THE EVIDENCE: THE ECONOMIC BENEFITS OF SUSTAINABLE MOBILITY

Eileen O’Connell  
Position: Managing Director  
Institution: Interactions Ltd

Graham Parkhurst  
Position: Professor/Director, Centre for Transport & Society  
Institution: University of the West of England

Ian Shergold  
Position: Research Fellow, Centre for Transport & Society  
Institution: University of the West of England

Abstract  
The Evidence project (www.evidence-project.eu) has reviewed ‘evidence’ on sustainable transport initiatives, to help politicians and transport practitioners understand the economic benefits that can be achieved from expenditure on sustainable transport. This knowledge will support greater integration of sustainable transport measures into urban mobility plans.

The project was conceived in the context of the EU’s obligations to reduce climate change gas emissions by 2050, which requires member states to move beyond mobility policies that emphasise car use. However, attempts to pursue carbon reductions in transport are often seen to conflict with the goals of economic development, and the view that ever-more (car-based) mobility is needed to support economic growth.

The EVIDENCE team looked at how transport funding is allocated; often it is targeted at projects aimed at increasing road capacity which can then be ‘appraised’ to demonstrate a return on investment. This project appraisal usually involves some form of Cost Benefit Analysis (CBA) which is particularly useful for infrastructure projects but the EVIDENCE Project found it has drawbacks for smaller interventions, e.g., extensive data requirements, the dominance of the value of ‘travel time’, the difficulty of monetising some elements and the exclusion of wider socio-economic effects. The project team analysed a variety of sustainable urban mobility interventions (SUMI) which had been evaluated using different techniques (including Cost Benefit Analysis and Multi Criteria Analysis -MCA) and can now demonstrate the economic benefits of these initiatives. In total, 350 reports and case studies from around the world were studied covering 22 individual measures under seven themes as follows:

- Clean vehicles and fuels
- Urban freight
- Demand management strategies
- Mobility Management
- Collective passenger transport
- Transport Telematics
- Less car dependent mobility options

The economic benefits of the measures were examined according to strength and timescale; including factors such as increased economic activity and retail revenues, increased patronage and footfall, fuel savings, efficiency gains, savings on direct expenditure, improvements in air quality (health outcomes) and reductions in financial sanctions and casualties. There was strong evidence of benefit for six measure types, which means that local administrations can be confident in allocating resources and gaining economic benefits with these interventions.

The review also identified gaps and weaknesses where there was limited evidence available or it was of poor quality; the project has identified steps to improve the evaluation of the economic benefits of SUMI, especially to widen the set of criteria currently used in CBA to encompass indirect effects on health, absenteeism, labour turnover, etc. and the wider evidence base of property values, and CO₂ performance.
This paper will go on to look in-depth at two illustrative themes, Demand Management, and Collective Passenger Transport, showcasing some of the most successful measures and how they can best be implemented.

**Context for the EVIDENCE Project**

The European Union (EU) has tough international treaty obligations to radically reduce climate change gas emissions by 2050, and in addition, the EU directives on air quality require Member States to end the exposure of citizens to highly harmful air pollution concentrations. Its **low-carbon economy** [1] roadmap suggests that:

- By 2050, the EU should cut emissions to 80% below 1990 levels.
- Milestones to achieve this are 40% emissions cuts by 2030 and 60% by 2040.

Greenhouse gas emissions in other sectors decreased 15% between 1990 and 2007 but emissions from transport increased 36% during the same period. This increase occurred despite improved vehicle efficiency because of increases in personal and freight transport. Since 2008, greenhouse gas emissions from transport have started to decrease. Despite this trend transport emissions in 2012 were still 20.5% above 1990 levels and would need to fall by 67% by 2050 in order to meet the 2011 Transport White Paper target reduction of 60% compared to 1990. Climate change emissions from transport are therefore a particular concern, with current mobility choices and the investments in new infrastructure having to change radically in order to create the low-carbon future required. At present, emissions from the transport sector are 22% of worldwide carbon emissions, but 30% and rising in OECD countries.

At the same time, the transport sector is expected to address a greater range of public policy objectives - responding to travel demand whilst keeping cities as places where citizens want to live and work. Achieving a healthy, sustainable city requires local air quality and noise to be brought within acceptable limits, whilst also responding to wider environmental concerns and supporting European climate change targets. However, when trying to respond to these competing demands, planners are increasingly faced with concerns that such choices might have unintended negative effects. For instance, attempts to pursue significant carbon reduction in transport may be seen to conflict with economic development. Addressing these issues is complex and challenging and it is often difficult to prioritise environmental and social impacts over economic aspects. This is of particular relevance if sustainable transport schemes compete for funding against infrastructure investments, especially in times of constrained municipal budgets.

Meeting this challenge, as well as other environmental, social justice and accessibility concerns means cities must rethink transport solutions and focus greater attention on how they deliver urban mobility. Such a refocus will require changes to investment priorities, with funders also needing to analyse more critically the problems that need to be addressed when deploying their resources and to embrace investment in innovative mobility solutions.

The EVIDENCE project is a strategic initiative funded by Intelligent Energy Europe (IEE) to uncover the economic benefits of the measures within Sustainable Urban Mobility Plans (SUMPs) an important tool in meeting EU climate change objectives. Quite often, the evidence available for cities is ad-hoc, of varying quality and either inaccessible or unavailable within the timescales of decision making. Policy makers and professionals that need it don’t have the time or resources to search through it and to gauge the credibility.

The EVIDENCE expert team have been working to solve this ‘credibility gap’, and has:

- completed extensive research to identify existing data (research papers, reports, feasibility studies, etc.) available on the economic benefits of sustainable transport
- completed a series of peer reviews of this data to sort out the reliable research from the unreliable data
- made the evidence available on its website (over 350 source documents)
- produced reviews of 22 sustainable mobility measures
- published an in-depth report of the whole review process
- produced Training Materials for academics and trainers
This enhanced knowledge should be used to support, and facilitate the effective integration of sustainable transport into urban mobility plans, transforming them into SUMPs. In doing so, countries, regions, towns and cities will be better placed to improve health, increase economic efficiency, enhance access to employment, and reduce the running costs of transport.

**Issues and current practice in project appraisal and decision making**

As a starting point, the EVIDENCE project team examined the role of project appraisal in decision making at urban level [2] and its impact on the allocation of funding. Project appraisal is frequently supported by decision support tools such as CBA which is often used to justify investment in substantial transport projects, e.g. major infrastructure projects [3] rather than small scale sustainable transport initiatives. Theoretically, a project could be accepted or rejected based on the net present value (NPV) and by comparing the Benefit Cost Ratio (BCR) of alternative projects, the one with higher benefits could be identified. However, the way CBA is used varies from country to country. The TIDE project [4] investigated the current assessment practice of 14 EU cities and found that they do not have a standard appraisal method for all transport projects, with methodologies being selected depending on the measure being assessed.

The CBA concept has extensive data requirements and tends to be dominated by the value of travel time. Many wider social, environmental and economic effects are difficult to quantify and gauge in precise economic terms (Table 1). As a result, CBAs are rarely conducted for small scale sustainable initiatives; many of these are of low cost and the effort required to collect the necessary data is excessive. Consequently, assessment of such measures is challenging and cities generally consider more specific impacts, such as congestion reduction or CO₂ mitigation rather than BCR.

**Table 1: examples of indicators often not appropriately represented in a CBA [5]**

<table>
<thead>
<tr>
<th>Effect</th>
<th>Reason for difficulty</th>
</tr>
</thead>
<tbody>
<tr>
<td>Real estate value</td>
<td>Highly site-specific</td>
</tr>
<tr>
<td>Visual intrusion</td>
<td>Difficult to monetise and highly site specific</td>
</tr>
<tr>
<td>Employment</td>
<td>Extensive data requirements</td>
</tr>
<tr>
<td>Distributional effects</td>
<td>Lack of data</td>
</tr>
<tr>
<td>Vibration</td>
<td></td>
</tr>
<tr>
<td>Quality of life</td>
<td>Difficult to monetise and lack of data</td>
</tr>
<tr>
<td>Sense of comfort</td>
<td></td>
</tr>
<tr>
<td>Commercial attractiveness</td>
<td>Potential lack of data</td>
</tr>
<tr>
<td>Energy security</td>
<td>Values only available for the USA</td>
</tr>
<tr>
<td>Image/user perception</td>
<td>Difficult monetisation; can be assessed with marketing research</td>
</tr>
<tr>
<td>Modal distribution</td>
<td>Often integrated in other criteria, not assessed in isolation</td>
</tr>
</tbody>
</table>

Where attempts have been made to assess the BCRs of sustainable transport measures the results are often positive. They are more inclined to be associated with the externalities defined above, and the resulting economic benefits can be significant – either direct (investment or operational costs) or indirect (real estate value or health care costs).

The EVIDENCE project team conducted interviews across Europe with transport practitioners and policy makers, in order to identify the issues facing them and nature of the
barriers to implementing sustainable mobility solutions. Many of those involved in delivering more sustainable urban mobility in line with policy objectives of the EU report that they need to know more about the economic benefits of such interventions. The key barriers identified were:

- insufficient knowledge about the different types of sustainable urban mobility interventions (SUMI) available, and the benefits that they could bring, including economic benefits
- uncertainties about how to conduct pre-implementation appraisals and post-implementation evaluations of SUMI, in a way that fairly and validly demonstrates the extent and range of economic benefits offered
- concerns that the experiences of successful implementation elsewhere might not be relevant to the local context of mobility management, including the expectations of local politicians, stakeholders and funders
- awareness that specific skills and experience might be necessary to deliver SUMI rather than traditional interventions, and that those skills might not be present or sufficiently embedded within their city decision-making and planning communities

To meet these needs, the EVIDENCE research team investigated the readily available evidence in order to address some of these barriers and to encourage change towards SUMI. The wide-ranging review undertook to:

- provide easily accessible and practical information about the economic benefits of SUMI, with detailed explanations in expertly-reviewed summaries,
- identify good practice examples and provide signposting to a database of economic evidence,
- examine the relevance of the dominant technique for evaluating transport investment, CBA, providing a commentary on its suitability for assessing SUMI,
- indicate ways in which a transparent, formal process of decisions about investment can provide a fair and level playing field for these interventions.

The EVIDENCE Review

The specific types of SUMI considered by the EVIDENCE team reflect those promoted by the European Commission in ‘Guidelines: Developing and Implementing a Sustainable Urban Mobility Plan’ [6]. These different interventions are grouped and aligned to the SUMP guidelines. The resulting seven themes and twenty-two measure categories have been used throughout the EVIDENCE data collection and analysis process, and are listed in Table 2 below.

Table 2: Themes and Measures explored by EVIDENCE [7]

<table>
<thead>
<tr>
<th>SUMP Theme*</th>
<th>Measures</th>
<th>Example interventions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clean vehicles and fuels</td>
<td>Electric Battery and Fuel Cell</td>
<td>Charging point provision</td>
</tr>
<tr>
<td></td>
<td>Enhancements to ICE technologies</td>
<td>Retrofitting buses</td>
</tr>
<tr>
<td>Urban freight</td>
<td>Urban freight</td>
<td>Freight consolidation</td>
</tr>
<tr>
<td>Demand management strategies</td>
<td>Access restrictions</td>
<td>Bus gates</td>
</tr>
<tr>
<td></td>
<td>Roadspace reallocation</td>
<td>Public transport lane</td>
</tr>
<tr>
<td></td>
<td>Environmental zones</td>
<td>Low emissions zones</td>
</tr>
<tr>
<td></td>
<td>Congestion charges</td>
<td>Urban road pricing</td>
</tr>
<tr>
<td></td>
<td>Parking</td>
<td>Permit-based restrictions</td>
</tr>
</tbody>
</table>
The literature available on the impacts of sustainable mobility is extensive, appearing in committee papers and conference presentations as well as academic publications. The EVIDENCE research team acquired material for review through an international call for evidence, from searches of existing databases, and through the knowledge and personal resources of the project partners. The material was chosen for consideration if it addressed the following three elements:

- Costs: Including planning and implementation, project management and investment as well as recurrent expenditures such as operation, maintenance, administration and enforcement
- Benefits: Such as additional jobs, travel expenditure savings and travel time savings, revenues from fees and charges.
- Socio-economic benefits: Such as air pollution, climate change emissions, noise, access, traffic safety and liveability

Given the important role of CBA in analysing transport projects, some of the evidence reviewed did utilise this approach. In some countries, rather than reducing the use of CBA in appraising SUMI, attempts were being made to monetise additional factors in order to also evaluate social and environmental impacts. While high returns on investment were often found, the approach is problematic and time-consuming, because of a lack of consistency in the values and methodologies used. Assumptions and monetisable outcomes can vary across different types of intervention. In the context of the role of CBA in project evaluation, two principles were important for the EVIDENCE Project analyses:

- the absence of a CBA was not accepted as meaning that net economic benefits did not exist for any particular SUMI;
- the presence of a CBA did not automatically mean that the BCR or NPV outputs, whether positive or negative for the promotion of SUMP, were full and true representations of actual economic value.

Around 750 documents in total were collected for review and analysis. A significant portion of the material collected did not offer specific evidence, had a wider focus on urban mobility issues, or transport evaluation and appraisal issues. The next consideration was the type of evidence provided – qualitative or quantitative - and whether it contained MCA or CBA. Finally, the quality of the evidence offered was evaluated as follows:
- Low: No usable evidence is presented, although there is some assessment (ex-ante or ex post) of (socio) economic costs and benefits of SUMI.
- Medium: The report evaluates (ex-ante or ex post) economic costs and benefits of SUMI. The method used is not a CBA but assesses costs such as planning and implementation, project management and investment cost as well as recurrent expenditures such as operation, maintenance, administrative and enforcement.
- High: The report assesses (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.

OR

The report assesses (ex-ante or ex post) socio-economic costs and benefits of these measures, which might include monetisation and other quantitative weighting of different units as well as qualitative assessments.

The information was then used to provide ‘measure-specific’ lists of material for the reviewers to analyse. A minimum of 10 and up to 25 pieces of evidence were analysed for each of the 22 measures under review. The strength and quantity of evidence varied across the 22 measures and it is difficult to enable a direct comparison between interventions. However, it has been possible to provide an indication of which measures might provide specific economic benefits, based on an informed qualitative assessment by the project team. These assessments are presented in Table 3 below.

Table 3: Extent of economic benefits [7]

<table>
<thead>
<tr>
<th>Theme</th>
<th>No</th>
<th>Measure</th>
<th>Strength of Economic benefit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clean vehicles and fuels</td>
<td>1</td>
<td>Electric Battery and Fuel Cell Vehicles</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Cleaner Vehicles</td>
<td>✓✓</td>
</tr>
<tr>
<td>Urban freight</td>
<td>3</td>
<td>Urban freight</td>
<td>✓✓</td>
</tr>
<tr>
<td>Demand management strategies</td>
<td>4</td>
<td>Access restrictions</td>
<td>✓✓</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>Road space reallocation</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>Environmental zones</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>Congestion charges</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>Parking</td>
<td>✓</td>
</tr>
<tr>
<td>Mobility management</td>
<td>9</td>
<td>Site-based travel plans*</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>Personalised travel planning*</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>11</td>
<td>Marketing and rewarding</td>
<td>✓</td>
</tr>
<tr>
<td>Collective passenger transport</td>
<td>12</td>
<td>Public transport enhancements</td>
<td>✓✓</td>
</tr>
<tr>
<td></td>
<td>13</td>
<td>New public transport systems</td>
<td>✓✓</td>
</tr>
<tr>
<td></td>
<td>14</td>
<td>Integration of modes</td>
<td>✓</td>
</tr>
<tr>
<td>Transport telematics</td>
<td>15</td>
<td>e-ticketing</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>16</td>
<td>Traffic management</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>17</td>
<td>Travel information</td>
<td>✓</td>
</tr>
<tr>
<td>Less car dependent mobility options</td>
<td>18</td>
<td>New models of car use</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>19</td>
<td>Walking</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>Cycling</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>21</td>
<td>Bike sharing</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>22</td>
<td>Inclusive urban design</td>
<td>✓</td>
</tr>
</tbody>
</table>

Key:

| ✓✓✓✓  | ✓✓✓ | ✓✓ | ✓  |
| Evidence of more substantial economic benefits | Evidence of strong economic benefits | Economic benefits clearly seen | Some Economic benefits identified |
The types of economic benefits found include:

- Reductions in operating costs and increased commercial returns for operators
- Increased economic/retail activity and revenues and value of property
- Reductions in road casualties
- Savings on direct transport expenditure
- Reductions in fuel use and emissions
- Increased patronage levels on public transport
- Contributions to regeneration schemes
- Improvements in air quality (health outcomes)

The resulting twenty-two Measure Reviews capture key information including the types of intervention, the economic evidence available and the results of the evaluation, as well as lessons for successful deployment elsewhere. All the reviews were subject to a peer-review by a panel of three international transport experts. These in-depth reviews are available to download from the project website [www.evidence-project.eu](http://www.evidence-project.eu) as well shorter summary reviews [8].

The three hundred and fifty documents that informed the measure review process have been collated into a database of evidence. This searchable database of source materials is available on the EVIDENCE website with links to the original documents where possible.

Some of the stronger measures (those for which strong evidence was available) include Demand Management Strategies (including access restriction, roadspace reallocation and parking policies) and new public transport systems. Elements of the evidence related to these particular measures are illustrated below.

**The Evidence – Demand Management**

The key findings show that roadspace reallocation, access restriction and pedestrianisation can bring substantial benefits. Reducing road space can provide a cheap and effective way to improve the attractiveness of public transport, but this would be untenable if displaced traffic brought neighbouring roads to a standstill. A meta-study by Cairns et al. (1998) [9] examined the impact of road space reductions from over 100 case studies around the world. These interventions were categorised according to whether space has been re-allocated to mixed priority, public transport, cycle only, or high occupancy vehicle lanes. Irrespective of the cause, in such circumstances, there are often predictions of major traffic chaos. Examination of the evidence suggested that these predictions rarely, if ever, prove accurate.

In a case study of a small pedestrianised zone in Oxford in the UK [10] through-traffic was removed from a wider area (particularly through the use of bus gates, which allowed buses but not general traffic through) traffic entering the city centre fell by 17%, whilst total visitor numbers remained stable. Pedestrian volumes in the pedestrianised streets increased slightly. There was a 9% increase in the number of visitors to the city centre by bus, including expansion to park and ride sites, more than compensating for the loss of visitors by car. Retail floorspace reached a record level and retail property rents rose more quickly than elsewhere.

A study of 6 German towns that had deployed pedestrianisation schemes [11] showed that retail turnover increased for 64% of businesses surveyed, with the largest concentration (32.4%) reporting an increase between 5% and 10%. The effect was slightly more positive in the larger towns than smaller towns. Other studies found that there was sometimes a slight fall in turnover immediately following pedestrianisation. In the longer-term, shops on pedestrianised streets tend to benefit, whereas those on trafficked streets nearby tend to suffer. This report describes resistance to pedestrianisation proposals from traders and their representative organisations in several towns, however they “virtually never campaign for the abandonment of a scheme once it has come into operation…traders are often the main people to voice a desire to extend its boundaries or period of operation.”

A quasi-experimental evaluation of the pedestrianisation of a shopping street in Hong Kong was conducted in 2003 [12]. Although there are cultural and spatial differences from European contexts, it is included here because it is, as far as we were able to find, the only
rigorous academic study of this question which enables causal inferences to be drawn. Both the intervention and control streets are busy shopping streets. The intervention street suffered from overcrowding and conflict between pedestrians at busy times. It has been closed to traffic from 4pm to midnight on Mondays to Saturdays and from noon to midnight on public holidays. On the control street, pavements were widened and traffic calmed but it remained open to traffic. Data was obtained on the rateable values which rose on both streets but considerably more on the experimental street. After controlling for other factors pedestrianisation added 17% over and above the traffic calming and pavement widening on the control street. The changed environment on the intervention street led to more activities such as street theatres and ‘live forums’.

**Lessons for successful deployment of demand management**

The broad evidence base for these measures suggest that they can be implemented anywhere. Restricting road space has the general impact of reducing traffic volumes and providing greater priority to cycle and bus lanes can be expected to improve journey times and increase usage levels. However, an important caveat is that capacity restrictions are likely to reduce speeds and increase journey times for general traffic (and concomitant increases in emissions) and this can have the unintended consequence of delaying buses in cases where continuous priority lanes have not been implemented. The evidence is weak, however, on the reallocation of space to HOV lanes as an effective means of increasing vehicle occupancy and improving traffic flow. This is an area that certainly demands further research [13].

Retail benefits of access restriction/pedestrianisation were found to be greater in larger cities than in small towns. Additional benefits include improved street environments, creation of ‘street life’, community activities and events, and improved community cohesion. The main barriers include local opposition, particularly from shop owners and motorists. Involving stakeholders in scheme designs may alleviate some of these concerns but there is evidence that brave decisions and successful implementation are the best ways of overcoming opposition [14].

**The Evidence – Parking Policy**

Evidence is unanimous on the importance of parking to manage car travel demand in urban areas, with parking issues strongly influencing the decision-making process of travellers.

New technology applied to parking can help drivers to reduce search traffic. In Pittsburgh (USA) a technology-based smart parking system project provided real-time information to users [15]. 57% of drivers needed less time to find a parking space; with the reduction varying from 1 to more than 6 minutes less search time. The authors estimate the pilot to have saved 5,746 hours of cruising valued at $117,460 and 2,873 gallons of fuel valued at $10,056.

The SFpark pilot project in San Francisco has produced similar results [16]. The system involved an area where all on-street parking bays were equipped with sensors to allow the local authority to collect data on parking management. Real time information was provided to drivers on occupancy rates and fees (that varied according to the occupancy rate). Detailed data collection showed that parking availability improved dramatically with the target occupancy rate (60-80%) increased by 31%; cruising for parking reduced by 43%, with 30% fewer vehicle miles travelled and reduction in GHG emissions. Transit speed increased where double parking was reduced and, most important, net parking revenue increased slightly while the average hourly fee rate decreased.

**Lessons for successful deployment of parking policy**

Parking management schemes do not usually require large investment (compared with interventions such as public transport infrastructure for example), and can be realised in a relatively short time. Restrictive parking policy measures (i.e. parking pricing) are not seen to have detrimental effects on the local (retail) economy. Effective parking management can actually increase the attractiveness of a city centre and its economic vitality.
Parking policies can contribute to reducing car commuting and technology-based smart-parking systems can reduce search time or cruising looking for spaces; this can bring significant benefits in fuel use, air quality and congestion. [17]

The Evidence – Bus Rapid Transit

Two case studies [18, 19] illustrate the extent to which BRT can deliver high capacity passenger transport. The Istanbul Metrobüüs system (2012) has a design capacity of 24,000 passengers per hour, but the system carries up to 60,000 passengers per hour in peak periods and suffers from over-crowding at stations. It is estimated that the system achieved a 9% modal shift from car use. Fare revenues are higher than operating costs and the system had started to recover its capital costs after five years of operation. Passengers saved 50 minutes per day on average (based on the before and after journey times reported by 1000 users of Metrobüüs)

Ridership of the Los Angeles County Metro Orange Line BRT system also exceeded expectations attracting 21,828 average weekday boardings (the target for 2020 was 22,000 weekday boardings). 18% of riders had transferred from driving and consequently time spent in congestion on a nearby highway was observed to reduce by 14%. However, BRT travel times were higher than expected - 41 to 50 mins compared to the anticipated 29-40 minutes [18]. The longer journey times were caused in part by the lack of selective vehicle detection to provide priority at signalised junctions and a need to reduce bus speeds to avoid collisions at junctions.

The Embarq [20] study reported a post implementation cost-benefit analysis of four BRT case studies (Bogota, Mexico City, Istanbul and Johannesburg). Benefits include change in travel time, change in vehicle operating costs, change in carbon dioxide emissions, change in exposure to local air pollutants, road safety benefits, and changes in physical activity. Estimates of BCRs ranged from 1.2 (Mexico and Johannesburg) to 2.8 (Istanbul). With this style of CBA, travel time savings are shown to make the biggest contribution to benefits. It is also noted that most users of the BRT systems came from lower to middle income groups, demonstrating potential to meet social equity aims. This is in contrast to light rail systems which were observed to be less successful in serving lower income groups.

Lessons for successful deployment of BRT

New high capacity passenger transport systems such as BRT are most successful if they are highly segregated, operate along corridors with high population densities, and serve areas with strong and growing levels of economic activity [21]. Given the relatively large capital expenditure requirements, strong national and local political support is necessary to deliver schemes of this magnitude. Strong and convincing passenger demand forecasts are also required to attract the necessary long term private sector investment. Successful deployment is usually accompanied by sympathetic land use policies that prioritise new development in the vicinity of transit stops to stimulate demand. It is also necessary for local bus services to be rationalised and re-organised to feed rather than to compete with new high capacity transit systems. It is important that land use policies that deliver high population densities and economic activity in the vicinity of new transit systems are pursued and maintained in the long term.

Evidence Gaps

It is important to note that EVIDENCE 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 limited documentation in others. In general, material seemed to be more plentiful for particular interventions, for example walking and cycling, whilst other measures generated few evaluations. While most of the evidence found was in the English language, the team was successful in reviewing documents in a range of European languages; however, for some countries where material might expect to be seen (for example France), results have been limited.
There is a general lack of ‘before and after’ evaluations which would have produced robust findings. Some studies focused on selected outcomes and missed the opportunity to measure wider sustainable mobility impacts.

Other common issues included:

- Lack of long-term evidence and real-life impacts for some measures,
- A current focus on implementing / evaluating specific interventions within a measure, sometimes driven by specific funding initiatives or demonstration programs,
- Limited quantitative and statistical studies of interventions,
- Limited studies on replacing road-capacity with alternatives.

The Method Report [22] provides further reflections on how to improve economic evidence collection in the future:

- Where evaluation techniques attempt to quantify and compare disparate effects (economic, social and environmental), care should be given to not give economic aspects undue 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; 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.

Recommendations for the implementation of SUMI

The evidence review found that some interventions are more likely to be successful when they are introduced in conjunction with other interventions. Some examples of these packages of measures are seen in the table below:

Table 5: Packages of Measures [23]

<table>
<thead>
<tr>
<th>Measure</th>
<th>Companion measures to maximise economic benefit(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electric Battery and Fuel Cell Vehicles</td>
<td>• Congestion charging and Parking management (with EV concessions)</td>
</tr>
<tr>
<td></td>
<td>• Roadspace reallocation (with EV concessions)</td>
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<td>• Urban freight consolidation</td>
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<td>• Low emission zones</td>
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<td>• (Charging infrastructure)</td>
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<tr>
<td>Cleaner Vehicles</td>
<td>• Environmental Zones (Low emission zones)</td>
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<tr>
<td>Urban freight</td>
<td>• Access restrictions (including pedestrianisation)</td>
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<td></td>
<td>• Environmental Zones (Low emission zones)</td>
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<td>• Congestion charging</td>
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<td>• Inclusive urban design</td>
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Interventions that introduce new capacity, or extend existing networks of more sustainable modes, such as public transport, will also benefit from some element of restraint being applied on the use of private vehicles.
Some interventions may not be cost effective if deployed on their own, but can be successful as part of a package. For instance e-ticketing infrastructure such as introducing smart ticketing to replace cash fares may be prohibitively expensive to implement as a stand-alone change, but may be supportable as part of a wider integrated ticketing initiative and enhancements to public transport services which together will enhance patronage levels.

There is a need to be aware of the potential for misconceptions in respect of proposed interventions and their expected outcomes, and it is important to engage in constructive dialogue with all stakeholders. For example, measures to reduce traffic or parking will often be seen by retailers to threaten trade (with perceived negative economic effects) although the balance of evidence does not support this.

Conclusions

What the EVIDENCE study has confirmed is that it is too simplistic to expect the wide range of SUMI reviewed here to provide a uniform indicator of economic benefit. The conditions needed for deployment, and the assumptions made about costs and benefits are too complex to simply compare one measure against another.

Trying to use the long-standing and finely-developed techniques of appraisal and evaluation of transport projects will often not be valid or useful (particularly in respect of making funding choices). It is accepted, though, that when justifying expenditure for sustainable mobility interventions it is likely that there will be a need to present a business case. The EVIDENCE project and its outcomes offer an indication of the sorts of economic return and benefit that are likely to be experienced from the range of interventions commonly found in a SUMP. Policymakers should be conscious of the fact that some individual interventions may not achieve a payback in their own right, but will contribute to the success of others.

Making the case for delivering more sustainable mobility within a city will also need to address a more holistic understanding of outcomes. As is the case with any transport infrastructure project, it is only when the components of the mobility system are working together that the most benefits will accrue.
References