



Northern Ireland  
Assembly

## Research and Information Service Research Paper

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7 October 2020

**Des McKibbin**

# Decarbonising Transport in Northern Ireland

**NIAR 289-20**

This paper provides an overview of potential policies for decarbonising road and rail transport in Northern Ireland in support of UK wide commitments to reach net zero Green House Gas (GHG) emissions by 2050. It has been prepared for the NI Assembly Infrastructure Committee to inform their discussion on potential areas of inquiry.



# Executive Summary

## Policy Framework

Tackling climate change requires an international effort and as such both the UK and the EU are parties to the United Nations Framework Convention on Climate Change (UNFCCC).

Both the UK and EU have signed up to international climate change obligations, such as the Kyoto Protocol and the Paris Agreement.

The 2015 Paris Agreement, a successor to the Kyoto Protocol, has been signed by 194 states and the European Union

The UK has ratified the Paris Agreement separately from the EU and has committed to upholding its Paris Agreement obligations post Brexit.

The Climate Change Act 2008 (2008 Act) originally established long term statutory targets for the UK to achieve an 80% reduction in GHG by 2050 against a 1990 baseline. In 2019, the UK Government amended the 2008 Act by introducing a target for at least a 100% reduction of GHG emissions (compared to 1990 levels) in the UK by 2050. The 2019 amendment order applies to the whole of the UK.

Transport has become the largest contributor to UK domestic GHG emissions, contributing 28% of UK domestic emissions in 2018. Within transport, road transport is the largest emitter of GHG with cars the largest contributor in this subsector.

The UK Government is developing a transport decarbonisation plan (TDP) that will seek to deliver net zero emissions across all transport modes by 2050.

Already the UK Government has published 'Road to Zero', a strategy aimed at "effectively zero emissions from road transport by 2040". It is based around the decarbonisation of road vehicles, eventually ensuring almost every car and van is zero emission by 2050. Again the objectives of this policy apply across the UK.

Northern Ireland must contribute to UK commitments around emissions and decarbonising the road transport sector. To do this, the Committee for Climate change recommends policy focuses on:

- encourage shifts to active travel and public transport.
- addressing the financial and non-financial barriers to electric car uptake.

## **Policies to promote ultra-low emission vehicles**

The Committee on Climate Change (CCC)'s net zero technical report notes that, in order to achieve the net zero target, sales of non-zero emission cars, vans and motorcycles are likely to need to end by 2035.

Currently ultra-low emission vehicles (ULEVs) account for less than 1% of licensed vehicles in the UK.

The CCC also suggests public concerns about charging infrastructure reliability are a barrier to uptake for consumers and something which the NI Executive could address. It estimates Northern Ireland may require between 30 to 35 public rapid chargers on major roads, and 800 to 950 public top-up chargers. The current network consists of 337 public charge points of which approx. 17 are rapid chargers.

The vast majority of HGVs will also need to be either electric or hydrogen powered by 2050 in order to reach net zero. However, there are significant challenges around developing zero-emissions vehicles and development of fuelling infrastructure that must be addressed.

Translink has developed a strategy that aims to deliver a zero emission bus and rail fleet by 2040. Translink is currently piloting a small fleet of Fuel Cell Electric Vehicles, with funding from the DfI and the Office of Low Emission Vehicles (OLEV). Current Hydrogen gas costs and the capital investment in terms of vehicles and infrastructure is a barrier to roll out.

Translink has indicated that to upscale the use of electricity and hydrogen as a bus fuel an average annual requirement of 120 vehicles per annum is required. This will require circa £41.6m between over the next ten years. The rail fleet programme will require over £40m per annum.

## **Travel behaviour in Northern Ireland**

Northern Ireland is highly car dependent with over 70% of all journeys made by car. In general, public transport and walking/cycling have higher modal shares in larger urban areas, and as settlement size reduces so too does their modal share.

Over one third of the NI population live in rural areas, often returning to urban areas daily for work. This is apparent with the high levels of peak period congestion in and around Belfast and some of the larger towns and cities in NI.

Travel behaviour has not changed significantly in NI over the past 20 years. Public transport journeys have risen slightly. However, this was in line with population growth and no modal shift had occurred. Investment in rail services, Belfast's metro, and rapid transit have been successful in increasing passenger numbers but Ulsterbus, which is responsible for carrying the highest number of passengers, had seen journey numbers fall.

The COVID-19 pandemic had an immediate impact on demand for public transport and reduced travel and transport demand in general. Northern Ireland's lockdown began at the end of March by which time public transport patronage had fallen to around 10% of 2019 levels. By mid-August they had returned to less than 50% of the previous year's levels.

### **Policies to achieve modal shift**

The absolute minimum requirement of both public transport systems and active travel interventions is that they provide comfort, accessibility and safety. With this in place policies can be developed that can encourage modal shift. This paper looks at three approaches described broadly as push, pull and nudge measures. Case study evidence is used to demonstrate that an integration of these three approaches is often necessary to achieve long term and sustainable modal shift.









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# 1 Policy Framework

Tackling climate change requires an international effort and as such both the UK and the EU are parties to the United Nations Framework Convention on Climate Change (UNFCCC). Both the UK and EU have signed up to international climate change obligations, such as the Kyoto Protocol and the Paris Agreement. During the (Brexit) transition period, the UK must continue applying and implementing EU law that falls within the scope of the Withdrawal Agreement.<sup>1</sup> However, the level of the UK's involvement, future cooperation and alignment with EU climate change efforts remains subject to ongoing negotiation.<sup>2</sup>

## 1.1 The Paris Agreement

The 2015 Paris Agreement, a successor to the Kyoto Protocol, has been signed by 194 states and the European Union. The UK has ratified the Paris Agreement separately from the EU.<sup>3</sup> The Agreement aims to respond to the global climate change threat by keeping a global temperature rise this century well below 2 degrees Celsius above pre-industrial levels and to pursue efforts to limit the temperature increase even further to 1.5 degrees Celsius.<sup>4</sup>

The UK Government has confirmed it remains committed to the Paris Agreement and that (post Brexit) it will continue to be bound by the Paris Agreement as an individual party under international law. The Government's post-Brexit guidance states:

*“The UK will also remain a Party to international climate change agreements, including the Paris Agreement. Its commitment to them will remain as strong as ever and will be unaffected by leaving the EU.”<sup>5</sup>*

## 1.2 UK legislation

The UK has domestic legislation and policies in place to reduce greenhouse gas (GHG) emissions. The Climate Change Act 2008 (2008 Act) originally established long term statutory targets for the UK to achieve an 80% reduction in GHG by 2050 against a 1990 baseline (translated into five-yearly carbon budgets). Northern Ireland does not currently have any separate climate change legislation, but GHG from Northern Ireland contribute to the UK total under the 2008 Act, and it has a key role to play in meeting the UK's obligations under the Paris Agreement.<sup>6</sup>

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<sup>1</sup> Suzanna Hinson and Sara Priestley, [Brexit: Energy and Climate Change](#), House of Commons Library, June 2020

<sup>2</sup> Ibid.

<sup>3</sup> UK Government, [UK ratifies the Paris Agreement](#), 18 November 2016, accessed 30 September 2020

<sup>4</sup> UNFCCC, [The Paris Agreement](#), accessed 27 September 2019

<sup>5</sup> Department for Business, Energy & Industrial Strategy, [Meeting climate change requirements from 1 January 2021](#), September 2020

<sup>6</sup> Committee on Climate Change, [Reducing emissions in Northern Ireland](#), February 2019

### 1.2.1 Net zero

In 2019, the UK Government amended the 2008 Act by introducing a target for at least a 100% reduction of GHG emissions (compared to 1990 levels) in the UK by 2050.<sup>7</sup> This is otherwise known as 'net zero' emissions. The 2019 amendment order applies to the whole of the UK. However, Scotland (net zero by 2045) and Wales (95% emissions reduction by 2050) have their own targets which reflect local circumstances. Northern Ireland does not currently have its own long-term target for emissions but is included within UK targets.<sup>8</sup>

It is known as a net zero target because some emissions can remain if they are offset (i.e. by removal from the atmosphere and/or by trading in carbon units). If met, this target would effectively mean the UK would end its contribution to global emissions by 2050.<sup>9</sup>

## 1.3 Transport decarbonisation plan

The UK Government is developing a transport decarbonisation plan (TDP). The ultimate aim of the plan will be to achieve net zero emissions across all transport modes by 2050.<sup>10</sup> The TDP will be based on six strategic priorities to deliver net zero emissions:

- Accelerating modal shift to public and active transport;
- Decarbonisation of road vehicles;
- Decarbonising how we get our goods;
- Place based solutions;
- Establish UK as a hub for green technology and innovation; and
- Reducing carbon in a local economy.<sup>11</sup>

The TDP consultation document notes that transport has become the largest contributor to UK domestic GHG emissions, contributing 28% of UK domestic emissions in 2018. Transport emissions are 4% higher than in 2013 and are only 3% lower than in 1990.<sup>12</sup> Transport emissions include freight and passenger transport, both for private and business purposes.

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<sup>7</sup> [The Climate Change Act 2008 \(2050 Target Amendment\) Order 2019](#)

<sup>8</sup> Committee on Climate Change, [Net Zero – The UK's contribution to stopping global warming](#), May 2019

<sup>9</sup> Sara Priestley, [Net zero in the UK](#), House of Commons Library, December 2019

<sup>10</sup> Department for Transport, [Decarbonising transport: setting the challenge](#), March 2020

<sup>11</sup> Ibid.

<sup>12</sup> Department for Business, Energy & Industrial Strategy, [2018 UK greenhouse gas emissions: final figures – statistical release](#), May 2020.

Figure 1: Contribution (%) to UK greenhouse gas emissions in 2018, by sector



Source: DfBEIS

Since 2005 national transport emissions have decreased, even though there has been an increase in both the number of passenger vehicles and the vehicle kilometres travelled. This is due to lower petrol consumption by passenger cars outweighing an increase in diesel consumption, and improvements in fuel efficiency of both petrol and diesel cars.<sup>13</sup>

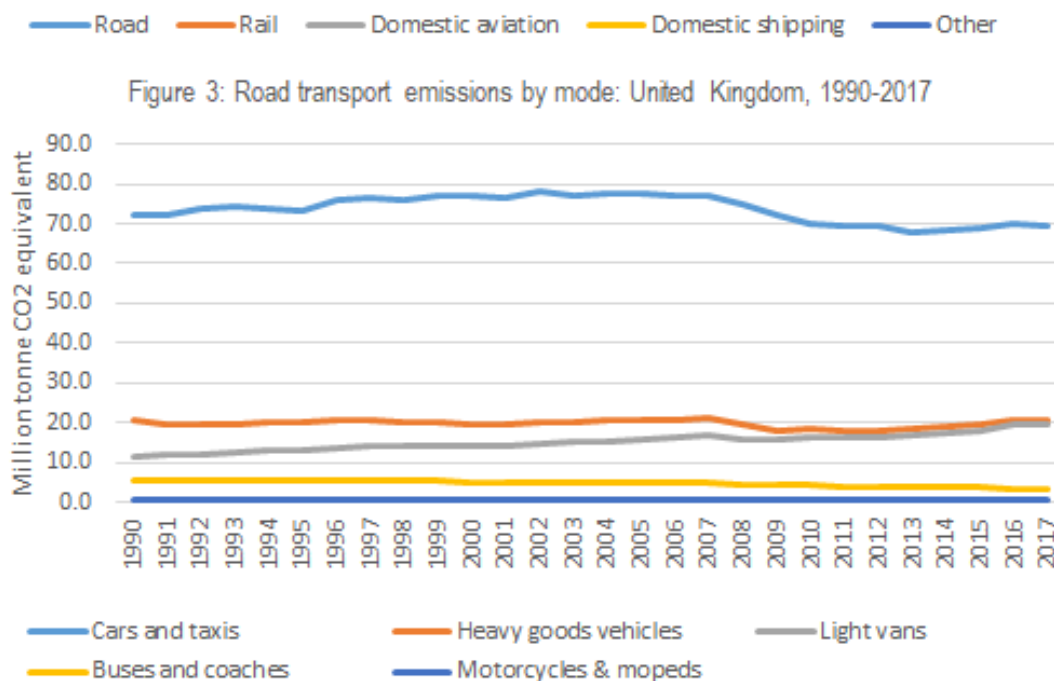
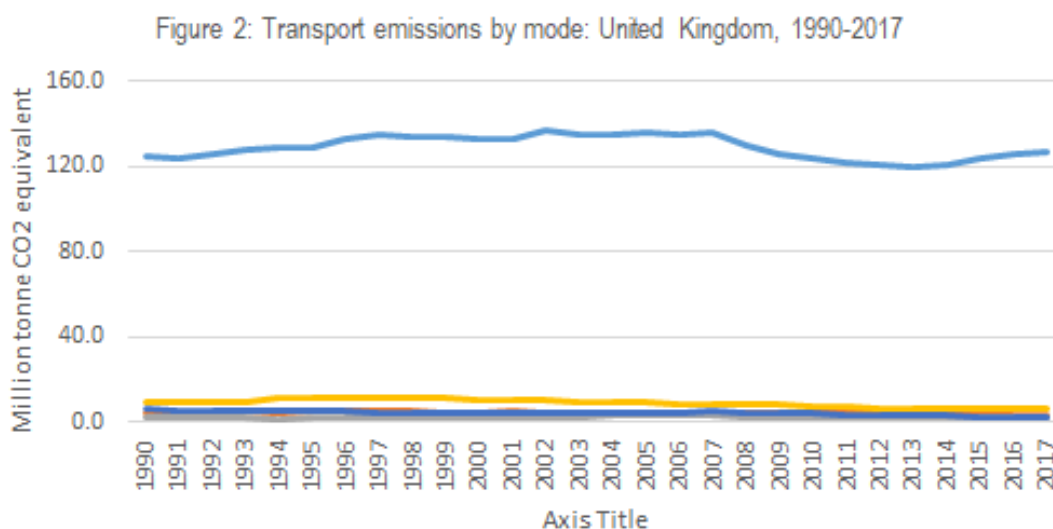
## 1.4 Road to zero

Within transport, road transport is the largest emitter of GHG with cars the largest contributor in this subsector. The UK Government's '[Road to Zero](#)' Strategy set out long-term measures to reach "effectively zero emissions from road transport by 2040", based around the use of carbon free fuels. The Government intends to:

- See at least 50%, and as many as 70%, of new car sales and up to 40% of new van sales being ultra-low emission by 2030;
- End the sale of new conventional petrol and diesel cars and vans by 2040;
- Ensure that by 2040 that the majority of new cars and vans sold to be 100% zero emission and all new cars and vans to have significant zero emission capability; and
- By 2050 ensure almost every car and van to be zero emission.<sup>14</sup>

<sup>13</sup> Department for Business, Energy & Industrial Strategy, [2005 to 2018 UK local and regional CO2 emissions: statistical release](#), June 2020

<sup>14</sup> Office for low emission vehicles, [The Road to Zero](#), July 2018



Source: [Department for Business, Energy & Industrial Strategy](#)

### 1.5 Policy recommendations for Northern Ireland

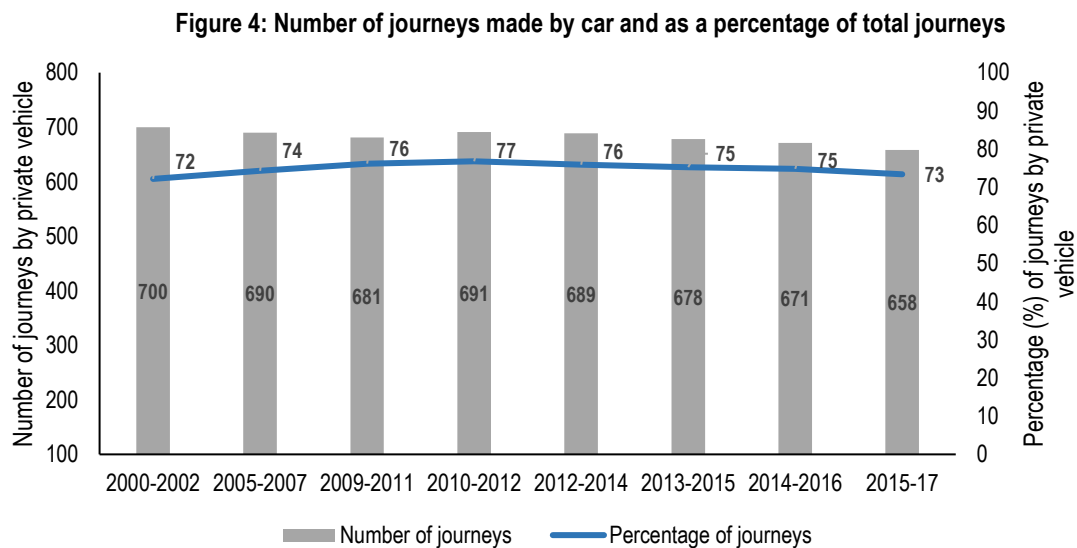
The CCC points out that the UK Government has a central role in setting vehicle standards, subsidising biofuels and setting road and fuel tax rates which will be key policy levers towards decarbonised transport sector. The CCC suggests policy in Northern Ireland can have a significant impact on demand reduction policies and encouraging the uptake of electric vehicles through policies that address the financial and non-financial barriers. Reducing demand for road based trips will require policies that encourage behaviour shifts to active travel and public transport. <sup>15</sup>

<sup>15</sup> Committee on Climate Change, [Reducing emissions in Northern Ireland](#), February 2019

## 2 Travel behaviour in Northern Ireland

### 2.1 Car dependence

Northern Ireland has a highly car dependent society. Over 70% of all journeys in NI are by car whereas only 26% of all journeys which are made by walking, cycling or public transport. 87% of journeys of one mile or over are made in a car.<sup>16</sup>



Source: Department for Infrastructure: [TSNI Headline Report 2015-17](#) and [TSNI in-depth report 2010-12](#)

Northern Ireland's car dependence is reflected in the high levels of car ownership and licensed drivers:

- There are almost one million licensed cars in NI (944,000);<sup>17</sup>
- This equates to 6478 licensed cars per 10,000 of the eligible population (17+)<sup>18</sup>. This is a higher rate than in Scotland, England and Wales (figure 5);
- 81% of households have access to at least one car (a rise from 74% in 2004-06);
- 81% of men (17%) and 71% of women (17+) had a full car driving licence in 2016;
- 42% of 17-20 year olds had a full car driving licence in 2016 (up from 27% in 2004-06);<sup>19</sup>

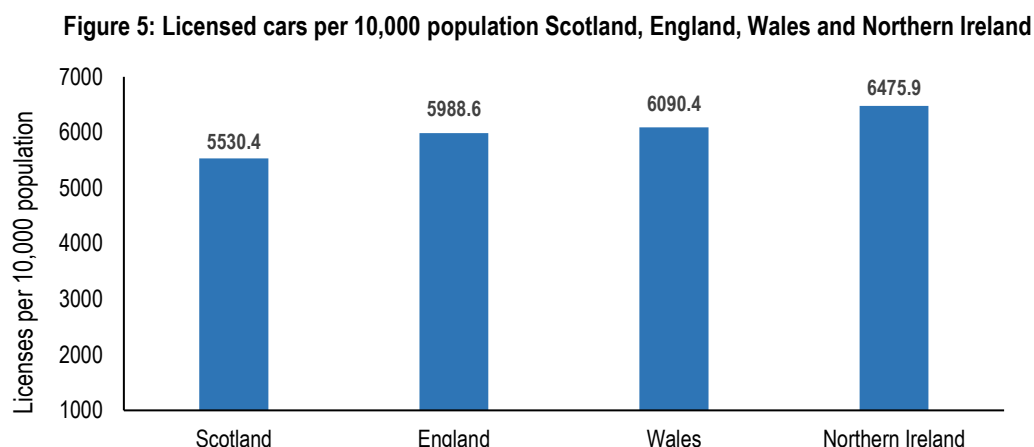
<sup>16</sup> *ibid.*

<sup>17</sup> Department for Transport, [Table VEH0105](#), accessed 17 November 2018.

<sup>18</sup> calculated using: NISRA, 2017 Mid-Year Population Estimates for Northern Ireland, [population by sex and single year of age \(1991-2017\)](#), accessed 12 December 2018

Excel (1.1 MB)

<sup>19</sup> Department for Infrastructure, [Travel Survey for Northern Ireland in-depth report 2014 – 2016, table 1.2: Basic Travel Statistics](#), November 2017.



Source: ONS, [MYE2: Population estimates: Persons by single year of age and sex for local authorities in the UK, mid-2017](#) and DfT, Vehicle Licensing Statistics: [Table VEH0105](#)

## 2.2 Rurality

In general, public transport and walking/cycling have higher modal shares in larger urban areas, and as settlement size reduces so too does their modal share.<sup>20</sup>

Therefore, one reason for the reliance on private transport in NI is the large and growing rural population:

- Over one third of the population (36%) live in rural areas.<sup>21</sup>
- The rural population is growing at a faster rate than the urban population, increasing by 18% between 2001 and 2017, compared to a 6% growth in urban areas.<sup>22</sup>
- Within this time there has been an above average population increase in rural areas located within an hour from Belfast suggesting many commute there for work.<sup>23</sup>

Counter-urbanisation, where people move from towns and cities to more rural areas, has been identified as a significant and cross-cutting policy issue in NI.<sup>24</sup> In terms of transport, it is arguably most apparent in the high levels of peak period congestion in and around Belfast and some of the larger towns and cities in NI as people travel in out to work.

### 2.2.1 Travel to work

For those who work, getting to and from there generates the highest number of trips per year:

- Those who work make on average 298 commuting journeys per year;

<sup>20</sup> S Cooke and R Behrens, [Correlation or cause? The limitations of population density as an indicator for public transport viability in the context of a rapidly growing developing city](#), Transportation Research Procedia, World conference on transport Research, 10-15 July 216

<sup>21</sup> Northern Ireland Statistics and Research Agency (NISRA), [Settlement 2015 Documentation](#), accessed 25 October 2018.

<sup>22</sup> NISRA, [Mid-year estimates - population change](#), January 2019

<sup>23</sup> *ibid.*

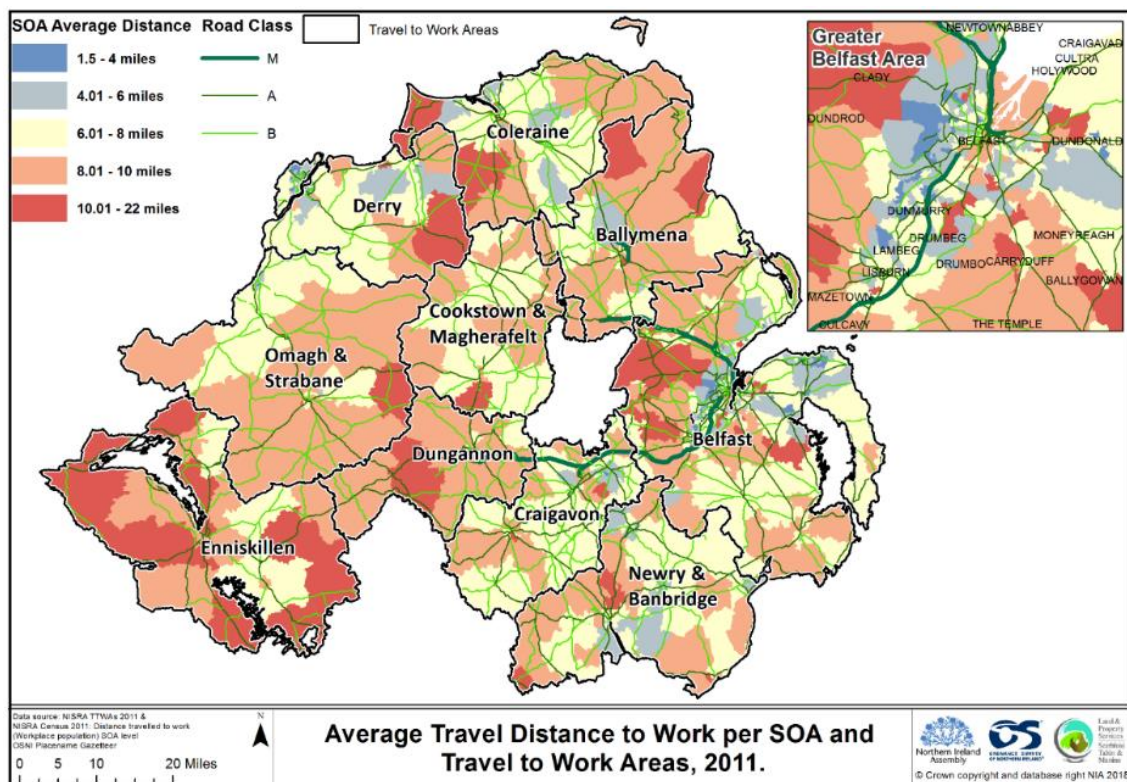
<sup>24</sup> DRD (2010) RDS 10 Year Review (Consultation) Page 15 (para 2.5)



- this accounts for 16% of all journeys and 22% of the total distance travelled.<sup>25</sup>

A large proportion of these journeys are over distances which would make it difficult to walk and cycle in large numbers while restricted access to public transport, particularly in the more rural west, may explain high levels of car dependence. Map one shows the average travel distance to work (TDTW) and travel to work areas (TTWAs) for major settlements in NI.<sup>26</sup>

Map 1: Average Travel Distance to Work and Travel to Work Areas, 2011



This shows large pockets of the working population, particularly in the West and North were travelling more than eight miles to work. Indeed, across NI, it is only in larger urban settlements where average travel to work distances are less than six miles.

Census data also tells us that even within more urban areas and/or among those who live closer to work, there are also high levels of car use. For example:

- 40% of NI's working population live within 5km of work - 70% drive, 23% walk or cycle while 7% use public transport.
- Of those who travel less than 2km 59% drive, 38% walk or cycle and 3% use public transport.<sup>27</sup>

<sup>25</sup> Department for Infrastructure, [Travel Survey for Northern Ireland: Report 2015-17](#), July 2018

<sup>26</sup> Northern Ireland Statistics and Research Agency (NISRA), [Travel to work areas](#), accessed 25 October 2018.

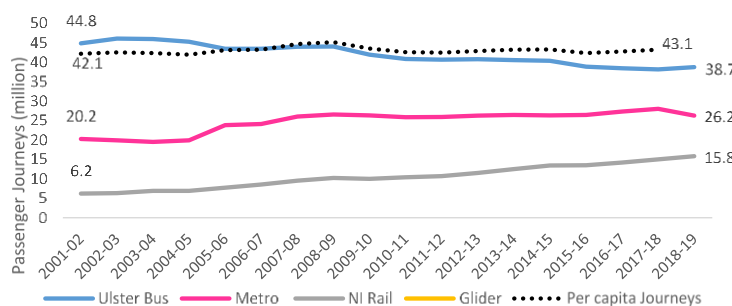
<sup>27</sup> Table DC7701NI: method of travel to work by distance travelled to work

## 2.3 Public Transport use

Increasing public transport use and active travel have been long term policy objectives since the publication of the first Regional Transportation Strategy (RTS) in 2002. The effectiveness of the approach taken to achieve this objective was examined by the NI Audit Office in 2015<sup>28</sup> The NIAO review included analysis of performance, in terms of realising targets for modal shift and increased passenger numbers.

The report noted that while overall public transport journeys had risen slightly, this was in line with population growth and no modal shift had occurred (see figure 6). It noted that significant investment in rail services and Belfast metro had been successful in increasing passenger numbers but that Ulsterbus, which is responsible for carrying the highest number of passengers, had seen journey numbers fall.

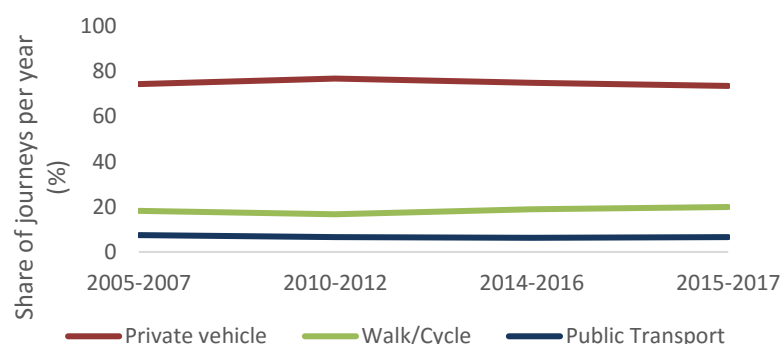
**Figure 6: Ulsterbus/Metro/NIR passenger journeys and PT journeys per capita: 2001-02 to 2018-19**



Source: Department for Infrastructure

This is reflected in modal share statistics from the Travel Survey. This shows that the proportion of journeys made in private vehicles in 2017 (74%) is at the same level as in 2007.<sup>29</sup>

**Figure 7: Journeys per person per year NI by main mode**



Source: Department for Infrastructure

The report concluded that commuters were now less likely to use public transport to get to and from work than a decade ago, causing increasing peak time congestion on Belfast’s arterial routes. The report indicated that a re-balancing of funding between

<sup>28</sup> NI Audit Office, [DRD: the effectiveness of public transport in Northern Ireland](#), April 2015.

<sup>29</sup> DfI, Travel Survey NI [2016-2018 in-depth report](#), February 2020

roads and public transport was needed in order to achieve modal shift targets in what is a car dependent society.

In response to the NIAO report the NI Assembly’s Public Accounts Committee suggested that while more innovation was required in the planning and delivery of public transport services the vision and leadership to integrate this with interventions designed to restrict private transport is also necessary.<sup>30</sup>

Where there has been investment in public transport there have been notable increases in patronage. For example:

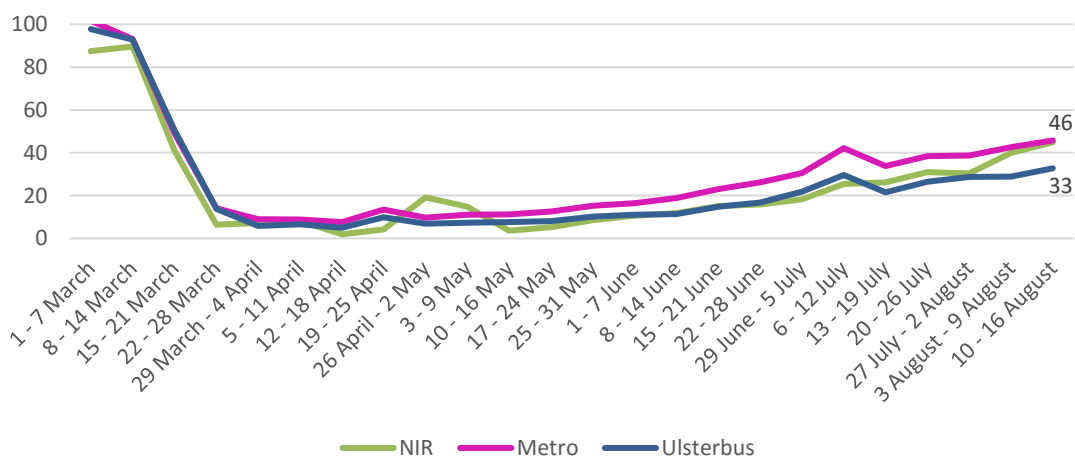
- Translink has seen patronage increase by over 75% on the routes now operated under the Glider brand on the Belfast Rapid Transit System.
- It is estimated that on the Glider bus corridors a modal shift of between 8% has occurred from the private car since 2018.
- NI Railways new trains were introduced in 2003/04 and 2012/13. Since then rail patronage has increased by 232%.<sup>31</sup>

### 2.3.1 Impact of COVID-19 on travel behaviour

The COVID-19 pandemic had an immediate impact on demand for public transport and reduced travel and transport demand generally. Immediately after Northern Ireland’s lockdown began at the end of March public transport patronage had fallen to around 10% of 2019 levels. This began to recover as lockdown measures eased. However, there remains uncertainty when or if this will return to previous levels.

Figure eight shows, patronage remained just below 50% (46%) on both NIR and Met, as of August 16. Ulsterbus, which carries the largest proportion of passengers, has seen its numbers recover to 33% of 2019 levels.

**Figure 8: Patronage (%) NIR, Metro and Ulsterbus 1 Mar – 16 Aug, as compared to 2019**



<sup>30</sup> Public Account Committee, [Report on DRD: The Effectiveness of Public Transport in Northern Ireland](#), June 2015.

<sup>31</sup> Translink, [Energy Strategy Call for Evidence CfE0055](#), June 2020

Source: Department for Infrastructure

The NI Executive continue to advise people to work from home where possible, while the BBC report only 5% of office-based staff in Belfast have returned to their workplaces full time.<sup>32</sup> Indeed, the lockdown has been described as the ‘world’s mass homeworking experiment’<sup>33</sup> with organisations being having to adapt quickly to remote working.<sup>34</sup>

It could be argued that much of this drop off is temporary as people continue to work from home only until restrictions are lifted. However, academics have suggested there is growing evidence working practices may have altered permanently, requiring a acknowledgement in current transport policy:

Professor Greg Marsden pointed out that the UK Government road investment plans are based on the assumption of 1% traffic growth per year – meaning 35% by 2055. However, he argued that post-COVID-19, an actual fall in traffic was more likely. He said:

*"The likely drop in traffic levels post the COVID-19 crisis means that we should delay the road expansion programme and focus instead on rebuilding public transport and switching more of our vehicles to zero emissions."*<sup>35</sup>

If remote working practices continue they will have a significant impact on the demand for travel, given as discussed, travel to work accounts for so many of our journeys. However, the long-term impacts of the pandemic on the demand for travel and modal choice remain to be seen.

### 3 Policies to promote ultra-low emission vehicles.

Given the dependence on private transport in NI, it is apparent that switching to zero emission vehicles will be critical if NI is to contribute to the UKs net zero commitments.

The Committee on Climate Change (CCC)’s [net zero technical report](#) notes that, in order to achieve the net zero target, sales of non-zero emission cars, vans and motorcycles are likely to need to end by 2035.<sup>36</sup> As a result there have been widespread calls for the Government to accelerate the uptake of electric vehicles (EVs) and to phase out conventional petrol and diesel engine vehicles earlier.<sup>37</sup>

Data from the Department for Transport (DfT) highlight the scale of the challenge associated with decarbonising road transport by 2050. Out of approximately 39.4

<sup>32</sup> John Campbell, [Coronavirus: Only 5% of Belfast employees have returned to workplaces](#), BBC News Online, 1 September 2020

<sup>33</sup> Andrew Hill and Emma Jacobs, ‘How is the world’s mass homeworking experiment going?’, *Financial Times*, 30 March 2020

<sup>34</sup> Reuters, [Zoom’s daily participants](#), April 2020

<sup>35</sup> Roger Harrabin, [Coronavirus will transform UK work and travel, says AA](#), 3 April 2020, accessed 27 September 2020

<sup>36</sup> Committee on Climate Change, [Net Zero – Technical Report](#), May 2019

<sup>37</sup> Noel Dempsey and Suzanna Hinson, [Electric vehicles and infrastructure](#), House of Commons Library, March 2020

million licensed vehicles in the UK at the end of 2018, around 0.2 million (0.5%) were ultra-low emission vehicles (ULEVs).<sup>38</sup> Of the approximately 1.2 million licensed vehicles in Northern Ireland,<sup>39</sup> just over 3,600 (table 2) were ULEVs (0.3%).

**Table 1: Licensed ultra-low emission vehicles (ULEVs) at the end of 2020 Q2, by body type and region, United Kingdom**

	All cars	All motorcycles	Goods vehicles	HGV	Buses and coaches	Other vehicles	Total
England	263,625	3,121	11,278	334	649	4581	283,588
Wales	6,108	82	379	5	1	51	6,626
Scotland	17,181	139	745	8	27	177	18,277
Northern Ireland	3,511	32	127	1	0	2	3,673

The CCC suggests the NI Executive can support greater uptake of ULEVs by addressing the shortage of charging infrastructure. It notes that public concerns about charging infrastructure reliability has been identified as a barrier to uptake of EV. Therefore, the CCC suggests:

*“Northern Ireland may require between 30 to 35 public rapid chargers on major roads, and 800 to 950 public top-up chargers. Northern Ireland has 470 charging points as of June 2018, a share of 2.8% of UK charging points”.*

### 3.1 Freight sector

The CCC has also indicated that the vast majority of HGVs will also need to be either electric or hydrogen powered by 2050 in order to reach net zero. However, there are significant challenges around developing zero-emissions vehicles and development of fuelling infrastructure.<sup>40</sup> According to the Chartered Institute of Logistics and Transport (CILT):

*“...at present, there are no feasible ultra-low emission or electric HGV’s on the market that provide businesses with options based on their business model and vehicle requirements”.*<sup>41</sup>

The Freight Transport Association (FTA) points out that Northern Ireland has no public fuelling infrastructure for CNG or Hydrogen whilst there is also limited electric charging points meaning businesses will not invest in these technologies. The FTA suggests,

<sup>38</sup> ONS, [Road transport and air emissions](#), September 2019

<sup>39</sup> DfT, Vehicle Licensing Statistics: 2019 Quarter 1 (Jan - Mar), April 2019

<sup>40</sup> Committee on Climate Change, [Net Zero – The UK’s contribution to stopping global warming](#), May 2019

<sup>41</sup> CILT, [Energy Strategy Call for Evidence Response CfE0031](#), June 2020

*“significant investment in refuelling or recharging infrastructure across the Strategic Road Network would be required. Goods vehicles including vans travel nationwide delivering goods and services and they would need the certainty to know that wherever they were needed, they would be able to successfully and efficiently refuel or recharge their vehicle, with limited down time.”*

The CCC accepts that HGVs will be harder to decarbonise, but that a hydrogen/EV based switchover is possible if there is appropriate investment in infrastructure.<sup>42</sup>

### 3.2 Decarbonising public transport

Translink has developed a strategy that aims to move from the current diesel dominated public transport fleet to a zero emission fleet by 2040.<sup>43</sup> Translink is currently involved in a pilot scheme to introduce a small fleet of Fuel Cell Electric Vehicles in 200. The pilot will see the Energia Group supply renewably-sourced hydrogen fuel from an on-shore North Antrim windfarm to power three Hydrogen fuelled double decker buses supplied by Wrightbus.<sup>44</sup> The project, which is supported by funding from DfI and the Office of Low Emission Vehicles (OLEV) will cost £4.7m, including the delivery of the first ever Hydrogen refuelling station of its kind in Ireland.

According to Translink, current Hydrogen gas costs and the capital investment in terms of vehicles and infrastructure is a barrier to roll out.<sup>45</sup> Translink has modelled the capital investment for upgrading the bus fleet to zero emission, estimating it would require 120 vehicles annually at a funding requirement of circa £41.6m between 2019 and 2030.<sup>46</sup>

The rail fleet programmes will require the procurement of 150 extra vehicles between 2019 and 2030 to provide the estimated capacity to keep pace with passenger growth. This equates to an average annual funding requirement of £40.1m per annum up to 2030 for new rolling stock and traction improvements on existing rolling stock.

According to Translink’s assessment of the environmental improvements achieved by its Fleet Strategy shows that by 2030, the proposed bus fleet would emit approximately 61% less CO<sub>2</sub>, 90% less NO<sub>x</sub> and 91% less PM, compared with the emissions from the 2019 fleet.

Translink has pointed it out that while initial investments are high they are likely to reduce as zero-emission technologies become more mature and the increased demand for them give rise to economies of scale. Furthermore, it points out that while the adoption of zero-emission technologies requires significant capital investment,

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<sup>42</sup> Committee on Climate Change, [Net Zero – The UK’s contribution to stopping global warming](#), May 2019

<sup>43</sup> Translink, [Energy Strategy Call for Evidence CfE0055](#), June 2020

<sup>44</sup> Energia Group, Energia Group to provide renewable hydrogen for NI public transport, 29 January 2020, accessed 30 September 2020

<sup>45</sup> Translink, [Energy Strategy Call for Evidence CfE0055](#), June 2020

<sup>46</sup> Ibid.



these vehicles could provide a circa £5m annual saving in operational costs in terms of fuel and maintenance (i.e. an annual saving of over 9%); and could be regarded as “invest to save” programme.<sup>47</sup>

## 4 Policies to achieve modal shift

An individual’s choice of transport mode is influenced by a number of factors. Social norms, habitual and automatic behaviour and quality of public transport infrastructure have been identified as particularly important.<sup>48</sup> Analysis of a range of studies by Batty (2015) looking at what qualities attract people to public transport found that comfort, accessibility, speed, seamlessness of journey, safety, security, affordability and reliability are fundamentals, without which modal shift will not occur.<sup>49</sup> Similar factors, particularly speed, convenience and safety are also key determinants of active travel uptake, much more so than factors such as weather, age or gender.<sup>50</sup>

Providing the type of quality infrastructure that encourage modal choice can be broadly as ‘pull’ factors i.e. the types of qualities that might attract people to alter their travel behaviour. They are largely delivered through investments in infrastructure and services. In contrast there are conditions under which car usage can be made either unattractive, difficult or impossible to undertake, with users effectively ‘pushed’ to change behaviour. This approach often, though not always, struggles to gain public support, and hence political support is rarely forthcoming.

It is argued that neither approach works in isolation and implementing a combination of ‘pull’ and ‘push’ policies is the most effective way to change travel behaviour.<sup>51</sup> It is therefore likely that significant and sustainable modal shift will require a range of interventions.

While there is a significant body of evidence that demonstrate the benefits of push and pull interventions, there is growing recognition that the human decision making process is often more complex. Behavioural sciences and particularly behavioural economics attempt to explain peoples’ behaviour. According to the theory, by examining the role of psychological, social, and emotional factors have in the decision making process non-intrusive interventions, referred to as ‘nudges’, can be designed to modify behaviour.

The remainder of this paper will look at a range of push, pull and nudge policies that have been employed elsewhere to achieve modal shift.

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<sup>47</sup> *ibid*

<sup>48</sup> House of Lords Science and Technology Select Committee, 2<sup>nd</sup> Report of Session 2010-12, [Behaviour Change](#), HL Paper 179, July 2011.

<sup>49</sup> Paul Batty, et al., Challenges and opportunities in developing urban modal shift, *Travel Behaviour and Society* vol. 2, 2015, pp. 109–123

<sup>50</sup> Danique, Ton, et al. [Cycling or walking? Determinants of mode choice in the Netherlands](#), *Transportation Research Part A: Policy and Practice* Volume 123, May 2019, Pages 7-23

<sup>51</sup> Federal Ministry for Economic Cooperation and Development, [Transportation Demand Management](#), April 2009

## 4.1 'Push' Interventions

### 4.1.1 Road user charging

Road user charging is by no means a new concept, with records of toll roads dispersed throughout history.<sup>52</sup> The basic principle has been implemented in various ways under terms including road pricing, congestion charging, road tolling and variable pricing.<sup>53</sup> These schemes can be organised into the following categories:

Economists view the concept in terms of simple market economics; roads users, like the users of any other valuable and limited resources, should pay all the costs arising from their use.<sup>54 55</sup> However, from a practical point of view, the challenge lies in how to implement the concept, "not only in terms of developing technically efficient charging mechanisms, but also in gaining political acceptance as a valid policy instrument"<sup>56</sup> due to the general perception that the public are opposed to such measures.<sup>57</sup>

Critics of road pricing point to the likelihood of certain undesired distributional effects, for example it may disproportionately affect commuters and/or those with no alternative but to drive and therefore pay the charge.<sup>58</sup> However, there is evidence to suggest that the way in which the scheme is designed is critical and if implemented correctly can ultimately produce equitable outcomes.<sup>59</sup>

The literature suggests that a lack of public support and the unwillingness of politicians to introduce unpopular mechanisms such as a congestion charge is the main reason these schemes are so rare.<sup>60</sup> However, there is evidence from cities such as Stockholm and London that while there is often initial resistance acceptance grows out of familiarity when the benefits begin to be realised.<sup>61</sup> Some experiences with both planning and introducing congestion charges are discussed here.

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<sup>52</sup> Louise Butcher, [Roads: national road pricing](#), House of Commons Library, August 2010

<sup>53</sup> Waafa Saleh, Road user charging: Theory and practice, *Transport Policy*, vol. 12(5), pp. 373-376.

<sup>54</sup> Waafa Saleh, Road user charging: Theory and practice, *Transport Policy*, vol. 12(5), pp. 373-376.

<sup>55</sup> Matthew Gibson and Maria Carnovale, The effects of road pricing on driver behaviour and air pollution, *Journal of Urban Economics*, vol. 89, July 2015, pp.62–73

<sup>56</sup> Yang, Hai and Huang, Hai-Jun, *Mathematical and Economic Theory of Road Pricing*, Emerald Group Publishing Limited 2005.

<sup>57</sup> Stephen Jess and Maria Börjesson, [Understanding attitudes towards congestion pricing: a latent variable investigation with data from four cities](#), *Transportation Letters*, vol. 11 (2), pp. 63-77.

<sup>58</sup> Benjamin Bureau and Matthieu Glachant, Distributional effects of road pricing: Assessment of nine scenarios for Paris, *Transport Research Part A: Policy and Practice*, volume 42 (7), pp. 994-1007.

<sup>59</sup> Andrew Koh, et al. [Road user charging and implications for transport policy: Findings from the CURACAO project](#). In: General Proceedings of the 12th World Conference on Transport Research Society. July 2010.

<sup>60</sup> G Santos, et al. 2008. London Congestion Charging. *Brook.-Whart. Pap. Urban Aff.*, pp. 177–234.

<sup>61</sup> Jonas Eliasson and, Lina Jonsson (2011) The unexpected "yes": Explanatory factors behind the positive attitudes to congestion charges in Stockholm, *Transport Policy*, vol. 18, pages 636–647



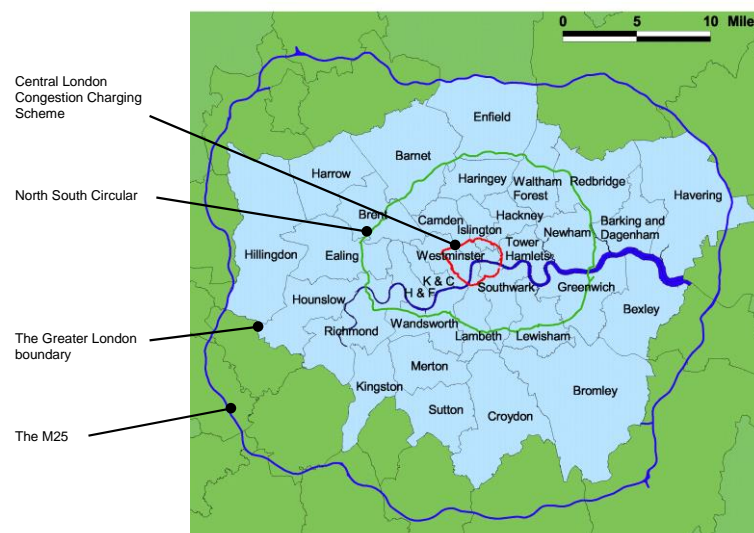
### Case study 1: London Congestion Charge (LCC)

Transport for London introduced an area-based congestion charging scheme for London in February 2003. The charge is an 'area licence' that allows drivers entering the 21km<sup>2</sup> charging zone (see below) to drive there throughout the day between 07:00 and 18:30. The charge has risen gradually from £5 in 2003 to £11.50 today, residents from inside the zone receive a 90% discount.<sup>62</sup>

It cost around £162 million to set up the LCC scheme (2005 prices). Areas of expenditure included traffic management methods, communications and public information on the scheme, systems set up and management.<sup>63</sup> Initially it was thought that all vehicles that travel into London would have to be fitted with electronic in-vehicle transponder units. That would have added both cost and complexity therefore a simpler collection and enforcement mechanism, using cameras and ANPR technology was chosen.<sup>64</sup> The Gross income for the LCC was around £230m in 2017/18, operating costs totalled £74m leaving net revenues of £156m, which are hypothecated to transport schemes in London.<sup>65</sup>

A cost benefit analysis of the LCC in 2007, reported in the Fifth Annual Impacts Monitoring Report, suggested that the identified benefits exceeded the cost of operating the scheme by a ratio of about 1.5 with the original £5 charge, rising to about 1.7 when the price increased to £8. This takes account of the net effects on public accounts, for example, indirect impacts on tax revenue. The more traditional resource-based estimates give benefit: cost ratios of around 2.0:1 and 2.5:1 with the £5 and £8 charge.<sup>66</sup>

Figure 7: London Congestion Charging Scheme in Relation to London



Source: [Defra](#)

<sup>62</sup> Transport for London, [Residents' discount](#), accessed 09 December 2018.

<sup>63</sup> Transport for London, [Central London Congestion Charging Scheme: ex-post evaluation of the quantified impacts of the original scheme](#), June 2007

<sup>64</sup> UK Air, [Detailed Assessment of London Congestion Charging](#)

<sup>65</sup> Transport for London, [Annual Report and Statement of Accounts 2017-18](#), July 2018.

<sup>66</sup> Transport for London, [LCC Impacts Monitoring – Fifth Annual Report](#), June 2007.

The LCC is considered to have been successful in relieving congestion in central London with TfL data showing that car traffic entering the congestion charging zone (CCZ) fell by 39 per cent between 2002 and 2014.<sup>67</sup>

There are other notable benefits from the LCC:

- It has enabled capacity previously allocated to private motor vehicles to be reallocated largely to bus lanes and pedestrian routes making these (bus and walking) more attractive;
- There has been a road safety impact with fewer car trips resulting in fewer injuries;
- 50-60% of the displaced car trips transferred to public transport, 20-30% divert around the zone, and 15-25% have made other adaptations, such as changing the timing of trips;<sup>68</sup>
- The LCC represents around five per cent of TfL's income;
- Over £1.7 billion has been raised in total from the scheme since 2003/04.
- The revenue raised is spent on improving transport in line with the Mayor's Transport Strategy.<sup>69</sup>

### ***Future of London Congestion Charge***

Traffic levels in the CCZ have fallen since its introduction. Despite this, congestion levels have returned to similar levels seen before the scheme. This is due to a redistribution of road space in Central London, with more space allocated for walking, cycling and bus priority. TfL has stated that without the Charge, congestion in central London would be significantly worse.<sup>70</sup>

The London Assembly (LA), while acknowledging the success of the LCC, has described it as a 'blunt instrument [...] too narrow in scope'.<sup>71</sup> It suggests London needs a way of charging people for road usage that is better targeted at the places congestion occurs, at the times it occurs, recommending reform of the LCC so it no longer requires drivers to pay one daily flat rate.<sup>72</sup> The LA further recommends that the Mayor develops proposals for a 'wider, single and simple' road pricing scheme for London that charges drivers according to how much, when and where they drive.<sup>73</sup> It suggests that many drivers that have a relatively low impact on congestion may pay less than they do

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<sup>67</sup> London Assembly, [Written evidence submitted to the House of Commons Transport Select Committee Urban congestion inquiry](#), February 2017.

<sup>68</sup> UK Air, [Detailed Assessment of London Congestion Charging](#)

<sup>69</sup> London Assembly, [Written evidence submitted to the House of Commons Transport Select Committee Urban congestion inquiry](#), February 2017.

<sup>70</sup> Transport for London, [Written evidence submitted to the House of Commons Transport Select Committee Urban Congestion inquiry](#), January 2017

<sup>71</sup> London Assembly, [Written evidence submitted to the House of Commons Transport Select Committee Urban congestion inquiry](#), February 2017

<sup>72</sup> *ibid.*

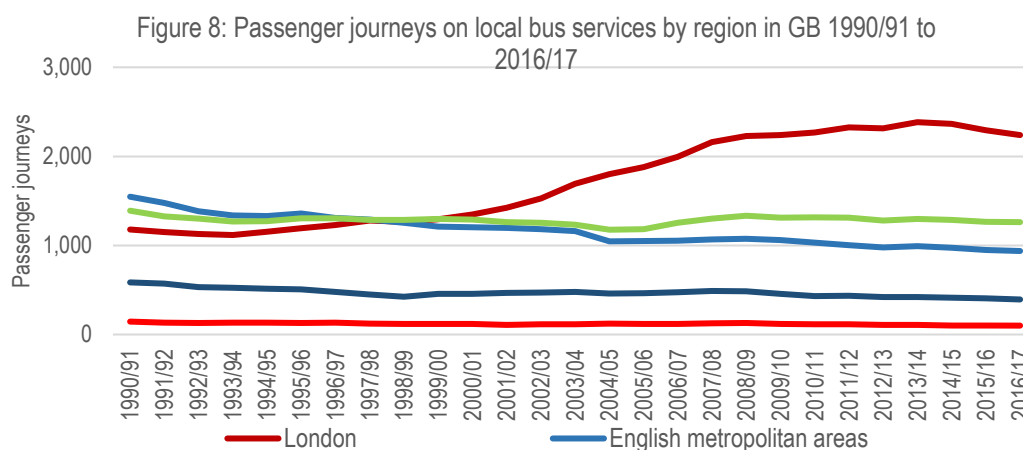
<sup>73</sup> *ibid.*

today, while others contributing most to congestion would be disincentivised from doing so.<sup>74</sup>

The Mayor of London's 2018 Transport Strategy notes that in order to meet targets for 80 per cent of travel in London to be either walking, cycling or public transport, the way road users pay for roads must change. The strategy suggests that while the LCC approach was effective in its time, technological developments could facilitate a new approach where road charges take better account of the impacts and context of individual journeys".<sup>75</sup> The Mayor suggests a 'per mile' charge which takes into account distance, time, congestion, emissions and road danger in an integrated way will be developed by TfL.<sup>76</sup>

### Key success factors

Combing pull measures, in the form of improved bus services and active travel infrastructure, was critical to acceptance of the LCC push measure. London's 'BusPlus' policy, also known as the London Bus Initiative, was introduced at the same time. In addition to increased capacity, BusPlus delivered improvements in reliability, service quality, journey times, accessibility and information along key routes in and around central London. Providing this suitable alternative saw the number of passengers entering the central charging zone by bus increased by 37 per cent by 2007. TfL estimates up to half this growth reflected displaced car travellers with the remainder reflecting wider improvements to bus services.<sup>77</sup>



### Transferability

The evidence has shown that congestion charging is an effective means of reducing congestion in certain urban centres. However, it is a policy that is not universally acceptable and its success as a driver of modal shift appears to be highly dependent

<sup>74</sup> *ibid.*

<sup>75</sup> Mayor of London, [Mayor's Transport Strategy](#), March 2018

<sup>76</sup> Mayor of London, [Mayor's Transport Strategy](#), March 2018

<sup>77</sup> Transport for London, [LCC Impacts Monitoring – Fifth Annual Report](#), June 2007.

on the existence of a highly functional public transport system that offers an alternative to car use.

Congestion in many towns and cities, including Belfast, is largely restricted to a small number of peak hours each day and a limited number of roads. Even though some of these roads experience severe congestion, the question would remain as to whether it is bad enough to introduce such an extreme and potentially contentious measure.

A House of Commons Transport Select Committee has previously questioned the cost-effectiveness of local congestion charging schemes, in cities other than London. It suggested the local authority has to be confident that it will capture sufficient revenue to cover both the costs of the scheme's infrastructure, administration and enforcement, and to pay for the improved public transport services that would ensure the urban areas remained easily accessible. The committee noted that part of the risk associated with local charging schemes is whether an individual city would be able to withstand the economic impact of trade diverting to other neighbouring cities that did not have a congestion charge, and with out-of-town shopping centres and business parks, which already provide strong competition.

#### 4.1.2 Car parking charges

Copenhagen plans to reach zero carbon emissions by 2025, primarily through decarbonising and expanding the public transport fleet and providing more bike lanes. In 2017, 85% of municipal vehicles were electric, hydrogen, or hybrid-powered. By 2020, the city plans to have 500 electric charging points and four hydrogen filling stations.<sup>78</sup> Copenhagen is regarded as one of the most cycle friendly cities in the world.<sup>79</sup>

In addition to the pull of its comprehensive public transport and cycling provision Copenhagen has employed restrictive parking measures as a central component of its broader modal shift policy. The literature suggests that the availability and cost of car parking can significantly influence modal choice.<sup>80</sup>

Copenhagen's parking strategy focuses on reducing incoming commuter traffic, increasing both the size of the charging area and the rates applied. This measure reduced inner-city car traffic by 6% from 2007-09. A further measure to limit access to parking for commuters, introduced in 2009, was to assign much of the inner city car parking capacity to residents and local businesses via a permit scheme.<sup>81</sup> While there is still some parking available to visitors/commuters the cost has proven to be a deterrent. The City of Copenhagen reported that its policy led to:

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<sup>78</sup> Deloitte, [City Mobility Index](#), March 2019

<sup>79</sup> *ibid*

<sup>80</sup> Hakim Hammadou and Claire Papaix, [Policy packages for modal shift and CO2 reduction in Lille, France](#), Vol. 72, December 2018, Pages 242-247

<sup>81</sup> City of Copenhagen, [Impacts of Copenhagen's Parking Strategy](#), June 2014

- a 40% reduction in private vehicles parking during the morning rush hours;
- a fall in the proportion commuting by car from 22% to 16%;
- the proportion commuting by train rising from 24% to 33%; and
- the proportion using bus and bicycle or walking remaining largely static.<sup>82</sup>

Numerous empirical studies have shown that the cost of parking significantly affects individuals' travel choices. In a study of UK employers that had implemented workplace travel plans, Cairns et al. (2010) found that organisations which had constrained workplace parking or increased its cost reduced the modal share of driving to work by an average of 25 percent. This was more than double the reduction achieved by organisations that attempted to reduce driving without changing their parking practices.<sup>83</sup>

The availability of convenient, guaranteed or free parking is a major factor influencing people's decision to drive to work. In Northern Ireland 91% of rural commuters and 75% of urban commuters drive, while 80% of this total do so alone in a single occupancy vehicle. This places a huge strain on road capacity during peak travelling times and is a major cause of congestion and emissions.

### ***Case study 2: Workplace parking levy***

Under the Transport Act 2000 local traffic authorities in England and Wales, outside London, were given powers to introduce a Workplace Parking Levy (WPL).<sup>84</sup> This policy is intended to provide local authorities with a means to manage transport demand whilst also providing hypothecated funding for transport investment.<sup>85</sup> To date, Nottingham is the only local authority area to have sought and obtained approval for a scheme, which began 1 April 2012.<sup>86</sup> Some of the key characteristics of the scheme are listed below:

- The levy is an annual charge of £387 per parking place for employers with 11 or more spaces for 2017-18.
- Every workplace parking space is licensed, and employers with 10 or fewer spaces receive a 100 per cent exemption, creating a complete database of parking spaces in the city.
- Annual increases in the charge are linked to increases in inflation.
- Disabled parking spaces and 'blue light' services are exempt.
- The levy raises £9 million a year which is used to fund improvement to public transport in the city and costs around £500,000 a year to run.

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<sup>82</sup> *ibid*,

<sup>83</sup> Cairns, et al., [Understanding successful workplace travel initiatives in the UK](#). Transport Research Policy Practice, vol. 44 (7), pages 473–494.

<sup>84</sup> Louise Butcher, [Roads: Workplace Parking Levy](#), March 2012

<sup>85</sup> Simon Dale, et al., [Evaluating the impact of a workplace parking levy on local traffic congestion: The case of Nottingham UK](#), Transport Policy, vol. 59, July 2017, pages 153-164

<sup>86</sup> Louise Butcher, [Roads: Workplace Parking Levy](#), March 2012

- All funds are ring-fenced for transport improvements, including the tram and bus network and the redevelopment of Nottingham Rail Station.
- The city has used the money to bid for other sources of match funding in investment into the city: for every £1 raised, £3-4 of other funding is levered in. The Department for Transport (DfT) matched £221 million of local funding that included the WPL with £432 million for the extension of the city's tram network
- It achieves 99 per cent compliance from employers and about half of firms pass the costs of the levy down to their employees.<sup>87</sup>
- According to 'Centre for Cities' (CfC), public transport usage in Nottingham is among the highest of any city in the UK.<sup>88</sup>

A similar scheme in Perth (Australia) had a significant impact on modal share.

Richardson 2010 presents figures which show that in the 10 years' period following the implementation of a WPL, public transport's share of commuter trips rose from 35% to over 50% (1999-2009), while overall public transport use grew by 67%. While this certainly demonstrates a positive modal shift, it should be noted it took place during a rapid expansion of Perth's population and economy.

## 4.2 'Pull' Interventions

In 2004, the Department for Transport published 'Smarter Choices: Changing the Way We Travel', which reviewed the evidence available at that time on the effect and scale of implementation of smarter choice measures. These were widely described as 'soft' transport policy measures, as opposed to 'hard' measures such as physical improvements to transport infrastructure or operations. They included:

- workplace travel plans;
- school travel plans;
- personalised travel planning;
- public transport information and marketing;
- travel awareness campaigns;
- car clubs;
- car sharing schemes;
- teleworking;
- teleconferencing, and
- home shopping.<sup>89</sup>

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<sup>87</sup> Naomi Clayton, et al., [Nottingham Workplace Parking Levy](#), December 2017

<sup>88</sup> [Core Cities](#), accessed 20 April 2019

<sup>89</sup> Sally Cairns, et al., *Smarter Choices – Changing the Way We Travel*, July 2004.



### 4.2.1 Sustainable Travel Towns

The DfT then launched the Sustainable Travel Towns (STT) demonstration project to provide a real-world test of whether town-wide 'smarter choice' programmes might have such an impact on travel behaviour and traffic.<sup>90</sup> The STT ran between 2004 and 2009. The 5-year project aimed to demonstrate the effect a sustained package of 'Smarter Choice' measures would have when coupled with infrastructure improvements. The project was funded by £10 million of DfT funding together with £5 million of local funding. The towns of Darlington, Peterborough and Worcester were chosen after a competition.<sup>91</sup>

The towns employed a range of measures, including personal travel planning, public transport information and marketing, travel awareness campaigns, cycling and walking promotions and car clubs. The results across all three towns showed,

- a 9% reduction in car trips;
- a 10 to 22% increase in bus trips;
- a 26 to 30% increase in cycle trips; and
- a 10 to 13% increase in walking trips.<sup>92</sup>

### 4.2.2 Local Sustainable Transport Fund

All three authorities continued some, or all, of the activities that were begun as part of the STT programme, successfully attracting funding from the Local Sustainable Transport Fund (LSTF), launched on the back of the STT demonstrations. The LSTF saw expenditure in excess of £1bn between 2011 and 2015. The DfT distributed £540 million in grants to 12 'Large Projects' (46% of the total) and 84 'Small Projects' (receiving up to £5 million each).<sup>93</sup>

The Local Sustainable Transport Fund was an objective-based fund that sought to achieve two primary core objectives of:

- Supporting the local economy and facilitate economic development, for example by reducing congestion, improving the reliability and predictability of journey times, or enhancing access to employment and other essential services; and
- Reducing the carbon emissions, for example by bringing about an increase in the volume and proportion of journeys made by low carbon sustainable modes, including walking and cycling.<sup>94</sup>

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<sup>90</sup> S Cairns and M Jones, Sustainable travel towns: An evaluation of the longer term impacts, Transport Research Laboratory, July 2016

<sup>91</sup> Department for Transport, [Sustainable Travel Demonstration Towns](#), accessed 2 April 2019.

<sup>92</sup> House of Lords Science and Technology Select Committee, [Behaviour Change 2 Report of Session 2010-12](#), July 2011

<sup>93</sup> Lynn Sloman, et al. [Impact of the Local Sustainable Transport Fund: Synthesis of Evidence](#), Report to the Department for Transport, August 2018.

<sup>94</sup> Hiblin B, Taylor I and Sloman L, [What Works? Learning from the Local Sustainable Transport Fund 2011-2015](#), Report to the Department for Transport, July 2016

Alongside these, were a number of secondary objectives: wider social and economic benefits, safety, air quality, environmental, increased physical activity and health benefits.<sup>95</sup>

Essentially the main focus of most activities related to the programme involved supporting modal shift from car to more sustainable modes. Like the STT projects, the LSFT supported an integrated policy approach to achieving modal shift that included public realm enhancement and behaviour change activities such as personalised travel planning and workplace travel planning with the aim of making travel by bicycle, public transport and walking easier, more appealing, quicker, cheaper, or more reliable. It was recognised that for many car use is unavoidable, therefore the LSTF promoted measures to encourage more efficient vehicle use, including car clubs, which increase vehicle utilisation; car sharing, which increases vehicle occupancy; and eco-driver training and vehicle assessments, which reduce fuel consumption.<sup>96</sup>

An overview of the main interventions identified in the impact report are listed below:

- Nearly 90% of LSTF Projects included activities to increase cycling. They built 740km of cycle routes and 33,600 cycle parking spaces. They gave 62,000 adults the skills to repair a bike or serviced their bike for them. They gave 27,900 adults cycle training, and 55,900 took part in led cycle rides.
- More than half of LSTF Projects funded new bus services, or upgraded existing bus services to run more often, operate longer hours, or serve more places. 90% of Projects included actions to improve bus travel, and 3,800 bus stops received major improvements such as real-time information displays, new shelters or higher kerbs for step-free bus access.
- Over 90% of LSTF Projects helped people travel to work by sustainable transport. Commuters to 6,600 workplaces are estimated to have been assisted by LSTF-funded schemes.
- Over half of LSTF Projects encouraged train travel or sustainable travel to stations. Better access routes and station facilities for pedestrians, cyclists and bus users were installed at 230 stations. Thirty stations received more train services, and two completely new stations were built.
- A quarter of LSTF Projects helped unemployed people to access work. About 116,000 job-seekers received some form of support as a result of LSTF-funded schemes.
- Personalised travel planners contacted more than 390,000 households, of which 206,000 requested sustainable transport information, taster bus tickets, free cycle training or other offers.

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<sup>95</sup> ibid

<sup>96</sup> Hiblin B, Taylor I and Sloman L, [What Works? Learning from the Local Sustainable Transport Fund 2011-2015](#), Report to the Department for Transport, July 2016 (Page 10)



## Outcomes

The range of pull measures taken in both the STT demonstrations and the LSTF projects contributed to reduced car use in most areas. Many LSTF projects aimed to increase bus travel. However, it was set in a period of declining bus patronage nationally (local authority spending on public transport fell by 9% between 2010-11 and 2015-16<sup>97</sup>) and this trend was also reflected in LSTF areas, albeit at a slower rate than in non-LSTF areas.

There was evidence that levels of walking and cycling had increased with specific interventions including cycle routes, secure cycle parking, cycle training, cycle maintenance schemes and cycle hire, along with promotional events such as cycling challenges, festivals and led rides supporting this. The evaluation found that promotional activities were unlikely to be successful without good cycling infrastructure, and that a combination of approaches was most effective.

Many LSTF projects aimed to change the way people travel, focussing especially on people who drive to work. The evaluation suggested that the approach taken, which focussed on encouragement and information, rather than reducing or restricting parking, was ineffective. This evaluation concluded that, in future it is important that such initiatives reduce or ration car parking, as well as encouraging people to change how they travel to work, it noted:

*For workplaces in Large Project areas who encouraged people to avoid driving to work, the proportion of people who drove to work fell by 2.7 percentage points. This change was smaller than change found for previous initiatives. This may be because LSTF initiatives focussed on changing behaviour through encouragement and information, rather than forcing a change by reducing or restricting parking.*

### Case Study 3: Nottingham

The Nottingham LSTF programme aimed "...to establish Nottingham as a national exemplar for integrated sustainable transport". To achieve this, the Nottingham LSTF programme had four core elements of mutually supporting measures:

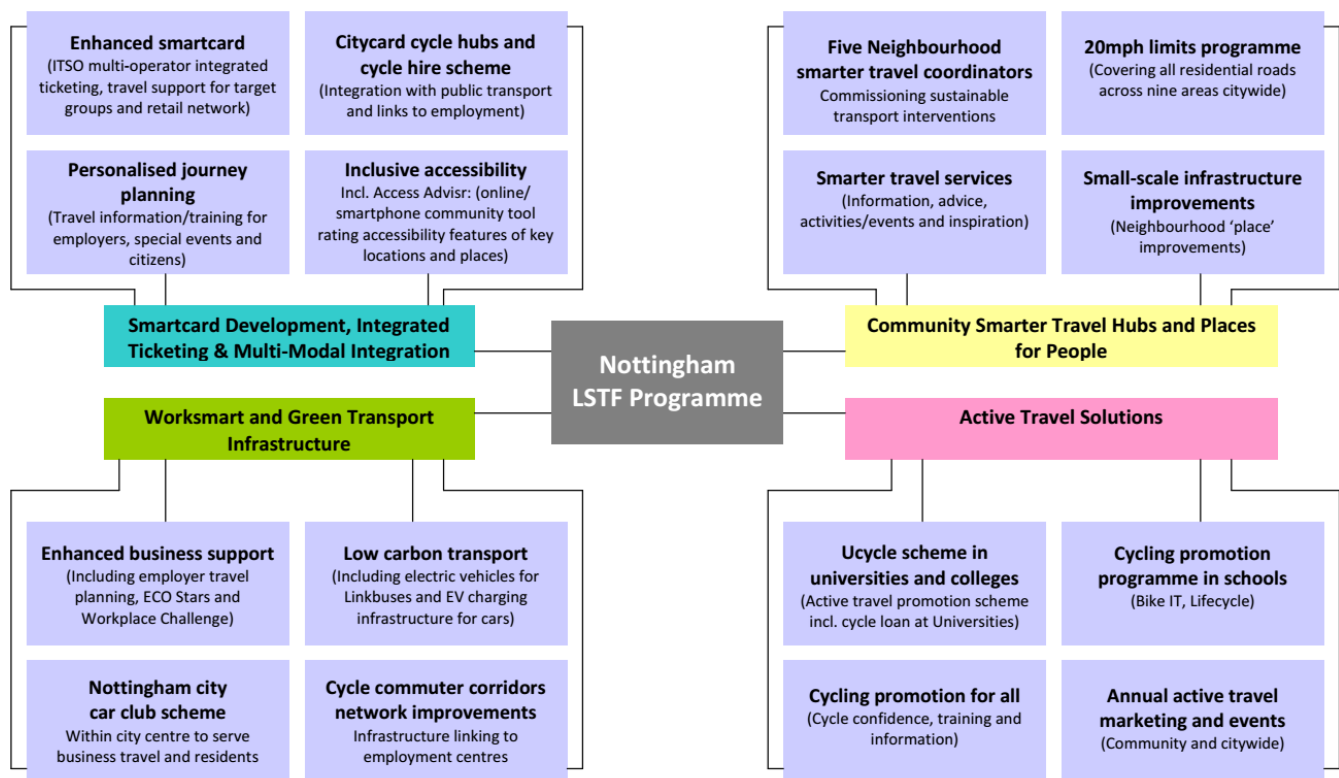
- Smartcard development, integrated ticketing and multi-modal integration: Supporting access to employment and training by improving integration and unlocking travel opportunities using low carbon transport (all supported by the development of smartcards).
- Community smarter travel hubs and places for people: Delivering integrated smarter travel services at a neighbourhood level to support local people to adopt low carbon and active travel choices and address travel barriers.

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<sup>97</sup> National Audit Office, [Financial sustainability of local authorities 2018](#), March 2018.

- Worksmart business support activities and green transport infrastructure: Supporting the needs of the business community with smarter travel services and developing the low carbon transport network.
- Active travel solutions: A comprehensive programme of active travel marketing, promotion and events to make walking and cycling the norm for local journeys.

Figure 8: illustrates the make-up of the Nottingham LSTF programme work strands and elements



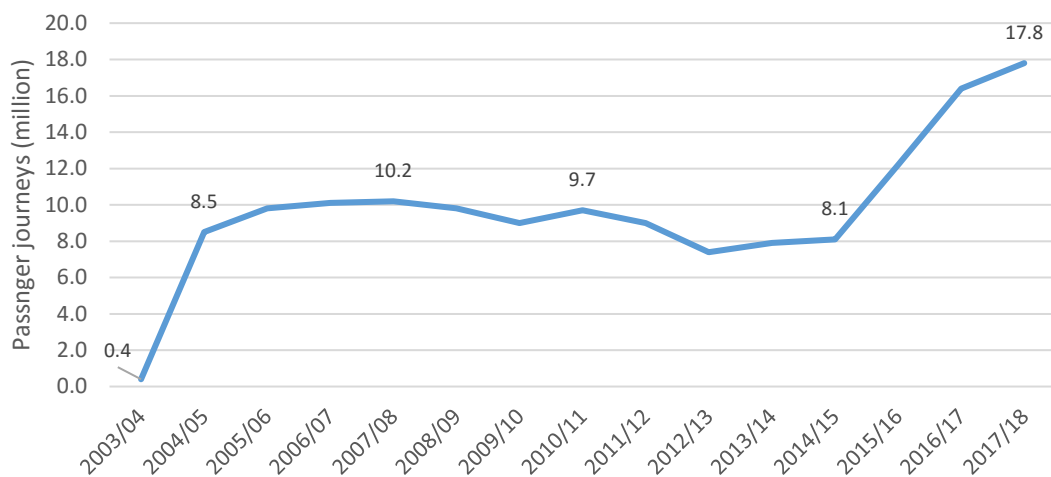
Source: [Nottingham City Council](#)

The Department for Transport (DfT) awarded the Nottingham Urban Area £15.4 million through LSTF programme 2011-2015 with a further £1.2 million secured for 2015/16 as continuation funding. This coincided with a period of substantial capital investment – over £750m – aimed at delivering a strong integrated transport system for the region.<sup>98</sup> Major capital schemes included the expansion of the Nottingham tram network and redevelopment of the bus and rail stations which were part funded by the Workplace Parking Levy discussed in section two.

Nottingham has seen significant long term growth in public transport journeys since the introduction of The Nottingham Express Transit system (NET) in 2004. In 2008 the NET had over 10m passenger journeys annually, the opening of a second line in 2015, has seen this increase to 17.8m in 2017/18.

<sup>98</sup> Nottingham City Council, [Outcome Monitoring Plan: Nottingham Urban Area Local Sustainable Transport Fund \(LSTF\) Programme](#), September 2013

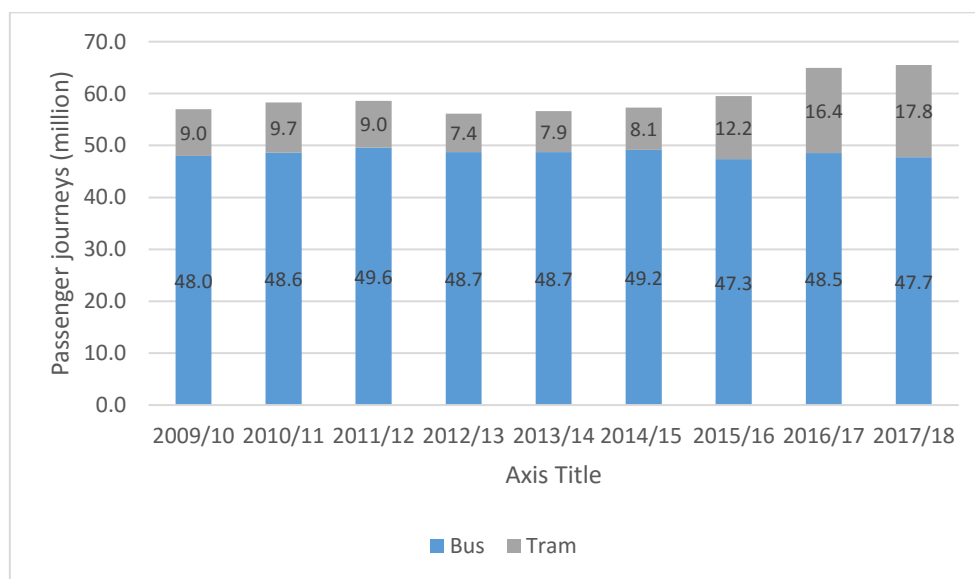
Figure 9: Passenger numbers of Nottingham Express Transit



Source: DfT, table: [LRT0101](#)

The data shows NET users are not simply displaced bus users, figure 9 shows that bus patronage remained fairly consistent since 09/10 while tram users have almost doubled. Therefore, these are almost all entirely new public transport users suggesting there has been a clear modal shift. Nottingham goes against the national trend of declining public transport use across local authority areas.

Figure 10: Public transport use in Nottingham (Bus and Tram) 2009/10 to 2017/18



Source: DfT, table: [LRT0101](#) and [BUS0109](#)

The revenue support provided by the LSTF enabled the region to realise the full potential of these large-scale capital investments supporting a number of complementary measures and education/promotional campaigns events. In Nottingham the LSTF funding supported the development of:

- A multi-modal integrated ticketing Smartcard covering bus, tram, local rail, bike hire and a local car club;

- A number of community-based behaviour change programmes ran local events, activities, services and a travel support package for job-seekers;
- A range of business support activities to promote 'smarter choices' among commuters, alongside the development of a low carbon transport network;
- A comprehensive programme of active travel marketing, promotion, events and services to make walking and cycling the norm for local journeys;
- LSTF projects were almost entirely reliant on 'pull' measures. Nottingham was a notable exception with its workplace parking levy.

Nottingham achieved the biggest reduction in per capita car traffic of any English local authority outside London during the LSTF period (-8.2% between 2009-11 and 2015).<sup>99</sup> Nottingham City Council reports that of the 305,680 people who live within the Council's administrative area, 43.7% of households do not have access to a private vehicle, which clearly contributes to high levels of public transport journeys and walking/cycling. The council suggests that introduction of the country's first Workplace Parking Levy scheme in April 2012, has affected the commuting patterns of 40,000 car commuters travelling across the urban area and beyond into the city of Nottingham.<sup>100</sup>

According to an independent evaluation of the Nottingham LSTF programme, it performed positively against all the agreed outcome targets (increasing sustainable mode share, stabilising traffic levels and reducing carbon emissions from transport, increasing access to employment and increasing cycling levels in key intervention areas) and was particularly strong in supporting people into employment. Key programme outputs and outcomes for 2011/12 – 2014/15 include:

- A total of over 250,000 people were engaged in some way through the Nottingham LSTF programme;
- 919 additional people supported into work equating to 618 FTE positions;
- 325,245 bus trips generated and a net increase of 66,234 additional public transport trips;
- 87,424 people changed cycle behaviour generating 1.4m additional cycling trips, 2,824 more people cycling regularly, 9.2mins average increase cycling/day and an average increase of 144km cycled/annum/person;
- 63,288 people changed walking behaviour with 1.6m additional walk trips and 2.3m additional km walked resulting in 2.18m fewer car trips, 28.4m fewer car km travelled and 23,529 fewer Tonnes CO<sub>2</sub>e emitted
- The overall programme is estimated to have delivered a Benefit:Cost Ratio of between 3.8 to 4.8 which represents a high to very high value investment.

<sup>99</sup> Department for Transport, [Impact of the Local Sustainable Transport Fund](#), June 2017

<sup>100</sup> Nottingham City Council, [Nottingham Urban Area Local Sustainable Transport Fund Outcomes Update Report 2014/15](#), March 2016

### **Critical Success Factors**

According to the DfT's overall evaluation of the LSTF there are a number of critical success factors:

- Target projects carefully. Choose geographical areas where there is the most potential for change, and where the project has strong community and political support;
- There is a trade-off between ambition and deliverability. If funding is only available for a short time period, or political support is lukewarm, focus on something that you know you can deliver. But if you have a longer funding period, and solid political recognition of the value of sustainable transport, then aim high;
- Thorough desk-based research is essential in the preparatory phase, to understand travel patterns and barriers to behavioural change.

### **Improve user experience**

A key element of Nottingham's success was the multi-modal smart card. This is an obvious example of improving the user experience enabling them to access a range of mobility services using one card. 'Smart ticketing' systems enable mobility providers to provide better and more personalised customer information. They are convenient, doing away with the need for cash and/or paper tickets, allowing customers to buy tickets in advance and online. They also allow the ticket to be tracked from creation through use, meaning the operators get a better understanding of their user enabling them to improve services and provide better information.

According to the DfT, provision of 'better information about different transport options' can increase passengers' confidence to make journeys by more sustainable transport modes. It suggests that for many, transport choices are based on habit and many people are not aware of all of the options available to them.

*"By giving people the information they need to plan and make their door-to-door journey by public transport, cycling or walking, transport providers can help them to consider these alternative ways of making their journey."*

There are obvious limitations to existing transport information sources, where typically operator websites provide information only about their own services. There is, however, increasing awareness of the potential for smart technology to significantly enhance consumers' interaction with mobility services including public transport.<sup>101</sup> This has seen the emergence of MaaS (mobility as a service), a concept whereby users can use (primarily) smart phone applications to plan, book and pay a range of mobility services,

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<sup>101</sup> König, D., et al. [Deliverable 5: Technology for MaaS](#), February 2017

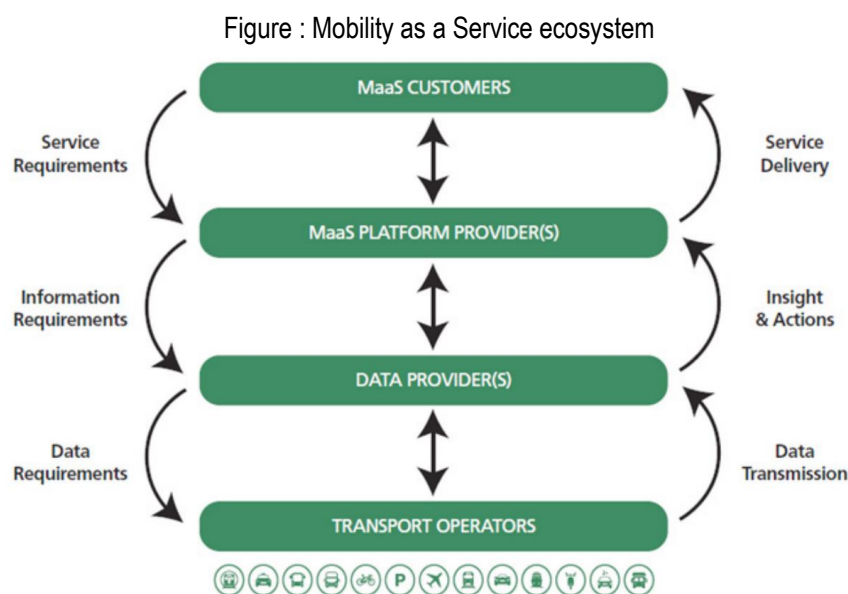
according to their individualised needs and preferences.<sup>102</sup> MaaS is essentially a consumer focused, technology based, method of integrating public, private and voluntary transport services.<sup>103</sup>

*“MaaS solutions aim to improve the user experience and convenience in transport by offering a single account or application to provide different mobility services ranging from public transport (for example rail and metro services) to rental, as well as ridesharing services (for example Uber, Lyft etc.) and self-driving cars. The idea is that transit data is made public and is leveraged using data analytics to create new, responsive services.”<sup>104</sup>*

#### 4.2.3 Mobility as a Service (MaaS)

MaaS solutions depend on a network of interconnected actors known as an “ecosystem”. The MaaS ecosystem is made up of:

- customers;
- MaaS platform provider(s): who design and offer the MaaS platform (typically a smartphone app) and create packages based on customer demands;
- data provider(s): who share and use data, which is crucial to MaaS; and
- a range of transport operators.



Source: Transport Systems Catapult, Mobility as a Service: Exploring the Opportunity for Mobility as a Service in the UK, July 2016, cited in HOC Transport Committee Report, [Mobility as a Service](#), December 2018

<sup>102</sup> Hensher, D., (2017) '[Future bus transport contracts under a mobility as a service \(MaaS\) regime in the digital age: Are they likely to change?](#)', *Transportation Research Part A: Policy and Practice*, Vol. 98, Pages 86-96

<sup>103</sup> Eckhardt, J., et al. [Deliverable 2: European MaaS Roadmap 2025. MAASiFiE project funded by CEDR](#), May 2017.

<sup>104</sup> Juniper Research, [Why mobility as a service \(MaaS\) is the future of city transport](#), September 2018

Development of MaaS is at a very early stage, and as a result evidence of the costs and benefits are limited. Evidence given to the House of Commons Transport Select Committee suggests that the potential benefits of MaaS include:

- reduced road congestion with associated benefits;
- improvements to users' physical health by encouraging increased use of active modes of travel such as walking and cycling;
- improvements to passenger travel experience by offering simplified ticketing and payment processes, and more bespoke and personalised journeys;
- improved customer choice by facilitating awareness of, and access to, various transport modes and thereby empowering people to make better and more informed choices; and
- better management of travel demand and transport infrastructure: by utilising aggregated customer and travel data from the MaaS app, transport planners can both optimise use of existing transport networks and better plan necessary infrastructure enhancements.<sup>105</sup>

Early research from pilots demonstrates there is potential for MaaS to lead to modal shift. However, there is a lack of largescale and longitudinal evaluations on which to base any strong conclusions on the long-term impact of MaaS.

### ***Horizon 2020 - MaaS4EU***

Horizon 2020, the EU's research and innovation programme, has identified the potential for MaaS to bring about a "paradigm change in transportation" commenting that it could

*"...offer travellers easy, flexible, reliable, price-worthy and environmentally sustainable everyday travel [through, for example] public transport, car sharing, car leasing and road use as well as more efficient goods shipping and delivery possibilities".<sup>106</sup>*

Under the Horizon 2020 scheme, the European Commission is funding the [MaaS4EU project](#). This project aims to "...provide quantifiable evidence, frameworks and tools to enable the MaaS concept, by addressing challenges under four pillars: business; end users; technology & data and policies."<sup>107</sup> Their definition of MaaS is a

*"...user-centric, intelligent mobility distribution model, in which users' needs are met via a single platform and are offered by a service provider, the mobility operator".*

The project has a series of [work programmes](#) looking at practical issues around creating a new technology that fundamentally changes the way people view and

<sup>105</sup> House of Commons Transport Committee, [Mobility as a Service, Eighth Report of Session 2017-19](#), December 2018

<sup>106</sup> European Commission, [Smart, green and integrated transport, Horizon 2020 work programme 2016-2017](#), April 2017.

<sup>107</sup> MaaS4EU, [Project Overview](#), accessed 6 March 2019



manage their personal mobility. It also seeks to demonstrate the concept and prove it works through pilot studies.

#### **Case study 4: MaaS in Greater Manchester**

TfGM is facilitating one of the [pilots for MaaS](#), focusing on the role of door-to-door, demand responsive services, within the overall MaaS environment. The pilot will assess the potential of shared bus services, delivered by community transport groups, to fill gaps in the current multi-modal transport provision within Greater Manchester. A key outcome of the pilot will be the development of an app based booking platform that will “enable communities to run their community transport more effectively, and support the services with a sustainable finance model”.<sup>108</sup>

TfGM has also worked with [SNC-Lavalin's Atkins](#) business “to create a commercial and business case for MaaS, by testing MaaS viability in a real-world trial in Salford, Greater Manchester”. The trial investigated the potential for MaaS to get commuters to shift from cars to public transport or active travel options. This work was done in collaboration with 13 partners (including local authorities, transport operators, service providers, local residents, and local businesses). The trial involved:

- 39 participants from all areas of the city, working at three organisations in Salford (Media City, Salford Hospital and Salford Council) were chosen to take part in the live trial;
- Participants were incentivised with a free travel pass and personalised travel plans;
- Personalised journey plans were provided to participants each day, with participants split into two ‘persona’ groups.
- Seven modes of travel including buses, trams, carshare, taxi, bike share, on demand shared mini-bus and walking were all offered in the personalised journey plans and available through a single ticketing option
- Data was collected via in-depth interviews and ride-alongs with passengers, which provided insights into the key issues being faced by commuters day to day.

Based on the in-depth research which took place prior to and throughout the trial, a personal profile for each participant was created, and behavioural ‘nudges’ were sent to encourage changes in travel behaviour. A quarter of nudges were accepted by participants, with responses providing early indicators of what does and does not motivate individuals to change their travel behaviours.

- Immediately following the trial, 26% of participants were more willing to use public transport, and 21% were more willing to cycle and walk.
- There was a 27% increase in positive perception of public transport; a high level of enjoyment was reported by participants from their integrated ticket and real-time information.

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<sup>108</sup> MaaS4EU, [Transport For Greater Manchester \(TFGM\): Partner profile](#), accessed 6 March 2019.



- Re-engagement with the trial participants, six months after trial found 82% wanted MaaS back;
- One third of car owners wanted to give up their vehicle following the research, and the majority of participants were willing to pay an increase in their monthly travel spend for MaaS;
- 20% of participants had incorporated active travel into their daily commute six months on, one participant moved jobs to be able to walk to and from work, and another stating that the MaaS trial “gave me the push I needed to start cycling again... I love it and I’ve lost weight”.

This trial in Manchester indicates that MaaS can encourage modal shift, by improving perceptions and patronage of public transport services as well as additional mobility services such as bike and car share. Accordingly, TfGM are continuing to develop the business case for MaaS in terms of commercial relationships, the MaaS operating framework, the strategic case for MaaS and the financial model.<sup>109</sup>

### ***Elsewhere in UK***

Transport for the West Midlands (TfWM) – the transport executive of West Midlands Combined Authority (WMCA)) – have employed the Whim app, developed and operated by Finnish start-up MaaS Global, to launch their own MaaS pilot.

Whim was introduced in Helsinki, Finland in 2016 and has over 45,000 users there (around 7% of its population). It calculates optimal routes across different modes of transport (including taxis, car rentals, rail, metro, tram and local ferries) and allows customers to book combined end-to-end journey tickets for their preferred option. MaaS Global sells tickets to customers on behalf of transport operators via monthly subscription packages or on a pay-as-you-go basis.

The West Midlands pilot began in August 2017 and includes a variety of operators including National Express West Midlands (bus and tram services); Enterprise (car hire); and Gett (taxi service). Bike sharing (via Nextbike) and National Rail services (via On Track Retail) are expected to be introduced into the app soon. The West Midlands app is now in its beta release and has been downloaded around 500 times.

### ***Previous research***

Sweden and Finland, where Whim was created (see above), are considered to be the main pioneers of MaaS.<sup>110</sup> As a result much of the evidence which exists on the development of MaaS originates from these countries. In Sweden the concept evolved when research began into the business potential for offering multimodal transport services to metropolitan citizens via an app. Trials then took place, the first of which was UbiGo.

<sup>109</sup> Heathcote-Marcz, F, [MaaS in Manchester: the journey continues](#), Local Transport Today, October 2018

<sup>110</sup> Smith, G., et al., [Mobility as a Service: Comparative Developments in Sweden and Finland, Conference proceedings](#), CoMaaS 2017

### Case study 5: UbiGo in Gothenburg

UbiGo was as a public 6-month trial of a MaaS model in the city of Gothenburg, Sweden. The primary aim of the trial was to encourage individuals to change their travel behaviour, from driving cars to more sustainable modes, including public transport. The trial involved a web-based smartphone application that enabled planning, booking and payment across numerous modes including public transport, car sharing, rental car service, taxi and bike-sharing services. The application provided 24/7 technical support, an "improved" travel guarantee and "bonuses" for sustainable travel choices.

The results of the UbiGo trial were largely positive; there were decreases in car use among participants along with increases in alternative modes such as car sharing, bus/tram, and bike (see table ).<sup>111</sup> According to the evaluation,

- participants appreciated the packaged concept, i.e. all needs met on one app;
- it made participants feel like they had more travel options;
- it made them consider their trip more, empowering them to adapt modal choice to a particular trip, rather than just doing same thing i.e. car ownership and travel cards, for example, were seen to 'lock' people in to that mode;
- participants enjoyed the pay-per-use aspect along with the ability to roll over and top up credit which made costs more transparent.<sup>112</sup>

Table 2: Travel Behaviour of participants before and during UbiGo Pilot

Mode	Before participating in UbiGo	During participation in UbiGo
Walk/Run	25%	-5%
Bicycle	10%	+35%
Private Car	25%	-50%
Carsharing	2%	+200%
Tram	15%	+5%
Bus (Local)	15%	+35%
Bus (Express)	3%	+100%
Train	2%	+20%

Source: [World Congress on Intelligent Transport Systems 2016](#)

According to Sochorm (2016) adoption of an innovation, such as MaaS, requires relative benefit or added value for users.<sup>113</sup> This can be relative to the individual user, but at a minimum outcomes must be, at least, no worse than their existing choice i.e. not more expensive, less flexible or convenient, accessible or easy to understand and use.<sup>114</sup>

<sup>111</sup> Karlsson, M. A., (2016) 'Developing the 'Service' in Mobility as a Service: experiences from a field trial of an innovate travel brokerage', *Transportation Research Procedia*, vol. 14, pages 3265-3273.

<sup>112</sup> *ibid.*

<sup>113</sup> Jana Sochorm, [Benefits of MaaS: Evidence from the UbiGo MaaS pilot in Gothenburg, Sweden](#), Conference proceedings: 23<sup>rd</sup> World Congress on Intelligent Transport Systems, October 2016

<sup>114</sup> *ibid.*

Research shows satisfying these basic requirements is essential in achieving acceptance of any new innovation or service. For example, Batty (2015) suggests that consideration of externalities, such as the environment, will only come into play once requirements such as comfort, accessibility, speed, seamlessness of journey, safety, security, affordability and reliability have all been satisfied.<sup>115</sup>

### **Limitations**

The UbiGo platform was only a prototype and the extent of the trial was limited; it took place over a short 6-month period and involved only 83 households and 195 individuals who were presumably open to the idea of adapting their travel behaviour, on the basis they volunteered and paid to participate.<sup>116</sup>

UbiGo did not continue immediately after the trial, with a number of barriers identified:

- lack of financial resources to further develop the platform and provide back office support;
- regulatory issues relating to public support for private enterprises;
- uncertainty around the interaction of various private and public sector stakeholders; and
- an understanding that it was only ever a trial.<sup>117</sup>

### **Lessons**

Karlsson emphasises that MaaS is reliant on “...cooperation and collaboration, on the notion of a co-operative and interconnected transport system (including service, infrastructure and payment), where boundaries between not only transport modes are blurred but between public and private operators.”

Collaboration, even within Northern Ireland's public sector, has often proved problematic. Looking at barriers to integrating publically funded transport services in the region, the previous Committee for Regional Development criticised transport stakeholders for an “...unwillingness to communicate and adopt common goals, reverting to their own individual “silos””.<sup>118</sup> The former Minister for Regional Development pointed to the development of an integrated transport pilot scheme in Dungannon as evidence of a changing attitude among stakeholders.<sup>119</sup>

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<sup>115</sup> Paul Batty, et al., Challenges and opportunities in developing urban modal shift, *Travel Behaviour and Society* vol. 2, 2015, pp. 109–123

<sup>116</sup> *ibid.*

<sup>117</sup> Karlsson, M. A., (2016) ‘[Developing the ‘Service’ in Mobility as a Service: experiences from a field trial of an innovate travel brokerage](#)’, *Transportation Research Procedia*, vol. 14, pages 3265-3273

<sup>118</sup> Regional Development Committee, [Inquiry into the better use of public and community sector funds for the delivery of bus transport in Northern Ireland](#), Report NIA 65/11-15, May 2013.

<sup>119</sup> Official Report, [Committee for Regional Development: Better Use of Public and Community Sector Funds for the Delivery of Transport Options](#), 2 July 2013

The outcomes of this particular scheme may highlight some of the challenges that may be encountered in developing a MaaS approach in Northern Ireland. In addition, as highlighted by the Department for Transport (DfT), difficulties may arise when working with the private sector, unless there is a willingness to join platforms and develop joint commercial agreements, implement open data regulations and share ticketing platforms.<sup>120</sup>

The UbiGo trial did demonstrate that the concept could work where this collaboration exists. This evidence has generated support from local Public Transport Authorities (PTA) in Sweden who view MaaS as a viable means of supporting the national target of ‘doubling’ the market share of public transport in Sweden.<sup>121</sup> A new UbiGo pilot was relaunched in Stockholm in April 2018. The service includes public transport, ride sharing, P2P car sharing, taxi, rental bikes, and shared bikes. The goal is to increase sustainable traveling reducing the need for owning a private car. It is based on a

#### **Swedish transport Governance**

Passenger transport services are organised in a three tier structure:

- PTAs are a sub body of the regional government responsible for the policy direction of local and regional transport. PTAs own and maintains much of the public transportation infrastructure, including stations and depots.
- PTAs oversee an [arm's length body](#) responsible for organising delivery including the planning and franchising of urban and regional public transport.
- Various operators are contracted to deliver services

Source: [Urban Transport Group](#)

monthly subscription with an account that is shared among all members of a household.<sup>122</sup> Initially this scheme launched with 200 to 300 households in five specific areas in Stockholm, a similar MaaS project, on a much smaller scale, is being tested in a housing project in Gothenburg in which 70 families took part for six months. It is anticipated it will be rolled out across the city following this pilot.<sup>123</sup>

#### **Case study 6: Stuttgart**

Stuttgart’s ‘Sustainable Mobility in Stuttgart’ action plan aims to reduce car traffic, promote sustainable modes of transport and address the city’s air pollution problem.<sup>124</sup> Since 2012, digital technology company, moovel (which will soon become Reach Now as part of the mobility joint venture between Daimler AG and BMW Group) and Stuttgarter Straßenbahnen (SSB), the leading public transport operator in Stuttgart, have been working on various app based platforms intended to simplify access to

<sup>120</sup> House of Commons Transport Committee, [Mobility as a Service, Eighth Report of Session 2017-19](#), December 2018.

<sup>121</sup> Grönlund, A., [The Swedish Doubling project](#), Conference Proceedings: Thredbo 15, Stockholm 2017

<sup>122</sup> EMTA, [Stockholm and Mobility-as-a-service pilots during 2018](#), accessed 20 March 2019.

<sup>123</sup> Siegfried Morkowitz, [MaaS Set to Get Rolling in Stockholm](#), Automotive, February 2019

<sup>124</sup> Sarah Wray, [Mobility-as-a-Service: Cities on the move](#), March 2019

mobility. According to the SSB chief Executive, the city of Stuttgart is embracing MaaS in order to

*“complement our existing bus and train service with flexible, customer-oriented solutions. This way we can fill the gaps, both in time and location. The goal is to have ever more citizens choosing public transportation.”*

There have been various milestones in the development of MaaS in Stuttgart:

- In 2015, the [‘moovel’ app](#) made it possible for both citizens and visitors to book and pay for public transport tickets, as well as journeys with car2go, mytaxi and Deutsche Bahn (German Rail) via one app.
  - The app features trip planning, real time arrivals, multimodal integrations, and ipayment options including Apple and Google Pay.
  - It works across all contactless technologies including NFC (Near-field Communication), Bluetooth and QR codes and barcodes enabling fast and simple mobile fare validation.
- At the beginning of 2018, the [SSB BestPreis app](#) was introduced, based on moovel-technology. BestPreis (Best Price) uses Artificial Intelligence to calculate the best price for users based on their travel history.
  - Within a flexible month, the so-called "viewing period", trips are booked via the "BestPreis" app. At the end of the viewing period (month), BestPreis calculates the individual combination of tickets, users then receive a statement showing the optimised price with savings. Payment options include PayPal or credit card and are collected at after the end of the period.
- In June 2018, [SSB Flex](#) was launched as the next stage, following a pilot test with more than 20,000 passengers. This on-demand public transportation network service operates in Degerloch and Cannstatt during the day, as well as in the city centre of Stuttgart, Degerloch and Bad Cannstatt on weekend evenings. Passengers make their journey requests via an app, on-demand,<sup>125</sup> and then ride-share part of their journey with other passengers.<sup>126</sup> This product complements existing public transport services, providing a last mile solution where gaps exist and potentially increasing public transport use rather than replacing it.

### **The future of MaaS: Ireland**

The National Transport Authority (NTA) is an Irish government agency responsible for securing the provision of public passenger land transport services, including bus and rail services by Bus Éireann, Dublin Bus, Go Ahead, Luas (light rail) and Irish Rail (heavy rail). The NTAs mission is,

<sup>125</sup> SSB, [SSB Flex – A New Mobility Offer for Stuttgart](#), Conference Proceedings, June 2018, accessed 20 March 2019.

<sup>126</sup> moovel, [The new mobility service SSB Flex to launch in Stuttgart on June 1, 2018](#), accessed 20 March 2019

*“To provide high quality, accessible, sustainable public transport connecting people across Ireland”*

The NTA has recognised the evolution of transport demand and is beginning to work towards the introduction of MaaS. According to official Barry Dorgan, it is the role of the NTA, as the public transport authority in Ireland, to facilitate (and create where necessary) an environment where:

- Multiple mobility service providers can co-exist, both publicly and privately run;
- Different service providers can be integrated;
- Innovative business models can be catered for; and
- Revenue assurance can be provided via appropriate governance and regulatory oversight arrangements<sup>127</sup>

According to a presentation delivered at the United Nations Economic Commission for Europe Working Party on Rail Transport in November 2018, the NTA will use a nationwide account based ticketing system as the catalyst for a ‘Total Mobility Solution’ providing for integration and convergence of mobile ticketing, with enhanced national journey planning applications and real time information systems. Users will be able to access their accounts via a single app based platform giving them access to a range of public and private transport/mobility providers to plan and book their trip from door-to-door. According to Mr Dorgan this total mobility solution will:

*“...open up the opportunities for a consumer to get a tram or bus to the city centre, take a city bike to the train station, take train to a regional city and then complete their final leg using a Go Car, including paying for parking at the final destination all using a single travel entitlement, with real-time updates as they travel and automated route recalculation if necessary, providing best value to the customer across both public and private transport providers.”*

The NTA has already linked its Leap Card with Dublin Bikes (bike hire) and Go Car (car sharing) and is planning to converge the national journey planner, real-time passenger information and ticketing apps.

### **Role of Government**

As noted in the previous section NTA official Barry Dorgan sees the role of the NTA, as the public transport authority in Ireland, to facilitate an environment where MaaS can develop. The House of Commons Transport Select Committee has held an inquiry into the future of MaaS in the UK expanding on what is required to ‘facilitate this environment’: <sup>128</sup>

<sup>127</sup> NTA, Innovation in Railways NTA Ireland, Conference Proceedings: United Nations Economic Commission for Europe Working Party on Rail Transport (SC.2) 72nd Session November 21, 2018

<sup>128</sup> House of Commons Transport Select Committee, [Mobility as a Service: Eighth Report of Session 2017-19](#), December 2018.

- Leadership: The Government needs to set out its vision for MaaS, how it wants to see the sector develop, make clear its position on the desirability of a national scheme versus local schemes and how it expects MaaS to contribute to its policy objectives like those on air quality, and how it would expect MaaS to contribute to modal shift and encourage cycling and walking by encouraging schemes to give preference to certain journey types;
- Practical support: The Government needs to provide financial and other support for piloting and development of schemes, including help developing a framework for governing the sector, the development of standards for interoperability and cross-platform working, sharing experience, helping local authorities and others develop workable schemes; and
- Suitable legislative and regulatory unpinning: The Government needs to review the current legislative framework from transport services and identify what areas need to be updated to take account of developments like MaaS. It also needs to identify what areas are not covered by existing legislation and bring forward the necessary legislative proposals.

#### 4.2.4 Tax incentives

The impacts of congestion and road traffic emissions on the economy and environment have been noted. However, whilst the tax system makes allowances for private motorists' efforts to reduce emissions, apart from perhaps the 'cycle to work scheme', there is no provision to support those who use alternative modes. To address this perceived disparity, there are those who advocate a tax free allowance for commuting expenses such as public transport, park and ride costs. It is believed this could be an effective 'pull' intervention.<sup>129</sup>

#### ***Case study 7: Qualified Transportation Plan (USA)***

Internal Revenue Service code section 132(f) allows employers to provide employees with a tax-free allowance for the payment of expenses (For 2018, the monthly limit on the amount that may be excluded from an employee's income for qualified parking benefits was \$260. Commuters can receive both the transit and parking benefits (i.e., up to \$520 per month) related to commuting such as public transport fares, eligible parking, vanpooling or bicycle commuting.<sup>130</sup> It is effectively a salary sacrifice scheme similar to TaxSmart.

Section 132 Commuter Benefits, also known as a Qualified Transportation Plan, is a fringe benefit program to help Participants reduce the cost of commuting to and from work. Under Section 132(f) of the Internal Revenue Code (IRC) employees are permitted to pay for commuter vehicle expenses, transit passes, and qualified parking

<sup>129</sup> Tourism and Transport Forum, [Tax incentives for Sustainable Transport](#), October 2011.

<sup>130</sup> Department of the Treasury Internal Revenue Service, [Employer's Tax Guide to Fringe Benefits](#), December 2016



expenses on a tax-favoured (pre-tax) basis. Pre-tax commuter benefits are available in two separate “spending accounts”:

- Commuter Spending Account – Transportation cost associated with a commuter highway vehicle for travel between an employee’s residence and place of employment, and any transit pass can be pre-taxed.
- Parking Spending Account – Qualified Parking Expense can be pre-taxed.

The benefits to employers include a reduction in payroll tax liability, the ability to encourage employees to choose efficient modes of commuting thus minimising lost productivity due to congestion, and an attractive employment condition to offer workers in a competitive labour market. Nationally:

- Approximately 21 per cent of companies offer tax-free commuter benefits;
- The percentage of all commuter journeys covered by the scheme varies between 10 and 20 per cent, and is higher in cities with heavier public transport use.
- In 2009, the city of San Francisco made it mandatory for companies with more than 20 employees to offer tax-free commuter benefits. Several large metropolitan areas followed — New York City, Seattle, and Washington DC and Los Angeles while New Jersey became the first state is the first state to impose transit benefit requirements on local employers.
- The US Environmental Protection Agency (EPA) estimates that a full commuter benefits program can achieve a 30 per cent reduction in peak motor vehicle use and associated emissions for any given workplace.
- Overall use of public transport by employees increased 10 to 50 per cent at workplaces that implemented a commuter benefits program, with 10 to 25 per cent of participants being new users.<sup>131</sup>

### **Canada**

In Canada a similar Public Transit Tax Credit (PTTC) scheme was introduced in 2006, remaining in place until 2017, when it was discontinued. Similarly, to the QTP in the USA, the PTTC enabled Canadians to claim part of their public transit expenses against federal income taxes. Analysis of the PTTC scheme found that the large majority of recipients are those that would have taken transit regardless of the availability of the tax credit. A research report concluded that “...as a strategy for reducing car traffic, changing public behaviour to promote increased mode-share for public transit, and reducing emissions of greenhouse gases, the policy is expensive and considerably less cost-effective than potential alternatives”.<sup>132</sup> The report went on to highlight potential inequalities with this type of approach, commenting that “non-refundable fiscal measures not only prevents lower-income commuters from accessing the policy’s social benefits and enhancing its environmental ones, but also enables

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<sup>132</sup> Nicholas Rivers and Bora Plumptre, [The effectiveness of public transit tax credits on commuting behaviour and the environment: Evidence from Canada](#), Case Studies on Transport Policy, Volume 6 (4) December 2018, pp. 651-662



most credit claimants to receive support for commuting behaviour they would have engaged in anyway.”<sup>133</sup>

#### 4.2.5 Workplace travel schemes

There are examples of workplace travel schemes in the UK where employers purchase annual season tickets for travel on public transport and the cost of the travel pass is then deducted in 12 monthly instalments from salary through payroll deduction, spreading the cost and making it more affordable.<sup>134</sup> This may be simply a means of helping those who have no alternative but to travel by public transport, but in addition to making travel more affordable, it gives employees access to the potential savings on offer from buying season tickets which they might not have been able to access otherwise. This is not insignificant, analysis by the BBC England Data Unit of more than 80 season tickets found that commuters can pay up to one fifth of their salary on season tickets,

*“A season ticket from Southampton Central to London will cost £5,885, which is over a fifth of the average full-time take-home wage for London, £28,685”*

If this type of scheme included a tax incentive, equivalent to that previously offered through the Northern Ireland TaxSmart scheme (commuters could save up to 32% of annual tickets) those commuters travelling from Southampton Central to London could save up to £2000 per year. Potential savings for an NI commuter using the 238 bus service, for example, would be over £500:

- A 40 journey ticket on the 238 Belfast to Newry bus service costs £260.50;
- This accounts for four weeks of commuter journeys (to and from work 5 days per week);
- Based on 228 working days per year (365 days - (weekends + holidays)), commuters would have to buy six tickets at a cost of £1,563;
- The old TaxSmart scheme offered up to 32% off this fare;
- Commuters from Newry to Belfast could potentially save over £500.

While the success of this particular cost-related travel demand management intervention is unknown, cost of travel is recognised as an influential factor on modal choice.<sup>135</sup> Research conducted by the Transport Research Laboratory concluded that, “Reduced fare levels might produce significant shifts. For example, a 50 per cent across-the-board reduction in public transport fares might be enough for eleven per cent of long distance travellers and three per cent of regular travellers to change

<sup>133</sup> *ibid.*

<sup>134</sup> Newcastle Upon Tyne Hospitals, Trust Travel Scheme

<sup>135</sup> R J Balcombe, I O York and D C Webster, [Factors influencing trip mode choice](#), TRL Report TRL568, June 2003.

modes.”<sup>136</sup> This same piece of research modelled the impact of various transport improvements on modal shift:

- Reliability: It estimated that if travellers were fully confident of adherence to service schedules then some 12% of long-distance travellers and 6% of regular travellers might switch modes from car travel to public transport.
- Reduction in public transport journey times. A 20% reduction in overall journey times is estimated to produce a 6% diversion from car travel to public transport.
- Improved access to and egress from railway stations and bus stops. If these linking journeys could be made substantially quicker public transport might become more attractive.
- Elimination of interchanges to provide direct services. If long-distance journeys by public transport could be accomplished with no more than one interchange, and regular journeys made with no interchanges, then some 2% of travellers might be diverted from car use.
- Better, more accessible passenger transport information would make journey planning and public transport use easier for some travellers, and could possibly attract 2% of them from their cars.
- Increasing public transport service frequencies came out as the least effective of the measures tested. It is estimated that increasing frequencies to four services per hour might produce modal shifts of the order of 1%.

### 4.3 ‘Nudge’ interventions

The challenge of reducing car use, particularly single occupancy journeys, will be only be overcome if we are successful in changing behaviours. In the previous two sections this paper has looked at the more traditional methods of doing this, ‘pushing’ and ‘pulling’ individuals, with varying degrees of success, towards a desired behaviour. Increasingly policy makers are taking notice of insights from across the behavioural sciences and particularly behavioural economics that attempt to explain peoples’ behaviour by examining the role of psychological, social, and emotional factors in the decision making process. This is being used to develop non-intrusive interventions, referred to as ‘nudges’, to modify behaviour.

#### 4.3.1 Behavioural Insights in Policy

Applying behavioural insights to policy making requires setting aside many of the assumptions about what influences behavioural change and focussing on actually understanding behaviour. The UK Government was the first to formally and systematically apply behavioural insights to policy development when it set up the Behavioural Insights Team (BIT) in 2010. BIT was created within government, for

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<sup>136</sup> *ibid* (page 33).

government, to deliver practical solutions to complex policy challenges using psychological, cognitive and social science-based behavioural insights.<sup>137</sup>

*behavioural insights help government better understand the impact of cognitive biases, which is our tendency to make flawed judgements by relying on previous experiences and preferences. Ultimately, BIT helps encourage a more realistic view of human behaviour to be adopted within decision-making<sup>138</sup>*

The Cabinet Office has identified public savings of at least £300m since the launch of the BIT 2010. In addition, BIT generates revenues of £14m a year consulting businesses and public bodies around the world. Some of the policy areas where it has been most successful are:

- Education: A 34% increase in acceptances of pupils from underrepresented schools to top universities, following a letter to the pupils from a top-tier student with a similar background;
- Education: A 27% increase in maths or English pass rates of further education students experiencing 'study supporter' intervention;<sup>139</sup>
- NHS waiting times: A 38% reduction in patient referrals to overbooked hospitals, resulting from installing a pop-up prompt in the GP referral system; and
- Public finances: A 37% rise in tax declaration rates following text-message reminders to 750,000 businesses in Mexico. This built on early work in the UK, where reminders about self-assessment brought forward £200m in tax revenue in a year.<sup>140</sup>
- Prescriptions: Sending letters to British GPs who were prescribing more than their peers, produced cut in unnecessary prescriptions by 3.3%.

### ***The theory***

Until recently explanations of individual behaviour have been dominated by views held by economists that people are rational, and make decisions accordingly.<sup>141</sup> This thinking assumes people are informed about the options available to them, consider their own beliefs, values and preferences then calculate the best option on this basis.

In terms of transport policy development, it has always been assumed that most peoples' modal choice can be explained primarily in terms of differences in journey times and costs and therefore interventions which enhance these have been employed.<sup>142</sup> Behavioural economics, on the other hand, argues that individuals do not

<sup>137</sup> Government Office for Science, [Behavioural Insights: Do experts know what they don't know?](#), accessed 17 April 2019.

<sup>138</sup> *ibid*

<sup>139</sup> BIT, [The Behavioural Insights Team Update Report 2016-17](#), 2018

<sup>140</sup> Ben Quinn, [The 'nudge unit': the experts that became a prime UK export](#), The Guardian, Saturday 10 November 2018

<sup>141</sup> John Maule, [Understanding Decision Making in Legal Services: Lessons from Behavioural Economics](#), June 2013

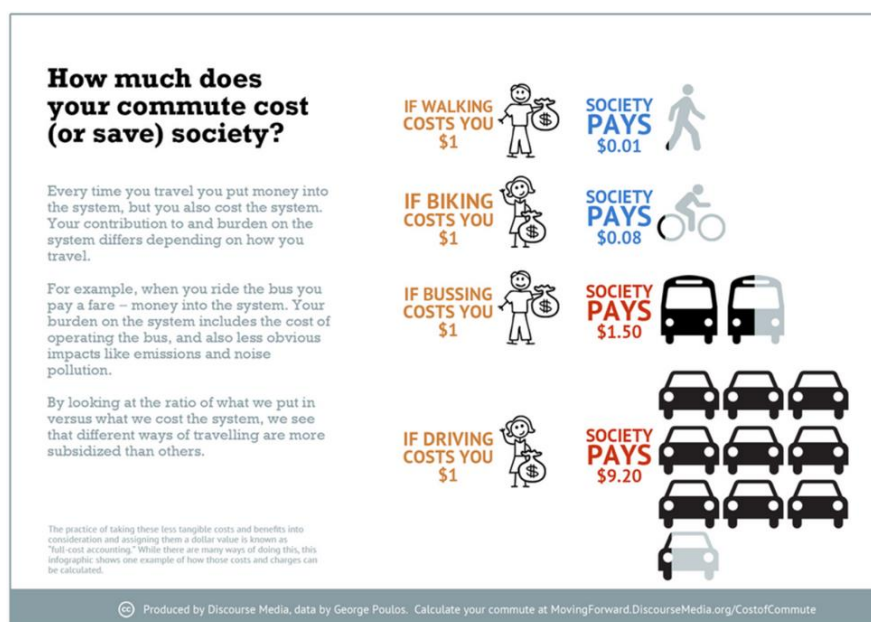
<sup>142</sup> R J Balcombe, I O York and D C Webster, Factors influencing trip mode choice, TRL Report TRL568, June 2003

make rational decisions, instead they rely on mental shortcuts (heuristics) and are deeply influenced by perceptual and cognitive biases.<sup>143</sup>

## Bias

Perceptions and Bias affect everyone – impacting decisions from what products we buy, what we watch on television and indeed what mode of travel we use to get about. Research shows people perceive public transport as being slower, less reliable and simply more hassle than driving<sup>144</sup> while cars are associated with status, comfort, control and freedom.

While cost is an important factor in travel choice, our bias's undervalue many of the related costs of driving (see figure ), both personal (purchase cost, road tax, insurance) and societal (congestion, emissions, air quality) because they are not paid entirely simultaneously with car use.<sup>145</sup> From a transport policy perspective the negative perception of public transport and positive associations with car use are barriers to modal shift.



Source: [CITYLAB](#)

## Habits

One behaviour that is particularly pronounced with mobility is the tendency to keep doing what we have always done – known as the status quo bias. Research shows that once people have chosen a transport mode and a route to reach a certain destination,

<sup>143</sup> Alessandro Innocenti, et al., [Car stickiness: Heuristics and biases in travel choice](#), Transport Policy Volume 25, January 2013, Pages 158-168

<sup>144</sup> R J Balcombe, I O York and D C Webster, [Factors influencing trip mode choice](#), TRL Report TRL568, June 2003.

<sup>145</sup> The Behavioural Insights Team, [Applying Behavioural Insights to Transportation Demand Management](#), December 2010.

there is a strong tendency to stick to this mode<sup>146</sup> and route.<sup>147</sup> The daily commute, school runs, popping to the shops are all habitual activities and once the mode and route are formed as habits, they become second nature and breaking them can be near impossible.

### **Nudges**

The idea of the 'nudge' is inextricably linked to behavioural insights. The word "nudge" was originally used in the context of influencing behaviour by Richard Thaler and Cass Sunstein. They define a "nudge" as:

*"... any aspect of the choice architecture that alters people's behaviour in a predictable way without forbidding any options or significantly changing their economic incentives. To count as a mere nudge, the intervention must be easy and cheap to avoid. Nudges are not mandates. Putting the fruit at eye level counts as a nudge. Banning junk food does not."<sup>148</sup>*

Thaler & Sunstein suggest that through choice architecture, and the incorporation of nudges into the choice environment, policy makers can devise interventions that help individuals make better decisions, overcome cognitive biases, and change behavioural change – without restricting choices or imposing penalties.

According to Avineri and Goodwin, one of the limitations of the 'nudge' strategy is that being designed to

*"influence individuals' behaviour through intuitive and impulsive processes of the automatic system they do not address the fundamental problem of behavioural change. Nudges work best on unintentional/automatic behaviours within a controlled context, however they do not lead directly to a real change to the individual's knowledge, attitudes or values, and they are not designed to change the decision making process in the reflective system".*

They conclude that nudges are unlikely to achieve long-term and sustainable behavioural change, while behavioural change achieved by designed nudges might be offset by unintended effects.

Looking at transport specifically Avineri and Goodwin comment that while the "...nudge approach to transport has not been tested or systematically analysed, its effectiveness remains an open question".<sup>149</sup> However, they do note that some of the instruments used as a matter of course in road design, to influence driving behaviour, including

<sup>146</sup> Gardner, B., 2009. [Modelling motivation and habit in stable travel mode contexts](#). Transportation Research Part F, 12(1), pp. 68-76

<sup>147</sup> Srinivasan, K.K., Mahmassani, H.S., 2000. [Modelling inertia and compliance mechanisms in route choice behaviour under real-time information](#). Transportation Research Record, 1725, pp. 45-53.

<sup>148</sup> Avineri, E. and Goodwin, P. (2010). [Individual behaviour change: Evidence in transport and public health](#). The Department for Transport, London, UK

<sup>149</sup> *ibid.*

gateways, sightlines, coloured or textured road surfaces, could be considered nudges and have been in use for many years.<sup>150</sup>

Nudges offer gentle, non-coercive, and cost effective ways to guide people toward desired choices. However, rather than being an alternative to more challenging policy interventions nudges are more likely to sit alongside and complement traditional push and pull interventions as part of an integrated policy package.

*“...it unlikely that there is a large latent body of easy, cheap, hardly noticed initiatives that will have big effects without the need to consider more substantial interventions. The real promise seems rather to help to design the bigger initiatives better, that is to add ‘nudges’ to improve or speed up the effects rather than as a replacement for other interventions.”<sup>151</sup>*

#### **4.3.2 Designing transport specific nudges**

A report by Alta Planning and Design and the Behavioural Insights Team (BIT), looking at applying behavioural insights in transportation demand management, outlined a simple 3 step behavioural approach methodology to increasing and improving public transport use

- Map out behavioural touch points to identify the points in the process where there are psychological or behavioural barriers keeping people from using public transit.
- Design an intervention to ensure the solution is targeted at a specific behaviour and group of people.
- Test whether the intervention worked to evaluate whether solutions are impactful and cost effective before scaling up.

They acknowledge that ‘nudges’ may not be the panacea for correcting the transport system but that

*“...if a low-cost behavioural intervention can move some people to use the bus that would otherwise have taken the car, or shift some daily riders to off-peak times, the approach should free up resources to be spent on those bottlenecks that require significant investment—such as improving frequency or adding more stops to a route.”*

This documents separates public transport users into three groups and recommends different approaches for each group:

- For low-frequency users, proposals focused on ways to nudge people toward trying public transportation by overcoming bias toward change and aversion to trying something new

<sup>150</sup> *ibid.*

<sup>151</sup> Erel Avineri and Phil Goodwin, [Individual Behaviour Change: Evidence in Transport and Public Health](#), November 2009

- For mid-frequency users, nudges should be targeted at making public transport a habit, in accordance with research that transportation is a behaviour largely guided by habit; and
- For high-frequency users, ways in which they can serve as “public transportation ambassadors” in their communities should be identified.

The report acknowledges that little is known about how psychology affects public transportation decisions, and recommends piloting and testing of interventions in order to quantify what works and what works best.

### **Examples**

Non habitual travel often evokes a change of behaviour: For example, travelling to a business meeting in an unknown location requires the traveller to consciously consider options for how to travel, such as mode, distance, time, availability and costs of parking or public transport. Once such issues have been considered, the traveller consciously *chooses* how to behave. Behavioural Scientists who study habits, and commuting habits in particular, suggest forced changes of habit, like going somewhere new, or particularly as a result of important life events; such as the birth of a child as well as residential or working locations, behaviour can be altered.<sup>152</sup>

*“At these moments, the normal cues that automate commute habits get disrupted, transit options and price incentives come back into play, and people can establish new behavioural patterns.”<sup>153</sup>*

Research looking at the impact of moving workplace has found how people tend to respond directly to the new environment. For example, studies on the impacts of relocation from city centre to suburban locations show an increase in car usage triggered by good parking facilities and poor access to public transport,<sup>154</sup> while lower increases in car use for commuting are found on sites that have sufficient access to public transit or if a considerable part of employees already live closer to the new location.<sup>155</sup>

Do biases now inform the decision on how to travel i.e. the office is in a suburban area so it must be inaccessible by public transport or is this a simple fact. Research suggest that Information and assistance around issues relating to personal mobility (e.g., provision of bicycle parking facilities or a scheme to help and/or incentivise the purchase season ticket for public transport), targeted at the right people at the right time may be an effective ‘nudge’ to limit driving.

<sup>152</sup> Sascha von Behren, [Office relocation and changes in travel behaviour: Capturing the effects including the adaptation phase](#), Transportation Research Procedia 32 (2018) 573–584

<sup>153</sup> Eric Jaffe, [A Universal Lesson in Breaking the Habit of Car Commuting](#), CITY LAB, September 26, 2014

<sup>154</sup> Vale, D.S. [Does commuting time tolerance impede sustainable urban mobility? Analysing the impacts on commuting behaviour as a result of workplace relocation to a mixed-use centre in Lisbon](#), Journal of Transport Geography, vol. 32 (2013), pages 38–48.

<sup>155</sup> *ibid.*



There may however be instances where a ‘nudge’ isn’t enough. Throughout the literature, including analysis of the Nottingham workplace parking levy, there is a particularly strong correlation between the availability and cost of car parking and modal choice.<sup>156</sup> It would appear this is an obvious area for policy intervention, through either regulation (e.g. work place parking levy) supported by education (work place travel schemes) to explain any types of levy.

The potential of reliable and immediate travel data via a costless multi-modal travel information platform is considered a key ‘nudge’ intervention in supporting changes changing travel habits.<sup>157</sup> This paper has discussed the potential for MaaS and this may prove to be a solution to overcoming many of the negative perceptions of public transport.

Financial incentives are considered another possible ‘nudge’ intervention. An experiment targeting 43 drivers was carried out, in which a one-month free bus ticket was given to 23 drivers in an experimental group but not to 20 drivers in a control group. Attitudes toward, habits of, and frequency of using both and bus were measured immediately before, immediately after, and one month after the one-month long intervention.

The results showed that attitudes toward bus were more positive and that the frequency of bus use increased, whereas the habits of car use decreased from before the intervention, even one month after the intervention period. Furthermore, the increase in habitual bus use had the largest effect on the increase in the frequency of bus use. The results suggest that offering car drivers a temporary free bus ticket, may be an effective intervention for achieving modal shift.<sup>158</sup>

This type of initiative could potentially be delivered through employers, targeting new starts, graduates and apprentices potentially influencing their behaviour over a long career – creating a new habit. Translink could offer “try before you buy” vouchers or passes, promotional codes to cover a few rides, or free fare days. This strategy would allow people to try public transport for free, introducing them to a new experience and hopefully dislodging any misconceptions they may have.

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<sup>156</sup> Sascha von Behren, [Office relocation and changes in travel behaviour: Capturing the effects including the adaptation phase](#), Transportation Research Procedia 32 (2018) 573–584

<sup>157</sup> Caspar Chorus and Benedict Dellaert, [Travel Choice Inertia: The Joint Role of Risk Aversion and Learning](#)

<sup>158</sup> Satoshi Fujii and Ryuichi Kitamura, [what does a one-month free bus ticket do to habitual drivers? An experimental analysis of habit and attitude change](#), Transportation, February 2003, Volume 30, Issue 1, pp 81–95



