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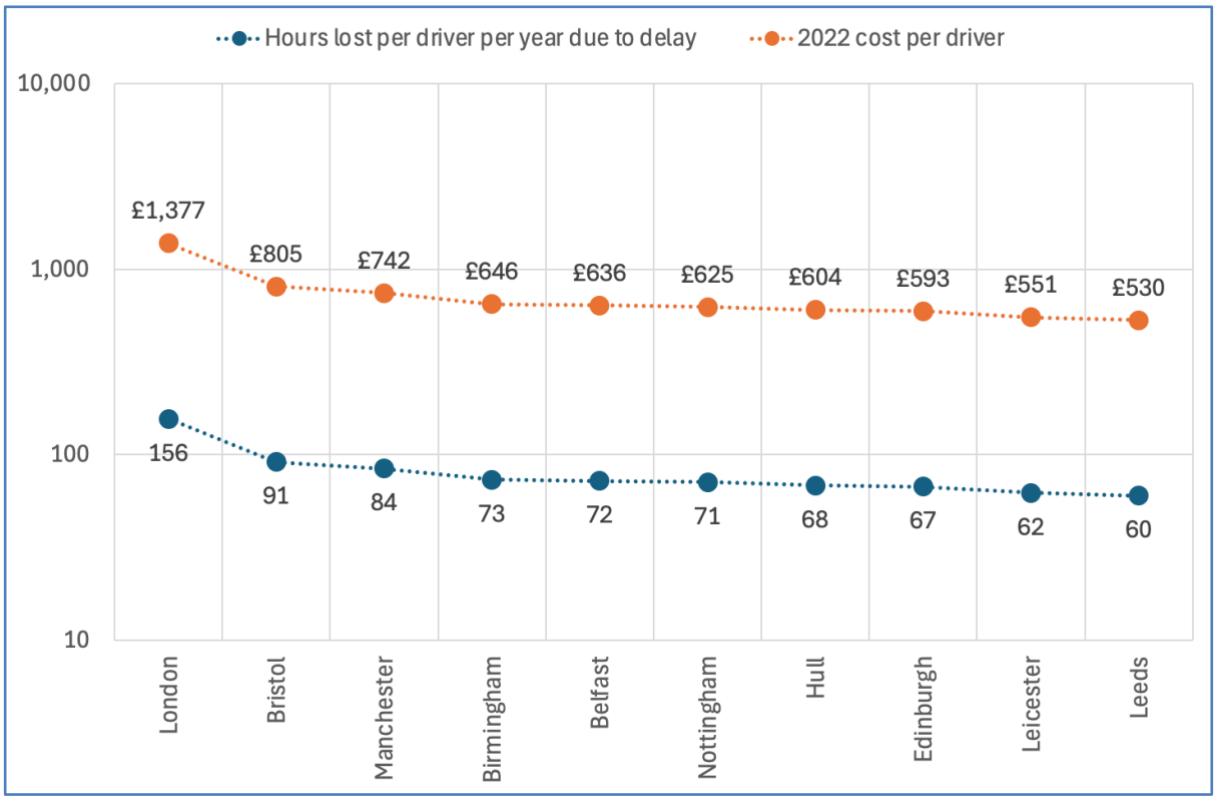
The Transport Economist

The Journal of the Transport Economists' Group



Editor Peter Gordon

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Integrated Network Management Digital Twin – Economic Benefit Analysis

Kieran Arter
(Arup)

Online

23 April 2025

Introduction

Kieran Arter introduced himself as a transport economist with around 20 years' experience and a background on transport business cases, and particularly economic cases. His focus has been physical infrastructure such as High Speed 1[1] and the Elizabeth line. He would describe research conducted on behalf of the Department of Transport (DfT) by a consortium led by Arup, including the Connected Places Catapult and Digital Twin Hub, on the economic analysis of digital twins[2]:

- the evidence review;
- the "use cases" of how Integrated Network Management Digital Twins might be used in transport; and
- the economic benefit analysis.

Digital twins

Kieran defined a digital twin as "a realistic digital representation of assets, processes and systems in the built or natural environment". Figure 1 illustrates the two-way exchange of information between the asset and the digital twin, allowing a better understanding of the asset. He provided an example from the energy sector of The Hague, City Hall, where a digital twin linked to the building's network of temperature sensors provided insights which enabled a 39% reduction in the building's energy consumption, saving costs and carbon emissions.

[1] Successively named the Channel Tunnel Rail Link (CTRL), the New Kent Main Line, the Union Railway, High Speed 1 (HS1) and, as of 2025, London St. Pancras Highspeed.
[2] https://www.gov.uk/government/publications/integrated-network-management-digital-twin-economic-benefits-analysis.

Figure 1: Digital twins

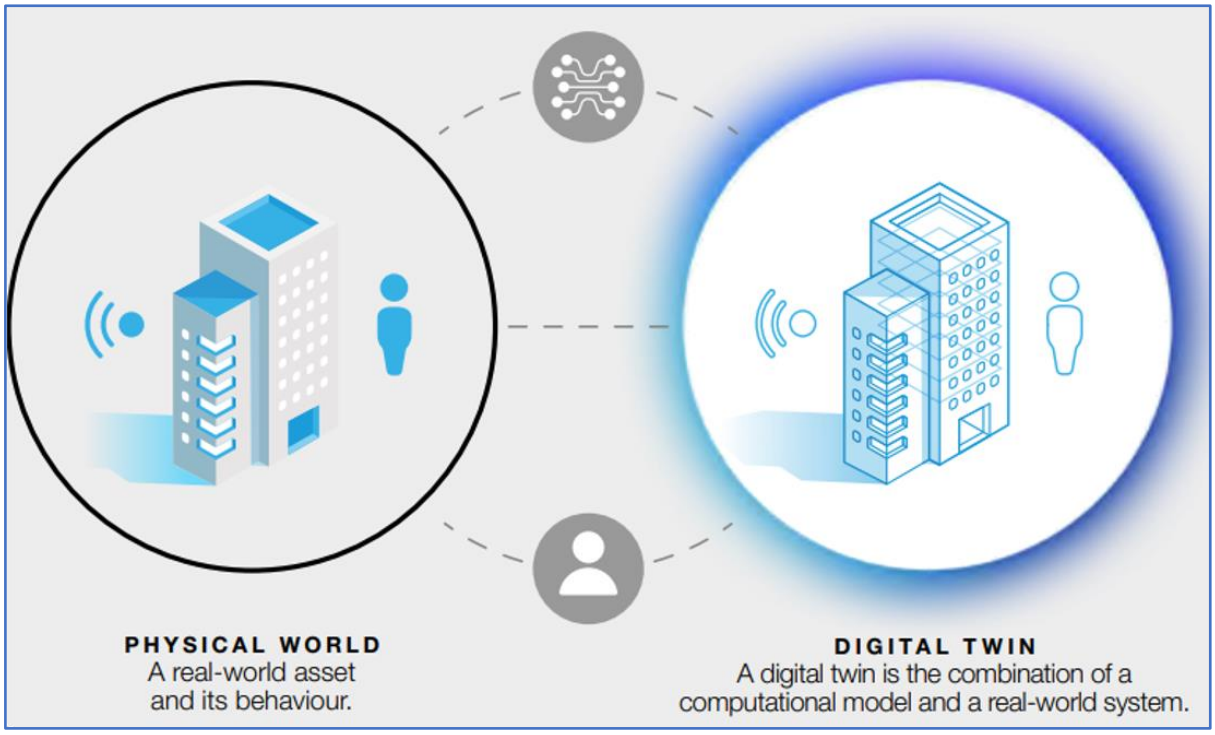


Figure 2: Integrated network management digital twins

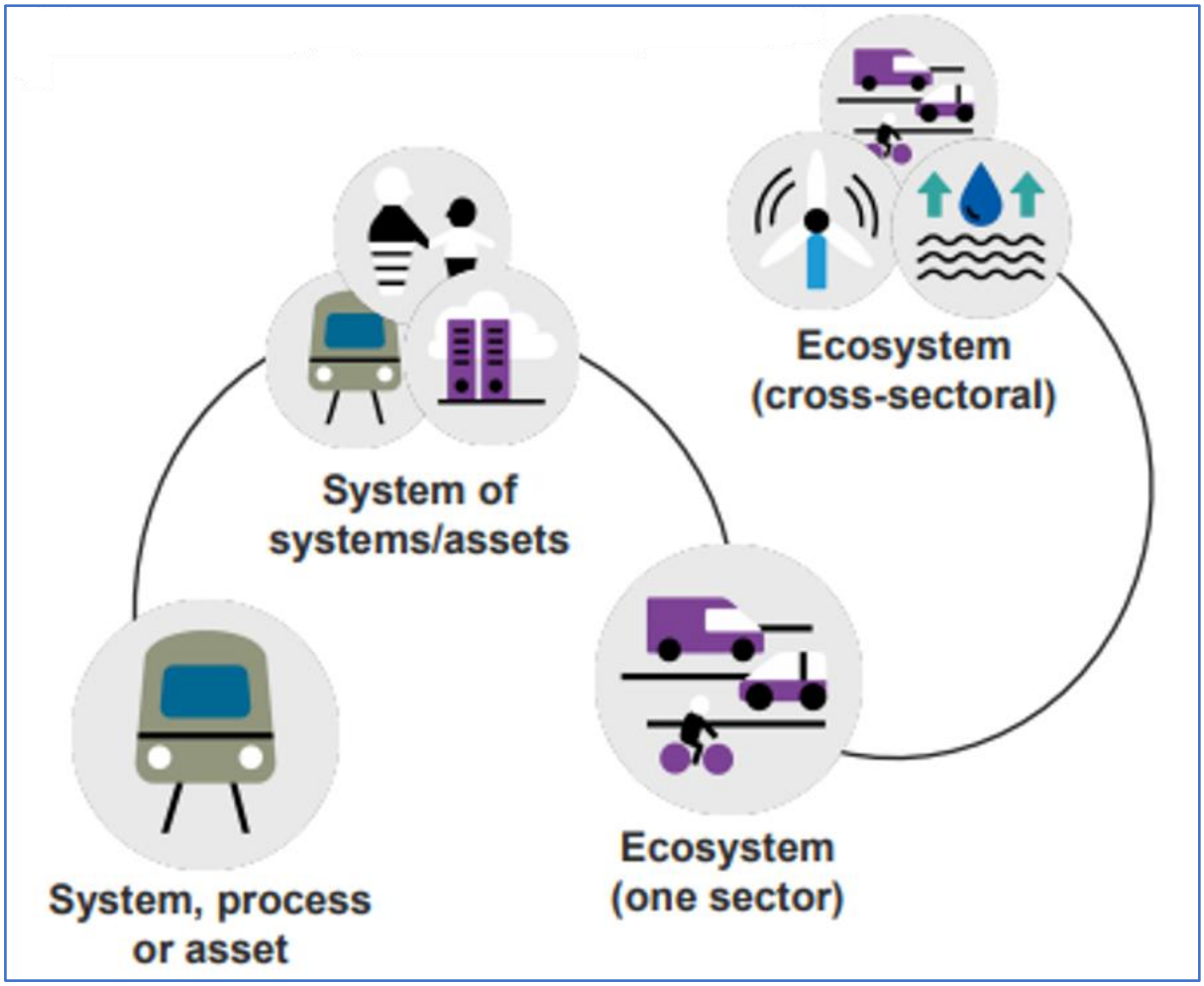


Figure 2 shows how digital twins can be "federated" into ecosystems covering a whole sector, such as transport networks (the focus of the study), but in theory could also be extended to multiple sectors, such as linking transport to energy.

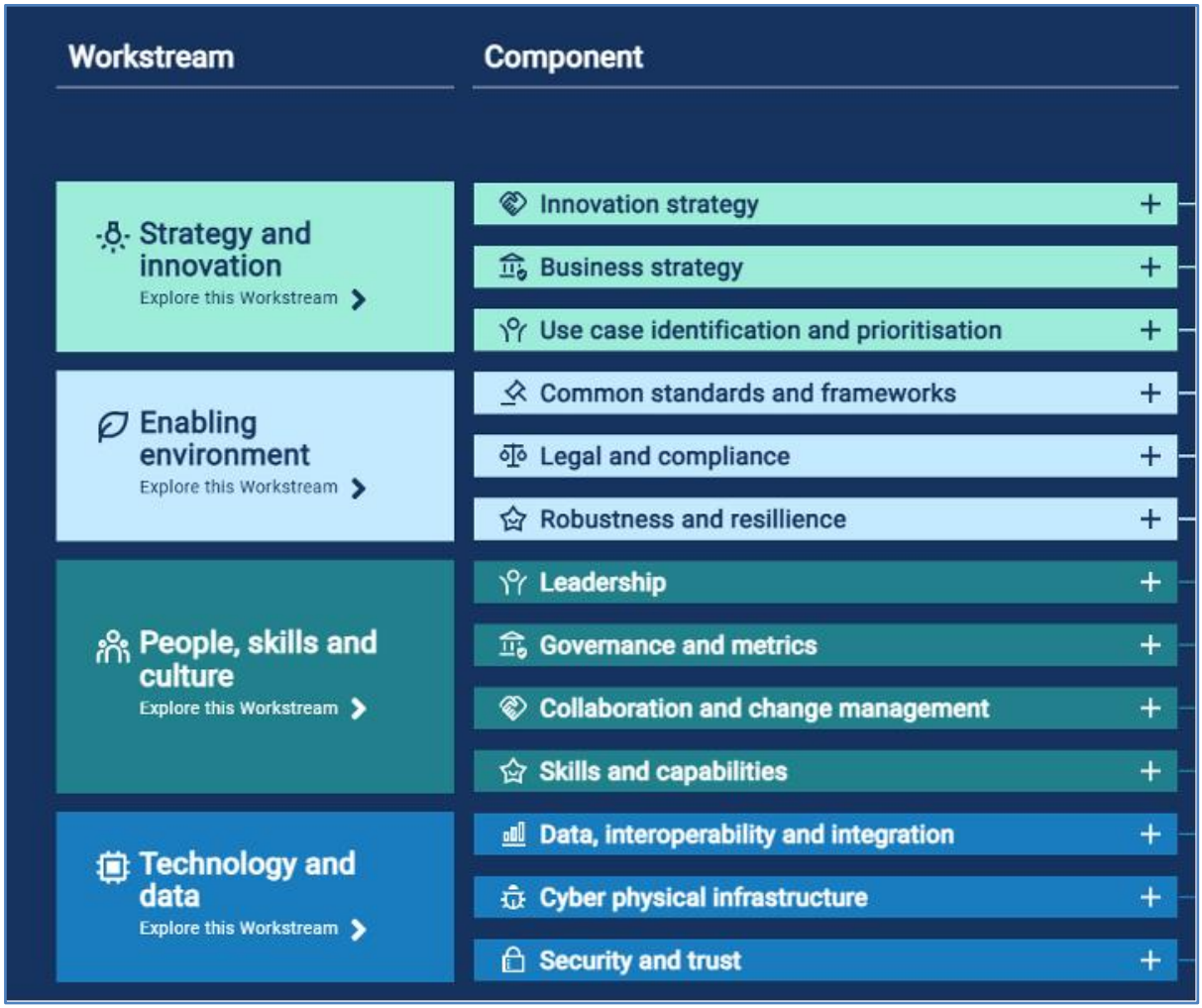
This could enable data sharing across organisation and even sectoral boundaries, facilitating whole-system decision-making to achieve better mobility for transport users and operators.

Background to the study

The study was commissioned by the DfT Digital Twins team, and builds on the DfT Transport Research Innovation Board (TRIB).

Figure 3 shows the TRIB Vision and Roadmap to facilitate development of the ecosystems described above to improve the performance of multimodal transport in the UK by 2035.

Figure 3: TRIB Digital Twin Vision and Roadmap 2035

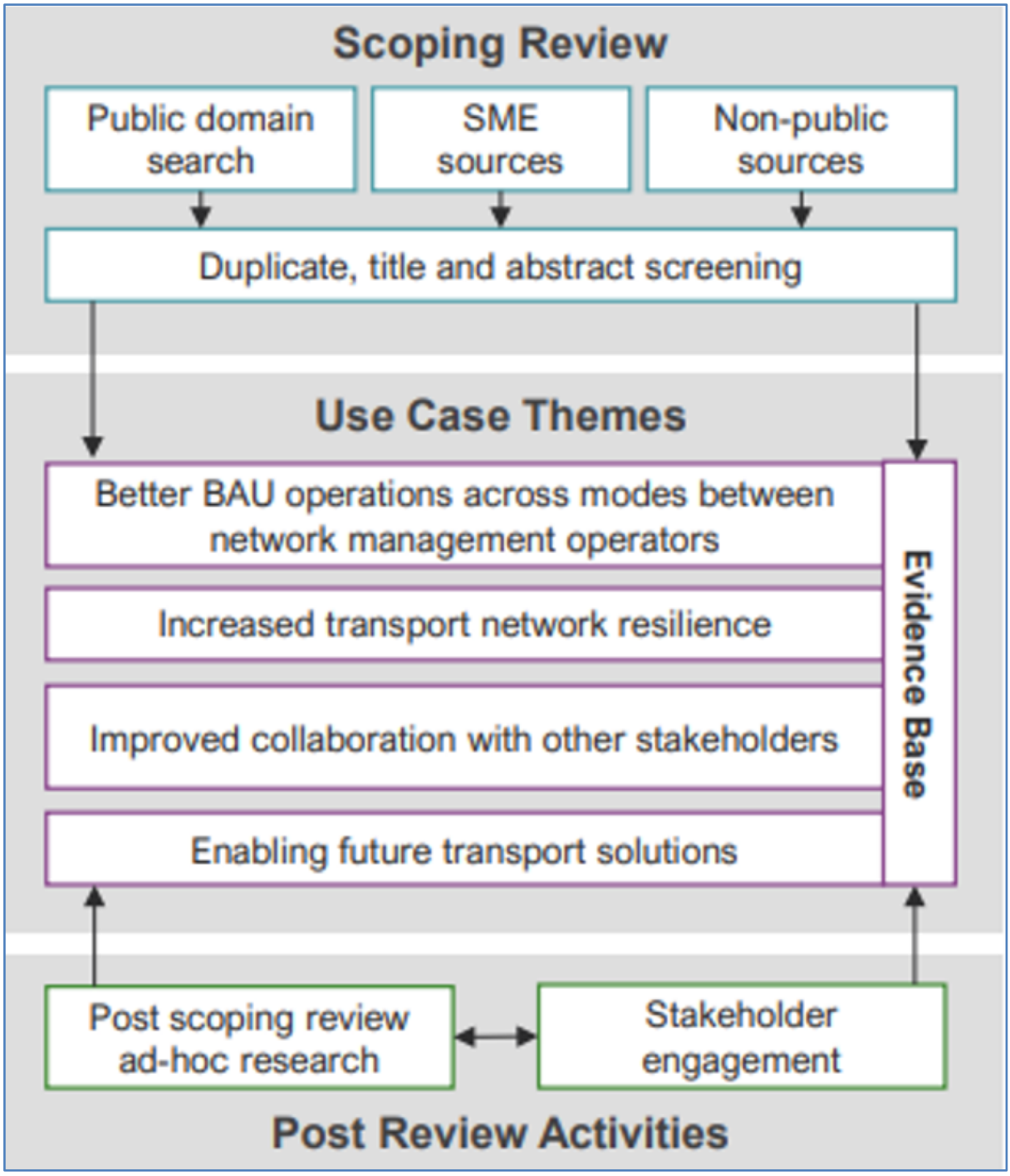


The central objective of the study was to quantify the potential economic benefits of such an ecosystem, not taking cost into account, but ensuring that the economic benefit analysis was consistent with Transport Analysis Guidance (TAG).

Evidence review

Figure 4 provides an overview of the study evidence review.

Figure 4: Study evidence review



The review was undertaken by the Arup team and examined over 2,000 documents from the public domain, subject matter experts (SMEs) and non-public data held by DfT and Arup. Two major challenges emerged:

- There was a lack of a published methodological approach to quantifying the benefits for the concept of digital twins.
- There were only a limited number of directly comparable case studies that had identified the benefits associated with the concept of digital twins.

Stakeholder engagement

Figure 5 illustrates the range of organisations involved in a stakeholder engagement exercise, with over 20 interviews, as part of the evidence review. There was also a wider process of a call for evidence. The aims were:

- to understand perceptions of the concept of integrated network management digital twins;
- to identify additional use cases; and
- to identify which themes were the most important.

Case studies

Kieran summarised two case studies from the evidence review.

Case study: Portsmouth City Council (PCC)

PCC's network management team face interactions between ferries, crossing between the Gunwharf ferry terminal and the Isle of Wight, and the road network. Delays to ferries resulted in a backlog of vehicles waiting to enter the terminal, leading to delays to other vehicles to the City Centre road network.

PCC used relatively inexpensive sensors to track the location of the ferries against the timetable and to detect anomalies to assess the potential impact on approach roads, vehicle stacking, emergency services, and to inform customers on travel arrangements. The solution has improved situational awareness and helped overcome communication challenges between ferry operators and PCC.

Figure 5: Stakeholder engagement

Case study: Transport for London (TfL)

TfL's Surface Intelligent Transport System (SITS) contains a digital twin interacting with an upgraded Real Time Optimiser traffic signal system, Common Operational View Incident Management System, integration service, and a predictive capability in the future.

SITS is leading to improvements in situational awareness, incident management, congestion relief, air quality, road safety, and supporting the prioritisation of bus services and active travel across London.

This was one of the case studies for which the benefits had already been quantified. SITS has an approximate lifetime cost of £118 million (£75 million capital expenditure and £43 million operational expenditure) and an original estimated Benefit Cost Ratio (BCR) of 7.3:1. A more recent analysis has suggested benefits of around £1 billion per annum from 2028.

Use case themes

Kieran described "use cases" as concepts of how a digital twin might be used with the sector to help the transport network.

The evidence review was used to identify a long list of 20-30 use cases, from which were identified four overarching themes, shown in Table 1, dealing in turn with:

- improving business-as-usual operations;
- improving resilience;
- improving collaboration, potentially between sectors; and
- enabling future systems.

Use case prioritisation

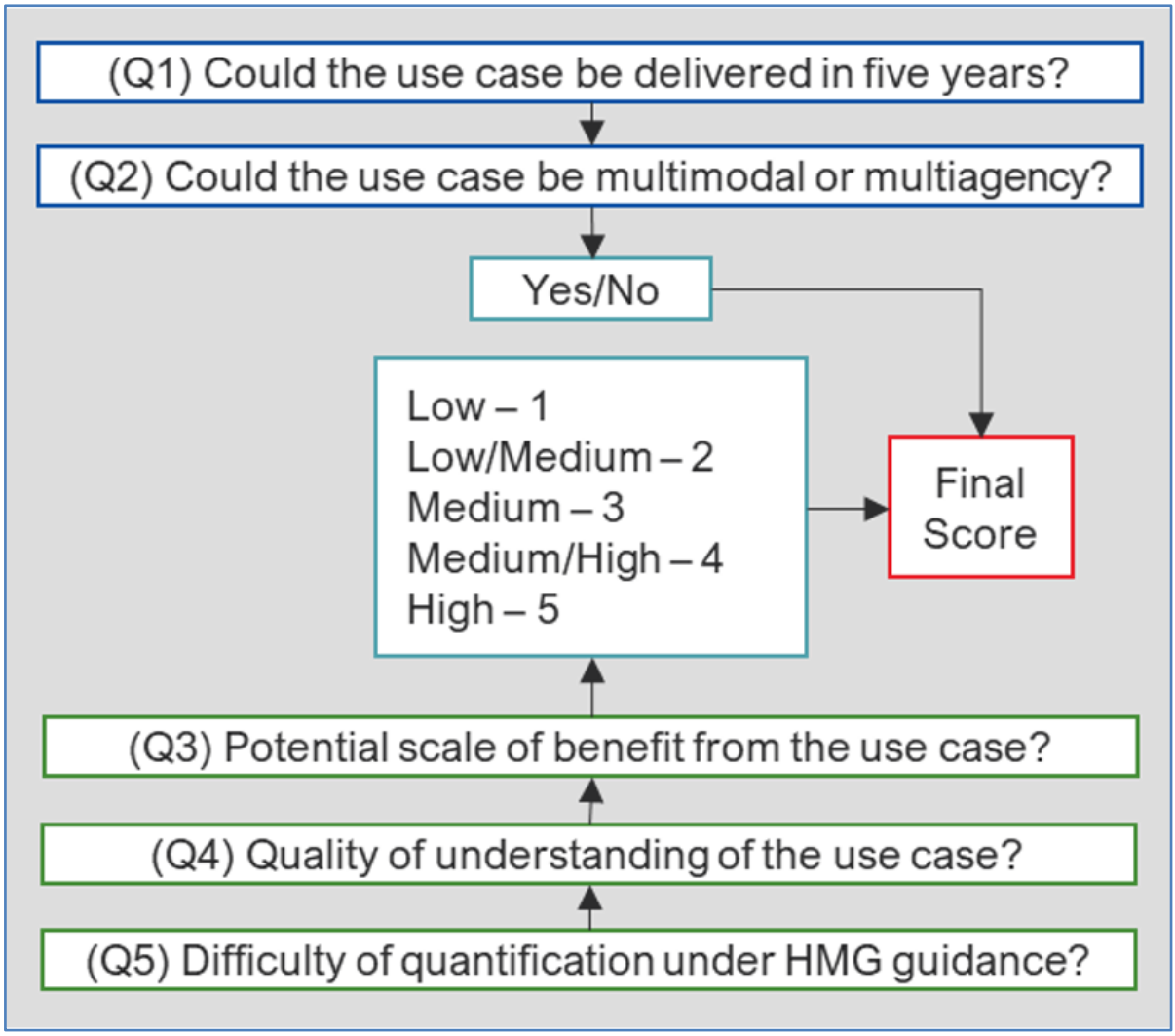
Figure 6 shows how, from the long list of use cases, the study team followed a prioritisation process which could be seen as a mini multi-criteria assessment (MCA).

This included two pass/fail questions focusing on timescales relevant to the Roadmap (Q1) and whether the use case was multimodal or multiagency (Q2).

Table 1: Use case themes

1	**Better business-as-usual operations across modes …** enabled from sharing operational information/data between transport system actors (such as in multimodal schedules) at local and/or national scales to enable more comprehensive network performance monitoring, design of timetables, and network capacity management for network management organisations.
2	**Increased transport network resilience …** from network monitoring, coordination and dynamic response at a "whole system" level. This more holistic operational decision coordination between authorities, agencies, and modal operators could lead to faster and more efficient detection and response to planned and unplanned events across transport networks. It includes an understanding of implications to wider transport network elements and transport network users to minimise disruption.
3	**Improved collaboration with other stakeholders …** through the creation of a single way of interacting digitally. This includes cross-sectoral private sector organisations (such as road, rail, energy, weather, manufacturing, utilities) leading to more effective network operations, more reliable journeys, improved processes, especially at hubs such as stations, depots and ports. While not the focus for this analysis, this could include benefits to other sectors, such as those given as examples above.
4	**Enabling future transport solutions …** such as self-driving vehicles or drones through digital twin technologies. An Integrated Transport Network Digital Twin (IN-DT) could potentially support and de-risk deployment and enable a level of collaboration beyond what is currently possible.

Figure 6: Prioritisation



Use cases which passed the pass/fail questions were then scored out of five, with a focus on use cases with significant benefits (Q3) which were well-understood (Q4) and could be quantified in TAG (Q5).

Use cases selected

Table 2 shows the five use cases that emerged from the shortlisting process.

Table 2: Use cases selected

Use case	Description	Geography applied	Key mode
1: Network Capacity Management	Network management decisions can be made to impact and improve capacity across a network and for specific modes.	15 UK cities excluding London	Highway modes including car, goods vehicles, buses
2: Multimodal journey optimisation	Improving the timeliness, accuracy, and richness of data associated with individual transport modes could enable the better linking up of modal interchanges.	National excluding London	Public transport modes including rail and bus
3: Integrated incident and emergency management	Improving the timeliness, accuracy, and richness of incident and emergency detection, including across transport modes, could directly impact the quality/coordination of response and communication with the most appropriate system actors.	15 UK cities excluding London	Highway modes including car, goods vehicles, buses, rail
4: Planned works and maintenance management	Better access to planned works and timely and reliable asset condition data across stakeholders could improve scheduling of asset maintenance that reduces impacts on network availability.	National excluding London	Highway modes including car, goods vehicles, buses, rail
5: Freight management at ports	Port freight management efficiency is influenced by many factors centred around matching infrastructure with inbound/ outbound transport and an appropriate supply of freight. Port decision support systems enabled by digital twins have proved valuable in improving these activities e.g. through reducing vehicle dwell times, lowering fuel use/emissions.	National	Could be multiple modes, but focus here on maritime emissions

Use cases 1 and 2 focused on the business-as-usual theme, about capacity management and improving interchange. Use cases 3 and 4 focused on the resilience theme, during incidents and emergencies and during planned works. London was excluded from use cases 1-4, as SITS already exists.

Use case 5 focused on environmental issues, with the aim of reducing port dwell time and fuel usage.

Use case benefit mapping

Table 3 shows the mapping of the five use cases to benefits which could be evaluated within the TAG framework. The ticks show the benefits on which the analysis focused, but the absence of a tick did not mean an absence of benefit.

For use case 2, journey quality benefits were valued using parameters from the Passenger Demand Forecasting Handbook (PDFH), and there were also estimates of the potential benefits of mode shift and the associated environmental gains.

For use case 5, the focus was environmental benefits and reductions in emissions.

Use case benefit estimation

The quantification was not based on detailed modelling but instead focused on conservative estimates of the likely scale of benefits of digital twins.

Table 4 shows some of the key data sources, and Kieran highlighted how some estimates were derived from source data.

For congestion, for example, INRIX provided estimates of hours lost per driver per year for the top ten most congested UK cities for 2022, with London having by far the largest lost hours. INRIX converts it to a cost to a cost per driver (Figure 7) and then a corresponding cost per city (Figure 8), in which London dominates, with 80% of the total cost.

The study used INRIX's estimates of hours lost per driver, but then went back to first principles to take into account costs to passengers and to convert these to overall congestion costs using TAG values and data from TfL's economic case for how much each type of congestion could be reduced by SITS.

Table 3: Use case benefit mapping

✓ = benefits evaluated (a lack of ✓ does not imply that there are no benefits, only that they have not been evaluated).	Use Case:				
	1	2	3	4	5
					
Impacts / Benefits:	**Network Capacity Management**	**Multi-Modal Journey Optimisation**	**Multi-Modal Incident Management**	**Planned Works & Maintenance Management**	**Freight Management at Ports**
Journey time savings	✓	✓	✓	✓	
Reliability	✓		✓		
Journey quality		✓			
Vehicle operating costs	✓		✓	✓	
Mode shift benefits excluding environmental		✓			
Environmental benefits		✓			✓
Output change in imperfectly competitive markets	✓	✓	✓		

Table 4: Use case benefit estimation: key data

Data:	Description:	Which use case used for:	Reference:
INRIX congestion data	Hours lost per driver due to congestion in assorted UK cities.	1 and 3	https://inrix.com/scorecard/
TfL Surface Intelligent Transport System	Information about composition of congestion and what the scale of savings could be.	1 and 3	Provided by TfL
National Travel Survey - interchanges	Number of interchanges between different modes of transport, by region.	2	Provided by DfT
Roadworks information	Number of roadworks per year in England, by organisation and region.	4	Provided by DfT (from Street Manager)
Port emissions and emissions factors	Fuel consumption and associated emissions of the UK shipping sector.	5	https://uk-air.defra.gov.uk/assets/documents/reports/cat07/1712140936_ED61406_NAEI_shipping_report_12Dec2017.pdf

Figure 7: INRIX estimated congestion hours and cost per driver

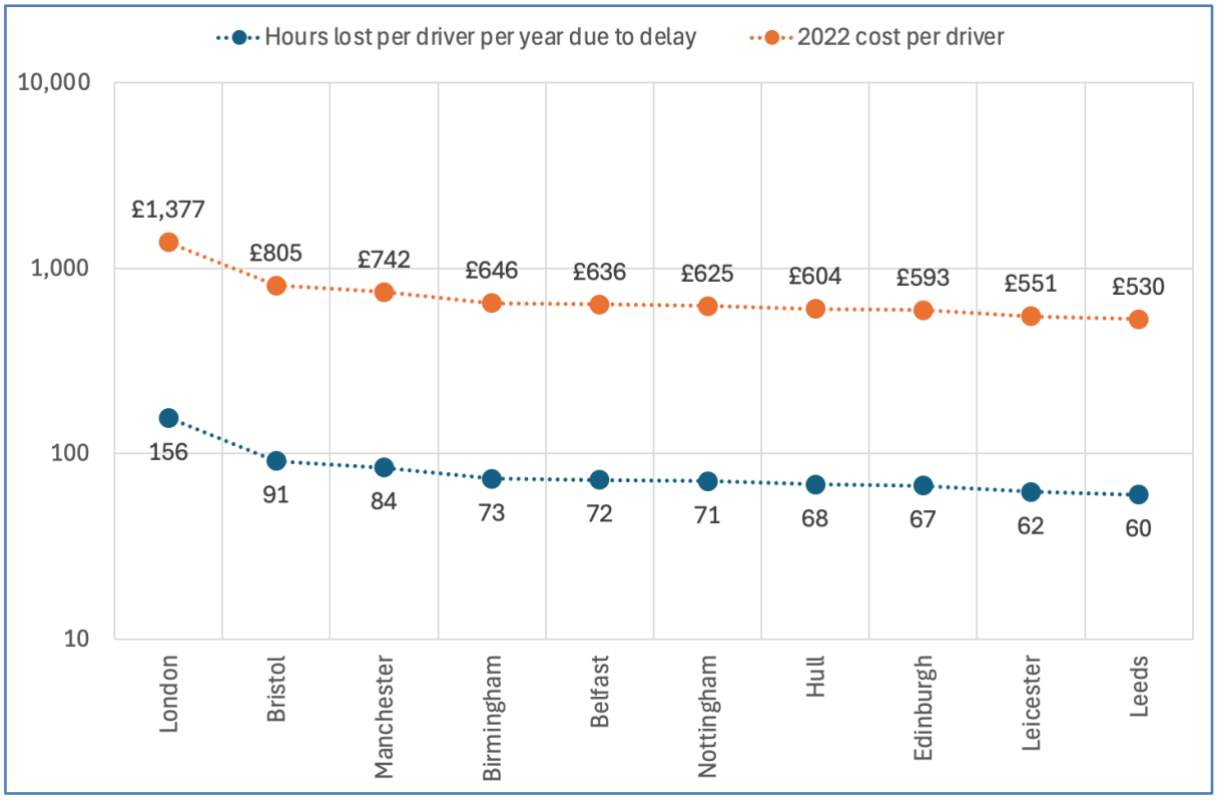
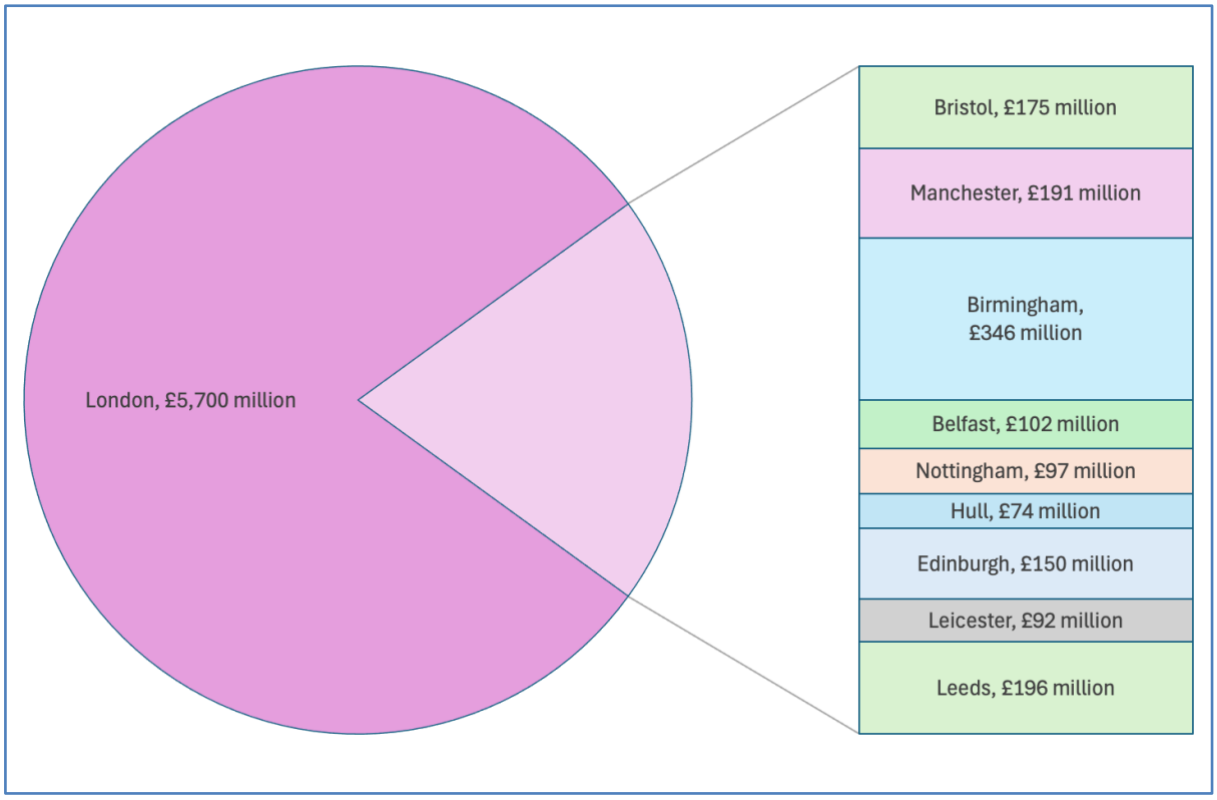


Figure 8: INRIX estimated congestion cost per city



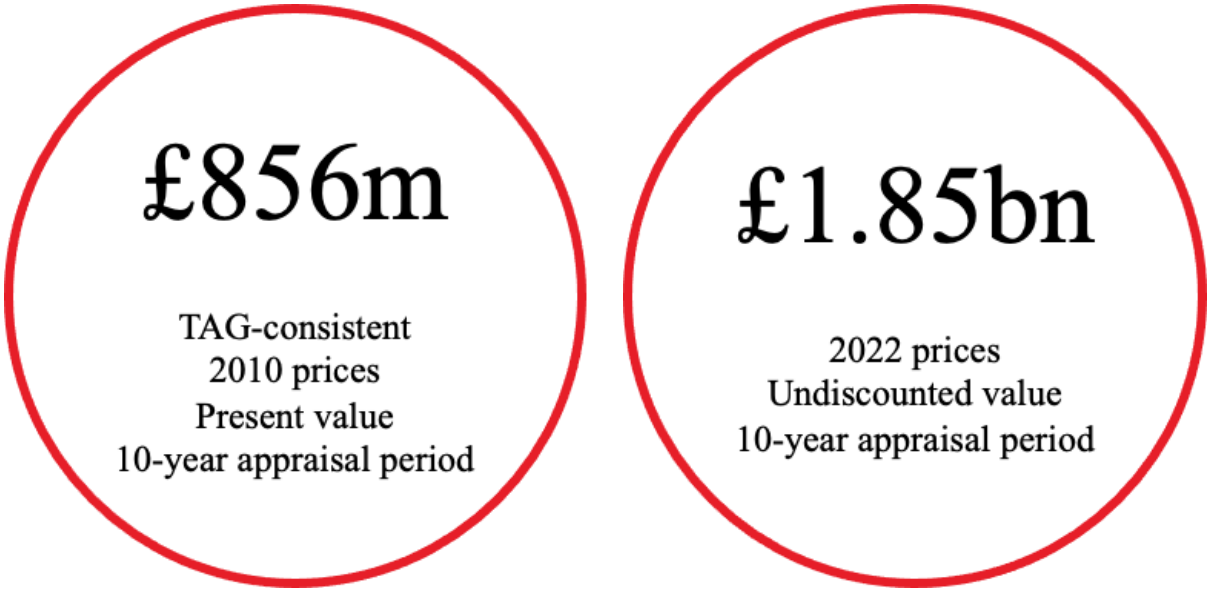
Use case benefit summary

Table 5 shows the results of the analysis, calculated in 2010 present values. Given the fast-moving nature of the digital industry, the appraisal period was restricted to the ten-year period 2028 to 2037.

Journey time savings tend to be the largest quantifiable potential benefit, but a range of other potential benefits were identified.

The bottom row of the table shows the results of a range of sensitivity tests to understand how the core results would change if key assumptions were adjusted.

Kieran also summarised the results as shown below, in 2010 values from Table 5 (left) and 2022 values (right).



However, there were several caveats to the analysis:

- It was limited to the five use cases examined in the study.
- Evidence of realised economic benefit is scarce.
- There are limitations on evaluating the benefits of resilience to high impact low probability events, as discussed below.

Finally, he identified potential for further work. For example, pilots should help refine the use cases, further develop the benefits case, and sharpen assumptions.

Table 5: Results

User case	1	2	3	4	5
Benefit	**Network Capacity Management**	**Multi-Modal Journey Optimisation**	**Multi-Modal Incident Management**	**Planned Works & Maintenance Management**	**Freight Management at Ports**
Journey time savings	91.6	108.4	73.3	505.0	-
Reliability	13.7	-	11.0	-	-
Journey quality	-	2.1	-	-	-
Vehicle operating costs	2.5	-	1.9	23.2	-
Mode shift benefits excluding environmental	-	0.04	-	-	-
Environmental benefits	-	0.03	-	-	16.9
Output change in imperfectly competitive markets	3.0	0.4	2.4	-	-
TOTAL (core assumptions)	**110.8**	**110.9**	**88.7**	**528.3**	**16.9**
Range from applying sensitivity tests	**£60m - £230m**	**£55m – £160m**	**£40m - £190m**	**£180m - £880m**	**£10m - £35m**

Resilience

Kieran ended with some discussion of resilience, which in some cases can be difficult to value. One use case on the long list had been "crisis and disaster planning", summarised in the study report as:

"Better respond to major events such as extreme weather by being able to more accurately and completely model the response of transport system users from 'real' operational data captured on a continual basis. This fidelity of modelling allows a number of transport system management responses to be tested, and for better responses to be deployed, ultimately allowing decisions to be more holistically made, leading to more broadly successful outcomes (or more broad limitation of negative consequences). A digital twin could enable this scenario planning to be done on both a long term/long-range basis, or in a shorter term, approaching real-time to significantly improve the accuracy of the predictions being made by the twin."

However, in addition to forecasting and valuing low probability high impact events, there were also:

- uncertainties in modelling the scope for Integrated Network Management Digital Twins to reduce their impact; and
- difficulty in obtaining suitable data.

As a result, coverage of resilience in the study was limited to qualitative, rather than quantitative, analysis.

Discussion

Peter Gordon (Editor, The Transport Economist) ask how the costs of congestion in various cities had been estimated. **Kieran** said that much use had been made of Transport for London's SITS work, and caveated that in some cases assumptions from London had been used for other cities. The study had focused on major cities but, even so, London was very much an outlier, but some of the assumptions had been flexed in the sensitivity tests to see what effect this had.

John Preston (University of Southampton) thanked Kieran for an interesting presentation and surmised that, twenty years ago, much of the subject matter would have been called Intelligent Transport Systems (ITS), not Digital Twins, which had been subject to much analysis of costs and benefits, including at the University of Southampton. He noted that London and Rotterdam were probably "hyper-congested" locations: what steps had been taken to adjust for this and to avoid over-estimation of potential benefits? **Kieran** said that, as far as possible, estimates of inputs such as total congestion costs were based on local data, but at this stage in the analysis it was reasonable to make use of the limited data available and test the sensitivity of the results to key assumptions. **Dick Dunmore** thought that it did not seem surprising that suitable case studies were most likely to have been done in large cities with major problems. Subject to the limited work to date on their costs, was it possible that the study could result in "rules of thumb" thresholds of the scale of congestion at which digital twins were likely to be worth investigating? **Kieran** agreed that cost data would be needed, but would in principle make it possible to make such assessments.

Ola Faleti asked whether the five use cases focused on peak time, or what was available in each city or port? Kieran agreed that most of the figures probably related to commuting at peak times and hence the largest build-up of congestion.

David Metz noted the development of digital navigation ("Satnav"), in which the private sector provided real time models of speed and journey time, which might be called "digital twins" of the road network. This private sector effort and resource had been disregarded by the public sector, including in the study. Why had public-private collaboration not been studied and incorporated into the conclusions? **Kieran** said that the stakeholders engaged had included some from the sector, but acknowledged that technologies such as Google maps were interesting and could be relevant. **John Preston** noted that INRIX was a private sector company. **Kieran** confirmed this and that the study had used data from their publicly available Global Traffic Scorecards.

Peter Gordon asked what distinguished digital twins from other types of modelling, or for what purposes they were particularly suitable. **Kieran** said that a key differentiator was the ability to use digital twins in real time, with a constant two-way flow of information supporting dynamic decisions. **Dick Dunmore** assumed that this implied that digital twins had an ongoing cost of monitoring and reacting, requiring staff with clear authority and chains of control to direct responses. Did Kieran have any insights into this area? **Kieran** agreed that both up-front and ongoing costs would need to be considered, and thought that further work may be in hand in this area, but noted that there would be an expectation of (more than) offsetting cost savings or benefit gains as a result of monitoring and reacting.

David van Rest asked why digital twins could not be used to smooth motorway traffic to prevent saturation, when Birmingham had the highest delays for this reason, particularly because of commuting traffic. Access restrictions could divert traffic, presumably to public transport. **Kieran** agreed. **Peter Gordon** noted the use of ramp metering but was less confident that drivers were diverted to public transport. **Mark Sullivan** agreed that ramp metering was a proven technology, and thought that the digital twin approach would be very useful, particularly where local traffic caused congestion on a motorway conceived for through traffic. **Dick Dunmore** noted that there was a presentational issue: voters were much more supportive of better management of supply than of any management of demand.

Report by Dick Dunmore

Future Rail Planning: A Tourism User Perspective

Dr Nikolas Thomopoulos
(Surrey Business School, University of Surrey)

Online

28 May 2025

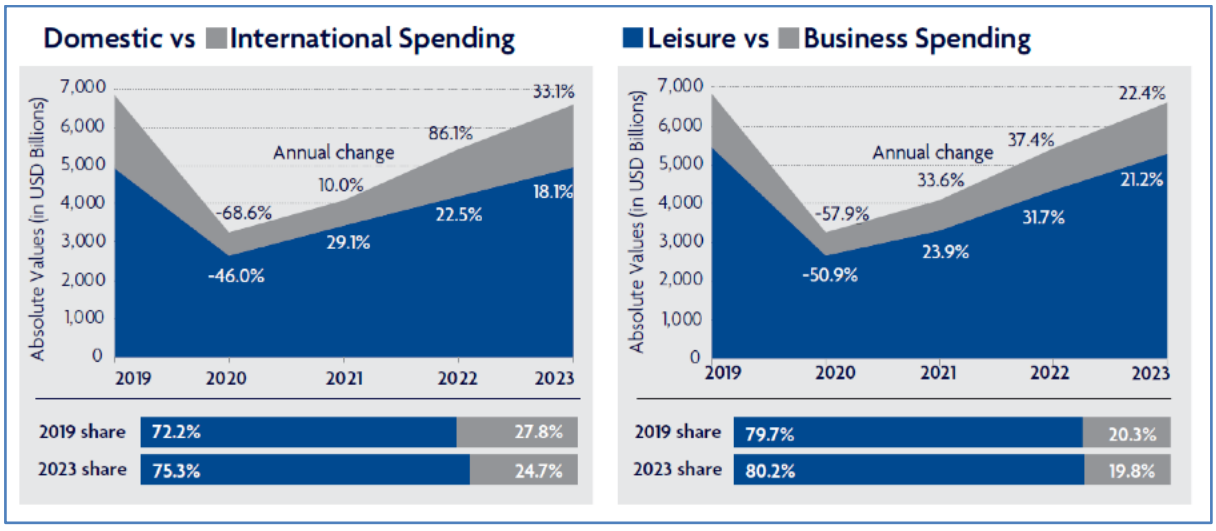
Introduction

Dr. Thomopoulos began by explaining the economic relevance of tourism with data from the World Travel & Tourism Council:

- In 2024, travel and tourism, included the direct, indirect and induced impacts of the sector, contributed some $10.9 trillion to global GDP, representing around 10% of the global economy (all in US dollars).
- In 2024, domestic visitors spent $5.3 trillion, 5.4% above the 2023 level, and international visitors spent $1.9 trillion, 11.6% above the 2023 level.
- The sector is also an important source of employment, supporting a total of 357 million jobs globally, or around one in ten of all jobs worldwide.

Figure 1 disaggregate tourism spending by domestic and international and by leisure and business.

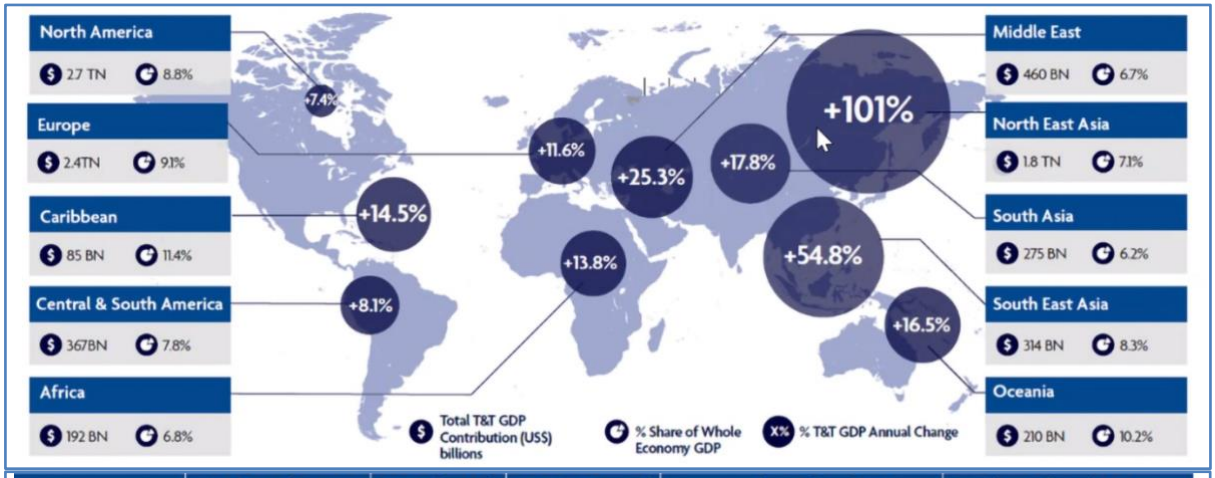
Figure 1: The economic importance of tourism



Source: World Travel & Tourism Council (2024)

Figure 2 shows how tourism makes significant contributions to the GDP of various regions across the world and in particular countries.

Figure 2: Travel and tourism regional performance 2023



	T&T Contribution to GDP (US$ BN)	T&T's share of economy(%)	T&T GDP annual change (%)	Share of total T&T spending (%)		Share of total T&T spending (%)	
				Domestic	International	Leisure	Business
1 United States	2,356.0	8.6%	7.0%	89.8%	10.2%	69.8%	30.2%
2 China	1,302.9	7.3%	135.8%	92.6%	7.4%	81.5%	18.5%
3 Germany	487.6	11.0%	9.0%	91.1%	8.9%	82.2%	17.8%
4 Japan	297.0	7.1%	34.4%	80.5%	19.5%	86.2%	13.8%
5 United Kingdom	295.2	8.8%	35.3%	78.7%	21.3%	68.7%	31.3%
6 France	264.7	8.8%	5.7%	66.9%	33.1%	82.7%	17.3%
7 Mexico	261.6	14.4%	3.6%	86.1%	13.9%	94.7%	5.3%
8 India	231.6	6.5%	18.4%	85.8%	14.2%	95.2%	4.8%
9 Italy	231.3	10.5%	8.4%	69.6%	30.4%	84.6%	15.4%
10 Spain*	227.9	14.5%	9.1%	43.6%	56.4%	88.9%	11.1%
11 Australia	167.4	9.8%	17.0%	82.2%	17.8%	84.7%	15.3%
12 Brazil	165.4	7.7%	4.4%	94.3%	5.7%	89.5%	10.5%
13 Türkiye	131.4	12.0%	9.1%	31.2%	68.8%	94.2%	5.8%
14 Canada	127.4	6.0%	24.8%	68.8%	31.2%	67.5%	32.5%
15 Saudi Arabia	118.5	11.5%	32.3%	38.5%	61.5%	92.9%	7.1%
16 Russia	81.8	4.1%	15.2%	86.7%	13.3%	88.7%	11.3%
17 Indonesia	66.1	4.8%	29.5%	57.5%	42.5%	83.5%	16.5%
18 South Korea	64.9	3.8%	18.2%	58.6%	41.4%	84.2%	15.8%
19 Argentina	58.3	8.8%	9.4%	89.5%	10.5%	71.8%	28.2%
20 South Africa	30.8	8.2%	11.5%	78.4%	21.6%	69.8%	30.2%

* Spain is included here as it is invited to G20 events as a permanent guest.

Source: World Travel & Tourism Council (2024)

According to Visit Britain, tourism is one of the most important sectors of the British economy. Studies have shown that the visitor economy is complex and that a full understanding of inbound tourism measurement needs to take account of this complexity. From a visitor perspective, tourism is a composite product involving a variety of goods and services provided by different sectors, such as visitor attractions, travel agencies, accommodation, food and beverage, transport and retailing. Thus, tourism statistics should take full account of these economic activities in addition to just counting visitor numbers.

The International Passenger Survey (IPS) is the major source of information on UK inbound tourism performance.

Measuring inbound tourism accurately has crucial implications for the visitor economy and for designing policies. Major regional disparities exist in inbound tourism which are substantially, but not only, due to imbalanced tourism resources and infrastructure across the various regions of the UK.

At a global level, the inbound price elasticity for tourism has been assessed as around -1.02, with an overall elasticity of -1.26. However, other research has indicated that tourists' sensitivity to UK price variations is moderate, with elasticities ranging from -2.11 from Turkey to -0.95 from Australia.

Nikolas also drew attention to other methods used in tourism research, including those in two research papers[3,4].

Transport and tourism

For inbound visitors to the UK, the most popular means of getting around within a town or city is public transport.

Table 1 overleaf shows how:

- To explore urban destinations, 49% of inbound visitors used bus, tube, tram or metro and 28% used taxis.
- To explore further, 23% of inbound tourists used train.
- Less commonly, 10% used online ride hailing platforms such as Uber.
- Self-drive rental vehicles, coaches or minibuses and other modes were each used on smaller percentages of visits.

Analysis by trip purpose shows a similar pattern except for business travellers, who made relatively more use of taxi. This may partially explain the difficulty of meeting sustainability objectives by certain groups of transport users, depending on who pays their travel costs. It also suggests that students are doing more during their stay in the UK than just studying.

[3] Kim, Y., Williams, A., Park, S., Chen, J. (2021) "Spatial spillovers of agglomeration economies and productivity in the tourism industry: The case of the UK", Tourism Management: Volume 82, February 2021.
[4] Jiao, X., Chen, J., Li, G. (2021) "Forecasting tourism demand: Developing a general nesting spatiotemporal model" Annals of Tourism Research: Volume 90, September 2021.

Table 1: Visitor travel by mode and journey purpose

Visit purpose	All	Study	Holiday	Visting Friends and Relative (VFR)	Business	Miscellaneous
Urban public transport	49%	72%	58%	50%	31%	40%
Taxi	28%	29%	27%	24%	37%	26%
Non-urban train	23%	43%	25%	26%	14%	18%
Ride hailing apps	10%	15%	11%	10%	10%	7%
Self-drive car or vehicle	5%	2%	5%	7%	5%	2%
Non-urban bus or coach	5%	20%	5%	6%	2%	5%
Private coach	2%	6%	3%	1%	2%	4%
Ferry or boat	1%	3%	2%	1%	0%	1%
Domestic flight	1%	4%	2%	1%	1%	1%
Vehicle brought to UK	1%	1%	1%	1%	0%	1%
None of the above	27%	13%	23%	27%	35%	34%

Source: Visit Britain (2020)

Rail travel

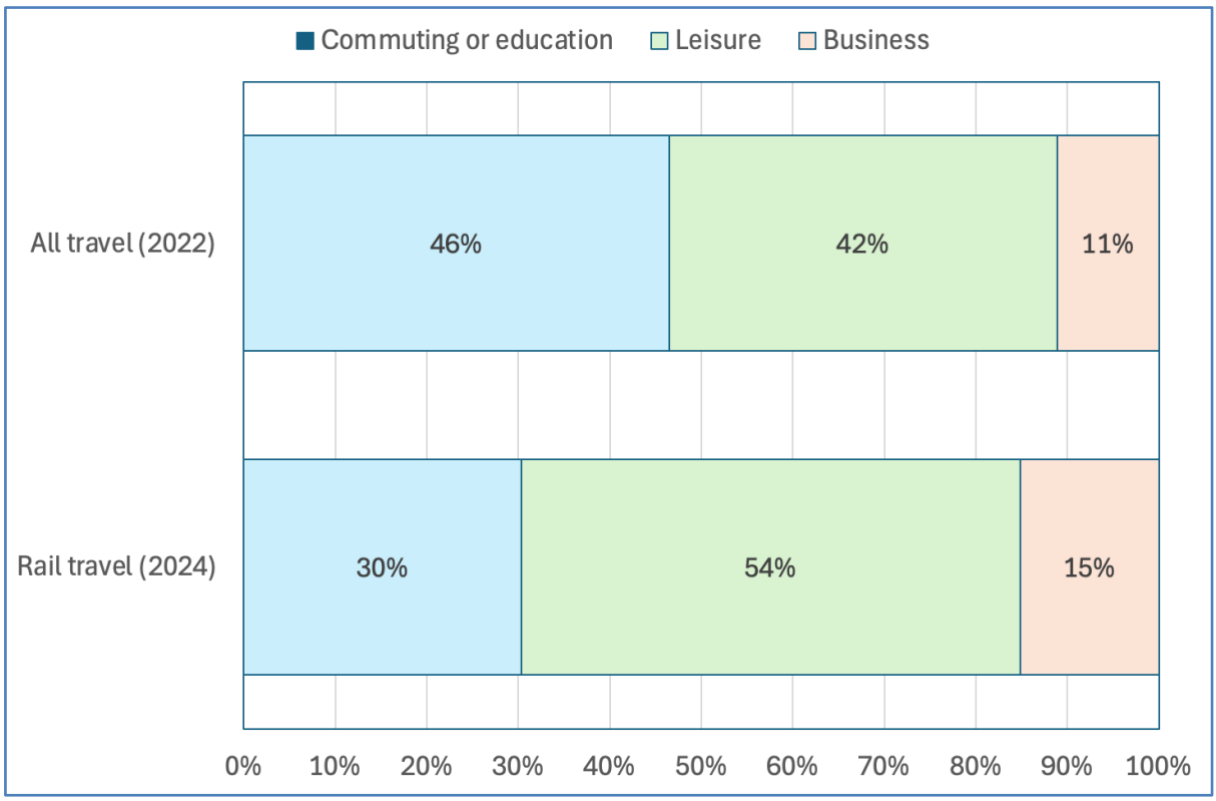
About 7% of all inbound visits to the UK are now by Eurostar. However, as table shows, 23% of visits included a train journey to explore outside a town or city during their stay, predominately by those in the UK for study, holidays or VFR.

Rail travellers tended to be significant users of other public transport:

- On 74% of visits, they used urban public transport.
- On 37% of visits, they used taxis.
- On 14% of visits, they used ride-hailing apps.
- On 10% of visits, they used non-urban public bus or coach.

Figure 3, for comparison, shows the overall mix of domestic travel.

Figure 3: All domestic travel by purpose



Source: Department for Transport

The Windsor Rail Stations Study

Nikolas began by explaining the purpose and results of the Rail Passenger Survey carried out with University of Surrey colleagues for Network Rail. Their work was intended:

- to facilitate the inclusion of Windsor stations user input into the "Windsor Strategic Stations Plan" (SSP);
- to support Network Rail through a baseline survey to develop a holistic SSP;
- to incorporate an inclusive SSP approach aligned with sustainable development; and
- to test and evaluate an approach for wider regional and national use.

Windsor is served by two railway stations, as shown in Figure 4.

Figure 4: Stations serving Windsor

Windsor & Eton Riverside is served every 30 minutes by direct South Western Railway trains to London Waterloo, taking 53 minutes.

Windsor & Eton Central is served every 20 minutes by a Great Western Railway (GWR) shuttle to Slough, taking 6 minutes, with total journey time to London Paddington taking around 30 minutes on terminating main line services or 40-45 minutes on through Elizabeth line services.

The survey, supported by staff of both rail operators, was conducted at both stations on weekdays and at weekends in February and March 2024. Between 07:30 and 20:30, three members of Surrey University distributed paper and online questionnaires travellers on station platforms and on trains. Over 500 responses were received, 75% of them online, of which 420 were valid and 370 allowed geo-spatial analysis.

Respondents came from the UK and 16 other countries: (in alphabetical order) Angola, Australia, Brazil, Chile, Czechia, France, Germany, Ireland, Italy, Mexico, Netherlands, New Zealand, Poland, Saudia Arabia, Spain and the USA.

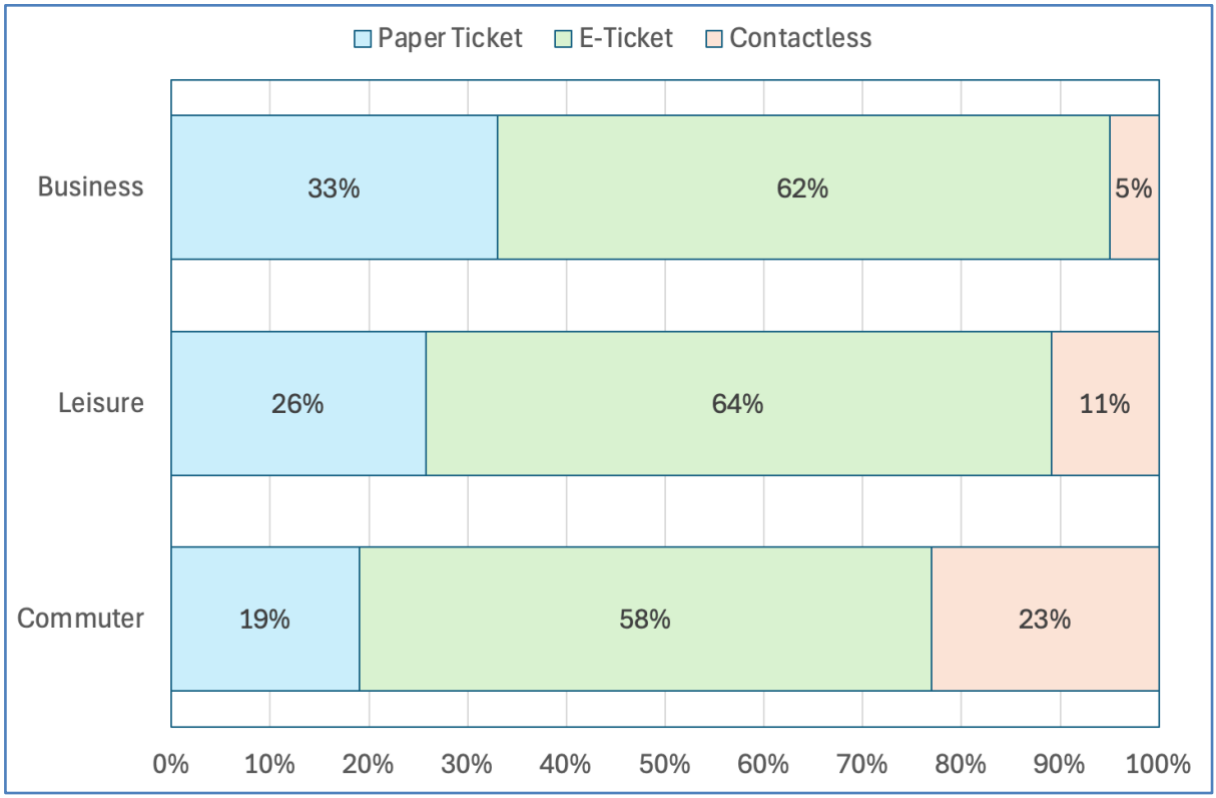
Survey findings

Travellers in the survey were asked to score various reasons why they had chosen to make the journey by train.

- They accorded positive scores to safety, personal security, reliability, frequency, interchange with other modes, environmental impact, lack of alternatives and cost.
- Fewer than 50% of them recorded the availability of an integrated ticketing option as a reason to travel by train.

Figure 5 shows the national mix of ticket type by trip purpose.

Figure 5: All rail travel ticket type by purpose



Source: Department for Transport survey (2025)

Nationally, business travellers made the greatest use of paper tickets from ticket offices or automated ticket machines (33%), and the lowest use of contactless (5%), which is used much more by commuters (23%).

Travellers in the survey were also asked how often they made their journey and their method of payment for travel:

- Ticket offices were used by most one-off leisure and tourism visitors.
- Automated ticket machines were not popular.
- Mobile phone apps were used by more regular travellers.

The survey included roughly equal proportions of commuters and visitors:

- The 26-35 age group formed the largest body of survey respondents.
- In general, commuters were younger than visitors, except in the over-65 age range.
- Most respondents were using trains to get to work. Female commuters tended to be younger than their male counterparts.
- Female respondents were equally represented among the commuters and visitors.
- Male respondents had a lower proportion of commuters, possibly a function of car commuting to employment in the Thames Valley.
- Respondents overwhelmingly had degrees or higher degrees, even among those using the trains for leisure.

There was high support for improved station access such as ramps and accessible toilets. This was expected, and has also been found in similar studies elsewhere.

It was also possible to chart where respondents from the UK residents had come from to start their train journey. There was some support for integrated ticket including local offers, but primarily by those residing closer to the stations rather than those living further away in the Royal Borough.

Table 2: Respondents views on station facilities

No clear demand	• Cycle access • Cycle storage • Car parking • EV charging points
Limited demand	• Shops or cafés • Extra workspaces • Extra local information
Demand	• Drop-off/pick-up points • More frequent connecting public transport • Extra waiting spaces • Better integrated ticketing arrangements • Electronic device chargers • Greenery

The survey also examined the relative use by both commuters and tourists of the two stations:

- more tourists use Central; but
- more commuters use Riverside, and use it more often.

This results in Riverside station having a higher overall usage[5] and a higher proportion of users under 35. Nikolas showed an interesting figure about trip-chaining, based on Saud and Thomopoulos (2021), which offers valuable insight about the various transport modes used when travelling to and from rail stations in Windsor.

Journey to work was the single largest travel purpose but still accounted for fewer trips than other purposes. This was the same for both male and female respondents.

[5] As context, ORR statistics for the year ending March 2024 estimate that Riverside was used by 1.0 million passengers and Central was used by 1.7 million passengers.

Future outlook

Nikolas concluded that tourism has a key role for UK transport and more focus is needed on leisure and tourism travel. While the study had some limitations, the intention was to publish its findings. Network Rail had yet to finalise their Strategic Station Plan for Windsor[6]. Further work at other stations might usefully involve linking survey findings with stakeholder priorities, and allowing prioritisation based on organisational and policy needs.

Discussion

Dick Dunmore (Secretary, TEG) noted that the study was a snapshot in time, and that the Elizabeth line had made travel to Windsor via Slough much easier from many points. However, many people may not be aware of, or understand, the differences between the coverage of Zones 1-6, Oyster cards, Freedom Passes and contactless ticketing. Since February 2025, both Windsor & Eton stations have been within the London contactless area, enabling payment for travel with most debit or credit cards, and some automatic ticket machines now recommend using contactless rather buying a ticket. Many one-off or infrequent travellers may be unaware of this and may have broken their journey unnecessarily to visit a ticket office. He wondered whether, as Contactless expanded, Transport for London (TfL), rather than National Rail, should take the lead in explaining, marketing and ticketing the destinations that contactless covered. **Nikolas** agreed that it was difficult for visitors to understand the different systems and their coverage. A more coordinated approach between TfL and National Rail aimed at visitors was needed, particularly regarding foreign tourists.

Peter Gordon (Editor, The Transport Economist) asked whether data had been available on passenger-kilometres as well as passenger-journeys. **Nikolas** said that this had not been collected, although there could have been additional value in doing so.

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[6] Now published at https://sacuksprodnrdigital0001.blob.core.windows.net/regional-long-term-planning/Southern%20region%20-%20planning%20documents/Windsor%20Stations%20Strategic%20Station%20Plan.pdf

Peter also asked how tourism had been defined. **Nikolas** referred to the scope of the study as set out in one of the slides. In brief, one definition is that a visitor is someone who visits a location for the day, whereas a tourist is someone who stays overnight. **Dick Dunmore** agreed that consistent analysis would be difficult if definitions varied, in particular in the boundary between leisure travel and tourism. Travel to watch a football match (or concert performance) locally might be regarded as leisure, but an away match might involve tourism. Alan Peakall (Freelance Economist) noted that he carried out much "tourism" facilitated by travel to football matches elsewhere in the UK or abroad. Following football had sparked his first interest in transport economics.

John Cartledge (formerly of London TravelWatch) noted that provision of information at stations had improved greatly in recent years, but referred to the importance that rail passengers attached to the provision of toilets on trains and at stations. This had not specifically been referred to in the presentation, although it did appear in the "word cloud" on one of the slides showing the issues that respondents had raised, as well as in the geo-spatial analysis about inclusion. He pointed out that trains between Windsor & Eton Riverside and Waterloo had toilets but Elizabeth line trains serving Slough did not. Might this affect travellers' choice of route? **Nikolas** reported that toilet provision is an important issue as it was raised by a number of respondents in the "free form" section of the survey. Time limits had prevented him going into too much detail on every aspect of the survey during the presentation.

Tali Diamant (Atkins SNC Lavalin & TEG Chair) asked through the chat whether there was a need for tourism trips to be appraised using a different value of time. In this context **John Cartledge** noted the phenomenon of "slow travel" and agreed that tourists may have different approaches to time savings, punctuality and reliability. **Dick Dunmore** added that there was a wider issue of all appraisal parameters. Appraisal currently tended to focus on journey time savings and the economic benefits of connecting residents to employment, whereas for tourism the issue might be reducing non-time barriers to travelling to destinations and creating employment there. The linkages between transport and economic growth were very

different. **Nikolas** felt that value of time assessments could only ever represent one aspect of economic appraisal, so it is pertinent to review how these are included in cost-benefit analysis (CBA) as slow travel and AV (Autonomous/Automated Vehicles) travel have been discussed for a few years now.

Peter Gordon felt that a more granular analysis of the survey would be interesting, such as to separate the results for domestic and overseas tourists, or to see differences in visitors' rail usage separately for day trips and overnight stays. However, he acknowledged the problems with sample sizes for some cross-tabulations. **Nikolas** acknowledged that deeper analysis of the results was possible and this was something they might investigate and consider for future studies, since this was a time-limited project.

Peter White (Emeritus Professor, University of Westminster) drew attention to the regular public express bus service between central London and Windsor. Off-peak economics of this service relied heavily on tourists. Did the survey provide any data on who used the service and how leisure users had found out about it, since it is not part of the TfL network? **Nikolas** said that this service had not been specifically covered in their survey work.

Dick Dunmore noted Nikolas's earlier reference to Uber as a variant on taxi. One advantage of platforms such as Uber and Citymapper is that they offer the same "look and feel" everywhere and hence may be familiar to foreign tourists. He also noted that Uber was now selling rail tickets, although this might leave some visitors unaware of the option of using contactless. **Nikolas** agreed that such global platforms were very useful for tourists but could divert visitors' attention from cheaper or more convenient locally available travel and ticketing options. The answer would appear to be better integration of data from all sources.

Report by Gregory Marchant

Scotland Rail Peak Fares Removal Trial – Final? Results

Andy Park
(Transport Scotland)

Online

25 June 2025

Introduction

Scotland's National Transport Strategy 2 said that "We will have a sustainable, inclusive, safe and accessible transport system, helping deliver a healthier, fairer and more prosperous Scotland for communities, businesses and visitors."

The Bute House Agreement, between the Scottish National Party (SNP) and Scottish Green Party, included a Fair Fares Review to ensure a sustainable and integrated approach to public transport fares to examine the range of discounts and concessionary schemes available on all modes including bus, rail and ferry.

The December 2022 Budget Statement announced the ScotRail Peak Fare Removal Pilot as a "Fair Fares Review Pathfinder Project", the first of its kind in the UK. The original trial, with £15 million funding, for six months from October 2023 to March 2024, was extended twice, to the end of June 2024 and then the end of September 2024.

In August 2024, Ministers decided that, while the published analysis supported the trial as value for money, budget constraints meant that it could not be made permanent. Instead, there were discounts of 20% on Season tickets and Flexipasses instead. However, as budget pressures eased, the 2025 *Programme for Government* announced that the policy would be permanently reinstated from September 2025.

Future fares policy will examine the whole system, including cross modal (integrated) ticketing.

A brief detour: the history of rail fares

Andy briefly outlined the history of rail fare, beginning with Figure 1 showing the evolution of fares while regulated.

Figure 1: The evolution of rail fares nationally

Period	Rate/mile 3rd class	Cost/100 miles 3rd class	1st/3rd class ratio	Cost/100 miles 1st class
Pre-1914	1d	8s 4d 42p	Nearly 2:1	16s 80p
1928-1933	1½d	12s 6d 63p	1.67:1	£1 0s 4p £1.04
1938-1946	1.575d	13s 1½d 66p	1.67:1	£1 9s 10d £1.49
1949	2½d	£1 0s 10d £1.04	1.6:1	£1 13s 4d £1.66
1953-1959	1¾d	14s 7d 73p	1.5:1	£1 1s 10½d £1.09
1960	2d+	17s 0d 85d	1.5:1	£1 5s 6d £1.33
1961	2½d	£1 0s 10d £1.04	1.5:1	£1 11s 3d £1.66
1962-1964	3d	£1 5s £1.25	1.5:1	£1 17s 6d £1.88
1966-1967	3¼d	£1 7s £1.35	1.5:1	£2 0s 6d £2.03
1968-	Not applicable	-	Not applicable	-

N.B.: 3rd class was re-designated 2nd class in 1956, which more recently was restyled into standard class.

Until the mid-1960s, fares were set in old pence (£1 = 240d) and based on distances in public timetables and Bradshaw, which existed from 1839 to 1968. In 1844, the Third Class rate was set in statute as 1d per mile and remained at that level until 1914. The First Class fare varied from 1.5-2 times the Third Class rate.

Between 1914 and 1921 there was cumulative inflation of around 40%, and the rates in this period have not been identified.

From 1968, the fare structure became much more complex and was determined by the selective fares manual, of which an extensive, but not complete, selection is held in the National Rail Museum and can be consulted on request. No record is held of season ticket rates.

Figures 2 and 3 compare current and historic fares.

Figure 2: The evolution of rail fares relative to inflation

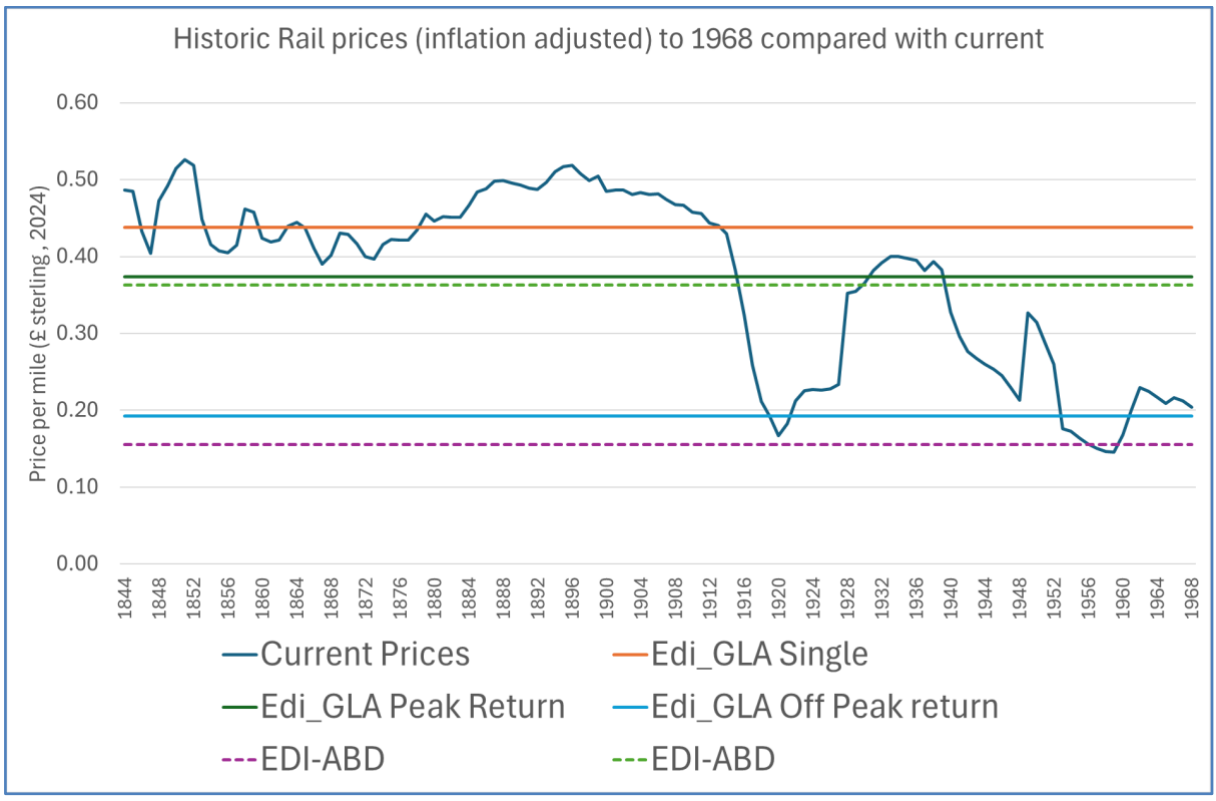

Figure 3: The evolution of rail fares relative to earnings

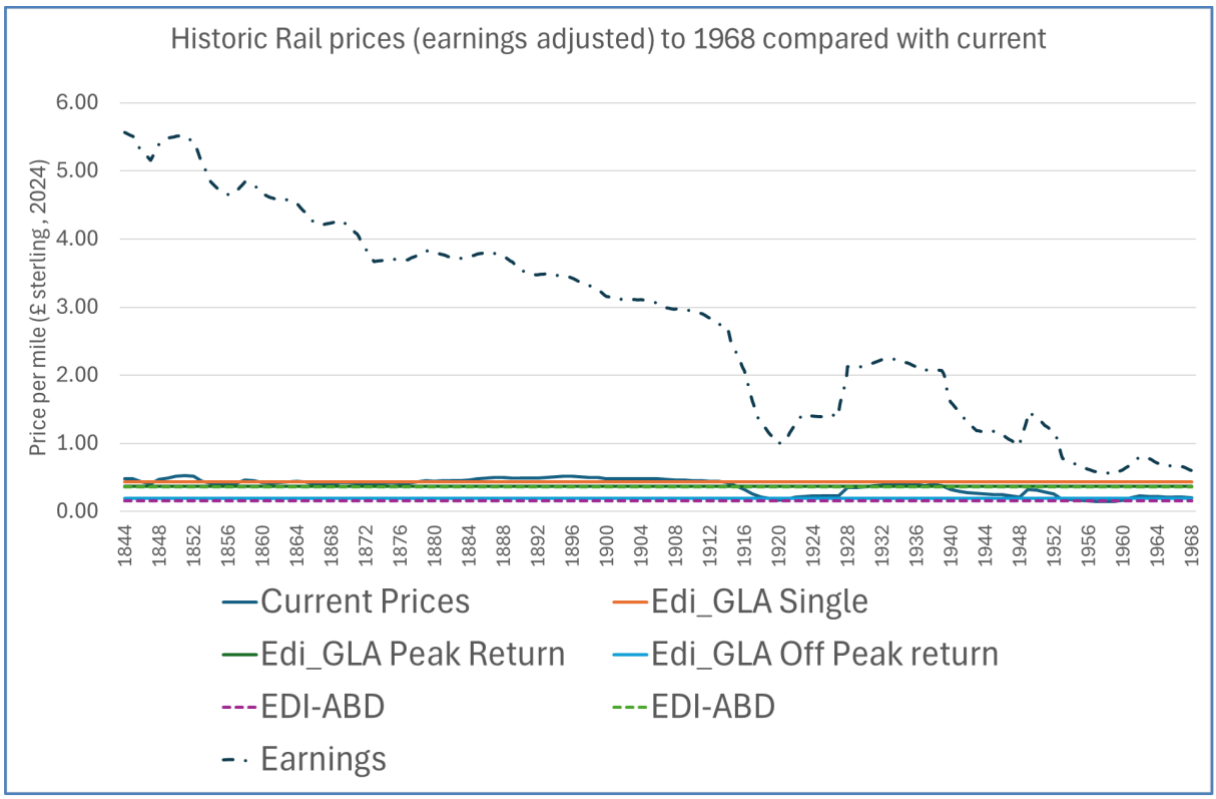

Figure 2 shows how, before the First World War, historic fares were the equivalent of 40-50p per mile at 2024 prices. The subsequently fell, briefly returned to historic real levels before the Second World War, but by the time distance-based pricing ended in the mid-1960s, had fallen to around 20p per mile. If current fares are compared with this range:

- Peak (Anytime) Edinburgh to Glasgow Single (solid red) and Return (solid green) fares are at the upper end of the real historic fares.
- Off-Peak Edinburgh to Glasgow Return (solid blue) fares are at the lower end of the real historic fares.

Figure 3 repeats the analysis, but with historic rail fares adjusted to reflect growing real earnings. Relative to earnings, even peak fares are now only around 10% the level set in 1844.

Note that Off-Peak fares were introduced as a discount on peak fares to encourage spreading of demand. There is a common misconception that peak fares were introduced to raise revenue.

Appraisal v evaluation

Transport Scotland has published reports on the evaluation[7,8]. The trial was a novel experiment, in that it was the first time that something of this scale has been tried in the UK. The normal approach to transport analysis is ex-ante appraisal followed by ex-post evaluation. This project was much more of a "blend" as:

- It was temporary: in contrast, if a bridge is built or a road is dualled, it is permanent.
- The aim was to examine the impact in the specific context of rail demand still recovering from being hit very hard during the pandemic.

Note also that the "Scottish approach" to interpretation of appraisal results does not rely on a Benefit-Cost Ratio (BCR) but takes wider issues into consideration: it works in both directions. Arguably, the recent Green Book review moves in this direction.

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[7] Interim Report https://www.transport.gov.scot/publication/scotrail-peak-fares-removal-pilot-interim-evaluation-report/
[8] Final Report https://www.transport.gov.scot/media/spen0osc/scotrail-peak-fares-removal-pilot-final-evaluation-report-august-2024.pdf

Normally appraisal and evaluation works in transport models of the future in a "Business as Usual" (or "Do-minimum") scenario, and in scenarios with the intervention in place. It is the difference between the two that is of interest, and transport models are generally good at capturing that difference. Bluntly, if the model is equally wrong in both scenarios it gives the right answer. Then there is generally evaluation at specific points to test if the model gave accurate results.

For the trial, there was good knowledge of what happened, but what will never be known is what would have happened without the intervention. The results are therefore very sensitive to what is assumed about the counterfactual and, arguably, this sensitivity is greater than the sensitivity of the modelling. There were, however, also concerns about the accuracy of modelling through the Transport Model for Scotland (TMfS), which was not primarily designed to examine fare changes.

Evaluation of the pilot

There is data on every ticket sold, but there are 359 stations in Scotland and thus 128,522 different possible single journeys.

Table 1 overleaf shows the average reduction between the eight regions. The average reduction across all journeys was 16.8%, but this was as high as 50% for some peak tickets.

There were big fluctuations by day of the week, and the analysis needed to capture this, but the biggest issue was how to account for the impact of weather, strikes and major events. Therefore, data could be analysed by, day, "Service Group" and route.

The political commitment to a national trial precluded clever experimental design. The trial was constrained by the ticketing and allocation systems, which required ScotRail to retain Anytime and Off-Peak tickets, so it removed timing restrictions on the Off-Peak fares it set, harmonising their price and restrictions with Anytime fares. Gateline data on boardings and alightings is available at key stations, giving timing at the gateline but not details of the other end of the trip. Survey work was therefore commissioned to understand more about the characteristics and choices of travellers.

Table 1: Average reductions in peak fares between regions

Area	Far North	Aberdeen & North East	Dundee – Stirling	West Highlands	Edinburgh	Inner Glasgow	Outer Glasgow	South West Scotland
Far North	-1%	-28%	-17%	-4%	-19%	-19%	-19%	-20%
Aberdeen & North East	-28%	-21%	-14%	-17%	-22%	-21%	-20%	-19%
Dundee - Stirling	-17%	-14%	-20%	-20%	-32%	-35%	-23%	-20%
West Highlands	-4%	-17%	-20%	-4%	-22%	-9%	-9%	-5%
Edinburgh	-19%	-22%	-32%	-22%	-33%	-41%	-37%	-31%
Inner Glasgow	-19%	-21%	-35%	-9%	-41%	-34%	-34%	-31%
Outer Glasgow	-19%	-20%	-23%	-9%	-37%	-34%	-34%	-29%
South West Scotland	-20%	-19%	-20%	-5%	-31%	-31%	-29%	-30%

The impact on demand

The conclusions are critically dependent on what is assumed about trend growth in demand and recovery from COVID-19. Andy explained that there was as much art as science to determining the counterfactual.

Table 2 shows the five scenarios considered.

M2 (prime) and M4 were considered as the best scenarios:

- M2 matches UK demand.
- M4 is intuitive and broadly replicates the raw results from Transport Model for Scotland (TMfS), which is what would have been done had this not been a trial.

Table 2: Scenarios for assumed underlying demand recovery

	Recovery assumption and comments
M1	Recovery continued on the trend before the trial.
M2	Recovery stabilised at the end of July 2023 at 90% of demand before COVID-19. This was equivalent to the UK position and considered the primary scenario.
M3	Recovery stabilised at the end of March 2023 at 80% of demand before COVID-19. This was a test only and not viewed as appropriate.
M4	Recovery had stabilised at the end of September 2023, before the trial began.
M5	Recovery continued to the end of November 2023 at 100% of demand before COVID-19 and is then capped at this level.

Econometric analysis

The impact on demand was estimated using the econometric approach used in the Interim Report that covered the period to mid-May 2024, but was applied to data to 3 July 2024.

Ordinary Least Squares regression (the simplest form of regression analysis) was used, as the nature of the dependent variables was fortunately simplistic: mainly time-based dummy variables and a shift and trend parameter at the introduction of the trial.

The approach used is a "General to Specific" methodology:

- First, all variables are included, and a model estimated.
- Then, the most statistically insignificant variable is excluded and the model re-run.
- This is repeated until all remaining variables are significant.

The analysis used GRETL, an open-source econometric package that is easy to use and can be installed on SG IT systems. The GRETL results were then transferred to Excel, and the impact of the trial assessed by using the predicted results for the full time period with and without the trial shift and trend change parameters in place.

In total, 42 different models were run, but the focus was on the national scenarios and the five ScotRail "Service Groups".

Table 3: Results of econometric analysis: variables

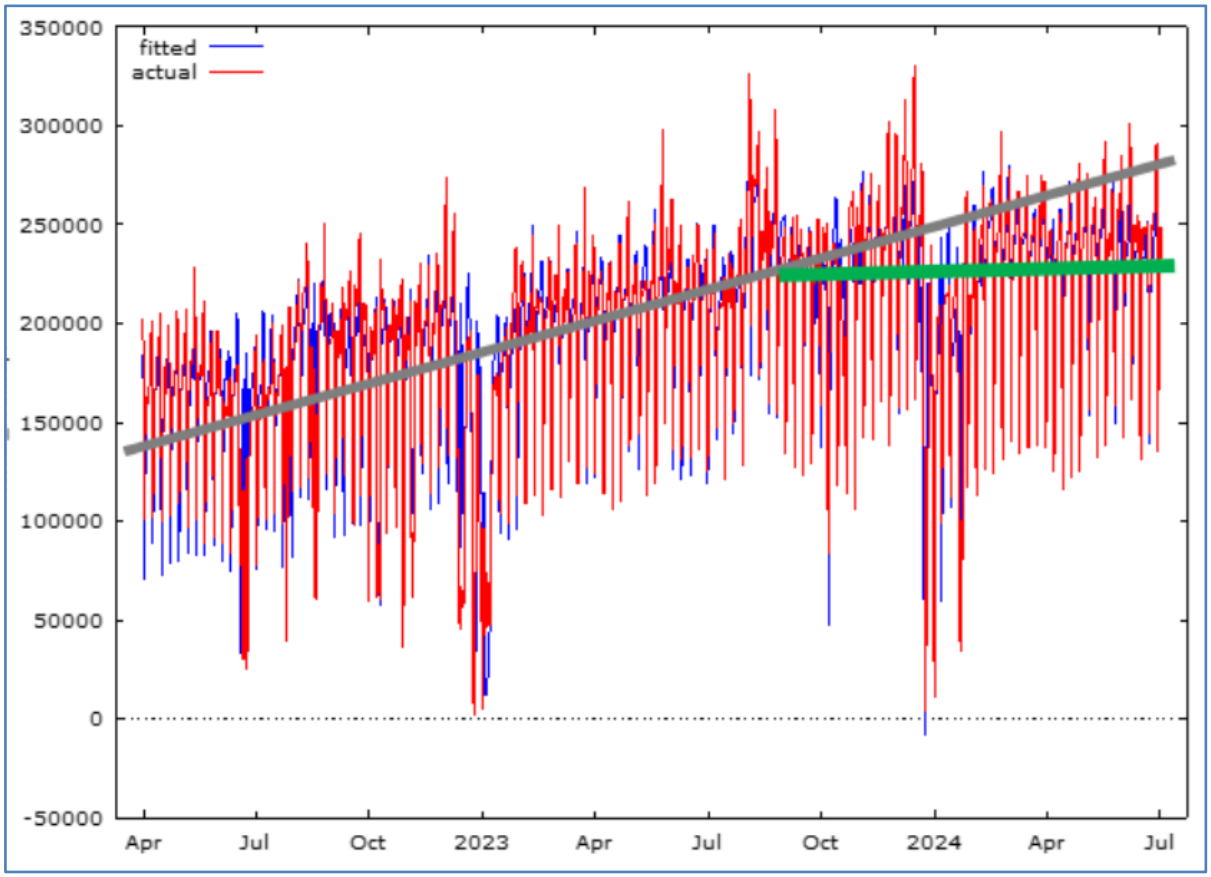
Variable	Description
Constant	A standard constant or intercept
Trend	An overall trend growth rate – varies and choice has a strong influence on results. The preferred version is that in which demand stabalises pre-trial at 90% of pre-C19 demand in line with rail demand across the UK.
PFT Dummy	A Peak Fares Trial Dummy - A variable that takes the value 1 from October 1 2023 and 0 before and allows a shift in demand from the Pilot to be estimated
PFT trend	A trend variable from October 1 2023 that allows the ongoing impact of the Pilot to be estimated
Day of the week variables	Wednesday is chosen as the base and Sunday, Monday, Tuesday, Thursday, Friday and Saturday variables take the value 1 on relevant day of the week to allow daily variations to be captured*
Month variables	Similar to the Day variables, September is chosen as the base* (All other months take the value 1 when applicable). This is a standard way of capturing seasonal impacts.
XmasNewYear	To account for distinctly different travel demand over the Christmas and New Year period.
Sport	1 if there was a major sporting event that would be assumed to influence rail demand on the day
Concert	1 if there was a major concert or cultural event on the day
Strike	1 if strike action within Scotland.
Bad weather	1 if yellow weather warning on day
Extreme weather	1 if major weather event on day.
Travel demand difference	Proxy variable for general travel demand. Is the variation in road travel demand from the equivalent period in 2019 as percentage variation. Various specifications tested and make no difference to other results and just vary interpretation of this variable.
Fares Rise	A dummy variable to account for the rise in fares in April 24

Table 4: Results of econometric analysis: national

Scenario	**Fare change**	**Change in demand from peak fares**	**Elasticity**
M1	-16.8%	-5.07%	+0.30
M2	-16.8%	+6.81%	-0.41
M3	-16.8%	+15.90%	-0.95
M4	-16.8%	+2.36%	-0.14
M5	-16.8%	+0.00%	0.00

Figure 4 shows the fitted and actual journeys in scenario M2.

Figure 4: the preferred scenario, M2



M2 is the preferred scenario and the key one reported, although various factors suggest that Scottish demand may have recovered more than this without the trial in place as in the M4 scenario. Compared with the UK as a whole, Scotland had less industrial action, better performance (at least until July 2024)

and wider factors such as geography and public ownership. On balance, it is likely that the actual recovery of demand was between the M2 and M4 scenarios.

Table 5: Results of econometric analysis: regional

Region	**Fare change**	**Change in demand from peak fares**	**Elasticity**
Express T90	-27.5%	8.86%	-0.32
InterCity T90	-9.2%	3.54%	-0.38
West Suburban T90	-17.0%	7.07%	-0.42
East Suburban T90	-16.9%	13.66%	-0.81
Scenic T90	-8.3%	6.45%	-0.78

A more detailed breakdown by sub-routes is available (see Table 6 overleaf), but there are issues with reading too much into finer detail without going very fine indeed.

The calculated elasticities are similar to those in the Passenger Demand Forecasting Handbook (PDFH) but there is not a direct link between the calculated elasticities and revenue in the normal way, because of changes in the nature of demand in areas, which is important when considering costs.

Costs

The impact on cost is primarily driven by the estimated impact of changes in demand generating revenue to offset that lost by the reduction in fares. These additional costs incurred by ScotRail are added to this estimate.

Modelling shows that the pilot would be "self-financing" if the increase in demand had been around 10%, subject to significant uncertainty. The current estimated additional costs are £2.5 million over the trial period, or £3.3 million per year, but this includes Trainline costs (for changing fares) without which there is a cost of £2.7 million per year. Subsequent analysis used a figure of £3 million per year.

Table 6: Results of econometric analysis: route analysis

Route	**Fare change**	**Change in demand from peak fares**	**Elasticity**
Edinburgh – Dunblane	-16.0%	+6.8%	-0.43
Fife Circular	-18.3%	+10.2%	-0.56
Glasgow Central – Shotts - Edinburgh	-17.8%	+18.2%	-1.02
Edinburgh Haymarket – North Berwick	-14.4%	+15.7%	-1.09
Aberdeen – Inverness	-6.8%	+4.5%	-0.67
Edinburgh – Aberdeen	-6.5%	+1.8%	-0.28
Glasgow/Edinburgh – Dundee/Arbroath	-14.5%	-3.6%	+0.25
Glasgow/Edinburgh – Inverness	-4.0%	+3.5%	-0.88
Glasgow – Aberdeen – Dyce	-10.6%	+16.4%	-1.56
Montrose - Aberdeen	-8.5%	-32.5%	+3.84
Edinburgh Crossrail – Borders	-13.5%	+9.4%	-0.70
Glasgow/Carlisle – Stranraer	-7.0%	+12.1%	-1.73
Glasgow – Oban/Fort William/Mallaig	-1.3%	-6.9%	+5.20
Inverness – Kyle of Lochalsh	-0.6%	-3.8%	+6.81
Inverness – Wick/Thurso	-0.6%	-3.0%	+5.29
Argyle line	-16.6%	+7.0%	-0.42
Edinburgh – Bathgate	-15.8%	+57.4%	-3.63
Glasgow Northern Suburban (S)	-19.2%	+4.7%	-0.25
Glasgow – Ardrossan/Largs (S)	-14.1%	+12.5%	-0.88
Glasgow – Ayr (S)	-13.5%	-5.1%	+0.38
Glasgow – Barrhead – Kilmarnock (S)	-15.2%	+16.7%	-1.10
Glashow – East Kilbride (S)	-18.3%	+9.5%	-0.52
Glasgow – Paisley Canal (S)	-20.2%	+3.6%	-0.18
Glasgow – Stirling – Dunblane	-21.5%	+12.7%	-0.59
Glasgow – Wemyss Bay – Gourock (S)	-15.3%	+7.1%	-0.46
Glasgow – Springburn/Cumbernauld (S)	-16.1%	+5.3%	-0.33
Glasgow – Stirling – Dunblane (S - Croy)	-21.5%	+9.3%	-0.43
Glasgow SE North – (S)	-17.8%	+7.7%	-0.43
Glasgow SE South – (S)	-18.9%	+15.0%	-0.80

Revenue

The econometric approach suggests a net loss in revenue of £12.7 million over nine months, which would be £17 million over a year, giving an annualised total of £20 million including the additional ScotRail costs, but small variations in functional form change this dramatically.

The TMfS approach suggests an annualised total of £17 million (M2) or £37 million (M4), including the additional ScotRail costs. This is also "what the model said" and was used in initial costings, which illustrates how sensitive the results are to the demand assumptions made. ScotRail estimate the cost to be £20-27 million on an annual basis including the additional costs.

A prudent view of annual costs would be in the range of £25-30 million, with a downside scenario of up to £40 million. Financial prudence in the context of very constrained budgets pushed the preferred estimate to the high end, driven by higher results when looking at a range of sub-areas.

Value for Money (VfM)

The TMfS model of Scotland's surface transport system is highly complex and was designed to look at the impact of changes in infrastructure. It uses 2010 as a base year for prices and discounting: as a rule of thumb, multiply numbers by 2.4 to get to current prices and values. The TMfS run estimated the increase in rail demand to be 2.17%.

The Transport Economic Efficiency (TEE) results of this initial model run were set up in such a way that they could be scaled to the estimated regression outputs.

Using the demand and cost information for the M2 scenario, the estimated Benefit-Cost Ratio (BCR) of the project (on an annual basis as per standards) is 1.5, falling to 1.2 for the M4 scenario.

The "3 BCRs" in the table reflect the impact of indirect tax (VAT) which accrues to the UK Government. The model assumes that money saved on public transport that is not subject to VAT is spent on goods and services that are subject to VAT.

Performing "distributional weighting" to account for the higher incomes of rail users reduces the BCR to 1.0 and 1.25.

Figure 5: Appraisal for scenario M2

	Scenario 1			BaseLine (TMFS)		
Change in Rail Demand (%)	2.174	**6.8**		**2.17**		
ALL USERS	All	Road	Rail	All	Road	Rail
Travel time	-1758	1239	-2997	-562	396	-958
VOC	1567	1567	0	501	501	0
User Charges	13779	0	54364	17377	0	17377
User Charges Rail Existing	19067			19067		
User Charges Rail New	-14200			-4539		
User charges bus	5933			1897		
User charges Balance	2978			952		
Total	13588	2806	51367	17316	897	16419
Additional costs	-1310			-1310		
	All	Fares	Patronage	All	Fares	Patronage
Revenue	-10801			-16425		
Rail	-4868	-19067	14200	-14528	-19067	4539
Urban Bus	-838	-2	-836	-268	0	-267
InterUrban Bus	-5096	-1600	-3496	-1629	-511	-1117
Subsidy to Rail	6178			15838		
NET BUSINESS IMPACT	-4623			-587		
Indirect Tax - Road	-873			-279		
Indirect Tax - Rail/Bus	582	2280	-1698	1737	2280	-543
Indirect Tax - All	-291			1458		
TOTAL Business + Consu	8965			16729		
Greehouse gases	651			208		
Total BENEFITS	9616			16937		
		Subsidy to Rail	Indirect Tax		Subsidy to Rail	Indirect Tax
Cost to Government	6468	6178	291	14380	15838	-1458
Cost to SG	6178			15838		TEE Only
NPV (UK)	3147			2557		2349
BCR (UK)	**1.49**			**1.18**		
NPV (SG)	3438			1099		
BCR (SG)	**1.56**			**1.07**		
NPV(SG VAT assign)	3292.782685			1828		
BCR (SG VAT assign)	**1.52**			**1.12**		

Survey work

The survey also identified the income, employment status and age of:

- new rail users;
- existing rail users who did and not change behaviour; and
- non-rail users.

Income

Existing rail users who did not change behaviour were, relative to the population as a whole, concentrated in an above average income group (£35,000 to £49,999).

New rail users were more likely than existing users to be in lower income groups (less than £35,000).

Non-rail users were more likely than either existing or new rail users to be in very low-income groups.

There is some moderate evidence that the trial encouraged rail use among low to middle income households, while primarily benefiting existing users, who tended to be above average income.

Employment status

New rail users were less likely to be working full time (49%) than existing rail users who changed behaviour (67%) or did not change behaviour (56%).

New rail users were more likely to be retired (18%) than existing users, but non-users are much more likely to be retired (33%).

There is strong evidence that the trial has helped existing users who are in work, and encouraged greater rail travel among this group, but has had a lower impact in encouraging full-time workers who did not use rail to use it.

Age

Existing users who changed their behaviour tended to be young, with the majority in the 31-40 age group. 16-21-year-olds who are eligible for concessionary bus travel were only a small proportion of all groups.

New rail users' age profile was very similar to that of existing users who did not change their behaviour, but with a greater proportion of people over 65.

There is relatively weak evidence that the trial encouraged older users to use rail when they didn't before and has encouraged 31- to 40-year-old existing users to travel more by rail.

Gateline data

Gateline data on boardings and alightings (but not station-to-station movements) was available for 22 platforms on 17 stations in half-hourly time bands for the period 1 October 2022 to 2 July 2024.

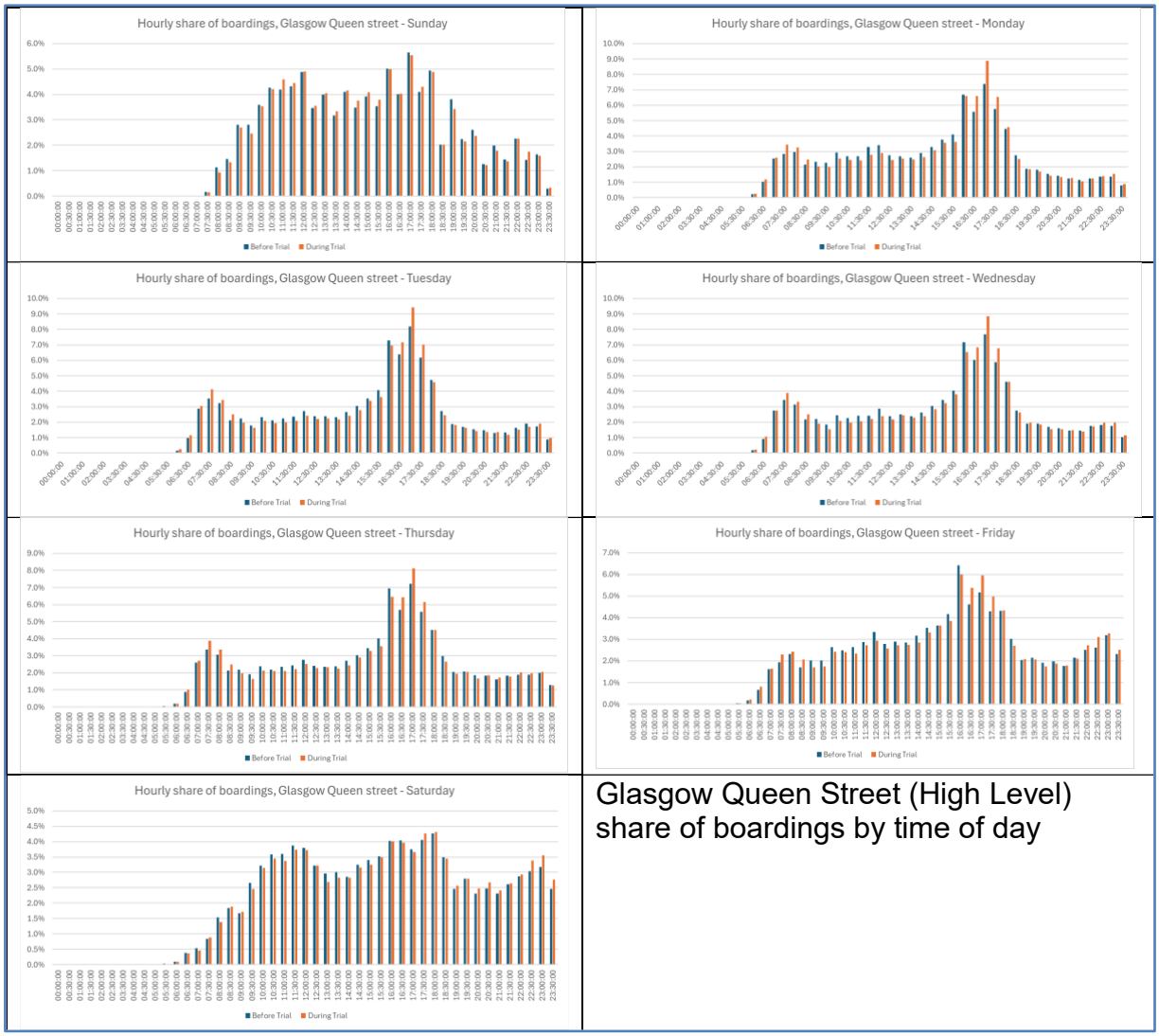
Table 7: Stations providing gateline data

Station	Notes
Aberdeen	
Anderston	
Argyle Street	
Bathgate	
Charing Cross	Glasgow
Dundee	
Edinburgh Gateway	
Edinburgh Park	
Exhibition Centre	
Glasgow Central	Platforms 3-6, 7-8, 9-10, 11-15, Low Level
Glasgow Queen Street	Main station, Low Level
Haymarket	Edinburgh
Inverness	
Motherwell	
Perth	
Stirling	
Waverley	Edinburgh

The data includes around 1.5 million data points, making it difficult to present. In addition, to avoid crowding when stations are particularly busy, the gatelines tend to be switched off, and this is more common at stations where the physical layout presents greater issues.

The analysis focused on boardings (station entries) which could be accurately mapped to the AM and PM peaks. Alightings (station exits), in contrast, provide no information on when a journey began (especially in the PM peak) and whether it previously required an Anytime fare.

Figure 6: Boardings at Glasgow Queen Street



Glasgow Queen Street (High Level) share of boardings by time of day

At Glasgow Queen Street there was an increase boardings during the week in both AM and PM peaks, with the biggest impact being between 17:00 and 17:30. Friday's significant nighttime demand also increased during the trial period.

Carbon impacts and context

Over the nine months from October 2023, the trial resulted in up to around four million extra rail journeys.

Mode shift from car (2 million trips)

The survey results agreed with TMfS modelling that around half the new passengers had switched from private car. Removing two million car journeys over nine months is in the context of around five billion private car journeys annually in Scotland.

Mode shift from bus (1 million trips)

There was some mode shift from bus, but the modelled scale of abstraction was less than 0.25% of bus journeys. Discussions with bus operators suggested that this was not significant and was more than outweighed by growing demand from the Under 22s Free Bus Travel Scheme.

New trips (1 million trips)

The remainder of the additional demand was new trips. The value for money analysis includes around £1.5 million monetarised CO_2 savings from reduced car use at current prices. This represents less than 0.1% of 2022 car emissions of around 5 million tonnes.

Summary of the pilot evaluation

The analysis undertaken by Transport Scotland and ScotRail suggested that the Peak Fares Removal Trial had an impact on demand of around 6.8% over the nine months of the trial, with an estimate from ScotRail of 4.4% over the first six months, and a downside scenario of 2.4%.

In all the scenarios (other than M1, see Table 2), the costs, which are in the range of £20-40 million, are such that the project initially shows positive Value for Money with a BCR of 1.2-1.5, with the best estimate to the higher end of the range. This falls to a BCR of 1.0-1.25 once "distributional weighting" is taken into account.

The project can be shown to pass on Value for Money (VfM), but is relatively poorly targeted in terms of those most in need, and had a minimal impact on CO_2 emissions. This, and significant concerns regarding immediate affordability (in year 2024-25) and the wider budget position at the time, explained the decision by Ministers to restore peak fares but to offer reductions in the price of season tickets/Flexipasses for those who need to travel regularly.

During the first half of the last three months of the trial after the evaluation, industrial action resulted in a reduced timetable on all ScotRail services. Services returned to "normal" before the trial ended, but there are likely to be some longer-term impacts.

The end of the trial

A big concern was that the end of the trial would cause a fall in demand, as would be expected by economic theory. This did not happen, and demand continued to grow, but at a slower rate.

Revised analysis to the end of May 2025 suggests that demand growth slowed in the last 3 months of the trial, meaning that the overall impact of the 12 months was slightly lower, but this does not significantly affect the overall Value for Money.

The outcome is likely to be a result of some combination of:

- The trial permanently influenced positive views of rail.
- The season/Flexipass discount was very well targeted: some evidence for that is shown above.
- There were material external factors, such as greater "return to the office".

However, it may suggest that demand is less sensitive to price than to other factors and might be "sticky".

In addition, the trial was temporary. Ministers are interested in long term effects, and this influenced the decision to reinstate it.

Transport Scotland will shortly be publishing a full analysis and starting an advertising campaign. Peak fares will be permanently removed at the beginning of September.

The team is busy on a range of issues that were less relevant during the trial but will be more important on a permanent basis. These include what to do about Seasons/Flexipasses and Railcards and discounts: many are currently time limited, but not all are within the control of the Scottish Government.

There are also questions such as whether it is still relevant to have separate Anytime and Off-Peak tickets, which is an issue within the ORCATS system used for allocating revenue between operators. There are also oddities and anomalies throughout the fare structure.

Transport Scotland is planning a large scale and continuing evaluation, with significant additional survey work and, in the longer term, will aim for further simplification of the fare structure.

Discussion

Gregory Marchant said that public transport was free in Luxembourg. Had Andy contacted the authorities there? **Andy** said that there been contact, but it was a very different geography, and he was wary of international comparisons. The approach in Luxembourg is radical, but free travel could encourage unnecessary trips, and how could demand be controlled? Scotland's budget position still not improved much. Much of the population (under 24 and over 60) has access to free bus travel, but extending it much further becomes difficult because of how the compensation system for bus operators works. It might require nationalising the bus industry.

Dick Dunmore noted the difficulties in identifying time of travel and asked if there had been a focus on Glasgow Queen Street, and whether the trial had led to overcrowding at peak times. **Andy** said that he had just used Glasgow Queen Street as an example, and the same analysis was repeated for all the stations with gatelines. On overcrowding, there were no significant issues, possibly helped by some large stations (such as Edinburgh Haymarket, Dundee and Glasow Queen Street) recently being redesigned. Some train services were strengthened, but ScotRail was still recovering from COVID-19 at the start of the trial, and there was deliberately little initial publicity to avoid possible sudden surge in demand. **Dick** also wondered if there were any issues with cross-border fares? **Andy** said that they had let other operators react however they wished, but also noted that most long-distance journeys are not done regularly and many are not at peak times.

John Cartledge asked about the limited publicity: was selling the trial left to the politicians? **Andy** replied that there was a light touch at first, with more advertising later, but the politicians did advertise it a lot. There will be a big push at the reinstatement, which will include a large advertising campaign.

Gregory Marchant asked if any thought had been given to ending First Class? **Andy** said that it was not a big issue: while some groups dislike the concept, other travellers view it positively, and accommodation can always be declassified if required. There are no real issues caused by using some capacity for First Class.

Simon Temple asked if there was larger diversion from bus on certain key corridors. **Andy** said that probably yes: they were concerned about it and, to some extent, still are. On many bus routes, passengers are predominantly using concessionary travel. Transport Scotland is not concerned now, but may be in the future. The relativities between bus and train vary by region.

Mark Sullivan asked if there was an afternoon return restriction on Off-Peak fares? **Andy** said that the afternoon peak restriction was in place for parts of the network, which added to the complexity, but that this was probably overshadowed by differences in fares across the country and the availability of bus services. For example, there is a large suburban rail network in Glasgow but not in Edinburgh, where bus services by the council-owned Lothian Buses are very good. **Mark** also asked if there had been a large increase in the basic fare? **Andy** said yes, but the increase but been shifted to April to fit the budget cycle, and at 8.7% it was broadly in line with inflation since the previous rise. It didn't have an impact on demand in the modelling, but was consistent with the basic assumptions in the rail Passenger Demand Forecasting Handbook (PDFH) which is based on changes in real, rather than nominal, fares.

Andy closed the discussion concluded with a few other points:

- He noted that the timing of the trial may have been optimal in policy terms but was very difficult for analysts, because in April 2022 the rail network was still at the early stages of recovering from COVID-19.
- He reiterated that the trial had been a one-year pilot and was unlikely to have led people to make permanent life decisions. It will be fascinating to see how the permanent change affects where people choose to live, work and play. He was concerned that he and his team may find evaluation problematic because the counterfactual, already difficult to specify, will become more and more so over time.
- He noted that Flexipasses are good value: so much so that, when they are adjusted for the new single fare, they will be much more competitive with season tickets.

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The Transport Economists' Group, formed in 1973, provides a forum for people involved in transport economics to meet regularly and discuss matters of mutual interest. Membership is open to economists working in transport and others whose work is connected with transport economics.

The aim of the Group is to improve the quality of transport management, planning and decision-making by promoting lectures, discussions and publications related to the economics of transport and of the environment within which the industry functions.

Meetings, online or at Arup's Central London HQ, from September to June (except December), consist of short papers presented by speakers, drawn from both within the Group's membership and elsewhere, followed by discussion.

The Group's Journal, "The Transport Economist", is published three times a year reporting on meetings and other activities of the Group. It reviews recent publications of interest and contains papers or short articles from members. The Editor welcomes contributions for inclusion in the journal, and can be contacted at petersgordon@blueyonder.co.uk.

The current membership of over 150 covers a wide range of transport modes and types of organisation. Members are drawn from transport operators, consultants, universities, local and central government and manufacturing industry. All members are provided with a full membership list, updated annually, which serves as a useful source of contacts within the profession. Applications from people in all sectors are welcome.

Applications for membership should be made on a form which can be downloaded from the Group's website at www.transecongroup.org

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