ENGLAND'S ECONOMIC HEARTLAND

First/ Last Mile International Best Practice Review

A technical report produced by WSP and Steer for the EEH evidence base

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1 INTRODUCTION

1.1 PROJECT CONTEXT & VISION

England's Economic Heartland (EEH) has acknowledged that its ambition to significantly grow the economy across the Heartland, deliver 'clean growth' and pursue a net zero-carbon transport network will not be achieved through a 'business as usual' approach.

A high quality, tailored, multimodal mobility eco-system, which includes the provision of sustainable first-mile / last-mile (FMLM) choices, integrating with long distance modes linking key centres, will be a key catalyst for the change required to maintain the region as a global competitor.

'First-mile last-mile' is typically used to describe the beginning or end of an individual journey to or from a transportation hub or service. Within the Heartland the definition of first-mile last-mile represents a wider choice of both traditional and emerging transport modes that enable access to opportunities and needs.

Those living, working, playing and creating prosperity within the Heartland will have a choice of motorised and non-motorised mobility solutions and services to;

- Easily access employment, skills, education and housing as well as healthcare and leisure needs & opportunities either directly or indirectly (by interchanging to another mode)
- Access mobility hubs providing friction-free interchange for longer distance trips by mass transit (rail, coach and bus) within and beyond the Heartland
- Link people and businesses with goods, services and markets through physical and digital means, including avoiding the need to travel.

For many decades, the transport network has been dominated by the private car and major mass transit modes (bus, coach, rail and in certain places, light rail). Government policy and spending has focussed on these major modes as the means by which large movements of people, for significant distances, can be facilitated. In taking this approach, the focus has been firmly on the longer 'middle mile' stages of journeys i.e. these major modes associated with the longest parts of their journeys.

However, there is a growing acceptance that for the transport network to operate effectively, not only do the major modes, catering for the middle miles, need to be planned for and invested in but the journeys to and from these modes via their interchanges, the first and last miles, need to be optimised. This is particularly the case for mass transit which needs to be a truly viable alternative to the private car

Use of the private car often enables entire journeys to be undertaken without FMLM elements, or at least without the first mile stages, making them more attractive than mass transit. Furthermore, mass transit often needs private cars or taxis for the FMLM stages. It is also recognised that shorter, more sustainable first and last mile journeys which use a single mode to a destination, without interchange, need to be part of the solution. Therefore, greater consideration and provision of FMLM solutions is necessary to maintain user choice and ease of use, support access to and from mass transit interchanges and ultimately to enable sustainable short distance trips.

Typical first mile/last mile journeys include:

- Short journeys from home to end destinations and short place to place trips

- Journeys from home to mass transit interchanges
- Journeys from mass transit interchanges to workplaces

Therefore, not only does greater focus need to be given to the FMLM modes themselves, the interfaces between the middle mile modes and the FMLM modes need consideration to ensure that interchanges operate efficiently and do not themselves act as an unintended barrier to improved FMLM provision.

This report therefore considers best international practice for a range of FMLM solutions and their potential applicability to the needs of the Heartland, and, emerging best practice for middle mile/FMLM interchanges.

1.2 REPORT PURPOSE

The purpose of this report is to set out the current international best practice on First Mile Last Mile which has been used to inform the development of a wider FMLM toolkit for EEH. This report details the contents across a range of FMLM interventions (as agreed with EEH) which are also provided in easily digestible dashboards within this report.

2 FIRST MILE LAST MILE SEGMENTATION

2.1 MODE SEGMENTATION

The table below provides a segmentation of all current and emerging FMLM modes and solutions including an assessment of the typical range which the mode serves.

Mode Summaries

	Sub - Mode	Description	Range (*note this is in terms of 'normal' users and does not necessarily represent the journey range of a fit/ competitive individual*)
On foot	**n/a**	A journey undertaken by an individual on foot	<3km
Cycling	**Self-powered & owned**	A journey undertaken by a bicycle / tricycle that is self-powered and is owned by the user	<10km
	Powered & owned	A journey undertaken by a bicycle / tricycle that is power-assisted and is owned by the user	<10km
	Self-powered & shared	A journey undertaken by a bicycle / tricycle that is self-powered using a shared bicycle collected docking station or dockless	<10km
	Powered & shared	A journey undertaken by a bicycle / tricycle that is power-assisted using a shared bicycle collected from a docking station or dockless	<10km
Personal Mobility Device	**Self-powered & owned**	A journey undertaken by a self-powered personal mobility device (micro-scooter, skateboard etc.) and is owned by the user.	<3km
	Powered and owned	A journey undertaken by a powered personal mobility device (powered micro scooter, personal light electric vehicles such as balanced wheels, hoverboards, 'Segways', powered skateboard or similar) that are owned by the user. (***Note:*** *these are currently illegal on public roads in the UK but the DfT is currently considering legislation*)	<3km
	Powered & owned mobility devices for mobility impaired users	A journey undertaken by a powered personal mobility device (powered wheelchair, mobility scooter) designed specifically for mobility impaired users that is owned by the user.	<3km
	Self-powered & shared	A journey undertaken by a self-powered personal mobility device (micro-scooter,	<3km

		skateboard etc.) that is shared and collected from a docking station or dockless.	
	Powered & shared	A powered personal mobility device (powered micro scooter, personal light electric vehicles such as balanced wheels, hoverboards, 'Segways', powered skateboard or similar) that are shared and collected from a docking station or dockless. (***Note**: similar limitations regarding legality apply as above*)	<3km
	Powered and shared mobility devices for mobility impaired users	A journey undertaken by a powered personal mobility device (powered wheelchair, mobility scooter) designed specifically for mobility impaired users that is shared.	<3km
Car	**Owned**	A single occupancy or informal carpool journey undertaken using a privately owned/leased or rented vehicle	Unlimited
	Shared	A multi-occupancy journey undertaken using a privately owned, leased or rented vehicle that has been setup using a formal carpooling service/ a journey that has been undertaken using a vehicle that has been sourced via car club membership that has been collected or not collected from a dock.	Unlimited
Traditional Bus	**n/a**	Traditional, 'registered' public bus services (large, midi and mini bus) on fixed, generally linear routes	<30km
Traditional & Emerging Taxi	**n/a**	Private hire registered taxis operating under a radio system	<20km
Ride-hailing / Demand Responsive Services	**n/a**	Ride-hailing schemes match drivers and passengers making similar regular or one-off trips. Drivers and passengers register their available / desired trips via a website or app and the service matches logical pairings. Includes 'taxi, 'van' and 'minibus' and autonomous based solutions. Demand responsive services refer to some on demand community based transport (including social care and education transport)	<30km
Drones / Pavement delivery devices	**n/a**	Deliveries by low level automated air technologies (commonly referred to as drones) or wheeled devices operating on pavements (sometimes called droids or robots)	<10km

Digital as a mode	**n/a**	The use of digital connectivity .to reduce / remove the need to travel can be referred to as 'digital as a mode'. Digital access to work, education and healthcare provides for similar opportunities without physical movement.	Unlimited

3 MODE DASHBOARDS

3.1 BACKGROUND

3.1.1. The following section discusses each mode in relation to its typical attributes, a commentary on challenges, benefits and opportunities, its range, technical maturity, commercial maturity and best practice exemplars from the UK and around the world. The information for each mode is presented separately in individual dashboards.

3.2 MODE ATTRIBUTES

ON FOOT

Mode: On Foot

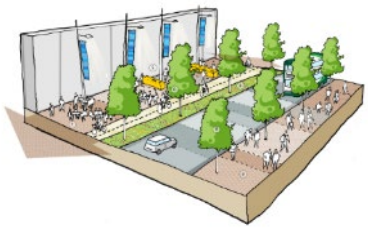
Definition	A journey undertaken by an individual on foot
Sub-Models	Accompanying children and people with physical mobility impairments
Typical Use Cases	▪ Travelling between a home location and a workplace or place of education ▪ Travelling between a major mass transit interchange and major retail centre ▪ Travelling between a remote car park and a mass transit stop/station ▪ Walking for leisure
Benefits	▪ Economic • No major limitations to capacity • Flexible and truly on-demand • (almost) zero cost to user • Already forms part of all journeys for most people • High levels of infrastructure in place in most urban and many rural locations • Reduces reliance on motorised travel • Reduction in short journeys by single occupancy vehicles ▪ Environment • Zero resource requirements • Zero carbon emissions at point of use • Low noise • Limited impact on built and natural environment • No waste materials ▪ Wellbeing • Physical and mental wellbeing benefits • Widely accessible to those without significant health impairment • Increasingly part of a healthy lifestyle including “steps per day” targets
Opportunities	▪ Economic • Mode shift may reduce some capacity issues on other modes • Improved health and wellbeing may have wider economic benefits and potential cross sector cost savings • Reduced transport costs

	▪ Environment • Increases in mode use will reduce carbon emissions and improve air quality • Increases in walking may reduce transport-related noise ▪ Wellbeing • Increase walking can improve physical and mental health
Barriers	▪ Economic • Availability of continuous infrastructure particularly in rural areas • New infrastructure can be comparatively expensive in rural areas where pavements do not exist • Lack of space for enabling infrastructure where it is missing and difficult to economically justify in low footfall locations • Slow compared to other 'mechanised' modes • Limited / no revenue or monetisation opportunities ▪ Environment • Unattractive walking environments in some locations ▪ Wellbeing • Lack of physical capability • Perception of fitness requirements • Weather conditions can reduce attractiveness • Perceived and actual safety of users • Perceived and actual security of users • Overcoming existing habits

Technical Maturity	Concept	Feasibility	Piloting	Initial real-world operation	Mature technical operation
	Walking is a fundamental part of most people's lives. Technology is even starting to play a role in this most basic of mobility modes. There are examples of organisations using augmented reality (AR) technology, with smartphones, to aid navigation when travelling on foot. For example, from early 2019 **Google Maps** has been trialling AR navigation to help users when walking; the camera on the back of the phone is used to identify a user's location and superimposes directions and details on the display aiding the navigation process. Additionally, if a user is going in the wrong direction, the display will alert them until they have moved the screen to face the correct direction. Google Maps AR is currently available on Pixel 3a phones as part of a trial, with no official launch date announced yet.				

Commercial Maturity	Not operating commercially in the UK	Commercial testing/pilot	Commercial launch	Operating commercially	Mature commercial operation
	In terms of commercial maturity this is not applicable to 'on foot' as a mode				

Business Models	There are limited business opportunities for this mode, although some life insurance / healthcare providers have been linking physical activities to reduced premiums for those willing to share activity data from their smartphones and smartwatches" https://www.vitality.co.uk/rewards/partners/active-rewards/apple-watch/

Journey Range	<3km				
	The journey range for on foot journeys is limited for the majority of users to under 3km largely due to physical capabilities and journey time.				
Supporting infrastructure and systems	▪ Data, websites and apps for journey planning ▪ Quality footways and pedestrian crossings ▪ Pedestrian bridges ▪ Showers and lockers				
UK Best Practice Example	**Transport for Greater Manchester's Streets for All** strategy is a new approach to thinking about the role that streets have in creating sustainable, healthy, and resilient places. It considers the needs of everyone who uses Greater Manchester's streets, as well as the communities, buildings and spaces that they link. The programme started with identifying and developing schemes along major radial and orbital corridors in Greater Manchester. Using a combination of data appraisal and site analysis, the work has defined a set of recommendations around movement and place driven street typologies, strategic proposals, project locations and concept designs for a series of interventions. The work identified priority sections, where concepts were developed to support a strategic case for intervention. Source: https://assets.ctfassets.net/nv7y93idf4jq/2GBbEBM4hm68q9qqvdaI1T/97f7b3d51ef9b312b756cd15bd0b008c/190128_Delivery_Plan_2020-2025_Draft_MASTER_final.pdf The Streets for All programme has focussed on a broader 'people and place' approach to improving streets, rather than simply aiming at improvements for active modes alone, resulting in more inclusive and comprehensive proposals and meeting a wider range of objectives **Liveable Neighbourhoods** is a **Transport for London** funded programme to support the health and wellbeing of Londoners by improving the quality of London's streets. It aims to provide more active and sustainable transport choices, reduce congestion, use road space more efficiently and improve air quality. Several London boroughs are working to transform town centres and neighbourhoods through a holistic package of interventions, including new or improved public realm, walking and cycling links, traffic restrictions and behavioural measures. Central to the approach for developing and testing design ideas is establishing close links with residents and businesses to understand what changes they want in their area and how they think these can happen. These and other Liveable Neighbourhood schemes represent some of the best examples of how the Healthy Streets approach can be		 		

	applied on the ground. Source: https://tfl.gov.uk/info-for/boroughs/liveable-neighbourhoods The Liveable Neighbourhoods programme, similarly to Streets for All, focusses on a more comprehensive approach to street design than simply improvements for active modes, aiming to achieve much broader aims. The borough of **Waltham Forest** in London was awarded £30 million from TfL as part of the **'Mini Holland'** programme. As part of this, new public spaces, street art and pocket parks were introduced in areas formally used by traffic. The project dramatically lowered traffic levels (the programme has resulted in 10,000 fewer cars on the road across the borough) and created more space for people to walk through the area. Source: https://www.livingstreets.org.uk/media/3890/pedestrian-pound-2018.pdf The above projects demonstrate that it is possible to deliver major improvements to public realm and space for active modes whilst also bring down traffic substantially across a whole borough. These improvements have provided for a wider range of benefits in addition to more people walking. **Play Wales** has launched '**Opening streets for play**' toolkit for local authorities and partners in Wales to develop policies and procedures to enable resident-led street play projects in their areas. The aim is to make it easier for children to play out in their neighbourhoods, for better health and wellbeing, It is informed by the Cardiff Street Play Pilot Programme which facilitated resident-led regular temporary street closures to provide more space for children to play. Source: https://www.playwales.org.uk/login/uploaded/documents/Publications/Opening%20streets%20for%20play.pdf The Play Wales approach demonstrates that the public highway can be repurposed for community activities on a regular temporary basis. This could be operated by local authorities in the EEH area particularly where open space for play is limited.	
Europe Best Practice Example	**Barcelona** has released a new mobility plan for 2019-2024 that aims to restrict traffic to a number of major roads within the city. The plan aims to reduce traffic by approximately 21%, in turn improving air quality and enabling secondary streets to become 'citizen spaces' for culture, leisure and the community. The Barcelona 'super-block' approach has a distinct hierarchy putting pedestrians first by restricting through traffic, creating shared spaces and only allowing certain vehicles at low speeds to access. Source: https://www.barcelona.cat/mobilitat/en	

Until 1962, all the streets and squares of **Copenhagen** were used intensively for vehicle traffic and parking. To combat this, the city's main street, Strøget, was pedestrianised in 1962 as an experiment. This proved to be a huge success with businesses realising that traffic-free environments provided increased financial revenue and thus further pedestrianisation throughout the city followed. Following the first year of the pedestrianisation of Strøget, pedestrian volumes increased by 35%, additionally pedestrian space has increased from 15,800 m^2 in 1962 to 99,700m^2 in 2005, and there has been a 20% increase in citywide pedestrian volume

Source:https://globaldesigningcities.org/publication/global-street-design-guide/streets/pedestrian-priority-spaces/pedestrian-only-streets/pedestrian-streets-case-study-stroget-copenhagen/

Geneva is at the forefront in Europe when it comes to promoting walking even though, unlike other European cities, it does not have an specific pedestrian area. The first master plan for walking was published in 1991 and since then the focus of transport planning has been predominantly on increasing walking. The master plan has been implemented in small steps to influence decision-makers to take an interest in promoting walking. The proposals have particularly focussed on improving walking connections between residential areas and the centre as well as walking conditions in the recreational areas. This approach has resulted in a modal share of 43% for walking.

Source: http://www.tut.fi/verne/wp-content/uploads/Best_European_Practices.pdf

Historic and contemporary European experience demonstrates that substantial increases in pedestrian activity can be secured through designing the urban realm to remove traffic from minor routes and reconfigure space for walking, community and cultural activities.

Global Best Practice Example

In **New York** the Department for Transport works with various organisations to create neighbourhood plazas throughout the city to transform underused or reallocated streets into vibrant, social public spaces. The **New York City Plaza Program** is a key part of the efforts to ensure all residents live within a 10-minute walk of quality open space. Interventions include closures on parts of Broadway including a large part of Times Square. Other places, such as Lower Manhattan, close streets on a temporary basis before becoming more permanent.

Source: https://globaldesigningcities.org/publication/global-street-design-guide/streets/pedestrian-priority-spaces/pedestrian-plazas/case-study-plaza-program-new-york-city-usa/

Avenida Paulista in Sao Paulo has been pedestrianised every Sunday in a project starting in 2016. Approximately

	30,000 people use the space on a typical Sunday. The project has brought the community together by giving people a highly sociable space where street art thrives and where people can enjoy exercising outdoors. The project approval rate in 2017 was 76%. The pedestrianisation also led to an increase of 12% in the number of visitors to the Museum of Art of Sao Paulo Assis Chateaubriand (Masp) in the first weeks after the project started. Similarly, hotel and high street shop owners have also reported an increase in their number of clients. Source: https://vejasp.abril.com.br/cidades/capa-avenida-paulista-passeio/ These global examples also demonstrate how walking can be central to wider improvements to place-based projects and achieving wider objectives. From early 2019 **Google Maps** has been trialling AR (augmented reality) navigation to help users navigate when walking. The camera on the back of the phone is used to identify a user's location and superimposes directions and details on the display aiding the navigation process. Source:https://www.pocket-lint.com/apps/news/google/147956-what-is-google-maps-ar-navigation-and-how-do-you-use-it There are currently limited innovations focussing on enhancing walking as a mode.	
Notable Failures	As part of its **Inclusive Transport Strategy**, launched in July 2018, **DfT** brought in a moratorium on all new **'shared space'** schemes. Such schemes often provide a flat open surface with no level differences or curbs differentiating between areas for pedestrians and those for traffic. This has led to concerns and complaints from visually impaired groups who say that such schemes are dangerous as it is difficult for people with such impairments to find the transition between pedestrian and vehicular space. Whilst the wording of the moratorium created some confusion amongst practitioners, the overall result has been that such schemes, where there is no physical differentiation (such as kerbs), have been halted and are no longer seen as best practice. Source:https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/728547/inclusive-transport-strategy.pdf There is a need to consider all users in the development of new transport schemes and that whilst improvements may be beneficial overall, some groups may be disadvantaged significantly. **Transport for London** previously introduced plans to pedestrianise Oxford Street, however **Westminster City Council** stated that a majority of the public were against the proposals to make it traffic free because they were concerned about the knock-on impact on traffic on surrounding roads. Instead, a **Place Shaping and Delivery Plan** has now been approved by Westminster Council. This includes reducing congestion and pollution by re-routing buses around the Oxford Circus district, closing some surrounding streets to cars and buses during the busiest times of day, and reducing speed limits from 30mph to 20mph. The area will be part pedestrianised with a new "public piazza" created on either side of the junction with Regent Street.	

	Source: https://www.theguardian.com/environment/bike-blog/2018/sep/13/westminster-councils-actions-show-it-puts-cars-first-not-people https://londonist.com/london/news/oxford-street Engagement with users is key to delivering locally-specific and appropriate improvements and they can be substantially improved following inputs from the public.			
Spatial Typologies	City Centre		Remote Rural	
	Small Town		Parkway	
	Suburb		Business Park	
	Village			
Spatial Density	High Density			
	Medium Density			
	Low Density			
Summary	▪ Walking forms part of the vast majority of journeys whilst also being the only mode used for a significant proportion. Walking has significant economic, wellbeing and environmental benefits but has limited opportunities for commercialisation and further technical development. ▪ However, provision of infrastructure to support walking (and other active modes) can form parts of wider place-making schemes which bring wider benefits to areas. ▪ Walking needs to be central to the provision of FMLM journeys and any supporting strategy. ▪ The best practice highlighted in this dashboard provide examples of approaches to encouraging walking, including as part of wider place-making projects, which are applicable across a range of spatial typologies within the EEH area			

CYCLING

Self-powered and Owned

Mode: Cycling (self-powered & owned)

Definition	A journey undertaken by a bicycle / tricycle
Sub-Models	A journey undertaken by a bicycle / tricycle that is self-powered and is owned by the user
Typical Use Cases	▪ Travelling between home and major transport hub ▪ Travelling between home and work location or place of education ▪ Travelling between home and retail centre ▪ Cycling for leisure
Benefits	▪ Economic • Flexible and on-demand • Low operational cost to user after initial purchase • High levels of non-mode specific infrastructure in place in most urban and many rural locations but lower provision of mode specific infrastructure • Reduces reliance on motorised travel • Reduction in short journeys by single occupancy vehicles ▪ Environment • Limited resource requirements • Zero carbon emissions at point of use • Low noise • Limited impact on built and natural environment • Limited waste materials ▪ Wellbeing • Physical and mental wellbeing benefits • Widely accessible to those without significant health impairment
Opportunities	▪ Economic • Mode shift may reduce some capacity issues on other modes • Improved health and wellbeing may have wider economic benefits and potential cross sector cost savings • Reduced transport costs ▪ Environment • Increases in mode use will reduce carbon emissions and improve air quality • Increases in cycling may reduce transport-related noise ▪ Wellbeing • Increase cycling can improve physical and mental health
Barriers	▪ Economic • Infrastructure capacity where demand is high and infrastructure provision is inconsistent within and between areas • Initial purchase costs and subsequent maintenance • Availability of infrastructure particularly in rural areas • New infrastructure can be expensive

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Lack of space for enabling and connected infrastructure
Limited revenue opportunities
Poor interchange provision and parking – at destinations, onboard mass transit and at hubs
Theft, vandalism and damage, including lack of secure parking availability

Environment

Unattractive cycling environments

Wellbeing

Lack of training and competency
Lack of physical capability
Perception of fitness requirements
Inconvenience for clothing
Unattractiveness and inconvenience of helmet wearing
Weather conditions can reduce attractiveness
Perceived and actual safety of users and others
Perceived and actual security of users
Overcoming existing habits

</td></tr>
<tr><td rowspan="2">Technical Maturity</td><td>Concept</td><td>Feasibility</td><td>Piloting</td><td>Initial real-world operation</td><td>Mature technical operation</td></tr>
<tr><td colspan="5">Cycles have continued to develop over the last few decades with increasing levels of technology making them lighter and easier to use. Improvements have also been made in cycling clothing and protection equipment (such as lighting) helping to improve the cycling experience and safety.</td></tr>
<tr><td rowspan="2">Commercial Maturity</td><td>Not operating commercially in the UK</td><td>Commercial testing/pilot</td><td>Commercial launch</td><td>Operating commercially</td><td>Mature commercial operation</td></tr>
<tr><td colspan="5">The purchase of cycles and related goods, as well as maintenance, is commercially mature.</td></tr>
<tr><td>Business Models</td><td colspan="5">The development of business models for owned cycles has been limited to their sale and maintenance. However, in recent years the development of cycle hubs at major interchanges and other locations has provided business opportunities to support cyclists.</td></tr>
<tr><td rowspan="2">Journey Range</td><td></td><td><10km</td><td></td><td></td><td></td></tr>
<tr><td colspan="5">The under 10km range relates to ‘typical’ users and does not necessarily represent the journey range of a fit/competitive individual</td></tr>
<tr><td>Supporting infrastructure and systems</td><td colspan="5">

Data, websites and apps for journey planning
Standard ‘all vehicle’ carriageway provision for cycles
Cycle route infrastructure and crossings
Cycle storage
Cycle hubs
Showers and lockers

</td></tr>
</table>

UK Best Practice Example

The **Mini-Holland Programme** in **London** provided £30m to three outer London Boroughs (Enfield, Kingston and Waltham Forest) to help them create a network of cycle routes. The 'Mini-Hollands' are designed to have features that make cycling feel safer and more convenient, targeting people who make short car journeys in outer London that could easily be cycled or walked instead. As a result of the programme, the proportion of people cycling in these boroughs has increased by 18%.

Source: https://tfl.gov.uk/travel-information/improvements-and-projects/cycle-mini-hollands

The Mini-Holland programme aims to make cycling more accessible and attractive to all by improving safety and convenience. This project illustrates that these types of improvements can encourage substantial increases in cycling.

Bristol has plans to double cycling levels between 2013 and 2020. This has involved creating a series of segregated cycle lanes including a 200m segregated cycle route along Baldwin Street that forms part of an East-West city centre route which includes one of Bristol's most popular cycle paths, Castle Park. Additionally, Bristol has introduced bus stop bypasses as part pf the cycle lanes. The bypasses enable cyclists to ride round the inside of stopped buses and bus stops rather than pulling out into traffic. Additionally, several routes have Toby bollards, which protect cyclists from passing traffic.

Source: https://www.cyclingweekly.com/news/latest-news/five-uk-cities-outside-london-with-dutch-style-cycle-infrastructure-154996

Similar to the Mini-Holland Programme, these interventions aim to increase cycle safety and accessibility. This project demonstrates that other road users can also be positively impacted as the street design reallocates space for bus bypasses that can reduce conflict between cyclists and other traffic.

The **Bee Network** is a vision for **Greater Manchester** to become the very first city region in the UK to have a fully joined up cycling and walking network; the most comprehensive in Britain covering 1,800 miles. The aim of the proposals is to connect every neighbourhood and community in Greater Manchester, as well as providing a clear strategy for effective delivery of a network that will make cycling and walking a viable choice for many of those that don't currently use active travel.

Source: https://tfgm.com/made-to-move/bee-network

The Bee Network sets out comprehensive and ambitious plans for encouraging active travel across

	a city region. This example promotes a long-term and area-wide approach to improving provision and encouraging the take up of active modes.	
Europe Best Practice Example	'**Good, Better, Best' Copenhagen's Bicycle Strategy** 2011-2015 sets out aims and aspirations for the Danish capital to become the world's best cycling city. Data from 2018 showed a 49% modal split for work and education trips versus 6% walking, 18% public transport and 27% car. **Copenhagen's** approach focuses on enabling cycling for all, at all times of year and for every type of activity. Source:https://kk.sites.itera.dk/apps/kk_pub2/pdf/823_Bg65v7UH2t.pdf The implementation of a strong strategy can significantly impact the proportion of those travelling by bike to work. **Utrecht** (Netherlands) is a rapidly growing city that wants to make cycling even more attractive for the over 100,000 people who already ride their bike as part of their commute. The city has improved main routes, built cycle streets, bicycle bridges, bicycle subways and roundabouts. It has also improved bicycle parking facilities at Utrecht's Train Station, aiming to increase cycle parking from 12,500 bicycles to a total of 33,000 by 2020. Source: https://bicycledutch.wordpress.com/2016/04/19/utrecht-cycling-city-of-the-netherlands/ **Groningen (Netherlands)** has ensured bikes are competitive with cars with good route planning. High-quality cycle tracks go directly from residential areas to the centre, whereas motorised vehicles need to go around the ring road. The journey from residential areas to the city centre may be twice as long by car when compared to cycling. In addition, cycling along the good quality cycleways is more attractive as they run separately from car traffic. The convenience and speed are increased by cycle tracks having right of way over distributor roads and residential streets. Source: http://www.tut.fi/verne/wp-content/uploads/Best_European_Practices.pdf The Groningen example illustrates that high quality cycle infrastructure, combined with journey time hinderances to motor vehicles, can make cycling more attractive for some journeys. The **Vennbahn Cycle Route** is Europe's longest disused railway cycle path, specifically developed as a tourism product exploiting the rail bed and associated infrastructure of tunnels and bridges, the region's scenic beauty and its cultural heritage. The cycle trail stretches 125km from Aachen in Germany, through east Belgium and ending in Luxembourg. In 2015, the number of recorded cycle trips was over 300,000 and	   

	the hotel occupancy rate in the region has increased by up to 20%. Source: https://www.vennbahn.eu/en/about-the-project/ The utilisation of current or historic infrastructure for cycle routes can encourage a significant number of trips to be made by cycle. It also shows that cycle routes can be implemented in scenic areas with minimal impact on the cultural heritage.	
Global Best Practice Example	In **Tokyo** (Japan), one fifth of the metropolitan area's 20 million rail commuters cycle to the station and in many neighbourhoods the modal share can reach 30 percent. This is due to the large numbers of parking facilities for bikes, including parking cellars located near train stations. Source: https://www.dailymail.co.uk/news/article-2386880/Tokyos-underground-cycle-rack-holds-200-bikes-streets.html Tokyo's approach to cycle parking, particularly at train stations, demonstrates that innovative and high-quality cycle parking solutions can increase mode share. New buildings in **Portland**, Oregon may be required to provide parking for cycles. The currently being developed amendments to policy would require all new buildings in Portland larger than five residential units to provide some form of bike parking. If the building has 12 units or less, the parking could be located inside the apartment near the main entrance. For larger buildings, at least half of the parking would need to be in a dedicated bike room. Space would need to be made for large bikes and those that need electric sockets to charge. All long-term parking spaces would need to be covered and well-lit. Source: https://www.opb.org/news/article/portland-oregon-bike-parking-requirement-buildings/ Government policy can be implemented to ensure developers include cycle parking as part of residential and mixed-use developments	
Notable Failures	In June 2019, cycling commissioners in the **UK** wrote to the transport secretary stating that painted cycle lanes do not make people feel safer. The letter stated that "as there are currently no national minimum safety standards for walking and cycling infrastructure, these practices can and will continue wasting public money and failing to persuade people to change their travel habits". Source: https://www.theguardian.com/politics/2019/jun/17/painted-bike-lanes-waste-money-cycling-commissioners The level of segregation and the quality of cycle infrastructure can impact the propensity for people to cycle. Safety perceptions of current infrastructure can prevent some people from cycling. Cycling across the **US** has generally increased 61% between the 2000 census and a 2008-2012 survey. Despite this, the research findings show that cycling in low-income areas	

	such as east of the Anacostia River, Washington DC, remains low despite the recent substantial cycling infrastructure. Source: https://www.citylab.com/transportation/2014/07/how-low-income-commuters-view-cycling/374390/ Even with improved infrastructure, some parts of the community, particularly low-income groups, can be reluctant to cycle or feel a disconnect from cycling, resulting in lower rates of uptake compared to other parts of the population. This indicates a need to have interventions particularly targeting low-income areas.			
Spatial Typologies	City Centre		Remote Rural	
	Small Town		Parkway	
	Suburb		Business Park	
	Village			
Spatial Density	High Density			
	Medium Density			
	Low Density			
Summary	▪ Cycling using a self-powered and owned bike is a technically and commercially mature mode but makes up a relatively small proportion of all journeys in the UK. However, UK, European and Global best practice indicates that comprehensive planning and provision of supporting infrastructure can have significant impacts on encouraging the uptake of this mode which has significant economic, wellbeing and environmental benefits. The best practice provides examples that are applicable in areas across EEH. ▪ At present the majority of FMLM journeys by bike are by owned rather than shared bikes and this is likely to remain the case for first mile journeys from home locations, particularly in less dense locations. However, in the densest locations, where shared bikes are more widely available, owned bikes may decline significantly as a proportion of all cycle journeys.			

Powered and Owned

Mode: Cycling (powered & owned)

Definition	A journey undertaken by a power-assisted bicycle / tricycle
Sub-Models	A journey undertaken by a bicycle / tricycle that is power-assisted and is owned by the user
Typical Use Cases	▪ Travelling between home and major transport hub ▪ Travelling between home and work location ▪ Travelling between home and retail centre ▪ Cycling for leisure
Benefits	▪ Economic • Flexible and on-demand • Low operational cost to user after initial purchase • High levels of non-mode specific infrastructure in place in most urban and many rural locations but lower provision of mode specific infrastructure • Reduces reliance on motorised travel • Reduction in short journeys by single occupancy vehicles ▪ Environment • Limited resources requirements • Zero carbon emissions at point of use • Low noise • Limited impact on built and natural environment • Limited waste materials ▪ Wellbeing • Physical and mental wellbeing benefits • Widely accessible to those without significant health impairment
Opportunities	▪ Economic • Mode shift may reduce capacity issues on other modes • Improved health and wellbeing may have wider economic benefits • Reduced transport costs • Potential for further development of technologies ▪ Environment • Increases in mode use will reduce carbon emissions and improve air quality • Increases in cycling may reduce transport-related noise ▪ Wellbeing • Increase cycling can improve physical and mental health • Powered bicycles extend the physical activity in later life and for the less able
Barriers	▪ Economic • Infrastructure capacity where demand is high • Higher initial purchase costs than self-powered bicycles, maintenance of drive train is a specialist skill • Availability of infrastructure particularly in rural areas • New infrastructure can be expensive • Lack of space for enabling infrastructure

<table>
<tr><td></td><td>

Limited revenue opportunities
Poor interchange provision and parking – at destinations, onboard trains and at hubs
Theft, vandalism and damage

Environment

Unattractive cycling environments

Wellbeing

Lack of training and competency
Lack of physical capability
Perception of fitness requirements
Weather conditions can reduce attractiveness
Perceived and actual safety of users and others
Perceived and actual security of users
Overcoming existing habits

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</td></tr>
<tr><td>E-bikes are now in mature technical operation and are becoming mainstream in the UK. In 2018 more e-bikes were sold in the Netherlands than traditional pedal-powered cycles[1]. E-bikes are continuing to develop, getting lighter and with larger battery capacities.

In the UK, HMRC figures show that 63,500 e-bikes were imported in 2018, only 1.8 more than in 2017. However, the overall value of those imports rose by 9.5%.</td></tr>
<tr><td rowspan="2">Commercial Maturity</td><td>
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<tr><td>Not operating commercially in the UK</td><td>Commercial testing/pilot</td><td>Commercial launch</td><td>Operating commercially</td><td>Mature commercial operation</td></tr>
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</td></tr>
<tr><td>The purchase of cycles and related goods, as well as maintenance, is commercially mature but e-bike maintenance is a relatively specialist skill.</td></tr>
<tr><td>Business Models</td><td>The development of business models for owned cycles has been limited to their sale and maintenance.</td></tr>
<tr><td rowspan="2">Journey Range</td><td>
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Data, websites and apps for journey planning
Standard ‘all vehicle’ carriageways
Cycle route infrastructure and crossings
Cycle storage
Charging points
Cycle hubs
Showers and lockers

</td></tr>
</table>

[1] https://www.welovecycling.com/ie/2019/03/25/e-bikes-outselling-standard-bikes-in-netherlands/

	▪ Specialist maintainers	
UK Best Practice Example	**E-bikes London** (in partnership with Transport for London) enables potential buyers of an e-bike to take a free e-bike test ride to understand how they work and to help with choosing one that is right for them. The website also provides advice and support for e-bike users, including maintenance as well as information on the latest e-bike offers. Furthermore, e-bikes are now part of the government's '**Cycle to Work Scheme**' enabling participants to save money on purchasing an e-bike and associated cycle kit. Source: https://ebikes.london/ Marketing, test-riding and financial incentives provide opportunities to increase the update of e-bikes. In 2015, **DfT** distributed funding for the **Electrically Assisted Pedal Cycle Sharing Pilot Scheme**. Eleven local authorities, including rural areas such as Hebden Bridge in hilly West Yorkshire, were awarded funding to offer a variety of opportunities to hire e-bikes. These included ▪ a new tourist cycle-hire scheme offering 25 e-bikes to visitors in the Isle of Wight, ▪ a housing association setting up a trial to install 18 e-bikes in low-income communities to provide cheaper, convenient and more accessible travel ▪ 20 e-bikes to encourage more students to cycle to the University of Brighton. Source: https://www.gov.uk/government/news/cycling-revolution-goes-electric There is a range of potential approaches to increasing the uptake of e-bikes and supporting a range of different use cases. In June 2018, the **Scottish Government** announced funding to encourage the use of e-bikes, particularly for shorter journeys. The **E-bike Grant Fund** allocates funding for local authorities, public sector agencies, community organisations, colleges and universities to encourage large-scale e-bike adoption. Grants are expected to fund e-bike pools, secure cycle parking and safety equipment. Source: https://www.bicycleassociation.org.uk/wp-content/uploads/2019/07/The-Case-for-a-UK-Incentive-for-E-bikes-FINAL.pdf Investment in infrastructure and equipment may be needed locally to support an increased uptake of e-bikes.	 

Europe Best Practice Example	An e-bike project was carried out in **Halmstad, Sweden** for a period during 2014 and 2015. The project was aimed at avid car users who wanted to start cycling - participants were given a e-bike and a helmet to borrow for a period. In the following year after the end of the project, half of the participants had continued to cycle at least three days per week. Furthermore, the participants had the opportunity to buy the e-bike after the project, and one-third of them did so. Source: https://www.eltis.org/discover/case-studies/encouraging-halmstad-drivers-use-e-bikes-sweden Test-riding of e-bikes can be a useful tool in encouraging mode shift. In **Sweden,** a national grant scheme was introduced in early 2018, subsidising purchases of e-bikes by 25% up to maximum of 10,000 SEK (around £798). By the start of October 2018, more than 87,000 grants had been made to a total value of over 368m SEK (around £29m). The scheme covered e-bikes, mopeds, motorbikes and vehicles intended for people with physical impairments. Just under 92% of grants were for e-bikes, with demand spread widely across the country. Source: https://www.bicycleassociation.org.uk/wp-content/uploads/2019/07/The-Case-for-a-UK-Incentive-for-E-bikes-FINAL.pdf Subsidies can encourage significant uptake of e-bikes.	 
Global Best Practice Example	Since 2007, Austin Energy in **Austin, Texas** has offered incentives for EVs, including e-bikes, scooters, mopeds, and motorcycles. They offer a flat rate that is variable based on the price of the vehicle. For example, an e-bike under $500 receives $50 whereas an e-bike over $2000 would receive $300. The program has seen relatively high levels of participation, around 100 per year since the program began. Source: https://peopleforbikes.org/wp-content/uploads/2019/05/E-bike-Incentives-Paper-05_15_19-Final.pdf Subsidising e-bikes can increase uptake by incentivising potential users who may not be able to afford the upfront cost.	
Notable Failures	In **China,** some cities are banning the adoption of e-bikes due to the lack of proper infrastructure and government regulations. In many cities, electric bikes dominate cycle lanes at the expense of self-powered bikes and have led to significant problems with rider behaviour. In addition, it is common for more than one person to ride the same e-bike on the streets. The traffic violations have led to a very high number of e-bike fatalities, and consequently, some cities decided to ban the use of e-bikes. Source: https://www.forbes.com/sites/wadeshepard/2016/05/18/as-china-chokes-on-smog-the-biggest-adoption-of-green-transportation-in-history-is-being-banned/#65b98df7141b	

Spatial Typologies	City Centre		Remote Rural	
	Small Town		Parkway	
	Suburb		Business Park	
	Village			
Spatial Density	High Density			
	Medium Density			
	Low Density			
Summary	▪ E-bikes present a significant opportunity to encourage more people to cycle through the reduced need for physical fitness. ▪ E-bike uptake has increased substantially in recent years with the Netherlands now selling more e-bikes than conventional pedal-cycles. ▪ However, the higher purchase costs are a barrier to this mode but some success has been achieved in encouraging their uptake through subsidies. Consideration also needs to be given to supporting infrastructure including charging and secure parking; the latter due to increased risk of theft as a result of their higher value.			

Self-powered and Shared

Mode: Cycling (self-powered & shared)

Definition	A journey undertaken by a bicycle / tricycle
Sub-Models	A journey undertaken by a bicycle / tricycle that is self-powered using a shared bicycle collected from a docking station or dockless
Typical Use Cases	▪ Travelling between home and major transport hub ▪ Travelling between home and work location ▪ Travelling between home and retail centre ▪ Cycling for leisure
Benefits	▪ Economic • Flexible and on-demand • Removal of initial purchase cost • High levels of non-mode specific infrastructure in place in most urban and many rural locations but lower provision of mode specific infrastructure • Reduces reliance on motorised travel • Reduction in short journeys by single occupancy vehicles • Improved last-mile mode choice • Improved integration with other modes ▪ Environment • Limited resources requirements • Zero carbon emissions at point of use • Low noise • Limited impact on built and natural environment • Limited waste materials ▪ Wellbeing • Physical and mental wellbeing benefits Widely accessible to those without significant health impairment
Opportunities	▪ Economic • Mode shift may reduce some capacity issues on other modes • Improved health and wellbeing may have wider economic benefits and potential cross sector cost savings • Reduced transport costs ▪ Environment • Increases in mode use will reduce carbon emissions and improve air quality • Increases in cycling may reduce transport-related noise ▪ Wellbeing • Increase cycling can improve physical and mental health
Barriers	▪ Economic • Infrastructure capacity where demand is high • Ongoing operational and participation costs including need for subsidy • Availability of infrastructure particularly in rural areas • New infrastructure can be expensive • Lack of space for enabling infrastructure

	• Theft, vandalism and damage • Self-powered bikes have lower level of usage than powered shared bikes (approximately half)[2] ▪ Environment • Unattractive cycling environments ▪ Wellbeing • Lack of training and competency • Lack of physical capability • Perception of fitness requirements • Weather conditions can reduce attractiveness • Perceived and actual safety of users and others • Perceived and actual security of users • Overcoming existing habits				
Technical Maturity	Concept	Feasibility	Piloting	Initial real-world operation	Mature technical operation
	Self-powered docked cycle hire schemes are now technically mature with proven systems in a number of locations in the UK, Europe and globally. Dockless schemes in the UK have been initially operated in the real-world but have suffered from technical issues around theft and vandalism.				
Commercial Maturity	Not operating commercially in the UK	Commercial testing/pilot	Commercial launch	Operating commercially	Mature commercial operation
	Self-powered docked cycle hire schemes are commercially mature albeit with substantial subsidies required. Dockless schemes have proven to be substantially less commercially viable with a number of failures in the UK and abroad.				
Business Models	The business models focus on docked or dockless systems and either on account or pay-as-you-go. However with the advent of Mobility as a Service, cycle hire can be packaged as part of subscription services.				
Journey Range		<10km			
	Note this is in terms of 'normal' users and does not necessarily represent the journey range of a fit/ competitive individual				
Supporting infrastructure and systems	▪ Data, websites and apps ▪ Standard 'all vehicle' carriageways ▪ Cycle route infrastructure and crossings ▪ Docks (for docked schemes) ▪ Showers and lockers				

[2] https://ice.org.uk/getattachment/eventarchive/wales-national-transport-conference-2019-cardiff/Krysia-Solheim-Nextbike.pdf.aspx

UK Best Practice Example	**Santander Cycles** operate docked bike schemes in Milton Keynes and London. In **Milton Keynes** there are 42 docking stations consisting of 300 cycles that can be rented by visitors and residents of the area. In **London** the Santander Cycles make up the largest cycle hire scheme in Europe with over 11,000 bikes and 800 docking stations. Cycles may be rented at any time and the first 30 minutes of each trip is free of charge. The London scheme achieved 10.5m hires in 2018 equivalent to almost 29,000 hires per day. Source: https://www.santandercycles.co.uk/ The Santander cycle hire projects demonstrate the potential for such schemes and the scale that they can achieve however both installation and operating costs are comparatively higher than dockless schemes. **NextBike** in **Cardiff** is expanding its offering with more bikes and docking stations across the city due to demand. Nextbikes have been used on more than 500,000 rides by almost 50,000 registered customers across Cardiff since the scheme started in May 2018. The scheme has been particularly successful in attracting students with 5,300 of Cardiff University's students (15%) signing up and in some months they make up around 50% of the hires. Source: https://www.walesonline.co.uk/news/local-news/nextbike-cardiff-next-bike-stations-16409426 **City Bike** in **Liverpool** is a docked bike sharing scheme that consists of 1,000 bikes available for hire from 140 docking stations. Membership is low cost from £3 per day, £9 for a week or £60 for a year allowing the cycles to be used by many of Liverpool's residential population and visitors. Source: https://www.citybikeliverpool.co.uk/ These UK examples of cycle hire schemes demonstrate that such projects can generate significant levels of membership and increase the number of journeys that are being made by bike helping to achieve wider objectives around environment and wellbeing. The Next Bike operation demonstrates that cycle hire schemes can work in locations where weather conditions are generally less favourable.	 
Europe Best Practice Example	**Dublin** has one of the most successful bike rental schemes worldwide. In September 2009, Dublin City Council introduced the '**Dublinbikes**' public bike rental scheme. Since then, the scheme has gone from strength to strength with 91,000 subscribers and more than 4.7 million journeys recorded to date. The scheme's 550 bikes, hired from 58 stations located across the city, are used on average 5,000 – 7,000 times per day, Monday to Friday, with 95% of all journeys being less than 30 minutes and not incurring a rental fee. Source: http://www.dublinbikes.ie/How-does-it-work	

The large number of journeys by Dublin's bike rental scheme shows how implementing bike rental locations can encourage people to cycle within the city, particularly for shorter journeys. Dublin has seen more intense use of its bike scheme than in London.

In the Netherlands the OV-fiets bike share scheme is nationwide and has 300 rental locations at railway stations, bus stations, metro stations and at Park & Ride sites. The scheme is marketed towards users for the last mile of their journey. OV-fiets offers multiple ticket types including season tickets, day returns, single journeys and tourist tickets.

Source: https://www.ns.nl/en/door-to-door/ov-fiets

Global Best Practice Example

The Hangzhou Public Bicycle Initiative in southeast China consists of a fleet of more than 66,000 bikes with plans to reach 175,000 over the next six years. The scheme began in 2008 with 2,000 bikes, to initially cater for the city's seven million inhabitants. The distinctive red bikes – some of which even come complete with child seats – can be accessed from any one of the 2,700 bike share stations spread 200-300m apart within the city centre and 500-800m apart in the suburbs. Funded by the local government, users hand over a returnable deposit of 23 pounds ($30) and can use a bike for free for the first hour.

Source: http://www.chinadaily.com.cn/china/2017-06/14/content_29733704.htm

Adaptive Biketown in **Portland,** Oregon, rents out cycles for people with a range of disabilities, including tandems, handcycles and tricycles, and aims to increase access to cycling for all disabled people.

Source: https://wheelsforwellbeing.org.uk/wp-content/uploads/2017/11/v2-Nov-2017.pdf

Bike share schemes can be inclusive and open the possibility of cycling to more parts of the community and can encourage greater uptake in cycling.

Notable Failures

Ofo is a **Chinese** dockless bike-sharing firm that allows users to hire bikes and leave them at their destination using a phone application rather than dock. However, after launching in the UK, Ofo pulled out of multiple cities including **Norwich, Sheffield, Oxford and London** due to financial issues. This was reportedly due to the lack of take-up and vandalism.

Source: https://www.theguardian.com/uk-news/2019/jan/10/ofo-cycle-hire-firm-pulls-out-of-london

Contrary to some of the above examples, Ofo experienced a low uptake in usage of the bikes which, along with other factors, eventually led to the firm pulling out of multiple UK cities.

Mobike's first dockless bike-sharing scheme in Europe was launched in **Manchester** but after signing up a significant user base, the company had to withdraw due to the particularly high and unsustainable level of theft and vandalism of their bikes with up to 10% being lost each month. The remaining bikes from the closed scheme were transferred to their operations

elsewhere, however, they have also withdrawn from some other UK operations for similar reasons.

Source: https://www.theguardian.com/uk-news/2018/sep/05/theft-and-vandalism-drive-mobike-out-of-manchester

Mobike's dockless system was particularly vulnerable to theft and vandalism and was launched in Manchester with limited engagement with the local authorities. Consideration needs to be given to local circumstances and partnerships in the development of micromobility sharing schemes.

The **Canal and River Trust** has called for cycle hire firms to do more to help clear dumped bikes from canals. The Trust said it was growing increasingly frustrated by the number of hire bikes abandoned in and beside its 2,000-mile network. It said more than 100 hire bikes a year were being thrown into canals in **London** alone.

Source: https://www.theguardian.com/uk-news/2019/jul/21/cycle-hire-firms-urged-to-help-clear-dumped-bikes-from-canals

Vandalism of dockless bikes has wider impacts with other organisations being affected by dumped bikes, leading to clear-up costs.

In July 2019, officials admitted that the **West Midlands** flagship bike-share scheme, West Midlands Bike Share had been a failure due to the supplier **Nextbike** only delivering 25 of the 5,000 promised bikes. In a statement by WMCA, the Nextbike contract was terminated "after persistent breaches by the provider".

Source: https://www.birminghammail.co.uk/news/midlands-news/mayor-andy-streets-boris-bike-16645039

https://www.networkwestmidlands.com/ways-to-travel/cycling/west-midlands-bike-share/

https://www.wmca.org.uk/news/statement-on-the-west-midlands-bikeshare-scheme/?_ga=2.255646216.1074810777.1572603656-448876852.1572603656

Despite the success of large-scale cycle hire schemes around the UK and abroad, there remains potential for failure in the market.

Spatial Typologies	City Centre		Remote Rural	
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	Village			
Spatial Density	High Density			
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	Low Density			

Summary

- The self-powered and shared approach to cycling is now a mature model, both technically and commercially with some very large operations around the world including a number in the UK. These primarily remain focussed in the densest spatial areas with lower viability elsewhere.
- However, whilst there have been successes, there remains significant scope for failure with many schemes requiring significant subsidy and some very recent examples in major cities

with otherwise well operating transport networks.

- Shared cycles do, however, provided true last mile capabilities between hubs and end destinations and avoid some limitations of owned cycles including carrying capacity on mass transit. The above best practice examples show what is achievable with evidence applicable to locations within the EEH area.

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Opportunities	▪ Economic • Mode shift may reduce some capacity issues on other modes • Improved health and wellbeing may have wider economic benefits and potential cross sector cost savings • Reduced transport costs • Potential for further development of technologies • Shared e-bikes have a higher (approximately double) level of usage than self-powered bikes ▪ Environment • Increases in mode use will reduce carbon emissions and improve air quality • Increases in cycling may reduce transport-related noise ▪ Wellbeing • Increase cycling can improve physical and mental health • Powered bicycles extend the physical activity in later life and for the less able

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Infrastructure capacity where demand is high
Ongoing operational and participation costs
Availability of infrastructure particularly in rural areas
New infrastructure can be expensive
Lack of space for enabling infrastructure
Impacts on existing built environment
Limited revenue opportunities
Poor interchange provision and parking – at destinations, onboard trains and at hubs
Theft, vandalism and damage

Environment

Unattractive cycling environments

Wellbeing

Lack of training and competency
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Standard ‘all vehicle’ carriageways
Cycle route infrastructure and crossings
Docks (for docked schemes) including charging points for e-bikes
Showers and lockers

</td></tr>
<tr><td>UK Best Practice</td><td colspan="5">Introduced in 2016, Exeter’s Co-bikes are the first city-wide electric shared bike scheme in the United</td></tr>
</table>

Example	Kingdom. Funding was awarded by the Department for Transport (DfT) to Bike Plus in March 2015, providing £700,000 to allocate across the partner cities (DfT, 2015). Through collaboration with Devon County Council, Co-bikes has managed to expand the existing network from three docking stations in 2016 to seven in 2018 with a total of 20 bikes. Source:https://tps.org.uk/public/downloads/FqIRG/TPM%202019%20Best%20Paper-%20Lessons%20learnt%20from%20the%20first%20fully%20electric%20bike%20share%20scheme%20in%20the%20UK.pdf Due to the success of the scheme and the optimisation of different funding streams, Co-bikes in Exeter has expanded its network. This example shows that exploiting all funding opportunities can help to support the success of a shared e-bike scheme. However, the network remains small in comparison to many other self-powered hire bike schemes. In 2018 **Milton Keynes** launched the country's first fleet of **Lime-E** electric-assist bikes. The e-bikes are equipped with a 250-watt motor and a rechargeable lithium battery and cost just £1 to unlock and 15p per minute to ride. The scheme is dockless and app based so can be accessed by anyone and initially started with around 100 bikes. Source: https://www.li.me/second-street/lime-launches-smart-mobility-in-the-uk In May 2019, Uber launched electric '**JUMP**' bikes in areas across **London**. The bikes feature an electric pedal-assist of up to 15mph, have adjustable seats and a basket for the users' belongings. Additionally, each bike is GPS tracked and has a built-in cable lock so that users can easily locate and park the bikes using Ubers app. Finally, each bike costs £1 to unlock and users can use the service free of charge for the first five minutes before being charged at a rate of £0.21 per minute. Source: https://www.jump.com/gb/en/cities/london/ Powered and shared bike schemes are becoming established in the UK but are not at the level of maturity of self-powered schemes.	 
Europe Best Practice Example	**Bycyklen** in **Copenhagen** is a docked bike share scheme that consists of 1,800 electric bikes and over 100 docking stations. The bike has an electric motor that can assist up to 24 km/h with a range of up to 25km. The bikes are pay-as-you-go and cost DKK12 per minute. Source: https://bycyklen.dk/en/ In 2015, **Milan** introduced 1,000 electric bicycles to its **BikeMi** bicycle network, boosting the total number of public bikes in the city to 4,600. The bicycles include	

batteries which allow a range of 55-65km on a single charge and can be re-charged up to 300 times. The electric bicycles cost € 0.25 for the first half-hour, rising to € 3.75 for two hours.

Source: https://www.eltis.org/discover/news/milan-adds-1-000-e-bikes-city-bike-scheme-italy

Águeda introduced an electric bike sharing scheme **'BeAgueda'** in 2011 in order to encourage people to cycle in the hilly city. In the first phase of the scheme, 10 electric bikes were docked at a station next to the City Hall. The bicycles were used to travel around 40,000 km in their first four years of operation. Users paid a fixed annual fee to use the bikes, after which their use was free. The bikes were available during the day and were then recharged at night. In response to demand from citizens, the city is now planning to introduce a larger electric bike share scheme, which will have 20 electric bikes stationed at four locations. All bicycles will be fitted with GPS and the system will be complemented by a smartphone app.

Source:https://ec.europa.eu/transport/themes/urban/cycling/guidance-cycling-projects-eu/cycling-measure/bicycle-sharing_en

BeAgueda demonstrates how implementing an electric bike share scheme can overcome topographical barriers to traditional cycling.

There can be variety in the offering of different bike share schemes from bikes with different ranges to the business model and cost. Some schemes, such as BeAgueda, offer an annual fixed fee whereas others are pay-as-you-go such as BikeMi and Bycyklen where users pay per-minute for the duration of the rental.

Global Best Practice Example

The launch of an e-bike share scheme in **Summit County, Utah**, USA marked a significant milestone, as it was the first 100% electric-assist bike share system in North America. System statistics revealed that people were using the system in great numbers, with approximately 85,000 trips resulting in more than 160,000 miles travelled since the start of their operation in July 2017.

Source: https://bewegen.com/en/bike-share-case-studies/summit-county

The launch of an e-bike share scheme in **Peninsula Papagayo, Costa Rica** is a model for shared mobility in a private setting. Bewegen's electric-assist bike share is a clean-energy transportation solution supporting the environmental credentials of the region. System statistics revealed that over 8,000 trips resulting in more than 34,000 miles have been travelled since the start of operation in August 2018.

Source: https://bewegen.com/en/bike-share-case-studies/peninsula-papagayo

Notable Failures	Although **Derby's** e-bike scheme saw more than 7,000 riders travel 150,000 miles, the scheme was closed down due to vandalism. The scheme saw 200 electric bikes provided for hire via an app or website and thirty docking stations were installed. The estimated costs of repairs have been described as "significant" and **Hourbike**, which ran the scheme, said that it had become unaffordable. Source: https://www.derbytelegraph.co.uk/news/derby-news/derbys-ebike-scheme-closes-after-3099864 Similar to the self-powered and shared cycle schemes, vandalism has played a role in the closing down of the Hourbike scheme in Derby – even though the service was well used. **Citi Bike's** fleet of pedal-assist electric bicycles in **New York** has been grounded since May 2019. The company announced that a redesign for e-bikes is currently underway, with a rollout of that new model expected in the autumn. Some riders experienced issues with the bikes' brakes, with dozens of incidents reported, some of which led to injuries for riders. Source: https://ny.curbed.com/2019/5/13/18617801/citi-bike-electric-bike-lyft-motivate-redesign Bike safety and issues with the functionality of the e-bikes has caused Citi Bike in New York to pause operations.

Spatial Typologies				
	City Centre		Remote Rural	
	Small Town		Parkway	
	Suburb		Business Park	
	Village			

Spatial Density	
	High Density
	Medium Density
	Low Density

Summary	
	▪ E-bike hire is commercially less mature than the pedal-powered equivalent schemes but there are growing examples of success in this market with the focus again being on the most dense spatial areas. ▪ Similarly to the pedal-powered schemes, whilst there has been success there remains scope for failure and long term subsidy can be required. ▪ E-bikes provide longer range and reduced issues regarding the need for physical fitness, particularly in areas with more challenging topography. However, as with the pedal-powered schemes safety and security can be an issue.

PERSONAL MOBILITY DEVICE

Self-powered & owned

Mode: Personal Mobility Device (self-powered & owned)

Definition	A journey undertaken by personal mobility device.
Sub-Models	A journey undertaken by a self-powered personal mobility device (micro-scooter, skateboard etc.) and is owned by the user.
Typical Use Cases	▪ Travelling between a home location and a workplace ▪ Travelling between a major mass transit interchange and major retail centre ▪ Travelling between different locations within a campus-style development
Benefits	▪ Economic • No major limitations to capacity • Flexible and on-demand • Low cost to user • High levels of infrastructure in place in most urban and many rural locations • Reduces reliance on motorised travel • Reduction in short journeys by single occupancy vehicles ▪ Environment • Zero resources requirements • Zero carbon emissions at point of use • Low noise • Limited impact on built and natural environment • Limited waste materials ▪ Wellbeing • Physical and mental wellbeing benefits • Accessible to those without significant health impairment • Accessible to some with health impairments
Opportunities	▪ Economic • Mode shift may reduce some capacity issues on other modes • Improved health and wellbeing may have wider economic benefits and potential cross sector cost savings • Reduced transport costs • Increased data on users' travel • Opportunities for further technological development ▪ Environment • Increases in mode use will reduce carbon emissions and improve air quality • Increases in walking may reduce transport-related noise • Move towards low emission vehicles will reduced carbon impacts ▪ Wellbeing • Use can improve physical and mental health

<table>
<tr><td>Barriers</td><td colspan="5">

Economic

Initial purchase costs
Availability of infrastructure particularly in rural areas
New infrastructure can be expensive
Lack of space for enabling infrastructure
Slow compared to other modes
Limited revenue opportunities
Poor interchange provision and parking – onboard trains, at stations, hubs
Theft, vandalism and damage
Lack of user awareness and understanding of the system

Environment

Unattractive user environments

Wellbeing

Lack of training and competency
Lack of physical capability
Weather conditions can reduce attractiveness
Perceived and actual safety of users and others
Perceived and actual security of users
Overcoming existing habits

</td></tr>
<tr><td rowspan="2">Technical Maturity</td><td>Concept</td><td>Feasibility</td><td>Piloting</td><td>Initial real-world operation</td><td>Mature technical operation</td></tr>
<tr><td colspan="5">The use of self-powered mobility devices is only recently becoming seen as a legitimate form of transport although the devices have been available and used as such for decades</td></tr>
<tr><td rowspan="2">Commercial Maturity</td><td>Not operating commercially in the UK</td><td>Commercial testing/pilot</td><td>Commercial launch</td><td>Operating commercially</td><td>Mature commercial operation</td></tr>
<tr><td colspan="5">The purchase of devices and related goods is commercially mature.</td></tr>
<tr><td>Business Models</td><td colspan="5">The development of business models for owned personal mobility devices has been limited to their sale and maintenance.</td></tr>
<tr><td rowspan="2">Journey Range</td><td><3km</td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="5">The journey range of these devices is limited to approximately 3km</td></tr>
<tr><td>Supporting infrastructure and systems</td><td colspan="5">There is no specific supporting infrastructure and systems for these devices.</td></tr>
<tr><td>UK Best Practice Example</td><td colspan="5">There is very limited evidence in the UK or elsewhere supporting the use of self-powered skateboards and scooters as a mode of transport.

In 2014 a public campaign saved the historic undercroft skateboarding spot at London’s Southbank Centre from being turned into retail units. Today, as well as its Section 106 agreement guaranteeing the continuance of skateboarding in the undercroft, the Southbank Centre is keen to pursue further skateboarding and other urban arts activities under its Hungerford Bridge site.</td></tr>
</table>

	Skateboarding is now an established part of this major international arts venue. (Note that this example isn't directly related to transit). Source:https://www.theguardian.com/cities/2015/apr/20/skate-city-skateboarders-developers-bans-defensive-architecture	
Europe Best Practice Example	For **Snøhetta's Opera House** in **Oslo**, architects consulted skateboarders regarding surface textures and materials, leading to parts of the building and its immediate surroundings having marble ledges, kerbs, bench-like blocks and railings. Source:https://www.theguardian.com/cities/2015/apr/20/skate-city-skateboarders-developers-bans-defensive-architecture	
Global Best Practice Example	**US** travel surveys (that include skateboarding as an option) have measured notable amounts of skateboard travel, highlighting the skateboard as a legitimate mode of travel. In Los Angeles, public transport users use skateboards 30,000 times each day to get to and from bus stops and train stations. Additionally, observers in Portland, Oregon, found that at least one skateboarder passed through 79 percent of intersections. At one intersection, they counted 17 skateboarders — about one every seven minutes. Source: https://transfersmagazine.org/faster-than-walking-more-flexible-than-biking-skateboarding-as-a-real-mobility-mode/ **Arizona State University** has a large number of students who skateboard as a means of travelling to classes. At one point the University was becoming crowded with skateboards and so decided to create an Access Management Plan. The plan delineated different campus throughways so that some could be used for bikes and skateboards, whilst others would be "walk-only." The plan also vastly increased the parking infrastructure for skateboards and the University now has over 250 skateboard racks, which hold 12 skateboards each. Source:https://www.forbes.com/sites/scottbeyer/2017/08/28/skateboarding-another-urban-transportation-form/#2d2efdd2541b The global best practice examples indicate that skateboarding in the USA is being used as a legitimate mode of travel for short journeys or as part of longer multimodal journeys. This has led to skateboard specific infrastructure including parking racks.	
Notable Failures	In **California**, about 90% of cities regulate skateboarding in some way. This is partly due to negative perceptions of recreational skateboarding — that it is unsafe, damaging to property, noisy etc. Some cities regulate what they consider as undesirable skateboarding through infrastructure design to prevent tricks and recreational skateboarding (such as skate stoppers – metallic knobs). However, some jurisdictions prohibit skateboarding in various places such as on public streets and pavements, in business districts or at night.	

	Source: https://transfersmagazine.org/faster-than-walking-more-flexible-than-biking-skateboarding-as-a-real-mobility-mode/			
Spatial Typologies	City Centre		Remote Rural	
	Small Town		Parkway	
	Suburb		Business Park	
	Village			
Spatial Density	High Density			
	Medium Density			
	Low Density			
Summary	▪ Self-powered and owned personal mobility devices (skateboards and micro-scooters) are only recently becoming seen as a legitimate form of transport but there remain safety concerns with users mixing with pedestrians on footways. There is very little best practice concerning this mode and the main focus has been on limiting the anti-social aspects of their use. However, there are few limitations on their uptake except the physical ability and capability of users.			

Powered & Owned

Mode: Personal Mobility Device (powered & owned)

Definition	A journey undertaken by personal mobility device.
Sub-Models	A journey undertaken by a powered personal mobility device (powered micro scooter, personal light electric vehicles such as balanced wheels, hoverboards, 'Segways', powered skateboard or similar) that are owned by the user. (Note: these are currently illegal on public roads and footways in the UK but the subject of DfT legislative review)
Typical Use Cases	▪ Travelling between a home location and a workplace ▪ Travelling between a major mass transit interchange and major retail centre ▪ Travelling between different locations within a campus-style development
Benefits	▪ Economic • No major limitations to capacity • Flexible and on-demand • Low operational cost to user after initial purchase • High levels of infrastructure in place in most urban and many rural locations (if legal obstacles were removed) • Reduces reliance on motorised travel • Reduction in short journeys by single occupancy vehicles ▪ Environment • Zero resources requirements • Zero carbon emissions at point of use • Low noise • Limited impact on built and natural environment • Limited waste materials ▪ Wellbeing • Physical and mental wellbeing benefits • Accessible to those without significant health impairment • Accessible to some with health impairments
Opportunities	▪ Economic • Mode shift may reduce some capacity issues on other modes • Improved health and wellbeing may have wider economic benefits and potential cross sector cost savings • Reduced transport costs • Increased data on users' travel • Opportunities for further technological development ▪ Environment • Increases in mode use will reduce carbon emissions and improve air quality • Increases in walking may reduce transport-related noise • Move towards low emission vehicles will reduced carbon impacts ▪ Wellbeing • Use can improve physical and mental health
Barriers	▪ Economic • Initial purchase costs

	• Availability of infrastructure particularly in rural areas • New infrastructure can be expensive • Lack of space for enabling infrastructure • Slow compared to other modes • Limited revenue opportunities • Poor interchange provision and parking – onboard trains, at stations, hubs • Theft, vandalism and damage • Laws, licensing and regulation • Lack of user awareness and understanding of the system ▪ Environment • Unattractive user environments ▪ Wellbeing • Currently illegal to use on footways and highways in the UK (but the subject of review) • Lack of training and competency • Lack of physical capability • Weather conditions can reduce attractiveness • Perceived and actual safety of users and others • Perceived and actual security of users • Overcoming existing habits

Technical Maturity	Concept	**Feasibility**	Piloting	Initial real-world operation	Mature technical operation
	Within the UK, powered personal mobility devices cannot be used on the public highway (including footways) therefore the use of privately owned devices has not got beyond feasibility stage at the time of writing.				
Commercial Maturity	Not operating commercially in the UK	Commercial testing/pilot	Commercial launch	**Operating commercially**	Mature commercial operation
	Privately owned powered devices are on sale commercially.				
Business Models	The development of business models for owned personal mobility devices has been limited to their sale and maintenance.				
Journey Range	**<3km**				
	The journey range of these devices is limited to approximately 3km				
Supporting infrastructure and systems	▪ Data, websites and apps for journey planning ▪ Charging locations				
UK Best Practice Example	Due to powered mobility devices currently being illegal to operate in public spaces in the UK, there are no examples of best practice in the country. **Segway** is perhaps the best known of these devices and a range of different models are available for sale in the UK. The company markets them for a range of different uses, within private land, including leisure, policing & security, farming, distribution, construction, events & exhibitions, sport and manufacturing.				

	Source: https://www.segway-uk.net/ However, **eBay** reported sold more than 5,000 Hoverboards (self-balancing scooters) on Black Friday and claims to have sold one hoverboard every 12 seconds on Cyber Monday. (Note that this example isn't directly related to transport). Source: https://www.popsci.com/what-are-hoverboards-and-why-do-they-explode/ The rise in sales of powered devices shows that there may be demand for such devices to become a legitimate form of transport but at present these have often been used as toys than for transport.	
Europe Best Practice Example	German electric skateboard, **Mellow** has introduced a new range of less expensive models (999 euros). This skateboard consists of a battery that can cover up to 15km and a remote to control the speed and brake. Source: https://electrek.co/2018/06/28/german-engineered-mellow-electric-skateboards/	
Global Best Practice Example	**Future Motion** is a Californian based company that was set up in 2014 and produces a powered transporter known as the 'Onewheel'. The Onewheel is essentially an electric skateboard platform with a small tyre in the centre with a range of up to seven miles on a single charge. Demand for the boards (which cost $1,399 and $1,799 for a longer-range version) has allowed the company's bottom line to double each year and today Future Motion has 40 employees and $7 million in funding. Additionally, users of the Onewheel tend to be mixed-use customers - they commute on their Onewheels but also use them for recreational purposes. Source: https://www.inc.com/kevin-j-ryan/best-industries-2019-future-motion.html Xiaomi, **ACTON** smart electric skateboard was funded by Chinese investors but designed in Silicon Valley. It launched in China in 2018. It can generate speeds up to 22.5km/h and can climb a 15% slope gradient. The powered batteries have up to a 12km range and takes just 90 minutes to change from 0-100%. Source: https://www.xiaomitoday.com/xiaomi-acton-smart-electric-skateboard/	
Notable Failures	Powered skateboards are currently growing in popularity in the **UK**, however they are still illegal to ride on public land as they are considered to be "powered transporters" by the DfT. The current policy surrounding powered personal mobility devices in the UK limits any implementation specific for these modes due to them being illegal to ride on public land. However, a currently ongoing regulatory review by DfT may bring about changes to these laws.	

In **Oxfordshire**, a 38-year-old man died in hospital following an accident on an electric skateboard. In **London** a 35 year old woman was killed on an e-scooter when she collided with an HGV. These deaths led to the DfT restating that the use of e-scooters and electric skateboards was illegal on public roads and other prohibited spaces.

Source: https://www.theguardian.com/uk-news/2019/aug/03/man-dies-after-electric-skateboard-accident-in-oxfordshire

https://www.theguardian.com/uk-news/2019/jul/13/tv-presenter-emily-hartridge-dies-in-scooter-crash

Source: https://www.standard.co.uk/tech/electric-skateboarders-bid-to-government-for-permission-on-public-roads-a3924371.html

Accidents involving **Segways** are on the increase, according to a study. It also suggested that people hurt on them are more likely to be admitted to the hospital, particularly with traumatic head and face injuries, than pedestrians struck by cars.

Source: http://www.nbcnews.com/id/39382682/ns/health-health_care/t/segway-scooters-can-lead-serious-injuries-experts-warn/#.XYysA0ZKjIV

Cheaply made hoverboards (self-balancing scooters) have exploded and caught fire due to faulty batteries. This has forced Amazon to stop selling specific models and Overstock to discontinue all sales. Additionally, **London** and **New York City** have declared hoverboards illegal and warned people that they could be met with fines and other penalties if they are caught riding them in the street.

Source: https://www.popsci.com/what-are-hoverboards-and-why-do-they-explode/

Injuries to the public from the use of powered personal mobility devices can set back or stall any developments of these technologies as they may receive increased public resistance due to perceived safety concerns.

Spatial Typologies	City Centre		Remote Rural	
	Small Town		Parkway	
	Suburb		Business Park	
	Village			
Spatial Density	High Density			
	Medium Density			
	Low Density			

Summary

- At present the use of powered mobility devices is illegal in public spaces in the UK and therefore there is no best practice available from the UK. If the laws are changed, the use of such devices may be such that they become part of the transport mix in the FMLM market.

Mode: Personal Mobility Device for Mobility Impaired Users (powered & owned)

Definition	A journey undertaken by powered personal mobility device for mobility impaired users.
Sub-Models	A journey undertaken by a powered personal mobility device (powered wheelchair, mobility scooter) designed specifically for mobility impaired users that is owned by the user.
Typical Use Cases	▪ Travelling between a home location and to local shops and services ▪ Travelling between a major mass transit interchange and work place
Benefits	▪ Economic • No major limitations to capacity • Flexible and on-demand • Low operational cost to user after initial purchase • High levels of infrastructure in place in most urban and many rural locations • Reduces reliance on motorised travel including specific provision for mobility impaired users • Reduction in short journeys by single occupancy vehicles • Increases access to economic activity including employment ▪ Environment • Zero resources requirements • Zero carbon emissions at point of use • Low noise • Limited impact on built and natural environment • Some waste materials ▪ Wellbeing • Mental wellbeing benefits • Accessible to some with health impairments • Increases personal independence and accessibility
Opportunities	▪ Economic • Mode shift may reduce some capacity issues on other modes • Improved health and wellbeing may have wider economic benefits and potential cross sector cost savings • Reduced transport costs • Opportunities for further technological development ▪ Environment • Increases in mode use will reduce carbon emissions and improve air quality • Move towards low emission vehicles will reduced carbon impacts ▪ Wellbeing • Use can improve mental health and reduce potential loneliness
Barriers	▪ Economic • Initial purchase costs • Availability of infrastructure particularly in rural areas • New infrastructure can be expensive • Slow compared to other modes • Limited revenue opportunities • Poor interchange provision and parking – carriage on board trains, trams and buses, at stations, hubs ▪ Environment

<table>
<tr><td></td><td colspan="5">

Unattractive user environments

Wellbeing

Lack of training and competency
Lack of physical capability
Weather conditions can reduce attractiveness
Perceived and actual safety of users and others
Perceived and actual security of users
Overcoming existing habits

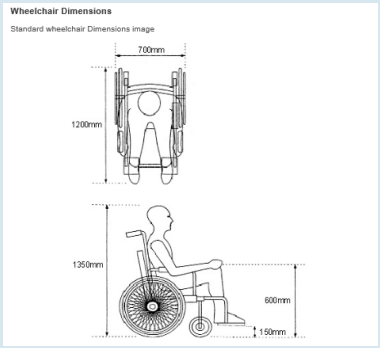
</td></tr>
<tr><td rowspan="2">Technical Maturity</td><td>Concept</td><td>Feasibility</td><td>Piloting</td><td>Initial real-world operation</td><td>Mature technical operation</td></tr>
<tr><td colspan="5">The ownership and use of powered mobility devices for mobility impaired users is technically mature and widespread in the UK. The laws for the use of these devices on pavements and roads is set out by the DfT[3]. Class 1 are unpowered wheelchairs. Class 2, with a speed of up to 4mph can be used on pavements and pedestrian areas and Class 3, with a speed of up to 8mph can be used on pavements, pedestrian areas and roads (but should not use dual-carriageways with a speed limit over 50mph but they are required to use of an amber flashing light if they do so). All devices should not exceed 4mph on pavements and pedestrian areas.

Through the use of owned devices, they can provide first and last mile stages of journeys whilst also being taken onboard the middle mile vehicle (train, tram, bus).</td></tr>
<tr><td rowspan="2">Commercial Maturity</td><td>Not operating commercially in the UK</td><td>Commercial testing/pilot</td><td>Commercial launch</td><td>Operating commercially</td><td>Mature commercial operation</td></tr>
<tr><td colspan="5">Privately owned powered devices are on sale commercially.</td></tr>
<tr><td>Business Models</td><td colspan="5">The development of business models for owned personal mobility devices has been limited to their sale and maintenance.</td></tr>
<tr><td rowspan="2">Journey Range</td><td><3km</td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="5">The journey range of these devices is limited to approximately 3km</td></tr>
<tr><td>Supporting infrastructure and systems</td><td colspan="5">

Data, websites and apps for journey planning
Quality footways and pedestrian crossings
Standard ‘all vehicle’ carriageways (up to dual-carriageways with 50mph speed limit)

</td></tr>
</table>

[3] https://www.gov.uk/guidance/the-highway-code/rules-for-users-of-powered-wheelchairs-and-mobility-scooters-36-to-46

UK Best Practice Example	The UK has a large market for the sale of mobility scooters and powered wheelchairs, with a significant range in size and capability including all-terrain versions. Terrainhopper produces all-terrain mobility scooters in the UK. Within the range of models are four-wheel drive versions with high ground clearance and abilities to climb 35° inclines and cope with differing types of ground conditions including mud, sand, snow and rocks. There is a significant range of mobility scooters available to users in the UK and an open market. Source: https://www.terrainhopper.com/products National Express Coaches and Megabus both provide carriage for mobility scooters (if they weigh 20kg or less or the heaviest dismantled part weighs 20kg or less) but passengers cannot remain seated in them and the devices must be stored in the luggage compartment Source: https://www.nationalexpress.com/en/help/accessibility https://uk.megabus.com/help?searchTerm=mobility%20scooters The majority of trains in the UK can accommodate small Class 2 mobility scooters but provision does vary across the train operators. Source: https://www.nationalrail.co.uk/stations_destinations/216140.aspx#Policies There is a varying level of provision for mobility scooters on strategic public transport services but the majority of rail operators provide for smaller devices. In the UK there are multiple charities that can help an individual fund the potentially high cost to own a powered wheelchair. The Motability Scheme enables disabled people to lease a new car, scooter or powered wheelchair by exchanging their Government funded mobility allowance. Source:https://www.bettermobility.co.uk/charity_funding_options.php https://www.motability.co.uk/	 
Europe Best Practice Example	In the Netherlands motorised mobility scooters are legally allowed to go up to 45km/h (28mph) on the road, which is only slightly slower than motorised traffic (50km/h or 31mph). On cycle paths, in the built-up area, motorised mobility scooters can go 30km/h (18mph). This would be considerably faster than most cyclists but most users of mobility scooters use the cycle paths at the same speed the cyclists go (20km/h or 12.4mph), so they blend in nicely. The cycle paths offer people with disabilities freedom to travel where they wish. Source: https://bicycledutch.wordpress.com/2012/12/06/who-else-	

	benefits-from-the-dutch-cycling-infrastructure/			
Global Best Practice Example	In the USA, grant funding is available for mobility scooters, whether you can receive funding and the level of funding is dependent on which state. Local providers of power wheelchairs use Medicare, Medicaid and other national or local organisations that offer funding. Source: https://silvercross.com/getting-funding-for-accessibility-equipment-in-the-usa/			
Notable Failures	In 2018, in Great Britain, there were 249 road traffic accidents involving mobility scooters of which 64 were serious and 13 fatal. This compares to 115 accidents in 2013 of which 5 were fatal. The statistics also reveal that more accidents involve mobility scooters than horse riders and about half as many as involve agricultural vehicles. Source: https://www.gov.uk/government/statistical-data-sets/ras20-drivers-riders-and-vehicles-in-reported-road-accidents There are concerns over the safety of mobility scooters and the statistics reveal that a notable number of serious and fatal accidents occur each year and there is a general upward trend in those accidents. Benidorm has banned the use of mobility scooters from its pavements and imposes a 12mph speed limit on the electric vehicles with owners warned they face £430 fines. User must also have insurance, wear a helmet and have a reflective vest or bell. The same has been enforced in other Spanish cities such as Madrid and Barcelona. Source: https://www.dailymail.co.uk/news/article-6856155/Benidorm-bans-mobility-scooters-pavements-tourism-crackdown.html			
Spatial Typologies	City Centre		Remote Rural	
	Small Town		Parkway	
	Suburb		Business Park	
	Village			
Spatial Density	High Density			
	Medium Density			
	Low Density			
Summary	▪ The market for powered personal mobility devices for mobility impaired users is extensive and open in the UK providing users with choice and a range of capabilities. ▪ Devices can provide the first and last mile elements of journeys whilst also being used onboard the middle mile stages (train, tram and bus). ▪ Provision on public transport varies but is increasing but on-vehicle provision is largely for smaller devices. ▪ There are concerns over the safety of these vehicles with an increasing trend in serious and fatal accidents over the last few years. ▪ These devices provide significant opportunities for increasing accessibility and mobility for impaired users and provision needs to be considered as part of FMLM networks as well as on the connecting mass transit corridors.			

Self-powered & Shared

Mode: Personal Mobility Device (self-powered & shared)

Definition	A journey undertaken by personal mobility device.
Sub-Models	A journey undertaken by a self-powered personal mobility device (micro-scooter, skateboard etc.) that is shared and collected or not collected from a docking station.
Typical Use Cases	▪ Travelling between a home location and a workplace ▪ Travelling between a major mass transit interchange and major retail centre ▪ Travelling between different locations within a campus-style development
Benefits	▪ Economic • No major limitations to capacity • Flexible and on-demand • Low cost to user • High levels of infrastructure in place in most urban and many rural locations • Reduces reliance on motorised travel • Reduction in short journeys by single occupancy vehicles • Improved last-mile options • Improved integration between modes ▪ Environment • Zero resources requirements • Zero carbon emissions at point of use • Low noise • Limited impact on built and natural environment • Limited waste materials ▪ Wellbeing • Physical and mental wellbeing benefits • Accessible to those without significant health impairment • Accessible to some with health impairments
Opportunities	▪ Economic • Mode shift may reduce some capacity issues on other modes • Improved health and wellbeing may have wider economic benefits and potential cross sector cost savings • Reduced transport costs • Increased data on users' travel • Opportunities for further technological development ▪ Environment • Increases in mode use will reduce carbon emissions and improve air quality • Increases in walking may reduce transport-related noise • Move towards low emission vehicles will reduced carbon impacts ▪ Wellbeing • Use can improve physical and mental health
Barriers	▪ Economic • Operational costs

	• Availability of infrastructure particularly in rural areas • New infrastructure can be expensive • Lack of space for enabling infrastructure • Slow compared to other modes • Limited revenue opportunities • Poor interchange provision and parking – onboard trains, at stations, hubs • Theft, vandalism and damage • Lack of user awareness and understanding of the system ▪ Environment • Unattractive user environments ▪ Wellbeing • Lack of training and competency • Lack of physical capability • Weather conditions can reduce attractiveness • Perceived and actual safety of users and others • Perceived and actual security of users • Overcoming existing habits

Technical Maturity	Concept	Feasibility	Piloting	Initial real-world operation	Mature technical operation
	There are presently no shared self-powered personal mobility device systems in the UK				
Commercial Maturity	Not operating commercially in the UK	Commercial testing/pilot	Commercial launch	Operating commercially	Mature commercial operation
	There are presently no shared self-powered personal mobility device systems in the UK				
Business Models	There are presently no shared self-powered personal mobility device systems in the UK				
Journey Range	<3km				
	The journey range of these devices is limited to approximately 3km				
Supporting infrastructure and systems	Devices are dockless, therefore, major supporting infrastructure is not required but data, apps, websites and supporting systems to operate and manage the system will be required				
UK Best Practice Example	No information found – shared personal mobility device schemes are predominately operated using powered e-scooters				
Europe Best Practice Example	No information found – shared personal mobility device schemes are predominately operated using powered e-scooters				
Global Best Practice Example	No information found – shared personal mobility device schemes are predominately operated using powered e-scooters				
Notable Failures	No information found – shared personal mobility device schemes are predominately operated using powered e-scooters				

Spatial Typologies	City Centre		Remote Rural	
	Small Town		Parkway	
	Suburb		Business Park	
	Village			
Spatial Density	High Density			
	Medium Density			
	Low Density			
Summary	▪ The lack of best practice examples of this mode demonstrates that there is a limited interest in bringing shared and self-powered mobility device business models to the market.			

Powered & Shared

Mode: Personal Mobility Device (Powered & shared)

Definition	A journey undertaken by personal mobility device.
Sub-Models	A powered personal mobility device (powered micro scooter, personal light electric vehicles such as balanced wheels, hoverboards, 'Segways', powered skateboard or similar) that are shared and collected from a docking station or dockless.
Typical Use Cases	▪ Travelling between a home location and a workplace ▪ Travelling between a major mass transit interchange and major retail centre ▪ Travelling between different locations within a campus-style development
Benefits	▪ Economic • No major limitations to capacity • Flexible and on-demand • Low operational cost to user and no purchase cost • High levels of infrastructure in place in most urban and many rural locations (if legal obstacles were removed) • Reduces reliance on motorised travel • Reduction in short journeys by single occupancy vehicles • Improved last-mile options • Improved integration between modes ▪ Environment • Zero resources requirements • Zero carbon emissions at point of use • Low noise • Limited impact on built and natural environment • Limited waste materials ▪ Wellbeing • Some limited physical and mental wellbeing benefits • Accessible to those without significant health impairment • Accessible to some with health impairments
Opportunities	▪ Economic • Mode shift may reduce some capacity issues on other modes • Improved health and wellbeing may have wider economic benefits and potential cross sector cost savings • Reduced transport costs • Increased data on users' travel • Opportunities for further technological development ▪ Environment • Increases in mode use will reduce carbon emissions and improve air quality • Increases in walking may reduce transport-related noise • Move towards low emission vehicles will reduced carbon impacts ▪ Wellbeing • Use can improve physical and mental health to a limited extent

<table>
<tr><td>Barriers</td><td colspan="5">

Economic

Availability of infrastructure particularly in rural areas
New infrastructure can be expensive
Lack of space for enabling infrastructure
Slow compared to other modes in some places
Limited revenue opportunities
Poor interchange provision and parking
Theft, vandalism and damage
Laws, licensing and regulation
Lack of user awareness and understanding of the system

Environment

Unattractive user environments

Wellbeing

Currently illegal to use on footways and highways in the UK
Lack of training and competency
Lack of physical capability
Weather conditions can reduce attractiveness
Perceived and actual safety of users and others
Perceived and actual security of users

Overcoming existing habits
</td></tr>
<tr><td rowspan="2">Technical Maturity</td><td>Concept</td><td>Feasibility</td><td>Piloting</td><td>Initial real-world operation</td><td>Mature technical operation</td></tr>
<tr><td colspan="5">The technical operation of a shared powered personal mobility device system is being piloted/trialled in the UK at present but on private land only due to legislative restrictions.</td></tr>
<tr><td rowspan="2">Commercial Maturity</td><td>Not operating commercially in the UK</td><td>Commercial testing/pilot</td><td>Commercial launch</td><td>Operating commercially</td><td>Mature commercial operation</td></tr>
<tr><td colspan="5">The commercial operation of a shared powered personal mobility device system is being piloted/trialled in the UK at present but on private land only. However, operators are waiting for the outcome of the regulatory review of the legality of the devices with at least one operator already preparing to launch in the UK.
Source: https://www.telegraph.co.uk/technology/2019/07/04/e-scooter-company-dott-raises-34m-funding-ahead-uk-launch/</td></tr>
<tr><td>Business Models</td><td colspan="5">The business models focus on either on-account or pay-as-you-go operations. However with the advent of Mobility as a Service, the sharing of these devices could be packaged as part of subscription services.</td></tr>
<tr><td rowspan="2">Journey Range</td><td><3km</td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="5">The journey range of these devices is limited to approximately 3km</td></tr>
<tr><td>Supporting infrastructure and systems</td><td colspan="5">Devices are (generally) dockless, therefore, major supporting infrastructure is not required but data, websites, apps and supporting systems to operate and manage the system will be required. However, this mode can lead to street clutter, reduced pedestrian space and capacity and tripping hazards.</td></tr>
</table>

UK Best Practice Example	**Bird,** an electric scooter-sharing application established in 2017, allows users to unlock an electric scooter with an app, then lock it again once the journey is complete. People in turn pay a small fee per minute of use. The service has been launched commercially across the USA and Europe but only a trial is running in the **London Olympic Park** in the UK (recently extended to Summer 2019). The Olympic Park is privately-owned land and therefore the current UK ban on the use of such vehicles in public spaces does not apply. Source:https://www.telegraph.co.uk/technology/2019/03/08/electric-scooter-start-up-bird-extends-olympic-park-trial/ The outcome of the Bird trial in London has the possibility to impact any future powered shared mobility schemes in the UK. The outcome of the regulatory review of the use of such devices in public spaces will have a major influence on their future in the UK.	
Europe Best Practice Example	In the first seven months since its launch, **Voi** claimed to have served 400,000 riders, who had taken a total of more than 750,000 rides and travelled over 1.5 million km in total. Currently, Voi scooters are available in **Stockholm, Gothenburg, Malmö, Lund, Uppsala, Copenhagen, Paris, Lyon, Madrid, Malaga, Zaragoza, Murcia, Lisbon and Faro**. The company said that it is helping to develop an informal "Code of Conduct" for shared e-scooter platforms operating in Stockholm and across Europe. In October 2018 the Traffic Office of Stockholm was considering banning shared electric scooters from the city but that did not happened. Source: https://tech.eu/brief/swedish-e-scooter-startup-voi-raises-30-million-claims-to-be-close-to-profitability-in-several-cities/ Voi has been successful in securing take up and usage of its e-scooters in cities across Europe. The Code of Conduct will allow for a lessons learned and best practice to influence other similar platforms.	
Global Best Practice Example	Shared electric scooters are close to overtaking bike sharing, according to the **US National Association of City Transportation Officials**. In 2018, of the 84 million micromobility trips taken, 38.5 million of those were on scooters. Thus, electric scooter rides accounted for 45.8% of all micromobility trips in 2018. Source: https://techcrunch.com/2019/04/17/shared-electric-scooter-rides-accounted-for-45-8-percent-of-all-micromobility-trips-in-2018/ **Bird** has put over 1,000 of its scooters on the streets in 18 U.S. cities, including **Los Angeles, Dallas and Washington D.C**. In April, Bird said its scooters had already been taken for over 1 million rides since launching in September 2017.	

	Source: https://www.cnbc.com/2018/07/11/lime-bird-spin-why-scooter-start-ups-are-suddenly-worth-billions.html The global uptake of electric scooters has been significant with various operators, including Bird, operating in many large cities. This uptake could be replicated in UK cities if policy/law was to change and the right infrastructure and business model platforms were put into place.			
Notable Failures	There have been several accidents and fatalities involving **e-scooters**. In June 2019 a 35-year-old YouTuber and TV presenter was killed while riding an e-scooter in Battersea, south-west London. In Paris (which has an estimated 20,000 e-scooters) a young man was hit by a truck and died. Following the incidents, the UK Metropolitan police has staged an operation targeting e-scooters, with approximately 100 people receiving warnings, fines or having their devices confiscated during a one-week period in July 2019. Source: https://www.telegraph.co.uk/news/2019/07/26/e-scooters-crackdown-met-police-launches-first-operation-target/ A disabilities rights group has filed a lawsuit against **San Diego** and three scooter companies (**Bird, Lime and Razor**) for violating the Americans with Disabilities Act. The group argued that dockless scooters have been allowed to proliferate unchecked, taking up space and blocking "varying portions of the City's public sidewalks, crosswalks, transit stops, curb ramps, pedestrian crossings and other walkways". As a result, the group has asked for statutory damages and for scooters to stop operating on pavements and other pedestrian routes. Source: https://nextcity.org/daily/entry/disabilities-rights-group-files-lawsuit-against-san-diego-scooter-companies#targetText=Disabilities%20Rights%20Group%20Files%20Lawsuit%20Against%20San%20Diego%2C%20Scooter%20Companies&targetText=A%20disabilities%20rights%20group%20has,Act%2C%20reports%20NBC%20San%20Diego. To regulate the surge and issues in electric scooter use, **Paris** plans to regulate them with a €135 fine for riding on the pavements. The French capital's council voted to impose the penalty ahead of national legislation on e-scooters expected this year. There will also be other fines including a €35 penalty for blocking pavements with parked scooters and badly parked devices will be taken away by the council. A larger fine of €1,500 will be enforced for going over the speed limit. Source: https://www.euronews.com/2019/04/03/paris-to-tackle-electric-scooter-craze-with-fines-for-riding-on-pavements There are some concerns over the longevity of e-scooters with some reports stating that in one city (**Louisville, Kentucky**, US) on average the devices only lasted 28 days of service. However, operators state that they are increasing the lifespan of their devices and improving the re-use and recycling of parts. Source: https://phys.org/news/2019-07-electric-scooters-eco-friendly.html A main concern surrounding powered shared mobility devices is safety. Concerns focus on traffic collisions, street clutter, waste and their impact on people with mobility impairments. To combat this, Paris, for example, is looking to adopt regulations and penalties to misuse of the scooters.			
Spatial	City Centre		Remote Rural	

Typologies	Small Town		Parkway	
	Suburb		Business Park	
	Village			
Spatial Density	High Density			
	Medium Density			
	Low Density			
Summary	▪ Schemes to share powered mobility devices are becoming more common place in major cities in Europe and the US but they are currently banned from public spaces in the UK. However, a regulatory review of such devices is currently underway and may change the position of the UK government. Due to the ban, the maturity of the mode, technically and commercially, is lagging behind in the UK. These modes are most suited to high density, central locations, and as shown elsewhere, schemes are being launched in major cities first. ▪ With significant safety concerns, the issue of cluttering and the waste resulting from short lifespans of shared devices, there remain significant challenges in schemes becoming widely adopted and accepted.			

Mode: Personal Mobility Device for Mobility Impaired Users (Powered & shared)

Definition	A journey undertaken by powered personal mobility device for mobility impaired users.
Sub-Models	A journey undertaken by a powered personal mobility device (powered wheelchair, mobility scooter) designed specifically for mobility impaired users that is shared.
Typical Use Cases	▪ Travelling between a home location and to local shops and services ▪ Travelling between a major mass transit interchange and work place
Benefits	▪ Economic • No major limitations to capacity • Flexible and on-demand • Low operational cost to user and no purchase cost • High levels of infrastructure in place in most urban and many rural locations • Reduces reliance on motorised travel including specific provision for mobility impaired users • Reduction in short journeys by single occupancy vehicles • Increases access to economic activity including employment ▪ Environment • Zero resources requirements • Zero carbon emissions at point of use • Low noise • Limited impact on built and natural environment • Some waste materials ▪ Wellbeing • Mental wellbeing benefits • Accessible to some with health impairments • Increases personal independence and accessibility
Opportunities	▪ Economic • Mode shift may reduce some capacity issues on other modes • Improved health and wellbeing may have wider economic benefits and potential cross sector cost savings • Reduced transport costs • Opportunities for further technological development ▪ Environment • Increases in mode use will reduce carbon emissions and improve air quality • Move towards low emission vehicles will reduced carbon impacts ▪ Wellbeing • Use can improve mental health
Barriers	▪ Economic • Availability of infrastructure particularly in rural areas • New infrastructure can be expensive • Slow compared to other modes • Limited revenue opportunities • Poor interchange provision and parking – onboard trains, at stations, hubs ▪ Environment

<table>
<tr><td></td><td colspan="5">

Unattractive user environments

Wellbeing

Lack of training and competency
Lack of physical capability
Weather conditions can reduce attractiveness
Perceived and actual safety of users and others
Perceived and actual security of users
Overcoming existing habits

</td></tr>
<tr><td rowspan="2">Technical Maturity</td><td>Concept</td><td>Feasibility</td><td>Piloting</td><td>Initial real-world operation</td><td>Mature technical operation</td></tr>
<tr><td colspan="5">The ownership and use of powered mobility devices for mobility impaired users is technically mature and widespread in the UK. The laws for the use of these devices on pavements and roads is set out by the DfT[4]. Class 1 are unpowered wheelchairs. Class 2, with a speed of up to 4mph can be used on pavements and pedestrian areas and Class 3, with a speed of up to 8mph can be used on pavements, pedestrian areas and road (up to dual-carriageway with a 50mph speed limit). All devices should not exceed 4mph on pavements and pedestrian areas.

In the UK, shared solutions are often located at shopping centres and car parks rather than at multi-modal interchanges. They are therefore more likely to support the last mile element of car based journeys rather than those where the middle mile is undertaken by mass transit.</td></tr>
<tr><td rowspan="2">Commercial Maturity</td><td>Not operating commercially in the UK</td><td>Commercial testing/pilot</td><td>Commercial launch</td><td>Operating commercially</td><td>Mature commercial operation</td></tr>
<tr><td colspan="5">The sharing of powered devices is commercially mature</td></tr>
<tr><td>Business Models</td><td colspan="5">Business models vary between charitable organisations (e.g. Shopmobility) in city/town centres and commercial businesses hiring out different types of device to tourism locations and supermarkets providing devices free of charge.</td></tr>
<tr><td rowspan="2">Journey Range</td><td><3km</td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="5">The journey range of these devices is limited to approximately 3km</td></tr>
<tr><td>Supporting infrastructure and systems</td><td colspan="5">

Data, websites and apps Data, websites and apps for journey planning
Quality footways and pedestrian crossings
Standard ‘all vehicle’ carriageways (up to dual-carriageways with 50mph speed limit)

</td></tr>
</table>

[4] https://www.gov.uk/guidance/the-highway-code/rules-for-users-of-powered-wheelchairs-and-mobility-scooters-36-to-46

UK Best Practice Example	**Shopmobility** is a nationwide scheme that lends manual wheelchairs, powered wheelchairs, and scooters to people with limited mobility, thus allowing them to shop and visit leisure and commercial facilities within a town, city or shopping centre. The scheme is open to anyone with mobility impairments, be it permanent or temporary. Each local scheme operates slightly differently; some provide Shopmobility as a free service while others make a charge. Source: http://nfsuk.org/ There is an extensive network of shared devices across the UK but predominately in major centres. **Countryside Mobility South West** is a not for profit mobility equipment hire scheme working to improve access to the countryside for people with limited mobility living in and visiting the South West region. The organisation works with partners who hire out mobility scooters at their visitor attractions across the south west, to enable people with limited mobility to enjoy and access to the countryside. Source: http://www.countrysidemobility.org/ A number of providers supply shared devices to enable mobility impaired travellers to visit tourist attractions and the wider countryside.	 
Europe Best Practice Example	**WHILL** have trialled autonomous wheelchairs in **Amsterdam Schiphol Airport** where users could request a WHILL wheelchair using an app. Once the trip was completed, the wheelchair then automatically returned to its base autonomously. Source: https://www.iamsterdam.com/en/business/news-and-insights/news/2019/wheelchair-manufacturer-whill-opens-amsterdam-office There continues to be innovation in this space with automation being developed.	
Global Best Practice Example	**Global** There is currently an ongoing trial at airports in **Dallas** and **Winnipeg** where travellers with mobility limitations can book a **WHILL** through the Scootaround app. Using sensing technologies and automatic brakes, WHILL's wheelchairs detect and avoid obstacles in busy airports, allowing customers to get to their gate faster. Source: https://techcrunch.com/2019/11/20/whill-brings-its-autonomous-wheelchairs-to-north-american-airports/ Japan Airlines has partnered with Japan Airport Terminal (JAT) and are currently trialling **WHILL**'s self-navigating electric wheelchairs at **Tokyo Haneda Airport**. The autonomous wheelchairs will allow passengers with reduced mobility to navigate the airport without any external assistance. They are electric, feature real-time	

gate and boarding updates and are equipped with sensors that can detect obstructions and stop the vehicle automatically.

Source: https://www.airport-technology.com/news/whill-autonomous-wheelchair-haneda-airport/

Abu Dhabi Airports has partnered with Etihad Airways and are currently trialling **WHILL**'s autonomous wheelchairs at **Abu Dhabi International Airport**. Passengers will be able to access airport facilities easily and effectively, whether arriving to, departing from, or transiting through Abu Dhabi International Airport. The wheelchairs will offer passengers up-to-date boarding times and gate information, an automatic brake function, voice activated features for users who may be visually impaired, and sensors to detect any obstacles.

Source: https://www.airsideint.com/abu-dhabi-international-airport-begins-trials-of-autonomous-wheelchairs/

Launched in 2017, Toyota's Mobility Unlimited Challenge is a global competition designed to inspire new technologies that change the lives of sufferers of lower limb paralysis. Five finalists have been awarded $500,000 and the winner will receive $1million. Of the five finalists, one looks at a shared option for users of wheelchairs. The **Moby**, from Italy's **Italdesign**, consists of a network of sensors built into a larger wheeled vehicle which wheelchair users can roll into to turn their ride into an electrically powered one. These Moby vehicles would be available throughout cities as part of an app-based ride-sharing scheme.

Source: https://newatlas.com/toyota-mobility-unlimited-challenge-finalists/57949/

Walt Disney World in Florida offers Electric Conveyance Vehicles (ECV) for a daily rental cost of $50 with a refundable deposit up to $100. Each ECV needs to be returned to the same location where it was picked up but if guests choose to visit multiple places within Walt Disney World they can pick up another ECV for no extra cost – accessible buses, monorails and trams connect these places.

Source: https://disneyworld.disney.go.com/en_GB/guest-services/ecv-rentals/

Notable Failures	Due to the type of expectant user of powered mobility devices, there are limited examples. Users of powered mobility devices are likely to require permanent or long-term access to a powered mobility device and therefore will own or be financing the vehicle. Therefore, the examples above are focussed on large destinations where perhaps a user may have driven and not brought their own mobility device – such as airports, shopping centres and theme parks.

Spatial	City Centre		Remote Rural	

Typologies	Small Town		Parkway	
	Suburb		Business Park	
	Village			
Spatial Density	High Density			
	Medium Density			
	Low Density			
Summary 	▪ The market for powered personal mobility devices for mobility impaired users is extensive and open in the UK with a range of providers of shared solutions. ▪ Opportunities to share these devices are frequently in town and city centres, located close to retail centres and often in car parks rather than at multi-modal interchanges. ▪ Sharing is predominately focussed on the last mile stage of journeys. ▪ Provision on public transport varies but is increasing but on-vehicle provision is largely for smaller devices. ▪ There are concerns over the safety of these vehicles with an increasing trend in serious and fatal accidents over the last few years. ▪ These devices provide significant opportunities for increasing accessibility and mobility for impaired users and provision needs to be considered as part of FMLM networks as well as on the connecting mass transit corridors.			

CAR

'Owned'

Mode: Car ('Owned')

Definition	A journey undertaken in a car / van.
Sub-Models	A single occupancy or informal carpool journey undertaken using a privately owned/leased or rented vehicle
Typical Use Cases	▪ Travel between home location and major mass transit interchange ▪ Travel between home location and workplace ▪ Travel between workplace and external location ▪ Travel between home location and remote areas
Benefits	▪ Economic • Flexible and on-demand • High levels of infrastructure in place in urban and rural locations ▪ Environment • Potential reduced impacts (over traditional combustion engine) from electric vehicles ▪ Wellbeing • Provides independence • Convenient • Widely accessible but with limitations from affordability
Opportunities	▪ Economic • Electrification reduces running costs • Digitisation increases data on users' travel • Further development of technologies including automation ▪ Environment • Electrification reduces carbon emissions from the tailpipe • Further development of electrification technologies ▪ Wellbeing • Electrification reduces carbon and air quality issues
Barriers	▪ Economic • Limitations on highway capacity • New infrastructure is very expensive • Lack of space for enabling infrastructure • Initial and ongoing costs • Availability of EV charging infrastructure and supporting grid capacity • Encourages continued dominance of single occupancy vehicle travel ▪ Environment • Very significant resource requirements • Carbon emissions and air quality issues may lead to restrictions on use of ICE-powered vehicles and may still exist with EVs (tyre and braking particulates) • Traffic noise • Significant impacts on built and natural environment

<table>
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Significant waste materials

Wellbeing

Encourages unhealthy lifestyles
Range anxiety but this is being addressed
Reducing number of younger people obtaining driving licenses
Reduced availability for younger and older demographics
Highway safety

</td></tr>
<tr><td rowspan="2">Technical Maturity</td><td>Concept</td><td>Feasibility</td><td>Piloting</td><td>Initial real-world operation</td><td>Mature technical operation</td></tr>
<tr><td colspan="5">Car use has been technically mature for many decades but it should be noted that electric drive trains (battery and hydrogen) are in various stages of maturity.</td></tr>
<tr><td rowspan="2">Commercial Maturity</td><td>Not operating commercially in the UK</td><td>Commercial testing/pilot</td><td>Commercial launch</td><td>Operating commercially</td><td>Mature commercial operation</td></tr>
<tr><td colspan="5">Car use and ownership (personal or vis lease) has been commercially mature for many decades</td></tr>
<tr><td>Business Models</td><td colspan="5">The business models for ‘owned’ vehicles is changing with traditional ownership becoming only a very small proportion of car ‘purchases’. The advent of Private Contract Plans means that approximately 90% of private vehicles are now leased and alternatives are coming forward including rental at various periodic increments including daily, weekly and monthly.</td></tr>
<tr><td rowspan="2">Journey Range</td><td></td><td></td><td></td><td></td><td>Unlimited</td></tr>
<tr><td colspan="5">Journey range is limited only by the ability of the driver to remain safe to operate the vehicle aside from ‘fuelling’ requirements</td></tr>
<tr><td>Supporting infrastructure and systems</td><td colspan="5">Supporting infrastructure include highways, car parks and fuelling including an increasing number of EV charging points</td></tr>
<tr><td>UK Best Practice Example</td><td colspan="3">Milton Keynes has the UK’s first brand neutral EV Experience Centre dedicated to electric vehicles which aims is to provide free education and advice about electric and plug-in vehicles. In the first two years of operation, the centre had over 100,000 visitors, over 3,600 short term test drives and 600 long term test drives.

Source: https://evexperiencecentre.co.uk/

Milton Keynes has the UKs largest universal rapid charging hub for electric vehicles that was installed by BP Chargemaster. The site has eight 50kW rapid chargers supporting all standards of EV rapid charging. The hub incorporates three highly-visible canopies to help drivers locate the rapid chargers, as well as to shelter them from inclement weather, and provides access to the facilities at the main Coachway building, including a café.

Source: https://www.bp.com/en_gb/united-kingdom/home/news/press-releases/uks-largest-public-rapid-charging-hub-inaugurated-in-milton-keynes.html</td><td colspan="2">  </td></tr>
</table>

Milton Keynes has one of the highest rates of EV registrations in the UK with more EVs registered than any entire Shire county. The marketing of EVs and the provision of charging points have made a significant contribution to this success.

Dundee has one of the highest concentrations of EVs in the UK. An EV hub has opened in Dundee that uses solar canopies and a battery storage system to charge up 20 vehicles at a time. The new hub, along with two more planned, will provide an extra 300 charge point connections across Dundee. With more than half the population of Dundee not having a driveway or off-street parking, the aim is to allow commuters to charge at the new hubs during the day, with residents of nearby homes able to access them at night.

Source: https://www.bbc.co.uk/news/uk-scotland-tayside-central-49796127

Bristol could become the UK's first city to introduce a ban on diesel vehicles to boost air quality. The vehicles will be prohibited from entering a central area of the city between 7am and 3pm every day under proposals by Bristol City Council. A wider charging zone for commercial vehicles such as buses, taxis, vans and lorries that do not meet certain emissions standards is part of the measures that could be implemented by March 2021. There is also a plan to launch a car scrappage scheme to help diesel car owners buy an alternative vehicle.

Source: https://www.theguardian.com/uk-news/2019/oct/30/bristol-could-become-uk-first-city-ban-diesel-cars

To help improve air quality, an Ultra-Low Emission Zone (ULEZ) now operates 24 hours a day, 7 days a week, within the same area of central **London** as the Congestion Charge. Most vehicles, including cars and vans, need to meet the ULEZ emissions standards or their drivers must pay a daily charge to drive within the zone. £12.50 for most vehicle types, including cars, motorcycles and vans (up to and including 3.5 tonnes) or £100 for heavier vehicles, including lorries (over 3.5 tonnes) and buses/coaches (over 5 tonnes)

Source: https://tfl.gov.uk/modes/driving/ultra-low-emission-zone

Increasingly strong action is being taken in the UK to improve air quality in urban areas with Bristol and London making some major strides. These actions could be applicable to major locations in EEH where there are significant air quality issues.

Europe Best Practice Example	The **Norwegian** success story in transitioning to electric cars is first and foremost due to a substantial package of incentives developed to promote zero-emission vehicles into the market. The incentives have been gradually introduced by different governments and broad coalitions

	of parties since the early 1990s to speed up the transition. The Norwegian Parliament has implemented a national goal that all new cars sold by 2025 should be zero-emission (electric or hydrogen). As of May 2018, there are 230,000 registered battery electric cars (BEVs) in Norway. Battery electric and plug-in hybrid vehicles together hold a 50% market share. The speed of the transition is closely related to policy instruments and a wide range of incentives. Source: https://elbil.no/english/norwegian-ev-policy/ In **Sweden**, the market share of electrically chargeable vehicles is 8.0%. Incentives include an incentive scheme up to SEK 60,000 (£4,803) for battery electric vehicles and SEK 10,000 (£800) for plug-in hybrid electric vehicles emitting less than 60g CO2/km. Source: https://www.acea.be/statistics/article/interactive-map-electric-vehicle-incentives-per-country-in-europe-2018 The Scandinavian countries are leading the way in driving the change to electric propulsion with significant incentives to purchase EV.	 
Global Best Practice Example	Since its debut in 2017, the **Tesla Model 3** has dominated electric car sales in the US. According to HIS Markit, the Telsa Model 3 accounted for 67% of the market for electric vehicles in the US in the last quarter, outcompeting models such as the Nissan Leaf and Chevrolet Bolt. This is helping with Tesla's target to sell 360,000 to 400,000 cars in 2019 – they sold a record 97,000 in Q3 of 2019 (2,000 below forecast) but could hit their target if they sell 105,000 in Q4. Source: https://qz.com/1703260/teslas-model-3-may-never-catch-up-to-the-nissan-leaf/ **Canada** outlined a vision for future EV uptake accompanied by very ambitious policies in some provinces, such as the zero-emissions vehicles (ZEVs) mandate in **Quebec** (similar to one in California). **British Columbia** announced legislation for the most stringent ZEV mandate worldwide: 30% ZEV sales by 2030 and 100% by 2040. This places Canada in a similar framework as the ten states in the United States that have implemented a ZEV mandate. Source:https://www.iea.org/publications/reports/globalevoutlook2019/	 
Notable Failures	A report published by **Zipcar** in 2018 highlighted that two-thirds (65%) of London based respondents would find it hard to give up their car. Emotional reasons Londoners feel so attached to their cars include the fact their cars provide them with a sense of luxury and success (21%), storage (21%) and special features like satellite navigation and leather seats (15%). Source: https://www.zipcar.co.uk/press/releases/londoners-love-affair-with-the-car-continues The **Department for Transport** plans to fully phase out the £3,500 Plug-in Car Grant subsidy. Although it is not certain when the grant will be scrapped, the Transport Secretary Grant	

	Shapps confirmed, in an interview with The Times, that the government was planning to end the grant Source: http://smarthighways.net/uk-government-plans-to-phase-out-plug-in-car-grant-subsidy-for-electric-cars/ Consumers are buying larger and less fuel-efficient cars, known as **Sport Utility Vehicles** (SUVs). There are now over 200 million SUVs around the world, up from 35 million in 2010. On average, SUVs consume about a quarter more energy than medium-size cars. SUVs were the second-largest contributor to the increase in global CO2 emissions since 2010 after the power sector, but ahead of heavy industry. Source: https://www.iea.org/newsroom/news/2019/october/growing-preference-for-suvs-challenges-emissions-reductions-in-passenger-car-mark.html EVs can help to tackle poor air quality and climate change however they alone cannot alleviate all car-based problems. For example, if EVs remain personal vehicles, there will be may be minimal change in car usage and the congestion problem will continue. Source: https://theconversation.com/not-so-fast-why-the-electric-vehicle-revolution-will-bring-problems-of-its-own-94980			
Spatial Typologies	City Centre		Remote Rural	
	Small Town		Parkway	
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Spatial Density	High Density			
	Medium Density			
	Low Density			
Summary	▪ Private car use for even very short FMLM journeys dominates the travel market, across most spatial typologies and densities with the mode being particularly dominant in less dense locations where alternatives are fewer. The user relationship with this mode is complicated and outside of dense urban centres, it out competes others for convenience, journey time and comfort. ▪ The focus of much transport policy is around replacing this mode with more sustainable options as highlighted elsewhere in this report. However, the mode continues to develop with the environmental impact being a key area of work at present and particularly the reduction in emissions through electrification to reduce carbon emitted and improve air quality. ▪ This mode is likely to remain a core element of FMLM networks but developments in automation of this mode over the coming decades my significantly disrupt the travel market in general. However, the focus for transport policy remains to reduce the number of single occupancy car journeys, particularly by conventionally powered by ICEs.			

Shared

Mode: Car (shared)

Definition	A journey undertaken in a car / van.
Sub-Models	A multi-occupancy journey undertaken using a privately owned, leased or rented vehicle that has been setup using a formal carpooling service/ a journey that has been undertaken using a vehicle that has been sourced via car club membership
Typical Use Cases	▪ Travel between multiple home locations and major mass transit interchange ▪ Travel between multiple home location and workplace ▪ Travel between workplace and external locations ▪ Travel between multiple home locations and remote areas
Benefits	▪ Economic • Reduces the need to own a car • Reduced operational costs than 'owned' • Flexible and on-demand • High levels of infrastructure in place in urban and rural locations • Reduction in single-occupancy journeys ▪ Environment • Reduced environmental impact per person carried ▪ Wellbeing • Provides independence • Convenient • Widely accessible but with limitations from affordability
Opportunities	▪ Economic • Potential for incentives e.g. parking location/cost, car-share lanes, etc • Electrification reduces running costs • Digitisation increases data on users' travel • Further development of technologies including automation ▪ Environment • Electrification reduces carbon emissions from the tailpipe • Further development of electrification technologies ▪ Wellbeing • Electrification reduces air quality issues
Barriers	▪ Economic • Not as flexible as single occupancy journeys • Limitations on highway capacity • New infrastructure is very expensive • Lack of space for enabling infrastructure • Initial and ongoing costs • Availability of EV charging infrastructure and supporting grid capacity • Encourages continued dominance of single occupancy vehicle travel ▪ Environment • Very significant resource requirements

	• Carbon emissions and air quality issues may lead to restrictions on use of ICE-powered vehicles • Traffic noise • Significant impacts on built and natural environment • Significant waste materials ▪ Wellbeing • Encourages unhealthy lifestyles • Range anxiety but this is being addressed • Reducing number of younger people obtaining driving licenses • Reduced availability for younger and older demographics • Highway safety • Actual or perceived security issues from sharing with strangers				
Technical Maturity	Concept	Feasibility	Piloting	Initial real-world operation	Mature technical operation
	These services are now technically mature in the UK				
Commercial Maturity	Not operating commercially in the UK	Commercial testing/pilot	Commercial launch	Operating commercially	Mature commercial operation
	Services are operating commercially but these tend to be in dense urban environments where markets are easily accessible				
Business Models	These services are operated commercially by a growing range of companies				
Journey Range					Unlimited
	Journey range is limited only by the ability of the driver to remain safe to operate the vehicle				
Supporting infrastructure and systems	Supporting infrastructure include highways, car parks and fuelling including an increasing number of EV charging points, as well as data, websites, apps and back office operating systems				
UK Best Practice Example	**Faxi** gives employers the opportunity to create their own commuter carpooling community. The Faxi platform can verify employee carpooling in real time which allows companies to offer incentives, such as priority parking to car-poolers. During its partnership with **Northamptonshire** County Council, staff ride sharing increased from 2% to 20% in the first 6 months after launch. Source: https://faxi.co.uk/corp/en/casestudies/ncc/ **Liftshare** enables employers to encourage car sharing amongst employees by setting up a car sharing scheme. In 2015, **Jaguar Land Rover** recruited the services of Liftshare to embed car sharing as a sustainable mode of transport for employees traveling to work. Since then, car sharing has not only contributed to lowering the carbon footprint of Jaguar Land Rover's operations, but has also eased the demand for parking at its sites and reduced traffic in the local community. Over 10,000 staff members have registered on the Liftshare platform and				

5,000 of these share on a daily basis.

Source: https://business.liftshare.com/case-studies/jaguar-land-rover/

Successful employer-led car sharing schemes can have a significant impact on mode share.

ZipCar is a car club with 250,000 members in **London** and almost 3,000 vehicles of varying sizes. Car-sharing is a fast-growing concept and ZipCar estimates that 800,000 Londoners (15% of those who drive) could be active car club members by 2025. ZipCar partnered with Volkswagen in 2018 to introduce 325 electric vehicles in to its fleet, and hopes this will help drive investment in London's rapid charging network. The company's vision is for its fleet to be fully electric across all vehicle types by 2025, helping keep Londoners moving while reducing the impact of cars on the urban environment.

Source: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/786654/future-of-mobility-strategy.pdff

Large car clubs are currently in operation in major cities in the UK and there is significant potential for growth in the market.

Co-wheels is a pay-as-you-go car hire scheme, with vehicles available to hire in convenient locations across the **UK**. As a car club member, you can book a car via an online booking system or over the phone. A smartcard is used to access the vehicles. There are designated bays that the vehicle is picked up from and must be returned to the same location. Insurance is included, and you can book a car from 30 mins to days at a time, only paying for the hire time and distance they drive.

Source: https://www.co-wheels.org.uk/faq

Enterprise Car Club has a large fleet of cars and vans spread across an ever-increasing number of **UK** cities. The vehicles are parked in designated bays and can be reserved for as little as half an hour, a day, or as long as needed. Users only pay for the time and distance they need a vehicle for, meaning they have all the convenience of a vehicle, without the inconvenience and expense of owning one. The cars and vans can be reserved via the app, online or by phone in advance or at the last minute. The vehicles are unlocked using the app or an access card.

Source: https://www.enterprisecarclub.co.uk/gb/en/home.html

Existing established vehicle rental operators are in the car sharing market as well as new entrants providing for both competition and different business models. These operators have a mix of on-street spaces and depots in large cities as well as existing depots in smaller towns and cities where traditional vehicle rental operations

	already exist.	
Europe Best Practice Example	**Car2Go,** which forms part of Daimler's mobility strategy offers flexible car sharing service operating in 26 locations in eight countries. It has more than 3 million customers with access to a fleet of 14,000 vehicles. Source:https://www.daimler.com/products/services/mobility-services/car2go/ Major automotive OEMs are entering the car sharing market, changing the dynamics in approaches to car ownership. **France** is the most successful market for Peer-to-Peer (P2P) car sharing in **Europe.** P2P comprises approximately 90% of car sharing with over one million users. The regulations impose that all free-floating vehicles must be electric or hybrid, and when the criteria are met, parking spaces are easily accessible. Source:https://www2.deloitte.com/content/dam/Deloitte/de/Documents/consumer-industrial-products/CIP-Automotive-Car-Sharing-in-Europe.pdf	
Global Best Practice Example	**Flightcar**, a P2P (Peer to Peer) operator based in **San Francisco**, enables owners to rent their cars to travellers coming in from the airport. In exchange, Flightcar owners receive free airport parking. Unlike other P2P programs, Flightcar operates a fixed payment program in which owners may earn between $150 and $400 each month. To qualify, owners must make their cars available for rental for all but four days per month. Source: https://sharedusemobilitycenter.org/p2p-carsharing-best-practices/ **Car Next Door**, is a P2P operator in **Australia**, which provides a "closed network" service that limits carsharing to members of specific apartment dwellings. Within the closed network, renters search only for cars offered by owners living in the same building. In 2014, Car Next Door launched a closed network program at Essence South Melbourne Apartments in Melbourne. Source: https://sharedusemobilitycenter.org/p2p-carsharing-best-practices/ There are a range of approaches to P2P car rental operations; open, focussed on particular locations (e.g. airport) or closed networks.	 
Notable Failures	**Didi Chuxing** suspended its carpooling service in China, Hitch, following several driver related crimes. Drivers were not appropriately vetted and as a result there were issues surrounding user safety. Source: https://www.wired.co.uk/article/didi-car-chuxing-uber-china-safety	

<table>
<tr><td></td><td colspan="4">After launching in 2011, the contract for the Autolib' one-way electric car sharing service in Paris was cancelled in 2018. The city cited financial issues, with expectations of 293m euros of debt by 2023, cleanliness, problems with parking and competition with other modes as the reason for the termination of the service. At its height, the service had 4,000 cars, 1,100 charging locations and 150,000 active users.

Source: https://www.reuters.com/article/us-france-autos-autolib/paris-ends-autolib-electric-car-sharing-contract-with-bollore-idUSKBN1JH2CM

The Autolib example demonstrates that even large and seemingly successful schemes can fail and that a large customer base does not necessarily lead to financial sustainability.</td></tr>
<tr><td rowspan="4">Spatial Typologies</td><td>City Centre</td><td></td><td>Remote Rural</td><td></td></tr>
<tr><td>Small Town</td><td></td><td>Parkway</td><td></td></tr>
<tr><td>Suburb</td><td></td><td>Business Park</td><td></td></tr>
<tr><td>Village</td><td></td><td></td><td></td></tr>
<tr><td rowspan="3">Spatial Density</td><td colspan="2">High Density</td><td colspan="2"></td></tr>
<tr><td colspan="2">Medium Density</td><td colspan="2"></td></tr>
<tr><td colspan="2">Low Density</td><td colspan="2"></td></tr>
<tr><td>Summary</td><td colspan="4">■ The shared car market is a growing and complex area of mobility provision with a mixture of existing established businesses adapting their models, OEMs transitioning away from solely selling vehicles and new entrants opening new opportunities for sharing vehicles.

■ The market has varying levels of technical and commercial maturity. OEMs have for some time provided alternatives to ‘ownership’ and are providing a wider range of options to access their vehicles. Businesses are altering their models or starting new commercial offerings for short to longer-term rentals and individuals have a range of options for Peer to Peer sharing of their ‘owned’ cars.

■ Overall, the changes occurring in the sharing of cars could lead to the reduced need for individuals or households to obtain long-term sole access (‘ownership’) to a vehicle, particularly in dense urban areas, where cars can be obtained for short periods as and when needed. These advances may also lead to a reduced need to have sole access to more than one vehicle in a household where additional cars are used less often than the ‘primary’ vehicle, this may be particularly the case in less dense locations where alternatives to the private car are less available.

■ The development of autonomous vehicles over the coming decades may have further significant disruptive effects on this and the wider transport market.</td></tr>
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Traditional Bus

Mode: Traditional Bus

Definition	Traditional, 'registered' public bus services (large, midi and mini bus) on generally, linear fixed routes
Sub-Models	N/A
Typical Use Cases	▪ Travel between home location and major mass transit interchange ▪ Travel between major mass transit interchange and workplace ▪ Travel between home location and major retail centre
Benefits	▪ Economic • High levels of infrastructure in place in most urban and many rural locations • Reduction in short journeys by single occupancy vehicles • No ownership costs and relatively inexpensive for users • Zero costs for older users ▪ Environment • Reduced carbon emissions per passenger ▪ Wellbeing • Physical and mental wellbeing benefits • Widely accessible and increasingly for those with health impairments
Opportunities	▪ Economic • Mode shift may reduce some capacity issues on other modes • Improved health and wellbeing may have wider economic benefits and potential cross sector cost savings • Reduced transport costs • Increased data on users' travel • Electrification reduces running costs and localise impacts • Digitisation increases data on users' travel • Further development of technologies including automation ▪ Environment • Increases in mode use will reduce carbon emissions and improve air quality • Move towards low emission vehicles will reduced carbon impacts • Further development of electrification technologies ▪ Wellbeing • Electrification reduces air quality issues • Increase walking can improve physical and mental health when combined with active modes
Barriers	▪ Economic • Lack of network coverage • Requires significant subsidy where not commercially viable • Limitations on capacity • Availability of infrastructure particularly in rural areas • New infrastructure can be expensive • Lack of space for enabling infrastructure • Can be slow and unreliable

	• Vandalism and damage • Procurement and regulation • Lack of user understanding of the system • Significant waste materials ▪ Environment • Costs of supporting electricity / hydrogen could be expensive depending upon location • Unattractive waiting environments • Carbon emissions from ICE powered vehicles • Air quality issues from ICE powered vehicles ▪ Wellbeing • Weather conditions can reduce attractiveness (passenger waiting) • Perceived and actual security of users

Technical Maturity	Concept	Feasibility	Piloting	Initial real-world operation	Mature technical operation
	Bus operation is technically mature with ongoing advances in propulsion technology with significant investment in electrified fleets as well as development of hydrogen fuelling				
Commercial Maturity	Not operating commercially in the UK	Commercial testing/pilot	Commercial launch	Operating commercially	Mature commercial operation
	Operation in the UK is a mix of commercial and subsidised services with a franchise system in London and potential for this to be implemented in other major cities where legal powers are enabled.				
Business Models	Business models outside of London focus on commercial operation of routes by private operators supplemented by subsidising of non-commercial services also operated privately.				
Journey Range				<30km	
	Typically bus journeys are significantly less than 30km but longer distance services operate between centres, particularly where rail services are limited or non-existent.				
Supporting infrastructure and systems	Supporting infrastructure includes highways with and without bus priority infrastructure, guided bus routes, bus stations and stops, and real-time information				
UK Best Practice Example	The **Leeds-Harrogate-Ripon bus route** has seen impressive growth in use since 2003, when its operator invested in high quality vehicles with leather seats – since 2003 the service has consistently returned double figure annual bus patronage growth (however this has tailed off over the last few years) Additionally, the service has been upgraded several times following the initial investment and now has some of the most comfortable and well-equipped buses in the country. Source:https://bettertransport.org.uk/sites/default/files/pdfs/bus-services-act-guidance.pdf https://www.busandcoachbuyer.com/transdev-harrogate-redefines-36/ Improvements to the quality of buses can positively impact patronage. In conjunction with bus operators, Merseytravel				

introduced '**Myticket**', a £2.20 flat fare for all day bus travel for young people from five to 18. The number of journeys made by young people has risen by 142 per cent in the three years following its introduction

Source:https://bettertransport.org.uk/sites/default/files/pdfs/bus-services-act-guidance.pdf

Cost may be a factor that impacts young people's travel choices as the MyTicket's flat rate prices for under 18s has led to a rise in patronage of younger people.

Following the passing of the **Bus Services Act 2017**, the Government is introducing regulations requiring bus operators or local authorities to publish information on timetables, routes, fares, tickets, live information and stops from early 2020. In advance of these regulations being laid, some bus operators are already taking a lead in opening up more data. **Reading Buses**, for instance, publishes fare data, real-time information on departure and arrival times and vehicle location, and accessibility information. Using its 'tech lab', it gives partners access to data, facilitating innovation that creates new commercial opportunities and improves customer experience. For example, its partner RouteReports developed a tree-strike tool, allowing areas where overgrown trees are striking buses to be reported to the Local Authority. The tool has since been commercialised.

Source:
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/786654/future-of-mobility-strategy.pdf

Sharing bus data, like Reading Buses, can create new commercial opportunities and improve customer experience.

Hydrogen powered buses will soon be introduced in the **Liverpool City Region** following a successful joint bid with the city of **Aberdeen**. The Liverpool City Region will become the first city the North of England where it is possible to catch a diesel-electric hybrid, battery, compressed natural gas or hydrogen-powered bus following a successful £6.4 million bid to the government's Office for Low Emission Vehicles. A total of 35 buses have been ordered – 25 for Liverpool and 10 for Aberdeen. These buses will contribute to Liverpool City Region's plans to both improve air quality and work towards a zero-carbon economy by 2040. The first bus trial is expected to take place in 2020. Fuel will be provided from a new hydrogen refuelling station at the BOC plant in St Helens initially deliver 500kg of hydrogen every day.

Source:
https://thenorthwestbusblog.co.uk/jamesgrundy/liverpool-launches-hydrogen-bus-project/

A range of new technologies are enabling buses to

operate with zero tailpipe emissions to reduce the carbon and air quality impacts of their operation.

In **Milton Keynes** eight electric buses operate on the Route 7, that runs up to every 15 minutes, seven days a week from Wolverton in the north of the city to Bletchley in the south. The route serves high-density residential areas as well as connecting the centre of Milton Keynes and the busy railway station. The buses are charged wirelessly during the day and only have a full charge overnight. This means that once the buses have left the depot for the start of service, they can remain on the road all day without any need to return to the depot. This is achieved via Inductive Power Transfer (IPT). At each end of the route charging plates have been set into the road which charge the buses parked on them. Only two wireless charging points are needed for all eight buses and the charging times are built into the schedule of the timetable.

Source: https://www.intelligenttransport.com/transport-articles/13992/wirelessly-charged-electric-buses-in-milton-keynes/

Wireless bus charging technology can improve reliability of electric services and reduce the downtime of each vehicle

An autonomous bus pilot in **Edinburgh**, known as **Project CAV Forth**, received a £4.35 million funding for an autonomous bus service running from the Forth Bridge into Edinburgh Park Train and Tram interchange. Five Alexander Dennis single-decker manual buses will be converted as part of the pilot, carrying up to 42 passengers on the 14 mile route.

Source: https://www.edinburghnews.scotsman.com/news/forth-road-bridge-driverless-buses-heres-how-technology-works-205367

Outcomes of the autonomous bus pilot have the potential to influence future similar schemes.

In the UK there are a number of guided busways including in **Leigh** and **Cambridge**. The Cambridgeshire Guided Busway connects Cambridge, Huntingdon and St Ives and is the longest guided busway in the world. The busway is made up of two concrete channels with kerbs and guide wheels on the vehicles connect with the kerb and run along it to steer the buses. The Leigh-Salford-Manchester Bus Rapid Transit scheme provides transport connections between Leigh, Atherton, Tyldesley, Ellenbrook and Manchester city centre via Salford. The scheme opened in April 2016 and includes Park & Ride sites, 21km of guided busway, enhanced passenger waiting facilities and eight services per hour.

Source: https://www.thebusway.info/about.shtml

https://transportknowledgehub.org.uk/case-studies/leigh-ellenbrook-guided-busway/

	A guided busway service can improve customer experience from the waiting facilities, to the quality of buses, journey time and journey time reliability.	
Europe Best Practice Example	**Transdev Sweden** has won a €757 million contract in Gothenburg, Sweden's second largest city. The company plans to put 160 new zero-emission electric buses into operation as part of the city's 370 strong bus fleet. Additionally, the remaining 210 buses will be operated without fossil fuels, instead being powered by biofuels. Transdev already operates approximately 60 electric buses in Umea, Eskilstuna, Stockholm and Gothenburg meaning that the contract will enable it to have the largest electric bus fleet in the country. Source: https://www.caissedesdepots.fr/en/sweden-transdev-will-transport-gothenburg#targetText=In%20Sweden%2C%20Transdev%20will%20transport%20Gothenburg&targetText=Transdev%20will%20put%20160%20new,and%20powered%20using%20only%20biofuels. **Dublin City Council** began sharing data generated by its bus services. Data is collected from bus timetables, inductive-loop traffic detectors, closed-circuit television cameras and GPS updates from each of the city's buses to identify the cause of delays and the most effective measures to put into place to improve traffic flow. From linking these datasets together, a digital map of the city has been built up and overlaid with the real-time positions of Dublin's buses. This allows traffic controllers to see the current status of the entire bus network at a glance. Source: https://www.centreforcities.org/reader/open-data-closed-doors/big-data/#case-study-5-dublin-ireland Sharing of bus data does not only improve customer experience but can help improve the day to day running of buses and increase reliability.	
Global Best Practice Example	**Nanyang Technological University in Singapore** has tested the world's first full size, autonomous electric bus in partnership with Volvo in March 2019. The single-deck bus is fitted with 36 seats and has capacity for almost 80 total passengers. Source: https://newatlas.com/volvo-first-electric-driverless-bus-singapore/58743/	
Notable Failures	The number of local bus passenger journeys in **England** fell by 85 million or 1.9% to 4.36 billion in the year ending March 2018**.** This follows a trend of increasing decline in bus	

	patronage since 2008/09. Furthermore, bus mileage in England decreased by 3.4 when compared with 2016/17. Source:https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/774565/annual-bus-statistics-year-ending-mar-2018.pdf#targetText=The%20number%20of%20local%20bus,the%20year%20ending%20March%202018. The UK has seen an long-term and ongoing decline in bus patronage outside of London.			
Spatial Typologies	City Centre		Remote Rural	
	Small Town		Parkway	
	Suburb		Business Park	
	Village			
Spatial Density	High Density			
	Medium Density			
	Low Density			
Summary	▪ Bus services are a mature, established and key element of the transport network serving all spatial typologies and densities but with greater suitability to high density locations where commercial operations are more likely to be sustainable. ▪ Despite their established nature, innovation and developments in their services are continuing with particular focus on decarbonisation, customer experience and ticketing. However, automation may have a significant disruptive influence on manually driven services both in terms of the automation of larger, high capacity 'trunk haul' services and competition from smaller, more flexible DRT and shuttle services, as well as the wider automation of cars. ▪ Innovation in the transport market is hindered by the current regulatory structure of bus services outside London where a deregulated and market-led approach brings barriers to closer integration and co-operation.			

TRADITIONAL AND EMERGING TAXI

Mode: Traditional and Emerging Taxi

Definition	Private hire registered taxi operating under a radio system
Sub-Models	Private hire registered taxi with alternative approaches to booking including apps and online
Typical Use Cases	▪ Travel between home location and major mass transit interchange ▪ Travel between major mass transit interchange and workplace ▪ Travel between retail centre and home location ▪ Travel between home location and education or healthcare site
Benefits	▪ Economic • Convenient • 24hr service • Flexible • High levels of infrastructure in place in most urban and many rural locations • Reduction in short journeys by single occupancy vehicles • No ownership costs and relatively inexpensive for users ▪ Environment • Reduced carbon emissions per passenger when shared ▪ Wellbeing • Widely accessible and increasingly for those with health impairments
Opportunities	▪ Economic • Reduced transport costs • Increased data on users' travel • Electrification reduces running costs • Further development of technologies including automation ▪ Environment • Move towards low emission vehicles will reduced carbon impacts • Further development of electrification technologies ▪ Wellbeing • Electrification reduces air quality issues
Barriers	▪ Economic • Expensive • Lack of network coverage and cost in rural locations • Limitations on capacity • Can unreliable during periods of high demand • Regulation and license implications ▪ Environment • Lack of EV charging points and supporting grid capacity • Carbon emissions from ICE powered vehicles • Air quality issues from ICE powered vehicles • Unattractive waiting environments

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Significant waste materials

Wellbeing

Perceived and actual security of users

</td></tr>
<tr><td rowspan="2">Technical Maturity</td><td>Concept</td><td>Feasibility</td><td>Piloting</td><td>Initial real-world operation</td><td>Mature technical operation</td></tr>
<tr><td colspan="5">The operation of taxis in the UK is technically mature</td></tr>
<tr><td rowspan="2">Commercial Maturity</td><td>Not operating commercially in the UK</td><td>Commercial testing/pilot</td><td>Commercial launch</td><td>Operating commercially</td><td>Mature commercial operation</td></tr>
<tr><td colspan="5">The operation of taxis in the UK is technically mature but has been disrupted by the advent of ride-hailing services. Some traditional operators are moving to technology based booking services using apps and text technologies.</td></tr>
<tr><td>Business Models</td><td colspan="5">Private hire is operated by commercial enterprises by users pre-booking journeys (unlike hackney carriages which can be hailed on street). Ride hailing has disrupted the business model, most significantly by undercutting prices.</td></tr>
<tr><td rowspan="2">Journey Range</td><td></td><td></td><td><20km</td><td></td><td></td></tr>
<tr><td colspan="5">Typical journeys are under 20km but long-distance journeys, to airports for example, are common.</td></tr>
<tr><td>Supporting infrastructure and systems</td><td colspan="5">In addition to highway infrastructure, services require fuelling infrastructure, particularly with the increased in EV taxis, as well as data, websites, apps and back office systems</td></tr>
<tr><td>UK Best Practice Example</td><td colspan="5">The London Electric Vehicle Company has stated that London taxi cab operators have saved £3.5 million in fuel costs since it introduced its PHEV electric cab last year. The electrified black cab has a range of 80 miles and an onboard range extender petrol engine. To date, 2,500 of the LEVC cabs have been sold, with 2,000 of them operating on the streets of London, and the remainder operating elsewhere in the UK.

Source: https://cleantechnica.com/2019/07/31/levc-says-electric-taxis-have-saved-3-5-million-in-fuel-costs-for-london-cabbies/

Radio Taxis which has a fleet of 3,000 black cabs and 80 executive cars, spends £100,000 each year on offsetting its carbon dioxide emissions. Radio Taxis is giving 80% of the cash to overseas renewable energy projects like solar panels in Sri Lanka and a Bulgarian hydro-electric plant. The remaining 20% is set to be spent on forestry projects both across the UK and in Germany. Radio Taxis says it emits almost 24,000 tonnes of carbon dioxide each year. The company says it is also committed to ensuring emissions from its vehicles are as low as possible, but admits this is difficult as the majority of its drivers own their vehicles. The company also uses a biodiesel blend using UK grown virgin oil stock that is specifically created for use in taxis. Developed in partnership with UK based

 
</td></tr>
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Infinitum Limited, it is claimed that the fuel blend significantly reduces NOX and CO with a 4.7 % reduction in particulate matter.

Source: https://trl.co.uk/sites/default/files/PPR349.pdf

There is a drive towards the electrification of taxis with a new version of the traditional London taxi being released with hybrid power.

In **London** there are a number of ride hailing apps that are now competing with Uber and traditional black cabs. These include:

- Formerly Taxify, **Bolt** arrived in London in 2017 but was removed by TfL for failing to acquire the right licensing. It relaunched as Bolt in 2019. Rides start with a £2.50 base fee, plus £1.25 per mile and £0.15 per minute.
- **Kabbee** is different to the other Uber alternatives in that instead of having its own cars and services, the app pulls together over 50 cab fleets from across the city to utilise London's minicab services. It specialises in airport rides and promises to be 28 per cent cheaper than Uber. In addition, it offers fixed fares and no surge pricing.
- French start-up **Kapten** is backed by Daimler and BMW. It launched in London in May 2019 and states that, in general, rides are 20 per cent cheaper than its competitors. One way that Kapten is able to keep fares lower for customers is that it covers the congestion charge on behalf of its drivers. It also operates a loyalty programme, rewarding customers with free rides and access to new benefits the more they use the app. Kapten now has 16,000 drivers in London.
- Based in London, **Wheely** does not work with taxis, but instead offers a chauffeur car service, with all of its drivers picked through an accreditation process to ensure they offer the highest level of service. Each ride takes place in a new Mercedes-Benz.
- **Xooox** pulls together a list of available taxis and private hires in London. Customers can compare prices and times from different firms, as well as car size and emissions output, before booking a ride in the app. Drivers do not pay commission to Xooox for rides, and are able to set their own prices and travel boundaries.

Source: https://www.standard.co.uk/tech/uber-app-alternatives-bolt-kapten-viavan-wheely-london-a4237621.html

Significant disruption has occurred to the taxi market, particularly in London and other major UK cities through the digitisation of booking and the emergence of ride-hailing.

Europe Best Practice Example	From 2023 onward, all taxis in **Oslo** will have to be zero emission and Norway wants all new cars to be zero emission by 2025. Oslo will become the first city in the world to install wireless charging systems for electric taxis, hoping to make recharging quick and efficient enough to speed the take-up of non-polluting taxis. Source: https://www.reuters.com/article/us-norway-electric-taxis/oslo-to-become-first-city-to-charge-electric-taxis-over-the-air-idUSKCN1R21ED The Norwegians are leading the world in electrification of their vehicle fleet including taxis with an ambitious targets for the mid-2020s.	
Global Best Practice Example	In June 2018, **Blu Smart Mobility** launched an all-electric taxi service in **Delhi, India.** The Delhi-based EV start-up partnered with Mahindra & Mahindra Ltd to launch its ride-hailing services in the region. The fleet has approximately 70 electric vehicles, however the company intends to increase this to 500 by April 2020. Source: https://yourstory.com/2019/06/mahindra-blu-smart-ev-ride-hailing-service A **South African** company, **Mellowcabs**, launched an on-demand low-cost environmentally friendly three wheeler that provides last-mile a transport service in its cities. Passengers pay a flat fee, within a four-kilometre radius and a single cab can provide over 120km of transport per day. It launched in early 2012 and is cheaper than a taxi. Source: https://www.virgin.com/virgin-unite/mellow-yellow-eco-taxis-providing-last-mile-transit-south-africa New alternatives to the car-based taxi continue to be developed around the world	 
Notable Failures	In August 2019, a study on behalf of ride-hailing companies, **Uber** and **Lyft**, revealed that their operations were potentially making traffic worse in the cities included in the study: **Boston, Chicago, Los Angeles, San Francisco, Seattle, and Washington, DC**. The rate of change varies between the cities but, for example, in San Francisco County '*Uber and Lyft make up as much as 13.4 percent of all vehicle miles. In Boston, it's 8 percent; in Washington, DC, it's 7.2 percent'.* The study also found that only 54 to 62 percent of the vehicle miles travelled by Uber and Lyft vehicles were with a rider in the backseat. Source: https://www.theverge.com/2019/8/6/20756945/uber-lyft-tnc-vmt-traffic-congestion-study-fehr-peers The development of new ride-hailing systems has potentially led to an increase in traffic in some major cities. Over the past year, a spate of suicides by taxi drivers in **New York City** has highlighted the overwhelming debt and financial plight of medallion (taxi license) owners. Officials have blamed the crisis on competition from ride-hailing companies such as Uber and Lyft, however, a New York Times investigation found much of the devastation can be traced to a handful of powerful industry leaders who steadily and artificially drove up the price of taxi medallions, creating a bubble that eventually burst. Over more than a decade, they channelled thousands of drivers into high risk loans and extracted hundreds of millions of dollars before the market collapsed.	

	Source: https://www.nytimes.com/2019/05/19/nyregion/nyc-taxis-medallions-suicides.html?module=inline A **Department for Transport** report of taxi and private hire statistics has revealed that there has been a decline in taxi numbers across the **UK**, while private hire numbers have increased. As of 2019, there are 70,600 licensed taxis in the UK, a 3% decrease in numbers from the previous year. Private hire numbers fared much better, with a 4.4% increase taking their figures to 221,200. Source: https://www.taxi-point.co.uk/single-post/2019/09/27/Taxi-numbers-in-decline-as-private-hire-numbers-increase The disruption of the traditional taxi model has been disrupted by new approaches to booking services leading to a change in the balance between taxis and private hire operators.			
Spatial Typologies	City Centre		Remote Rural	
	Small Town		Parkway	
	Suburb		Business Park	
	Village			
Spatial Density	High Density			
	Medium Density			
	Low Density			
Summary	▪ The taxi market faces ongoing disruption by new entrants into this space but taxis remain a core element of the transport market for FMLM journeys, particularly for greater distances. The impact of climate change and stronger action to meet air quality targets means that taxis are a significant focus for work to reduce emissions, particularly through electrification. However, the true impact on traffic of ride-hailing is not well known but there are indications that it may add to congestion. ▪ The development of autonomous vehicles may have a very significant disruptive effect on the taxi market with ride-hailing companies being major players in the development of automated technologies.			

POOLED RIDE-HAILING/DEMAND RESPONSIVE SERVICES

Mode: Pooled Ride-hailing / Demand Responsive Services

Definition	Pooled ride-hailing schemes match drivers and passengers making similar regular or one-off trips. Drivers and passengers register their available / desired trips via a website or app and the service matches logical pairings. Includes 'taxi, 'van' and 'minibus' and autonomous based solutions. Demand responsive services refer to on demand community-based transport (including social care and education transport)
Sub-Models	Pooled ride-hailing services allow users to share trips by picking up multiple users travelling on similar routes and to similar destinations.

Typical Use Cases	▪ Travel between home location and major mass transit interchange ▪ Travel between major mass transit interchange and workplace ▪ Travel between retail centre and home location ▪ Travel between home location and education or healthcare site
Benefits	▪ Economic • Convenient • Flexible • Real-time information • High levels of infrastructure in place in most urban and many rural locations • Reduction in short journeys by single occupancy vehicles • No ownership costs and relatively inexpensive for users ▪ Environment • Reduced carbon emissions per passenger when shared ▪ Wellbeing Widely accessible and increasingly for those with health impairments
Opportunities	▪ Economic • Reduced transport costs • Increased data on users' travel • Electrification reduces running costs • Further development of technologies including automation ▪ Environment • Move towards low emission vehicles will reduced carbon impacts • Further development of electrification technologies ▪ Wellbeing • Electrification reduces air quality issues
Barriers	▪ Economic • Lack of network coverage and cost in rural locations • Limitations on capacity • Regulation and license implications ▪ Environment • Lack of EV charging points and supporting grid capacity • Carbon emissions from ICE powered vehicles • Air quality issues from ICE powered vehicles • Significant waste materials ▪ Wellbeing • Lack of digital engagement by some demographic segments • Overcoming existing habits • Personal safety concerns

Technical Maturity	Concept	Feasibility	Piloting	Initial real-world operation	Mature technical operation

	Current technical maturity has over the past few years moved beyond piloting and into initial real-world operation with expansion of services as demand increases but they have yet to achieve a mature steady state for large scale operations.				
Commercial Maturity	Not operating commercially in the UK	Commercial testing/pilot	Commercial launch	Operating commercially	Mature commercial operation
	Some operations are operating commercially and are growing but there have been notable failures in the market				
Business Models	Business models vary in similar ways to traditional bus services with some operations being procured and subsidised by local authorities or as part of major developments				
Journey Range				<30km	
	Typical journeys are under 30km but long-distance journeys				
Supporting infrastructure and systems	In addition to highway infrastructure, services require fuelling infrastructure, particularly with the increased in EVs, as well as data, websites, apps and back office systems				
UK Best Practice Example	**ViaVan,** which was launched in 2017, is a service that takes multiple passengers heading in the same direction in one vehicle. Passengers are picked up at a nearby corner and then dropped off within a couple of blocks of their requested destination. Currently operational in **London** & **Milton Keynes** in the UK. Source: https://www.viavan.com/ **Vamooz** is an app-based crowd sourced service which uses individual customers to crowdfund regular services to specific destinations that do not lie conveniently on the existing bus network. The company works with employers to identify where demand could be and uses crowdfunding technology to check the viability of new services, this includes engaging with other businesses nearby to get a full picture of demand. Services offer a quality, direct services, with a regular driver, free Wi-Fi and mobile ticketing. Source: http://govamooz.co.uk/ **ArrivaClick** launched its first UK city service in **Liverpool** in August 2018. ArrivaClick combines the cost effectiveness of bus travel with the convenience of personalised transit. There are no fixed routes, with journeys determined by where passengers want to go within an area served running from Liverpool city centre to John Lennon Airport. Bus company Arriva worked with the city transport authority Merseytravel to roll out the app-based on-demand public transport service, initially with six luxury 15-seat buses but with a view to running 25 vehicles by summer 2019. Passengers can 'order' and track a vehicle from the app, which provides them with a guaranteed fare and allows them to choose their pick-up point and reserve a seat. Computer algorithms match passengers traveling in the same direction, dynamically routing vehicles in real time to find				

	the optimal route for their trip. During the pilot in Kent, over half the customers surveyed switched from using private cars to ArrivaClick, with 61% of users using the service a few times per week or more. Some 43% adopted the service for their daily commute and 9 out of 10 said they would recommend it to a friend. Source: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/786654/future-of-mobility-strategy.pdf The above examples of on-demand pooled ride hailing services are used to complement the existing bus services, connecting those who may live away from the traditional bus routes by offering street corners as pick-up locations. Each service offering above is a merger of traditional taxi and bus modes offering high quality vehicles.	
Europe Best Practice Example	**Allygator** (**Berlin**) is a service that allows users to book a ride on a minibus to a destination of their choice. The service then matches riders with similar origin and destination points Source: https://www.allygatorshuttle.com/en/operational-info.html For users with similar destination points and origins along a logical route, on demand pooled ride hailing services can offer a viable mode choice for journeys. **Shotl** (**Barcelona**) is a service that replaces low-ridership routes with on-demand minibus services. Users with the Shotl passenger app on their smartphones are able to submit a trip request. Riders are then informed with walking directions towards a pick-up point and from the drop-off point to their final destination. Source: https://shotl.com/platform On demand pooled ride hailing services can be used to replace bus routes that have low patronage.	
Global Best Practice Example	**UberPool** is available in 36 cities worldwide (16 in the **US,** and 20 internationally). The platform matches private vehicle drivers to those requiring a ride and allows riders	

going in the same direction to share a ride for a lower price. In the cities in which it operates, UberPool accounts for around 20% of all rides but is heavily subsidised to attract users.

Source:https://www.theverge.com/2018/2/21/17020484/uber-express-pool-launch-cities

Lyft Line (**Toronto**) encourages users to ride share by connecting users (both drivers and passengers) with similar trip destinations. However, Lyft Line is only available in areas where ride sharing is common and during busy periods.

Source: https://blog.lyft.com/posts/lyft-line-is-live-in-toronto

The above examples provide opportunities for drivers to share their vehicles with others facilitating more convenient journeys and shared costs.

public transportation system in **Goiania (Brazil)** only used for short distances in urban areas. The trips are requested using an app, the routes are dynamic and there are virtual bus stops along the way according to the demand. Passengers may be dropped off at a maximum distance of 400 metres from the requested drop-off location so that the costs are lower and the average journey times are as short as possible.

Source: https://citybusbr.com/faq/

Similarly to the UK examples, CityBus 2.0 provides a flexible demand responsive service as an alternative to traditional fixed route services or to fill in gaps in the network.

The **NAVYA** autonomous shuttle was launched in 2017, since then it has given 10,000 riders a free lift around a 0.6-mile route in downtown **Las Vegas.**

Source: https://www.businessinsider.com/las-vegas-downtown-self-driving-shuttle-review-2018-1?r=US&IR=T

Developments in automation around the world may have significant impacts on the operation of traditional bus services. Shuttle solutions may provide bespoke opportunities to connect communities with transport hubs.

Notable Failures	**Kutsuplus** (**Helsinki**) was a door-to-door ride sharing service that aimed to match passengers headed in the same direction with minibus drivers. The service was more expensive than the standard city bus, but provided a significant cost saving on taxis. The service was provided by the Helsinki Regional Transport Authority and ultimately, to outcompete other modes of transport, the service needed to reach a much larger scale - this was not manageable with the public money invested. Despite ridership surpassing 20,000 users, the service was closed at the end of 2015 after 3 years of operation. Source: https://circulatenews.org/2017/02/finlands-kutsuplus-cautionary-note-promise-demand-mobility/ **Ford Chariot** launched in the **USA** in 2014 and in **London** in 2018. In London the service ran a fleet of 14-seater buses across six routes that were accessed via an app. The service ceased global operations in early 2019, with the firm citing low ridership (average of five riders per vehicle per day reported in New York, USA) and lack of regulatory frameworks in operating cities as reasons for the shutdown. Source: https://www.wired.com/story/ford-axes-chariot-mobility-is-hard/ **RATP Slide**, which launched in July 2016 in **Bristol** as the first micro-transit service in the UK, operated an app-based weekday service allowing commuters on a similar route to share a ride to and from work. Despite the scheme making more than 40,000 passenger trips and being popular with customers (receiving an average rating of 4.9/5 in customer ratings), the service closed in November 2018. Challenging conditions posed by roadworks which impacted journey time reliability and increased competition from two new Metrobus Rapid Transit routes no longer made the service viable. Source: https://www.bbc.co.uk/news/uk-england-bristol-46360299 **Bridj** (USA), was launched in **Boston, Massachusetts** in 2014, however in April 2017 the company shut down. This was primarily due to funding talks falling through, however there were also suggestions that the failure was related to the little margin for error in expansion and the fact that Bridj hired drivers as full-time employees rather ran contractors to make up their labour force. Source: https://www.bostonglobe.com/business/2017/04/30/bridj-local-demand-bus-service-shutting-down/56xoGs674wYgyUWdrD9EuO/story.html The above failures show that even popular services can be commercially unviable and require significant funding and large market populations to viable.	

Spatial Typologies	City Centre		Remote Rural	
	Small Town		Parkway	
	Suburb		Business Park	

	Village			
Spatial Density	High Density			
	Medium Density			
	Low Density			
Summary 	▪ Pooling and DRT are a major area for expansion but there is complexity in the market. DRT is growing in maturity in the UK with several operators expanding over a range of geographies but there have also been significant failures. Pooling of rides in private vehicles and crowdsourcing of mobility services also operate in this space and there is potential for these approaches to disrupt each other and reduce their viability. ▪ Services provide a significant opportunity to supplement the existing mass transit network by both filling in gaps in the networks and by providing access to major hubs and interchanges. ▪ Again, automation of transport may present an opportunity for significant disruption for these modes for FMLM journeys.			

DRONES / PAVEMENT DELIVERY DEVICES

Mode: Drones / Pavement delivery devices

Definition	Deliveries by low level automated air technologies (commonly referred to as drones) or wheeled devices operating on pavements (sometimes called droids or robots)
Sub-Models	Potential sub-models for deliveries of heavy payloads
Typical Use Cases	▪ Goods delivery from retail unit to residential locations ▪ Goods delivery within campus style locations ▪ Goods delivery between service provider and workplaces
Benefits	▪ Economic • Reduces the need to travel • Convenient • Flexible and on-demand • Low cost to user • High levels of infrastructure in place in most urban and many rural locations • Reduces reliance on motorised travel • Reduction in short journeys by single occupancy vehicles ▪ Environment • Zero carbon emissions at point of use • Low noise • Limited impact on built and natural environment • Limited waste materials ▪ Wellbeing • Widely accessible including to those with health impairments
Opportunities	▪ Economic • Mode shift may reduce some capacity issues on other modes • Reduced transport costs • Increased data on users' travel ▪ Environment • Increases in mode use will reduce carbon emissions and improve air quality • Move towards low emission vehicles will reduced carbon impacts ▪ Wellbeing • Increased access to services
Barriers	▪ Economic • Public and stakeholder perception and trust • Availability of infrastructure particularly in rural areas • Slow compared to other modes • Theft, vandalism and damage • Laws, licensing and regulation • Lack of user awareness and understanding of the system ▪ Environment • Some waste

<table>
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- Wellbeing
  - Potential for increases in sedentary lifestyles and social isolation
  - Lack of digital engagement by some demographic segments
  - Perceived and actual safety
  - Perceived and actual security
  - Overcoming existing habits

</td></tr>
<tr><td rowspan="2">Technical Maturity</td><td>Concept</td><td>Feasibility</td><td>Piloting</td><td>Initial real-world operation</td><td>Mature technical operation</td></tr>
<tr><td colspan="5">The use of drones and robots for deliveries remains largely in the pilot stage of technical maturity with some initial real-world operation</td></tr>
<tr><td rowspan="2">Commercial Maturity</td><td>Not operating commercially in the UK</td><td>Commercial testing/pilot</td><td>Commercial launch</td><td>Operating commercially</td><td>Mature commercial operation</td></tr>
<tr><td colspan="5">The mode is presently in the commercial launch stage following piloting</td></tr>
<tr><td>Business Models</td><td colspan="5">Business models will vary depending on the service being provided. The Milton Keynes example below is via a subscription process for individuals but other trials take the form of contracts for deliveries for particular clients (e.g. the movement of medical supplies by drone in Africa.</td></tr>
<tr><td rowspan="2">Journey Range</td><td></td><td><10km</td><td></td><td></td><td></td></tr>
<tr><td colspan="5">At present drone deliveries are relatively short distance but there is potential for distances to increase</td></tr>
<tr><td>Supporting infrastructure and systems</td><td colspan="5">Infrastructure depends on the systems being operated but include:

- Data, websites and apps
- Docking and charging
- Landing sites
- Operating and tracking systems</td></tr>
<tr><td>UK Best Practice Example</td><td colspan="5">In Milton Keynes, residents can receive deliveries by autonomous pavement robots. The robots use sophisticated computer vision and software to identify objects such as cars, pedestrians, traffic lights and pavements allowing them to detect and avoid obstacles. The service is available through a mobile phone app which allows users to choose where and when the robots deliver their parcel, as well as enabling them to track the robot's journey in real time. The service costs £7.99 for a monthly subscription with unlimited deliveries. Recently, plant-based drinks firm Plenish has announced their vegan milk will be delivered by the autonomous pavement robots.

Source:https://postandparcel.info/98825/news/starship-launches-autonomous-delivery-services-to-milton-keynes/

https://www.miltonkeynes.co.uk/news/people/world-s-first-robotic-milk-round-arrives-in-milton-keynes-1-9137216

Autonomous deliveries by robots are already operating

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	in real-world conditions. A major overhaul of the **UK's air traffic control system** could make Amazon-style drone deliveries a reality. The national air traffic control service, NATS, has said it will allow drones to be flown beyond their operators' line of sight. Previously, the unconventional aircraft needed to be within sight of human operators which was a big barrier to companies like Amazon carrying out deliveries using drones. Source:https://www.standard.co.uk/tech/amazon-drone-deliveries-next-year-a3782276.html The new regulation of drones could allow for drone deliveries to become a reality across the UK	
Europe Best Practice Example	**Aha!** in **Iceland** has been using drones for regular goods delivery in Reykjavik since mid-2017. Each drone can carry a payload of up to 3kg, has a flight time of approx. 35mins and operates 50m above the ground. Source: https://www.aha.is/en/drone-delivery#aha-faq Drone deliveries are already being used in other countries, and now the UK regulation has changed, best practice from Aha! could be implemented. **Dutch** supermarket chain **Albert Heijn** has revealed its new delivery robot called 'Aitonomi' developed by Swiss company TeleRetail. the robot will work with students as part of a pilot program at High Tech Campus Eindhoven throughout the summer. Visitors will be able to place their orders through the app at Albert Heijn's AH to go store. Notably, the robot navigates itself using the virtual map and can be opened with the smartphone upon arrival. Source: https://siliconcanals.nl/news/startups/groceries-on-wheels-dutch-retailer-albert-heijin-unveils-autonomous-delivery-robot-aitonomi/?utm_source=MCAV+Newsletter&utm_campaign=f12bfbcee2-EMAIL_CAMPAIGN_2019_03_30_11_01&utm_medium=email&utm_term=0_dbb071750a-f12bfbcee2-83381577	
Global Best Practice Example	The most prominent use case for small freight drones is for humanitarian projects. In 2016 a national drone **medical delivery system** became operational in Rwanda through a partnership between **Zipline** and the health ministry, cutting average delivery time for blood from 4hrs to 30 mins. Source: https://www.theguardian.com/global-development/2018/jan/02/rwanda-scheme-saving-blood-drone The initial commercial operation of drones has been in low density locations with limited transport networks. **Google's Wing drones** have been granted permission to make public deliveries in **Canberra, Australia**. The service works by partnering with local businesses	

	including coffee shops and pharmacies to deliver their products. Regulatory approval comes after an 18 month trial and 3,000 deliveries Source:https://www.theverge.com/2019/4/9/18301782/wing-drone-delivery-google-alphabet-canberra-australia-public-launch **UPS** has been using drones to ferry medical samples between labs and a hospital in **North Carolina**. The drones follow a pre-determined flight path and are monitored by a trained pilot. Additionally, in July 2019 the firm announced its own dedicated subsidiary focused entirely on drone delivery, called UPS Flight Forward and is seeking FAA approval to operate its drones over populated areas, during night time hours and when not within view of a human operator. Source: https://newatlas.com/ups-drones-medical-samples-us-hospital/59039/ https://techcrunch.com/2019/07/23/ups-forms-a-new-subsidiary-for-drone-delivery-and-seeks-faa-approval-to-fly/ The use of delivery drones in more built-up and congested locations is starting to be rolled out as part of initial real-world operations but they have yet to become wide-spread. **Amazon** is experimenting with pavement delivery robots called Scouts in **Washington State**. Six of the autonomous electric trucks will deliver parcels "at walking pace" Source: https://www.bbc.co.uk/news/technology-46987779	
Notable Failures	In December 2018, tens of thousands of passengers were affected by drone sightings at **Gatwick Airport** with the runway being closed for approximately two days. The exclusion zone around airports will be extended to approximately a 5km-radius (3.1-miles), with additional extensions from runway ends. Additionally, operators of drones weighing between 250g and 20kg will be required to register and take an online drone pilot competency test. Police will also be able to issue fixed-penalty notices for minor drone offences to ensure immediate and effective enforcement of the rules. Source: https://www.standard.co.uk/news/transport/gatwick-drone-chaos-police-handed-extra-powers-to-tackle-threat-after-christmas-disruption-a4032891.html In **San Francisco** regulations have been put in place to restrict the number of delivery robots on the street. The restrictions involve robot permits being capped at three per company, and nine in total at any given time for the entire city. The robots are also only allowed to operate within certain industrial neighbourhoods, on streets with 6ft-wide sidewalks, and must be accompanied by a human chaperone at all times. This follows on from a coalition of residents, pedestrian advocates, and activists for seniors and people with disabilities describing the robots as “aggressively entrepreneurial wet dreams” and “the future Ubers of the sidewalk”. Source: https://www.theguardian.com/us-news/2017/dec/10/san-francisco-delivery-robots-laws When allowing drones or delivery robots on the network, regulations of where and how many can be rolled out are crucial to the success of the service.	

Spatial Typologies	City Centre		Remote Rural	
	Small Town		Parkway	
	Suburb		Business Park	
	Village			
Spatial Density	High Density			
	Medium Density			
	Low Density			
Summary	▪ The use of pavement delivery devices and drones are at the initial real-world technical operation stage with limited commercial maturity. ▪ These modes present opportunities to reduce the need for people to physically travel to access goods and services both in a local context and over longer distances.			

DIGITAL AS A MODE

Mode: Digital as a mode

Definition	The use of digital connectivity to reduce / remove the need to travel can be referred to as 'digital as a mode'. Digital access to work, education and healthcare provides for similar opportunities without physical movement.
Sub-Models	Augmented and virtual reality applications, virtual meetings
Typical Use Cases	▪ Working remotely and interacting with colleagues and centrally held documentation ▪ Accessing retail and services ▪ Accessing health and social care ▪ Accessing education
Opportunities	▪ Economic • Flexible and on-demand • Low cost to user • High levels of infrastructure in place in most urban and many rural locations • Reduces reliance on motorised travel ▪ Environment • Zero carbon emissions at point of use • Low noise • Limited impact on built and natural environment • No waste materials ▪ Wellbeing • Widely accessible including to those with significant health impairment
Benefits	▪ Economic • Mode shift may reduce some capacity issues on other modes • Reduced transport costs • Increased data on users' travel ▪ Environment • Increases in mode use will reduce carbon emissions and improve air quality through reduced need to travel • Increases may reduce transport-related noise ▪ Wellbeing • Reduced isolation
Barriers	▪ Economic • Corporate IT policies • Limitations on capacity • Initial purchase and operational costs • Availability of infrastructure particularly in rural areas • New infrastructure can be expensive • Lack of user awareness and understanding of the system ▪ Environment • Increase heating and lighting costs at home compared to shared spaces in work locations

	• Increase in energy needs for IT • E-waste ▪ Wellbeing • Potential for increases in sedentary lifestyles and social isolation • Lack of digital engagement by some demographic segments • Lack of training and competency • Perceived and actual security of users • Overcoming existing habits • Impact of work on home life				
Technical Maturity	Concept	Feasibility	Piloting	Initial real-world operation	Mature technical operation
	The range of technical systems to enable digital as a mode is vast and continuously expanding and gaining greater capability and capacity. However, the ability to undertake many day-to-day activities without leaving home is already widely available.				
Commercial Maturity	Not operating commercially in the UK	Commercial testing/pilot	Commercial launch	Operating commercially	Mature commercial operation
	Again there is a wide range of mature commercial operations supporting digital as a mode.				
Business Models	The business models supporting digital as a mode vary, particularly depending on the activity being undertaken				
Journey Range					Unlimited
	Broadly speaking digital as a mode has an unlimited range, however, depending on the activity being undertaken, there are limits. In terms of working remotely, this can be undertaken at an unlimited distance depending on corporate policies and the connectivity in specific locations. However, other services, including retail, education and healthcare are or can be geographically limited.				
Supporting infrastructure and systems	▪ Fixed broadband connectivity ▪ 4G/5G wireless connectivity ▪ Smartphones, tablets, laptops and peripherals				
UK Best Practice Example	**Babylon Health** (UK & Rwandan operations) is the **UK**'s leading digital health provider. It aims to make healthcare more accessible and affordable by using digital and online platforms to connect healthcare professionals to their patients. This can be through video and audio chats and can involve sharing photos and materials to aid consultations. Additionally, doctors can send prescriptions to their customers desired pharmacy so that they can be easily collected as well as Babylon's online "Healthcheck" service which includes answering lifestyle and family history questions to create personalised health reports and to get practical insights to stay health. Furthermore, the service enables patients to build a "Digital Twin" so that they can get a better insight of their body and its functions. Source: https://www.babylonhealth.com/about The **University of Cambridge**, in England's Economic				

	Heartland, offers some online only courses for distance learners providing opportunities to study at Cambridge from anywhere in the world. Students can study anytime, anywhere as long as they have access to a computer and the internet. Source: https://www.ice.cam.ac.uk/courses/online-courses **Open University** - established in April 1969 the Open University enables flexible, distance teaching in the **UK** and in 157 countries worldwide. The university has seen over 2 million students receive an education which they may have otherwise been denied at campus-based universities. The Open Universities distance learning works using online study materials such as online tutorial rooms, online forums and recorded lectures and broadcasts. Additionally, the University has an online library and provides each student with a tutor who can provide advice and guidance. Source: http://www.open.ac.uk/courses/what-study-like/distance-learning Digital services can connect users to various services including healthcare, education and employment and negate the need to physically travel. The range of activities able to be conducted via Digital as a Mode continues to expand and the increasing strength and reliability of digital connections means that more people are able to engage with this mode.	
Europe Best Practice Example	More than two-thirds of people around the world work away from the office at least once every week, according to researchers. A study released in May 2018 by **Zug** (a **Switzerland**-based serviced office provider IWG) found that 70 percent of professionals work remotely at least one day a week, while 53 percent work remotely for at least half of the week. Source: https://www.cnbc.com/2018/05/30/70-percent-of-people-globally-work-remotely-at-least-once-a-week-iwg-study.html	
Global Best Practice Example	As reported in 2017, 3.7 million **US** employees (making up 2.8% of the entire U.S. workforce) work from home for at least half the time**.** Additionally, the number of regular telecommuting employees (excluding the self-employed population) has grown by 115% since 2005 and the number of employers offering a work from home option has grown by 40% in the past 5 years. However, only 7% of all employers in the United States offer work from home flexibility. Source: https://www.fundera.com/resources/working-from-home-statistics More people have the opportunity to work flexible hours or from home due to the rise in digital infrastructure.	

Notable Failures	A study by **Business Insider** asked remote workers about their experiences. It found that loneliness, time management, and digital miscommunication are just some of the problems faced by those work from home or have another remote arrangement. Source: https://www.businessinsider.com/working-remote-challenges-work-from-home-2019-10?r=US&IR=T Measures need to be put into place to avoid loneliness and other negative implications of remote working.			
Spatial Typologies	City Centre		Remote Rural	
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	Medium Density			
	Low Density			
Summary	▪ Digital as a Mode presents significant opportunities to reduce the need to travel for a range of daily activities including working, learning, shopping, healthcare and leisure. In addition, improvements to wireless digital connectivity mean than more activities can be undertaken whilst travelling bring both efficiency and social benefits. ▪ Digital as a Mode can affect all spatial typologies and densities but can be particularly beneficial where transport networks are congested, activities require long journeys or where the users are in remote locations with poor physical transport networks. ▪ The roll out of 5G technologies, and fixed networks into the remaining poorly connected locations, will substantially increase the capacity of Digital as a Mode to and support ever greater range and depth of digital services providing more opportunities to alter travel patterns. ▪ However, there is a need to consider how reducing travel may impact on mental health and loneliness due to potential reductions in physical social interactions. ▪ Digital as a Mode should be a central pillar of all strategies and not just focussing on FMLM journeys.			

4 AGGREGATION OF FM/LM MODES

4.1 AGGREGATION

The primary purpose of FMLM mobility is to improve accessibility and connectivity for the proportionately shorter links to and from transport interchanges and the origin and/or destination of journeys. This clearly requires the integration of FMLM modes and mass transit (bus, coach, rail and in certain places, light rail). However, mobility networks are strengthened by the aggregation of more modes into single locations, where transport interchanges are served by a range of FMLM modes.

Mobility is further strengthened through the aggregation of modes with a wider range of traveller facilities and key economic or utility activities; this fast developing approach to improving interchange is termed a 'mobility hub'. This approach increases integration between modes providing more options for users and catering for a greater range of onward journey needs. Hubs integrate traditional and new modes as well as integrating first mile/last mile with 'middle mile' services and a range of user facilities. Mobility hubs further enhance integration and accessibility by incorporating or being located close to a range of land uses. This approach simplifies and reduces journeys in terms of frequency and length by enabling more purposes to be catered for in each journey within a single location.

Essentially, mobility hubs are the next generation of local interchanges, often building on existing and established locations and networks, including major linear trunk haul mass transit services, supplemented by new modes including first mile/last mile options. Building in supporting economic and utility activities will reduce local vehicle kilometres travelled through the combination of functions at a single location and simplification of journeys. These hubs, with the mixture of mobility and land use functions, can also provide a catalyst for reinvigoration of local areas and communities.

Mobility hubs are modular in concept with different components brought together, suited to the specific location. This enables the concept to be specific to different spatial typographies including major city centres, town centres, villages, campus-style developments, parkway locations and international gateways. In most cases, the number of modes, user facilities and land uses would decrease with the reduction in accessibility of the location, with city centre hubs providing more and village hubs providing the least, however, the modular elements at each site will need location-specific consideration.

4.2 BEST PRACTICE

UK

The **Milton Keynes** Mobility Strategy supports the aggregation of transport modes, with strategy objectives that look to provide an effective network and maximise travel choices - this will include exploiting Mobility as a Service which will digitally aggregate multiple modes of transport into a digital hub for mobility. The strategy also sets out medium/long term improvements that include passive preparation of infrastructure needed for future multi-modal hubs. The urban area of Milton Keynes lends itself to many aspects of future mobility with its strong network of highways, including significant quantities of two-lane roads, and a comprehensive network of cycleways, due to it's development as a New Town.

Milton Keynes provides a more future mobility-focussed example where last mile services include multiple providers of bike and e-bike share schemes such as Santander[5] and Lime[6]. Alongside the traditional bus network there is also an on-demand bus and Via Van, another app based flexible demand responsive transit (FDRT) service[7]. In addition, Milton Keynes also has freight solutions including autonomous delivery robots[8]. In April 2019, the Starship robots completed their 50,000th delivery in Milton Keynes with thousands of deliveries each week, potentially reducing the number of journeys made by people. The growth in popularity of Starship's service has also seen the company announce partnerships with Tesco and the Co-op.[9]

The multiple offerings within Milton Keynes allow for a natural aggregation of modes and services for multimodal journeys and freight solutions, particularly around transport interchanges such as the railway station where there is currently a taxi rank, bus station and a Santander cycles docking station. This approach is supported by a significant drive for electrification promoted by the EV experience centre, which is a brand neutral centre dedicated to electric vehicles aiming to provide free education and advice[10], and the UK's largest public rapid charging hub, with eight 50kW rapid chargers supporting all standards of EV rapid charging[11]. As of June 2019, the EV experience centre reached over 100,000 visitors and over 4,000 test drives, two years after opening[12] ,which supports the Milton Keynes Mobility Strategy objective to protect transport users and the environment by encouraging use of modes which minimise CO_2 and other pollutant emissions.

Cambridge Railway Station provides a good example of a location that follows mobility hub principles. It incorporates a major railway interchange with bus services, taxis and a three-storey cycle facility with 2,850 cycle spaces and a ground floor cycle shop. The station also incorporates a convenience retail store and café, as well as a range of usual major station user facilities. The large cycle parking facility and interchange between bus and rail services allows for more seamless multi-modal journeys and decreases dependency on car usage. The station improvements build on the exceptionally high level of cycling in Cambridge, compared to the rest of the UK, which has put the city in an already strong position with regard to FMLM provision between the station and the rest of the city.

Mobility hub principles align with the Transport Strategy for Cambridge and South Cambridgeshire (2014)[13] as the strategy develops local transport solutions with communities, which link to public transport along key routes. The strategy is also looking to implement additional Park & Ride options on the fringes of Cambridge which can act as mobility hubs.

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[5] https://www.santandercycles.co.uk/miltonkeynes
[6] https://www.li.me/second-street/lime-launches-smart-mobility-in-the-uk
[7] https://www.intelligenttransport.com/transport-news/72944/viavan-milton-keynes/
[8] https://tamebay.com/2019/04/starship-robots-50000th-delivery-milton-keynes.html
[9] https://tamebay.com/2019/04/starship-robots-50000th-delivery-milton-keynes.html
[10] https://evexperiencecentre.co.uk/
[11] https://www.bp.com/en_gb/united-kingdom/home/news/press-releases/uks-largest-public-rapid-charging-hub-inaugurated-in-milton-keynes.html
[12] https://bpchargemaster.com/celebrating-2-years-at-the-ev-experience-centre/
[13] https://www.cambridgeshire.gov.uk/residents/travel-roads-and-parking/transport-plans-and-policies/cambridge-city-and-south-cambs-transport-strategy/

EUROPE

In Europe, **Stockholm's** Urban Mobility Strategy prioritises walking and cycling first, then public transport. The strategy does not build solely on mobility but also accessibility and recognises that roads and streets are not only for transporting people and goods but they are also a vital part of the public realm and influence how a place is perceived for those wishing to work in, live in or visit Stockholm.[14] FMLM options build on Stockholm's strong mass transit network which has a mixture of rail, underground, trams and buses, as well as ferries around the city's waterways. There is also very strong existing provision for pedestrians and cyclists with extensive traffic-free and segregated routes. There are several shared mobility options in Stockholm that include e-scooters, bikes/e-bikes and car clubs along with an ongoing trial of Shotl, an on-demand shuttle service that matches passengers and destinations.[15] With regards to freight and deliveries, Airmee offers a digital platform for e-commerce companies enabling efficient last-mile connectivity to their customers with deliveries as quick as two hours.[16] These services are all working simultaneously on the network in Stockholm and although these tend to operate independently of each other, where all these modes are brought together, significant opportunities for interchange and choice in FMLM provision are available for users.

The **Dutch Mobihub**[17] (Mobipunt in Dutch) is leading much of the thinking around mobility hubs across Europe. Mobihubs are *"a transport hub on neighbourhood level, where different sustainable and shared transport modes are linked with each other. A mobihub can have multiple functions but some are essential. To install a mobihub for example, it is necessary to have at least some car sharing parking spots and a bicycle storage. Furthermore the hub should be near a public transport stop and easily accessible for everyone. So it's important to take into account mobility issues such as wheelchair friendliness and the safety aspects (for instance making sure it's neat and well lit). It is designed to enable and promote multimodal transport on a local level and can be tailored for different neighbourhoods."*

Mobihubs have five essential basic criteria:

- Parking spaces for car sharing
- High-quality cycle parking
- Close proximity to a public transport stop or shared transport
- Safety and security
- Easy access for all users

In addition, there are a number of conditions for the development of successful and high-quality hubs:

- Proximity to neighbourhood functions

[14] https://international.stockholm.se/globalassets/ovriga-bilder-och-filer/urban-mobility-strategy.pdf
[15] https://www.intelligenttransport.com/transport-news/89589/new-on-demand-mobility-service-trialled-in-stockholm/
[16] https://siliconcanals.com/news/startups/travel-mobility/stockholm-based-logistics-startup-airmee-secures-e3-7m-for-terrific-e-commerce-delivery-solution/
[17] https://mobihubs.eu/

- Quality facilities
- Hubs are integral to wider plans for shared mobility in the authority area
- Each hub has a unique name
- The hubs have clear and visible branding.

Source: Mobihubs.eu

GLOBAL

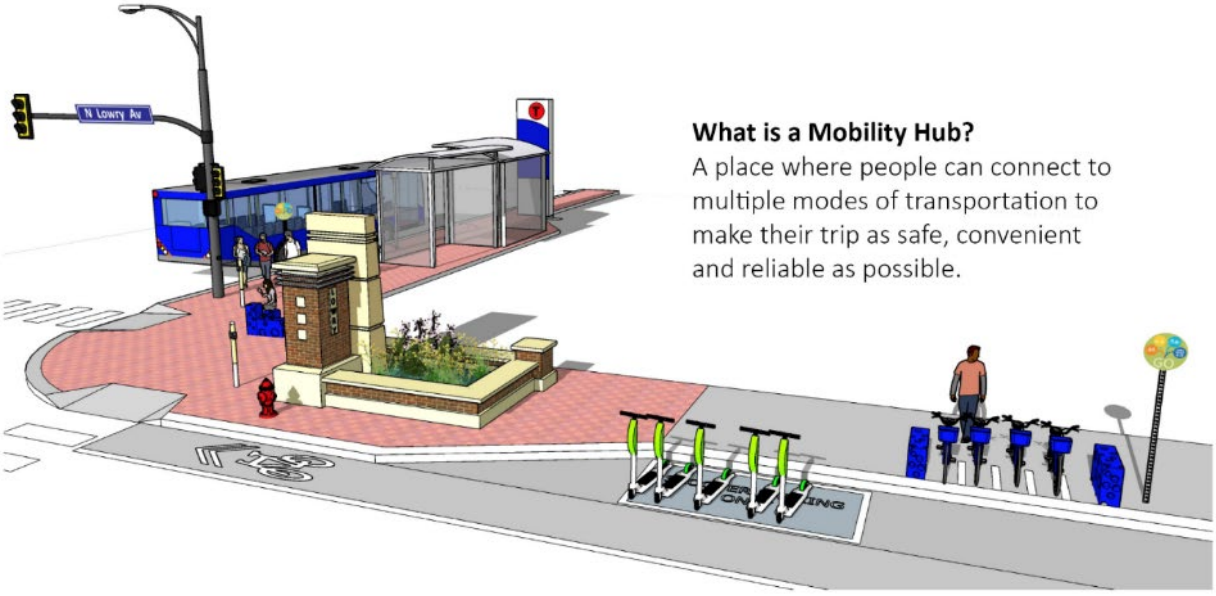
The **City of Minneapolis** has piloted a number of mobility hubs where people can access transit and other non-car modes including shared bikes and e-scooters. Minneapolis' transportation system is largely based upon a street grid design which can help to provide a high degree of connectivity and flexibility. The introduction of mobility hubs could utilise the high connectivity of the street grid by offering multiple options for users' journeys and consequently improve accessibility across the city. The hubs are designed to increase access to low or zero-carbon modes, particularly first mile/last mile options, to reduce car-based journeys. Mobility is prioritised in the Minneapolis Transport Action Plan[18] to help the city reach it's 2040 goals by embracing and enabling innovation and advances in transportation to increase and improve mobility and access options for all.

The hubs include:

- Bus stop
- Seating
- Bike-share
- E-scooter parking
- Way-finding signage with travel times to points of interest.

Data collected during this pilot will be used to inform infrastructure changes for a longer-term program that could include improvements to lighting, safety and accessibility.

[18] http://go.minneapolismn.gov/goals-strategies/mobility



Source: City of Minneapolis

Metrolinx, the Regional Planning Transportation Agency for **Ontario**, Canada has identified 51 mobility hub locations across its province at major transit locations where multiple modes of transport come together, serving as the origin, destination and transfer point for a significant number of trips. Typical transport and services offered can be seen in the figure to the right. They are also the points of concentrated employment, housing, recreation and significant economic development where employment, hospitals, education facilities, government service, information centres, retail and restaurants can be located. Guidelines on the development of the mobility hubs were first published in 2011 with the aim for the hubs to address nine key objectives:

Source: Metrolinx

- Seamless integration of modes at the rapid transit station
- Safe and efficient movement of people with high levels of pedestrian priority
- A well-designed transit station for a high quality user experience
- Strategic parking management
- A vibrant, mixed-use environment with higher land use intensity
- An attractive public realm
- A minimized ecological footprint
- Flexible planning to accommodate growth and change
- Effective partnerships and incentives for increased public and private investment

Whilst this example does represent some elements of best practice in transit-orientated development, there is limited specific mention of enhanced and new first mile/last mile mode provision. Due to the vast size of Ontario along with the large number of public transport interchanges, the province would benefit from mobility hubs to promote and support long distance multi-modal journeys by increasing first and last mile connections to rail interchanges.

Los Angeles has a mobility hub programme as part of its Mobility Plan 2035. The Plan supports the development to mobility hubs in the form of "multi-modal transportation support activities and services in proximity to transit stations and major bus stops, including but not limited to: adequate bus stop and layover space, transit shelters with real-time bus arrival information, bike share docking stations, car share facilities, taxi-waiting/call areas, Wi-Fi service, public showers/toilets, bicycle storage and repair facilities, and food and beverage providers. In supporting the roll out of hubs, the city has provided a design guide[19] for professionals to improve the development of multi-modal connectivity and access at existing or new transit stations. The hubs aim to support first mile and last mile solutions whilst also improving user experience. Los Angeles has infamously high levels of traffic congestion. With some areas dominated by wide roads, a mobility hub provides opportunities to connect districts across Los Angeles via multimodal journeys – cycling in residential areas to a mobility hub that offers onward further connections via mass transit or car share.

4.3 APPLICABILITY TO EEH

Mobility hubs could form a major component of an EEH first mile/last mile strategy with different hub location types applicable across the region.

- The mobility hub concept is applicable to locations across the region.
- There are a number of large city centres which would suit the siting of major hubs locations, particularly focussed around existing transport interchanges
- Small towns could benefit from greater integration of modes in through the development of smaller hubs.
- The region is also home to major business park and campus-style developments, including universities and major hospitals
- There are a number of parkway interchange sites including railway stations and Park & Ride network, with different locational contexts, which could be supplemented by a number of hub attributes
- Hubs do not need to work in isolation and across the region a network of hubs, based on existing major interchanges and new hub locations, could form the backbone of future mobility proposals using a format of building blocks that the travelling public recognise and understand.

[19] http://urbandesignla.com/resources/docs/MobilityHubsReadersGuide/hi/MobilityHubsReadersGuide.pdf

5 BEHAVIOUR CHANGE

5.1 INTRODUCTION

Behaviour change interventions have become an increasingly mainstream aspect of transport policy during the last two decades. They aim not only to influence how people travel using the established transport network, but also to support the introduction of new transport options.

From a First Mile / Last Mile (FMLM) perspective, though providing improved connectivity in England's Economic Heartland via enhancements to the existing network, introduction of significant new infrastructure or implementation of innovative new technologies, will improve FMLM opportunities for those travelling. Behaviour change interventions provide the opportunity to further influence people to travel in the most sustainable way and make best use of the resulting improved transport network.

This section provides a brief background to the application of travel behaviour change in the UK, before introducing the concept and importance of segmentation to achieve change amongst a diverse population with differing transport attitudes and needs. Finally, case studies are provided showing how the key FMLM modes have been supported by behavioural interventions in the UK or overseas and how they are of relevance to effective FMLM interventions in the Heartland.

5.2 BACKGROUND

Initial research in the UK, such as that focussing on the effectiveness of workplace travel planning as well as implementation of school travel plans, and small-scale community-based interventions, identified positive outcomes. This led to wider-scale pilots such as the Department for Transport's Sustainable Travel Demonstration Towns (2004 to 2009)[20] which bought a range of behavioural interventions together, supported by targeted infrastructure improvements, to reduce single-occupancy car use and increase use of more sustainable alternatives.

'Smarter Choices, Changing the Way We Travel', published in 2005[21], brought a wide body of evidence together of the impact of 'softer' behavioural interventions including workplace, school and personal travel planning, awareness and marketing campaigns as well as measures such as car sharing, car clubs, home shopping and home working. Lessons from this research and findings from the Sustainable Travel Demonstrations Towns informed projects funded by the Local Sustainable Transport Fund (LSTF)[22] and its follow-on funding programmes (LSTF2 and Sustainable Travel Transition Year) across many local authorities across the UK. Other mode specific programmes were also launched including Cycling Cities and Towns[23]. Most recently, the Access Fund[24],

[20] https://www.gov.uk/government/publications/sustainable-travel-towns-evaluation-of-the-longer-term-impacts

[21] https://webarchive.nationalarchives.gov.uk/20100304004945/http://www.dft.gov.uk/pgr/sustainable/smarterchoices/ctwwt/

[22] https://www.gov.uk/government/publications/local-sustainable-transport-fund-what-works

[23] https://www.gov.uk/government/publications/qualitative-research-for-the-cycling-city-and-towns-programme

[24] https://www.gov.uk/government/publications/access-fund-funding-decisions-2017-to-2020

currently in its third year, supports local authorities in their implementation of sustainable travel initiatives including behaviour change interventions. Each programme has provided further lessons and evidence of impact of behaviour change interventions.

Behaviour change interventions have also been introduced to supporting sustainable access to major transport interchanges such as rail stations and airports to support sustainable access and egress by those travelling to and from the sites as transiting passengers or, particularly in the case of airports, employees working on site.

ENGLAND'S ECONOMIC HEARTLAND

In England's Economic Heartland (EEH), its constituent local authorities have a history of delivering effective large-scale behaviour change programmes. Peterborough was one of the first UK pilots as part of the Sustainable Travel Towns programme and the TravelChoice brand still exists today. Other locations such as Swindon (Swindon Travel Choices), Luton (Travel Luton) implemented programmes via the Local Sustainable Transport Fund (LSTF). In Cambridgeshire, the Travel for Cambridgeshire Partnership (currently re-branding as Smarter Journeys) has provided support to workplaces since 1998.

Station Travel Planning, a key approach to supporting sustainable FMLM trips to/from stations, has also shown success in EEH with stations such as Leighton Buzzard, and Milton Keynes Central highlighted as best practice by the Rail Delivery Group. Development of Station Travel Plans for Luton, Leagrave and Luton Airport Parkway used geodemographic segmentation of the surrounding resident population to inform their respective action plans.

5.3 THE ROLE OF SEGMENTATION IN BEHAVIOUR CHANGE

Consumer classifications (or segmentation systems) are a useful way of understanding and modelling the population. They recognise that people differ in their travel behaviour, and that some types of people have similar behaviours, albeit not exactly the same. Geodemographic systems go a stage further and link types of people with place. This is extremely useful from a transport planning perspective since it enables planners to explore where a policy or intervention may work best, or what the optimum mix of policies might be for a particular area.

THEORETICAL BACKGROUND

In 2006, An Evidence Base Review of Public Attitudes to Climate Change and Transport Behaviour[25] was published, which introduced the idea of the "Attitude–Behaviour Gap". This is significant because it means that what people do is different to what they say, and similarly, how they will actually change their behaviour in response to an intervention differs from what they are likely to say. Evidence from the field of Behavioural Economics has since helped to explain why this is an although there are many factors, two key points are:

[25] https://www.fcrn.org.uk/sites/default/files/Evidence_of_public_attitudes_and_behaviour.pdf

- The great majority of decisions are made at a subconscious level with the conscious part of the brain then having to explain or post-rationalise this decision.
- Although everyone likes to feel they are in control, in practice, decisions are heavily influenced by external factors, not all of which people will be consciously aware of.

These two points together go a great deal of the way to explaining the Attitude-Behaviour Gap. It also helps us to understand that if someone tells us something about their behaviour or how they intend to change it, they genuinely believe this to be true, even if it is not correct.

In terms of behaviour change, bearing in mind that most decisions are made at a subconscious level, we can characterise them as being heavily influenced by habit, the use of heuristics (i.e. decision-making short-cuts), and based on imperfect information. Furthermore, given that travel is rarely an end in itself and that people are generally overloaded with demands on their time and mental energy, convenience is a major motivator.

The outcome of this is that behaviour is very 'sticky' – it takes a lot of effort to change behaviour, so it has to be worth investing the time and energy before attempting it. This generally means that prior to behaviour change there needs to be a motivation to change (this can either be in the form of a 'stick' or a carrot'), and a belief that there exists a better option. Generally, there will also need to be a 'trigger event' to initiate change, typically these are life events such as moving to a new house, changing jobs, starting a family, or retiring. A trigger event can also be transport related, such as a very bad experience caused by rail disruption or road congestion.

The theoretical background reinforces the importance of collecting and using data on actual behaviour and behaviour change, and of understanding the context in which travel decisions are made.

FACTORS INFLUENCING TRAVEL BEHAVIOUR AND BEHAVIOUR CHANGE

Key factors which influence travel and travel behaviour change are identified below. It is worth noting that while these factors are related to one another, they each contribute to overall picture. In addition, it is worth recognising the role of attitudes in influencing behaviour. The evidence (and theoretical background) suggests that the underlying factors identified here determine both attitudes and behaviour:

- income;
- working status;
- occupation type;
- household composition;
- gender;
- car availability;
- availability of public transport services; and
- urban-ness.

The value of attitudinal data can therefore be considered primarily in informing how to influence behaviour. These are discussed in turn below in terms of why and how they impact on travel behaviour. The final section then examines the link between these factors and the MOSAIC classification.

Income

Income is important because it determines the opportunities available to the individual. Higher incomes open up more options, and are likely to mean that there is more interest in trying different things. Low incomes mean that there is more of a focus on the everyday and just getting by. Cars can be seen as a way of providing some freedom to people constrained by low incomes, but they then consume much of the disposable household income – if it is a struggle to afford a car then there is an incentive to use it as much as possible, and a disincentive to spend more money on public transport fares. Conversely, those on high incomes can afford to own a car but not use it when there is a good public transport option available.

The consequence of this is that people on high incomes are more open to trying different things, and spending time and effort on exploring options.

Income, and particularly disposable income, also has a direct impact on mode choices in that people who have limited money available are more likely to choose what they see as the cheaper option.

In terms of cost, it is important to recognise that there is a substantial mismatch between how much people perceive different transport options to cost and how much they actually cost. This particularly impacts on the car: research for Transport for London has shown that drivers typically under-estimate by around a factor of three[26]. This is largely because many of the major costs are not taken into account, such as depreciation and the cost of finance. This effect is exacerbated by the dis-connect between using the car and paying for it. So many people just treat filling the car with fuel as part of the weekly household expenditure. This explains the very weak relationship between petrol prices and car use, which is in contrast with the relationship between rail and bus fares and travel demand.

One aspect of driving which can help to level the playing field with public transport is parking charges, which because they are directly linked with the trips being made, can impact on car use. The implication is that parking policy can be an effective demand management tool, in some circumstances.

Bearing in mind the distinction between income and disposable income, it will be noted that there are important interactions between income, age and household composition. So, the disposable incomes of older people who no longer have a mortgage to pay off are higher than might be expected, while the disposable incomes of people with dependent children are lower.

Working status

Working status has a direct impact on travel by influencing the purposes for which trips have to be made – most obviously commuting and work trips. People who work part time have less requirement to make commuting trips, though tend to make more leisure trips instead.

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[26] Source: The Influence of Cost on Car Use, Steer Davies Gleave on behalf of Transport for London, 2010 (not available online)

Students also need to commute where they don't live on campus, and also have time for leisure travel.

Being retired has a major impact, though there are interesting interactions with income - there are an increasing number of relatively well-off retired people who are quite active since they have both time and money (not necessarily high incomes, but low outgoings leading to high disposable incomes).

Occupation type

For those in work, the type of work also has an impact. The most visible factor is home working which has a substantial impact on travel patterns, though as with part time working, the impact on overall travel demand is dampened by the tendency for people who work at home to make more non-work trips. An interesting wider point is that there is good evidence that people have a relatively fixed travel time budget, meaning that if they save time making one type of journey there is a tendency to fill the budget up with another type. Conversely, for those that have a long commute, there is a tendency to make fewer leisure journeys.

However, in practice only a relatively small proportion of the workforce has the opportunity to work mainly from home (the current rate is 4% though it is growing, and this does not include employees who are able to work at home on an occasional basis). This is because only some types of occupation are compatible with home working, mainly professional office-based jobs.

A less obvious but in some ways more important factor is the connection between types of occupation, work locations, and commuting mode shares. Rail, for example, has a much higher mode share for town / city centre workplace locations which also tend to favour professional occupations (and thereby also the types of occupation where home working is more feasible). On the other hand, shift work and more flexible working tends to favour car.

Household composition

Household and family composition affect travel in a number of ways, though the biggest effect is the presence of children. School age children generate additional trips to and from school, many of which are made by car.

Whilst the number of trips by car is higher when there are children in the household, children can also encourage more active travel as schools look to encourage walking and cycling to school and in some cases, discourage the use of car near the school on air quality grounds. The interaction between the travel behaviour of children and parents is interesting and while parents have the greatest influence, children can also impact on their parents' mode choices.

In the context of children, there is an important interaction with urban-ness in that in more rural areas distances between home and school can preclude walking or cycling, and may require dedicated school buses. In urban areas where there is a dense bus network regular buses become important as a mode for children, while in more suburban areas, car will tend to dominate.

Aside from the impact of children, there are differences between single person households and households with a couple or multiple adults. One particular consideration, which also relates to car availability and gender, is households with two adults but only one car. In these households there is a tendency for one of the adults (more often than not the male) to be the primary car driver and the others to use travel more by public transport and as a car passenger.

Gender

There are noticeable gender differences in travel behaviour created by the still prevalent social norms around roles such as childcare. One gender difference highlighted in the discussion of household composition is that men are more likely to be car drivers than women, with this effect particularly noticeable in two-person households.

However, given the changes in social norms, gender effects differ substantially by age cohort and therefore will decrease over time. This cohort effect is well illustrated by data on car licence holding which shows how amongst the younger cohorts (age under 30 years) driving licence holding is the same for men and women while amongst older cohorts the rate of licence holding is much higher for men than for women, so amongst those aged 70+ while 80% of men hold a driving licence just 50% of women do.

One other gender difference concerns cycling: men are far more likely to cycle than women. This reflects attitudes towards cycling in the UK, though it is interesting to note that the same does not apply in countries where cycling is more common.

Car availability

Car availability has quite a complex set of influences when one considers factors such as trips by car passengers, use of car to access other modes (especially rail), and now the emergence of car clubs and taxi/cab apps such as Uber.

One clear effect though is that having a car available greatly reduces the use of bus. Those with a car available also tend to walk less, though one explanation is that if someone lives in a more rural area then walking distances can be a barrier and car more of a necessity (this effect also applies in urban areas though, so this is not the main reason).

Availability of public transport services

The availability of public transport services primarily affects mode choices, and as would be expected, areas with good public transport have higher bus modes shares and lower car shares. However, in addition, there is also a tendency for areas with good public transport to have higher walk mode shares.

There is a clear interaction between the availability of public transport and car ownership, and also with urban-ness given that public transport tends to be better in urban areas. It is too simplistic to say that good public transport causes lower car ownership, but it does enable it.

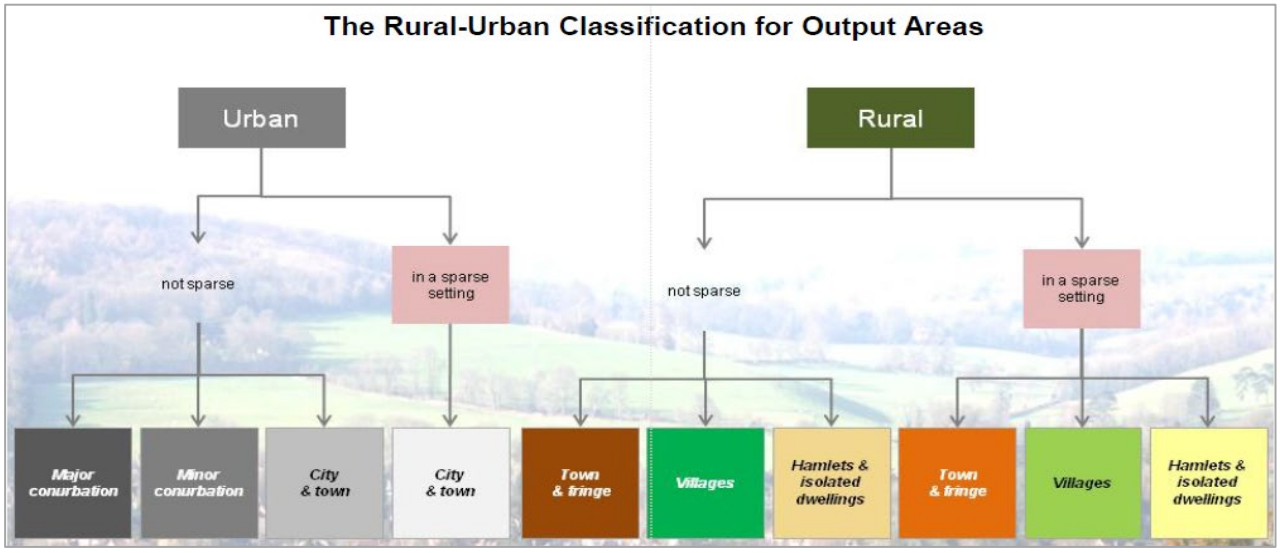
Urban-ness

Many of the influences discussed above are related to “urban-ness”: public transport provision tends to be better in city/town centres and conversely car ownership is lower, households with children are particularly likely to be located in suburban areas, and single adults in city centres. Note that the

official definition of urban-ness is based on the Office of National Statistics (ONS) urban-rural classification[27] which has the following categories:

[27] https://www.ons.gov.uk/methodology/geography/geographicalproducts/ruralurbanclassifications

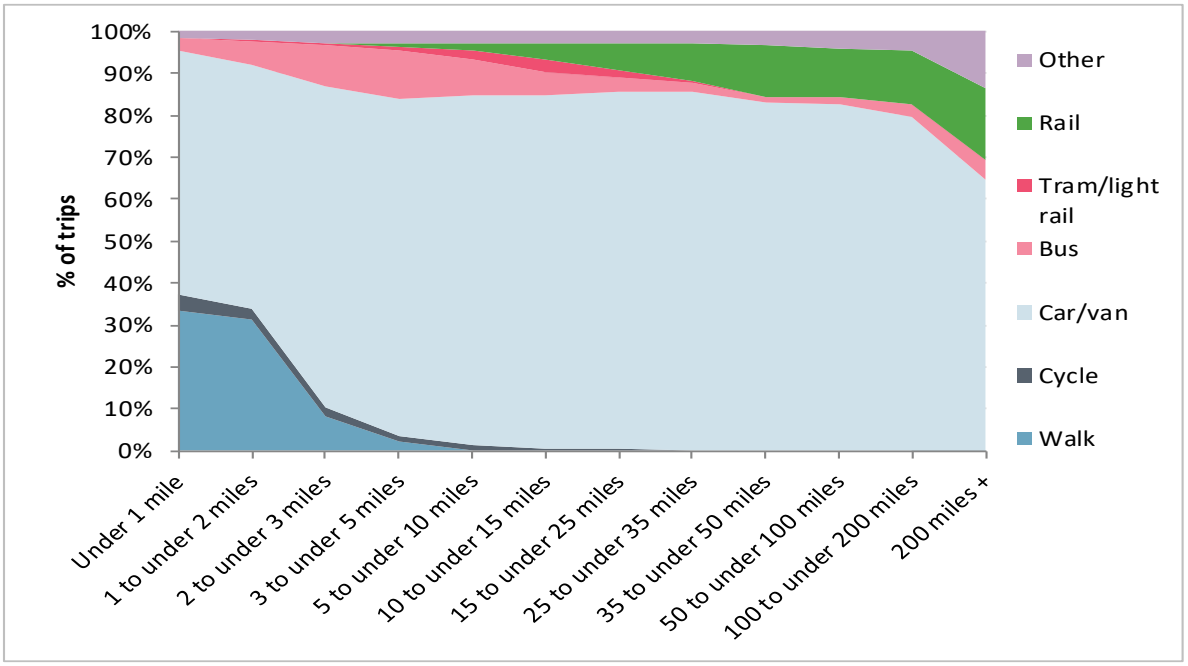
ONS Rural-Classification hierarchy



An important underlying influence on travel behaviour related to urban-ness is land use density and trip lengths. This is most obvious at the extremes with most services and facilities within walking distance for those living in a city centre, whereas for those living in rural areas there is a much greater need to use car or public transport.

It also impacts on travel in different ways for all the urban-rural categories lying between these extremes, particularly the mix of modes that are prevalent due to the typical distances people need to travel to access jobs, shops, schools, health services and so on. The overall relationship between distance and modes is illustrated below in a diagram showing how mode shares vary by trip distance. This highlights the optimal trip lengths for each mode, such as for bus around 2 to 10 miles, and rail 10 or more miles.

Relationship between trip length and mode share



Urban-ness is also closely related to lifestyle, with some people preferring a car-free lifestyle which then leads to living in a city centre, and others preferring to live in a market town, suburban area or more rural location. Lifestyle influences are a key determinant of geodemographic systems such as MOSAIC or ACORN which utilise data about where people live, what their demographic characteristics are and their economic circumstances to create their classification systems.

5.4 FIRST MILE LAST MILE BEHAVIOUR CHANGE INTERVENTIONS

It is often the case that programmes aiming to influence travel behaviour have a focus on what are FMLM trips, such as single-leg short local trips (such as a local commute) or a trip to a major transport interchange such as a station or airport which forms part of a much longer overall journey. In both cases, assuming alternatives are provided for, these could be made using more sustainable alternatives to driving in a single occupancy traditionally fuelled vehicle. These journeys are the ones most supported by programmes which aim to encourage sustainable travel at a local level.

The following section provides UK and international case studies focussing on mode specific behaviour change projects and programmes and highlight applicability in respect to FMLM trips in England's Economic Heartland.

MODE SPECIFIC

On Foot

Project	Walking Cities programme, Birmingham, Leeds/Bradford and Norwich, UK
Overview of project	With a view to encouraging residents living in the most inactive parts of the country to change travel behaviour, and get more activity into their complex lives, the UK charity Living Streets launched the Walking Cities programme. The programme ran from February 2014 until June 2015. Projects were delivered in Birmingham (Walking Revolution), Leeds/Bradford (City Connect Walking) and Norwich (Walk Norwich). A Walk To coordinator was employed, and small grants provided to community organisations for walking activities or improvements to the walking environment delivered by the city's highways authority. A range of sectors in local government were involved in delivering Walking Cities, public health, clinical commissioning, transportation (in particular highways) and sustainability, leisure and sport. In addition, local partnerships were created with health care providers, residents' groups, schools, social enterprises and transport providers. Elected members (cabinet level) and senior local government officials were involved in the strategic development and oversight of each Walking Cities project. Project management involved the cooperation of local government officers, district authorities, delivery partners (Living Streets and others) and supporting organisations. An evaluation of Walking Cities was provided to the Department of Health, which funded the programme. Source: Handbook of good practice case studies for promoting walking and cycling, PASTA consortium, 2017
Impacts and outcomes	The project reached more than 13,000 people with a message to increase the amount of time spent walking, and over 7,000 people took part in a walking activity. Retrospective surveys showed that 49% reported they were now more likely to choose walking over other modes of transport.
Applicability of FMLM in	The Walking Cities programme highlights how behaviour change campaigns can encourage walking as a mode of travel through promotion and small-scale infrastructure improvements.

EEH	The range of stakeholders involved in delivering an effective programme is also apparent. Within EEH, grants could be made available at a local level for improvement to the local walking environment, and associated promotion, on key FMLM routes.

Cycling (self-powered & owned)

	Cycling City, Greater Bristol, UK
Overview of project	In June 2008, Cycling England and the Department for Transport (DfT) awarded the urban area of Greater Bristol funding to invest in the promotion and encouragement of cycling through better infrastructure, training and promotion. The project, spanning two and a half years, led to an increase in investment of spend per head of population to £16 per annum, with the vision of more people cycling, more safely, more often. The overall programme included on-road and traffic free infrastructure improvements, 20mph zones, improvements to cycle parking and signage, workplace, school and community engagement activities. As part of the project between April 2009 and March 2010, Cycling City employed a team of cycle advisers, to undertake door-to-door personal travel planning, focused on cycling. This was targeted using MOSAIC demographic analysis to find households with a higher propensity to cycle. Over 10,000 households were targeted. Source: Greater Bristol Cycling City End of Project Report, Bristol City Council/South Gloucestershire Council, 2011
Impacts and outcomes	Evaluation of the Cycling City programme indicated strong evidence of an increase in cycling including automatic cycle counter data indicating an increase in volumes of cycles counted of 40% against a 2007 baseline. Considering the 2009/10 Personal Travel Planning projects specifically, 3,763 individuals participated in the project with support provided including referral to cycle trainers, provision of Dr Bike services, provision of tailored route maps, provision of a loan bike, and/or accompanied ride. Source: Outcomes of the Cycling City and Towns programme: monitoring project report, Sustrans, 2017
Applicability of FMLM in EEH	The case study highlights the need for complementary measures required in an effective programme aimed at increasing levels of cycling including both infrastructure improvement on routes and at FMLM destinations and complementary engagement activity which particularly supports owned self-powered cycling in the form of training, maintenance, and accompanied rides.

Cycling (powered and owned)

Project	ebikes,.London, London, UK
Overview of project	Transport for London (TfL) has undertaken an awareness campaign to increase the use of electric bikes (e-bikes) in London. The campaign includes a dedicated website (https://ebikes.london/) which assists consumers in tracking down information on where they can purchase, hire or try out e-bikes in London. The website also includes information for consumers on how to finance e-bikes e.g. via the cycle to work scheme or retail finance and how to care for an e-bike. TfL offered brands the chance to be part of a behaviour change scheme called on industry labels to sign up to ensure their promotional activities were listed on the new website. Offers enabling consumers to try or purchase e bikes were posted to the top of the page, with offers updated regularly. Brands getting involved are encouraged to regularly develop new promotions and events. Furthermore, companies involved were offered their own template-based sub-page on the dedicated website, as

	updated by those at the business. Further to the promotional activity, e-Bike grants have been handed out to local community groups, while a pilot project loaned out electric cargo bikes to businesses to show how deliveries could often be more time and cost efficient this way.
Impacts and outcomes	Over 50 suppliers are registered on the https://ebikes.london/ website.
Applicability of FMLM in EEH	TfL's ebike awareness campaign provides an applicable model for promotion of e-bike purchase in EEH, through partnership with suppliers of electric bikes across the Heartland.

Cycling (self-powered & shared)

Project	Capital Bikeshare and goDCgo, Washington D.C., United States
Overview of project	Capital Bikeshare or *CaBi* is a bike share system that serves Washington D.C. and surrounding local governments. The scheme runs using the same technology as London's Santander Cycle Hire. As of August 2019, *CaBi* had 500 stations and 4,300 bicycles, all owned by local government partners and operated in a public-private partnership with a delivery agent. The scheme started in September 2010 and is one of the largest bike-sharing services in the United States. In Washington D.C. itself, the bike share system is supported by a range of activities to encourage take up and behaviour change, delivered through the cities Travel Demand Management programme, branded goDCgo. This programme includes *CaBi* promotion to employers, residential developments, tourist sites such as hotels, and educational sites as well as a 'community partners' programme focusing on harder to reach audiences. Corporate memberships, providing discounted bike share membership are promoted via the *goDCgo* team. Training in how to use the scheme is also available. An e-bike pilot (Capital Bikeshare Plus) was introduced in 2018 and has been extended.
Impacts and outcomes	In respect to FMLM trips, research published in 2019, indicates that the impacts of *CaBi* vary by Metrorail station location. For core Metrorail stations, *CaBi* docking stations within ¼-mile of a Metrorail station reduce metro ridership. However, *CaBi* complements Metrorail in peripheral neighbourhoods. Source: Estimating the Impacts of Capital Bikeshare on Metrorail Ridership in the Washington Metropolitan Area, Ting, M, Knapp, J 2019
Applicability of FMLM in EEH	Where existing cycle hire schemes are present or new ones are implemented in EEH, workplace and community outreach programmes can be a key method of encouraging uptake. The Get to Work cycle scheme in Milton Keynes already provides the unemployed with subsidised annual subscriptions to the Santander Cycles MK bike hire. Planning for shared cycle hire should also consider the opportunity to best support FMLM to/from key transport interchanges in locations outside city centres.

Cycling (powered & shared)

Project	Shared Electric Bike Programme, England, UK

Overview of project	The Shared Electric Bike Programme installed electric bikes in eleven projects across England and studied how these bikes were used. Findings highlighted the opportunity to widen the appeal of cycling to those who don't wish to or cannot ride a standard bike. Though on-street schemes have the advantage of being visible and attracting usage from passing trade, Oxford Bike and Exeter Co-Bike included awareness raising activities to support increased usage. This included partnership working with organisations through stalls offering try outs. Co-Bikes' marketing campaign included an early launch announcement which was spread through a network of contacts at University and employers such as the Met Office and generated a sense of suspense. Co-bikes employed a PR agency for their launch which resulted in interest from local and national press. There was a strong emphasis on local coverage with prime-time weekday evening TV exposure. Source: Shared Electric Bike Programme Report, DfT, 2016
Impacts and outcomes	The data from 2,286 participants who made 11,702 journeys cycled over 27,000 miles showing that electric bikes can enable healthy, flexible, low cost travel for all abilities, in hilly areas and for longer distances without the need for too much exertion or specialist clothing.
Applicability of FMLM in EEH	Electric bikes would support FMLM travel in areas of the Heartland where topography is a greater challenge to cycling or where FMLM cycle trips may be unappealing by a traditional bicycle due to distance, but practical by electric bike. Though schemes would be visible on-street the case study highlights the role of awareness raising via events and media to increase usage over and above passing trade.

Personal Mobility Device for Mobility Impaired Users (powered & owned)

	Motability, UK
Overview of project	The UK Motability Scheme enables anyone in receipt of a higher rate mobility allowance (such as the Enhanced Rate of the Mobility Component of Personal Independence Payment or the Higher Rate Mobility Component of Disability Living Allowance) to use their mobility allowance to lease a car, scooter, powered wheelchair or Wheelchair Accessible Vehicle. The Scheme provides flexible and easy access to a brand new, reliable vehicle of giving you greater freedom to the user. Source: https://www.motability.co.uk/
Impacts and outcomes	According to the 2018 annual report, vehicle lease costs are 45% lower to the user than the commercial equivalent deals within the open market. More than 620,000 people nationwide access the service, of which 15,500 lease powered wheelchairs or mobility scooters.
Applicability of FMLM in EEH	This scheme is nationwide and as such covers the EEH area already. However, it demonstrates how financial support for specific user groups can generate very significant take-up.

Personal Mobility Device for Mobility Impaired Users (powered & shared)

	Shopmobility, UK
Overview of project	Shopmobility is a nationwide scheme that hires out manual wheelchairs, powered wheelchairs and scooters to people with limited mobility. The scheme is open to anyone

	with mobility impairments, permanent or temporary.
Impacts and outcomes	Shopmobility allows users to shop and visit leisure and commercial facilities within a town, city or shopping centre without the need to own a mobility scooter. This removes the high cost of purchasing a mobility scooter allowing them to be more accessible to everyone who requires one.
Applicability of FMLM in EEH	Although not specifically encouraging modal shift, this case study highlights that removing the initial cost of ownership of a personal mobility device can increase the accessibility of places for users with mobility impaired issues.

Car (owned)

Project	Stanstead Airport Commuter Centre and Car Share Scheme, England, UK
Overview of project	For over a decade, employees working at Stansted Airport have been able to register with an online car pool scheme which allows users to find potential partners making similar commuting journeys to them. The scheme is operated by Stansted Airport Commuter Centre who fund and promote the car pool, *Liftshare* who supply the car pool database, and a number of discount providers. The Commuter Centre website provides information about how to car pool safely and a cost calculator is provided so users are able to calculate their financial savings. Beyond this financial benefit of the scheme, participants are also offered a range of discounts including opticians, local leisure attractions and breakdown cover and can also benefit from the 50 dedicated car pool priority parking spaces at the Airport and an Emergency Ride Home scheme allowing employees to get a taxi ride in case of emergency and/or issues with their arrangement. The scheme is part of the Airport's wider programme to manage the demand for commuter travel and has been influenced by national and regional transport policy with the primary objective to encourage carpooling with a view to reducing the environmental impacts from staff commuting. To minimise any safety risk, the scheme is only open to staff and guidance in provided on how to make the arrangement work. To ensure priority spaces are not abused, the scheme requires users to register on the website and create a formal group. However, joining a group may be off-putting to potential users and therefore the 50 priority parking spaces are used as an incentive to take up. Source: Landside Accessibility to Airports, Interreg Central Europe, 2019
Impacts and outcomes	In 2017, the car pool programme had approximately 2,000 members, supported by the following critical success factors: ▪ Provision of a good level of incentive for participating staff e.g. priority spaces and additional discounts; ▪ Provision of an Emergency Ride Home scheme; ▪ Provision of a private car pool group for Stansted Commuter Centre (including a range of employers at the airport site, allowing a secure but wider group of potential matches); and ▪ Active promotion by the commuter centre.
Applicability of FMLM in EEH	Encouraging sharing of commute trips by drivers in their own cars improves the sustainability of traditional car use and is shown to particularly suited to larger employment locations where the volume and density of commuters results in a greater likelihood of matching. Stansted Airport highlights how a car share programme at such a site can be successful and which supporting factors such as provision of a secure private matching process, promotion and incentivisation, are required to make it successful in other

	employment sites with similar characteristics within EEH.

Car (shared)

	Car Sharing in Bremen, Germany
Overview of project	Car-sharing was first introduced in Bremen in 1990. It is now well established with several providers or car sharing services in the city. All providers in Bremen operate station-based car-sharing only. As of August 2017, almost 14,000 residents of Bremen use car-sharing. Both the 2009 Bremen Car-sharing Action Plan and the Transportation Development Plan Bremen 2025 (the VEP), which was adopted by Bremen's municipal parliament in 2014, formulate the goal of reaching at least 20,000 car-sharing users in Bremen by 2020. The VEP includes several behavioural measures to support car-sharing including mobility advice for new residents, businesses and schools and a travel card which people can use flexibly for public transportation, taxis, car-sharing and car rentals, without needing a vehicle of their own, as well as expansion of the car-share network itself. Source: Analysis of the impacts of car-sharing in Bremen, Germany, Interreg, 2017
Impacts and outcomes	The research in Bremen highlights the positive effects of the car-sharing scheme with a reduction of more than 2,300 privately owned vehicles and the fact that each car-sharing vehicle replaced up to 14 privately owned vehicles. Research also showed shifting of trips previously taken by car to environmentally friendly modes of transport.
Applicability of FMLM in EEH	The case study flags the potential for car sharing as a key mode, but of the importance of a strong supporting strategy including a range of supporting programmes to encourage car sharing amongst residents, workplaces and at education sites as well as integration with other sustainable modes.

Bus – fixed route

Project	SmartTrips Tri-Valley, Livermore Amador Valley Transit Authority, United States
Overview of project	*SmartTrips Tri-Valley* is a Personal Travel Planning project run by Livermore Amador Valley Transit Authority (LAVTA) in California, inland of San Francisco. *SmartTrips* provides targeted outreach to residents in the Tri-Valley area regarding the 30R Rapid Bus, a fixed bus route. One of its key objectives in relation to FMLM interventions was to encourage residents living within walking distance of the 30R route to take advantage of the improved bus service connecting to BART (Bay Area Rapid Transit). The PTP project targeted communities within walking distance of the 30R route and reached out to residents through a trained Travel Advisor team who provided individual trip planning support, informational materials including a neighbourhood map of 30R connected destinations and a travel card with a loaded value to try the bus for free. Source: SmartTrips Tri-Valley, Livermore Amador Valley Transit Authority, Steer, 2019
Impacts and outcomes	The project targeted over 4,000 households and outcomes of the programme included boardings increasing by 11% in the SmartTrips outreach zone between May - October 2017 and May - October 2018.
Applicability of FMLM in EEH	The case study highlights the potential for behaviour change interventions to support increased patronage of fixed route local buses providing FMLM links to key interchanges on the wider public transport network of EEH.

Ride-hailing/demand responsive services

Project	Carlsbad Connector, San Diego, United States
Overview of project	A demand responsive transit service pilot launched in San Diego, California in an area poorly served by public transit. This on-demand, flexible route service covers a geography of over 50 square miles. The service is free to people riding the train so it can seamlessly serve as the FMLM connection between the local station and major business park. The timetables operate in conjunction with the inbound trains and pick up/drop off and services are comparable to the time it would take to arrive via car. The program is a pilot paid for by three municipalities – the Transit Operator (North County Transit District) the City of Carlsbad (home to business park served) and San Diego Association of Governments (the overarching authority). The goal of the pilot is to create new transit riders and most users of the service are arguably that, as they had no way to make this first last mile connection until the service launched. The service functions via mobile app where users schedule a ride and it optimizes a route with others in a live ride-matching setting. Considering behaviour change interventions to encourage ridership, several large employers including ViaSat, ThermoFisher Scientific and the local government offices formed the initial core employment sites where the Carlsbad Connector was promoted to employees. The regional TDM employer outreach programme, iCommute, delivered the outreach which also included opportunities for employees that haven't used transit before to enrol in a 'Try Transit' program which gave them a free 1-month transit pass. The employers also did their own communications with the support of iCommute to promote the service.
Impacts and outcomes	Eligible participants were given a free one month pass to take this new service. The pass is valued at $170 dollars. Participants had to be new to riding transit and commit to riding twice a week for one month (eight trips in total). Approximately 50% of people given a pass activated it and met the requirements, and 65% of them continued to ride regularly paid by themselves.
Applicability of FMLM in EEH	The case study highlights the potential for demand responsive services to support improved accessibility in areas where fixed bus routes are unsuitable, as well as the opportunity to improve FMLM connectivity to key public transport interchanges. It also highlights the value of employer engagement programmes to support promotion of demand responsive services to key large employers and their employees.

Digital as a mode

Project	BT Options 2000 and Workabout, UK
Overview of project	BT began investigating teleworking in 1990. In 1997/98 promotion of teleworking was formalised through the Workstyle 2000 (then Options 2000) programme, which was renamed Workabout in 2002. Part of the motivation for the company is to use office space more efficiently, and teleworking has gone hand in hand with re-organisation and re-location of office space, including development of several 'Workstyle' buildings which incorporate Internet cafes, meeting rooms and hotdesk space for workers. Flexible working is also seen as a way of enhancing staff morale, addressing work-life balance issues, and as a positive selling point when recruiting. The *Workabout* scheme provided equipment and other support to teleworkers, particularly those who were giving up a permanent BT office space to move to a home-based/mobile working pattern. Today, flexible working arrangements are a prominent part of the organisation's employee benefits with flexible working, including the potential to work from home, promoted at the recruitment stage as can be seen on the careers section of its website

	(https://www.btplc.com/Careercentre/lifeatbt/flexibleworking/index.htm). Source: Smarter Choices, Changing The Way We Travel, DfT, 2005
Impacts and outcomes	Research indicated that between 1998/99 and 2002/03, the total distance travelled by company cars, private vehicles and the BT fleet, for which expenses claims were made, fell from 852 million kilometres to 760 million kilometres, a reduction of 11%.
Applicability of FMLM in EEH	The case study highlights the impact that flexible working practices, such as teleworking, can have in terms of reducing the need to travel. Though the potential for teleworking amongst employers in the Heartland will differ by sector and even between employer within a sector, the ability to provide useful advice and support on how best to implement flexible working strategies forms a key aspect of any workplace behaviour change programme for employers where teleworking is a viable option.

OTHER FMLM MODES CONSIDERED IN EEH

Due to the relatively immature market, no behaviour change examples have been noted in relation to traditional and emerging taxi, personal mobility devices and drones/pavement delivery devices.

OVERARCHING BEHAVIOUR CHANGE CASE STUDIES

Large scale behaviour change programmes often aim to influence use of a range of modes, as part of a package of interventions. Four examples are shown below.

Project	**Bella Mossa, Bologna, Italy**
Overview of project	Powered by the BetterPoints platform, Bella Mossa, meaning “good job” in English, was designed to encourage fewer single-occupancy car journeys in the city of Bologna through rewards and gamification. SRM, Bologna’s public transport authority, wanted to try a new approach to reduce congestion and CO2 emissions through incentivisation. With help from the EU Horizon 2020 EMPOWER programme, they partnered with BetterPoints in 2017 and 2018 to encourage large numbers of city residents to reduce their day-to-day reliance on single-occupancy car journeys. BetterPoints built a bespoke, locally branded version of the BetterPoints app and web portal (www.bellamossa.it), including tailored messaging, rewards and a range of incentives. Citizens signed up, downloaded the free app and tracked their journeys by foot, bicycle, train, bus and car-sharing to earn their BetterPoints and in-app medals. These points were redeemable in a range of partnering retailers. Participants could earn points in several ways, such as by tracking their activity, meeting certain goals (such as walking for 150 minutes a week or more), or traveling to special events. Points were able to be redeemed easily by scanning a mobile phone into a participating retailer’s barcode scanner. Journeys were tracked using GPS in participants’ mobile phones, verified by sophisticated algorithms and OpenStreetMap data. A validation system calibrated on each mode of transport and waypoint checking mitigated cheating. The programme in 2017 generated a huge amount of interest and earned SRM the CIVITAS Bold Measure Award that year. The success of the 2017 project resulted in SRM commissioning a second, six-month Bella Mossa programme in 2018. The 2018 project included more gamification, targeting the age group identified as ‘gamers’ (35–54). A monthly challenge was also created, which provided a social element to the programme. This addition extended user engagement with the Bella Mossa project over a longer period compared to 2017. Source: https://www.betterpoints.ltd/behaviour-change/

Impacts and outcomes	Over 22,000 people participated in the project. Outcomes including 78% of participants walking more, 63% of participants using their car less and 58% of participants cycling more. Results indicated that 1.4 million kgs of CO2 were avoided.
Applicability of FMLM in EEH	The Bella Mossa project highlights how platforms such as BetterPoints can encourage behaviour change towards more sustainable travel patterns and across a range of existing modes through incentivisation provided by local partners. The BetterPoints platform has also been used in the UK, for example Sutton, where the focus was on improving air quality, with results indicating behaviour change away from car use. The flexibility of the platform evident during the Bella Mossa and Sutton examples indicates it could be adapted to support incentivisation of FMLM trips in EEH. The technology used by the platform also allows travel by specific modes on specific routes to be incentivised thus having the potential to support promotion of specific FMLM modes and/or on strategic FMLM corridor improvements in the Heartland.

Project	Connected – Derby Council, UK
Overview of project	The 'Connected' project targeted South-east Derby, which is a major employment area in the city, characterised by large edge-of-centre business parks and industrial estates. Businesses range in type from call centres to high-tech engineering. The project targeted over 50 employment sites in the area including large employers and Small Medium Enterprises (SMEs) through both intensive and lighter touch engagement techniques. Intensive engagement included provision of bespoke travel information, bus promotional campaigns including free monthly and weekly bus travel, referral for support towards cycling and car sharing and commuter challenges. Light-touch engagement included provision of travel information and on-site promotional events. Source: What Works: Learning from the Local Sustainable Transport Fund 2011-2015, DfT, 2016
Impacts and outcomes	Evaluation indicated that one month after engagement, car driver mode share for commuters reduced by 18 percent points, bus travel increased by 17 percent points and cycle mode share increased by 3 percent points. Follow-ups done three months later indicated that employees who had changed their behaviour showed little tendency to revert to their pre-intervention travel patterns suggesting, at least short-term establishment of more sustainable travel patterns.
Applicability of FMLM in EEH	The Connected project in Derby highlights the impact that a comprehensive behaviour change campaign can have in terms of supporting mode shift towards sustainable travel options to edge of centre employment sites, highly relevant to encouraging sustainable FMLM travel choices to similar locations in EEH.

Project	Access LN6, Lincoln, UK
Overview of project	Prior to the Access LN6 project, Hykenham Station was underutilised, with only 23,262 annual passengers in 2009/10. The station had a low service frequency of eight trains a day and the station environment was poor. Since 2012 the station has been developed into a multi-modal transport hub to provide FM / LM connectity to an employment area on the outskirts of Lincoln. Rail frequencies were increased from eight to 30 trains a day and

	station faciltiies improved. Local walking, cycling and public transport links between the station and local residentail and commerical areas were improved including a bike hire docking station. To support this infrastructure, a range of behavuoural interventions were undertaken including Personal Travel Planning, contacting almost 10,000 homes, workplace and school travel planning initiatives and a programme of community events. Source: What Works: Learning from the Local Sustainable Transport Fund 2011-2015, DfT, 2016
Impacts and outcomes	Station patronage increased to 70,616 in 2014/15. Cycle flows on Station Road, adjacent to the station, increased from 172 per day in 2012 to 332 per day in 2014 and bus patronage of the No. 14 service running near the station increased by 10%.
Applicability of FMLM in EEH	The Access LN6 programme highlights how a combination of infrastructure improvement and behaviour change interventions targeting residents, employment and education sites, can support increased use of previously under-utilised station facilities and sustainable FM / LM connections to/from the station.

Project	AtoBetter, Norfolk, UK	
Overview of project	AtoBetter is Norfolk County Council's branded programme of behaviour change support which aims to encourage more journeys on foot, bicycle, public transport and car sharing. There are two key areas of focus – working with residents and working with developers (by whom the project is funded). A range of support is offered to developers:	
	• creating residential travel plans; • residential survey creation, analysis and reporting; • bespoke sustainable travel interventions • tailored travel information web pages for residents; • online personalised journey planning tool; • tailored sustainable travel information packs (STIPs);	• delivering residential travel plans; • managing travel vouchers and incentive schemes; • survey delivery (face to face and online) • bespoke sustainable travel intervention planning and delivery; • Travel Champion training; • postcode mapping.
	A range of residential developments have their own bespoke section of the AtoBetter website, providing tailored travel information for each site. Source: https://www.norfolk.gov.uk/roads-and-transport/atobetter	
Impacts and outcomes	The developer funding has allowed a programme of residential travel planning across new housing sites in Norfolk. Currently 20 developments area featured on the AtoBetter website.	
Applicability of FMLM in EEH	AtoBetter highlights how developer contributions can be used to support a comprehensive package of support for influencing travel behaviour at a key time for behaviour change e.g. moving house. This coordinated approach allows a range of support to be offered across a range of sites in a more efficient way than would be possible if each site was treated in	

	isolation. This approach is particularly of relevance for new residential developments in the Heartland in term of how FMLM trips are influenced from an early point when a resident moves to a new property.

6 DELIVERING FM/LM CONNECTIVITY

6.1 POLICY

National policy is developing around FMLM provision as seen in the DfT's Future of Mobility: Urban Strategy[28] and The Last Mile – Delivering goods more sustainably call for evidence[29]. It is therefore appropriate and necessary for sub-national and local authorities to start to consider and deliver policy to plan, deliver and manage FMLM improvements.

New modes are one of the six key changes to the mobility market (the others being automation, cleaner transport, new business models, data & connectivity, and changing attitudes) that the government is focussing on in its drive to deliver the future of mobility and these include FMLM modes. However, policy needs also to focus on integrating these new modes into the wider mobility market to become part of the overall network of services and infrastructure.

6.2 LEGISLATION AND REGULATION

The primary legislative barrier to FMLM connectivity is mode specific and relates to powered personal mobility devices (or 'powered transporters' in DfT language'). The DfT released updated guidance on the laws surrounding these modes in August 2019 stating that:

- *"Given how powered transporters are motorised and designed, they fall within the legal definition of a "motor vehicle". Therefore, the laws that apply to motor vehicles apply to powered transporters.*
- *It is illegal to use a powered transporter on a public road without complying with a number of legal requirements, which potential users will find very difficult.*
- *It is illegal to use a powered transporter in spaces which are set aside for use by pedestrians, cyclists, and horse-riders. This includes on the pavement and in cycle lanes.*
- *Any person who uses a powered transporter on a public road or other prohibited space in breach of the law is committing a criminal offence and can be prosecuted.*
- *It is legal to use a powered transporter on private land with the permission of the land owner."*

The use of such devices is part of an ongoing Government legislative review.

However, the last of the bullet points shows that there are situations where the use of powered personal mobility devices would be legal; essentially on private land. It is therefore possible that FMLM journeys entirely within private land, such as campus-style developments, could be undertaken using such devices.

In addition to any legislative barriers to FMLM modes, there are potential regulative issues to overcome and indeed, potential regulation to be put in place to minimise negative consequences

[28] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/786654/future-of-mobility-strategy.pdf
[29] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/786879/last-mile-call-for-evidence-government-response.pdf

that may result. Local highway authorities have the responsibility to protect public health, safety and welfare and ensure safe movement of vehicles on the public highway and rights of way.

There are a number of significant potential challenges for local authorities due to the implementation of new FMLM modes:

- **Lack of control**
  Where local authorities have no control over new modes in the mobility market, they will also have less control over the management, operation and commercial aspects which may have negative consequences on existing modes.

- **Integration**
  New modes may not be well integrated with existing modes and networks resulting in lost opportunities to improve multimodal connectivity.

- **Safety**
  Safety concerns are often a primary concern of authorities and the public in relation to new FMLM modes.

- **Parking and littering**
  The operation of dockless cycle hire schemes has led in some locations to oversaturation leading to overcrowding and blocked footways resulting in additional costs for authorities, for both environment and enforcement operations.

- **Public opinion**
  There can be a lack of clarity for the public in relation to responsibilities when new modes appear and this is a management and reputational risk for local authorities.

- **Waste and carbon emissions**
  There are a number of examples where new modes have resulted in significant levels of waste due to the limited life-span of vehicles. Not only can this result in costs to local authorities, it could also damage efforts to reduce the waste and carbon impacts of transport.

In response to potential risks, at a high level there are four broad approaches to regulation of new FMLM modes by local authorities:

- **Proactive**
  Regulations imposed before the implementation of new modes.

- **Reactive**
  Regulations imposed after technology implementation, particularly following negative consequences.

- **Free Entry**
  New modes implemented without any regulations in place and no action to impose regulation afterwards.

- **Outlawed**
  Implementation of new modes is banned by local authorities under existing powers.

  Global examples of all these approaches are set out below:

Approach	Location	Detail
Proactive	**Auckland**	The Lime e-scooter operator was the first micromobility entrant in Auckland back in October 2018. Other operators now include Wave, Flamingo and Onzo, who are taking part in the second phase of the e-scooter assessment trial, which is ending in October 2019. In the first phase trial, safety and appropriate regulation were major concerns. There were 155 random braking events reported across New Zealand, as a result of a glitch in the e-scooter technology which caused the wheels to lock during use. For the second phase, a 15 km/h speed limit will be imposed and geofencing GPS technology will identify e-scooters parked outside of designated areas. Non-compliant e-scooters will need to be removed within three hours or be fined. All e-scooter riders must be 18+ years old and possess a valid driver's licence. Helmet use is optional.
Proactive	**London**	There are 32 local authority districts in Greater London, each governed by a London borough council. This situation can be a hurdle for widespread rollout of micromobility across the city. Most new entrants have elected to pursue pilot operations with one or two boroughs, before scaling up. The launch of Mobike as a shared bicycle service coincided with TfL's Code of Conduct for dockless bicycle operators. This demonstrates a "Pro-Active" response from the city to put regulations in place before widespread use. London appears to be following a similar approach with e-scooters, currently banning their use until appropriate operating regulations are developed.
Reactive	**Singapore**	There are currently numerous micromobility operators available in Singapore: e-scooter companies Lime, Neuron Mobility, Telepod and PopScoot as well as shared bicycle operators MoBike, Ofo Bike, Anywheel and Moov. The "Re-active" approach to regulations was a source of opposition, notably regarding the dockless devices. There has been several reported incidents of speeding and people abandoning these devices recklessly causing damage and limiting the number of devices available to customers. Singapore is implementing several regulations to help control safety and the uptake of micromobility, such as speed limits and designated parking areas. As of July 1, 2019, it will be a serious offence to ride an unlicensed micromobility device. Singapore will also limit the fleet size of operators under licences
Reactive	**Stockholm**	Stockholm adopted a "Re-active" approach. During the last year, several operators have entered the market. The city is now facing several challenges implementing policy and regulation. Rapid uptake of micromobility devices and lagging regulation has contributed to several accidents including one user fatality. As a result of public concerns, Stockholm has signed a letter of intent (not legally binding) with several micromobility operators. The intent is to ensure regulations (prohibited parking, operating zones, speed limits on several streets) are aligned with the interests of the city. Furthermore, the City of Stockholm has awarded a 400 million SEK contract to the Swedish mobility company VOI to operate the city's rental bicycle service. Over 7,500 new bicycles are set to be introduced, thus demonstrating a collaborative approach with these operators.
Outlawed	**Toronto**	The Toronto Bike Share network has 360 docking stations, over 3,750 bicycles and is used in over 2 million passenger trips each year. However, all other micromobility operators are currently "outlawed" by the City of Toronto. To justify its decision, the city expressed concerns regarding public safety, parking, littering and the operators' integration to the existing cycling infrastructure. E-scooter operators Lime and BIRD are attempting to work with the City of Toronto and get proactive legislation in place. Lime has piloted its e-scooter service in the nearby university-centric city of Waterloo, ON with the goal of establishing trust before expanding to Toronto and other Canadian cities

Where FMLM provision is procured by local authorities, a high degree of control can be placed on the operators and systems can be regulated through contracts. Regulation of commercial FMLM operations has a number of limitations:

- Local authorities have no control over the design of bikes and mobility devices and limited capacity to enforce design or physical condition
- Commercial operators have shown (e.g. MoBike in Manchester) that they can launch operations without significant engagement with local authorities
- Understanding of FMLM modes, operations, legislation and regulation may vary within and between local authorities
- Commercial operations may not recognise local authority boundaries resulting in varying levels of local regulation and control
- Local authorities often do not have the capacity to enforce regulations robustly and consistently

As the benefits and negative aspects of new modes become clear, new legal and regulative controls may be required. This has proven to be the case, for example, with central government updating the laws and regulations around the use of drones. Where legal powers for local authorities are not available to regulate FMLM modes, it may be appropriate for local authorities to lobby central government for those powers to be made available or for overseeing bodies to produce guidance. In the United States, the National Association of City Transportation Officials has produced guidance[30] on regulating 'shared micromobility' (bikes, e-bikes and e-scooters).

6.3 DELIVERING FMLM MODES

FMLM mobility is provided by a combination of traditional, enhanced and new modes and through a range of delivery channels, both in the public and private sectors. Who continues to deliver these modes in the future very much depends on the location and the individual modes themselves, and whilst the delivery models for some traditional modes have been fixed over a period of time, much of the existing status quo is open for disruption from new entrants to the market.

OPERATION AND DELIVERY AND PROCUREMENT

FMLM improvements are often delivered through a combination of approaches and it is not necessarily the role of the public sector to actually deliver all aspects of FMLM connectivity.

PUBLIC SECTOR ROLE

In addition to regulation, where necessary, the key role of the public sector, both regionally and locally, is to set the short and long-term policy and strategy for the delivery of improvements in FMLM provision, as part of wider transport, spatial and economic policy. This will need to be supported by interconnected policies on stakeholder, industry and public engagement, regulation, digital connectivity and energy.

[30] https://nacto.org/wp-content/uploads/2019/09/NACTO_Shared_Micromobility_Guidelines_Web.pdf

Within that policy framework each local authority will need to set its own approach to delivering FMLM connectivity including, importantly, which elements will be procured and which it will leave open to the commercial market. Currently, FMLM provision is a combination of procured and commercial with the public sector having a larger role in the delivery of established modes. Local authorities are most likely to need to step in with a procured approach where the market is unable or unwilling to deliver specific elements of an area's FMLM strategy and this is more likely to be the case in areas with smaller mobility markets where commercial viability may be lower.

In addition to a role in the delivery of individual modes, the public sector has a major role in agglomerating modes at interchanges and through the development of mobility hubs. This role is not just restricted to local authorities but is also applicable to Network Rail and other Transport Authorities who own, manage and operate major rail interchanges. Again, at these hubs, the public sector does not necessarily have to provide all the individual modes but provide physical space for commercial providers to operate services, as part of a mobility market.

The public sector also has a role to work across sectors both within the public sector and private, to co-ordinate policy and delivery across geographies. When successful this could develop single approaches to FMLM provision, enabling larger-scale deployments and cost efficiencies.

It will also be important for the public sector to engage with influential private landowners who will have commercial interests in trialling new modes across their estates (e.g. airports, logistics, business parks) can help to expand that FMLM connectivity. In addition, it will be important to engage with both public and private sector estates that would be appropriate locations for mobility hubs (e.g. universities, hospitals, business parks, etc).

PRIVATE SECTOR ROLE

A key private sector role is to bring new FMLM offers to market to support the delivery of local policies and strategies as part of the wider mobility network. This may include the operation of individual or a number of modes as well as mobility hubs and non-mobility components of those hubs. In doing so, the private sector will take a significant proportion of the risk of delivering new modes but may require public sector financial intervention in areas where commercial viability is insufficient to attract the private sector.

There is also a role for the private sector in delivering new developments that fit with local policy on FMLM connectivity and build in appropriate modes and their agglomeration.

PILOTING

As new FMLM modes come forward and much has still to be learned about their viability, operation, management and regulation, piloting projects is an appropriate approach to take, ensuring that lessons are learned before wide-scale commercial operations are commenced. Indeed, this is the Government's approach through the Future Mobility Zone programme which will deliver FMLM improvements, as parts of wider packages, in up to three major city locations over a four year period on a trialling and piloting basis.

7 CONCLUSION

This report has reviewed the current extent of practice in the UK, Europe and globally of a range of First Mile/Last Mile (FMLM) modes. For each mode the report has summarised the following:

- Typical use cases
- Benefits, opportunities and barriers to their use
- Technical and commercial maturity
- Business models
- Journey range
- Supporting infrastructure and systems
- UK, European and global practice
- Notable failures
- Spatial typologies and densities that they are most suitable for.

In summary and conclusion, relative to each FMLM mode (*at the time of writing*):

- **Walking** should remain central to any FMLM Strategy and transport policy in general

- **Cycling** is key to longer FMLM journeys with owned likely to remain the majority for the first mile element of journeys, but shared bikes may take up increasing proportions of journeys in the most densely populated areas

- **E-bikes** are taking an increasing share of the market and they are particularly important for removing some barriers to pedal cycling including fitness and topography, but they need more infrastructure.

- **Shared cycles** have had success in a number of locations in the UK, Europe and around the world with some very large schemes, however, many schemes require subsidy to operate and there have been significant commercial failures, particularly of dockless schemes. However, as a true FMLM mode they offer sustainable travel between hubs and end destinations with e-bikes adding to this capability.

- **Self-powered mobility devices** are only recently being seen as a legitimate form of transport and there are concerns around mixing with pedestrians and anti-social behaviour and there are also limitations in terms of the physical ability and capability of users. There also appears to be limited interest in the operation of commercial shared models for self-powered devices.

- **Powered mobility devices** are becoming increasingly popular in Europe and around the world, but they are currently illegal to use in public space in the UK. However, this may change once the outcome of the ongoing regulatory review is known and there are companies waiting to launch shared operations in the UK if the laws are relaxed.

- **Powered mobility devices for mobility impaired users** have a strong market in the UK with a range of owned and shared options. Shared approaches tend to focus on the final mile and support car-based journeys for the middle mile. There remain safety concerns over these devices

with an increase in serious and fatal accidents over the last few years. However, for mobility impaired users, these devices provide a significant opportunity to increase access to daily activities.

- **Private car** use for even very short FMLM journeys continues to dominate transport across most spatial typologies and densities with the mode being particularly dominant in less dense locations where alternatives are fewer. The focus of much transport policy is around replacing this mode with more sustainable options as highlighted elsewhere in this report. However, the mode continues to develop with the environmental impact being a key area of work at present and electrification being delivered to an increasing extent to reduce carbon emitted and improve air quality. This mode is likely to remain a core element of FMLM networks but developments in automation of this mode over the coming decades my significantly disrupt the mode and the travel market in general. However, the focus for transport policy remains to reduce the number of single occupancy car journeys, particularly by conventionally powered by ICEs.

- **The shared car market** is a growing and complex area of mobility provision. The market has varying levels of technical and commercial maturity. OEMs are providing a wider range of options to access their vehicles, new commercial offerings for short to longer-term rentals are establishing themselves and individuals have a range of options for Peer to Peer sharing of their own cars. Overall, the changes occurring in the sharing of cars could lead to the reduced need for individuals or households to obtain long-term sole access to one vehicle, or indeed a second or third vehicle. The development of autonomous vehicles over the coming decades may have further significant disruptive effects on this and the wider transport market.

- **Bus services** are a mature, established and key element of the transport network serving all spatial typologies and densities but with greater suitability to high density locations where commercial operations are more likely to be sustainable. Innovation and developments in their services are continuing with particular focus on decarbonisation, customer experience and ticketing. However, automation may have a significant disruptive influence on manually driven services both in terms of the automation of larger, high capacity ‘trunk haul’ services and competition from smaller, more flexible DRT and shuttle services, as well as the wider automation of cars. Innovation in the transport market is hindered by the current regulatory structure of bus services outside London where a deregulated and market-led approach brings barriers to closer integration and co-operation.

- **The taxi market** faces ongoing disruption by new entrants into this space, including ride-hailing, but taxis remain a core element of the transport market for FMLM journeys, particularly for those of greater distances. The impact of climate change and stronger action to meet air quality targets means that taxis are a significant focus for work to reduce emissions, particularly through electrification. However, the true impact on traffic of ride-hailing is not well known but there are indications that it may add to congestion. The development of autonomous vehicles may have a very significant disruptive effect on the taxi market with ride-hailing companies being major players in the development of automated technologies.

- **Ride-pooling and DRT** are a major area for expansion but there is complexity in the market. DRT is growing in maturity in the UK with several operators expanding over a range of geographies but there have also been significant failures. Pooling of rides in private vehicles and crowdsourcing of mobility services also operate in this space and there is potential for these approaches to disrupt each other and reduce their viability. Services provide a significant opportunity to supplement the existing mass transit network by both filling in gaps in the networks and by providing access to major hubs and interchanges. Again, automation of transport may present an opportunity for significant disruption for these modes for FMLM journeys.

- **The use of pavement delivery devices and drones** are at the initial real-world technical operation stage with limited commercial maturity. These modes present opportunities to reduce the need for people to physically travel to access goods and services both in a local context and over longer distances.

- **Digital as a Mode** presents significant opportunities to reduce the need to travel for a range of daily activities including working, learning, shopping, healthcare and leisure. In addition, improvements to wireless digital connectivity mean than more activities can be undertaken whilst travelling bring both efficiency and social benefits. Digital as a Mode should be a central pillar of all strategies and not just focussing on FMLM journeys.

In addition to reviewing practice in individual modes, this report has considered the agglomeration of FMLM modes and development of mobility hubs. Essentially, mobility hubs are the next generation of local interchanges, often building on existing and established locations and networks, including major linear mass transit services, supplemented by enhanced and new modes including first mile/last mile options. Building in supporting land uses will reduce local vehicle kilometres travelled through the combination of functions at a single location. These hubs, with the mixture of mobility and land use, can also provide a catalyst for reinvigoration of local areas and communities.

Mobility hubs are likely to form a major component of an EEH FMLM strategy with different hub location types applicable across the region. Hubs do not need to work in isolation and across the region a network of hubs, based on existing major interchanges and new hub locations, could form the backbone of future mobility proposals using a format of building blocks that the travelling public recognise and understand.

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