The Economic Benefits of Sustainable Urban Mobility Measures

Independent Review of Evidence: Method
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Evidence collection and review

This document provides a description of the methods used by the EVIDENCE project to find and analyse source material for the study on The Economic Benefits of Sustainable Urban Mobility Measures. It includes the processes of selection and assessment, as well as the rational for analysis. Templates used in the selection and review process are also included.

1.1 Introduction

The literature available on the impacts (economic and otherwise) of delivering transport solutions more sustainably is quite diverse and relatively extensive. The main body of empirical experience is led by local policy agencies, especially local government and transport providers, who have different (and sometimes very low) publication priorities, in formats including committee papers, conference presentations, popular pamphlets and PR material. It also features in a very wide range of academic articles and books, spread over many different disciplines. The evidence is international and some very important aspects of it are recorded, naturally enough, in the various countries' own languages.

An estimate is that there must be several thousand, perhaps over 10,000, relevant sources in the public domain. Although the relevant knowledge includes important strands taught in University courses, at undergraduate and graduate level, there are rather different traditions of work in architecture, planning, civil engineering economics, and marketing, and no single textbook which captures all of this richness.

Nevertheless, a familiarity with some of the sources is perhaps the main way in which the training of transport professionals differs now from the narrower approaches which were common 20 years ago.

There is not any easy short cut to full understanding of this material, and there is nobody (including the researchers working on this EVIDENCE project) who can claim to have read it all. Thus it is important to note that EVIDENCE has selected a range of material that was available, and that this material may reflect a much wider body of sources in respect of some interventions, and fewer in others. It is also the case that whilst considerable efforts were made to try and uncover material from practitioners and policy agencies as described above, the response here was disappointing. It was a similar case in respect of material in languages other than English. The team was successful in reviewing documents in a range of European languages, but for some countries where material might expect to be seen (for example France), then again results have been limited. The goal of this project was to understand the economic benefits of sustainable transport interventions in an

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1 Sustainable mobility describes a set of choices for resolving the travel needs of individuals and organisations in a less energy intensive and less polluting way than at present. This might include different modes of transport, alternative fuels, alterations to infrastructure and the built environment, or even changes in our behaviours.
1.2 Categorising Interventions

Sustainable urban mobility interventions (or SUMI as they will be termed through this report) are the transport and travel related actions implemented by a city to help it become more sustainable. For example, a new bus service, improved cycle parking, smart ticketing on a route or changes to a road layout are all examples of such interventions.

For EVIDENCE to review and report on all of these individual interventions would have created such an extensive resource that cities might be deterred from using it, as well as been very time consuming and potentially repetitive (in terms of outputs). To make best use of resources, EVIDENCE has instead grouped the wide range of interventions into twenty-two categories, or ‘Measures’, and it is at this level that EVIDENCE presents its detailed review.

These ‘Measures’, reflect urban policy challenges and responses emerging from earlier work in Europe on urban mobility programmes, such as CIVITAS. More specifically, EVIDENCE has taken as a starting point the top-level themes in the annex to the document: “Together towards competitive and resource-efficient urban mobility”\(^2\) which sets out a concept for the development of city-wide sustainable mobility programmes. The themes proposed as typically needing addressing in an urban context are illustrated in Table 1 below.

### Table 1 Proposed SUMP intervention themes and objectives

<table>
<thead>
<tr>
<th>Theme</th>
<th>Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>A Public transport</td>
<td>Enhance quality, security, integration and accessibility of public transport services, covering infrastructure, rolling stock, and services.</td>
</tr>
<tr>
<td>B Non-motorised transport</td>
<td>Raise attractiveness, safety and security of walking and cycling. Improve or add to infrastructure as appropriate, and consider dedicated facilities to separate walkers and cyclists from heavy traffic.</td>
</tr>
<tr>
<td>C Inter-modality</td>
<td>Better integrate different modes, facilitating seamless and multi-modal mobility and transport.</td>
</tr>
<tr>
<td>D Urban road safety</td>
<td>Improve road safety in the urban area.</td>
</tr>
<tr>
<td>E Road transport (flowing and stationary)</td>
<td>Optimise the use of existing road infrastructure and improve the situation in identified ‘hot-spots’ and overall. Explore reallocating road space to other modes of transport or other public functions and use which are not related to transport where appropriate.</td>
</tr>
<tr>
<td>F Urban logistics</td>
<td>Improve the efficiency of urban logistics, including urban freight delivery, while reducing externalities such as emissions of GHG, pollutants and noise.</td>
</tr>
<tr>
<td>G Mobility management</td>
<td>Take action to foster a change towards more sustainable mobility patterns. Citizens, employers, schools, and other relevant actors</td>
</tr>
</tbody>
</table>

Intelligent Transport Systems

Support strategy formulation, policy implementation and monitoring of each of the measures designed under the framework of a SUMP.


These themes are re-ordered and then refined in the SUMP guidelines provided for cities looking to deploy a SUMP, and this forms the basis for the measure categories used in EVIDENCE. As noted, each measure reflects a type, or bundle of closely-related types, of intervention that a city might deploy to deliver sustainable urban mobility.

These measures, and some sample interventions are listed in Table 2 below. The categorisation proved effective in practice as a means of coherently managing the review and analysis tasks, although, as will be discussed further below, the range of high quality evidence available for each ranged widely.

### Table 2 Themes and measures explored by EVIDENCE

<table>
<thead>
<tr>
<th>Theme</th>
<th>No</th>
<th>Measures</th>
<th>Example interventions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clean vehicles and fuels</td>
<td>1</td>
<td>Electric Battery and Fuel Cell Vehicles</td>
<td>E-vehicles and h2 vehicles (except ICE) and infrastructure e.g. charging point provision. Includes e-bikes, cars &amp; buses</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Cleaner Vehicles</td>
<td>Alternative fuels for ICEs and associated infrastructure e.g. retrofitting buses; hybrid vehicles which are not plug-in.</td>
</tr>
<tr>
<td>Urban freight</td>
<td>3</td>
<td>Urban freight</td>
<td>Freight consolidation; cycle logistics; HGV route/weight restriction enforcement.</td>
</tr>
<tr>
<td>Demand management strategies</td>
<td>4</td>
<td>Access restrictions</td>
<td>Pedestrianisation; limited traffic zones; restrictions on through traffic e.g. zonal access schemes; bus gates.</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>Roadspace reallocation</td>
<td>Public transport lanes, HOV/HOT lanes, cycle lanes, carriageway narrowing (including reallocation to walking and cycling)</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>Environmental zones</td>
<td>Zones which control driver behaviour or limit access to vehicles achieving emissions limits e.g. Low emissions zones</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>Congestion charges</td>
<td>Urban road pricing including HOT lanes.</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>Parking</td>
<td>Time-based and permit-based restrictions; fee-based management; parking enforcement</td>
</tr>
<tr>
<td>Mobility management</td>
<td>9</td>
<td>Site-based travel plans</td>
<td>Corporate, school, university, public buildings, major traffic generators (hospitals, stadia).</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>Personalised travel planning</td>
<td>Individually focussed travel planning, such as that seen in new housing developments.</td>
</tr>
<tr>
<td></td>
<td>11</td>
<td>Marketing and</td>
<td>Marketing / social marketing which is brand / image / lifestyle</td>
</tr>
</tbody>
</table>

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The Economic Benefits of Sustainable Urban Mobility Measures: Independent Review of Evidence

1.3 The review process

EVIDENCE undertook a ‘selective review’ of literature, identifying and then appraising high quality research evidence relevant to a measure theme. EVIDENCE did not set out to duplicate existing systematic reviews of particular measures, or to capture ‘all’ of the published work relevant to a measure. Instead reviewers selected what was seen to be a sufficient range of material that would provide an understanding of ‘economic’ evidence available for the SUMI analysed in the project.

1.3.1 Selection and sourcing

Source documents were considered if they had addressed the following three elements:

- **Costs:** Including, planning and implementation, project management, investment as well as recurrent expenditures such as operation, maintenance, administration and enforcement.
- **Benefits:** Such as additional jobs, travel money and travel time savings (which can flow from less congestion and more reliable journey times), revenues from fees and charges.
- **Socio-economic benefits:** Such as local air pollution, climate change emissions, noise, access, traffic safety and liveability.

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4 Initially it had been intended to consider car-sharing and car-pooling as separate measures, but in practice there was insufficient material available on the separate elements (and some overlap in content) to create two reviews, so they were merged.
Material for review was acquired through three main routes:

1. **Through an international ‘call for evidence’** issued by the project in the spring of 2014, sent directly to a wide range of organisations, individuals and networks. It was repeated on the project website and publicised through other European sustainable mobility websites and newsletters. This approach was targeted at trying to find material not in the wider public domain, or not published in English, or reports from specific interventions produced for a city but not widely publicised.

2. **From searches of a range of source databases.** These included existing online repositories of information on urban mobility, for example the Eltis\(^5\) and CIVITAS\(^6\) websites, as well as academic literature accessed via specialist academic databases as well as the search engine ‘Google scholar’\(^7\). This approach was particularly useful in identifying academic literature and a range of previous review and synthesis reports as well as evaluations of EU-funded transport interventions.

3. **Through the knowledge and personal resources of experts** involved in the EVIDENCE project. This included the authors of the reviews themselves, members of research centres involved in the project, and three experts engaged to advise and provide input to the project\(^8\).

The majority of sources to be reviewed came via methods 2 and 3. Method 1 produced a limited amount of material: fewer than thirty documents in total\(^9\). There was no bar on the language of source material, nor was there any geographic limitation, although it was understood that there should be some applicability to the European context for the evidence to confirm its place in the process.

Source material was accepted in online and offline (i.e. hardcopy book) formats. However, due to the importance and dominance of both online search tools and online repositories, 90%-95% of items were accessed initially in electronic format. There was also an emphasis on material published in the last 20 years, in part reflecting the switch from paper to electronic documentation, but also the rise of SUMI as a feature of policy. However, some earlier relevant material was accessed indirectly through the review of meta-studies\(^10\) which provided critical, evaluative summaries. The use of ‘meta studies’ occurred for measures with relatively large associated literatures, when it was necessary and efficient to make use of the existing summaries as it would not have been possible with the available resources to go back to the original sources. Hence, in such instances the review had to rely on the quality of the meta-study as opposed to being able to explore all of the underlying work.

Evidence was sourced from countries around the world. The transport issues faced in Europe are generally synonymous with more developed mobility systems and it was not surprising that the large proportion of sources were obtained from the more developed countries.

Concerning the different linguistic traditions, the research team made efforts to ensure the principal European languages at least were covered in the search. Nonetheless there did initially appear to be a strong bias towards recovering English-language material, with a particular suspicion about the amount of material sourced in French and Spanish. As a result, additional efforts were made to recheck those literatures. It was concluded that the evidence

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\(^{5}\) [http://www.eltis.org/](http://www.eltis.org/)

\(^{6}\) [http://www.civitas.eu/](http://www.civitas.eu/)

\(^{7}\) [http://scholar.google.co.uk/](http://scholar.google.co.uk/)

\(^{8}\) Professor John Whitelegg, Professor Phil Goodwin, Mr Eric Schreffler.

\(^{9}\) It is the case unfortunately that governments and their agencies very rarely respond to calls to assist research and evidence-based reviews (such as EVIDENCE).

\(^{10}\) Meta-studies seek to summarise the findings of several empirical studies on a topic area. Hence, each of the EVIDENCE Project reviews was a meta-study, and in cases it was sensible for the work to draw upon existing meta-reviews.
obtained reflected the underlying availability, rather than a highly biased search process, although some bias due to the locations (UK, Netherlands, Germany) and linguistic capabilities of the search team (English, German, Dutch, French, Italian, Portuguese) are inevitable. The number of source documents from other European countries may have been higher if institutions from those countries had been more actively involved in the search and review process.

A number of factors are likely to explain this circumstance, including the importance placed on the economic evaluation of policy outcomes in English-speaking countries, notably the UK and US. In addition, the importance of English as the international academic language means that most findings are included in the English language record, even if published in other languages as well. Lastly, the importance of the European Union itself in funding SUMI means that the findings are disseminated in English.

The lack of some source material (official or project reports) from Africa and South America might be as a consequence of ‘impact analysis’ being a more common process in developed as opposed to developing countries. It was the case that some peer-reviewed articles and review reports (mainly from European and North-American institutions) did contain African and South American case studies and analyses.

The material that is available for some interventions is also sometimes focussed in particular countries. For example this is the case with material relating to ‘Workplace Travel Plans’ which is primarily looking at implementations in the UK. This might reflect different national traditions in spatial planning. For example those countries which apply stronger development control policies (i.e. the Netherlands) may then have less need for this sort of ‘retrofit’ intervention.

The EVIDENCE project search collected around 750 documents in total. These sources constituted the ‘long list’ for the review and analysis tasks.

1.3.2 Filtering and categorisation
Initial expectations were that it would be necessary to carry out in-depth reviews of around one hundred and fifty source documents to provide sufficient summaries of high-quality evidence for the study. This would necessitate a process of filtering the ‘long list’ to identify which material to consider in greater detail.

Material was ‘categorised’ and ‘classified’ to provide reviewers with a ‘pick-list’ of documents with which they could conduct the detailed evidence assessment and review steps below. The first element of the classification process was to distinguish between material that contained real cases (i.e. contained evidence) of project appraisal (both ex-ante and ex-post studies), and that which did not. A significant portion of the material collected turned out not to offer specific evidence, and instead focussed on wider consideration of sustainable urban mobility issues or transport evaluation and appraisal issues. As a consequence around one hundred and fifty documents were put to one side.

The next level of classification was to identify the different nature of the evidence being reported, whether it was quantitative or qualitative in nature, and then an assessment as to the quality of the material. The definitions used for the categorisation of the ‘type’ of evidence are listed in Table 3 below.

<table>
<thead>
<tr>
<th>Criteria for categorisation</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Qualitative description without criteria</td>
<td>1</td>
</tr>
<tr>
<td>Qualitative criteria</td>
<td>2</td>
</tr>
<tr>
<td>Quantitative criteria, using other methodology (Multi-criteria analysis or MCA, rough estimates)</td>
<td>3</td>
</tr>
<tr>
<td>Quantitative criteria using cost benefit analysis (CBA)</td>
<td>4</td>
</tr>
</tbody>
</table>
The second categorisation referred to quality (see Table 4), although this should be seen in the context of this being a search for evidence of economic benefit as opposed to any reflection on other aspects of the material. As a consequence, quantitative impact assessments are notionally considered of higher quality than purely qualitative ones, as an important aim of EVIDENCE was to inform policy practitioners about the economic benefits, and ‘return on investment’ of SUMI, and for this target group, monetisation was considered to be an important type of evidence.

### Table 4 Evidence quality classification

<table>
<thead>
<tr>
<th>Category</th>
<th>Criteria for categorisation</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>No usable evidence is presented, although there is some assessment/evaluation (ex-ante or ex post) of (socio) economic costs and benefits of SUMI.</td>
<td>1</td>
</tr>
<tr>
<td>Medium</td>
<td>Usable evidence about SUMI: The report assesses/evaluates (ex-ante or ex post) economic costs and benefits of SUMI. The method used is not a CBA but assesses, inter alia, planning and implementation cost, project management cost, investment cost as well as recurrent expenditures such as operation, maintenance, administrative and enforcement cost. Benefits might be, inter alia, additional jobs, travel money and travel time savings, revenues from fees and charges. OR The report qualitatively describes (ex-ante or ex post) socio-economic cost and benefits of these measures.</td>
<td>2</td>
</tr>
<tr>
<td>High</td>
<td>Usable evidence about SUMI: The report assesses/evaluates (ex-ante or ex-post) economic costs and benefits of measures using CBA to assess, inter alia, planning and implementation cost, project management cost, investment cost as well as recurrent expenditures such as operation, maintenance, administrative and enforcement cost. Benefits considered varied, but might include additional jobs created, travel cost and travel time savings, additional revenues from fees and charges. OR The report assesses/evaluates (ex-ante or ex post) socio-economic costs and benefits of these measures. This might include, inter alia, monetisation, other quantitative weighting of different units as well as qualitative assessments against certain types of socioeconomic benefits.</td>
<td>3</td>
</tr>
</tbody>
</table>

Other meta-data about the source documents were also recorded, including the type of publication (academic or project report for example), language, and how it was sourced. All of this information was used to provide measure-specific lists of material for the authors in the next step of the review process.

#### 1.3.3 Item and Measure review

The authors of the reviews were drawn from the academic and research team working on EVIDENCE with many of them having specific knowledge and experience in the topics they were asked to review. They worked to complete project-defined templates for both the reviews of the items of evidence which contributed to a review, and in producing the Measure Review itself. Analysis was conducted for up to twenty-five pieces of evidence per measure, although in most instances the number was around 11.

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11 See Appendices A and B for copies of the template for each.
half as many – 10-12 being seen as the threshold likely to be sufficient to capture the information needed.

Source documents were issued with a rank order for the measure review authors, providing the starting point for their work. In some instances supplementary material was required, as documents that had passed the initial categorisation proved less valuable on closer analysis. Thus some additional material was brought into the process at this stage, including some new documents that emerged during the project lifetime.

The Measure Review template was designed to capture key information, including the types of intervention being evaluated, the economic evidence available and the results of this evaluation. Information about the context in which benefits are likely to be seen, and acknowledgment of factors that might assist cities in successfully deploying similar measure was included where relevant. In those situations in which there was limited economic evidence then an attempt was also made to indicate reasons for this. Each summary also includes details of the source material that was reviewed12.

The Measure Reviews were subject to an additional assessment by the panel of three international transport experts (identified above), to provide peer review with a horizontal perspective across the reviews, and allowing the project to test its initial findings with individuals who have in-depth knowledge of issues around the economic appraisal of SUMI. As a consequence of this ‘peer review’ process, some further material was brought into the documents to add weight or clarity to the reviews where thought to be appropriate. Highlights from the Measure Reviews are presented in the EVIDENCE Report13, and the full content in the EVIDENCE Reviews14.

12 A database of source documents for all measures is also available on the EVIDENCE website with links to documents where possible.
2 Reflections on the material collected and reviewed

This chapter reflects on the material sourced for the review process, as well as highlighting areas where there is a need for more evidence. Consideration is also given to how the findings of the Measure Reviews compare to existing knowledge and understanding of the benefits of the twenty-two measures.

2.1 Availability of evidence

In general, material seemed to be more plentiful for particular interventions, for example walking and cycling, whilst other measures generated few evaluations, and in some instances, material was less likely to be found in the full range of outputs (including academic) collected by EVIDENCE. It was also apparent during the ‘search for evidence’ that material often seemed to follow what might be seen as trends in implementation. So for example whilst interventions were particularly favoured they might be generating more evidence than at other times. Specific funding streams, the emergence of new technologies, and changing political and public priorities are all potential influences on the sorts of interventions being deployed (and the evidence they provide) at specific times. It may have been the availability of funds for demonstration projects of a particular technology or intervention that produced a surge in evaluation studies, which was then superseded by different priorities meaning few studies in the following years. This variability might also be reflected in the nations in which evidence has being created. The effect was seen across all types of literature (including academic) and presented some issues with obtaining current material for some interventions.

More specific reflections on the availability of source material in respect of the different measures reviewed by EVIDENCE is summarised in Table 5 below. This provides indications of areas of research which are active, and where potentially new ‘economic’ evidence is likely to emerge, or conversely where additional research could usefully be focussed.

Table 5 Availability of evidence by measure

<table>
<thead>
<tr>
<th>Measure No</th>
<th>Research</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Electric Battery and Fuel Cell Vehicles</td>
<td>• An area of active, on-going research&lt;br&gt;• Range of vehicle types considered from bikes to buses, and some studies in an urban context</td>
<td>Material can be quickly out of date as technology changing rapidly&lt;br&gt;Economic results subject to changes in carbon and fuel prices as well as subsidy levels</td>
</tr>
<tr>
<td>2. Cleaner Vehicles</td>
<td>• An area of active, on-going research</td>
<td>Rarely focussed on place-specific (city) interventions&lt;br&gt;Limited post-implementation study available</td>
</tr>
<tr>
<td>3. Urban freight</td>
<td>• Most attention is focussed on Urban Freight Consolidation Centres</td>
<td>Published evaluations are limited Evidence may relate to demonstration projects</td>
</tr>
<tr>
<td>4. Access restrictions</td>
<td>• Some material looking at impacts on retail activity</td>
<td>Evidence is limited for topics such as pedestrianisation</td>
</tr>
<tr>
<td>5. Road space reallocation</td>
<td>• Current highway monitoring reports, but academic studies are 10-15 years old now</td>
<td>A bias towards UK material for this topic Studies more likely to consider the impact of priority lanes as opposed to the effects of re-allocating lanes</td>
</tr>
<tr>
<td>6. Environmental zones</td>
<td>• Studies mainly from last five years</td>
<td>UK focus for material on low speed zones and limits German focus for material on Low Emission Zones (LEZ)</td>
</tr>
<tr>
<td>7. Congestion charges</td>
<td>• Equal split between project reports and academic material on congestion zones as well as some material on road pricing</td>
<td>Focussed on London and Stockholm congestion schemes</td>
</tr>
<tr>
<td>8. Parking</td>
<td>• Material considering a range of parking measures found, all published in last 10-15 years</td>
<td>Park and Ride material fairly limited, and focussed on UK / US experience</td>
</tr>
<tr>
<td>9. Site-based travel plans</td>
<td>• Good number of workplace and school travel plan studies found</td>
<td>Most of the high-quality material reports experiences in UK, where local and national government has commissioned evaluation reports</td>
</tr>
<tr>
<td>10. Personalised travel planning</td>
<td>• Most material is post-2000</td>
<td>Plenty of UK-related experience, as well as Australia / US / Canada Limited material from continental Europe</td>
</tr>
<tr>
<td>11. Marketing and rewarding</td>
<td>• Limited material seen against this topic • Small number of studies that discuss eco-driving, reward schemes and individualised travel marketing</td>
<td>Some German material looking at ‘campaigns’</td>
</tr>
<tr>
<td>12. Public transport enhancements</td>
<td>• There is strong underpinning evidence around elasticity of demand in response to changes in service capacity (routes, frequency etc.) • Limited study of ‘quality’ enhancements</td>
<td>Other enhancements such as integrated ticketing and fare levels also provided a range of studies, mainly considering European cities</td>
</tr>
<tr>
<td>13. New public transport systems</td>
<td>• New light-rail (LRT) and bus rapid transit (BRT) systems are currently attracting research interest • Limited material available on urban demand responsive transport (DRT)</td>
<td>Material reflects strong interest in deploying these interventions across the world</td>
</tr>
<tr>
<td>14. Integration of modes</td>
<td>• Mainly academic sources • Good range of material related to park and ride schemes found</td>
<td>Schemes in the Netherlands well represented Most studies related to specific interventions.</td>
</tr>
<tr>
<td>Topic</td>
<td>Issues/Notes</td>
<td>Notes</td>
</tr>
<tr>
<td>-------------------------------------------</td>
<td>-----------------------------------------------------------------------------</td>
<td>----------------------------------------------------------------------</td>
</tr>
<tr>
<td><strong>15. E-ticketing</strong></td>
<td>• Limited material for this topic</td>
<td>Several studies relating to a scheme in Trondheim</td>
</tr>
<tr>
<td></td>
<td>• Evaluations consider range of scales from single route to national scheme</td>
<td></td>
</tr>
<tr>
<td><strong>16. Traffic management</strong></td>
<td>• Good range of material sourced for this topic</td>
<td>Although mainly focussed on EU examples, other studies consider US, Japan, Australia etc.</td>
</tr>
<tr>
<td></td>
<td>• Most studies reflecting on a single intervention in a city</td>
<td></td>
</tr>
<tr>
<td><strong>17. Travel information</strong></td>
<td>• The pace of development of technology in this area means that research interest is relatively high</td>
<td>Evidence can be out of date very quickly Review material relates to specific case studies</td>
</tr>
<tr>
<td><strong>18. New models of car use</strong></td>
<td>• Quite extensive material on Car Share,</td>
<td>Strong research interest in US and Canada as well as Europe</td>
</tr>
<tr>
<td></td>
<td>• Less material looking at Car Pooling</td>
<td>Limited study as yet of ‘free-floating’ schemes</td>
</tr>
<tr>
<td></td>
<td>• Most studies selected were less than 10 years’ old</td>
<td></td>
</tr>
<tr>
<td><strong>19. Walking</strong></td>
<td>• Much of the literature considers walking and cycling together, relatively little focussed on walking interventions</td>
<td>Most of the studies selected are from the UK, although some material from the US and New Zealand</td>
</tr>
<tr>
<td><strong>20. Cycling</strong></td>
<td>• Interventions deploying cycling infrastructure are an area of active research and scrutiny</td>
<td>Evidence is drawn from Australia, Denmark, Germany, The Netherlands, Sweden, UK and USA</td>
</tr>
<tr>
<td></td>
<td>• The majority of the material selected was less than 10 years’ old</td>
<td>Most sources are academic studies</td>
</tr>
<tr>
<td><strong>21. Bike sharing</strong></td>
<td>• The available evidence is relatively recent and generally refers to established schemes that have been operational for a while</td>
<td>There is little consistency in studies at present, making comparative analysis more difficult</td>
</tr>
<tr>
<td><strong>22. Inclusive urban design</strong></td>
<td>• Readily-available evidence is rather limited but varies across interventions</td>
<td>‘Shared space’ has been promoted in the UK stimulating research interest in that measure</td>
</tr>
<tr>
<td></td>
<td>• Older concepts such as traffic calming have generated limited material recently</td>
<td></td>
</tr>
</tbody>
</table>

### 2.2 Constraints on measuring benefits

As well as the general reflections on the evidence noted above, there were also a range of issues which specifically impacted on the suitability of some of the material being reviewed to contribute evidence on the economic benefits of interventions. These included:

**Weaknesses in methodology:** Some measures saw a lack of before-and-after studies that would allow the effects of interventions to be captured (Electric Vehicles (EV) for example). Other measures saw a lack of post-implementation studies in the public domain (integrated ticketing for example). There may have also been a lack of consistency in the types of impact being assessed, and the metrics being used, or in fact any common evaluation frameworks (as in the case of Urban Freight Consolidation Centre (UFCC) studies). In some instances, a lack of a robust ‘control’ group might have left the findings...
without a reference point for the estimation of benefits, whilst more effective use of statistical analysis could have helped attribution of effects of interventions. Sample sizes needed to be sufficiently large to produce robust results: not always the case in travel planning interventions, for example.

Problems with data: Limited data (or access to data) may have restricted research into the effects of some interventions (although the advent of more and more ‘connected’ devices, and moves towards ‘open’ data in cities may create volumes that are equally problematic). Data may have been ‘commercially sensitive’, making any comprehensive evaluation difficult. In other situations, data might have been collected by the proponents of an intervention, or those taking part in it – both potentially introducing forms of bias (albeit not deliberately). Data may only have been collected over relatively short periods of time, thereby giving no confidence as to the longevity of any effects. Problems with monetising social costs and benefits are also an issue, for example estimating appropriate values for time and a ‘life saved’.

Reliance on modelling: In several measures there was a reliance on modelling as opposed to observational study and the collecting of empirical data. This could mean that evaluation was based on assumptions rather than actual results. In some situations these models also lacked ‘control’ sites for comparison (in respect of Urban Traffic Control for example).

Time scales: Some evaluation is undertaken very soon after an intervention is introduced, before the true nature of impacts can be determined. In other instances there may be a ‘decay’ effect on results, which mean they become less effective over time (such as with congestion charges or travel planning for example). The time of year / week / day may also be a factor in specific sets of results.

Quantifying benefits: For some measures it is difficult to quantify the economic benefits that follow from measure deployment. For example, whilst measures which change the urban design of a street might be widely recognised as positive, economic evidence to support the value of such a change might be weak, because the main benefit is in terms of quality of life, rather than economic turnover.

Technology change: Where technology is changing rapidly, then assessment of economic benefits can be difficult. For EVs for example, vehicle costs are expected to fall as a result of increasing volume and efficiency of manufacture, so future BCRs can be expected to be higher than BCRs recorded now. Interventions that rely on mobile technologies and the internet are also evolving very rapidly, leading to uncertainty about future costs and benefits, for example, if investment is made in a specific technology, which is then made obsolete by another.

Limits to generalisation: Specific aspects of an intervention may limit its applicability to a specific context. For example, the costs of fossil fuels and subsidy levels can vary widely, which might limit the applicability of a tax discount incentive to an alternative fuel such as natural gas to jurisdictions with high taxes on diesel for road use.

Pre-existing conditions: In some cases benefits may have been more likely to be ‘realised’ if other conditions had been in place. For instance, high levels of road collisions or congestion may make the impact of interventions more visible. It was also the case that interventions targeted to ‘problem areas’ may be experiencing a degree of ‘regression to the mean’ as opposed to true impacts.

Multiple interventions: It can be difficult to analyse some interventions in isolation, to reach conclusions on the benefits that might be directly attributed to

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15 The statistical phenomenon whereby if the first measurement of a variable is extreme, it will tend to be closer to the average on its second measurement. A key example here is that sites with high collision rates will demonstrate that rate partly due to having relatively dangerous conditions and partly due to chance at the time of observation. After a safety enhancement, there will still be an element of chance, which would likely show regression to the mean, independent of any real safety benefit as a result of the intervention.
that action, whilst others may actually have effects at a different scale (e.g. city-wide versus national or international).

**External factors**: In some instances it could be difficult to distinguish the effects of an intervention, as the specific problem it addressed may have been part of a wider issue. For example, air quality problems may not just be transport-related. It is important to control for such factors for an effective evaluation. Similarly, changes in public transport use may reflect wider socioeconomic change: in conditions of rising car use, simply retaining public transport patronage as a result of enhancements may be a policy achievement, but this is hard to demonstrate without appropriate context to the evaluation. It can also be particularly difficult to predict how key drivers of value might change – for example the price of carbon and oil, or the future energy mix for electricity generation. Many of these issues are contingent on future political choices and decisions.

**Experimental interventions**: Where an intervention was ‘experimental’, there may be particular issues in respect of determining a valid evaluation strategy. It may be that emphasis is being given to ensuring that the experiment is successful – or that particular elements of the trial are being evaluated out of context with wider outcomes. This sort of issue was seen for example in respect of some trial implementations of UFCC.

### 2.3 Gaps in the Evidence

Although EVIDENCE has focussed its search for material on the economic benefits of SUMI, this has by its nature also been a process of looking for documents evaluating the impacts of the twenty-two measures. As a consequence, it is possible to say something then about the more general availability of such material (more specific reflections on the economic evidence can be found in Section 3 below), and to highlight areas where future studies might be usefully focussed.

Gaps identified for individual Measures are summarised in Table 6 below

#### Table 6 Measure-specific evidence gaps

<table>
<thead>
<tr>
<th>Measure No</th>
<th>Research gaps</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Electric Battery and Fuel Cell Vehicles</td>
<td>- Further evidence is needed on the long term application of electric vehicles and the associated effects from real-life examples.</td>
</tr>
<tr>
<td>3. Urban freight</td>
<td>- There are significant gaps in the knowledge base around urban freight measures that do not involve consolidation centres.</td>
</tr>
<tr>
<td>4. Access restrictions</td>
<td>- There is surprisingly little relevant, up-to-date, high-quality evidence available.</td>
</tr>
<tr>
<td></td>
<td>- There are many descriptive case studies available on-line, but these provide very little quantitative evidence on the impacts of such changes.</td>
</tr>
<tr>
<td>5. Road space reallocation</td>
<td>- Whilst there is a great deal of evidence on the impact of these different forms of priority lanes, fewer studies were found to have examined the specific effects of re-allocating existing road space to these modes. This was particularly true for high occupancy vehicle lanes, where only one detailed case study was identified.</td>
</tr>
<tr>
<td></td>
<td>- Few studies have applied statistical analyses, limiting the robustness of the findings to some extent.</td>
</tr>
<tr>
<td>6. Environmental zones</td>
<td>- A slight weakness is that literature here is strongly based on the UK (low speed zones) and Germany (LEZ), with few studies from elsewhere.</td>
</tr>
<tr>
<td>7. Congestion charges</td>
<td>- The fact that congestion charging schemes have only been implemented in a few cities worldwide provides a limitation to the evidence available.</td>
</tr>
<tr>
<td></td>
<td>- All reports and papers that have been analysed have been written after the introduction of congestion charging schemes (2003 in London and 2006/2007 in...</td>
</tr>
</tbody>
</table>
8. Parking
- There could be more quantitative evidence (for example none of the papers reviewed included a complete CBA).

9. Site-based travel plans
- The majority of detailed evidence in this review arises from 3 UK datasets. Although reports are available from elsewhere, these do not provide sufficient detail for the quality of evidence to be assessed.
- Most recent comprehensive data is from 2010 (UK) most evidence prior to this (from 2000 onwards) emerges from 2002-2004.

10. Personalised travel planning
- PTP is a relatively well-evaluated area: however, a minority of source documents provide detailed evidence.

11. Marketing and rewarding
- In general, little information of high quality is available, and there is limited formal quantitative evaluation material.

13. New public transport systems
- Evaluations of urban DRT systems are scarce and the review has had to rely on material from 2003.

14. Integration of modes
- Although documents have been identified in relation to passenger inter-modality, studies documenting the before and after effects of a scheme are much rarer.

15. E-ticketing
- There appear to be relatively few items of evidence that purely evaluate the implementation of e-ticketing (smart-ticketing or m-ticketing).

16. Traffic management
- For some elements here it has been necessary to look to evidence a decade old to find good-quality material.
- There is limited evidence on whether UTC systems can be optimised to reduce emissions as well as minimise delay across networks.

17. Travel information
- More evidence could be collected about the degree to which improved travel information leads to changed travel behaviour. (E.g. does real-time information provision lead to more bus patronage?)

18. New models of car use
- There is limited academic work on carpooling.
- Free-floating carsharing is a relatively recent development, and as yet there has been little data collection and research in relation to it.

19. Walking
- Case studies of urban design interventions that report an impact on walking levels often do not publish relevant quantitative evidence.
- Many publications claim physical activity (including walking) is beneficial to health, but there are only a few studies that present actual evidence of interventions with an impact on walking levels.
- It can be challenge separating out evidence from research that considers walking and cycling together in a study.

21. Bike sharing
- Independent and peer-reviewed in-depth evaluations of existing schemes are not readily available.
- No single BSS (of a sufficient scale) appears to have been fully and independently evaluated along an extensive range of impact and process dimensions.
- The evidence available on bike sharing does not generally offer a clear understanding of the specific objectives that a scheme had sought to achieve.

22. Inclusive urban design
- The amount of readily-available evidence is rather limited (even after searching Dutch and French language sources which might have been thought to provide material).
2.4 Consistency with other reviews

As part of each Measure Review, consideration was given to whether the material being reviewed was consistent with any established understanding of the economic benefits of SUMI (evidenced perhaps in earlier reviews of material). In general, there was consistency, although it was noted that in some instances there were other pertinent factors which may be relevant, but not necessarily explored here (e.g. the effects of price elasticity on parking outcomes). Whilst then there is a good match with existing knowledge on benefits, a number of specific issues were noted by reviewers (see table 7 below).

Table 7 Inconsistency with existing evidence

<table>
<thead>
<tr>
<th>Measure No</th>
<th>Commentary on inconsistency</th>
</tr>
</thead>
<tbody>
<tr>
<td>3. Urban freight</td>
<td>Whilst there is already an understanding of the benefits of urban consolidation facilities, this review identified that there was additional evidence (in this case from London) that even for companies that already have some form of goods consolidation in their distribution chain there are further benefits to be gained from last-mile micro-consolidation.</td>
</tr>
<tr>
<td>7. Congestion charges</td>
<td>Whilst earlier research had generally shown a positive effect of congestion charging, evidence identified in the review indicated that some of this material might overestimate some of the benefits.</td>
</tr>
<tr>
<td>9. Site-based travel plans</td>
<td>There is disagreement over precise levels of reduction in car-use with site-based travel planning. Some meta-analyses of material criticise the reliability of the data and have suggested exaggerated results in terms of car-use reduction.</td>
</tr>
<tr>
<td>10. Personalised travel planning</td>
<td>Previous reviews have been more polarised, ranging from the unequivocal “the case for PTP is made” to claims that vested interests have led to severe reporting biases because PTP seems to some to offer “the promise of something for nothing” as opposed to the more visible costs of transport infrastructure investment.</td>
</tr>
<tr>
<td>14. Integration of modes</td>
<td>With respect to inter-modal interventions, the author is not aware of a previous meta-review of accessibility to public transport journeys.</td>
</tr>
<tr>
<td>16. Traffic management</td>
<td>This review has explored the role of traffic management systems in promoting more sustainable modes (such as buses), whereas urban traffic control systems (UTC) are usually installed to reduce delays to general traffic, with analysis more focused on this objective.</td>
</tr>
<tr>
<td>19. Walking</td>
<td>Some evidence for economic benefit from walking (e.g. claims around property value and willingness to pay for walking infrastructure) does not seem previously to have been part of the discourse around the promotion of walking as a policy.</td>
</tr>
<tr>
<td>21. Bike sharing</td>
<td>In respect of bike sharing the material is broadly the same, but this review provided by the project is far more comprehensive.</td>
</tr>
<tr>
<td>22. Inclusive urban design</td>
<td>Some of the existing published material on shared space has tended towards advocacy rather than objective evaluation. The review rebalances this tendency.</td>
</tr>
</tbody>
</table>

3 Reflections on Economic Appraisal

This chapter considers how economic benefit is measured for sustainable mobility interventions, what specific issues in the evidence collected helped or hindered the review, and what steps could be taken to improve economic evidence collected in the future.

3.1 Approaches to economic appraisal applied to SUMI

Within the material it reviewed, the EVIDENCE project identified a range of factors being used to measure economic benefits across the twenty-two measures. These are summarised in Table 4 and further discussed below. As noted above, there is evidence of economic benefit readily available for many of the interventions considered here, although there is variation across the measure categories. Where there is limited evidence for a measure, it was either not found, despite the extensive searching, or has not been published, or simply does not exist. It is also the case that some measures are not typically assessed for economic benefits, or may measure their successes in different ways.

In some instances individual interventions are likely to be delivered as part of a wider package, and any assessment would be made at this higher level. The case of ‘road space reallocation’, where space used by motorists is transferred for use by more sustainable modes, is a useful illustration of this. In this instance little evidence was reviewed that directly identified the benefit of schemes that focussed just on this action. Instead, such changes are more likely to be contributions to wider schemes, for example pedestrianisation with bus priority, and as a consequence are appraised at that ‘package’ level. In the case of marketing schemes, which encourage travellers to modify their behaviours through altering psychological perceptions, such as the images of different modes, and reward-based approaches, the proximate measure for appraisal purposes is typically the analysis of ‘mode-share’.

Cost Benefit Analysis (CBA)

Some of the evidence reviewed for EVIDENCE has embraced traditionally-used economic appraisal tools, for instance CBA, although use of this approach is limited when viewed across all twenty-two categories.

Some of the strongest benefit-to-cost ratios (BCR) generated by CBA were evident in respect of cycling infrastructure, although this was an approach largely missing from cycle hire projects. There were also positive CBA results in a number of studies related to public transport (both enhancements and particularly new systems of LRT and BRT). Travel time savings still often provide the largest contribution to benefits for public transport interventions and to some cycling measures, although it might be other road users who experience the benefit, due to lower car use resulting in reduced congestion. Other measures with explicit CBA included urban freight (including

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17 The total estimated benefits, discounted to present-day values, per unit of total estimated costs, also discounted to present-day value. 2:1 is typically the starting point for a traditional infrastructure scheme to be considered fundable. Projects promising BCRs greater than 5:1 can be said to have a very high rate of return.
factors such as distance travelled, fuel use and emissions), congestion charging (travel time again being the focus), and e-ticketing. In the case of the latter, attempts were made to broaden the analysis to include social as well as economic factors.

In the travel planning interventions, strong BCR results were seen when ‘packages of measures’ were appraised, as opposed to individual interventions. There are also circumstances (in road space reallocation for example) where the assessment process could be very sensitive to the assumptions being made, leading to very high positive BCRs. Such levels need careful contextual interpretation. Other interventions did not produce BCR results, but did calculate net present value (NPV) results, which were generally positive.

How extensive the use of CBA has been in respect of a number of these measures should be seen in the light of the problems of using the approach for SUMI discussed in Section 2.2 below. It was also the case for some measures (e-ticketing for example) that CBA had been used but the methodology had proven to be poorly executed, or unreliable in respect of those interventions.

Valuation of externalities

Perhaps the most common approach to measuring benefit from an intervention was to consider changes in ‘externalities’, or the impacts of an intervention not directly related to users or operators. These can be benefits enjoyed or costs borne by third parties. The key factors that appeared in a number of measures were changes in air quality / pollution levels, and CO₂ emissions. However, in respect of air quality, the assessment is generally made in terms of the levels of the pollutants emitted in contrast to an attempt to quantify the financial benefits of cleaner air due to reduced public health costs. One exception to this is in the case of the London congestion charge, where consideration is given to the potential for the public authorities being fined for breaching the EC air quality directives, a threat which could be lifted if air quality improves as a consequence of the measure. Air quality benefits are a key feature of access restrictions (EVIDENCE Measure Review No. 4), road space reallocation (No. 5), environmental zones (No. 6), new public transport systems (No. 13) and traffic management and control (No. 16). Some of these interventions also consider reduced noise pollution as an outcome, but again, generally without monetisation. It was noted that some measures, low emission zones for instance, have a strong focus on pollution issues to the exclusion of measuring wider economic costs and benefits.

Reduced accident and casualty rates are another key potential benefit for those measures looking to change the public realm in favour of travel modes other than the private car: encouragement for cycling and walking or public transport. Whilst there are some attempts to monetise values here, and the countries with the more formalised appraisal procedures have tried to incorporate costs related to accidents, in many instances the evaluation is still in respect of numbers of incidents.

There are also cases of use of the Health Economic Assessment Tool (HEAT) methodology from the World Health Organisation (WHO). HEAT allows an economic assessment to be made of the health benefits of walking or cycling by estimating the value of reduced mortality that results from specified amounts of walking or cycling. Whilst one use for the tool is to assist in the planning of a new piece of cycling or walking infrastructure, it can also be used to illustrate economic consequences from a potential future change in levels of cycling or walking or to provide input into more comprehensive economic appraisal exercises, or prospective health impact assessments.

18 For example as used in the UK Sustainable Travel Towns program, where measures addressing demand management and use of alternatives were deployed
19 Net present value (NPV) is a calculation that provides an indication as to whether future benefits (discounted to today’s values) will outweigh the costs of implementing a scheme.
The third key externality considered by the evidence from a number of measures is CO₂ emissions. This is a factor considered across all measures that are looking to introduce either alternative (lower emission) fuels or to improve the efficiency of vehicles. Benefits here are costed, but are completely reliant on factors such as fuel prices and carbon costs, both of which are subject to change, and thus evaluation is subject to circumstances at the time of assessment.

Operational factors

Fare revenues and patronage levels commonly underpinned the economic evaluation of public transport-related interventions. Several of the reviewed studies used econometric modelling to better understand the factors impacting on increased patronage levels. Use of CBA here was relatively limited, with much of the benefit identified in terms of impacts on congestion. Some studies reported on ‘return on investment’ payback timescales, and evaluated high-level costs and revenue changes. In some instances, specific performance indicators were measured against scheme objectives. These might include patronage, fare-box recovery rates or subsidy levels.

One further factor considered in respect of public transport was the economic costs of ‘dwell time’, where reductions in the amount of time for passenger loading was seen to have some quite significant repercussions.

Other economic factors

In addition to the evaluation factors considered above, some of the source material reflected the use of specific indicators of economic benefit directly related to the interventions. For example, in respect of access restrictions, some attempts were made to consider levels of retail activity in businesses affected by the changes, whilst in respect of new public transport systems the value of land was a factor for assessment. Property values was also an area seen as having potential to create economic benefit, for example, one study examined investment in walking infrastructure from this perspective.

Self-contained evaluations

A feature of many of the evaluations of interventions seen in this study is that the process remained largely ‘self-contained’, in that the process used specific non-economic objectives set for the measure. So, for example, the assessment of road space re-allocation and traffic control measures might consider a range of specific performance indicators such as journey time for the different users of the road (i.e. car, public transport, bike), whilst parking and travel planning interventions might focus on mode shares. Mode shares could be assessed using a range of empirical data, such as counts of bus passengers, cyclists, pedestrians and vehicles, and in some cases qualitative inputs were also used.

Mode share or travel behaviour was also a common metric for appraising marketing schemes promoting more sustainable travel, and used to a limited extent in measures delivering enhanced travel information. The park and ride studies were also assessed by considering the mode previously used, and the locations of travellers’ origins, which provided an indication of the effects in terms of vehicle kilometres saved (or not), whilst other inter-modal interventions relied more on customer satisfaction to indicate changes in behaviour.

Notwithstanding some use of the HEAT tool, the measures that focussed on walking and cycling often emphasised health outcomes, but without necessarily attempting to monetise these benefits. In respect of cycling infrastructure, there was some CBA undertaken, as well as data analysis and data modelling, with variables created to represent the new infrastructure and to explain its benefits.
3.2 Some problems with evaluation of economic benefit

Currency of research

Some interventions have experienced periods when they have been more prominent as solutions and others when less so. One consequence of this is that the main body of available evidence may now appear to be ‘dated’. In the case of several measures (for example Light rail, travel planning, Traffic calming) the bulk of material being found for review was now ten or so years old. For some interventions the most relevant material might be older still.

This raises some issues and possibly concerns about how to properly relate such evidence to current or future implementations. For example the costs and benefits of implementation may now have changed as a result of evolving technologies, or of political choices such as levels of subsidy for electric vehicles (EV), or setting a carbon price. Public acceptability of a measure may also have changed, for example the willingness to accept a congestion charge for instance. This does not necessarily mean that older evidence is automatically of less value: for example, the health benefits of cycling in 2020 are likely to be as relevant as they were in 2000. However, it does mean that caution will need to be applied when considering the relevance of older studies to current circumstances.

Technology change

Some of the interventions reviewed by Evidence are subject to rapid technological change, and the emergence of new models of use such as the sharing economy, and thus the evidence dates rapidly – which can particularly impact on CBA, and the definition of user benefits. This is particularly pertinent in relation to technology-related interventions (for example EV, e-ticketing, technology-driven elements of bike and car share schemes).

Studies here can be out of date within a few years, and the current pace of development of mobile internet and smartphone driven solutions is only exacerbating this potential. This raises a concern then as to how relevant any existing (or even current) research in these particular interventions may be looking forward. Will the costs and benefits be the same in one year, two years, five years, and will the technology even be the same for example?

As already noted, there were sometimes a lack of studies in newly-emerging areas of intervention, but it was also the case that longer term studies were needed of ‘evolving technology’ areas to better understand the (economic) effects. This would allow any new technology to permeate into wider groups of travellers (i.e. e-ticketing, or car share schemes), thereby providing more accurate understanding of what the true benefits might be. Other interventions are likely to incur decay effects, for example congestion charging, and here again there would be value in analysing outcomes over a longer period.

Local contexts

Material has been reviewed for implementations of SUMI in the US, Australia and Asia, but there is a need to be mindful that there may be specific contexts relating to the success or not of interventions in those domains. These contexts may relate to the political structures or the social norms present in those countries which may facilitate different approaches to interventions (and their acceptance). There may also be different planning and funding models in use, with different requirements in terms of justification for finance.

Access to documents and evidence

Some of the relevant source material which could provide an important input to this review relates to studies undertaken by ‘consultants’ for a city. This

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20 Models of use that involve sharing resources across more than one user. For example car share schemes and on-street bike hire as found in many cities. Often these sharing systems depend on new mobile technologies to facilitate their use.
presented some practical issues for the project. For example, consultants might not be able to release information without client approval\textsuperscript{21}, which may be problematic – and may mean access to important data becomes more difficult over time. This suggests, that the data obtained in this review is simply the tip of the iceberg, and that there is a considerable repository of relevant data hidden from view, unevenly distributed, and generally not logged making it un-identifiable unless you are made aware of its existence by the people who undertook it.

3.3 More effective future economic evaluation of SUMI

The EVIDENCE review identified a range of issues experienced whilst searching for evidence of economic benefits for SUMI - even though such benefits exist. In particular there is perhaps a lack of the 'ideal', simple and consistent material that could provide easy, off-the-shelf economic information for cities currently choosing SUMP measures. The review has though provided some indications of where improvement might be made. These are detailed in general below, followed by specific suggestions for each of the twenty-two measure categories in Table 8 below.

- Where evaluation techniques attempt to quantify and compare disparate effects (economic, social and environmental), care should be given to not give economic aspects undue, or sole primacy.
- Where possible, evaluation should be carried out independently.
- Studies should look to consider a wide enough area for trends that may influence results of a specific intervention.
- Studies should also look for impacts at an appropriate scale (possibly happening at societal scale for instance).
- Evidence needs to be collected in many locations (and potentially many countries), to avoid misunderstanding or misrepresenting results from context and location specific circumstances. This will also help understand whether replication of the intervention will lead to success or failure in a different context.
- Efforts should be made to resolve the role of ’time savings’, currently seen to be a critical factor in many economic analyses (including of SUMI), particular effort should be made to ensure effective definition of values, and their measurement.
- Studies need to be aware of and take steps to avoid methodological issues such as selection bias, and low response rates in studies of SUMI

\textsuperscript{21} We are therefore extremely grateful to the (mainly independent) consultants who dedicated time to ensure that important data in Consultant reports could be released.
In respect of the specific measures, the following suggestions are made:

### Table 8 Suggestions for improving evidence of economic benefit for measures

<table>
<thead>
<tr>
<th>Measure No</th>
<th>Suggestions for improved research study</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Electric Battery and Fuel Cell Vehicles</td>
<td>Society must look for less carbon-intensive ways to enhance their economies, and the social implications of transport must be considered, irrespective of whether they are easily quantifiable or not. More holistic, less ‘econometric’ analysis is required here.</td>
</tr>
<tr>
<td>2. Cleaner Vehicles</td>
<td></td>
</tr>
<tr>
<td>3. Urban freight</td>
<td>There is a fundamental need for more evaluations, as most schemes are implemented but not monitored or evaluated at all. When they are, these evaluations are limited and often in-house, while they should be independent. Allocation of all the costs and benefits across all involved parties (public and private) should be a participatory exercise.</td>
</tr>
<tr>
<td>4. Access restrictions</td>
<td>More up-to-date European evidence is needed on the impacts of pedestrianisation. Proof of causality will probably remain elusive but the quasi-experimental approach adopted in one study which was reviewed could be extended to wider areas. More research is needed into the reasons for ‘disappearing traffic’. We know that it occurs but how much of the effect is due to modal shift, trip reduction or route changing we do not know.</td>
</tr>
<tr>
<td>5. Road space reallocation</td>
<td>Evaluations often rely on simple comparisons of before and after performance indicators. This is fine for assessment of, for instance, journey times along a single corridor. But in other cases simple trends may not necessarily be attributable to the scheme in question – For example, reductions in casualty numbers or increasing numbers of cyclists (which may be linked to a wider area trend). It is also important that wider area trends are controlled for in statistical analyses to ascertain whether interventions have had a significant impact in their own right.</td>
</tr>
<tr>
<td>6. Environmental zones</td>
<td>Larger areas that have been treated with lower speed limits should be targeted for an assessment of the effects at that scale. Evidence on LEZs in countries other than the UK and Germany could be conducted. Further economic evaluation of LEZs could be carried out.</td>
</tr>
<tr>
<td>7. Congestion charges</td>
<td>Studies need to more accurately measure and define time savings, since dependency upon this variable is large for this measure.</td>
</tr>
<tr>
<td>8. Parking</td>
<td>It is known that parking policy/management is effective but we still do not know how much it costs.</td>
</tr>
</tbody>
</table>
| 9. Site-based travel plans  | Future evidence generation should attempt to address, as far as is practically possible, methodological issues such as selection bias at the level of organisations and individuals providing data, and low response rates, so that greater confidence can be achieved with regard to the robustness of the data (particularly travel surveys), and in the attributing of outcomes to particular (packages of) measures. To supplement the data collected in travel-to-work and school travel surveys, greater use of secondary data sources such as traffic counts, and other available
The Economic Benefits of Sustainable Urban Mobility Measures: Independent Review of Evidence

10. Personalised travel planning (PTP)
   - Perceived weaknesses in PTP evaluation could be addressed through the use of more independent evaluators and greater care in achieving representative samples and large enough sample sizes.
   - Wider use of area-wide empirical data such as vehicle counts would also help.
   - More evaluation could be undertaken of the longer term effects of PTP, including giving more attention to the measurement of attitude change as well as behaviour change.
   - There remains a need for the development of evaluation methods for PTP which are both reliable and financially realistic.

11. Marketing and rewarding
   - Better understanding of the cost-effectiveness of measures.
   - Evaluation of the measure’s coherence with normative positions (e.g. climate change mitigation, avoidance of motorised transport)
   - Appraisal of packages of interventions and of measures

12. Public transport enhancements
   - The focus in the past has been on patronage levels. What is less evident in previous evaluations is any detailed analysis of modal-shift (although in extreme cases that produce large changes reduced congestion might be a proxy to some extent). Future evaluations should assess whether increased patronage was from car drivers, pedestrians, or just increased use by existing users.

13. New public transport systems
   - Light rail: It would be informative to conduct ex-post CBA for comparison to the projected BCRs estimated during scheme appraisal.
   - Light rail and BRT: Simple observed trends (changes in car traffic) cannot necessarily be attributed to the scheme in question. Where possible, indicators should be collected across wider areas and regression models used to examine the impact of the scheme while controlling for external factors (e.g. population characteristics, economic conditions).
   - Longitudinal studies tracking indicators over time offer improved evidence of causal relationships e.g. identifying how land values, air quality, local car ownership and use change post-implementation.
   - Urban DRT: There are few such systems in existence and efforts should be made to collect robust data on the impact of innovations here.

14. Integration of modes
   - Access is needed to a greater range of case study reports, in particular studies from a greater range of countries implementing schemes.

15. E-ticketing
   - Additional ex-post evaluations (particularly over longer time periods) could identify where benefits might be realised.

16. Traffic management
   - There is a need to conduct further evaluations of how traffic management techniques can be used to meet sustainability objectives, rather than the more traditional aim of reducing delays to motor vehicles.

17. Travel information
   - More evidence is needed about the degree to which improved travel information leads to changed travel behaviour.
   - In general there is a lack of information about the perceived (economic) benefits and costs of information provision

18. New models of car use
   - The evidence base surrounding free-floating carsharing is not extensive, and should be augmented.
   - There are a number of gaps still in the evidence regarding the benefits of carpooling from a societal, rather than individual user level.
19. Walking
- Health studies are generally looking at individual wellbeing, whereas infrastructure investments are looking at society as a whole. It would be helpful to bring the individual and societal benefits together?

20. Cycling
- All schemes to ensure automatic count data collection. Provision should be made for *user intercept surveys* to understand the profile of users.

21. Bike sharing
- Inclusion of extensive monitoring/evaluation indicators and requirements in contracts with bike sharing operators, or ensure open data policies (i.e. like London).
- Combine latest developments in GIS based and other computer based data visualisation and processing techniques with user surveys by mobile media to better understand impacts on travel behaviours.
- Have independent rather than in-house evaluation.

22. Inclusive urban design
- More quasi-experimental evidence to tease out the causal relationships relating to these interventions, particularly shared space.
- Before and after studies where removal of demarcations are the only changes made would be useful.
- These studies should cover a wider range of issues than just casualties.
- The impact of shared space on pedestrian behaviour and propensity to walk – particularly by vulnerable pedestrians – is an area that would benefit from more research.
# Appendix A – Item review template

<table>
<thead>
<tr>
<th>Evidence Project - Item Review Template</th>
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<tbody>
<tr>
<td>1.1 Reference No:</td>
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<tr>
<td>Review / Reviewer Information</td>
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<td>1.2 Reviewer:</td>
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<td>1.3 Organisation:</td>
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<td>1.4 Date of review:</td>
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<td>Item Reference Data</td>
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<tr>
<td>2.1 Author(s):</td>
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<td>2.2 Title:</td>
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<td>2.3 Published by:</td>
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<td>2.4 Publication Date</td>
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<td>2.5 Format:</td>
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<td>2.6 Measure:</td>
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<td>2.7 Extent of peer review:</td>
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<tr>
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<tr>
<td>3.1 Title of project</td>
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<tr>
<td>3.2 Study Objectives</td>
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<tr>
<td>3.3 Location of Population Studied</td>
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<tr>
<td>3.4 Duration of study</td>
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<tr>
<td>3.5 Outputs from study</td>
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<tr>
<td>3.6 Interim output title</td>
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<td>3.7 Final report title</td>
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</tbody>
</table>
3.8 How was this intervention facilitated (what programme and / or set of circumstance enabled the intervention to be undertaken)? See also 9. below.

4 Evidence Provided - To what extent has evaluation of the example SUMP measure occurred,

4.1 Scheme Type:

4.2 Transport mode Covered:

4.3 What is the nature of the ex-ante/ex-post evaluation:
   a. factors considered (e.g. traffic, revenues, emissions)
   b. means of evidence generation (e.g. simulation, actual data collection)
   c. duration of impact studied (e.g. timeframe between implementation and pre/post data collection events).

4.4 Methodology Type:

4.5 Brief summary of evidence:

5 Evidence content - What does this item of evidence say about this measure?

5.1 How successful is the intervention involving the measure described here?
   a. With reference to the approach(s) used to measure impact and success, and
   b. In response to problems / objectives identified in the material

5.2 What were the specific contexts for the intervention(s) at that time, in that place? Did these have an impact on success?

5.3 Does the evidence suggest / record that the measure is reliant on other factors / circumstances in order to be deployed successfully? (see also 9. below)

5.4 What role does this measure play in relation to other measures being deployed at the same time – or related to it?

5.5 What problems / issues of deployment / acceptance are reported on in this evidence?

5.6 Is consideration given in the evidence to the ongoing conditions necessary for continuing success of the intervention? (see also 9. below)

6 Validity: Does the research correctly establish independent and dependent study variables that reflect real world experience and behaviour?

Note: Responses to questions here may require a qualitative judgement depending on
<p>| | |</p>
<table>
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<tbody>
<tr>
<td><strong>material available / other studies etc.</strong></td>
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<tr>
<td>6.1</td>
<td>Have questionnaires been constructed so that reported preferences or behaviour generally represent real-world attitudes?</td>
</tr>
<tr>
<td>6.2</td>
<td>If a quantitative study, have appropriate statistical tests been correctly applied to give valid indications of the significance of observed differences between samples or variables</td>
</tr>
</tbody>
</table>
| 7 | **Reliability:** Would the same research project, conducted using the same methodology, and applied to the same population yield the same results?  
*Note: Responses to questions here may require a qualitative judgement depending on material available / other studies etc.* |
| 7.1 | Would the same research project, conducted using the same methodology, and applied to the same population yield the same results? |
| 7.2 | For qualitative studies, has the process of participant selection sought to include known or expected differences in the study group? (Reliability is generally enhanced by recruiting a sufficiently broad range of respondents with respect to relevant criteria for that study’s objectives). These criteria typically relate to demographic, economic, spatial, behavioural and life-history dimensions. Effective recruitment across the relevant dimensions will serve to minimise bias in sampling. |
| 7.3 | How feasible is it to reliably evaluate this measure in isolation from other external factors (economic / social), or other mobility-related interventions? |
| 8 | **Significance:** Some judgement on how significant in the ‘real-world’ this (economic) evidence is in respect of the effectiveness of this measure.  
*Note: Responses to questions here may require a qualitative judgement depending on material available / other studies etc.* |
| 8.1 | Is the intervention (and thus the evidence presented here) significant in its own right, or only as part of a suite of measures? |
| 8.2 | Are there issues of scale in respect of the intervention reported on that might constrain its wider value? |
| 8.3 | Are there ‘country’ specific and regional differences which apply to this item of evidence? If so what are they, and how much effect do they have on the significance of reported results? |
### PESTLE Analysis:

| 9.1 | Political factors 1: Is there any 'process evaluation' in the evidence that highlights particular issues within the measure delivery that helped, or constrained this intervention and its impact? |
| 9.2 | Political factors 2: Does the evidence reflect on any external political context(s) that helped, or constrained this intervention and its impact? |
| 9.3 | Economy 1: Is any evidence provided on the internal financial viability of the project delivering the intervention? What approach has been used to judge this? |
| 9.4 | Economy 2: Is there any indication of the macro-economic climate at the time that the measure was implemented, and of the effect this might have had on the success of the intervention? |
| 9.5 | Society 1: Does the material contain evidence of any social and cultural impacts (positive or negative) of the measure on the community affected? |
| 9.6 | Society 2: Does the material provide any insights into whether wider social and cultural factors are significant in the success (or not) of this measure / intervention? |
| 9.7 | Technology: Does the item report on any particular technology issues (including costs of technology) which may have helped or hindered this intervention? |
| 9.8 | Legal: Does the evidence comment on the role of any legal issues in delivering this measure? (E.g employment law, competition law etc). Did the intervention benefit from 'quotas' or positive discrimination towards a mode? |
| 9.9 | Environment: Is there any evidence provided in the material on the role that any specific environmental factors played in the success of the intervention, or of the ecological and environmental impacts (or benefits) that flow from the measure / intervention? |

### Any other relevant information:

| 10.1 | Any other relevant information: |
Appendix B – Measure review template

Note: whilst this was the template used to capture the review material, the published versions of the Measure Reviews have a revised format – with some additional material resulting from further analysis of the source documents added.

Evidence Project Measure Review

No. xx:

Measure Name

Note: This document is intended to provide a broad framework for reviewers to work within rather than be highly prescriptive – recognising that the quantity and type of available evidence will vary significantly between measures.

Definition of Measure

Should define the terms of the measure and any obvious categories of sub-measure e.g. travel plans might be subdivided in businesses/schools etc.

Note any debates as to what the measure name scope implies and indicate how are we interpreting use of the term in the context of those debates?

Should define the scope of the measure: what is the set of problems / objectives that schemes defined in this measure category are typically expected to address?

Statement of the Extent and Sources of Evidence

Text [overtype this and delete the text below]

- How many items (reports, papers, case studies etc) of evidence are readily available?
- How important were meta-studies to reviewing this measure or has it been possible to access actual intervention reports directly?
- How many items were selected / submitted for this study?
- Is implementation of this type of transport intervention an area that receives ongoing scrutiny / research?
- Which countries / locales / environments have provided material for evidence?
The Economic Benefits of Sustainable Urban Mobility Measures: Independent Review of Evidence

Summary of What the High-quality Evidence Claims

Sub-Heading (if needed)

Text [overtype this and delete the text below]

Note: This is a section which is expected to vary significantly between measures, but will hopefully be the most substantive section of the measure report. It needs to focus on the items which are highly credible but it will also be necessary to explain to some extent why certain evidence cannot be considered high quality. It may not be necessary to single out studies specifically, but discussion in general terms of why certain types of study cannot be considered high quality e.g. failed to contrast users of a scheme with non-users, or show no evidence of having considered obvious confounding variables (to take an extreme example: celebrating 25% growth in bus patronage over a decade but not taking any account for the city having doubled in population over that period).

The following points may help in building up this section.

- **What does the evidence reviewed show?** Summarise the main findings.
- **Nature of methods**
  - a. What methodologies are typically used in analysing and reporting on an intervention(s)?
  - b. Are there any systematic strengths / weaknesses in the methodologies applied to this measure?
  - c. How many interventions are considered to have been evaluated with high quality methodologies?
- **Are the reported findings**
  - a. valid (i.e. clearly relate to the main objectives of the measure and involving appropriate samples/populations)
  - b. reliable (i.e. derived from sound methodologies which are likely to be repeatable)
  - c. significant (i.e. the measure makes a real difference in the city studied and with upscaling could make a real difference in others). Here the presence of a CBA might be one means of testing/interpreting significance.
- **What are the evidence gaps remaining in relation to this measure?**
Findings Relating to Transferability and Upscaling

Text [overtake this and delete the text below]

- Transferability
  - Are there any systematic reasons to suppose that the evidence findings would not be relevant in other locations?
  - Does the extent of evidence in terms of its range of case-studies give confidence that the findings are likely to be transferable?

- Drivers/Barriers expressed in terms of PESTLE factors
  - i.e. What are the common problems / facilitators experienced in deployment of this measure?
  - PESTLE = Political/Economic/Social/Technological/Legal/Environmental factors

- Complementarity
  - What other measures / factors / circumstances are relevant to this measure being deployed successfully?
  - What role does this measure play in a successful SUMP?

- Resilience/durability
  - What does the evidence say about what is needed to ensure ongoing success for this measure?

Summary

Text [overtake this and delete the text below]

- What is our level of confidence regarding evidence relating to this measure?
  - Key strengths and gaps
  - Recommendations about future evidence generation

- How do we define 'success' in the context of this measure?
  - What is the range of results that ought to be expected from successful deployment?
  - What are the key 'must haves' and 'must avoids' for successful deployment?

References