barriers in remote locations, digital connectivity and mobile signal strength can be an issue in booking DRTs and on demand services. There is also an issue of digital poverty and lack of expertise to use on-line web or mobile app booking systems and would require assistance.

Rural communities have seen very little change in their travel behaviour in the last decade, both from a lack of investment in public transport and the high flexibility offered by high car ownership. Much of the shift in demand for travel is due to other drivers such as a healthier and greener lifestyle far from urban areas and the limitations linked to an aging population.

A holistic approach is required to remove targets linked to administrative boundaries, supported by a data-driven approach linked to travel patterns rather than disconnected trips. New data sources can support the setup of new mobility services and monitor potential changes in rural mobility due to the introduction of on demand mobility.

1.1.2 Latent Demand

Insights derived from mobile network data analysis and qualitative surveys to identify latent demand can provide a holistic view to support Local Authorities in the use of new data sources. This will provide evidence on changes of transport choices and travel patterns and increase the level of confidence in the use of new data source to better understand rural mobility.

The current pandemic-related crisis has introduced a level of uncertainty in the way residents travel. However, it can be seen also as an opportunity to capitalise on the rapid changes in travel behaviour and habits which happened during lockdown.

There is a risk that rural areas will revert to pre-lockdown travel behaviours as the restrictions are lifted. Hence it is imperative to implement initiatives designed to support changes in travel patterns and introduce innovations in the way rural citizens travel. The introduction of an integrated offer of mobility services calibrated on users' needs can be rolled-out through targeted pilots and the establishment of mobility hubs that would sustain the changes over time.

1.1.3 Impact of COVID-19 lockdown in rural areas

Although the workshop was not designed to consider the transformations and impact on travel habits during the COVID-19 lockdown and the transition towards a "new normal", participants talked also about the conditions and limitations experienced in rural areas.

Rural mobility provides access to jobs and services and, in many cases, there is a close bond with nearby urban areas. Commuting for work was no longer possible, so the time released for this activity has been use differently, travelling more locally and reconnecting with the place of residence.

Community spirit

During the COVID-19 lockdown rural areas have rediscovered their own individuality and independence, with local producers and organisations stepping up in volunteering and providing services to all local communities.

Hubs naturally formed from existing facilities to organise door-to-door deliveries (e.g. food, prescriptions) and to provide services to isolated residents, but also checking on them and on their mental health. For example, Northumberland National Park acted as a hub in Northumberland with volunteers collecting orders and delivering food and other necessities.

DRT and Active Travel

A reduced public transport service provided connectivity for key workers with adaptations put in place to prevent the spread of the virus. However, there was a general feeling that usage and patronage will go down as a consequence of the pandemic lockdown.

Instead, people rediscovered healthier lifestyles, walking and cycling in the local area without the need to drive. Also, local demand for travel and high-quality produce increased. On demand mobility services thrived during this period thanks to their ability to flex routes and serve the demand dynamically.

Social media and digital technologies

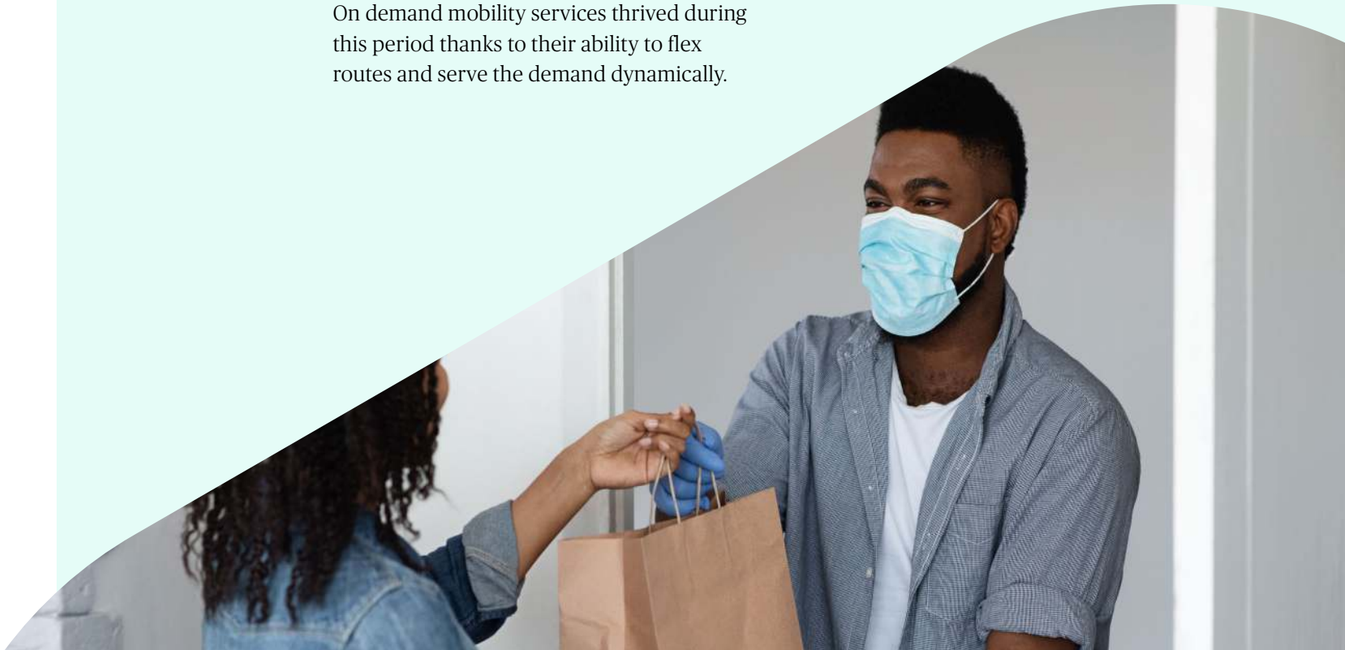
The lockdown acted as a catalyst to boost digital connectivity and use technologies to ease isolation and pay for services, either by phone, web or mobile apps. The shift was rapid, and people drastically changed their behaviours, being more open to a new way of fulfilling their needs.

Rapid shift in habits

Participants also queried if this rapid shift in habits will revert back to normal once the pandemic will be over.

In order to manage risks during the pandemic, new designs and practices were adopted to make public transport and DRT safe to use. Generally speaking, travelling in a minibus and sharing a vehicle with fewer people felt a safer and more convenient option compared to mass transit, which would need to change and adapt to new requirements.

Generally, people felt that the lockdown provided the opportunity to innovate and create a transition towards a healthier lifestyle, with the discovery of high quality and local produce and a renewed appetite for active travel in communities with high car ownership.



2 Defining Rural

For this project CPC adopted the Office for National Statistics Rural Urban Classification, developed by DEFRA (2017), based on populations and settlement type (density profile of dwellings in each 100 m × 100 m square in the country).

The classification defines areas as "Rural" if they fall outside settlements with more than 10,000 resident population. The Rural-Urban classification uses data from 2011 Census Output areas[8] to derive statistics.

Where data are not available, the classification can be also based on Local Authorities, divided into six categories based on the percentage of the total resident population (***Figure 1.2***).

Figure: 2.1: Rural Urban classification at Output areas (DEFRA, 2017)

8 the smallest geography for which Census 2011 data are available (average resident population of approximately 300 people).

Other urban-rural classifications mentioned during the workshop by participants were the Scottish government's Urban Rural Classification (2016) and the OECD classification.

The Scottish Government Urban Rural Classification uses population thresholds (125,000 for urban areas, 10,000 for small towns and 3,000 for rural areas) to define settlements and accessibility (drive time to the nearest urban area). This is available in six and eight categories. The latter further distinguishes rural areas into remote (areas that have a drive time between 30 and 60 minutes from a settlement with a population of 10,000 or more) and very remote areas (areas that are more than a 60 minute drive time from a settlement with a population of 10,000 or more).

Both the DEFRA and the Scottish Urban Rural classification systems then consider the number of residents and population density for the settlements with accessibility to urban areas as a further factor to distinguish rural areas.

The urban/rural interaction is further developed in the OECD Rural 3.0 people centre approach which uses three dimensions (objectives, type of rural and stakeholders) and a continuous view of territories. Rural is everywhere and interacts with urban in a bi-directional relationship that often crosses traditional administrative boundaries.

For the purpose of the AsSeTS for Rural Mobility project, the DEFRA classification at Local Authority district level is enhanced by looking at data which also measures accessibility. This considers both the physical networks (road and rail) and the digital connectivity. Public transport provision with its frequency and coverage of services is also used to measure *"how rural"* a place is.

2.1 Selection of study areas

Rural environments are often classified using population density without considering any other factors that could impact the travel choice of residents.

We demonstrated during the preliminary analysis, developed at village level, that residents travel to nearby villages and urban areas, hence the data landscape needs to focus on a larger area to understand the full extent of the travel dynamics.

For the purpose of the project, three case studies were selected as a comprehensive representation of the current challenges for rural settings.

We referred to the map at Local Authority Districts level (***Figure 2.2***), to identify three areas that cover the Predominantly Rural categories.

Rural-urban category	Resident population	Percentage
Predominantly rural	**11,058,000**	**20.9**
Mainly rural	4,723,000	8.9
Largely rural	6,335,000	11.9
Urban with significant rural	**6,898,000**	**13.0**
Predominantly urban	**35,057,000**	**66.1**
Urban with city and town	14,078,000	26.6
Urban with minor conurbation	2,107,000	4.0
Urban with major conurbation	18,872,000	35.6
Total England	**53,013,000**	**100.0**

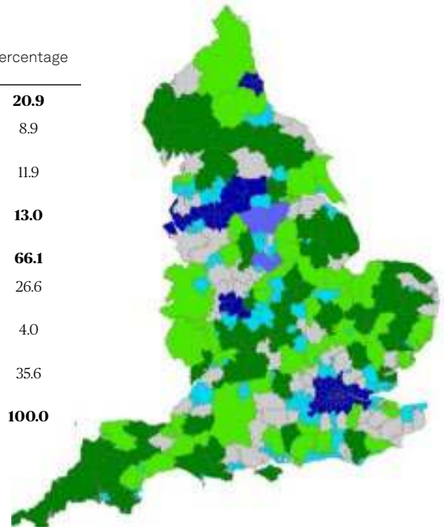


Figure 2.2: Rural Urban Classification at Local Authority district level (2011 Census Data)

The identified criteria used to select the study areas consider the population density, the structure of the places, the transport infrastructure available and the public transport services currently active, but also other factors aligned with the levelling up agenda:

1. **Population criteria**;
2. **Settlements distribution**: a variety of rural settlements (Market town, rural town, village, dispersed), to guarantee transferability to other geographies;
3. **Public Transport Ecosystem**: either fully developed or inadequate to satisfy residents' needs. The study looked at a possible integration with fixed-scheduled services to understand how community-based services would fit in the mobility landscape;
4. **Levelling-up**: Often perceived as areas of low demand for travel, the settlement is unable to attract funding for lack of vision or contribution of supporting organisations able to drive change and offering extra skills.

Based on these criteria and data examined, recommendations for the three case studies for AsSeTS for Rural Mobility were made for:

- Northumberland for Mainly Rural (8% of UK population) ;
- South Somerset for Largely Rural (11% of UK population); and
- Essex County Council for Urban with Significant Rural (13% of UK population).

Table 1: Case study areas characteristics (source Census 2011)

Characteristics	Northumberland	South Somerset Largely Rural	Essex Urban with Significant Rural
Population (2019)	322,000 (2019)	167,216 (2017)	1,470,000 (2018)
Young residents	16%	20%	19%
Working Age Population	59%	56%	61%
65% Population	25%	24%	21%
Zoning System at LSOA Level	534	103	1222

3 Rural Communities Engagement

Following the selection of three representative use cases (Northumberland, South Somerset and Essex), focus groups and on-line surveys provided insights on people travel habits and latent demand for travel.

CPC organised focus groups in July 2020 to establish criteria to be considered for the questionnaire. This provided information on people's travel habits and current barriers to travel in each rural area. Moreover, a specific section of both focus groups and on-line survey was dedicated to New Mobility Services (NMS) that they would like active in their area and their attitudes towards some of the most popular NMS in urban areas.

Activities to capture rural communities' attitudes towards alternative transport solutions included:

- Focus Groups with residents: two online groups were conducted in July 2020 for each area, with an average of five people per group;
- On-line surveys of residents between the 28th August and the 20th September 2020 with a representative sample of 1,549 respondents and an average of 500 respondents in each of the three locations with a sample representative by age and gender profiles;
- Additional 450 telephone interviews with 'hard to reach' groups (not picked up sufficiently during the online survey such as young residents or mature adults).

3.1 Findings

The findings highlighted that amongst the three regions, those in South Somerset are much more reliant on cars, and much less likely to use public transport. Whereas, those in Essex generally have good access to train stations and a wider selection of transport options available.

For commuters and those taking business trips, the chosen transport mode appears to either depend on convenience (favouring car), speed (favouring train) or cost (favouring bus).

The commute to work and school runs are the most frequently undertaken journeys. In South Somerset and Northumberland, the commute is more likely to involve driving than in Essex, where walking and taking the train are more common.

Attitudes towards transport vary with age, with older respondents being more risk averse and more aware of the impact of their transport choices on the environment. Younger respondents would like to find new ways to do things but worry about unfamiliar journeys.

Covid-19 Lockdown

Before lockdown, car and walking were the most frequent forms of transport taken to reach destinations. During lockdown, all forms of transport have shown a decline in usage. However, in future months, assuming no restrictions, residents expect to walk more and to take public transport less.

Attitudes towards New Mobility Services

Residents consider themselves unlikely to take up new forms of transport; especially those aged 55 and older. There are a variety of motivators to take up new mobility services such as being environmentally friendly, healthier and more flexible; however, the biggest barrier is preference for driving, which would need to be overcome when pursuing new methods.

However, there is evidence that an alternative service to the traditional scheduled bus service would have potential to be successful if it were: frequent; predictable and accurate for arrival times; easy to access; safe, especially in light of the pandemic; ticketless and cashless; bookable online and by phone; joined up with other transport services; serving desirable destinations.

Any new solutions would need a local focus - residents were keen on community led projects and services that could boost community spirit such as involving volunteers or using local stakeholders to run services. Given the reliance on the car for many communities, particularly in South Somerset, new services would perhaps be best employed where clear and popular benefits such as to the environment, ease of booking and payment, good value (e.g. compared to parking charges) and allowing flexibility could be emphasised.

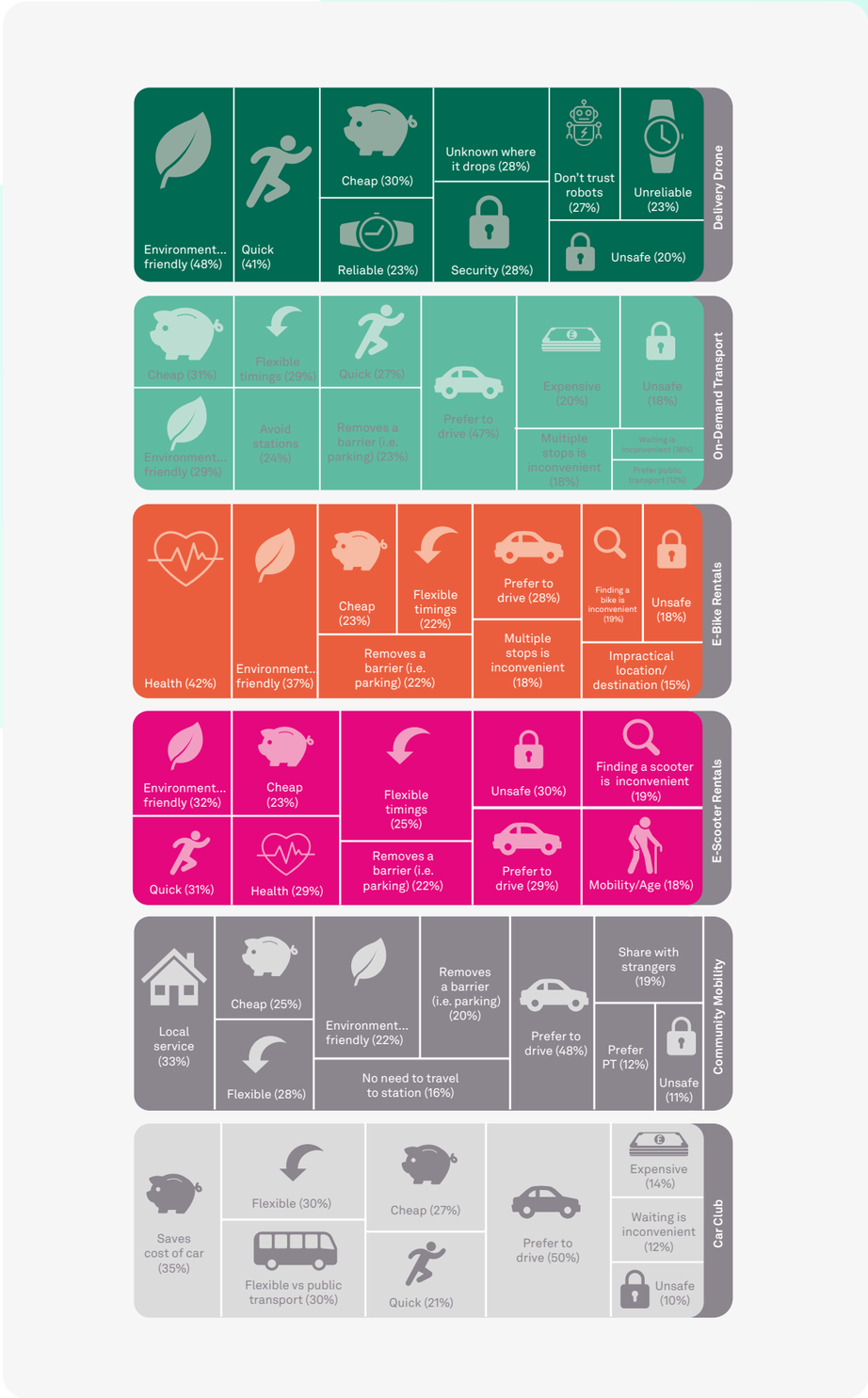
Better Public Transport tailored on local needs

Residents of South Somerset communicated that a better bus service (i.e. reaching a wider area, running more frequently and serving more locations) would solve a lot of the transport issues.

In Essex there is an appetite for location-centric travel provisions (i.e. transport which focuses on serving specific, popular destinations such as schools and shopping centres).

In Northumberland first and last mile solutions are important given the long distances between many residences and bus stops and stations.

Figure 2.1: Reasons for and against new services



3.1.1 Residents' travel habits and current barriers to travel

Participants recognised the unique challenges of rural locations and would like to have mobility services tailored around places and characteristics of the population in those specific areas rather than importing city and urban solutions directly. New transport solutions would need to consider unevenly distributed demand, remote areas, rough terrain, lack of mobile phone connectivity and a very wide demographic of users.

Convenience is key, both in accessing transport solutions and paying for them. There is a preference for cashless and for single ticket solutions, but with awareness that apps are not wholly practical for some users and in areas with limited mobile phone coverage.

There was a desire for services to run later on in the evening, but an appreciation that there may not yet be sufficient demand to run 24 hour services. People like environmentally friendly solutions and are very aware that modes need to be accessible for the elderly, those with mobility restrictions, people travelling with small children, and those carrying luggage or shopping.

Attitudes towards cars and status become clear as older respondents are more likely to associate driving a car with success; however, they also understand the importance of public transport on the environment and are aware of the impact of car usage on their carbon footprint. Whereas the focus with younger respondents is more associated with the ways in which new technologies interact with their transport needs. Younger respondents appear more willing to take risks, but also were more concerned about change, so this presents a potential barrier to overcome.

Public Transport availability

Despite all three areas being served by public transport with a good level of distribution of stations and stops, services are often inadequate to serve the demand for travel. Too often services are linked to travel patterns present in urban areas that are not fit for purpose in rural areas, where different segments of the population are present.

Residents from South Somerset are more limited when it comes to easy access to public transport, so they are more reliant on personal vehicles, as the vast majority can drive and have access to a vehicle. In South Somerset it was felt that a better bus service i.e. reaching a wider area, running at more times, and serving more locations, would solve a lot of the transport issues.
In Essex, improving the cycling infrastructure will encourage active travel, and there is an appetite for location-centric travel provisions i.e. transport which focuses on serving specific, popular destinations such as schools and shopping centres.

In Northumberland first and last mile solutions are important, with people ideating around taxis and on-demand minibuses.

Suppressed demand for travel

As expected, all travel reduced over the past few months, due to the Covid19 pandemic. People generally expect their transport usage to continue to be lower than pre-lockdown for most modes of transport; however, they do consider themselves more likely to walk than in the past.

Nearly half of the respondents have journeys that they do not take at the moment but would like to take more of in the future. Factors such as perceived complications, crowding and costs are particularly discouraging in these cases.
Other pandemic impacts on travel patterns/ demand include working from home more often and avoiding public transport; although people were willing to return to this once they feel safer. Many have used online shopping and deliveries to support them during lockdown periods.
Residents approve of community solutions, and the pandemic has given renewed appreciation for community help.

New Mobility services fit for different rural environments

Residents consider themselves unlikely to take up new forms of transport; especially those aged 55 and older.

There are a variety of motivators to take up these new transport types; however, the biggest barrier is preference for driving, which would need to be overcome when pursuing new services. Younger respondents are more open to all modes of transport, especially delivery drones.

Not all rural residents drive or rely solely on private cars, and novel solutions such as autonomous modes and on-demand transport are appealing, especially in remote locations.

Health and environmental factors are big motivators for both e-bikes and e-scooters. However, they are not considered practical for all journeys.

An on-demand mobility service could potentially address some of these requirements, as it would be able to reach remote areas. If it could be booked via a telephone, this is preferred for those without smartphones and mature adults.

First/last mile services are also important for people to travel from remote areas into central stations. Hubs of services such as buses, taxis, demand responsive minibuses and rental e-bikes to popular destinations (e.g. shopping centres, train stations and hospitals), could help streamline a lot of the demand for travel and provide a focal point for integration of routes, timetables and fares, particularly if planning, booking and payment for these were integrated into a single digital platform. Mobility hubs could be reached by on-demand shared transport options from people's homes or could be led by community-based services such as volunteer drivers. Moreover, they could act as first point of contact to introduce older users to digital mobility services.

A selection of mobility services fit to serve short and medium travel distances would help in overcoming barriers and limitations noted in the provision of fixed scheduled public transport that currently is unable to serve a dispersed demand across the day.

3.1.2 New Mobility Solutions

Respondents were asked to gauge their likelihood to use five new types of service and the reasons for their choice. They were shown videos of how services might work, and each service was defined as below:

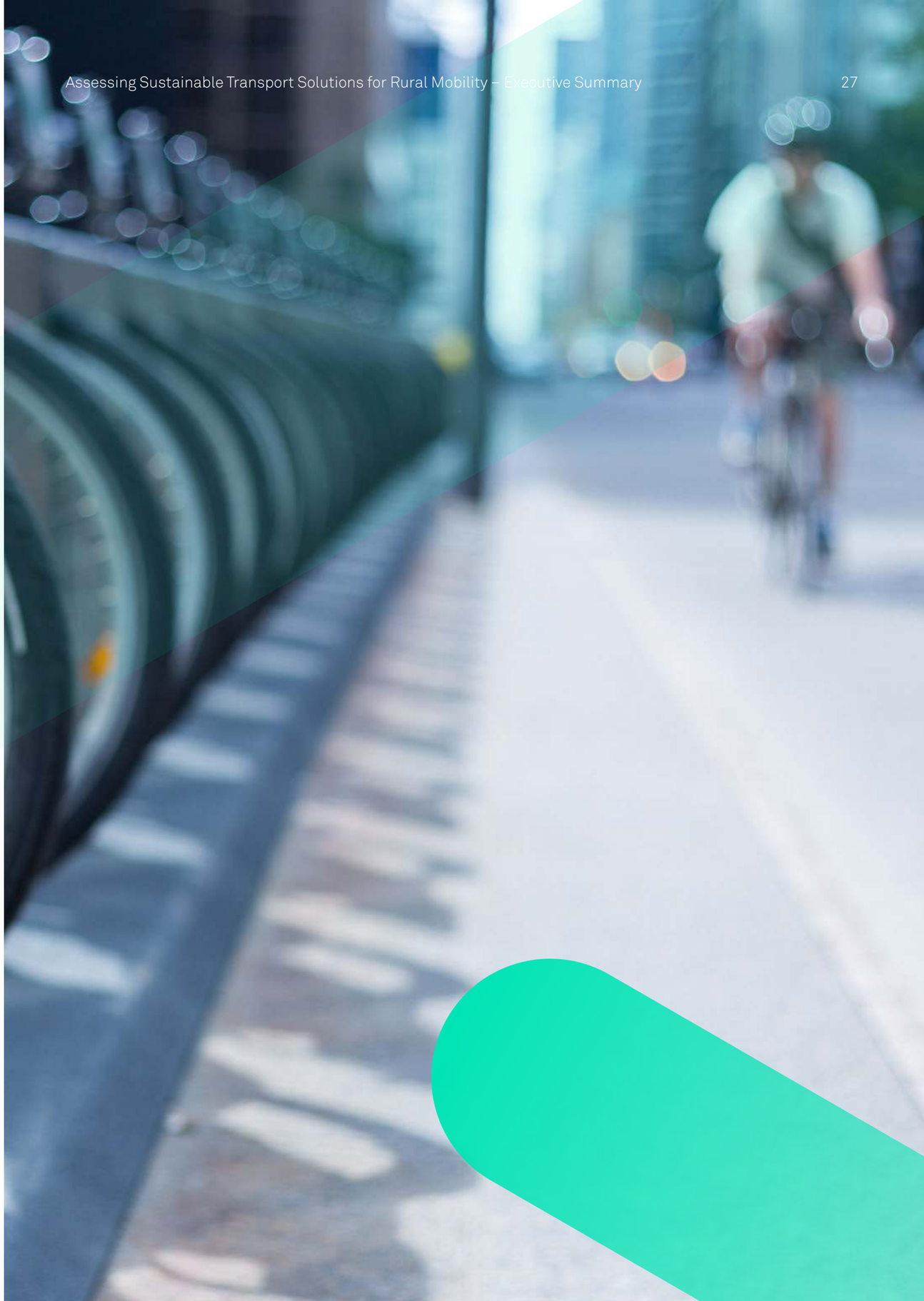
- **Delivery drone:** an autonomous vehicle (often an unmanned aerial vehicle), used to transport packages, food, medicines or other goods in remote locations. Delivery could be made to a local hub or to individual homes and reduces the need for delivery vans;
- **On demand Transport:** this is when users can access cars, buses or minibuses when you need to and share the lift with other people who are travelling in the same direction. It does not run on a timetable like traditional public transport. It does not have a fixed route and can either pick you up from the place of residence or from a convenient point a short walk from it;
- **Community Mobility services:** A service that links those who have access to a vehicle in the local community and are able to offer lifts with those who need transportation, particularly to places like hospitals, doctors' surgeries, train stations and town centre. The service would cost less than a typical taxi journey and be bookable by app, online or phone;
- **E-bike rentals:** electric bikes that use a small motor to make cycling less strenuous although the cyclist still pedals but the journey is easier - available to rent by the minute from convenient locations and bookable and payable via an app or a phone call;
- **Car Club:** these clubs allow access to drive a car when you need to and offer flexible pricing such as per minute or per hour. The cost includes fuel, insurance and breakdown assistance. The cars can be located and booked online or via an app;
- **E-scooter rental:** electric kick scooters that can be rented by the minute via an app. The scooters have a large deck in the centre on which the rider stands and can be picked up and dropped off locally.

Younger respondents are more open to all modes of transport, especially delivery drones. They are also more positive about using Smartphone Apps for both bookings and payments than older respondents. However, across all respondents, credit and debit cards are the most positively viewed form of payment. Other residents are wary about new forms of transport, but delivery drones (33%) and on-demand transport (26%) are the most likely to be considered.

Figure 2.1 shows the likely uptake for new mobility services proposed during the survey, aggregated for all areas and all users.

Table 2.1: Uptake for new mobility services in the three case study area

Characteristics	Essex	Northumberland	Somerset
Delivery drone	29%	35%	35%
On-demand transport	27%	25%	26%
Community mobility service	21%	24%	24%
e-bike rentals	14%	17%	19%
Car club	12%	16%	13%
e-Scooter rentals	11%	14%	14%



4 Data Landscape

The data landscape activity of the project aims to identify which data sources are currently available to understand travel patterns and habits for residents in rural areas, and how a data driven-approach could support the introduction of new mobility services.

This section describes how to assess data availability in rural communities to identify differences between geographies (e.g. accessibility, population density) and alternative new data sources to represent the demand for travel (pre-COVID lock down status). The study was developed in three phases: an existing data landscape to select the study areas, a data acquisition for mobile network data aggregated at trip-chain level and the analysis of the travel patterns, building on previous methods developed by Connected Places Catapult, to identify the purpose and mode of travel for each trip in the chain. The analysis looked at travel demand in the three previously described study areas and established requirements for different new mobility solutions depending on travel demand and travel habits.

4.1 Findings

During this phase of the study, a data landscape was created:

- To assess data availability in rural communities and to identify differences between geographies (e.g. accessibility, population density); and
- To develop analysis building on previous knowledge and methods using Mobile Network Data at trip-chains level and Origin Destination (OD) matrices.

The work developed for the Data Landscape for rural communities focuses on:

- Existing data landscape: what data is currently available for rural communities which supports identification of critical demand for on-demand mobility services. Rural communities will be classified in low, medium and high population density;
- Data acquisition: mobile network data at highly spatial and temporal granularity was acquired to understand real-world travel patterns in a pre-lockdown condition;
- Minimum population density assessment: Travel demand in the three areas is analysed to establish the minimum population density/ requirements for new mobility solutions depending on travel demand and travel habits

4.1.1 Existing Data Landscape

Initially a review of existing data was carried out to identify three representative case studies that would allow the study findings to be transferred to other geographies.

Factors included in the selection considered data currently available in rural areas, structure of places, road network and public transport services available, population density and the potential for the study to help levelling-up the area following the introduction of new mobility services.

4.1.2 Data acquisition

Main requirements to be able to inform mobility services is a full understanding of:

- Door-to-door movements, especially from residents;
- 24 hours variability with an increased focus during inter-peaks, which is when people is keener to try something new

Following a procurement phase, mobile network data was acquired from the network provider, Telefonica, to understand travel demand and patterns in the three selected areas.

Mobile phones generate “events” as they communicate with the national cell network. These events are collected on an anonymised basis for analysis and aggregated at a suitable spatial granularity (LSOA, MSOA, LA district). Each event is linked to a persistent and anonymised user ID, a timestamp and the cell ID of the cell that recorded the event. Events are classified as either active or passive:

- **Active Events:**
  - Connection events (when a user turns their phone on/off, loses or regains connection);
  - Call events (when a user makes or receives a phone call, or moves between cells when on a call);
  - Text events (when a user makes or receives a text message).
- **Passive Events:**
  - Movement events (occur when a user moves from one Land Area Cell (LAC) to another or when a transition occurs between 2G/3G/4G coverage);
  - Time-based events (whenever a user does not create an event for a sustained period of three hours). These events are used to identify longer dwells even if they are in the same LAC as the previous dwell.

Telefonica then analysed the spatial and temporal distribution of events to determine users’ movement patterns and provided two datasets aggregated at trip-chain and trip-based levels (origin-destination matrices).

Mobile Network Data are not normally collected for the transport industry but were aggregated according to specific project objectives.

Mobile network data (MND) aggregated at trip-chain level is a new data source that provides this information, since information on how the trips are connected together are retained (***Figure 3.1***).

The MND aggregated at trip-chain level was specifically created for the Connected Places Catapult on request for the MODLE project[9] (now commercially available) to study travel patterns and model mobility services.

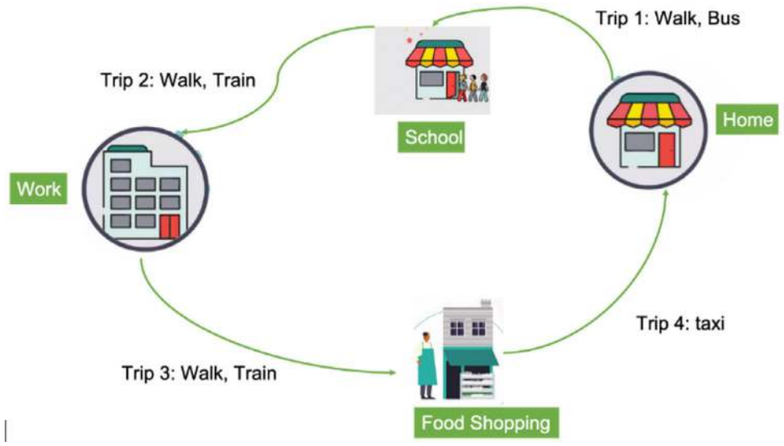


Figure 3.1: Example of a trip-chain

In order to understand travel patterns, MND data was acquired for an average weekday in March 2019 (excluding bank holidays and school holiday) at higher spatial granularity (Lower Super Output Area) for the study areas and for six time periods (AM peak - 07:00 to 10:00; inter-peak 1 - 10:00 to 13:00; inter-peak 2 - 13:00 to 16:00; PM peak - 16:00 to 19:00; off-peak 1 - 19:00 to 22:00; off-peak 2 - 22:00 to 07:00) in order to have an increased breakdown for the 24 hours.

Since residents often travel well beyond the administrative boundaries, MND covers the entire United Kingdom. To make the analysis less computationally intensive Scotland and Wales were acquired as one zone each.

Figure 3.2 shows how the raw trip-chain is processed to create OD matrices and how it is then analysed to assign purpose and mode of travel to each intermediate trip.

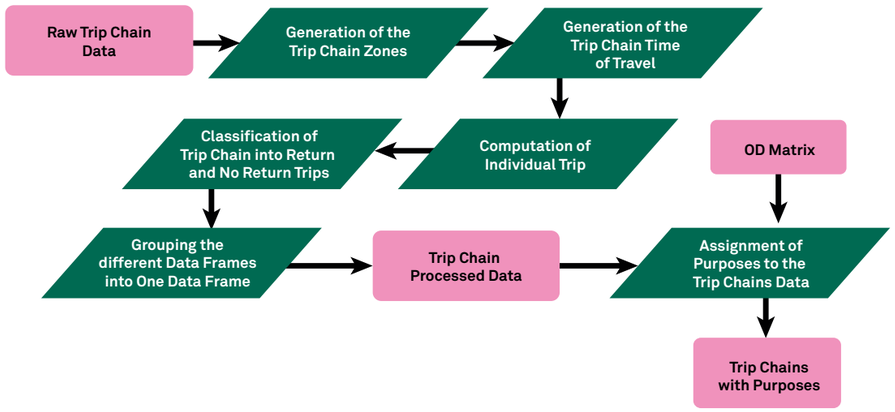


Figure 3.2: Steps to process trip-chain dataset

9 https://cp.catapult.org.uk/project/mobility-on-demand-laboratory-environment-modle-project/

4.1.3 Data analysis

MND were enhanced using the methodology developed for the DeMAND project[10], which allows the allocation of journey purpose and mode of travel to each trip in the chain using land use data, locations of interest (education settings, shopping centre, business and logistics parks), time of travel and distance travelled.

The data exploratory framework, a bespoke piece of software developed by CPC using the programming language Python, was developed further to analyse data for an average weekday and derive extra analytics from rural areas.

The software was also expanded to analyse MND data for weekdays and weekends for individual hours (from 05:00 until 20:00) downloaded from the GB portal maintained by Telefonica and for which CPC has licensed access for 2016 MND for the whole of Great Britain. The extra analysis identifies days where there is more demand for travel and how the demand changes during the day.

4.1.4 Results

Findings showed very similar travel patterns compared to urban areas in all three rural areas. In two areas (Northumberland and Essex), rural forms a close bond with the nearby urban area and demonstrates a relationship of interdependency.

Residents tend to travel more locally and mainly for leisure activities, although those that are commuting to work tend to travel for longer to reach their usual place of work and when they work locally they usually have more complex travel patterns (3-5 trips in one day) compared to urban residents (50% of journeys are made of two trips in a day). Because of this, rural residents have longer and flatter peak times (either in the morning or in the afternoon) and a stable demand for travel during the day that is linked to leisure activities.

The more rural a place is, the stronger the reliance is on deliveries to counterbalance the lack of services locally. This produces an increased number of higher count trip-chains which indicates local distribution of goods, usually sourced from the urban centre (from 12 up to 28 trips in one day). Travel patterns and time of travel for the long distribution of goods (defined as distribution outside the study areas) appears to be the same in all three areas (from 5 up to 12 trips in one day).

Northumberland (case study for mainly rural) and Essex (case study for urban with significant rural), despite representing two different population density conditions, are following similar travel patterns which stretch across the whole of the North of England for Northumberland and the whole England for Essex.

Despite Northumberland being the most rural of the case studies, residents have a more evenly distributed road network and quick rail links that allow them to travel further on a daily basis reaching other main cities in the North (e.g. Leeds, York) but also Nottingham, Wales and London easily. Public transport, especially bus services (230 rural services in rural North East against the 850 bus services in Tyne and Wear) requires improvement and are inadequate to satisfy current demand for rural travel.

Somerset has developed a close bond with the South West (mainly Dorset and Devon) with residents strongly relying on cars, which is limiting their travel habits to a more local area. This is mainly due to the poor transport network and the limited availability of public transport services (both rail and bus).

10 https://www.northumberland.gov.uk/NorthumberlandCountyCouncil/media/Roads-streets-and-transport/Public%20transport/Bus%20travel/MapE_1510.pdf

Northumberland

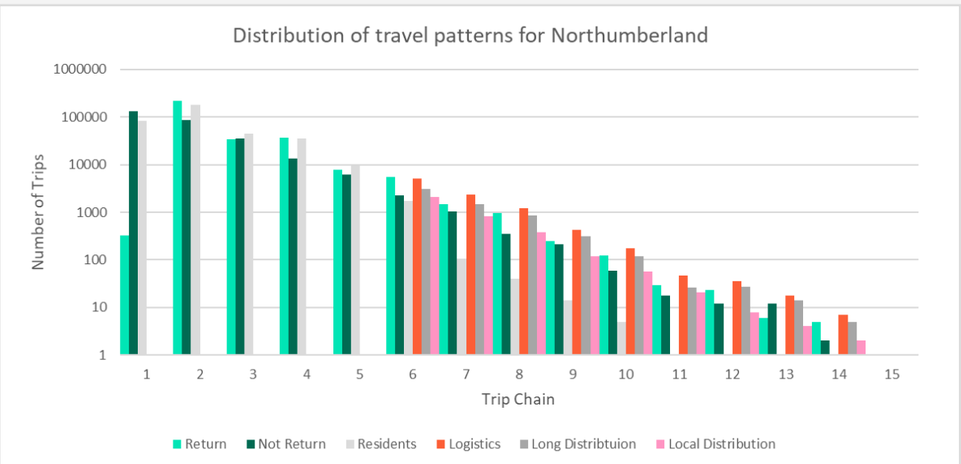
Northumberland County Council has a total population of 319, 010 (2019, 12% of 2,657 million in the North East). It is an area made of dispersed settings with a mix of large and small market towns with a great proportion of the county made of the Northumberland National Park.

The public transport is only serving main towns and seasonal routes are active during Summer to allow tourist to visit Hadrian's Wall (source Traveline[11]). Northumberland has a close interaction with the nearby metropolitan area of Tyne and Wear, which provides for jobs and services for rural residents.

The mobile network data analysed is made of MND 2018 (Trip-chains) and MND OD 2016 for 40 MSOA zones part of a zoning system of 998 zones representing the rest of the UK.

We used daily travel patterns from the synthetic population built for the agent-based model for the DeMAND project (Connected Places Catapult, 2020) and is referring to an average weekday for 2018 with the same data specification compared to the other two areas.

Resident's in Northumberland have travel patterns comprised between 1 and 5 trips in one day with a lower proportion of 2 trips (52.2%) and slightly more proportion of 3 (12.7%), 4 (8.6%) and 5 (2.4%). Above 5 trip-chains, it is likely that more complex travel patterns are linked to distribution of goods rather than residents with the higher trips rate being carried out by white van drives for local deliveries.



11 https://www.northumberland.gov.uk/NorthumberlandCountyCouncil/media/Roads-streets-and-transport/Public%20transport/Bus%20travel/MapE_1510.pdf

South Somerset

South Somerset District has a population estimate of 168,345 in 2019 (30% of the total population in Somerset, 562,525). With a combination of medium (Yeovil is the largest town with 47,780) and small towns. South Somerset is the only area that is not influenced by the presence of an urban area nearby.

The demand for travel follows similar patterns there are some significant difference compared to the Mainly Rural case study:

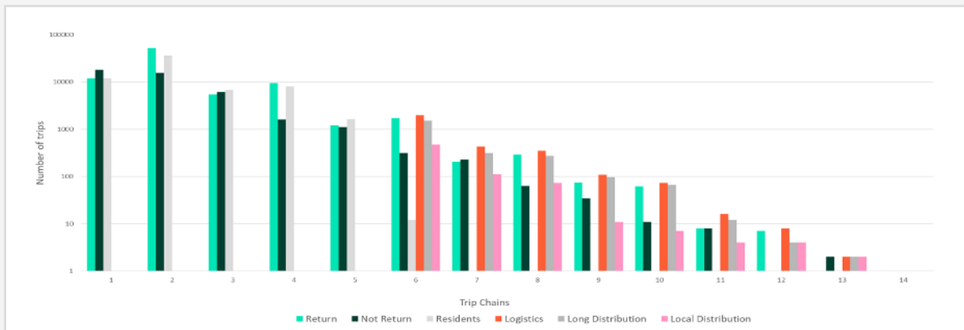
- Short trips (less than 2 miles) made 43% of residents' trips;
- Higher reliance on local distribution of goods probably due to lack of local services (up to 28 daily trips);
- Residents have more complex travel patterns with higher proportion of 3-5 trips per day compared to urban areas.

Residents are strongly relying on private cars since Public Transport is not providing for their mobility needs adequately.

Majority of travel patterns is made up simple tours (54% are within the 2 trip-chain subgroup) with 3, 4 and 5 trips representing respectively 9%, 9% and 2% of the total sample.

Considering only travel patterns made by residents of South Somerset, 56% are doing simple tours (36,622) whilst 16,596 residents are doing more complex travel patterns (11% of 3 trip-chains, 12% of 4 trip-chains and only 2% are doing 5 trips).

Beyond 6 daily trips, travel patterns are linked to logistics activities and distribution of goods at local or long haul range, where long distribution is concentrated mainly in the South West with very rare trips to Essex or London.



Essex County Council

Total population in Essex County Council is 1.49 million in 2020, with a higher proportion of population aged 65+ (2% higher than national average) and a 2% lower proportion of individuals in working age.

The MND 2019 aggregated at trip-chains captured 913,318 individuals of which 63% are residents of Essex County Council, whilst other network users are coming from nearby counties.

Only 2% of travel patterns are linked to logistics activities, however, 63% of these are referring to long distribution whilst local distribution accounts for 36%.

OD matrices included 854,363 total number of disconnected trips, aggregating them by all purpose and for the six time periods.

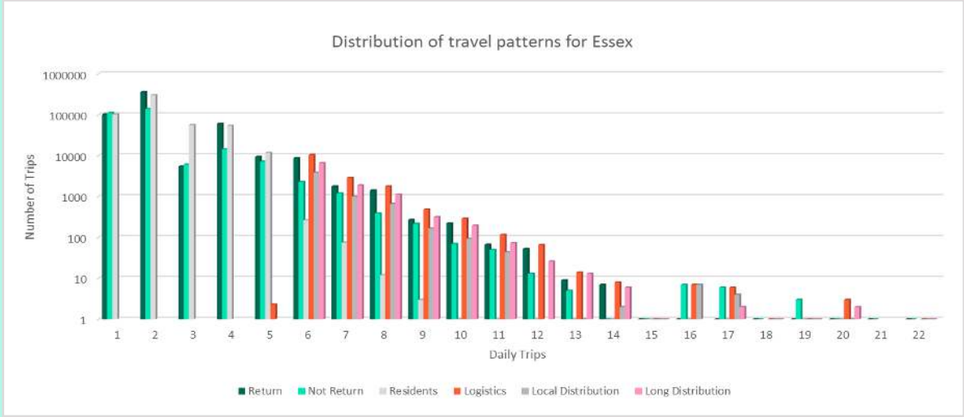
Coverage of the zoning system extends nationally with a total number of 1222 of zones:

- Essex County Council: 872 zones at Lower Super Output areas;
- Essex (Thurrock and Southend-on-Sea): 350 at Middle Super Output level.

Findings includes:

- Higher proportion of internal trips (48% made by residents);
- Less reliant on local delivery of goods compared to other rural areas;
- Higher proportion of simple tours with 57% of residents doing only two trips on a daily basis;
- Greater reliance on car for commuting to London and beyond;
- Long distribution of goods stretches concentrates on the East of England (46%) and London (16%) but stretches to the entire England.

The majority of the individuals (60%) captured by MND are doing simple tours. Since they are travelling longer distance both by rail and road, the proportion of complex tours is really low with 9% doing four daily trips. Among residents 57% is doing simple tours and 11% and 10% are doing three and four daily trips. Above five daily trips, only 2% of residents are doing extremely complex tour. As in other areas, logistics, which made up 2% of the total sample, is the activity identified for higher count of trips. These is divided in long (64%) and local distribution (36%).



4.1.5 Discussion

The use of mobile network data, aggregated at trip-chains level, together with a finer temporal resolution, allows to understand travel patterns in rural areas. The three case studies are representing different population densities, but travel patterns are comparable and also similar to what is happening in urban areas. Hence rather than defining a minimum population density the mobility services should cater for short and local trips (less than two miles) and for medium-longer distance trips, which should integrate with the wider public transport network in order to increase frequency of services.

Rural Travel Characteristics

A key feature of rural travel patterns is the high level of leisure travel that occurs across the whole day. However, those that are commuting to work travel for longer distances, producing flatter morning and afternoon peak periods than in urban areas.

Another feature that distinguish rural travel behaviours from urban areas is a higher proportion of internal trips. Depending on services available, rural areas are much more reliant on home deliveries, cutting back on shopping trips which are substituted with more local trips. The higher reliance on local deliveries can be noted from higher count trips (from 21 to 28 daily trips). The proximity of an urban area appears to greatly reduce the demand for delivery traffic.

Logistics activities are not linked to mobility needs of residents, so they can't be considered part of the demand for travel for rural residents. However, under the assumption that local distribution emerges from residents' requests, a higher proportion of local distribution was observed in Northumberland and Somerset. Moreover, following data analysis for the weekend and weekdays for Northumberland, the greater reliance of local deliveries appears to unlock the possibility to travel more locally over the weekend.

Table 3.1: Summary of characteristics for travel patterns in rural areas

Characteristics	Northumberland Mainly Rural	South Somerset Largely Rural	Essex Urban with Significant Rural
Internal trips	23%	24%	26%
Single Tours	52%	52%	60%
Complex Tours (3-4-5- daily trips)	23%	20%	12%
Total Logistics	2%	2%	2%
Local Distribution	37%	23%	36%
Long Distribution	63%	77%	64%
Internal trips (residents)	53%	40%	48%

Similar travel patterns between urban and rural areas are opens up the possibility to use demand agent-based modelling to test mobility interventions in rural areas. This fundamental step will allow the adoption of a data-driven approach to de-risk the introduction of on demand mobility in rural areas, further integrating tools and the knowledge base around the demand for travel for residents of urban and rural areas. The data-driven approach provides an unbiased representation of current travel patterns, therefore overcoming the limitations of the qualitative survey of residents, where only a small sample of the population, despite being statistically representative, is captured. The data-driven approach still shows its limitations in identification of suppressed demand for travel, which is instead well captured through the survey and interview

5 Business Models to evaluate commercial viability of rural mobility services

The last part of the study developed three business models for on-demand mobility services (Micro-mobility, Demand Responsive Transport and Delivery drones) for the case study areas of Essex County Council, Northumberland and South Somerset. The three services were chosen by residents in the study areas during the communities' engagements developed in September 2020.

This study explored tailored interventions to rural areas, to adapt features traditionally associated to urban mobility to a rural environment where demand and operations differs.

During the data landscape study, we found that populations in rural areas have considerably more short and local trips, are more reliant on private cars, either because of lack of public transport services and/or access to a car, or are no longer fully independent (and as such they need to rely on others). These mobility needs can potentially be satisfied providing access to on-demand mobility services which are cover different distances, so any combination of them can fulfil the mobility requirements for rural residents to move people and goods.

During the communities' engagements, residents were asked to choose from six alternative mobility solutions, including micro-mobility (e-scooter and e-bikes), Demand Responsive Transport (DRT) and delivery drones.

Each of these services fits the requirements of all rural areas, but for the purpose of this study three towns in each area were selected to develop the calculations for the business models, assigning each new mobility service (NMS) to one area only:

- Micro-mobility to Essex County Council (case study for Urban with Significant Rural)
- Demand Responsive Transport to South Somerset (case study for Largely Rural areas)
- Delivery drones to Northumberland (case study for Mainly Rural areas)

For each case study area, a revenue and cost model were developed; however, the findings can be improved if/when more data on the operation of these mobility services become available. Trials in micro-mobility and delivery drones are still limited in the UK. Also, commercially viable DRT in rural areas are rare, following the poor performance of DRT in urban areas.

In order to collect data and useful insights on the operation of these on-demand mobility services, a workshop was organised on the 11th February 2021 to discuss features and characteristics that would make these services viable and those that will need to run as community-based services. An audience of 40 attendees with a 50 per cent split between mobility operators and data platform providers and Local Authorities discussed characteristics of the three services, monitoring and evaluation criteria to make the services a success in rural areas.

Quantitative data was collected thanks to a literature review covering international cases studies and individual sessions within UK operators. Data from these sessions were then aggregated to provide the data input.

Micro-mobility

When considering the deployment of a micro-mobility service in a rural location there are a several key recommendations for the creation of a successful operation:

- Assess the locations characteristics and therefore suitability for a micro-mobility operation. For example, ensuring there is sufficient cycle lane provision for riders to safely travel along. Lots of fast country roads are unlikely to attract riders
- Use a parking bay, rather than free floating model, and place the bays around key focal points and points of interest
- The use of docks can add significant costs to the business model
- Engagement with the local community, both riders and non-riders, is important to the success of the service

Analysis clearly demonstrated the need to have a good utilisation rate. To make the business model viable at least two trips per vehicle per day are necessary. Feedback from the stakeholders has shown that operators believe that this is entirely possible.

By using a battery swap model, vehicles do not need to be removed from service and placed on charge, therefore, increasing the operational hours and ensuring continuous availability, which could help utilisation, although more data from trials would support determining whether this is a more appropriate model.

Generating sufficient demand could be challenging for operators. Although the value proposition indicates that residents are interested in greener and healthier modes of transport, the main reasons for modal choice are convenience and speed.

Therefore, micro-mobility services would need to be comparable on these fronts with other preferred modes. There are many factors that can also influence demand, such as provision of cycle lanes, location of the vehicle parking bays and also the weather, such as rain which is discouraging residents to use the service, or seasonal factors such as the darker, shorter days in winter.

Two factors require further investigation:

- Safety: roads need to be suitable for e-Scooters or e-Bikes use, that includes the provision of cycle lanes, in good state of repairs and at low speeds
- Parking: vehicles need to be close proximity to riders, not requiring them to walk too far which could tempt them into other modes

This does require a large enough fleet to ensure riders are in short walking distance to a vehicle. Using a parking bay, rather than a free-floating model, does mean that riders will know exactly where the vehicles are located.

Demand Responsive Transport

The feedback from DRT operators has indicated that there is strong demand for such services during peak time, although there can be a significant drop off in utilisation during off-peak.

The three key findings from the workshop and interviews are:

- Centring the service round a key hub or focal point is critical to the success of the service whether subsidised or not
- Having the appropriate fleet, both in terms of size, number and cost, which includes understanding the relative benefits of a premium vehicles versus the cost
- The software and platforms available were an important topic of conversation during the stakeholder interviews. A knowledgeable local driver could overcome issues introduced by the optimisation algorithm during assignment of customers to rides

Engagement with the local community, Local Authority and existing transport providers, working to fit gaps and the unmet need of the local community, rather than competing with other transport services.

Door-to-door DRT operations are the most convenient for passengers. However, research has shown that this model can lead to longer travel times and be more costly for operators as the fares are fixed.

Therefore, the majority of current DRT providers we interviewed operates a Corner-to-Corner service or utilise existing or redundant bus routes, within a Hub and Spoke model. Although, the research has indicated that offering a Corner-to-Corner service is the most efficient option, is also less inclusive for vulnerable or disabled users.

The Hub & Spoke model allows operators to plan and timetable routes to be most effective.

A hub and spoke/circuit service, with a semi-structured route appears to be most likely to be commercially viable in rural areas. Having a few routes that are commercially viable could help to subsidise the other routes. In addition, liaising with the locally community and supporting event driven occasions is a positive way to promote the service and increase usage and trust in the service itself. This then provides additional income to support the core DRT service.

A commercially viable DRT is unlikely to arise from passenger fares alone, which is why councils usually support them. DRT has been shown to work in rural areas as an extension of public transport services, and where bus operators may not think it's viable to run a standard bus service.

Delivering social impact and community benefits are important factors in locations that require public support, but the Councils are not the only source of subsidies. Some businesses also recognise the advantages of supporting these schemes as a way to support jobs and business growth in rural industrial/ business parks.

Although private hire and other revenue streams have been considered as possible means to create a commercially viable business model to subsidise the DRT services, current regulation on vehicles' licensing limits these opportunities. Within the interviews, reference was made to regulations restricting the use of vehicles, (e.g. switching from a commercial to a community-based service) and timetable rules restrictions, which undermine the adaptation of timetables to disruptions (i.e. holding a DRT service to meet a delayed train arrival).

One of the noticeable differences between urban and rural DRT services highlighted in the research was the customer views on waiting times. The feedback was that in some rural areas without any transport or little transport, people were happy to wait for longer and have longer ETAs. Although this varies by demographic, a survey conducted by one operator showed that for 48-49% of respondents 30 minutes was an acceptable wait time.

Delivery Drones

One key business model consideration is the type of Drone delivery service:

- Drone as a Service
- In-House Drone deliveries

In-House Drone delivery service is defined as a sole retailer using the service (such as Amazon, Ocado, or local restaurants). The benefits to the provider is that the scheduling and operation is fully under their control, however, the efficiency of operation within a rural setting where potential deliveries may be sparse, means that most of these provide use an alternative service (such as Just Eat, DPD, UPS or Hermes), who are able to bundle a number of retailer deliveries together to achieve effect and commercially viable service.

In rural locations a single **Drone as a Service** operation serving many retailers, may become more cost effective that each retailer having a fleet of drivers or using traditional delivery services. When considering the deployment for a Drone as a Service model, there are three key elements to consider:

- The location of the drone hub in relation to the retailer base
- The engagement with the retailer base – a strong retailer network is crucial to generating the consumer demand
- The engagement with the Local authority, community, and relevant authorities (CAA, Police, etc)

Drone delivery services are still very much in the infancy and there are several regulatory issues to be resolved before determining the viability of such services in all locations, not just rural. For example, whether one operator can control many drones, or allowing drones to operate 'beyond visual line of sight' (BVLOS).

Key to making the business model viable will be creating a **strong retailers' network on the platform.** As well as the regulatory barriers, there are also public trust and acceptance barriers to overcome. Although in less densely populated environments, such as rural locations, drones might be less likely to fly over residents' homes and gardens.

There are several potential social and economic benefits that are associated with drone deliveries, for example sending urgent supplies to residents in remote locations and providing local businesses with access to a wider customer base that ordinarily they could not reach.

6 Conclusions

This study was developed for the DfT funded project "Assessing Sustainable Transport Solutions (AsSeTS) for Rural Mobility" where the Connected Places Catapult investigated how to improve access to services in rural environments.

6.1 Feasibility of the data-driven approach

The adoption of a data-driven approach for the introduction of on-demand mobility in rural areas provides recent, at scale and comprehensive information on residents' travel patterns and habits. The use of MND in the rural travel context appears to capture more trips and performs better than in urban areas. Despite the tower/cell network being less evenly distributed, the MND localisation process is more precise because of the longer trips and the more defined land uses. The capacity of trip-chains to represent travel patterns as a combination of internal trips (to the zone), simple tours and complex tours separate, logistics and distribution activities, allows to target those areas and residents which are more likely to take up on mobility services, but also to consider appropriately the extra demand coming from non-residents on the network as well.

The Mobile network data at trip-chain level allows to access rapidly a large users' base, which emphasises also the link between places and the existing connection between urban and rural areas.

The transferability of the AsSeTS data-driven approach to other rural areas supports the introduction of new mobility services for people and goods and creates added value for councils and mobility providers.

This data-driven approach will allow Local Authorities to plan flexible mobility services tailored to residents' travel needs, including when periods of uncertainties linked to the Covid19 lockdowns occur.

Local Authorities could plan for integrated Rural Mobility services, quantifying the integration between on-demand mobility and public transport and can embed use of data for monitoring and evaluation of these services, whilst mobility providers can exploit a new perspective in identifying latent demand for on-demand mobility and can assess their business models and value proposition against rural area travel habits.

Mobile Network data aggregated at trip-chains level allowed to unveil similar travel patterns in rural areas to those already studied in urban areas (DeMAND project, 2020).

Mobile Network data aggregated at trip-chain level unveiled similar travel patterns in rural areas to those already studied in urban areas (DeMAND project, 2020).
Furthermore, mobile network data analysis confirmed a rapid growth in carbon intensive last mile road freight deliveries in rural areas across the three study areas, where a strong link between the role of "Goods to people" and "People to goods" emerged.

6.1.1 New modelling tools for mobility

The main finding is the demonstration that there is not a lack of demand for travel in rural areas, but that similar travel patterns and dynamics occur as observed in urban areas.

The current standard datasets and techniques in use are difficult to use for the assessment of new accessibility and mobility offerings because they were developed to inform and design new infrastructure.

This enables us to assess rural mobility needs using the same tools developed for urban areas, including-agent-based modelling. The data exploratory framework, originally developed by CPC for an urban demonstrator (DeMAND, 2020), analysed activity patterns for the three case study areas. A step further would allow the generation of daily activity plans for the generation of a regional synthetic population.

Establishing transferability of tools and models developed for urban areas to rural ones will ensure the development of a holistic approach to rural mobility through the adoption of agent-based and activity-based modelling for rural areas. This will pave the way to an integrated strategic national transport model where demand for travel arises from individual behaviours.

6.2 Community Engagement

The community engagement was structured in two phases (focus groups in July 2020 and surveys in September 2020) to allow to capture both rich qualitative information from the focus groups and an extensive survey with a representative sample (segmented according to the 2011 Census data) of the population. Both engagement processes were moved on-line to facilitate remote participation during the Covid19 lockdowns.

Focus groups allowed to structure the questionnaire and prioritise criteria for the on-line surveys, but also to understand residents' perspectives. Twenty-six people were recruited in the study areas of Northumberland, Essex and South Somerset thanks to the support of the Local Authorities in community groups. The choice of an on-line platform enabled exploration of travel habits, pain points but also alternative mobility solutions, providing practical examples (through videos and infographics) of six alternatives (Delivery drone, demand responsive transport, community mobility service, e-bike rental and e-scooter rentals, car club) and if they are seen as fit for purpose in their own rural area.

Residents are wary about new forms of transport, but delivery drones and on-demand transport are the most likely to be adopted. Younger respondents are more open to all modes of transport, especially delivery drones. They are also more positive about using Smartphone Apps for both bookings and payments than older respondents. Across all respondents, credit and debit cards are the most positively viewed form of payment. Preference for driving is a major barrier for some new mobility schemes, and many respondents are wary about new technology and security.

6.3 New Mobility Services

Although the three New Mobility Services are very different, there are some key themes that have run through all the research and stakeholder engagement that we have conducted.

Regardless of the service there are two key criteria that Councils will use to judge whether New Mobility Services are a success:

- A good safety record;
- The service is a viable alternative to car travel.

These two key success criteria are potentially more challenging for micro-mobility services to achieve than for DRT and drone delivery.

Adding e-Bikes or e-Scooters to roads with other road traffic will increase the risk of an accident, particularly in rural areas where country roads are more dangerous (i.e. narrow, poor maintenance conditions etc...) and there is less cycle lane provision. There is also a risk that the short trip lengths might attract walkers and cyclists rather than car users. Demand is likely to be heavily influenced by weather, and rain is likely to tempt residents to use a car rather than a micro-mobility service.

Throughout the research all stakeholders recognised that engagement with the local community is key, both for generating interest in the service and also for ensuring acceptance from the important community groups and non-users. This is particularly important with new concepts like micro-mobility and drone delivery which may be considered disruptive.

Addressing any concerns residents have and ensuring services fit the needs and support the community were important objectives for all service operators we engaged with.

The introduction of any New Mobility Service needs to be designed and deployed with the needs of all residents, not just users, in mind, and deliver benefits to the local community.

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Next steps

Growth in carbon intensive last mile road freight deliveries in rural areas risks compromising Government ambitions for 'net-zero' greenhouse gas emissions. To address this challenge within the DfT's Transport Decarbonisation Plan, the **Rural Innovation for Sustainable Environments (RISE) for Decarbonising Last Mile Road Freight** project will look at decarbonising road freight through consolidation of transport demand for last mile deliveries, using integrated agent-based and emissions modelling.

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