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Revised Feb 2024

Buses, Busways & BRT.- are they successful in attracting car drivers and solving congestion? Or are they a failing mode?

DECEMBER 21, 2018 / DAVE / NEWS

Above: the Curitaba Busway

Bus patronage

Today 2024, buses carry about 5bn passengers a year or 7% of all trips made in Britain, compared to 1.4bn by rail (1.7%). When car ownership was much lower, until the 1960's most people in towns only had the choice of walking or cycling instead of buses or trams. Municipal operators saw buses as a low cost replacement for trams wearing out and for which no financial contingency had been made.

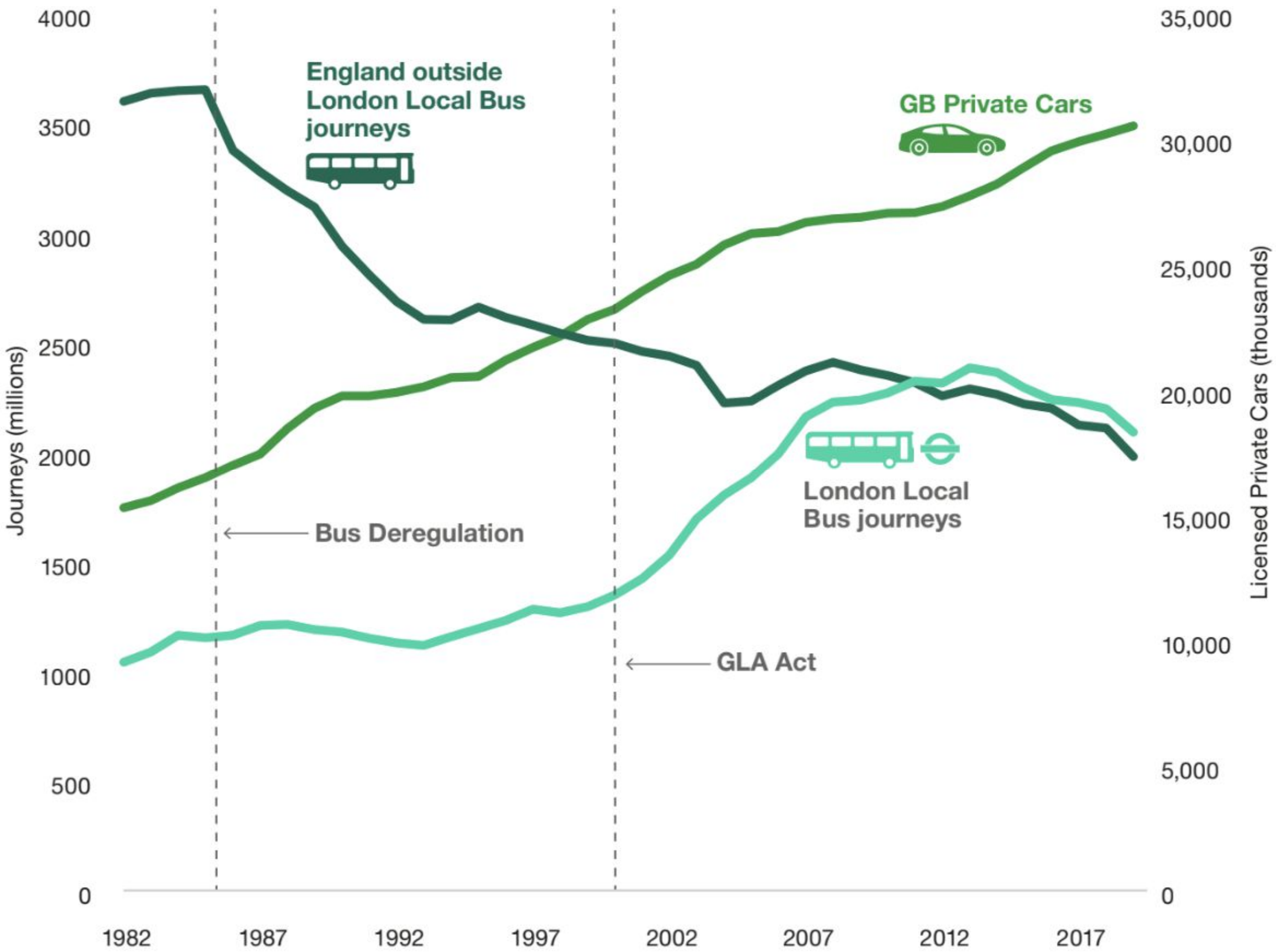
Bus use peaked in 1955 at about 15bn trips pa (London had 5bn), although there were still tramways in Aberdeen, Blackpool, Dundee, Edinburgh, Glasgow, Leeds, Liverpool, and Sheffield. By 1963 all except for Blackpool had scrapped trams for buses, which were new, often faster but continued average a third fewer passengers than the old 'rattly' trams. This however was better than the buses that replaced branch line railways closed after the Beeching Report. Here only a third of rail passengers transferred to bus services, which rarely lasted a year as people in rural areas bought or had access to cars.

Bus substitution to save costs is a 'supply side' approach and assumes a passive 'demand'. In fact, passengers do have and can make choices over travel, as London discovered after the 6 week long bus strike in 1958. It took nearly 40 years and a growth of population to regain the pre-strike level of ridership, during which time car ownership, traffic congestion and toxic pollution increased.

During the 1960's bus patronage nationally continued to decline, as people bought cars, moved house, or changed jobs, providing a chance to change travel patterns. In some urban areas bus use declined by more than the average of 1.5%pa. This led the government to pass the Transport Act 1968 to provide support for bus services. Fuel duty was rebated, to put buses on the same basis as duty free fuel used by railways. A 50% grant for new one man operable buses led to a rapid replacement of old buses and disappearance of conductors.

The "London model" has long been seen as a panacea for buses; but the "London model" was actually Ken Livingstone who had the courage to combine bus lanes and road pricing. Since 2012, the impact has worn off and TfL buses have been on precisely the same trendline for decline as buses outside the capital for the last nine years.

Bus usage in modern times 1982 - 2017



Since the start of the demise of Public Transport (multi-mode) in 1955, many attempts to reverse the trend have been tried but all but one have failed, and we now have several generations of trying to make the unworkable work

Mode Comparison

MODAL CHARACTERISTICS COMPARED (From the World Bank)

Mode Characteristics	Max. capacity (pph)
Car	1,000
Bus	2,500
Maximum Bus Priority	4,000
Segregated Busway	6,000
Tram	12,000

The above World Bank table is accurate for cars for the type of roads into most UK cities, but is perhaps optimistic for buses and trams, however it does show that trams are much more effective than buses. More realistic figures are shown in the tables below.

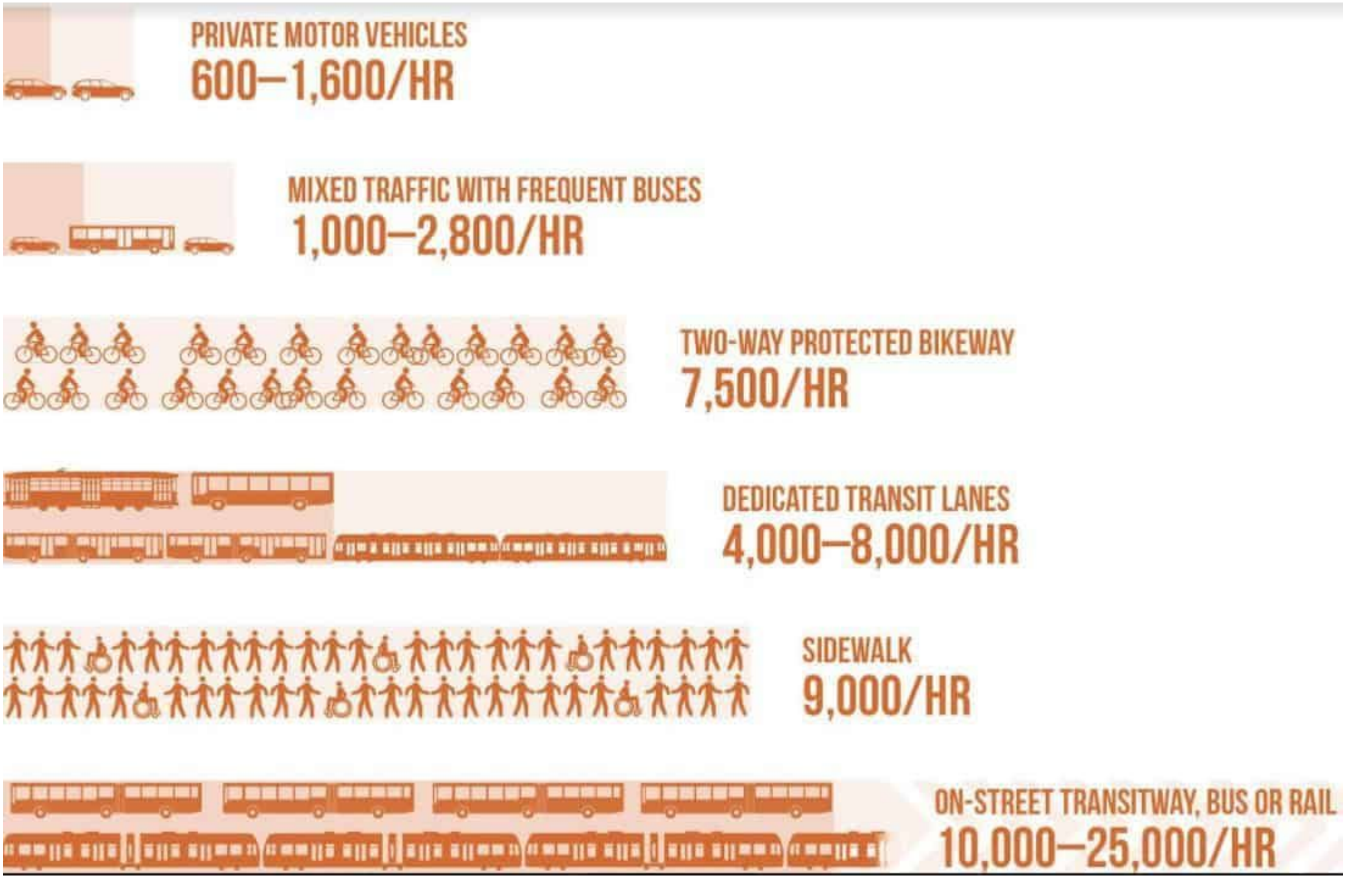
The roads into most UK cities have a maximum carrying capacity of about 1,000 persons per hour. From the information below we can see that buses can be 2.5 times more effective as car, but trams are 12 times as effective as cars, and about 5 times as effective as buses.

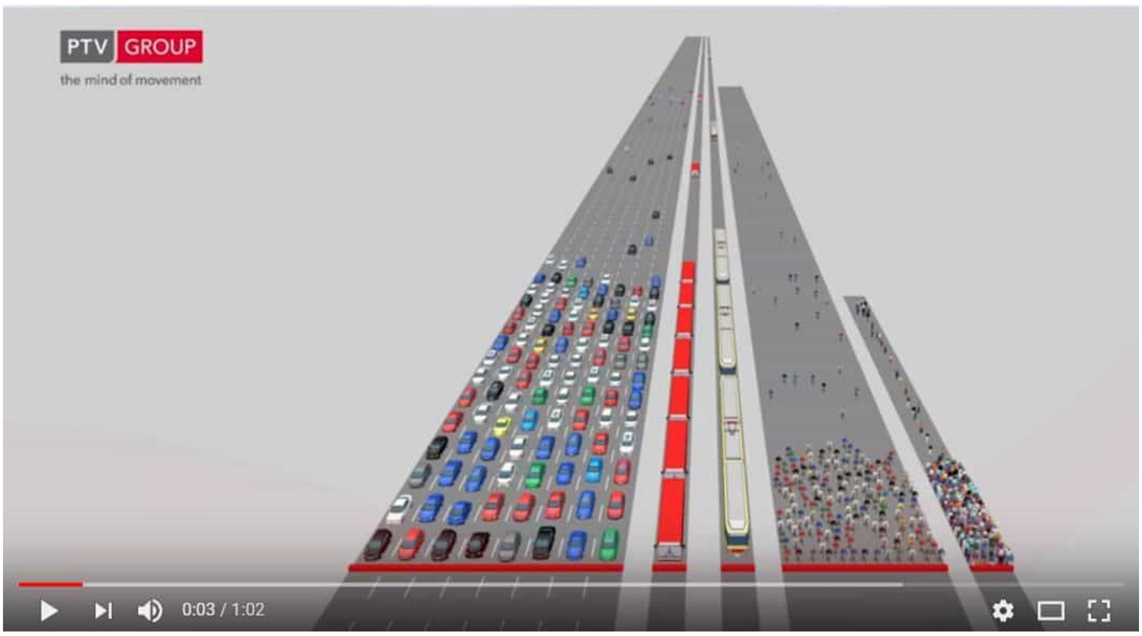
This is why trams can afford to operate at a 6 – 8 minute schedule throughout the day whereas buses have an inherently longer service interval and are more expensive per passenger kilometre, and thus tend to “cherry pick” the peak time routes.

“These tables are from “What light rail can do for cities,” published by the Passenger Transport Executive Group in 2005 (now called the Urban Transport Group). It’s a pretty comprehensive guide to trams. You can access it on-line at http://www.urbantransportgroup.org/system/files/general-docs/WhatLightRailCanDoforCitiesMainText_0218.pdf

These are values for vehicles in ordinary urban service. Table 3.1 gives maximum capacities based on a 1-minute headway, showing articulated buses at 7500 and trams at 21,000, but those are not sustainable except in special circumstances.

From David Walmsley, BSc PhD CMILT MCIHT, Transport Analyst:





In the above, it shows that the three car trams, white, in the centre, can replace 7 buses, and all the cars on the left, ie an 8 lane highway.

Runcorn Busway:

During the 1960's a second generation of new towns was also promoted. Arthur Ling, the Master Planner for Runcorn New Town decided that bus use decline could be reversed by making buses the first choice mode. He did this by designing a busway network focussed on the town centre ("Shopping City"), and clustering developments around bus stops, e.g., Castlefields. The road network was also built so that car trips would be slower than bus. It was confidently predicted that 50% of trips in Runcorn would be by bus. The busway opened in 1970 but designed for conversion to tram when use grew. "A major objective was to obtain a modal split of 50:50 between car and bus for work journeys. This was achieved in 1973 but not because car users were attracted to bus but due to the lack of choice for many people who did not have a car available."[3]

A further study in 1982 found 15% of Runcorn trips were made by bus, the same as other towns of an equivalent size without busways, and that most trips were by car. In 2015 ridership was 5%, and parts of the busway were out of use. Runcorn was the first busway in the world and became a model overseas.

Another aspect of the 1968 Act was the nationalisation of private bus companies into the National Bus Company in E & W, and the Scottish Bus Group. These together with Municipal operators meant that buses were run by public bodies. During the period of public ownership, Councils did not support their bus services well. Planning permission was granted for house developments that could not be served economically by buses. Out of town shopping centres appeared designed for car use.

Today most people have the choice of a car for most of their travel, or taxi, which has reduced in cost in real terms, even before Uber. The largest users of taxis are those in the poorest quartile households who do not have a car. Many US cities only have taxis as public transport!

During the period of public ownership various other methods were tried to halt the decline of bus use. The longest running was the South Yorkshire Low Fare Scheme, which began in 1976 by freezing fares. By 1986 it was anticipated that the cost of collecting fares would exceed the revenue, and that buses would then be 'free'. The TRRL monitored this 'experiment' during which bus use did increase slightly due to 'captive' riders making more trips, but no evidence was found of a modal switch from car.

Busways and priorities.

Bus Lanes: began to appear piecemeal to try to get buses past traffic congestion. Rarely however were they joined as continuous routes. Bus use continued to decline at about 1.5%pa. as car ownership passed the 25% of households with a car. The Transport & Road Research Laboratory (TRRL) calculated that each first household car reduced bus patronage by 390 trips a year, and ever second car by a further 250.

Unguided busways

The majority of busways worldwide are driver guided, like the first in Runcorn, where buses pass at a closing speed of 80mph on a narrow 'road' only 6.7m wide. These are the lowest cost busways to build and operate.

Ottawa

Ottawa has the largest 'unguided' busway system in the world. This however is being converted to light rail (tram) because:

- disappointing modal shift (almost zero) from car to bus
- main area high levels of pollution.

Houston

This major Texan city spent $100million per year for 10 years building busways during the late 1990's and early 2000's. At the start of this, buses carried 3% of all trips in Metro Houston. After ten years of busway building, the figure was 2.7%. Houston is now building a light rail.

Three lines already carry 32% of all public transport, or 0.85% of all trips in Houston.

Kent (UK)

A Fastrack network of busways is operated by Arriva. In winning the contract Kent County Council forecast 5m pa passengers. In the last 4 years patronage has stalled at 1.2m passenger pa. and is not financially viable.

For this reason, the local Director is calling for Fastrack to be converted to trams.

Curitiba

Many have held up the busway in Curitiba (Brazil) as proof that busways are the best way forward. The system is partly segregated in the centre of motorways and partly elevated. Although running on the right side, buses have their doors on the left hand side (like the UK) because island platforms are used throughout.

All buses are long, articulated with diesel engines. Like many South American Cities car ownership is lower than in North America or most of Europe, so many or most of the busway rides are 'captive'. The first part of the system was opened in 1974.

Curitaba busway

Guided busways.

There are two main methods of guidance: mechanical and other.

Kerb Guided Busways (KGB)

The first was built in Essen in 1980 to allow trolleybuses to run through narrow tram tunnels under the city centre. Subsequently the trolleybus was converted to tram.

Edinburgh

The KGB system was used for the City of Edinburgh Rapid Transit (CERT) later reduced to the West Edinburgh Bus System (WEBS) at a cost of £27million. This lasted for two years, as buses running on normal roads were faster, despite the contractor rebuilding part of the track. Some of WEBS was later demolished for the tramway.

Edinburgh Busway

Replacement Edinburgh Tram

Adelaide

A long KGB (guided busway) Line was built here as a result of a change of political control from Labour to Liberal (Conservative). One of the claimed advantages of the busway was through buses from suburbs to the city centre. In practice ridership on some branches does not justify through running, and passengers have to interchange at intermediate interchange stops. The busway is not being extended as recorded because of the high cost of the method of construction, nor will it be converted to tram, because while “the public would like that, but the changeover was unaffordable and not value for money”. New tramways are being built because “the well informed public voted 80% to 20% in favour of new tram lines and there is no campaign for new busways”.

Cambridge – St. Ives

This is the longest busway in the world, built after the tracks of the former railways were removed. Originally this was costed at £65m (buses extra). The out turn was £180m, two years late and a legal dispute between contractors and the County Council. Patronage figures remain ‘commercially’ confidential. Unofficially the figures are disappointing, especially as a third of passengers travel for free with pensioners passes. “The local MP has called it a White Elephant”.

Cambridge Busway

Caen

This proprietary busway was promoted as a tramway on rubber tyres and has been plagued with problems from the start, including ‘derailments’, spare shortages and costs. The Caen system uses a central slot for guidance and two overhead wires for electric power. The City Council recently decided to convert it to a tramway, noting it would have been cheaper in the first instance.

Caen busway, guided by central slot

Caen tramway replacement 2029

Leeds

The Scott Hall Road KGB was opened in 1995 to avoid a heavily congested road. Initially it was claimed that ridership had increased by 50%. Later it was clear that most of this was abstracted from parallel bus routes without a busway.

Trips attracted from cars were a statistically insignificant 3%.

Leigh – Manchester

A 4 miles KGB line on a closed railway links Leigh via the East Lancashire Road (A580) to central Manchester.

Now reaching its maximum pph, studies are ongoing to either scrap the guideway or adapt to enable to track share with a tram linking into Metrolink

Leigh – Manchester

Luton – Dunstable

It is noted that this is not very popular with local residents. Luton Airport has decided on a tramway link from the Parkway Station, rather than the planned busway extension. Passenger numbers on the busway are not impressive compared to new tram lines. There is also a poor accident record with buses crashing into each other and the central barrier. Residents have questioned why trams were not one of the alternatives during public consultations.

Luton – Dunstable busway **Luton Airport replacement**

Other guidance methods

The other guidance modes are either a buried cable or video following white lines on the roadway. Wire guidance was first demonstrated in Newcastle where it showed 'derailment' occurred when entering curves too fast. Nevertheless, the technology was then proposed for a Liverpool-Prescott where crash barriers on curves would have made the cost approach a conventional tramway, and the Government withdraw the offered grant.

Millennium Transit

A transit link between Charlton Station and the Millennium Dome was proposed to open for 2000. The estimated cost was £5m (buses extra). There were practical implementation problems and out turn cost was reported as £25m (buses extra). It has been reported the technology would not work reliably and buses are driven manually on the busway built. As it is the only way to and from the Jubilee Line North Greenwich Station it runs at capacity but cannot be economically expanded. On top of this the track is failing "after only 15 years and it is in urgent need of major repairs… there is no surplus revenue from the Millennium Transit fares to pay for them.

" Ironically, a tramway (including trams) was offered at £10m.

"Birmingham isn't a big city at peak times": How poor public transport explains the UK's productivity puzzle

By Tom Forth

The agglomeration effect

Many economists argue that larger cities are more productive than smaller cities and become ever more productive as they grow due to something called "agglomeration benefits".

There are many other factors that contribute to productivity, but this simple law seems to hold well in economies like the USA, Germany, France, and the Netherlands. For example, Lyon, the second largest city in France, is more productive than Marseille, the third largest city, which is in turn more productive than Lille.

Almost uniquely among large developed countries, this pattern does not hold in the UK. The UK's large cities see no significant benefit to productivity from size, especially when we exclude the capital.

The result is that our biggest non-capital cities, Manchester and Birmingham, are significantly less productive than almost all similar-sized cities in Europe, and less productive than much smaller cities such as Edinburgh, Oxford, and Bristol.

Public transport and city size

One notable difference between the UK's large cities and those in similar countries is how little public transport infrastructure they have. While France's second, third, and fourth cities have eight Metro lines between them (four in Lyon, two each in Marseille and Lille), the UK's equivalents have none.

Manchester and Lyon have similar-sized tramway systems, with about 100 stations each; but Marseille (3 lines) and Lille (2 lines) have substantially more than Birmingham (1 line) and Leeds (0 lines).

Is it possible that poor public transport in the UK's large cities makes their effective size smaller, and thus sacrifices the agglomeration benefits we would expect from their population?

Our Real Journey Time data lets us ask this question. Real journey time, and journey time variability

There is an important difference between bus public transport and fixed infrastructure public transport: reliability. I have used our Real Journey Time tool to calculate the worst-case (95th percentile) journey time on public transport on two routes into Birmingham. This is the time that a public transport user must leave for their journey to ensure that they are only late for work or a meeting once a month.

The first journey is a bus from the south of the city, Stirchley to, Birmingham. This 3.5 mile journey takes about 20 minutes between 6am and 7am, and about 40 minutes between 8am and 9am.

The second journey is a tram from West Bromwich to Birmingham. This 8.5 mile journey takes 30 minutes regardless of when it is taken, as the tram route is almost completely segregated from traffic.

While the tram is substantially quicker at all times than the bus, the reliability of its timing, even during the most congested periods, provides an additional large benefit to users.

We think that people generate the most agglomeration benefits for a city when they travel at peak times, to get to and from work, meetings, and social events. Our tool shows us that, at the times when people need to travel in order to generate these benefits, buses are extremely slow. And since buses are by far the largest mode of public transport in Birmingham, this is likely to have significantly higher impact there than in Lyon; in the latter, the largest mode of public transport is the metro, which delivers reliable journey times no matter the time of day.

Our hypothesis is that Birmingham's reliance on buses makes its effective population much smaller than its real population. This reduces its productivity by sacrificing agglomeration benefits. For the past six months, using our Real Journey Time tool, we've worked with The Productivity Insights Network to quantify that.

At peak times, Birmingham is a small city

The technique is quite simple. We pick 30 minutes as the travel time by bus that marks the boundary of the Birmingham agglomeration. This doesn't include walking at either end of a journey, or waiting time, so this figure may well mean a 50 minute total journey.

We then use our real journey time to examine how far from central Birmingham that allowed journey time would let a person live.

For example, by examining six months of journeys on the buses, we calculate that, at off-peak times a person five miles from Birmingham in West Bromwich is part of the Birmingham agglomeration. At peak times, this is no longer the case, and the outer boundary of the Birmingham agglomeration is reduced in size to just 3.5 miles away in Smethwick.

Making use of our data on trams, we can also imagine a Birmingham where major bus routes are replaced by trams and enjoy fast and reliable journey durations, even at peak times. The agglomeration then includes people as far away as Bilston, 9 miles away.

By repeating this process for bus route into Birmingham from every direction, we create a boundary of the effective size of Birmingham at different times of the day. By summing the population living within each boundary, we calculate the real size of Birmingham under three conditions: by bus at peak time, by bus at off-peak time, and in an imaginary future where all buses travelled as quickly and reliably as trams (simulated tram).

At this point you might see why we picked 30 minutes as our travel time. Allowing 30 minutes of travel time using fixed infrastructure such as a tram gives Birmingham a population of about 1.7 million people, which is very close to its population as defined by the OECD of about 1.9 million.

But at peak time Birmingham's effective population is just 0.9m – less than half the population that the OECD use.

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Birmingham's effective size might explain most of its productivity gap

This is where things get very interesting. If we consider that Birmingham has a population of 1.9m, and we assume that agglomeration benefits should work in the UK to the same extent that they work in France, Birmingham has a 33 per cent productivity shortfall. This underperformance of the UK's large cities is part of the productivity puzzle that UK economists have been desperately trying to solve.

But once you understand that Birmingham's real size is much smaller, below 1m people, the productivity shortfall reduces to just 9 per cent and is no longer significant.

Our hypothesis is that, by relying on buses that get caught in congestion at peak times for public transport, Birmingham sacrifices significant size and thus agglomeration benefits to cities like Lyon, which rely on trams and metros. This is based on our calculations that a whole-city tramway system for Birmingham would deliver an effective size roughly equal to the OECD-defined population.

This difference seems to explain a significant proportion of the productivity gap between UK large cities and their European equivalents.

So, what should we do?

The good news is that Birmingham's current plans for transport investment are aimed at increasing its effective size at peak times.

- Using our Real Journey Time tool, TfWM are targeting investment in bus lanes and bus priority measures to improve journey speed and journey reliability on existing bus routes.
- Seven sprint bus routes are being planned, with bus priority measures hopefully delivering journey time reliability similar to a tram.
- Two tram extensions (to Wolverhampton Train station and Edgbaston) are under construction, with two more (to Dudley and Birmingham Airport) under study.
- Station re-openings at places like Moseley and Kings Heath will offer reliable journeys by rail to new areas of the city.

The prize for achieving this is large. If bus journey times became as reliable at peak time as they are off peak, the effective population of Birmingham would increase from 0.9m to 1.3m. If we assume that agglomeration benefits in the UK are as significant as in France, this would lead to an increase in GDP/capita of 7 per cent.

Tom Forth is head of data at the Open Data Institute Leeds. This work was undertaken with Daniel Billingsley and Neil McClure.

It is this Government's ambition to leave our environment in a better state than we found it. We have made significant progress but there is much more to be done. The 25 Year Environment Plan that we have published today outlines the steps we propose to take to achieve our ambition.

There is a significant amount of Legislation in the pipeline to achieve the last paragraph especially as the fight for Climate Change gets more stringent especially in the next 10 – 15 years as many targets will be missed.

The greatest of them all which is barely regulated but will have the most significant impact on our Urban Bus Operation in the heavily polluted transport corridors is that what is loosely called "The Oslo Effect" named after that city who measured the Road, Tyre Brake dust generated by their bus and taxi fleet in 1988

The Oslo Effect or Non Exhaust Emissions (NEE)

Air pollution from tyres wear particles can be 1,000 times worse than what comes out of a car's exhaust, Emissions Analytics has found. Harmful particle matter from tyres is a very serious and growing environmental problem and is currently unregulated.

Non-exhaust emissions (NEE) – particles released into the air from brake wear, tyres wear, road surface wear and resuspension of road dust during on-road vehicle usage – are currently believed to constitute the majority of primary particulate matter from road transport: 60% of PM2.5 and 73% of PM10.

The 2019 report 'Non-Exhaust Emissions from Road Traffic' by the UK Government's Air Quality Expert Group (AQEG), recommended that NEE immediately be recognized as a source of ambient concentrations of airborne particulate matter, even for vehicles with zero exhaust emissions, such as EVs

What is non-exhaust emissions particulate matter?

Non-exhaust particles arise from a range of vehicle-related sources. The main contributors are the following:

Brake wear.

Standard frictional brakes on a vehicle function by virtue of the friction between a brake pad and a rotating disc or drum when the two are forced together by application of pressure to the braking system. The frictional process causes abrasion both of the brake pad and of the surface of the disc or drum leading to the release of particles, a substantial fraction of which become airborne. b)

Tyre wear.

The surface of a tyre when in contact with the road is steadily abraded by contact with the road surface. This leads to the release of large quantities of small rubber particles which cover a wide range of sizes. The larger particles will typically remain on the road surface until washed off in drainage water. However, the size range extends into sizes below 10 micrometres diameter and hence contributes to PM10 (and to PM2.5). The smaller abraded particles are liable to become airborne, contributing to non-exhaust particles in the atmosphere. If rubber tyre wear particles are considered to be a form of 'microplastics' then tyre wear would constitute an important source of microplastics into the environment, both via the airborne route but also via wash-off of the coarser tyre abrasion material remaining on the road surface. In this report, the term tyre wear particles is used without any implication as to whether they are also considered microplastic particles. **The terminology zero emission vehicle can therefore be misleading.**

Usage of the terminology 'zero exhaust emission vehicle' is more precise and is preferred. https://UK-air.defra.gov.UK/library/aqeg/zero-emission-vehicles 13 c

Road surface wear.

The friction between the tyre surface and the road surface which leads to tyre abrasion is also liable to abrade the road surface, especially where this is already fragmenting. Hence, road surface wear particles are also released to the atmosphere. Some studies have suggested that road wear particles are internally mixed with tyre rubber in the particles generated through this abrasion process. Sometimes the rubber comes off in a dramatic cloud of smoke when the car skids on the road. Sometimes the road surface is sharp, and slices fragments out of the rubber. But most of the time, in the course of normal rotation without skidding or cutting, the rubber is compressed and then expands. As it compresses and expands, tiny cracks develop and spread in the tread — and tiny particles of rubber flake off.

Each time a tyre rotates, it loses a layer of rubber about a billionth of a metre thick. If you do some numbers, this works out to about four million million million carbon atoms lost with each rotation.

A busy road with 25,000 vehicles travelling on it each day will generate around **nine kilograms of tyre dust** per kilometre

Resuspended road dust.

Dust from a number of sources accumulate on road surfaces. These originate from dry and wet deposition of airborne particles, especially coarser particles such as those deriving from soil.

Grinding

Additionally, abrasion products from the vehicle may be deposited on the road contributing to the road surface dust. Some of this material is in the PM10 size range when depositing to the road surface and the action of tyres on surface dusts may also cause some grinding leading to the creation of smaller particles from the coarser dusts. Studies of road surface dusts have shown a substantial fraction to be within the PM2.5 and PM10 size ranges. Such particles are rather easily suspended from the road surface, both by shear forces at the tyre-road interface and by atmospheric turbulence in the wake of the vehicle.

There will be H&S issues with workplaces such as shops, offices etc. that have frontages facing the traffic.

There is also evidence that elevated wind speeds contribute to the resuspension of surface dust. In addition to these major contributors, there are also other abrasion sources associated with the vehicle such as wear of exposed drive belts, rubber gaiters and clutch plates, although in the latter case the majority of the abrasion products are contained by the clutch housing.

Most UK roads since the end of the Second World War until recently have used recycled tyre (Carbon) materials as surface binders.

In the UK, two air pollutants (nitrogen dioxide and particulates) are responsible for an estimated 40,000 early deaths each year. Air pollution also threatens biodiversity and ecosystems across the UK. The UK has been unlawfully breaching nitrogen dioxide limit values since 2010.
Children, and the elderly, and those with existing medical conditions are at the greatest risk.

The UK's limit for particulate matter, for example, is currently significantly higher than the targets recommended by the WHO.63 Scotland has set lower limits for PM10 and PM2.5,64 and the Mayor of London declared that London would aim to meet WHO targets by 2030.65.

- The Clean Air Strategy was published in January 2019, and welcomed by the World Health Organisation as "an example for the rest of the world to follow". It sets out the comprehensive action required across all parts of government to meet our legally binding targets to reduce emissions of five key pollutants, fine particulate matter ($PM_{2.5}$), sulphur oxides (SOx), nitrogen oxides (NOx), ammonia (NH3) and non-methane volatile organic compounds (NMVOCs), by 2020 and 2030, and secure significant public health benefits. This includes action to reduce emissions from a range of sources, including domestic solid fuel combustion, agriculture, and industrial sources. The Strategy also made a commitment to bring forward primary legislation on clean air, delivered in the Environment Bill.

The main traffic sources of PM2.5 are exhaust emissions from diesel vehicles (cars, light goods vehicles and heavy goods vehicles, all rubber wheeled vehicles), together with tyre wear, brake wear and road surface abrasion from all vehicles.

A broadly similar picture prevails across the European Union. There are significant uncertainties attached to some of these emissions estimates at this stage although recent advances in measuring technology will remedy this, and particularly to the estimates of PM2.5 from non-exhaust traffic sources. With reductions in exhaust emissions of PM, the non-exhaust components of traffic emissions will become much more important, emphasising the need to develop measures to control emissions from these sources.

AQEG recommends that the enhancement of emissions inventories is essential if numerical models of atmospheric PM2.5 are to be improved. The key areas for improvement are: • non-exhaust vehicle emissions including tyre and brake wear, road abrasion and road dust resuspension.

What is the effects of air pollution on human health?

Health effects of PM2.5 10. The Committee on the Medical Effects of Air Pollutants (COMEAP) reports Long Term Exposure to Air Pollution: Effect on Mortality (COMEAP, 2009) and The Mortality Effects of Long-Term Exposure to Particulate Air Pollution in the United Kingdom (COMEAP, 2010) provide an excellent synthesis of the current evidence on the impact of particulate matter on mortality.

There is clear evidence that particulate matter has a significant contributory role in human all-cause mortality and in particular in cardiopulmonary mortality.

Fine particulate matter ($PM_{2.5}$) can penetrate through the lungs and further enter the body through the blood stream, affecting all major organs.

Exposure to $PM_{2.5}$ can cause diseases both to our cardiovascular and respiratory system, provoking, for example stroke, lung cancer and chronic obstructive pulmonary disease (COPD).

New research has also shown an association between prenatal exposure to high levels of air pollution and developmental delay at age three, as well as psychological and behavioural problems later on, including symptoms of attention deficit hyperactivity disorder (ADHD), anxiety and depression.

Current legal limits for PM2.5 are twice as high as what the WHO recommends, and it is urgent to adopt and meet WHO's limit as soon as possible to protect and promote the public's health.

More than 2,000 health centres in Great Britain, including major teaching hospitals, children's hospitals, clinics and GP surgeries are in areas which exceed safe air pollution limits for one of the most dangerous air pollutants.

2,220 GP practices and 248 hospitals are in areas with average levels of fine particulate matter (PM2.5) that are above the limit recommended by the **World Health Organisation (WHO) (10µg/m3 for the annual average).**

2 of the biggest children's hospitals in the country, Great Ormond Street Hospital and Birmingham's Children Hospital, are located in areas with unsafe levels of pollution.

Click on this link for air quality in your area

https://www.blf.org.uk/take-action/campaign/nhs-toxic-air-report

Recommended 2021 AQG levels compared to 2005 air quality guidelines

Pollutant	Averaging Time	2005 AQGs	2021 AQGs
$PM_{2.5}$, µg/m^3	Annual	10	5
	24-hour[a]	25	15
PM_{10}, µg/m^3	Annual	20	15
	24-hour[a]	50	45
O_3, µg/m^3	Peak season[b]	-	60
	8-hour[a]	100	100
NO_2, µg/m^3	Annual	40	10
	24-hour[a]	-	25
SO_2, µg/m^3	24-hour[a]	20	40
CO, mg/m^3	24-hour[a]	-	4

µg = microgram

[a] 99th percentile (i.e., 3–4 exceedance days per year).

[b] Average of daily maximum 8-hour mean O_3 concentration in the six consecutive months with the highest six-month running- average O_3 concentration.
Note: Annual and peak season is long-term exposure, while 24 hour and 8 hour is short-term exposure.

Is it wise to invest in this technology?

Urban Bus use has declined nearly continuously since 1955 and is now less than a third of the peak, despite the population increasing from 51m to 66m, and increasing urbanisation. Much of the decline in bus use is related directly to the increase in car ownership. In 1955 London had a third of UK bus usage. Today it is half. Car ownership was also boosted by the conversion of trams to buses, to 'save costs'. Each conversion reduced public transport use along the route by about 30%.

None of the busways, which claimed to have lower cost that trams, have resulted in any significant attraction of trips from cars (back) to public transport. As observe "relatively few busways are being built and Britain is possibly the only country in the developed world that still believes that building new busways is an innovative idea. "A few cities" have both busways and tramways. The public know what they want based on actual experience of use. Adelaide is possibly the best case study, where the popular vote of 80% for trams has led to new tramways being built.

There will remain many places where trams are uneconomic and lower cost bus services will provide a public transport service. These however will attract few car trips and cater for 'captive' riders. If car ownership continues to grow fewer bus services will remain financially viable. That is not to ignore the environmental problems of diesel engines and the 'Oslo' effect of rubber tyre, tarmac, and brake dust carcinogenic particles.

In many places for some people a lift with a friend or family will be the only travel option other than taxis.

The trouble is that whenever a tramway is proposed, there will be those who claim a busway gives 80 per cent of the benefits of a tramway for 20 per cent of the cost. I would say that is not true. A busway might (if you are lucky) give 50 per cent of the benefits for 50 per cent of the cost. In many cases, which might be enough; not all routes have demand high enough to support the 2000 or so passengers per hour you need to make a tramway viable. (If you are unlucky, of course, a busway might give 20 per cent of the benefit for 80 per cent of the cost.)

In brief, we would say that a busway or BRT system is fine if you want an enhanced bus service. But it is not a substitute for a tramway. In fact, we do not regard trams and buses as competitors at all. They serve different regions of the transport spectrum. Buses are best for lower-demand routes.

For higher demands (above about 2000 pphd), you need a tramway

In conclusion

The role of the rubber wheeled bus as a high volume passenger carrying vehicle in the Urban Corridor is coming to an end, it is still not unreasonable however, to plan the urban bus with its smaller capacity and its main strength of flexibility to re role from a significant carrier in the low air quality feeder routes to a steel on steel street corridor vehicle or to enhanced suburban heavy rail to tackle the main threat coming from the over use of the private car

This has been conducted successfully in Newcastle Tyne and Wear Metro, Nottingham has been so successful with their integrated, flexible Public Transport it would appear that they do not need CAZ on the same scale as elsewhere .

For cities and regions committed to bus base systems who will have serious Air Quality issues over the life of their vehicles (12 – 15 years) with very little infrastructure left at the end of that period and having to ask for replacement funds + 15 years inflation cost and are not in compliance with the Paris Agreement, we suggest that you consider your current plans be treated and labelled as an interim, a green pre rapid rail based transit system and advertised beforehand as such.

We believe that the evidence is clear that for most cities it's clear a tram needs to be the backbone of an integrated system with buses for rural and less trafficked routes.

The reason for this is that no type of bus in the UK as outlined above, has ever attracted sufficient motorists to make the roads freer for the bus to move quickly and to be attractive and therefore to attract motorists to keep the road clear etc. The trams will do this because they are very long and thin and generally have a much cheaper per passenger kilometre on the heavy routes having a much higher capacity (200+), generally granted priority which is difficult for buses. Another USP is that they are also attractive because unlike on a bus, on the tram you're not forced to sit or stand next to potentially undesirable others

Remember the uphill journey for Clean Air in transport has only just begun and will quicken and tighter as we get towards the next failing target dates

Courtesy:-
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