The Strategic Business Case for Smarter Traffic Management

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TRANSPORT TECHNOLOGY FORUM

About the Forum

This document has been prepared by the Transport Technology Forum to help drive more effective and efficient management of existing and new road networks, as a key national opportunity.

Road transport will remain a key pillar of how people and goods move across the nation, not just on strategic roads. Improving road travel through technology is a core aim of the Forum. We provide a neutral meeting place for senior policymakers and investors (government, industry and network operators) who are investing in technology for roads management and operation.

The Forum promotes a collaborative culture to open the opportunity and address the caution that has historically impeded efficiency and innovation.

Executive Summary

This report gives broad-brush estimates of the current and future value to the UK of road technology and connectivity to vehicles, fusing established sources of benefit estimates with new work on untapped areas. This is primarily designed to identify areas for detailed analysis but nevertheless gives an estimate of potential benefits. From looking at the size of current problems using published data and evidence of the ability of technology to reduce them, we conclude that:

The economic and cashable costs of "roads" - congestion, accidents, emissions and asset management - are now a £100bn per year problem. This is about four times fuel duty receipts from vehicles and about the same spend as the NHS budget in England.

Road technology already saves between £4-6bn of that cost across the UK, with a benefit to cost ratio of between 12 and 15 to 1, compared to a typical road scheme of 3 to 1. This benefit must firstly be safeguarded, as it is currently at risk from lack of funding, resource and skills pressures and lack of investment. It is also a key foundation for connected and later autonomous vehicles.

Overall there is a potential to rapidly save a further £4bn - £5bn of economic and cashable costs in the UK through adopting technology in the following areas:

- Helping towns and cities across the UK grow without hard infrastructure investment to add extra GDP of around £2.5bn per annum, to increase productivity nationwide. This needs traffic technology spread across authorities to be seen as a national, not local, investment. Local benefits add nationally to give major scheme level outcomes
- Through providing data and roadside services that help reduce the cashable cost of travel and parking to road users by £1.2bn
- Further reducing the cost of congestion by £400m pa across all of the UKs roads
- Reducing the economic cost of accidents by £360m pa and of emissions by £400m pa

Of these areas, those requiring the further exploration are:

- Emissions - work is already underway in DfT exploring this but it is a key potential benefit.
- Productivity - as exactly how to help cities grow using technology rather than hard infrastructure needs more analysis.
- Accessibility - reflecting the potential for Mobility As A Service but also unintended impacts.
- Asset management - as the potential cashable gains are high and there is appetite for change in the way roads are planned, maintained and operated.

Executive Summary

This work shows that using technology at the roadside is important as:

- There are clear cashable benefits as well as economic savings for the UK, impacting the whole UK road network and its users, not just motorways or the major road network.
- Vehicles with a high level of connectivity need to have connected roads to exploit, or else the UK business case for manufacturing them could suffer from low home market adoption, and the benefits from Connected and Autonomous Vehicles (CAVs) for safety and congestion may not be realised.
- In order that transport data can be shared and then exploited it needs to be collected and the control and management 'levers' need to be developed and in place. The data collected by the infrastructure and technology will lead to better network planning, building and operational efficiencies.
- Smarter parking is an immediate area of benefit in emissions, congestion and productivity as a quick win that will appeal to both authorities and users..
- Technology infrastructure can provide high benefit to cost ratio tools for the next 1-5 years that will pay for themselves before longer-term investments can start to deliver.
- There is a virtuous circle of safe speed improvement reducing congestion and NOx reduction
- More data is emerging on the true costs for congestion and safety across the UK, between £20-30bn cost for congestion and £36bn for accidents. Congestion is clearly impacting across all roads and road users in UK – not just London or strategic road network.
- These benefits are not evenly spread, so deployment needs to target specific areas of safety, congestion and emissions rather than taking a broader brush approach. For example, half of deaths are on 10% of UK roads and most serious accidents happen a junctions.
- Asset management in particular is only now starting to be explored using vehicles as data sources and there is potential for large cashable savings. So, using technology to address the UK wide local road congestion and emissions, plus asset management savings, local road safety and enabling wide data use (by collecting it and using it to plan infrastructure better) is a clear benefit, as well as paving the connected oad for Autonomous vehicles (AVs). Authorities need confidence to invest in technology locally and this business case needs translating to that local level.

Executive Summary

There is tension between the national view of the value of technology presented here and the assumption in WEBtag and all other assessments that transport investment has to be assessed at a local level. We should be building the national picture from aggregating the local rather than starting with the national and interpreting how this is applied locally. This tension potentially provides a barrier to the adoption of the arguments for smarter infrastructure as:

- We have insufficient evidence base at a local level – we may have for congestion and safety but it is likely to be impractical for emissions and productivity because the impacts of technology are quite subtle, diffuse and difficult to measure relative to a road scheme.
- The small scale of most technology investments will not stand the cost burden of a major assessment. This tends to mean that their value is not recognised.
- There is as yet no accepted national view of the value of technology.

A strategy for addressing this tension is at least as important as the business case. This needs:

- A widely adopted understanding of the place of technology in a modern city – it is not an optional extra but is core to effective operation.
- Develop ways of addressing or circumventing the traditional detailed local assessments enshrined in WEBtag.

Executive Summary

The following table summarises the benefits that are now detailed and explained in the rest of the report. It shows that future new large benefits come from untapped areas like productivity and reduced demand, not from current areas like congestion and safety.

Area of problem (in order of current knowledge)	Magnitude of value of problem per year	Our capability at the moment – what benefit are we protecting?	Potential to gain new benefit in 5 years	Potential for benefit from Technology	Rank by size	Confidence in capturing these new benefits through evidence	Action to deliver benefit
Congestion	£20bn – £30bn cost.	High – many tools and high penetration of technology	Medium – from new tools and new data	2% saving of £20Bn = £400M	4	High	Safeguard current tools and develop new ways to reduce congestion
Safety	**6bn cost.**	Medium - most improvement is vehicles, education/ enforcement	Low – as most tools now in place and core of less addressable accidents	1% of £36bn = £360M	5	Medium	Ensure we use tools to the fullest and explore key niche areas
Emissions	£20bn – £40bn cost.	Low - little technology impact	Medium/ High – from new tools and emissions driven traffic management	£20bn – £30bn cost.	3	Unkown- needs addressing	Needs further assessment but potential gains large
Cost of travel	£124bn	Low/medium – freight management is in place and getting smarter, but rarely links to network management	Low – as although new opportunities such as freight priority emerge the vast changes will be via vehicles and the fleet industry	1% of £124bn = £1.2bn	2	Unknown – needs more work	Area needs further assessment and evidence but potential gains large
Productivity	Untapped GDP increase on top of £1000bn GDP in cities	Low. In the future, the potential to improve productivity will relate more to managing and influencing demand	Medium – as this is a largely untapped area	0.25% of £1000bn = £2.5bn	1	Currently low	Consider UK traffic infrastructure as a nationwide asset on lines of major scheme increasing GDP
Accessibility	£2bn?	Low.	Medium – MAAS and other services may offer new means of travel	1 % of £2bn = £20m	7	Unknown – needs more thinking about impacts of MAAS	magnitude but may
Asset management and planning	£10bn	Low – little use of data and technology to reduce costs	High	3% of £10bn = £300m.	6	Unknown - clear candidate for more work	Area needs further assessment but potential large
Total	**around £220bn plus lost GDP**			**around £4-5bn**			

Introduction

The need for a Strategic Business Case

This report looks at "top down" figures for the scope and overall size of the potential areas of benefit from infrastructure and connectivity of roads across the UK. Together with "bottom up" detailed work to follow on, this aims to show:

- a clear and supportable strategic business case for continued national investment in Smart Infrastructure for roads; and
- the additional benefits from addressing problems in an integrated approach to road transport technology rather than the focus so far on automotive led solutions.

This is in line with the Forum's Vision for "Joined up technology and people to make roads work better - simpler, cleaner, safer, faster and more reliable - supporting innovation and enabling growth".
This is not a complete analysis of the potential benefits -its aim is at this stage to identify where there is an "undiscovered country" of benefits where more work is needed to model them in more detail.
The work was initiated in 2016 and reviewed with new data in 2017.

Individual problem areas of potential benefit

We have established initial quantified estimates of potential future benefit for:

- **Congestion** – i.e. road travel taking longer than optimal times. Note that there are many assessments of congestion, with various costs allocated, so we focussed on those using the DfT's Webtag approach.
- **The cost of travel without congestion** – even without congestion, travel and transport is a major cost to users and a barrier to industry and increasing GDP (parking, insurance, fuel).
- **Productivity increases** – this reflects the GDP growth beyond that from reduced congestion due to accumulation and agglomeration effects.
- **Safety** – i.e. fatalities, injuries and accidents involving all types of road user.
- **Reduction in emissions** – i.e. both as a contributor to greenhouse gases and more locally as a cause of fatalities and disease in cities. This might be the key benefit from making traffic smoother, without necessarily improving journey times.
- **Accessibility** – i.e. supporting a level of service for all travellers, in all places.
- **Asset delivery and management** – i.e. the cost of planning/installing new road infrastructure and to maintain current infrastructure.

An initial assessment of benefits already achieved by this technology –which need to be protected or are at risk from underfunding - is also derived.

Methodology

The objective at this first stage is to understand:

- What the current level of benefit is from transport technology, i.e. how much worse the situation might be without the current level of deployment?

- Which areas of future benefit are well understood and quantified and where knowledge is sparse or unsupported by evidence, and therefore additional analysis is required.

- Where there may be benefits from integration and joining together previously disparate approaches. As an example, a service combining satellite navigation, parking and signal timing information could reduce congestion and emissions, and increase the attraction of the city centre, all from a single app or device.

While many areas have mutually supportive benefits, i.e. reducing accidents reduces congestion which improves emissions, there will be also be tension. For example, the same combination as above would push against the wider use of public transport and improved accessibility and may have safety implications. It is finding the “sweet spot” in this balance that is the challenge.

It is also important to realise that not all monetary benefits are the same or have the same attraction:

- What we term for simplicity as “cashable” benefits mean industry, drivers or roads authorities spend less real money. This is increasingly a key driver for government, compared to:

- What we term “economic” benefits, where such measures as safety, driving time, emissions etc are monetarised, but there is no direct saving to the user, only to the wider economy.

Of course, there are combinations of these types of benefits – reduced emissions will have an economic benefit of saving lives but also may avoid in the short-term air quality fines and reduce the costs of cleaning city buildings (hard cash savings for an authority). Reducing driver’s time in congestion is only a true cash saving in some circumstances – e.g. a taxi, but for a typical driver commuting, there is only a marginal saving on fuel but a big improvement in customer service.

In theory, providing additional capacity for transport should help improve GDP, but this relies on the capacity being taken up where there are bottlenecks and additional “product” being developed. In the case of the M25 or a local small city, for example, attracting global companies to site their headquarters near to good transport links is good for GDP. Hence, we look specifically at productivity increases in GDP due to these impacts above and beyond simply congestion reduction.

There are also much wider hidden benefits we have not assessed (as the pool of quantifiable benefit is already big enough). Examples include that if “Mobility as a Service” (MAAS) replace parked commuter cars, car parks might be freed for development as housing. These benefits are beyond this “first pass” document but should not be forgotten. These could impact on GDP in the long term beyond the timescale of the TTF vision.

Comparing and quantifying benefits

Review of published data

Looking at literature about the benefits of technology, there is a great deal of hype and unsubstantiated assessments of benefits. Although these are unlikely to stand up to detailed scrutiny, they do provide a headline figure that is accepted due to its style rather than its substance. Such hype is actually quite useful for the Forum, as our work tends to be conservative in its benefits assessment. So being lower than these headline figures already adds a sense of realism and acceptability.

Our quantification of benefits falls into three groups:

a) Could be large but we don't know how to capture them, or how much...

These costs are largely vehicle related – at 40p per mile 311 billion vehicle miles[1] is £124bn. Improving road transport so fuel, loading and other efficiencies could gain even small improvements would deliver a large saving. But we have little evidence to date of how to gain this benefit with intelligent infrastructure rather than say fleet management services, so looking at how to reduce both vehicle miles and cost per mile would be a good investment.

Costs due to emissions are hard to estimate, and benefits even more so. But far more work is needed here. DfT have already recognised this but it is an area for this business case where expert analysis would be a good investment.

Increased productivity is often mentioned as a key benefit from reduced congestion, but there is a hidden benefit from people working more closely and goods moving more rapidly, the "agglomeration effect" that adds extra benefit. The appendix discusses this as a potential extra source.

Asset planning and management follows the same pattern. These are areas not traditionally at the core of road technology and suggest a new pool of benefit to address. DfT are now exploring this.

b) Known to be smaller, but we understand them already...

These are primarily congestion and safety. Together they are core to any developments – users expect safe and uncongested roads. But there may be less benefit than any or all of the above areas.

c) We just don't know...

How much accessibility might change with Mobility as a Service (for example costs to health, land use) we simply do not know. We have little evidence of the potential benefits here.

[1] DfT Transport Statistics 2016

Comparing and quantifying benefits

Additional unquantified benefits

Better road transport is not simply about fixing today's problems but being part of new wider opportunities. If we succeed, what we today call "ITS - Intelligent Transport Systems" and even the term "road transport" should dissolve into wider sectors – in the way for example what we used to call "e-commerce" is now part of "shopping". So, there are also other areas of benefit that are emerging, not to solve problems but to support new ideas and opportunities. Examples are:

- **New approaches:** Better roads support both smart city and mobility as a service. Would better roads support the more rapid uptake of Low Emission Vehicles? Can 2-hour delivery of shopping function well without better management of parking to deliver the goods? What change is needed to roads to support higher levels of automation, and the mix of automated and human technology?

- **Supporting new disruptive technologies and services.** These are where existing vehicles and roads combine with new services. Uber caught the roads sector unaware, and there will be other examples. Better roads need to support – not hinder – new technologies where they align with policy aims.

- **Enabling land use change.** Making road transport better – for example reducing reliance on the private car – could support changes in where and how we live.

- **Benefit to UK industry and government.** UK industry would be able to create revenue and jobs by firstly providing the UK with products and services, rather than foreign suppliers, and then exporting these. The current value of the UK transport technology industry is about £400M[2]. Equally UK government has a large cost for road transport – the NHS and MOD both have extensive fleets that cost the UK when caught in congestion[3].

None of the above yet have clear numerical values, so have not been looked at in detail.
There is also the potential for revenues from services for authorities, as highlighted in the TSC report on User Needs[4]. Those most likely to impact the TTF are, for example charges for enhanced parking services.

This analysis suggests more robust work needs to be done on benefits in emissions, asset planning and maintenance and reducing the cost of travel, as they are largely untapped areas of benefit. Mobility as a Service needs a wide-ranging view of benefits to capture its potential to assist accessibility. We also know safety and congestion are current benefits from intelligent infrastructure and need to ensure they are safeguarded with evidence of success.

[2] Early TTF research based on ITS-UK data

[3] Innovate UK data on the cost of NHS travel

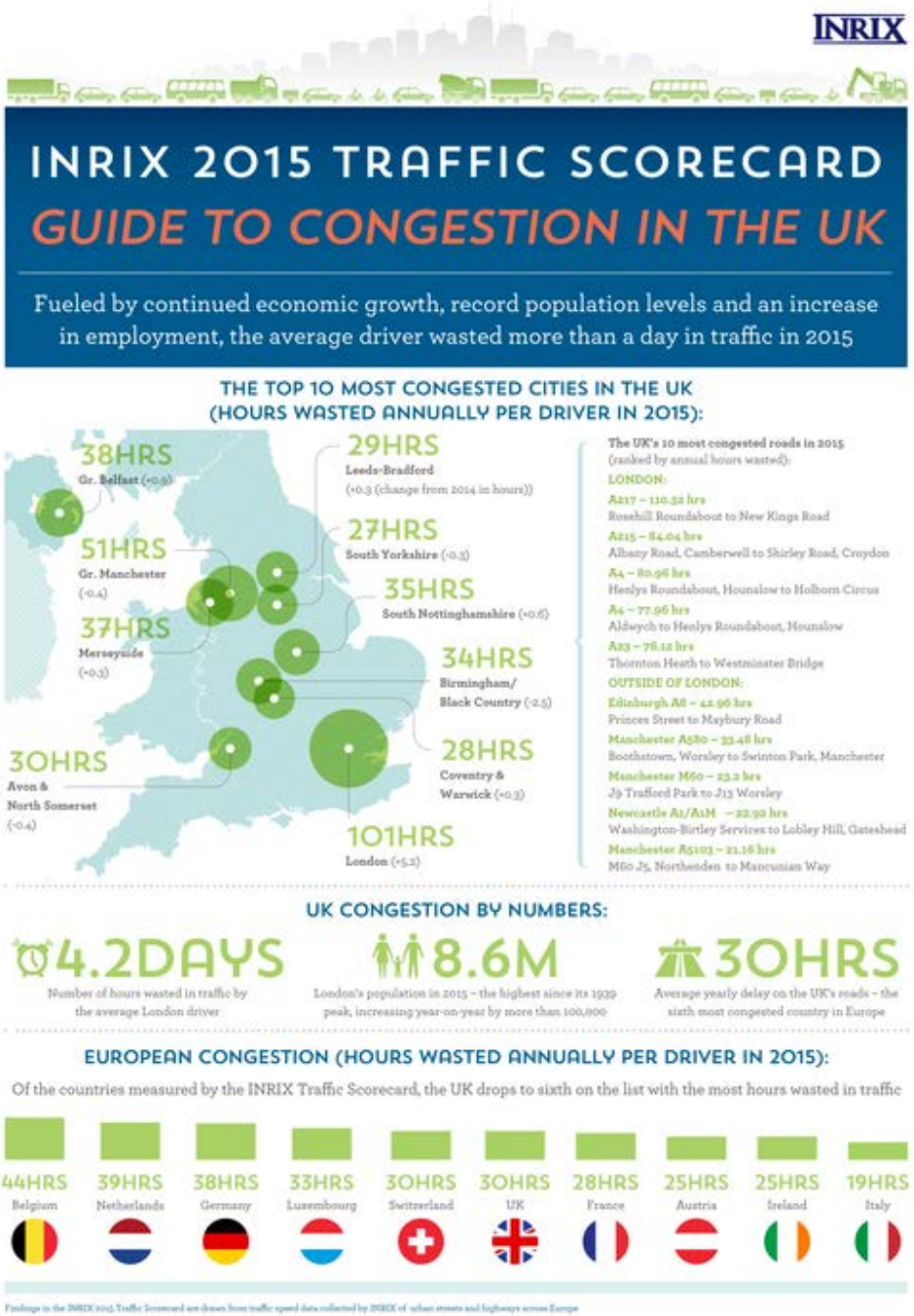
[4] https://ts.catapult.org.uk/current-projects/traveller-needs-uk-capability-study/

CONGESTION

How big is the problem?

The measurement depends on the definition of "congestion" – for example is it time spent driving at less than the speed limit? Hence there are varied estimates depending on data sources. DfT and Highways England look at average speeds and reliability of speed for a road section (as congestion may not be so much of an issue if it can be predicted). However, they have no overall "cost" directly derived from this data. A useful paper by ITS Leeds[5] has used past data and shown ranges of congestion costs in 2006 for between £2bn and £28bn, with DfT figures suggesting a cost of £7.8bn in 2004, and ECMTdata £11.7bn.

Data sources such as INRIX and TomTom, and bodies such as the CBI also produce congestion scorecards that enable estimates of the cost of congestion by looking at total time, as shown below.



5 ITS Leeds http://www.gov.scot/resource/doc/153566/0041321.pdf

CONGESTION

A report, "cost to UK economy of congestion in cities" by TomTom shows 129 hours per vehicle per year in cities. This is £915m in lost productivity composed of such elements as Belfast £14m, London £264m, Manchester £169m. This highlights the cross-UK nature of the congestion problem and that it is city based as well as strategic roads. It is not clear if these values use Webtag data but the UK wide spread is well demonstrated.

Data from INRIX published in February 2017 shows £31bn cost of congestion across 31 cities with a £968 loss per driver. London has a £6bn loss, while Exeter is the UK's slowest city with a peak speed of 4.6mph. Business suffers the most from traffic in Cardiff with congestion between the morning and evening peak periods, both in and out and within the city, occurring for 15% of days. Exeter and London suffer badly from congestion, sitting in traffic in the 'city centre' 17% and 16% of the time respectively during the day. This again highlights non- strategic network congestion and was undertaken by transport economists using Webtag values of time.

A summary of such estimates is:

Source	Cost of "congestion"
INRIX	£31bn in 2016 across the UK. 30 hours for every UK driver in congestion vs target speed = £1426 per UK household[6]
CBI	£20 Bn per year total UK cost often quoted. 19.2 seconds per mile lost due to congestion in 2010[7]
TomTom	127 hours stuck in traffic in 2015 for every UK driver[8]

From the above range, we can justifiably say, "whatever we mean by congestion, it costs the UK today over £20Bn and maybe £30bn". This is a large enough target not to warrant much further analysis given the broad-brush nature of this work. Future work could use DfT data but this may well come up with a similar answer.

What causes it?

- Demand for travel simply exceeding capacity, for example commuting, freight deliveries for internet shopping and holiday/tourist traffic;
- Accidents, weather, roadworks and other asset maintenance;
- Poor network optimisation and control; and
- Looking for parking.

6 http://inrix.com/press/scorecard-uk/

7 http://www.cbi.org.uk/business-issues/infrastructure/bold-thinking-roads-report/infographic-traffic-congestion-now-and-in-2035/

8 http://www.tomtom.com/en_gb/trafficindex/

CONGESTION

How does TTF vision help deliver benefits?

- Match demand to capacity (in time, space and occupancy of vehicles).
- Better management to match capacity to demand via better traffic control systems using better data.
- Reduced roadworks and asset management.
- Safety applications for example queue warning, weather warnings and better winter maintenance reducing associated congestion.

Also, congestion is the highly visible outcome of poor roads and network operation. It upsets customers, is politically sensitive and is a base expectation of a road user.

So, reducing congestion would be a key target not simply due to the size of the problem but also the credibility of the solutions. Congestion improvement also has added gains in reducing emissions as discussed later.

How does TTF vision help deliver benefits?

There is much evidence[9] that network management eg the SCOOT system can reduce delays by 10-20% across UK towns and cities. Other UK traffic systems eg ATM[10] on motorway reduce delays by between 5% and 24%.

These are existing benefits but wider adoption of technology across the UK can deliver more, so we conservatively adopt a 2% saving of the lower band of £20bn cost as potential extra benefit.

[9] Unpublished TTF Report to DfT on Future Smart Traffic Management and DfT Traffic Advisory leaflets 07/99 and 03/97

[10] http:/www.dft.gov.uk/pgr/roads/tpm/m42activetrafficmanagement/atm12mthsumrep.pdf

Safety

How big is the problem?

Here the DfT quantified data[11] is excellent. In headline terms, the UK had on roads in 2016:

- 1792 deaths in 2016, an annual increase of 4%
- 816 fatalities in cars but 448 pedestrians and 421 on motorbikes and cycles
- Vulnerable Road Users have much higher casualty rate per mile
- There were 789 fatalities in built up areas, 910 in non-built up, and 93 motorway deaths
- They calculate accidents cost the UK £36bn per year

This suggests that pockets of accidents need addressing by type and location, and that while UK roads aren't getting safer overall, motorways are not the problem people perceive them to be. To add to this, the Highways England Annual Accounts 2017[12] show that Killed and Seriously Injured numbers are increasing on their non-motorway network by 6% yet the target is to decrease by 40% by 2020. This again reflects the pots of cost and benefits away from motorways.

The report "Cutting the Cost of Dangerous Roads" by Eurorap[13] shows that 50% of road deaths occur on 10% of roads, with the biggest injury cause is behaviour at junctions. Simple solutions can reduce deaths including technology – the best 10 roads treated saved £17m of accident costs in one year. There remain 550 black sections of road requiring attention. This shows a good benefit to cost ratio for targeted not scattergun deployment. Technology may add a new tool where enforcement, education and engineering does not deliver anymore and roads authorities can use technology as a new tool beyond traditional ones e.g. at junctions for cycle safety.

But there is a challenge here. The UK has as "a big picture headline" some of the safest roads already. In absolute terms, the UK, along with Sweden, the Netherlands and Denmark, are the four safest EU countries. But each death or injury is still one too many and there are still some core issues – younger drivers, drink/drug driving, older motorcyclists, pedestrians that are not impacted by improvements in vehicle safety. So it is also an emotive area. We cannot be seen to be resting on our laurels.

11 https://www.gov.uk/government/statistics/reported-road-casualties-great-britain-annual-report-201

12 https://www.gov.uk/government/publications/highways-england-annual-report-and-accounts-2016-to-2017

13 https://roadsafetyfoundation.org/project/cutting-cost-dangerous-roads-british-eurorap-results-2017/

Safety

The DfT data shows that “failed to look properly” was the most frequent contributory factor, in 44% of all accidents in 2014. For fatal accidents, the most frequently reported factor was loss of control. For pedestrian accidents, “pedestrian failed to look properly”was reported in 59% of cases, and “pedestrian careless, reckless or in a hurry” 29% of cases. Exceeding the speed limit was a factor in 5% of all accidents, but these involved 17% of fatalities. Travelling too fast for the conditions was reported in 10% of all accidents and these accounted for 25 percent of all fatalities.

So human error is the key causal factor in most accidents. From the above, it is clear that road safety is not simply now about enforcement, engineering and education – it is a complex system where more sophisticated solutions may be needed, for example to reduce “failed to look properly” at junctions. Supporting the potential safety benefits from highly automated vehicles will require infrastructure deployment too.

How the TTF vision supports safety

- Speed and other enforcement technology, and other elements such as pay-as-you-go insurance.
- Detecting vulnerable users not otherwise seen by drivers and reduced driver error.
- Driver education and training using data eg fleet management.
- eCall for rural road responses where many accidents occur.
- Better Data on accident causality to understand new solutions.
- Co-operation between vehicles as well as road users.

How much might we benefit?

There is little proven evidence of the value of technology not already deployed, such as speed cameras and Active Traffic Management[14] on motorways. Nevertheless, there is a great potential from the many safety systems being developed for cycle safety, such as eCall so we conservatively adopt a 1% saving of the £36bn cost as potential extra benefit.

14 http:/www.dft.gov.uk/pgr/roads/tpm/m42activetrafficmanagement/atm12mthsumrep.pdf

EMISSIONS

How big is the problem?

Emissions are often the forgotten problem in road transport. Unlike a road accident, they do not grab headlines as people being killed suddenly. Instead, death occurs sometime in the future and it is difficult to allocate the cause to road emissions rather than general poor air quality. Air quality legislation and the threat of EU fines have raised it up the political agenda, and the recent VW scandal has also raised the level of research again.

Current work[15] suggests at least 29,000 people are killed in the UK from particulates every year, in addition to longer term effects from NOx and greenhouse gases. Around 25% of these are understood to come from transport. This suggests a rough estimate of around 7,000 deaths per year[16]. Looking at this compared to 2016 road accidents deaths of 1792 above, which have a total cost of £3.5bn, saving 7250 deaths per year due to emissions would equate to around £14bn of equivalent road accidents.

Emissions and links to deaths are a complex subject, but what is becoming clear is that it should no longer be the forgotten problem relative to congestion and safety.

Review of evidence

A report, Tackling Congestion and Pollution by Greener Journeys[17] shows that halving average speeds leads to 50% more NOx. It also shows in Central London that vehicle speeds have caused 10% more diesel NOx from cars and vans and more than 20% for large vehicles. They calculate the cost of air pollution = £20bn per year and note the contribution of vans. They also note congestion is UK wide. They show that increasing the speed of a diesel bus from 3.7mph to 5 mph halves NOX. This can be done by bus priority which reduces bus emissions per passenger by 75% compared to cars with a typical benefit to cost ratio of 3.5:1. This again shows the relationship between congestion and pollution – solve congestion and other gains follow. It also suggests more need for greater evidence of impacts. It also shows the value of infrastructure-based solutions instead of speed humps in keeping improved speeds safe.

A further report from the RAC[18], Road transport and air pollution by Ricardo suggests 534,000 years of life lost in UK per year due to NOx and particulates and cost to society for the UK as follows:

- Air pollution £25.3bn and carbon £3bn.
- Congestion £22.5bn (which compares well to the figure used earlier).

15 http://www.dft.gov.uk/vca/fcb/cars-and-air-pollution.asp and https://www.gov.uk/government/news/estimates-of-mortality-in-local-authority-areas-associated-with-air-pollution

16 https://www.telegraph.co.uk/news/earth/environment/10796035/Diesel-engines-responsible-for-7000-deaths-a-year.html

17 https://greenerjourneys.com/publication/tackling-pollution-congestion/

18 https://www.racfoundation.org/research/environment/road-transport-and-air-pollution-where-are-we-now

EMISSIONS

What causes it?

Vehicle Emissions in general come, as well as engine and exhaust system design issues, from:

- Vehicles stopped and in congestion with engines running;
- Vehicles not running at optimal speeds; and
- Poor routeing and choice of time of travel, and unladen vehicles.

Particulate emissions come not just from engines, but tyres, brake dust and other matter from vehicles too. These can also come from stop/start behaviour, especially in congestion and traffic signals, and looking for parking spaces. These are the key areas where infrastructure can add to automotive related benefits.

How the TTF supports reduced emissions

- Monitoring and information on pollution for decision making and future enforcement.
- Enabling people to use Low Emission Vehicles with confidence and Low Emission Zone charging and management.
- Better signal control strategies to smooth traffic and signal phase and timing (SPAT) to reduce stops at signals.
- Smarter motorway management.
- Smarter parking and emissions dependant parking prices.

These are in addition to other benefits from:

- Reducing congestion and accidents as above.
- Reducing the demand for travel (as described later) and improving overall efficiency of travel.

This highlights the interconnectivity of benefits – and possible potential for double counting. Reducing accidents will also reduce congestion and reduce emissions and increase reliability of journey times.

How much might we benefit?

Evidence of the value of technology in reducing emission is starting to emerge, e.g. through the COMPASS4D project and recent DfT unpublished research. But its likely that this will be highly site and time specific but could offer significant savings from new areas of deployment (in contrast to congestion and safety where there is much in place). So, we conservatively adopt a 2% saving of the £20bn average cost of the sources above as potential extra benefit.

THE COST OF TRAVEL (WITHOUT CONGESTION)

How big is the problem?

Setting apart congestion, transport is the key enabler for a vibrant economy but expenditure is huge:

- 311 bn vehicle miles were travelled in the UK in 2014[19]. At a notional 40 pence per mile as agreed with HMRC, this is a cost to the UK of £124 billion. Remembering that accidents and congestion were around £30bn, this show that small efficiencies in road transport in general (reducing vehicle miles or the cost per mile, or both) could have larger cashable impacts.

- Parking is both a key revenue source for an authority and a cost in terms of congestion and emissions, but also the key to a vibrant town centre. A report by Privilege Insurance[20] suggests UK motorists spend 2.2 days a year each looking for parking, - 47 minutes per week in Birmingham.

- Many UK companies pay over £1m per year in penalty charge notice fines for parking[21], as the risk of paying the fine is cheaper than the cost of a late delivery.

What causes the problem?

- Cost of empty vehicles, poor routeing, missed connections.

- Inefficient driving using fuel and wear and tear, multiple small deliveries to the same location.

- Parking and parking penalty costs.

How can the TTF assist?

- Using technology to make road travel smarter and manage demand, and help modal shift.

- Improve vehicle operations (vehicle miles) especially for internet deliveries via better route planning.

- Improve vehicle operations (vehicle miles) via LEV charging points.

  This highlights the interconnectivity of benefits – and possible potential for double counting. Reducing accidents will also reduce congestion and reduce emissions and increase reliability of journey times.

How much might we benefit?

Much of the reduction in non-congestion cost of travel will be due to vehicles and fleet management, but smarter infrastructure may also help reduce this through, for example, demand management. We have conservatively assumed a 1% reduction in travel costs is possible but this needs further detailed research.

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[19] DfT TSGB 2014

[20] https://www.directlinegroup.com/media/news/brand/2016/16122016.aspx

[21] Source: GRID smart cities presentation

PRODUCTIVITY

How big is the problem?

As well as the cost of congestion and road travel, poor transport links stop a town or city from being as productive as it may be in all its business and activities, due to its inability to grow sustainably. This is often seen as inability for businesses to recruit due to transport, poor supply chain reliability and delivery challenges. The problem is UK wide and impacts towns and cities, but also the strategic networks that feed them to some extent.

What causes the problem?

- Poor reliability of transport constrains city growth and investment that drives GDP.
- Poor parking, ineffective deliveries, poor public transport all constrain the ability to recruit and sustain workforces.
- Inability to access resources.

How can the TTF assist?

- Using technology to make road travel smarter and manage demand, and encourage modal shift, to help a city grow without physical infrastructure investment.
- Ability to apply to cities and towns across the UK.
- Improve deliveries, parking and adoption of new smart city approaches.

How much might we benefit?

A full discussion of productivity gains over and above congestion and vehicle costs is in the appendix, due to the complex nature of the arguments but in summary:

It is widely accepted that agglomeration, i.e. close proximity of businesses and labour supply to each other, increases productivity. Work done by the UK city regions suggests that a doubling of city size gives an increase in city productivity of between 3% and 8%, with potentially higher values for service industries and lower for manufacturing. So, if the GDP of primary urban areas - £1000bn pa, then:

- The 5% increase in capacity/activity enabled by technology in effect enables cities to be 5% “bigger” with no fundamental change in fixed infrastructure (certainly in city cores).
- This 5% increase in effective size gives 0.25% increase in productivity (based on 5% increase in productivity from doubling city size).

So net productivity gain from technology application:

= £ (1000*0.0025) bn pa, = £2.5bn pa

This is a large potential benefit for the UK as a whole, even with conservative assumptions of 0.25% increase in GDP. It warrants further exploration.

ACCESSIBILITY

How big is the problem?

22% of all households do not have access to a car[22]. There were nearly a billion concessionary bus journeys in England in 2016[23], and there are 2.4m Blue Badges for accessible parking[24]. It is difficult to put a value to the cost of people not being able to travel, but a proxy might be the cost of providing travel for example on buses. Local public transport is 14% of total transport expenditure. The UK Government supports bus services with £2.2bn of net support, whereas receipts from fares are £3.3bn[25].

What causes the problem?

Car ownership is both expensive and implies a driving licence is held. So many parts of society – teenagers, disabled, elderly, people in poverty, have no option but to use other forms of transport. This can limit their quality of life and freedom, can also be costly and has a social cost too.

How can the TTF assist?

By supporting the move to new forms of ownership of vehicles, and new vehicles too, Mobility as a Service could reduce the lack of access to personalised transport. Automated vehicles could remove the need for users to have driving licences. This is a longer-term benefit as yet not fully understood.

How much might we benefit?

If we assume technology could help reduce the £2bn of government support by 1% this gives us a conservative £20m, but this is an area where mobility as a service might make much higher gains and so further exploration is needed.

22 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/633077/national-travel-survey-2016.pdf

23 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/560716/concessionary-travel-statistics-year-ending-march-2016.pdf

24 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/572802/blue-badge-scheme-statistics-2016.pdf

25 https://www.gov.uk/government/collections/bus-services-grants-and-funding

ASSET MANAGEMENT AND PLANNING

How big is the problem?

The UK is investing £6bn on local roads and £4bn on motorways from 2015[26]. Planning the best use of this investment to deliver the best value is essential. Traditional road planning techniques often deliver inadequate infrastructure by the time the scheme is delivered. Highways England spends £1bn per year on maintenance of roads alone, with many local councils spending £50m on maintenance each. The UK local road maintenance budget is £3.6bn[27].

There is reportedly a £12bn backlog of pothole repairs also, with claims for damage to vehicles of £1.8m.

Review of literature

A report: "Digital Innovation: The Route to the Highways of the Future" by ADEPT October 2017 shows that 96% of roads by length are local authority managed, with the UK having transport infrastructure of the second lowest quality in the G7 countries. Of the £3.6bn spent on road maintenance, 61% is structural and 30% is routins. It values the UK local authority asset as being worth £400bn.

It shows many of the same data sources as for the TTF work e.g. connected vehicle data and highlights the need for a whole council digital view, the need for better procurement, standards, technology agnostic solutions, all of which align with the TTF thinking.

It highlights the need for assets and traffic management to be joined up in a Local Authority and that there is a risk of local systems being left behind. It asks for a knowledge exchange capability to support on local highway systems, need for how-to guides and toolkits and a retrofit demonstrator at scale. All of this aligns well with TTF thinking.

A report, "Pothole compensation claims 2016"[28] by the RAC shows that pothole claims cost UK councils £1.8m per year across 31,000 claims (average claim £432). Hampshire had nearly 2000 claims. This is a real hard cash loss to resource strapped authorities so Improved asset management might reduce this.

This is not a big value per se, but indicative of size of problem. Also claims need to be verified – authorities must have a cost in administration far more than the claim value.

What causes the problem?

There are many causes from sheer weight of traffic and axles due to accident damage. The current approach is for regular time-based surveys of assets using specialist survey vehicles, as there is little other data to feed smart asset management solutions.

26 https://www.gov.uk/government/collections/road-investment-strategy

27 https://www.adeptnet.org.uk/documents/digital-innovation-route-highways-systems-future

28 https://www.racfoundation.org/research/economy/pothole-compensation-claims-2015-16

ASSET MANAGEMENT AND PLANNING

How can the TTF Vision assist?

By supporting the move to new forms of asset management using new data sets collected from vehicles that may allow a more incident based asset management response (fixing a small problem before it becomes large) and trend information across days not years.

In addition, new data sources can help plan better hard infrastructure investments to reduce the risk of over or under capacity designs being deployed. This is an untapped benefit starting to be explored in, for example, York and through other projects.

How much might we benefit?

If we assume technology could help improve the effectiveness of the £10bn road infrastructure and asset management spend by 3% this gives us a conservative £300m but needs further analysis. The confidence in delivery of benefits is higher as ADEPT also indicate substantial opportunity in this area.

CURRENT ECONOMIC BENEFITS FROM ROAD TRANSPORT TECHNOLOGY DEPLOYMENT

It is valuable to use the above estimates of future technology to see where benefits are currently obtained, to:

- Highlight the benefits that need to be safeguarded due to funding, resource and skill shortages; and
- As a sanity check for the work undertaken on future benefits.

Area of problem	Magnitude of value of problem per year, and type of benefit from addressing	Our capability at the moment – what benefit are we protecting?	Potential for benefit from technology currently	Examples/ Evidence of benefit
Congestion	£20bn – £30bn economic benefit and cash	High – many tools and high penetration of technology	10% saving of £20bn = £2bn	SCOOT, ATM, MIDAS, MOVA, UTMC (Mova alone is valued by DfT at £220M)[29]
Safety	**£36bn economic benefit**	Medium - most improvement is vehicles, education/ enforcement	Say 5% of £36bn = £1.8bn	Most fatal accidents with VRUs, excess speed etc
Emissions	£20bn economic benefit plus avoided fines	Low - little technology impact so far but some savings from SCOOT MOVA etc	Say 2% of £20bn= £400m	
Cost of travel	£124bn cash benefit	Low/medium – freight management is in place and getting smarter, but rarely links to network management	Say 1% of £124bn = £1.2bn	VMS, parking info, route planning, roadworks info,
Asset management and planning	£10-£15bn cash saving	Low – little use of data and technology to reduce costs	nil	ADEPT report
Total	**around £220bn plus lost GDP**		**around £4-6bn**	

29 Traffic Advisory Leaflet 3/97 (in 1997 prices)

CURRENT ECONOMIC BENEFITS FROM ROAD TRANSPORT TECHNOLOGY DEPLOYMENT

Discussion of the comparison

If the total cost the current ITS sector as derived by earlier TTF work is £400m, this shows around a 10:1 to 15:1 benefit to cost ratio. Any single benefit area outweighs this cost. These are rough orders of magnitude numbers but show the current value of protecting investment.

The future benefits calculated are of the same order of magnitude as current benefits, but the technology for these has been developed and installed over many years. This suggests a more rapid benefits stream from new sources of benefit.

The current values suggest around a 5% nationwide saving in congestion and emissions which is in line with evidence (typically higher values for systems are obtained, but they are not installed nationwide). This 5% saving is a useful estimate for additional productivity shown in the next section. Both the current and future estimates are generally lower than other reports, e.g. the TSC data report[30] gives £14bn per annum benefits from use of data by 2025 compared to £4bn. Of this, £4bn is reduced congestion, £4bn of accidents, £500m productivity and £1bn emissions, so £4bn is GVA. In contrast, we estimate £400m congestion, £360m safety, £2.5m productivity and £400m emissions.

However, this is from use of data in all forms, so may have some vehicle derived benefits, and is on a longer timescale (2025 not 2022).

30 The Case for Government involvement to incentivise Data Sharing in the UK Intelligent Mobility Sector

IMPLICATIONS

This work shows that using technology at the roadside is important as:

- There are clear cashable as well as economic savings for the UK as a whole, impacting the whole UK road network and its users, not just motorways or the major road network.
- Vehicles with a high level of connectivity need to have connected roads to exploit, else the UK business case for manufacturing them could suffer if there was less home market adoption, and the benefits from CAVs for safety and congestion may not accrue.
- Sharing and exploiting transport data requires it to be collected and control and management "levers" to use it. Hence there is a key role of infrastructure and technology as it enables data use, better network planning and road building, not just operations.
- Smarter parking is an immediate area of benefit in emissions, congestion and productivity as a quick win that will appeal to both authorities and users.
- Technology infrastructure can provide high benefit to cost ratio tools for the next 1-5 years that will pay for themselves before these longer-term investments can start to deliver.
- There is a virtuous circle of safe speed improvement delivering reduced congestion and NOx reduction.

This work also shows that:

- More data is emerging on the true costs for congestion and safety across the UK, between £20-30bn cost for congestion and £36bn for accidents. Congestion is clearly impacting across all roads and road users in UK – not just London or strategic roads.
- These benefits are not evenly spread so deployment needs to target pots of safety, congestion, emissions etc rather than broad brush. For example, half of deaths are on 10% of UK roads and most serious injuries are at junctions.
- Asset management in particular is only now starting to be explored using vehicles as probes and there is potential for large cashable savings to help resources.

So, using technology to address the UK wide local road congestion and emissions, plus asset management savings, local road safety and enabling wide data use (by collecting it and using it to plan infrastructure better) is a clear benefit, as well as paving the connected road for autonomous vehicles. But authorities need confidence to invest in roadside technology locally and this business case needs translating to that local level.

APPENDIX:
EXAMINING "PRODUCTIVITY" BENEFITS

What are Productivity gains?

Technology applications to date are heavily focused on congestion reduction, but there remain opportunities to further increase their effectiveness and reduce cost through, for example, the adoption of new data sources and improved responses to travel disruption.

To date, productivity gains have focused on technology which increases the effective capacity of road infrastructure and which makes our cities and towns more usable (such as urban traffic control and parking management).

In the future, the potential to improve productivity will relate more to managing and influencing demand - providing of information to enable more efficient and effective overall use of available national infrastructure capacity. **This is a key benefit above and beyond simply reduced congestion.**

This benefit is because cities and major towns contribute disproportionately to the UK's £1.8tn GDP. Unlike the geographically limited impact of nearly all transport infrastructure schemes, applying technology to road transport increases the ability of every UK city and major town to handle activity, absorb population growth and deal with new demands for travel and mobility – it increases the economic capacity of the UK with little or no major infrastructure cost. This wider economic benefit is additional to the congestion costs savings experienced by travellers. So this appendix focuses on the "cities and major towns" component.

Basis of calculation/estimate

The "cities and major towns" element is exactly equivalent to Web Tag's "wider economic benefits" – it is benefit to the wider economy beyond the direct benefits to users represented above under "congestion management".

Conventional transport schemes are location-specific and the majority are reckoned to have wider economic benefits of zero – any effect on the local economy is assumed to be at the expense of other local economies, since economic activity is assumed to shift.

However, major schemes (eg HS2, Crossrail, M4 extension in Wales) are often deemed to have wider economic benefits.

Wide application of road transport technology can be considered alongside these major schemes because:

- It allows an increase in economic activity wherever it is applied – the "robbing Peter to pay Paul" displacement of economic activity does not apply. It increases the total economic capacity of he UK.
- The cost of road transport technology is small in relation to the cost of most major schemes.

APPENDIX:
EXAMINING "PRODUCTIVITY" BENEFITS

So DfT might usefully regard technology deployment to a good standard across the UK as a national major scheme of equal importance to more high-profile schemes. One barrier to this is the (unnecessary) presumption that transport schemes need to be location-specific.

We assume below that the wider economic benefits are focused on cities, since these are the hubs of economic activity and where agglomeration gains (see below) are felt.

Basic facts/assumptions

UK GDP: £493bn – 2017 Q4 – say £1900bn pa[31] : Source: UK population – 63.3 million

- Proportion of national population in the 64 primary urban areas including London (population 125,000 or more) – 54%

- Proportion of national population in London – 15%[32]

Based on the above, we assume £1000bn pa GDP produced in the primary urban areas (54% of £1900bn). In practice this is very conservative, since productivity in cities is higher than in non-cities, with London exceptionally high.

Capacity impact of applying technology (to date) - assume 5%. i.e. the combined effect of signals, SCOOT, parking guidance, etc, enables cities to handle 5% more vehicles/traffic (including public transport) than without such techniques (=productivity). This 5% is conservative and is broadly consistent with the 20% congestion savings identified by SCOOT and identified as the overall saving currently in place (i.e. a doubling of effectiveness of technology).

Percentage of urban (non-walk) journeys not by road (i.e. rail, underground, etc): London – 5.4m per day compared to 17.2m - 24% of non-walk trips[33] .Equivalent representative data for other cities not readily available but will be a smaller percentage than London.

Crude calculation of value of technology applied to roads to date

Basis:

- GDP of primary urban areas - £1000bn pa.

- Technology enables 5% more activity in those cities when networks are operating at capacity.

31 https://www.ons.gov.uk/economy/grossdomesticproductgdp:

32 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/321814/14-802-people-in-cities-numbers.pdf

33 https://data.london.gov.uk/dataset/travel-patterns-and-trends-london

APPENDIX:
EXAMINING "PRODUCTIVITY" BENEFITS

- This applies for, say, 1/3 of the road journeys per day (highest demand during peak periods).

- Only improvement to road journeys (76% of trips) contributes to this productivity improvement.

Therefore, net productivity gain from technology application:

= £ (1000*0.05/3*0.76) bn pa
= £12.7bn pa

Alternative Calculation based on agglomeration effects (technology applied to roads to date)

It is widely accepted that agglomeration, i.e. close proximity of businesses and labour supply to each other, increases productivity. Work done by the UK city regions suggests that a doubling of city size gives an increase in city productivity of between 3% and 8%, with potentially even higher elasticities for service industries and the lower elasticities associated with manufacturing[34].

Basis :

- GDP of primary urban areas - £1000bn pa.

- The 5% increase in capacity/activity enabled by technology in effect as calculated above for existing systems enables cities to be 5% bigger with no fundamental change in fixed infrastructure (certainly in city cores).

- This 5% increase in effective size gives 0.25% increase in productivity (based on 5% increase in productivity from doubling city size).

So net productivity gain from technology application:

= £ (1000*0.0025) bn pa
= £2.5bn pa

(We have not applied the factor of 0.76 in this calculation on the basis that the £1000bn is very conservative.)

Note that in the period between 2001 and 2011, the population of the primary urban areas grew by 7.5%. The ability of transport networks to accommodate this growth without a corresponding increase in fixed infrastructure will necessarily have been very important in enabling local economies to function effectively[35]:

[34] http://www.transportworks.org/evidence-base/agglomeration-effects

[35] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/321814/14-802-people-in-cities-numbers.pdf

APPENDIX:
EXAMINING "PRODUCTIVITY" BENEFITS

Potential additional gains

- New techniques will be developed to continue to squeeze more out of existing infrastructure
- Technology will beneficially influence the patterns of demand for available capacity
- Continued population growth (a further 10 million between 2012 and 2037 = 16%) will increase the necessity to continue to squeeze more productivity out of essentially fixed urban networks.

Agglomeration effects

There is a good deal of debate in academic circles about the validity of the concept of agglomeration effects. Webtag accepts that these effects exist and can be built into transport assessments. However, it is worth bearing in mind papers such as that produced by Melia, which sets out arguments for and against accepting agglomeration effects. Interestingly, a number of the arguments that he puts forward for not accepting agglomeration do not apply to technology interventions – because technology is very low cost, is innovative and is not creating new capacity that will readily be filled with induced traffic. So, the paper could be construed as saying that technology is a more effective means of generating agglomeration effects than conventional investment in infrastructure.

Agglomeration effects

There is tension between the national view of the value of technology presented here and throughout the TTF business case and the assumption in Webtag and all other regular assessments that transport investment has to be assessed at a locally specific level. Local transport planning assessments are becoming increasingly complex (albeit with some resistance to this complexity). We should be building the national picture from aggregating the local rather than starting with the national and interpreting how this might be applied locally.

This tension potentially provides a barrier to the adoption of the arguments for smarter infrastructure as:

- We have insufficient evidence base at a local level – we may have for congestion and safety but it is likely to be impractical for emissions and productivity because the impacts of technology application are quite subtle, diffuse and difficult to measure relative to a road scheme which either is or isn't there (e.g. how do we measure the increased attractiveness over time of a city which works more smoothly?)
- The small scale of most technology investments will not stand the cost burden of a major prior assessment. At present this tends to mean that their value is not recognised rather than their value being assumed.
- There is as yet no accepted national view of the value of technology.

[36] http://eprints.uwe.ac.uk/33772/1/Does%20Transport%20Investment%20Really%20Boost%20Economic%20Growth.pdf.

APPENDIX:
EXAMINING "PRODUCTIVITY" BENEFITS

A strategy for addressing this tension is at least as important as the soundness of the business case. This needs:

- A widely adopted understanding of the place of technology in a modern city – it is not an optional extra but is core to effective city operation. The TTF vision is part of this. Among authorities, TfL is well ahead of the game in this respect, regarding road technology as a fundamental part of what makes London attractive to its customers and work efficiently.

- Develop ways of addressing or circumventing the traditional detailed local assessments enshrined in Webtag. This might involve:

    - Using "rule of thumb" assessment techniques proportionate to the low levels of funding required for technology.

    - Regarding technology more along the lines of standards/guidance embodied in DMRB. For example, cities might be expected to adopt levels of technology provision/maturity in relation to their nature/size. As with a new road, expectations of standards of provision could be reflected in budgets

APPENDIX-
UPDATES AND NEW SOURCES DEC. 2017

This review was used to look at new sources of data and how they impact/support the original document.

Report: Socio- Economic benefits of Cellular V2X

Date: Dec 2017

By: 5GAA

Key problem related info: EU wide

Key solution related info: Benefits are safety led (20%) and congestion led (80%) (due to areas covered). Much higher benefits than a previous Ricardo study for 802.11p (20-43billion Euro net in 2035)

Key evidence: This shows large overall EU benefits – could be factored down for UK by say 5-10% of Europe to **get £1-4bn per year** by 2035 for the UK. Low benefits on motorways compared to rural and urban roads. Slow impact due to time to roll out in vehicles and roadside

Other action: Suggests a rollout of hybrid roadside equipment, and a slow takeup of net benefits due to cost of in vehicle – not the roadside equipment. Highlights benefits from smartphones

Key Summary: Looks at just connected vehicle benefits for safety and congestion across Europe with realistic roadside costs

Implication: Too long term but gives a high value top estimate of connected and C-ITS.

Vision Implication: Hybrid or market led communications solutions, focussing on roads problems where they occur

Report: RAC Foundation: Readiness of the road network for CAVs

By: Charles Johnson April 2017

Key problem related info: Impacts of CAVs on roads eg rutting, lane marking maintenance, digital maps, traffic signals, parking

So what? Evidence that roads and road systems are not ready for CAVs

Key evidence: Shows wide range of TTF aligned areas

Key Summary: Roads and roads tech needs a plan for CAVs – piecemeal won't do

SBC Implication: To gain benefits from Connected and Autonomous vehicles we need more roadside technology

Vision Implication: TTF helps consistent and interoperable transition to support Connected and then Autonomous Vehicles

APPENDIX-
UPDATES AND NEW SOURCES DEC. 2017

Report: The Case for Government involvement to incentivise Data Sharing in the UK Intelligent Mobility Sector

By: TSC April 2017

Key problem related info: Barriers to data but not clear from what size pot savings are made

Key solution related info: Suggests £14bn per annum benefits from data by 2025. Of this £4bn is reduced congestion, £4bn of accidents, £500m productivity and £1bn emissions, so £4bn is GVA

So what? Gives a high value estimate for comparison with our work but doesn't assess the current problem size. They highlight short term missed opportunity of £15bn by 2025 if nothing done.

Other action: **Needs a focus on sensing and control, at either end of the chain, to enable this benefit**

Key Summary: Roads and roads technology data offers benefits

SBC Implication: High value of data use (eg saving £4bn of **congestion)**

Vision Implication: TTF helps sources and users of data maximise this value

TRANSPORT TECHNOLOGY FORUM