

Transport impacts evaluation

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Transport baseline evaluation

Executive Summary

Arup and Volterra were contracted by Transport for London (TfL) and the Department for Transport (DfT) to carry out a Crossrail Baseline Evaluation Study. This report sets out the baseline for transport in the years leading up to the opening of the Elizabeth line using information until the end of the 2019/2020 financial year to avoid the confounding impact of the Covid-19 pandemic. At present, it is not clear to what extent the Covid-19 pandemic will permanently affect travel patterns, therefore trends in travel patterns will be explored in more detail in any post-opening analysis. It is part of a suite of documents that address economy, planning and regeneration aspects, the construction impacts, case study interviews, and pre-opening property impacts.

Key findings of the transport baseline are:

- In London, walking and cycling mode shares have increased to a greater extent than nationally due to initiatives around the promotion of active travel, noting however marked differences between inner and outer London. Car mode share is significantly

higher in outer London with cycling and walking attracting a much higher proportion in inner London (46% compared with 32% in outer London).

- The increase in rail capacity afforded by the Elizabeth line of around 10% into central London will relieve crowding and assist with accommodating London's growth. It is forecast to further increase the public transport mode share, which is likely to be at the expense of car, motorcycle and taxi.

The following points make reference to relevant transport metrics for the stations and lines which have the potential to be impacted by the opening of the Elizabeth line:

- One of the key objectives of Crossrail is to provide relief from on-train crowding on the London Underground network, primarily on the Central, District, Jubilee, Hammersmith & City/Circle, District, and Bakerloo lines. All of these have seen strong increases in demand and consequential increases in crowding levels over the period of the transport baseline.

- The Central, District, and Jubilee lines have seen substantial passenger demand growth since 2008 with the Jubilee line showing the most significant growth (over 50%), reflecting the introduction of 7-car services in 2006, the signalling system upgrade which enabled increases in peak frequencies and demand increases associated with the opening of the Westfield Stratford shopping centre and the ongoing development of the Queen Elizabeth Olympic Park (QEOP).
- In 2017, which is the last year for which consistent Rolling Origin and Destination Survey (RODS) data are available, the Jubilee line had approximately the same number of daily boarders as the Central line (approximately 1 million boarders per day).
- The Hammersmith & City/Circle, District, and Bakerloo all experienced growth of between 15 and 20% over the same period..

Transport baseline evaluation Executive Summary (continued)

- The stations with the most significant growth are in the east of London, including Stratford, Whitechapel, Canary Wharf, and Liverpool Street, coinciding with the high ridership on the Jubilee and Central lines and the development in the areas surrounding these stations. The most noticeable growth in station usage is at Stratford, reflecting network improvements (DLR, Jubilee line and major station redevelopment) and major development (Westfield and the QEOP). This has resulted in peak period crowding at Stratford Station which will benefit from the additional station capacity provided by Crossrail.
- In terms of customer satisfaction on lines that are likely to be impacted by the Elizabeth line, the Central line has had the lowest score each year since 2013/14, reflecting a number of factors including growth in demand, line crowding and station crowding associated with Stratford station. Customer satisfaction on the Hammersmith & City, Piccadilly and Central lines fell by around 1%-2% from 2017-18 to 2018-19. All other things being equal, it would be expected that crowding relief on the Central line as a result of passenger switching to the Elizabeth line would lead to an improvement in Central line customer satisfaction.
- Journey purpose by station has remained relatively constant since 2008 except for Stratford, where the opening of the Westfield Shopping development resulted in a significant increase in the percentage of shopping trips from 2009 to 2017.
- Analysis of Passengers in excess of Capacity (PiXC) indicates morning peak crowding on Greater Anglia was reasonably static but First Great Western services into London Paddington experienced the highest morning peak PiXC values for five consecutive years (2010-14). While the level in 2018 (latest available year) was better than in 2010, the PiXC value increased from around 5% in 2017 to 10% in 2018. TfL Rail has had the highest PiXC values each year from 2016 (a year after commencing its services) to 2018.
- Historic analysis of rail performance for service groups into Liverpool Street and Paddington indicates that the Public Performance Measure (PPM) (the percentage of trains that arrived at their final destination within 5 minutes of their scheduled arrival time) shows a general worsening over time until early 2018 but then an improvement to the end of the baseline period. Great Western and Greater Anglia Outers PPM fell to around 90% by early 2017/18 before significantly improving in the 2018/19 period. For TfL Rail Crossrail East, PPM fell from around 94% in late 2012/13 to around 90% in late 2018 reflecting essential weekend closures for works to accommodate Elizabeth line services. Once the number of closures fell, PPM improved substantially, rising to around 96% by late 2019.

1 Introduction

The 2015 Crossrail Business Case update sets out the likely transport changes forecast when the Elizabeth line opens. These changes include travel time savings, crowding benefits, accident savings benefits, emissions benefits and the impacts of modal shift. Metrics relating to these impacts (and subsets of) have been extracted from the datasets assembled.

For the purposes of transport impacts, the 'post-approval' baseline is the period between Royal Assent of the Crossrail Act of 2008 and the opening of through-running Elizabeth line services in 2022.

However, transport data has been assessed, where available, between 2007 and 2019/2020 - the latest available year prior to the onset of the Covid-19 pandemic (although several sources are not available back to 2007). It has been deemed that using data for the financial year 2019/20, where available, is suitable for use in this report as the data from January up

to mid March 2020 is largely unaffected by the impacts of Covid-19.

The datasets used for the transport baseline have been drawn from a number of sources including, inter alia, the National Travel Survey (NTS), London Travel Demand Surveys (LTDS), Travel in London (TIL), Central Area Passenger Counts (CAPC), Rolling Origin Destination Surveys (RODS), DLR loading and crowding data, DfT Rail statistics, the Canary Wharf Employee survey and the Isle of Dogs cordon survey.

Unlike the reports addressing wider economy, planning and regeneration aspects, which show how Crossrail is having an impact pre-opening, the majority of changes in the transport metrics set out in this report are not a result of Crossrail but rather, are due to changes in transport supply and demand resulting from a range of other underlying changes. Any impacts of Crossrail on changes in transport will manifest

themselves post-opening of the Elizabeth line.

2 Transport demand — study area

2.1 Introduction

The Crossrail Business Case sets out the likely transport changes predicted when Elizabeth line services begin. These changes include travel time savings, crowding benefits, road decongestion benefits, accident savings benefits, emissions benefits and the impacts of modal shift.

When Elizabeth line services begin in 2022, there are likely to be fundamental changes in how people travel to, from and across central London. In particular, [passenger volumes and crowding levels are forecast to reduce on a number of east-west lines](#), in particular the Central, District, Jubilee and northern section of the sub-surface lines (Hammersmith & City/Circle and District lines). Passengers switching from these lines to the Elizabeth line will [benefit from reduced journey times](#) with many areas, particular on the western section of the line, experiencing [significant improvements in accessibility](#). For these western sections, average journey times are forecast to reduce by around 40%, with a 20% journey time reduction for a selection of stations on the eastern section. The analysis in the following sections sets out the baseline in

terms of trip making, modal split, travel times, passenger volumes and crowding for those lines and modes that are predicted to be impacted by Elizabeth line services.

Indicators relating to these metrics have been extracted from the datasets assembled with time series data presented from 2007 up to 2019/2020. The study area assessed for this interim report in terms of transport is largely defined by the level and disaggregation of data currently available. In general terms, this is undertaken at the London level and disaggregated where appropriate and where it can be supported by the data. Examples of the disaggregation include: inner and outer London; borough level, LU and DLR lines; stations; Train Operating Company; and London termini for rail.

Where data is available for lines and stations, we have extracted data for those lines and stations which are identified in the Business Case as likely to be impacted by Elizabeth line services. For LU, the lines assessed are the Central line, District line, Jubilee line, Circle line via Farringdon, Hammersmith & City line and Bakerloo lines and Piccadilly line. Key LU

stations are Ealing Broadway, Paddington, Bond Street, Tottenham Court Road, Farringdon, Liverpool Street, Whitechapel, Canary Wharf and Stratford.

2.2 Number of trips

Daily trips by mode are shown in the left hand figure for Inner and Outer London residents combined. In overall terms these show a dip in 2008/9 and 2009/10 relating to the 2008 financial crisis, followed by steady growth up to 2013/14, with almost 20 million trips per day by Greater London residents. Since the 2013/14 period, trips started falling until 2017/18 but grew slightly in both 2018/19 and 2019/2020. While demand for National rail, London Underground, DLR and taxi have remained largely static, the proportion of walking trips has risen while that of car trips has fallen. For total

London demand, there were around 27 million trips per day ([Travel In London Report 13](#)). The right hand figure compares total daily trips for 2019/20 for inner and outer London. For outer London residents, car (driver and passenger) is the dominant mode accounting for almost 42% of all trips, which is lower than the national mode share of 61% but considerably higher than the 17% for inner London. Public transport mode share is some 9 percentage points higher for inner London residents (34.5% compared with 25.5% for outer London and 16% nationally).

Finally, walking constitutes a much more important transport mode for Inner London, accounting for 42% of daily trips made by residents, compared with 30% for Outer London residents and 26% nationally. This suggests that the increase in capacity resulting from Crossrail is likely to influence both mode choice (car to Elizabeth line) and route choice (from LU lines to Elizabeth line).

Figure 1: Total daily trips (all London)

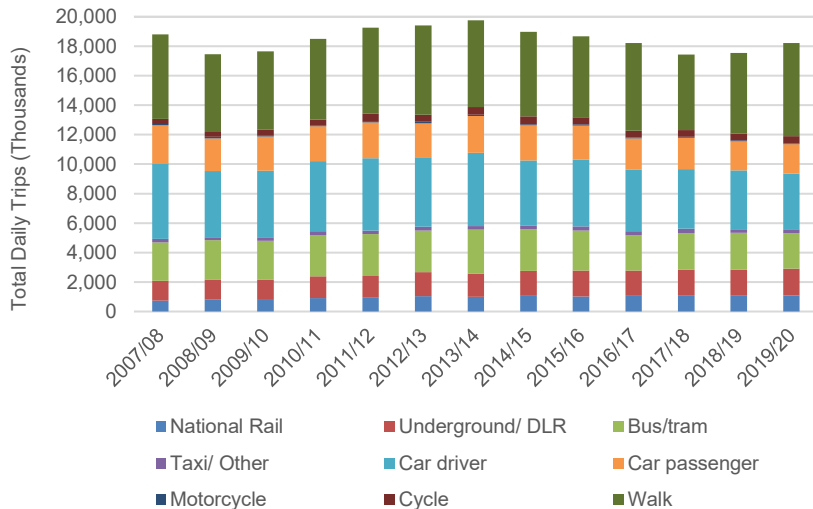
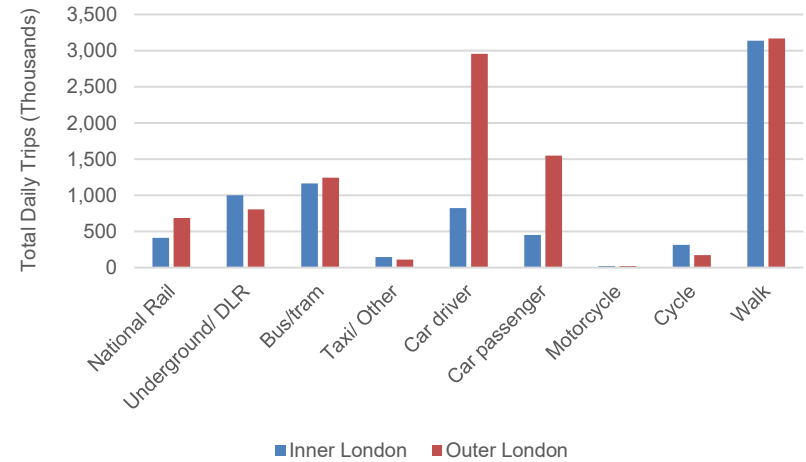


Figure 2: Total 2019-20 daily trips (Inner v Outer London)



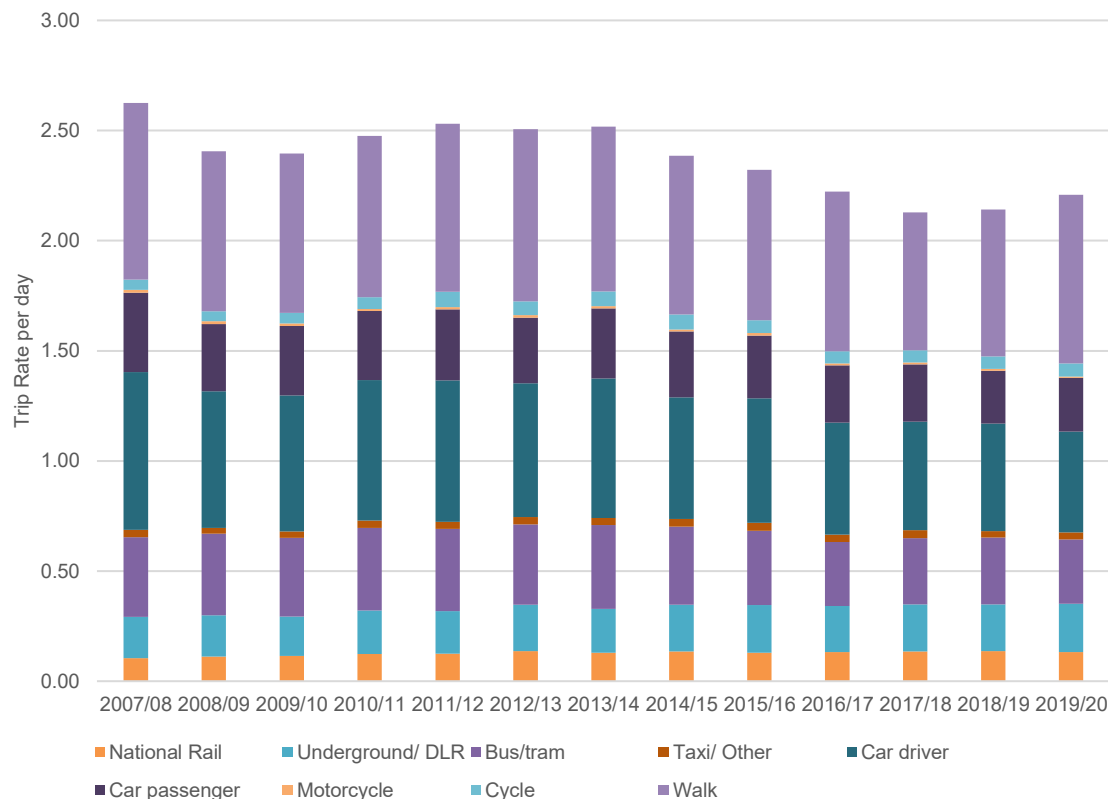
Source: [London Travel Demand Survey](#) (2007-20)

Source: [London Travel Demand Survey](#) (2007-20)

2.3 Trip rates

Overall trip rates per day are slightly higher for Inner than Outer London (2.25 trips per day compared with 2.18 trips per day) with the key differences being a much higher inner London trip rate for LUL/DLR, walk and cycle and much lower car-based trip rates. Overall trip rates have fluctuated over the years with a high in 2007/08 followed by another in 2011/12. Since then the trip rate steadily dropped year on year until 2017/18 after which the rates have gradually risen. While overall trip rates have gradually fallen since 2007/08, trip rates for walking have increased at the expense of car drivers and passengers, both of which have fallen.

Figure 3: Trips per person per day



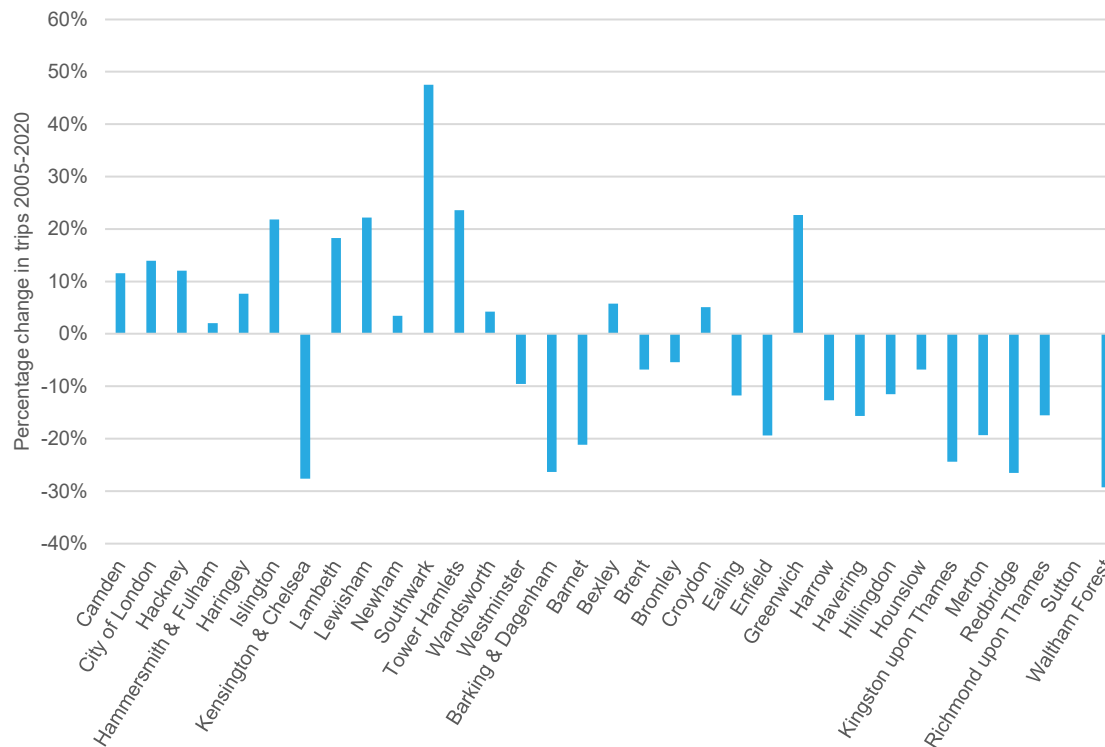
Source: [London Travel Demand Survey](#) (2007-20)

Trip rates (continued)

Historic London Travel Demand Survey (LTDS) data have been used to present trips by borough based on three years' worth of data to ensure a sufficiently robust sample; rolling trends for the 15 years between 2005 and 2020 are shown in the chart opposite for all London boroughs. The boroughs of Southwark, Tower Hamlets, Greenwich, Islington and Lewisham exhibit the greatest growth over this period. Of particular note for Elizabeth line stations are the increases for Islington (Farringdon), Tower Hamlets (Whitechapel, Canary Wharf), Camden (Tottenham Court Road), and City of London (Liverpool Street).

Other boroughs show more modest growth with some boroughs such as Kensington & Chelsea, Westminster and Havering, showing a decline in trip making.

Figure 4: Growth in trips (2005-08 to 2017-20)



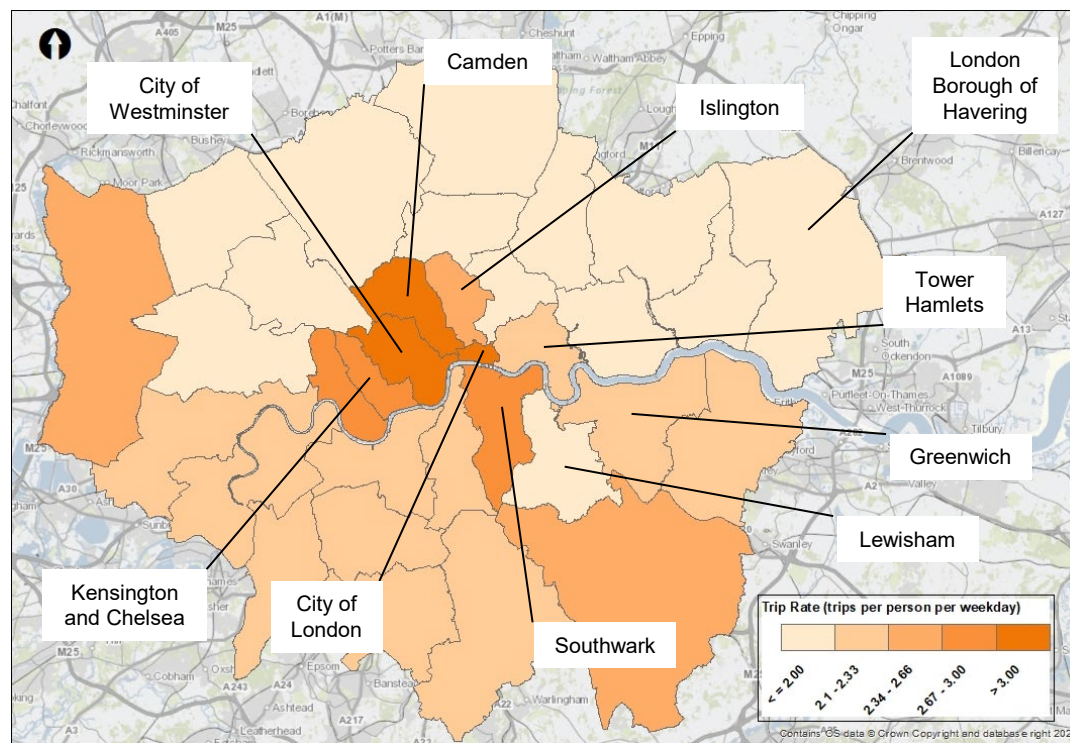
Source: London Travel Demand Survey (2005-20)

Trip rates (continued)

The Inner/Outer London split is shown spatially in the figure opposite which shows weekday trips per person over the period 2017/2018 to 2019/2020.

This shows that for more recent years, the inner areas of Camden, City of Westminster and City of London have the highest trip rates compared with the outer boroughs, particularly the northern boroughs.

Figure 5: Weekday trips per person (3 year average 2017-18 to 2019-20)



Source: London Travel Demand Survey (2017-20)

2.4 London Arrivals and crowding on National Rail

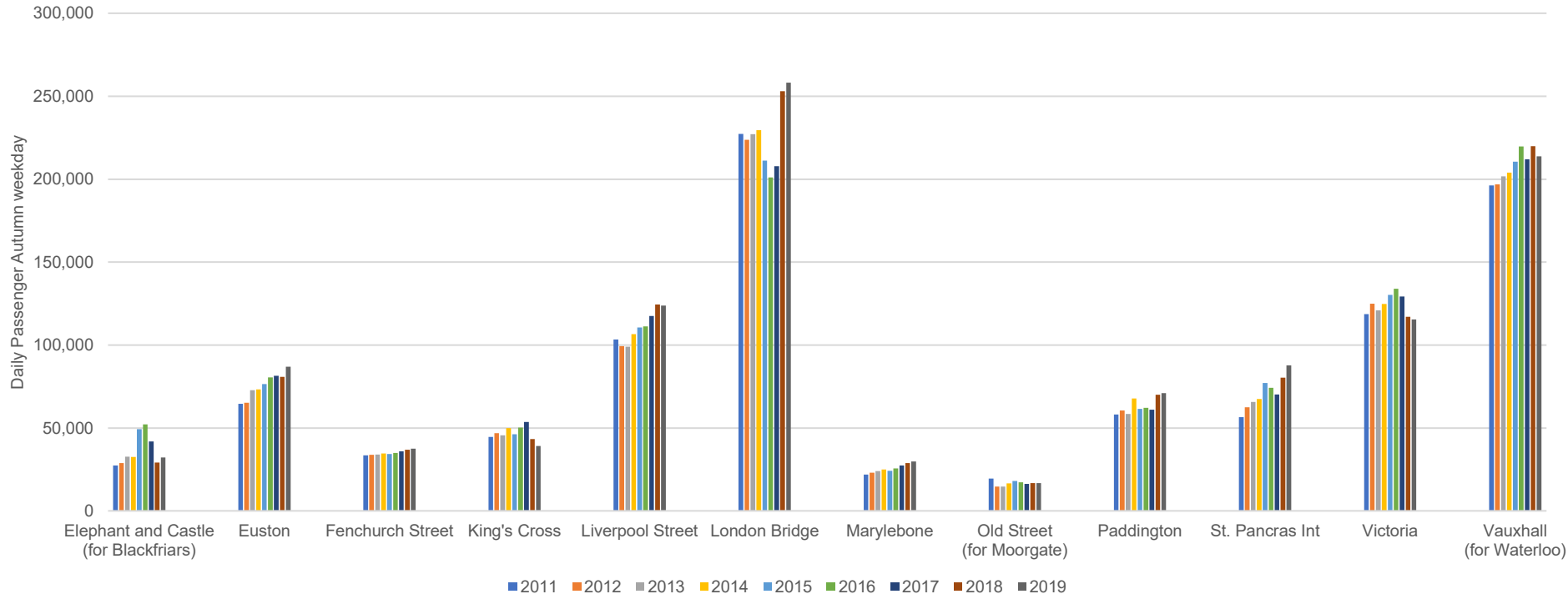
Arrivals at London termini have been analysed using DfT rail data available from 2011. London termini exhibit a gradual increase in arrivals between 2011 and 2019 for most termini with the strongest long-term growth at Euston, Liverpool Street, London Bridge, St Pancras International and Vauxhall (for Waterloo). Of particular relevance to Crossrail are the arrivals into Paddington and Liverpool Street; while Liverpool Street shows steady growth, growth at

Paddington has been more modest. Stations that showed a decline in arrivals from 2016/2017 are Elephant & Castle (for Blackfriars), Kings Cross and Victoria. These figures are influenced by the Thameslink Programme and London Bridge reconstruction. From 2015, the Thameslink services were diverted away from London Bridge and via Elephant & Castle and returned to London Bridge in May 2018. The May 2018 timetable

also provided a route from the East Coast Main Line to the Thameslink Core transferring passengers from Kings Cross to St. Pancras. It should be noted that the London Bridge figures in the chart include services to and from Charing Cross and Cannon Street as well.

Industrial action on the GTR network from 2015 to 2017 also gave a reduction in loading over this time period.

Figure 6: Central London arrivals by rail on a typical autumn weekday (2011 to 2019)



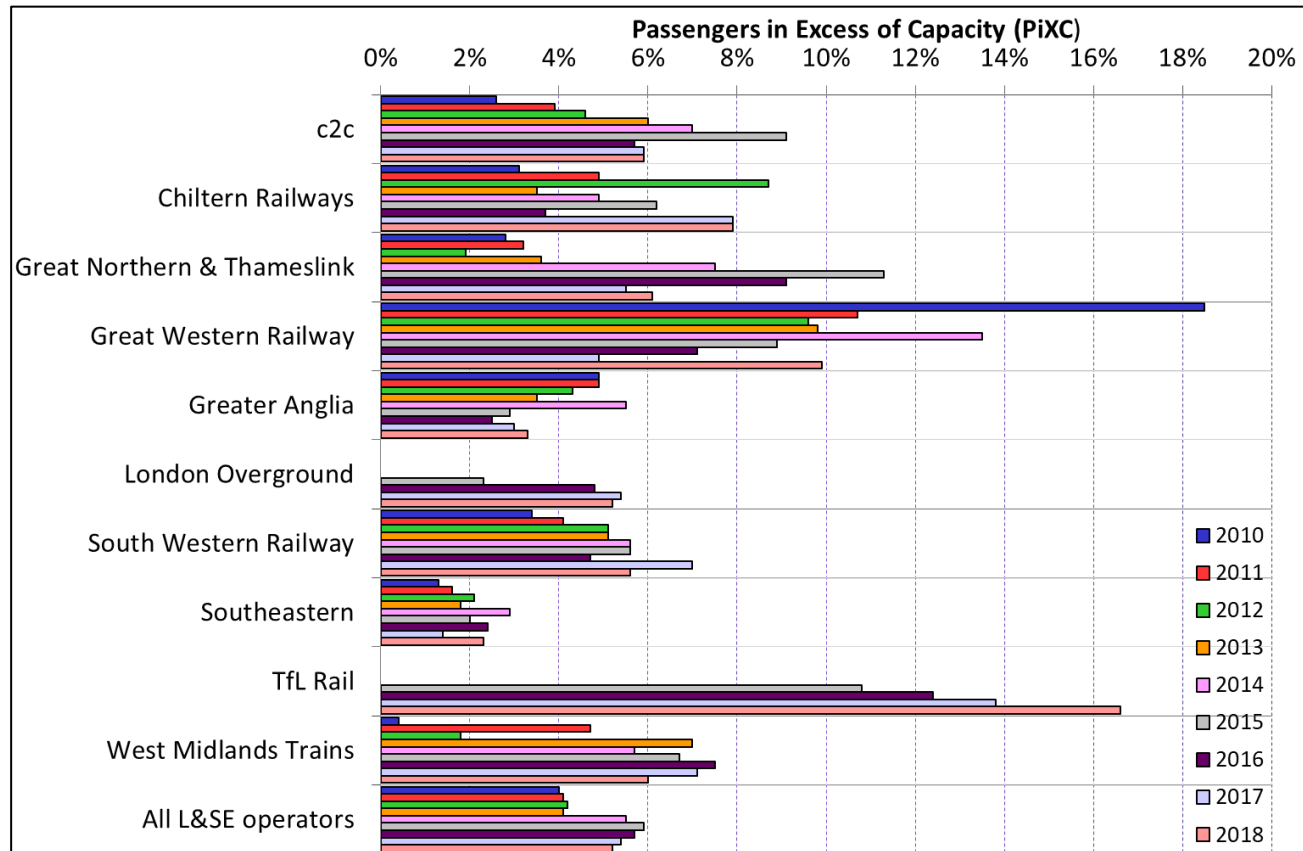
Source: [DfT Rail Passengers and crowding on weekdays](#), RAI0203 (2011-19)

London Arrivals and crowding on National Rail (continued)

Passengers in excess of Capacity (PiXC) data is presented in terms of passenger numbers exceeding PiXC for the AM peak, drawn from the Travel In London Report 12, 2019. Taking the period between 2010 and 2018, morning peak crowding on Greater Anglia was reasonably static but Great Western Railway services into London Paddington experienced the highest morning peak PiXC values for the 2010 to 2014 period, with TfL Rail taking over as the highest from 2015 onwards. The trend for TfL Rail has been increases year on year from 2015 to 2018.

Work supporting the Crossrail Business case indicates that comparing a no Crossrail to a with Crossrail scenario, there are forecast to be 105 million (or 8%) fewer passenger boardings per annum across London and the South East in 2031. This is likely to manifest itself in a reduction in crowding with Crossrail, with reductions in crowding likely on National Rail services via Greenwich and Lewisham stations, as well as into both Paddington and Liverpool Street. Accordingly, PiXC levels are likely to fall on some Southeastern services as well as Greater Anglia and Great Western Railway services.

Figure 7: Passengers in excess of capacity (2010 to 2018)



Source: [Travel in London Report 12](#), Figure 12.10, p227

2.5 London Underground Boarders by Line and Station

During the morning peak (07:00-10:00) period, forecasts for a future year of 2031 which underpin the business case indicate that the opening of the Elizabeth line will reduce passenger numbers on the following lines:

- 5,000 fewer passengers from Ealing Broadway on the Central line towards Central London.
- Around 10,000 fewer passengers on both eastbound and westbound Central line services in Central London
- Around 3,800 fewer westbound passengers from Stratford on the Central line towards Central London.
- 9,200 fewer eastbound passengers travel on the Jubilee line towards Canary Wharf from Central London with 5,500 fewer westbound from Stratford towards Canary Wharf.
- Between 5,000 and 6,000 fewer passengers in each direction on the north side of the Circle line via Farringdon in the AM Peak Period.
- An additional 2,000 passengers on the Hammersmith & City line and Bakerloo lines towards Central London.

Most of these London Underground lines have

seen strong growth in passenger demand as shown in RODS data which is available from 2009 onwards (shown overleaf)

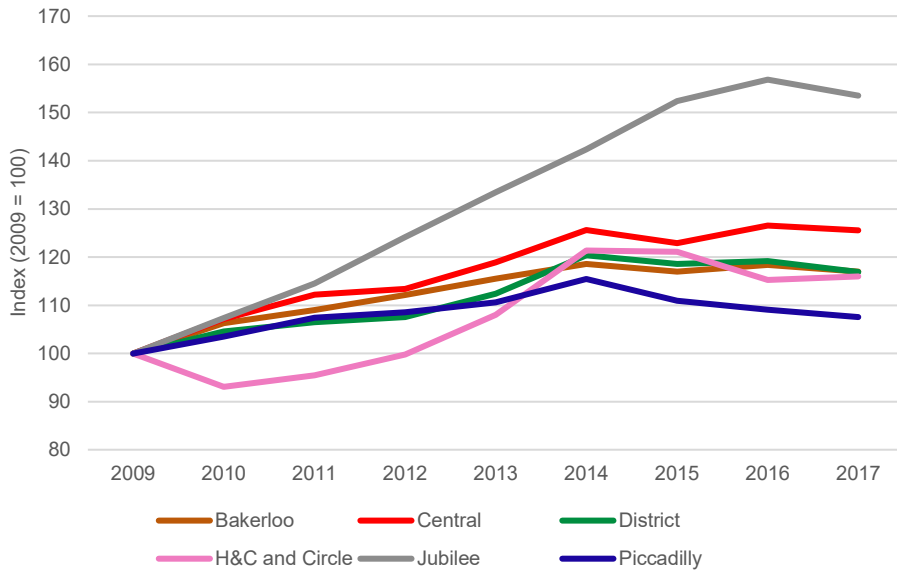
The Jubilee line has seen the most significant growth of over 50%, reflecting the introduction of 7-car services from 2006 and the signalling system upgrade which enabled increases in peak frequencies, from 24 to 30 trains per hour (tph) initially during the peaks but subsequently over longer periods. In 2015, the Jubilee line had approximately the same number of daily boarders as the Central line, with around one million boarders per day, but since then the Central line has crept ahead of the Jubilee line by 20,000 boarders in 2017. Other lines exhibiting strong growth include the Hammersmith & City/Circle, District, and Bakerloo (15-20% growth). Lowest growth is observed on the Piccadilly line at around 10%.

There has been considerable passenger growth at future Elizabeth line stations as shown in the figure overleaf. The RODS data is confined to LU and so the analysis presented includes all LU stations that will be served by the Elizabeth line. The stations with the most significant growth are in the eastern areas of London, including Stratford, Whitechapel, Canary Wharf,

and Liverpool Street. This growth coincides with the high ridership of the Jubilee and Central lines, and is also indicative of the development that has taken place in the areas surrounding these stations. Most noticeable is Stratford reflecting network improvements (DLR, Jubilee line and major station redevelopment) and major developments (Stratford City, Queen Elizabeth Olympic Park). However, by 2017 there was some more recent decline in station entries for Canary Wharf, Ealing Broadway and Whitechapel, whereas Farringdon, Stratford and Tottenham Court Road were on the rise.

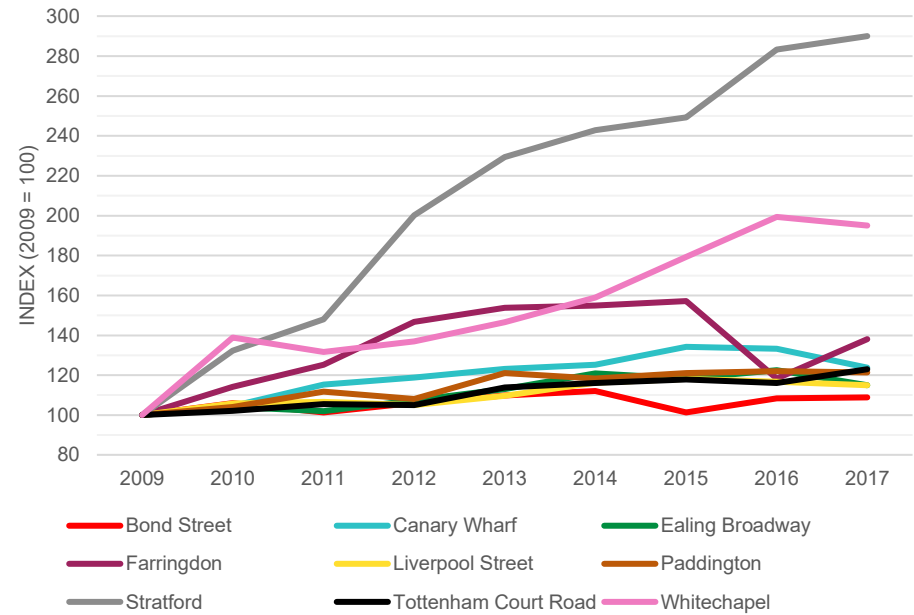
data has been presented to the latest year available for RODS data. Currently, not able to update to 2019/2020 with NUMBATS data.

Figure 8: Growth in daily boarders since 2009



Source: TfL Rolling Origin and Destination Survey (2009-2017)*

Figure 9: Growth in station access since 2009



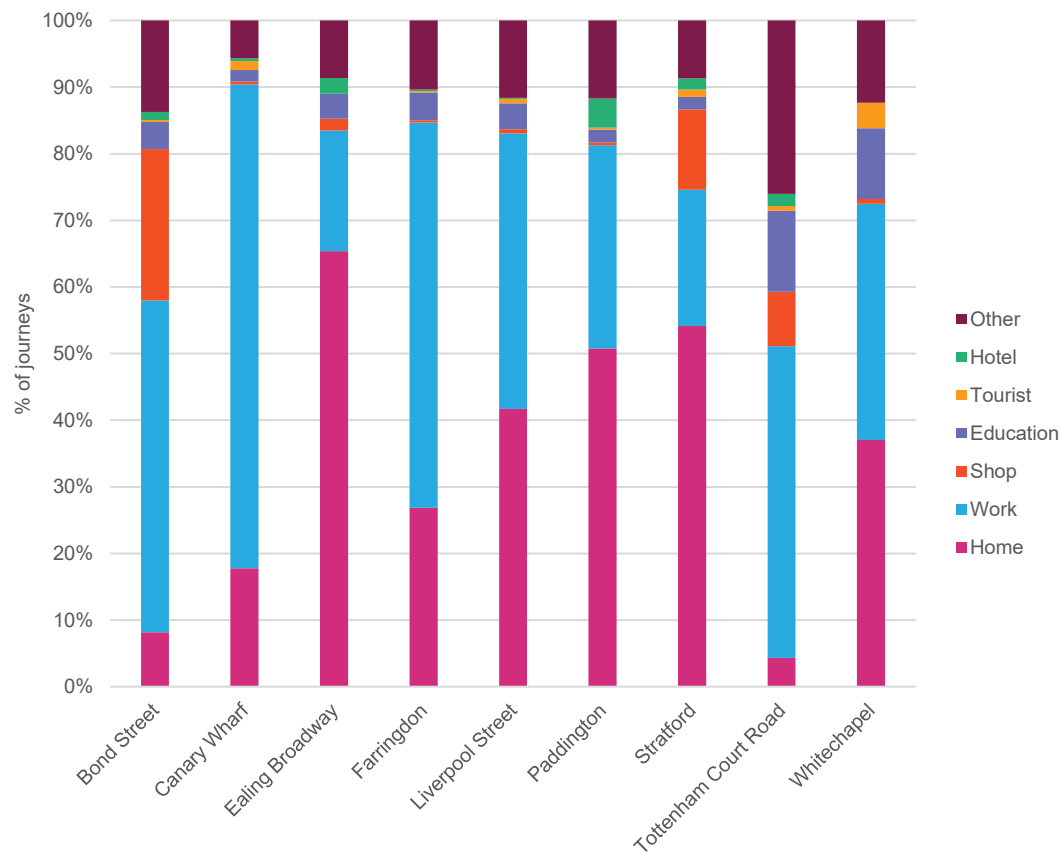
Source: TfL Rolling Origin and Destination Survey (2009-2017)*

* data has been presented with the earliest and latest years available for RODS data. Currently unable to update with 2018 to 2020 NUMBATS data.

London Underground Boarders by Line and Station (continued)

The journey purpose associated with the trips originating at each station can provide an indication of the type of land use and activity nearby. For example, there are a relatively high percentage of shop and work journeys that start at Bond Street, which is expected for a West End station. Journey purpose split has stayed relatively constant since 2009 with the exception of Stratford, where the Westfield Shopping development has resulted in a significant increase in the percentage of shopping trips from 2009 to 2017.

Figure 10: Journey purpose of origin station 2017



Source: TfL Rolling Origin and Destination Survey (2017)

2.6 Docklands Light Railway passengers and crowding

All lines on the DLR have experienced growth between 2007 and 2019, particularly the Airport line. The West and South lines have experienced the smallest growth over this period, and all lines have seen a decline since 2018.

Daily boarders on the North, East, and Airport routes have more than doubled from 2007 to 2019, reflecting extensions (King George V to Woolwich Arsenal (2009), the 3 car upgrade (2011) and the opening of the Stratford International Route (2011)). The West and South routes serve the financial employment centres within the City and Canary Wharf.

Notwithstanding these improvements, the 2008-09 financial crisis had a noticeable effect on ridership during this period. Ridership on these lines recovered to a peak in 2016, but have then fallen slightly since. Average daily boarder numbers have increased across all lines from around 214,000 per day in 2007 to 368,000 per day in 2019. For the Stratford International line, 17,000 boarders per day were recorded for 2019.

The introduction of Elizabeth line services are forecast to lead to passenger flow reductions and associated crowding reductions, in

particular on the East and Airport branches; the latter has shown nearly fivefold increases in passengers since 2007.

At a station level, there are four DLR stations that will interchange with the future Elizabeth line route. Woolwich Arsenal and Stratford have experienced significant growth in the number of passengers using these stations, particularly Stratford since 2010, reflecting Jubilee line upgrades, DLR upgrades the DLR International extension, station redevelopment and demand associated with Westfield Stratford. Whilst it is the busiest station, growth has been more modest at Canary Wharf. Over the past 10 years, there has been minimal change in the number of passengers using Custom House with the exception of closure of the station between January 2017 and February 2018 for works to increase capacity in preparation for Elizabeth line services. The static demand reflects the absence of interchange and ExCel being fully operational through the period (since its opening in 2000).

The total number of boarders can also be considered in terms of the average persons per square metre (PPMS) in order to assess crowding. The historic distribution for different years from 2010 to 2019 indicates that over the

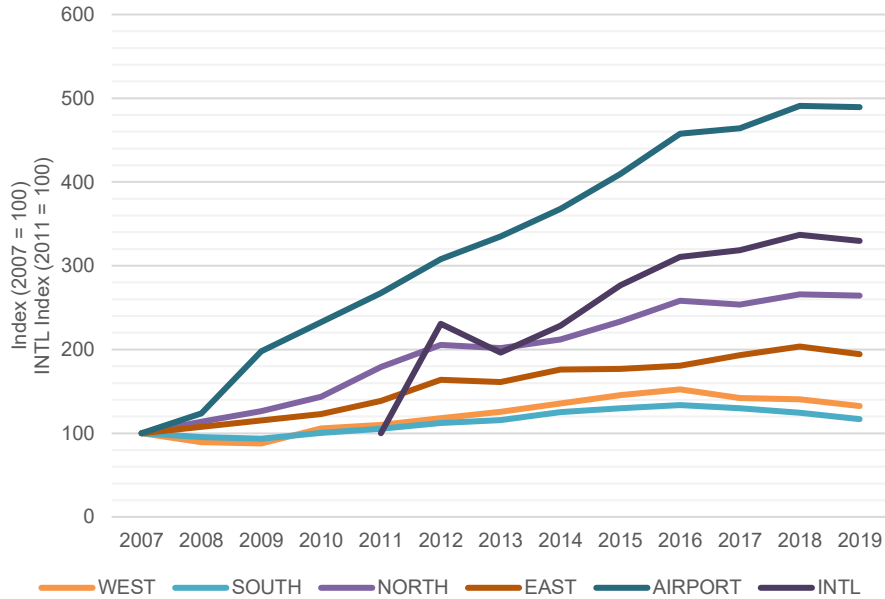
first half of this period, the North route had the highest levels of crowding, reflecting Stratford-Docklands demand, with PPMS often in excess of 3 (*severe* category), however more recently the most severe crowding is now experienced on the Airport line, reflecting the demand growth on this line, with other lines relatively static. The International route exhibited low levels of crowding, well below an average of 1 person per square metre, until around 2014 when ridership increased.

Generally, the trend is seasonal with significant changes in crowding possible within a given year. For example, the low crowding across the Christmas period is evident for each year. The gap in 2012 (periods 4, 5 and 6) corresponds to the 2012 Olympics for which there is no data.

Crowding is measured as:

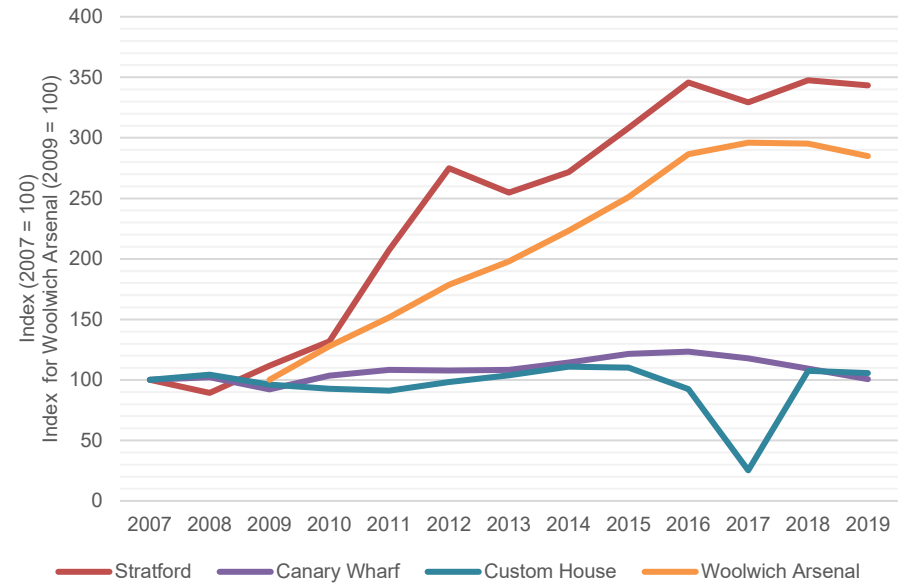
- 0-1PPSM Low crowding;
- 1-2 PPSM Medium crowding;
- 2-3 PPSM Heavy crowding;
- 3+ PPSM Severe crowding

Figure 11: Growth in daily DLR boarders by line



Source: DLR Historical Station Usage Grapher v0-721

Figure 12: Growth in daily DLR boarders by station



Source: DLR Historical Station Usage Grapher v0-721

Route Notes:

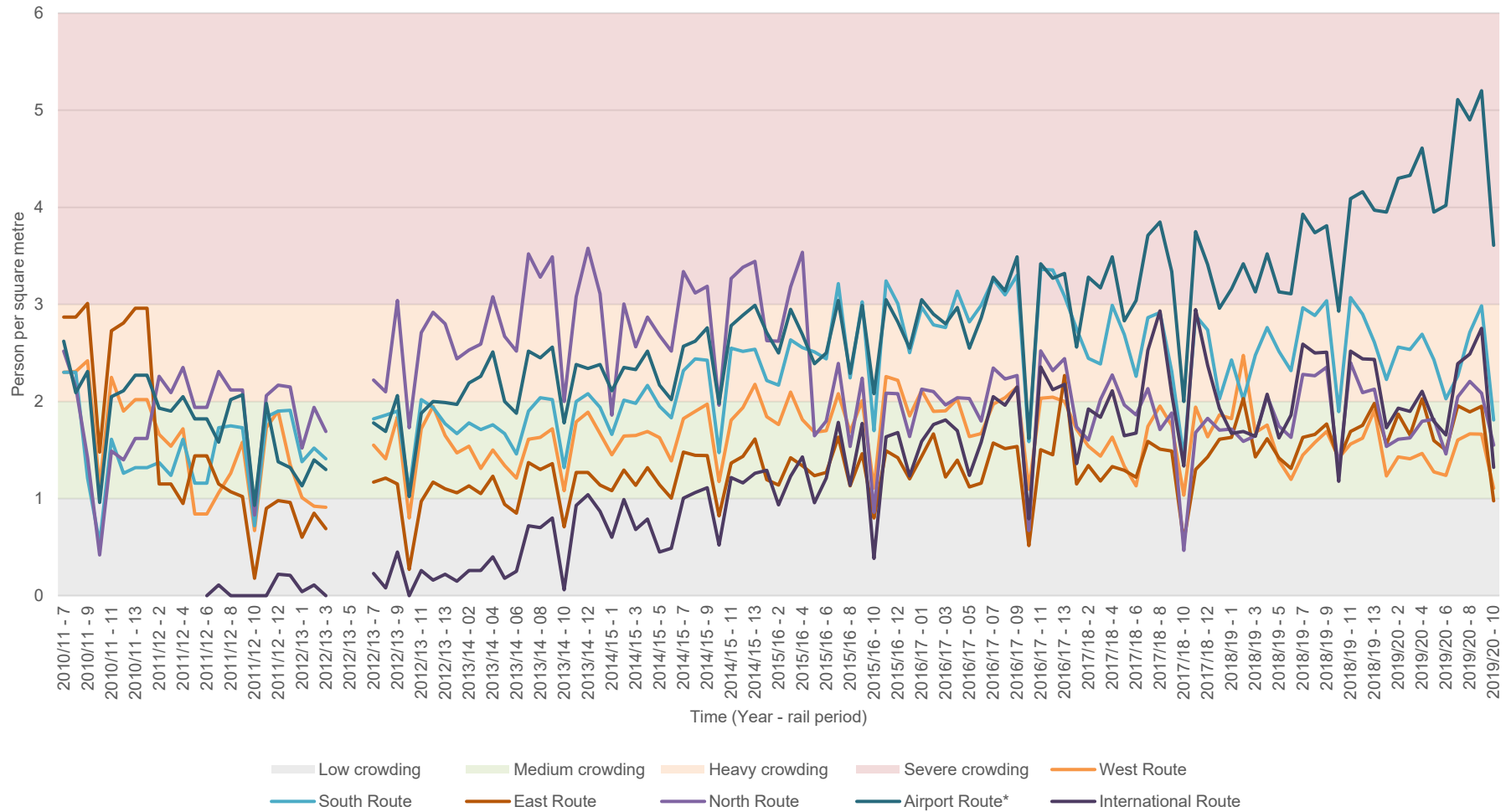
West: Westferry – Tower Gateway / Bank; South: West India Quay – Lewisham;

North: Poplar – Stratford;

East: Blackwall – Beckton via Canning Town; Airport: West Silvertown – Woolwich Arsenal; and

Int'l: Star Lane – Stratford Int'l.

Figure 13: DLR crowding by route (2010 to 2020)



Source: TfL DLR (ACAMOD)

3 Modal share

3.1 Inner London and Outer London

Modal share has been considered at an overall level for inner and outer London, for the Isle of Dogs and for central London using LTDS, the IOD cordon survey and Central Area Peak Counts (CAPC) respectively. The travel to work modal share in the study area is analysed in the Economy, planning and regeneration report.

LTDS data* is available from 2007-08 to 2019-20. The chart on the left presents mode shares for Greater London, and the chart on the right shows Inner London compared with Outer

London (for 2019-20). At the Greater London level, mode shares were fairly static up until 2015-16, after which the share of walking has increased by around 5%. Travel by National Rail, Underground and DLR has seen a slight increase over time with car driver and passengers decreasing.

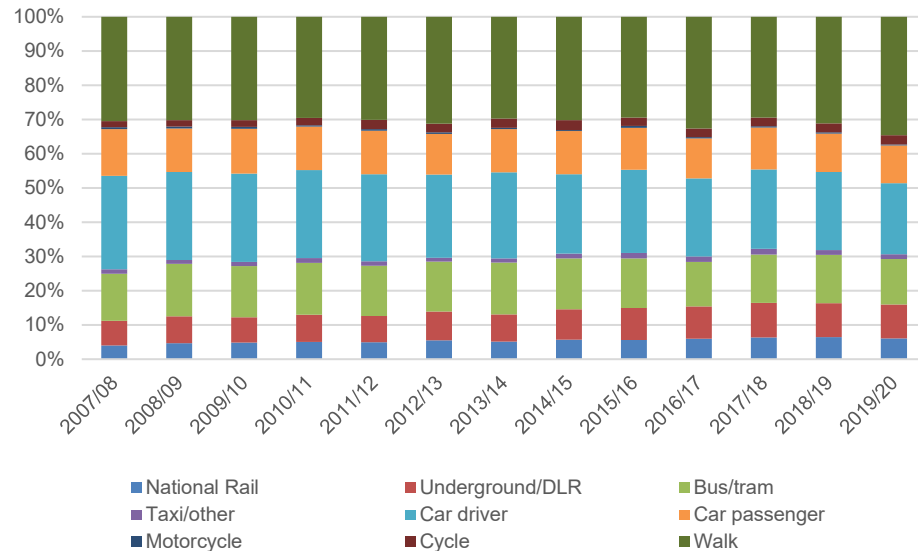
The main theme in the chart on the right is the marked difference between inner and outer London, with car-based travel being the dominant mode for outer London with nearly

42% compared to just over 17% for inner London. This is balanced by a higher share for cycle and walk (32% outer, 46% inner) and public transport (26% outer, 34% inner).

As with total number of trips, the Elizabeth line would appear to be more likely to influence mode choice in outer London and route (or sub-modal) choice in inner London.

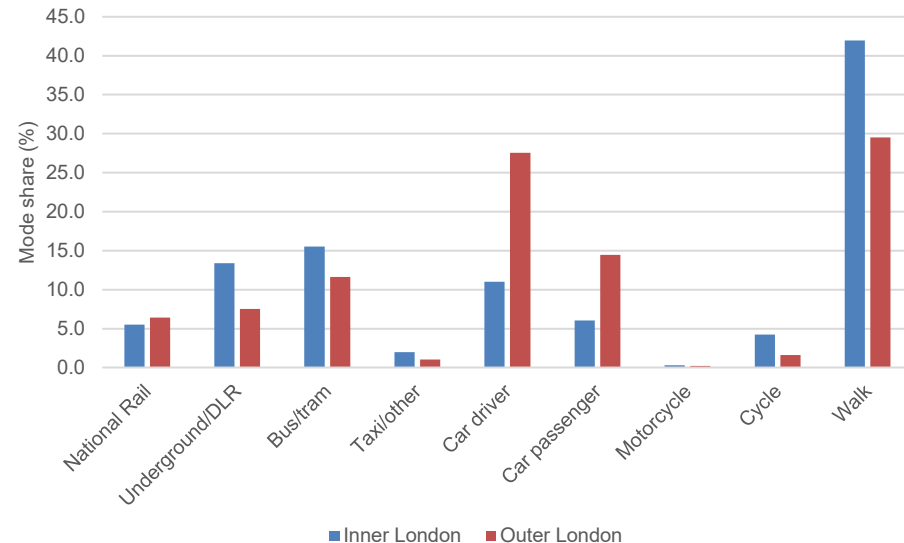
* based on London residents only, which may differ from other metrics in other reports, such as all travel in London used in the Travel in London reports.

Figure 14: Mode share – Greater London residents



Source: [London Travel Demand Survey](#) (2007-20)

Figure 15: Mode share – Inner vs Outer London residents (2019-20)



Source: [London Travel Demand Survey](#) (2019-20)

3.2 Isle of Dogs

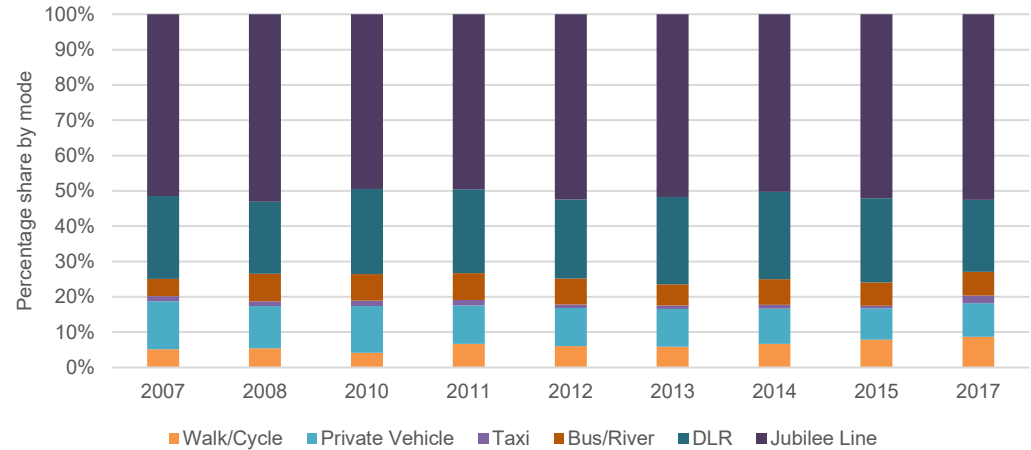
The Isle of Dogs Cordon survey quantifies the volume of movements into and out of the Isle of Dogs, the mode share of these movements, and data trends over time. Up to 2015, this was carried out annually, at which point it moved to bi-annual surveys. The 2019 survey results were not available at the time of producing this report.

Modal share to the Isle of Dogs during the morning peak (presented for 2007-2017 which was the latest year of data available) indicates that car share has decreased significantly from 14% in 2007 to 9% in 2017; over the same period public transport modal share has remained the same at 80% of the mode share, with walking and cycling increasing from 5% to 9%.

In terms of demand, between 2007 and 2017, the number of trips crossing the cordon has remained similar at approximately 88 million. However, this masks a gradual increase from under 80 million in 2010 to around 105 million in 2015 followed by a decline to 88 million by 2017.

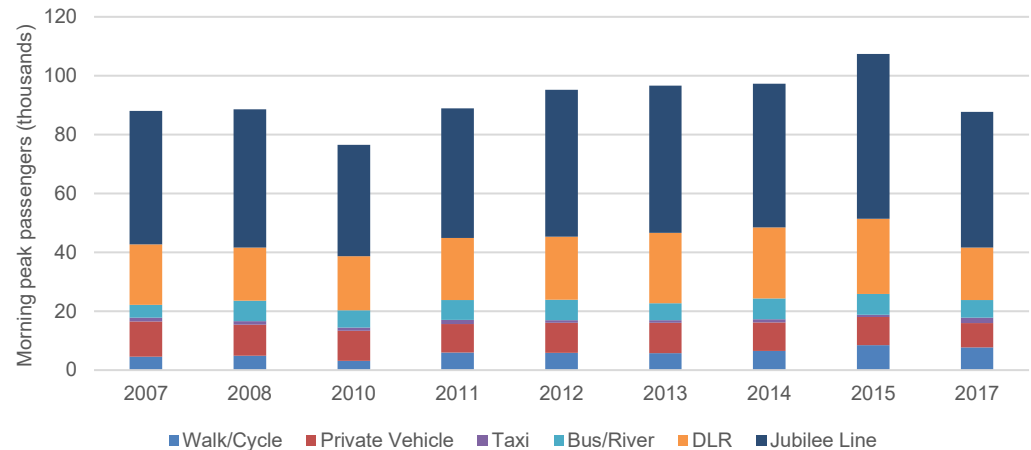
Overall, between 2007 and 2017, walking and cycling trips increased by around 3 million whilst private car trips decreased by around 3.7 million. For public transport, there has been an increase in bus/river trips and a small increase in the Jubilee line, but there has also been a decrease of 2.7 million trips using DLR across the cordon.

Figure 16: Morning peak mode share for Isle of Dogs



Source: Isle of Dogs Cordon Survey (2007-17)

Figure 17: Morning peak passengers for Isle of Dogs



Source: Isle of Dogs Cordon Survey (2007-17)

3.3 Central area peak counts (CAPC)

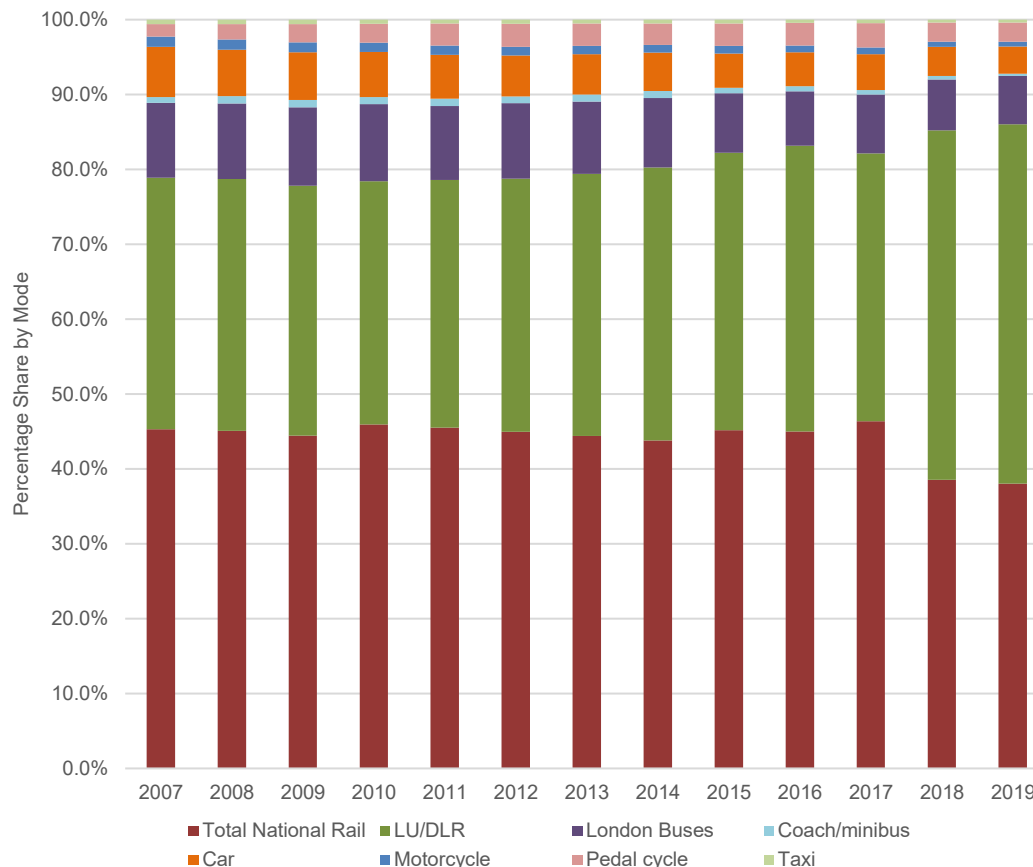
The annual central area peak counts (CAPC)* records the number of people and modal share of people entering central London during the morning peak. The modal share over the period between 2007 and 2017 is relatively static although cycling did see a 90% increase (but from a low base) and car use has fallen gradually. However, between 2018 and 2019 the share of LU/DLR significantly increased, compensated for by a decline in bus, coach and National Rail.

In absolute terms, total demand grew steadily from the 2007-08 financial crisis with an overall increase of almost 28%. Trips by car, motorcycle and taxi have all fallen with LU and DLR showing the largest increase of other modes with a 48% increase since 2007.

The increase in rail capacity afforded by the Elizabeth line of around 10% into central London is likely to further increase the public transport mode share, which is likely to be at the expense of car, motorcycle and taxi.

* This is a combined measure based on existing surveys

Figure 18: Mode Share of people entering central London - weekday morning peak (7am to 10am)



Source: CAPC summary by mode, TfL (2007-19)

4 Service Performance

4.1 Rail Performance

For context, the performance of rail has been assessed using a number of measures at sub-operator level for those service groups into Liverpool Street and Paddington that have been taken over by TfL Rail and will subsequently become part of the Elizabeth line when it launches. All data have been sourced from the ORR portal with data at the sub-operator level going back to 2010-11. The indices considered are:

Public Performance Measure (PPM) - the percentage of trains that arrived at their final destination within 5 minutes of their scheduled arrival time (within 10 minutes for Long Distance services). A higher score is better.

PPM moving annual average (PPM MAA) represents the percentage of trains that met PPM in the last 12 months.

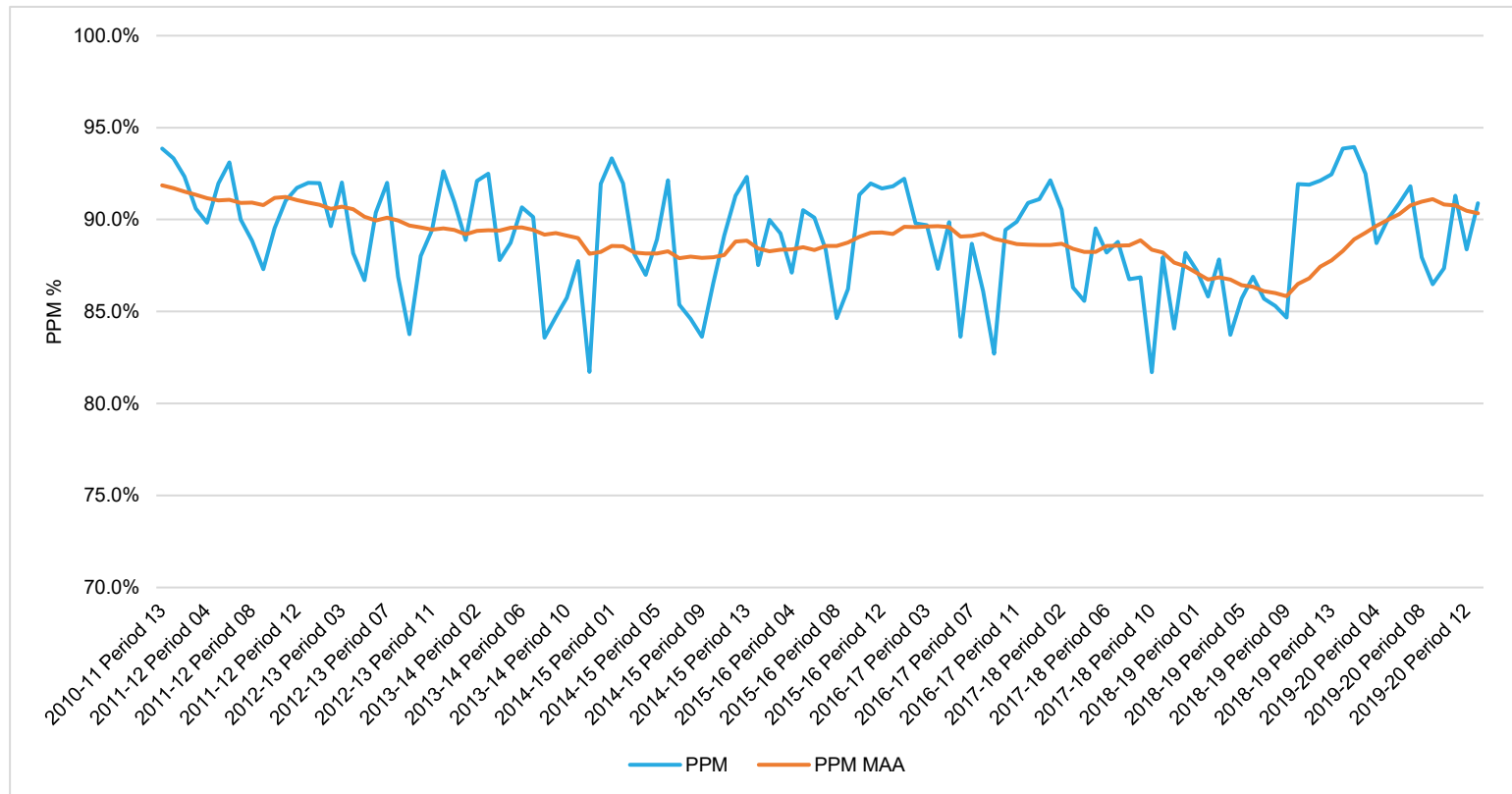
Cancellations and Significant Lateness (CaSL) - the percentage of trains that have been cancelled (in part or in full) and/or arrived at their final destination late by more than 30 minutes. A lower score is better.

CaSL moving annual average (CaSL MAA)

represents the percentage of trains that failed CaSL in the last 12 months.

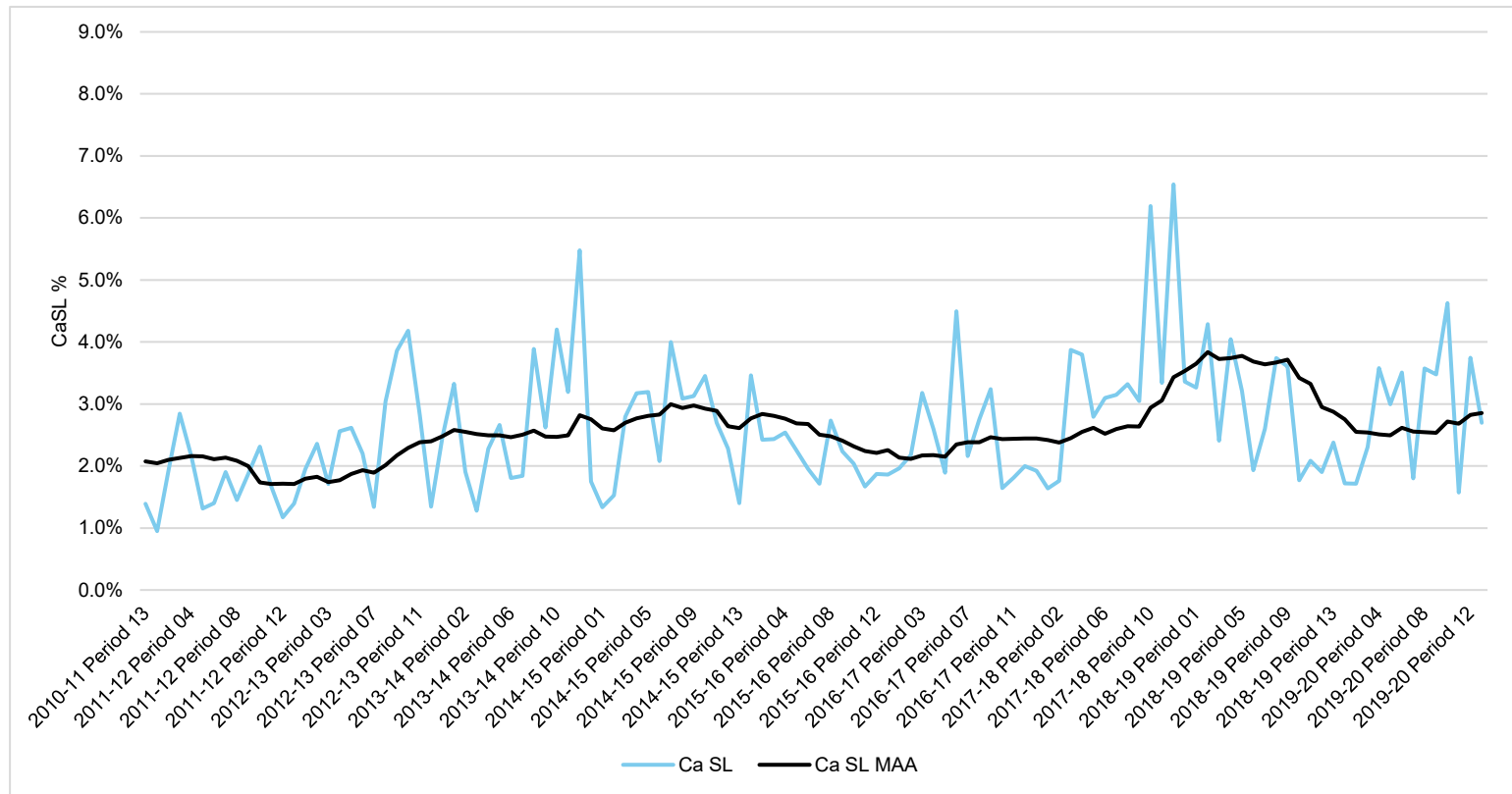
In general terms, PPM shows a general worsening over time until early 2018 but with an improvement thereafter. Great Western fell to 90% by early 2017/18 and Greater Anglia Outers fell from a high of around 92% in early 2013/14 to at or below 90%; both then significantly improved in the 2018/19 period. The PPM for TfL Rail Crossrail East fell from around 94% in late 2012/13 to around 90% in late 2018 reflecting essential weekend closures for works to accommodate Elizabeth line services. Once the number of closures fell, PPM improved substantially, rising to around 96% by late 2019. The pattern is mirrored by a reduction in CaSL with TfL Rail Crossrail East having the best improvement in CaSL, falling from just under 5% in early 2018 to around 1.5% for 2019/20 (period 8).

Figure 19: Public Performance Measure (PPM) – Great Western Railway (London and Thames Valley)



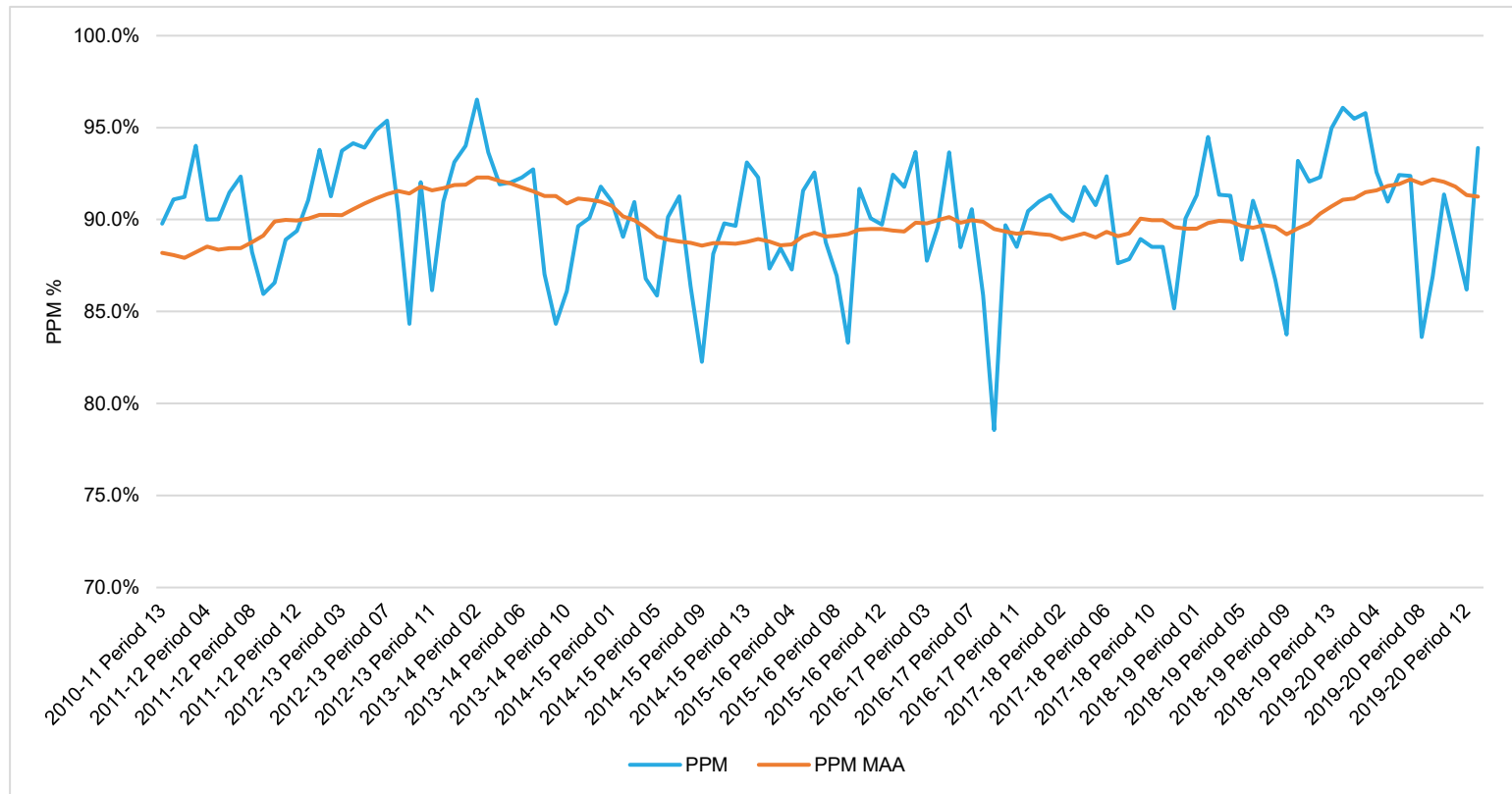
Source: [ORR](#) (2010-20)

Figure 20: Cancellations and Significant Lateness (CaSL) – Great Western Railway (London and Thames Valley)



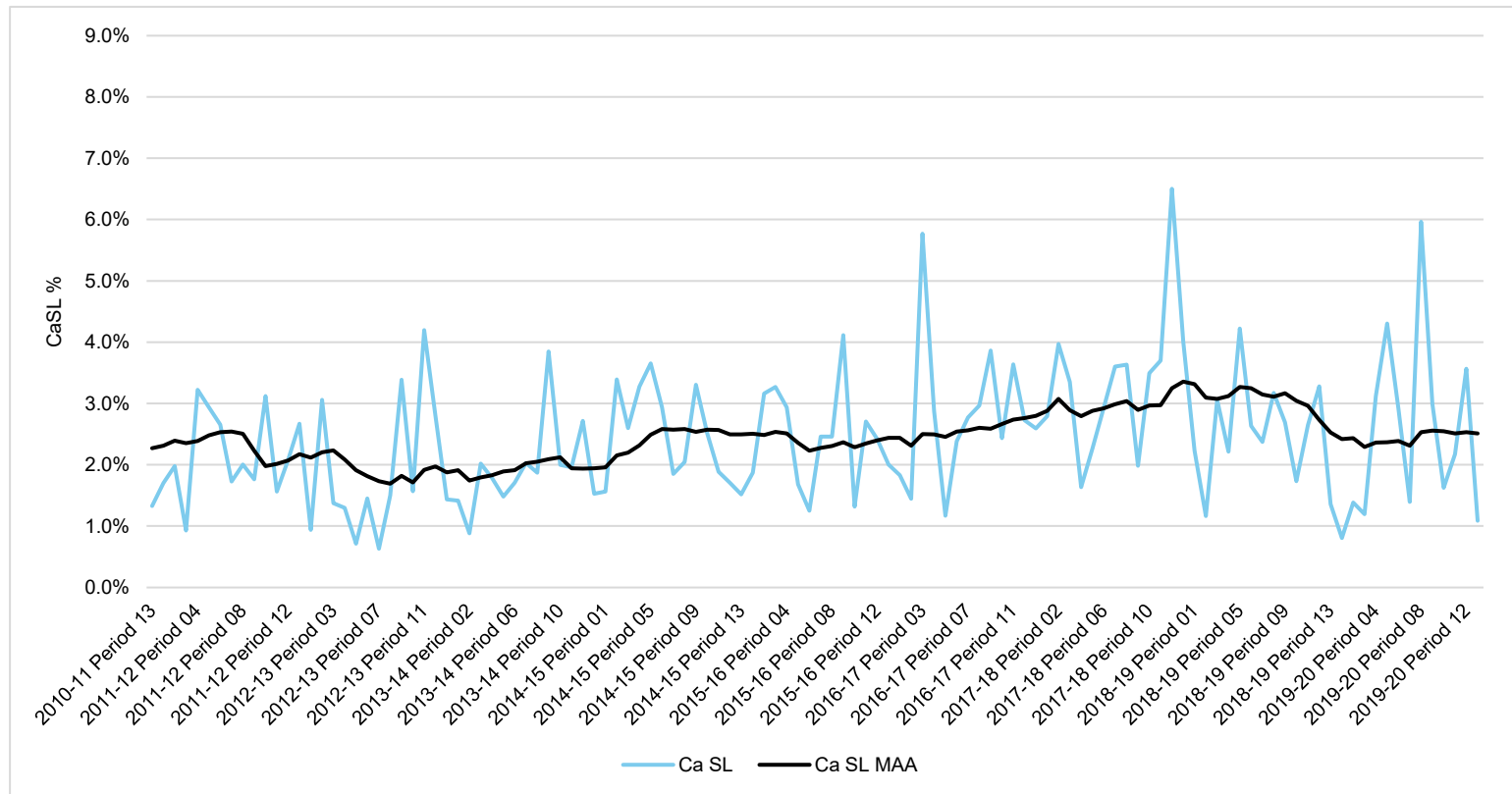
Source: [ORR](#) (2010-20)

Figure 21: Public Performance Measure (PPM) – Greater Anglia (GE Outer)



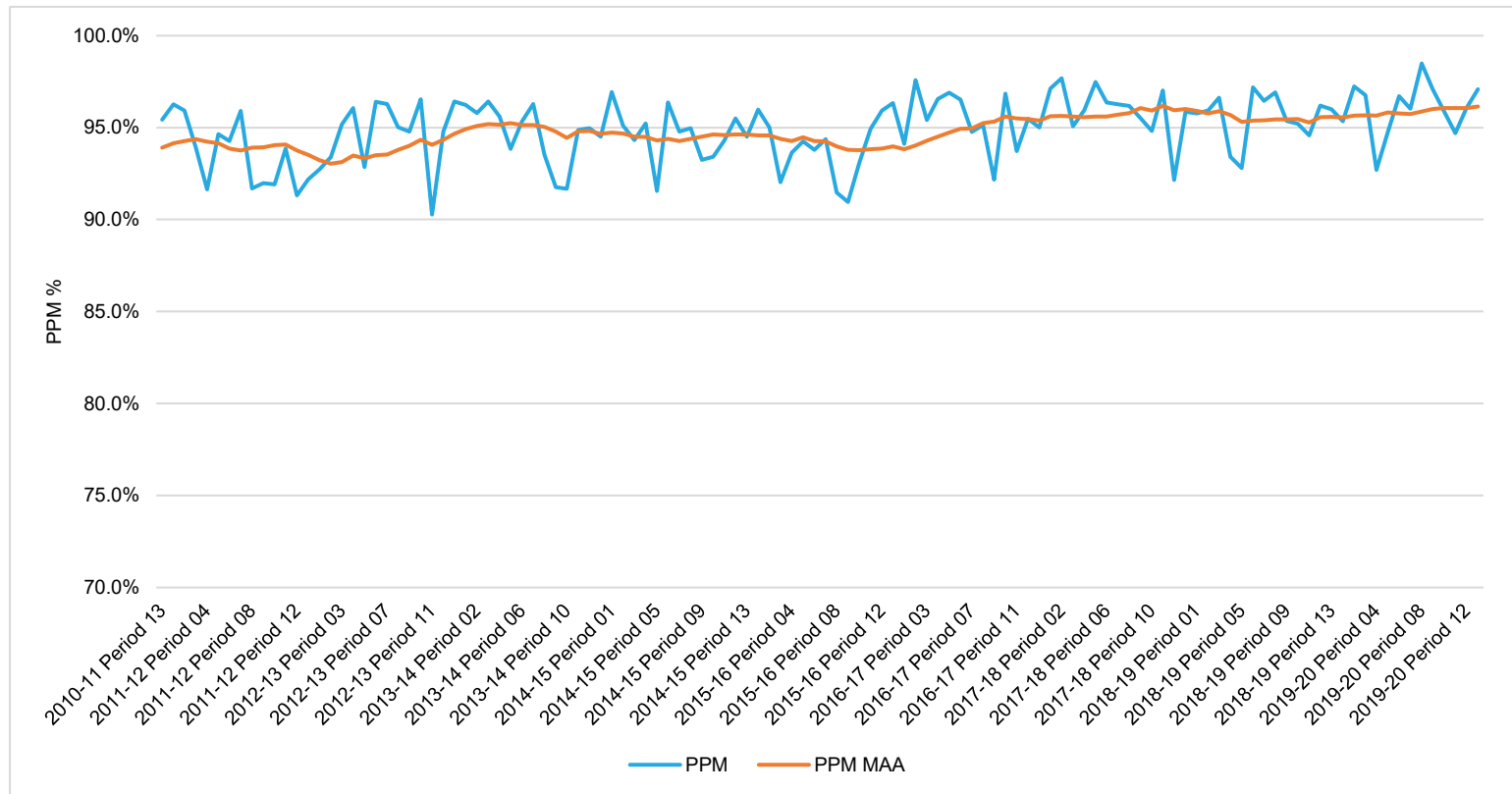
Source: [ORR](#) (2010-20)

Figure 22: Cancellations and Significant Lateness (CaSL) – Greater Anglia (GE Outer)



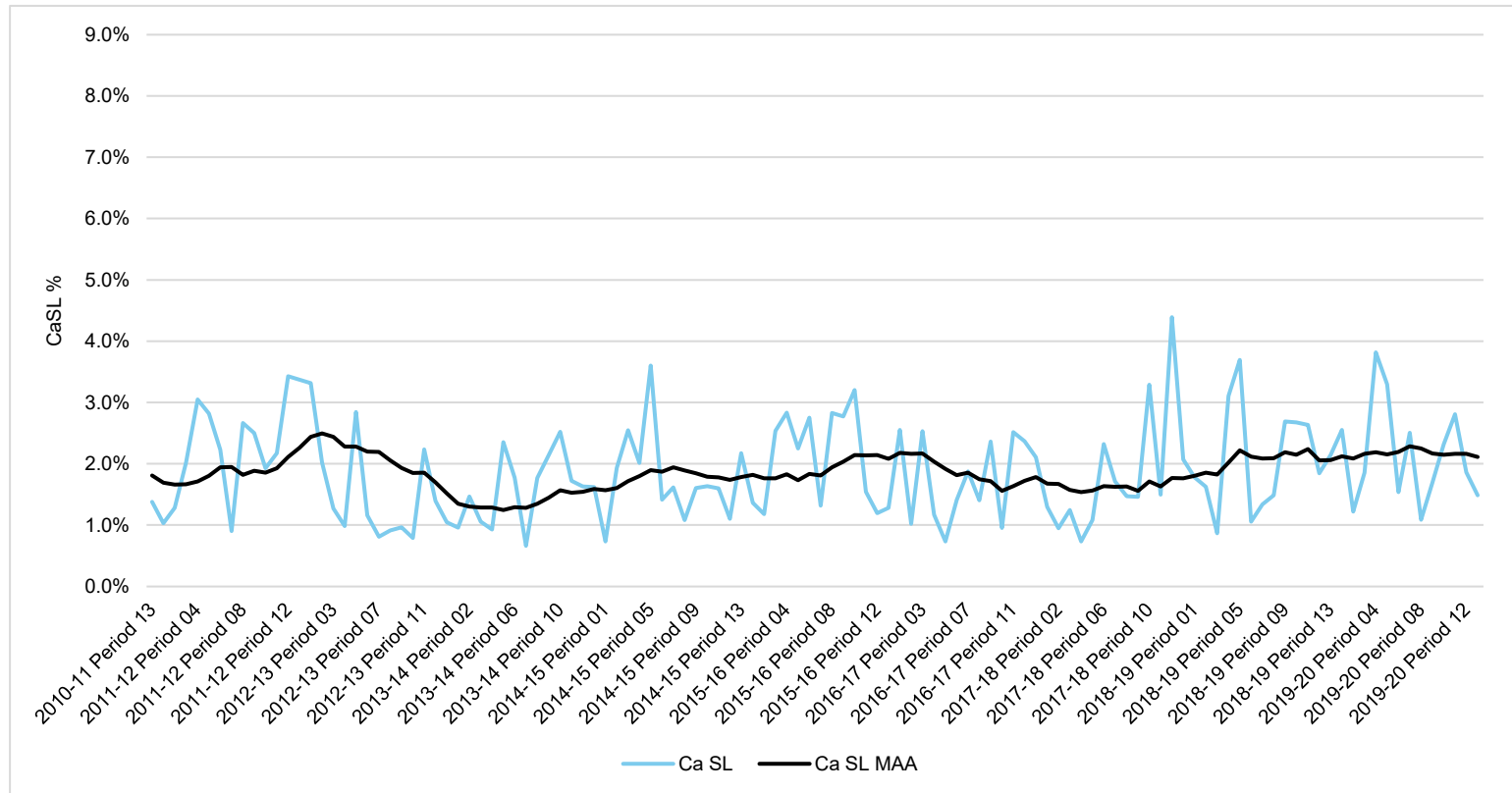
Source: [ORR](#) (2010-20)

Figure 23: Public Performance Measure (PPM) – London Overground (Anglia services)



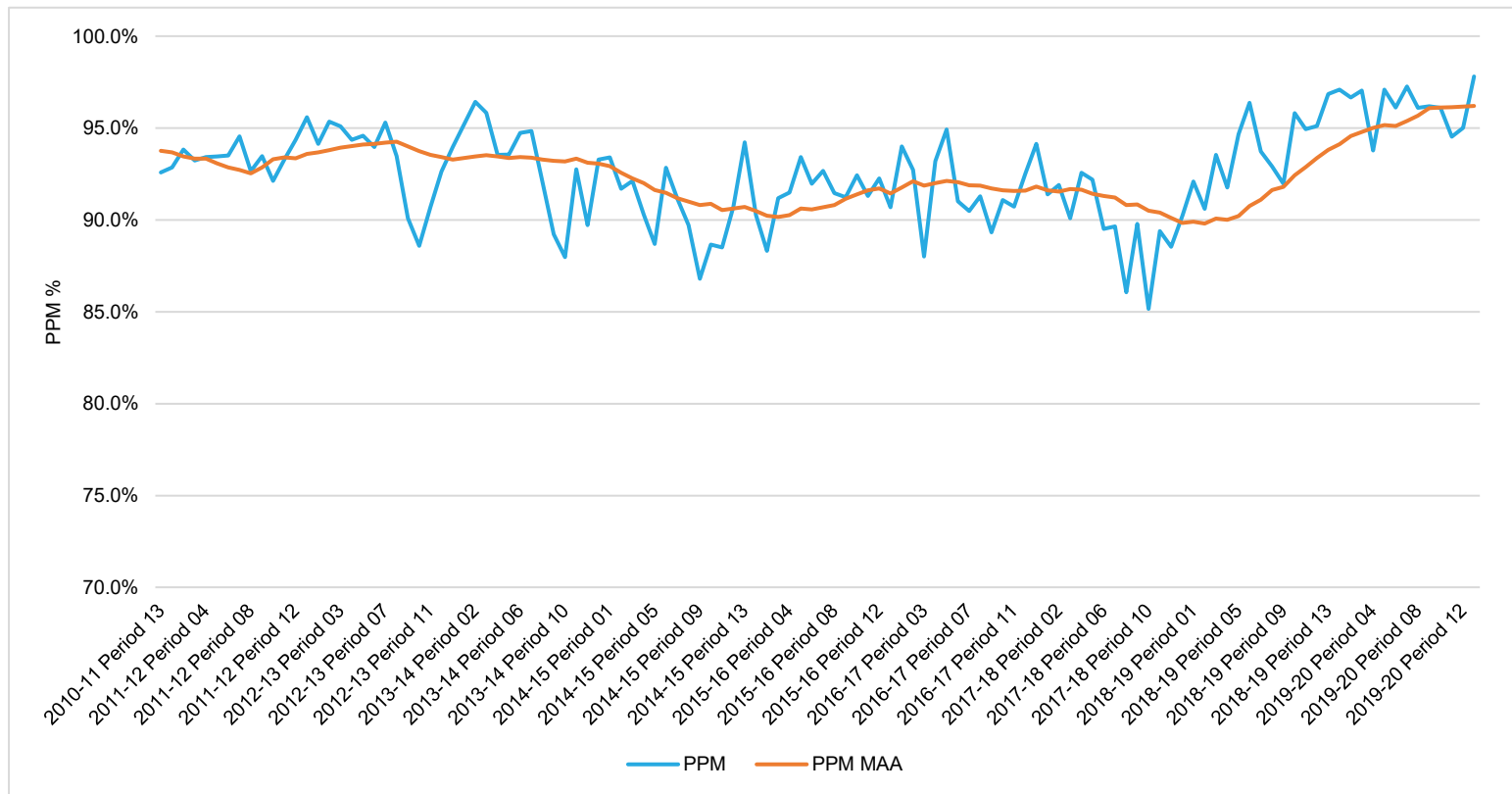
Source: [ORR](#) (2010-20)

Figure 24: Cancellations and Significant Lateness (CaSL) – London Overground (Anglia services)



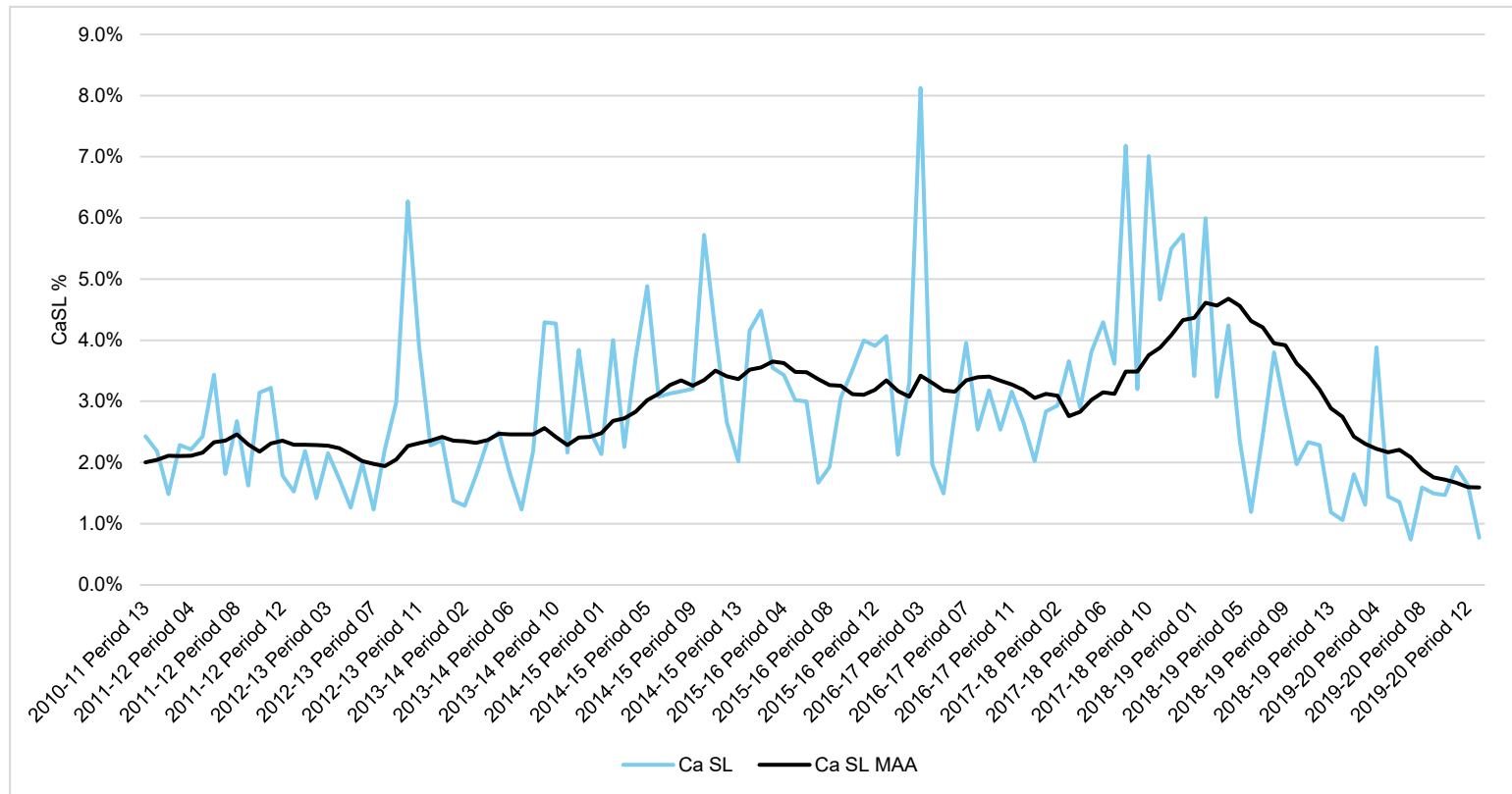
Source: [ORR](#) (2010-20)

Figure 25: Public Performance Measure (PPM) – TfL Rail (Crossrail East)



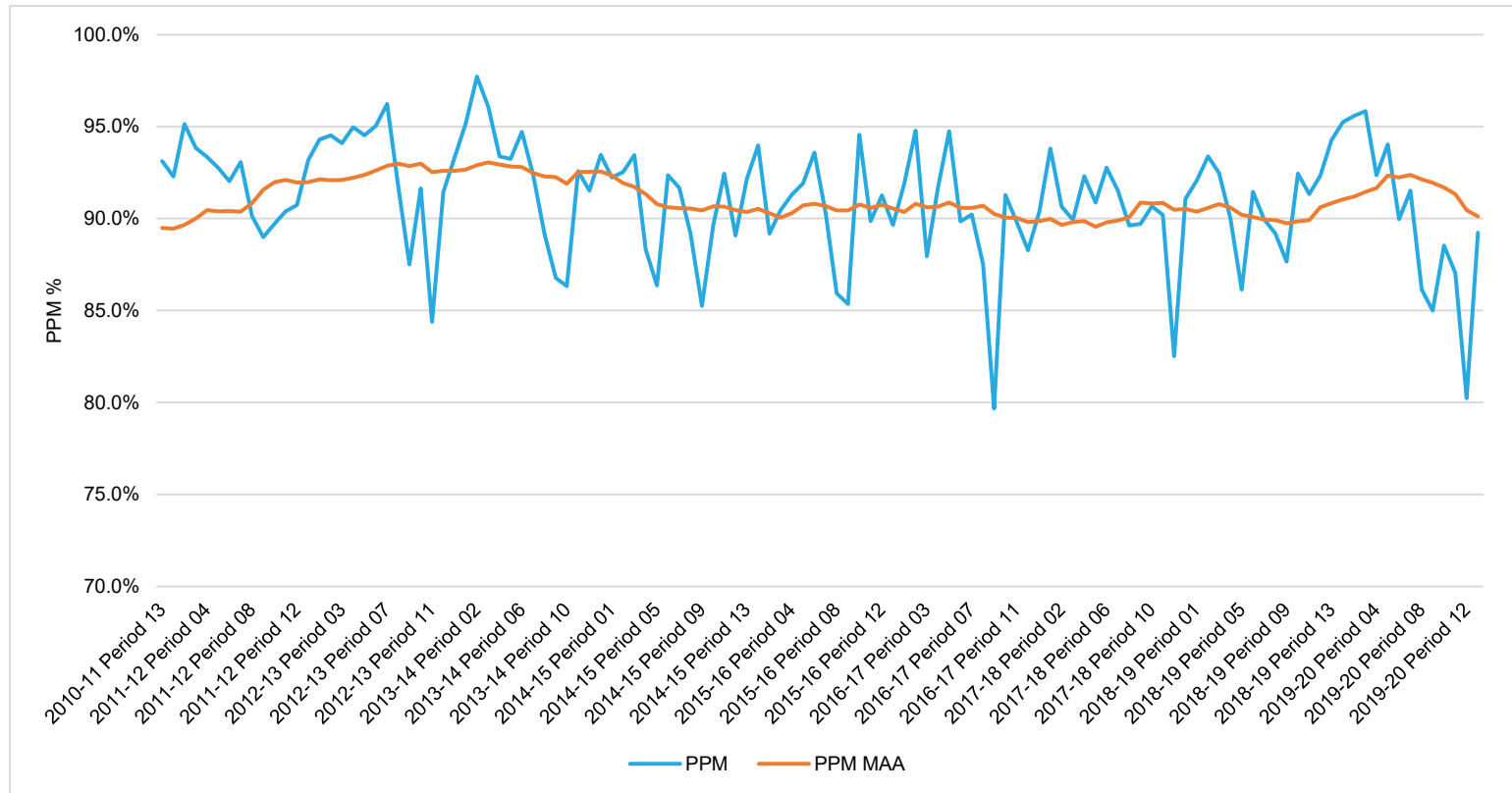
Source: [ORR](#) (2010-20)

Figure 26: Cancellations and Significant Lateness (CaSL) – TfL Rail (Crossrail East)



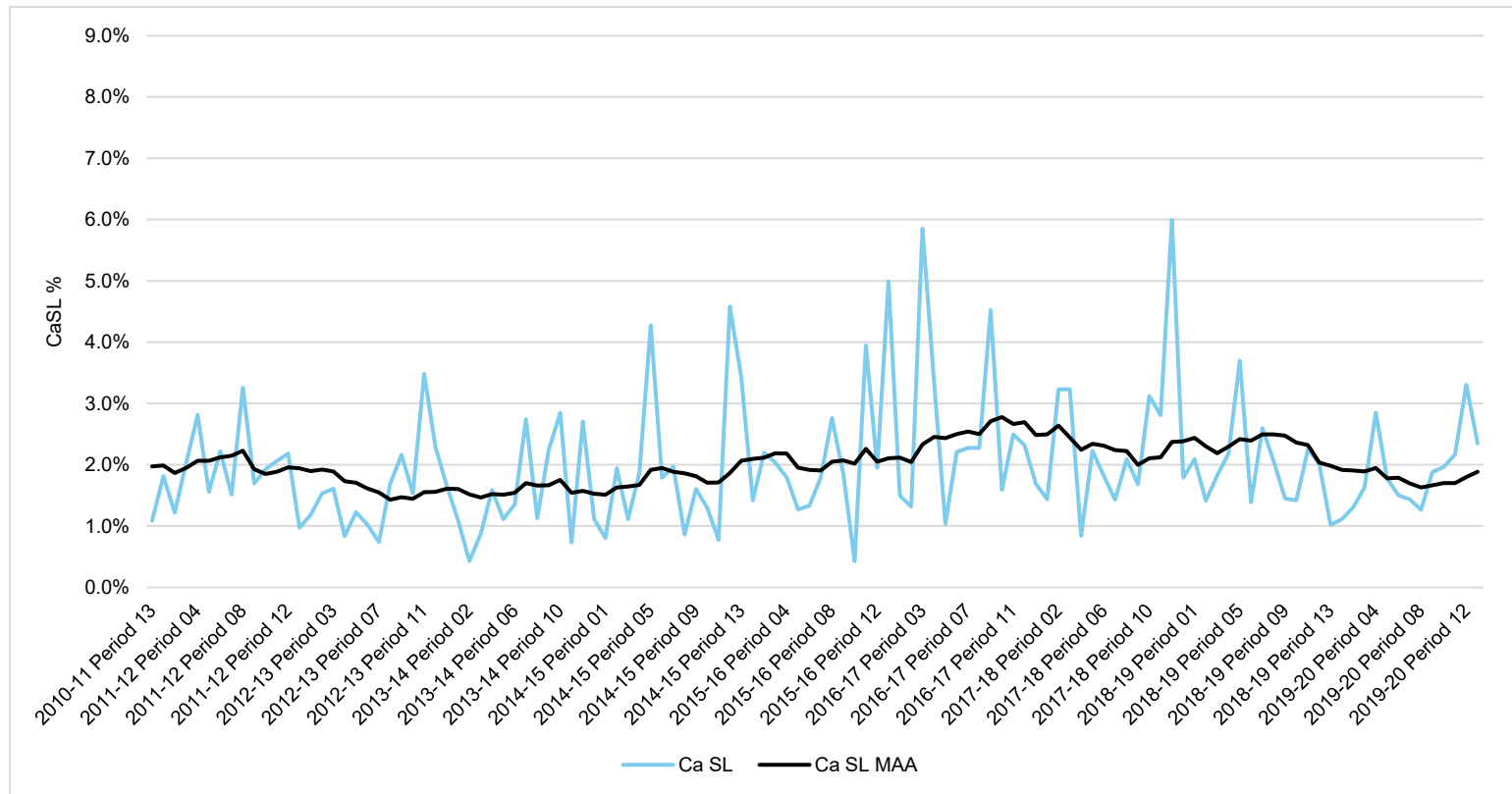
Source: [ORR](#) (2010-20)

Figure 27: Public Performance Measure (PPM) – Greater Anglia (Southend and Metro)



Source: [ORR](#) (2010-20)

Figure 28: Cancellations and Significant Lateness (CaSL) – Greater Anglia (Southend and Metro)



Source: [ORR](#) (2010-20)

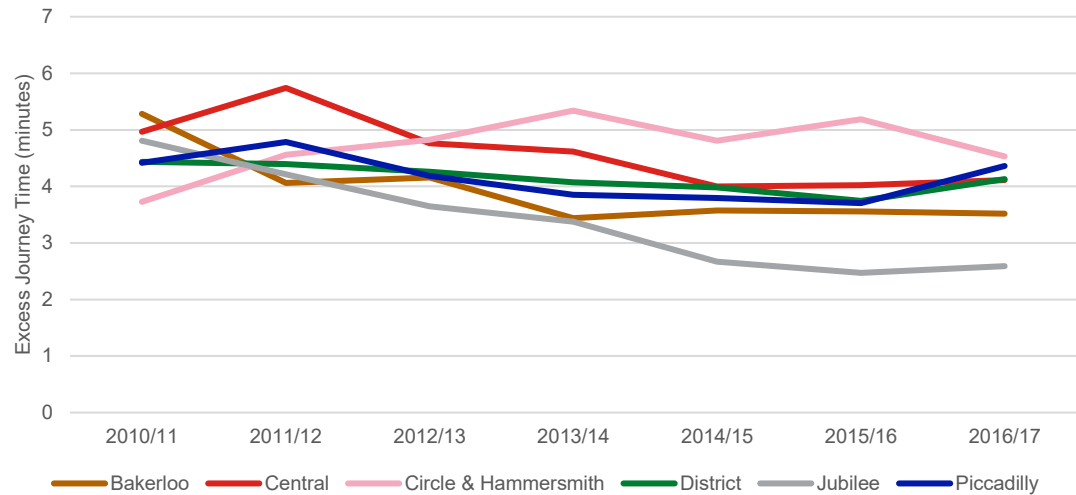
4.2 London Underground Performance

The performance of those London Underground lines likely to be impacted by the Elizabeth line have been assessed in terms of excess journey time, station closures and customer satisfaction.

TfL defines ‘excess journey time’ as the additional time required to complete a journey on the network over and above the expected journey time, weighted by customer time values. This provides an indication of the reliability of the service. With the exception of the Circle and Hammersmith & City lines, the overall trend has been a reduction in excess journey time since 2010, although the Piccadilly and District lines, while falling until 2015/16, have increased back to close to 2010/11 levels. Data for excess journey time is only available until 2016/17.

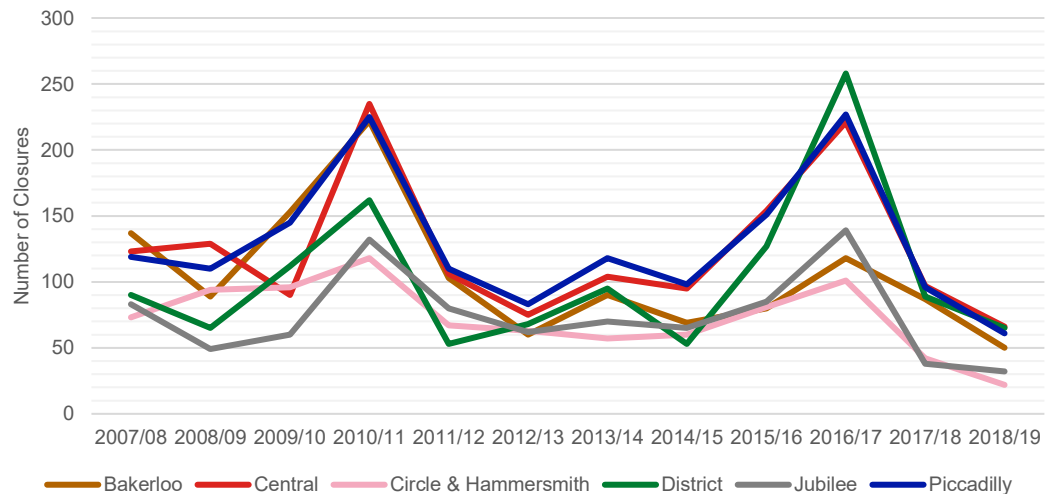
TfL defines a ‘station closure’ as an unplanned closure of entry and exit points, with trains non-stopping on the platform(s). The closure could be a result of non-availability of staff (including industrial action), security alerts, weather related incidents, or failure of safety or power equipment. The highest number of station closures on the lines which will interact with the Elizabeth line occurred in 2016/17 with around 62% of these closures on the Central, District, Northern and Piccadilly lines. The number of station closures has fallen significantly since the peak of 2016/17 and more modestly from 2010/11 as a result of investment in new track, trains and signalling.

Figure 29: London Underground excess journey time



Source: [London Underground Performance Data Almanac](#) (excludes industrial action, data unavailable by line after the 2016/17 period)

Figure 30: Station closures



Source: [London Underground Performance Data Almanac](#)

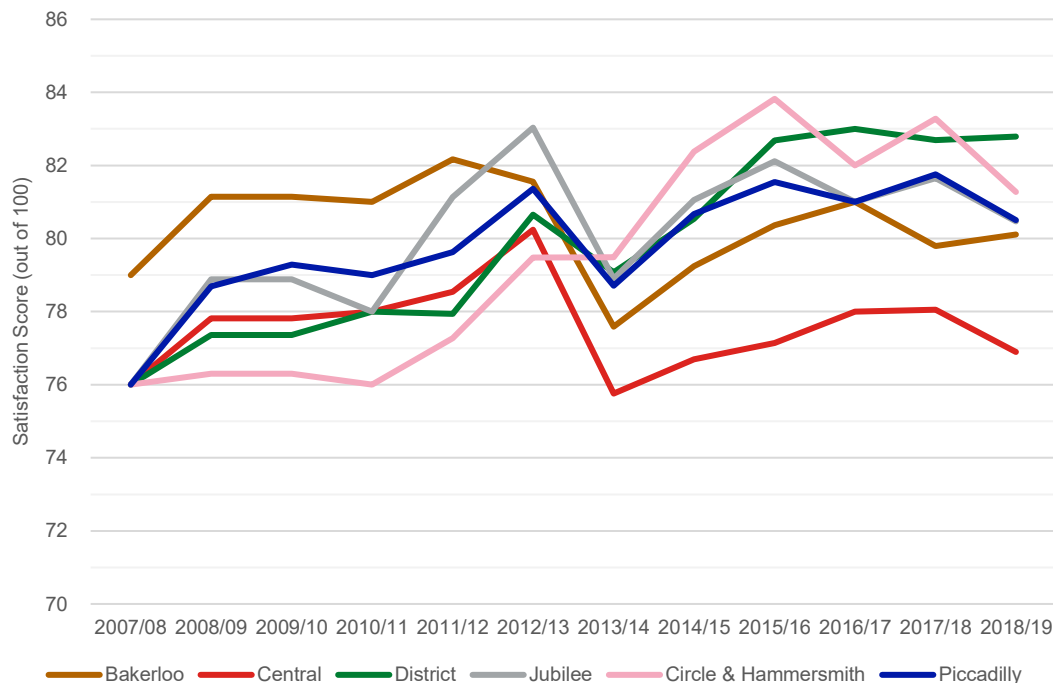
London Underground Performance (Continued)

TfL conducts its Customer Satisfaction Survey every quarter where passengers are asked to rate their level of satisfaction (from a score of 0-10) for the line that they had last travelled on. The survey covers both train service and station attributes. The ratings for each attribute are then averaged and multiplied by ten to provide an overall score out of 100.

Average train service satisfaction on lines intersecting with the Elizabeth line, with the exception of the Central line, is around 80 despite a temporary drop in 2013/14. The District and Circle and Hammersmith & City lines have the highest level of customer satisfaction in more recent years, while the Central line has had the lowest score each year since 2013/14. Customer satisfaction on the Hammersmith & City, Piccadilly and Central lines fell by around 1%-2% from 2017-18 to 2018-19.

All other things being equal, it would be expected that crowding relief on the Central line as a result of passenger switching to the Elizabeth line would lead to an improvement in Central line customer satisfaction.

Figure 31: Customer satisfaction (Train service)



Source: [London Underground Performance Data Almanac](#)

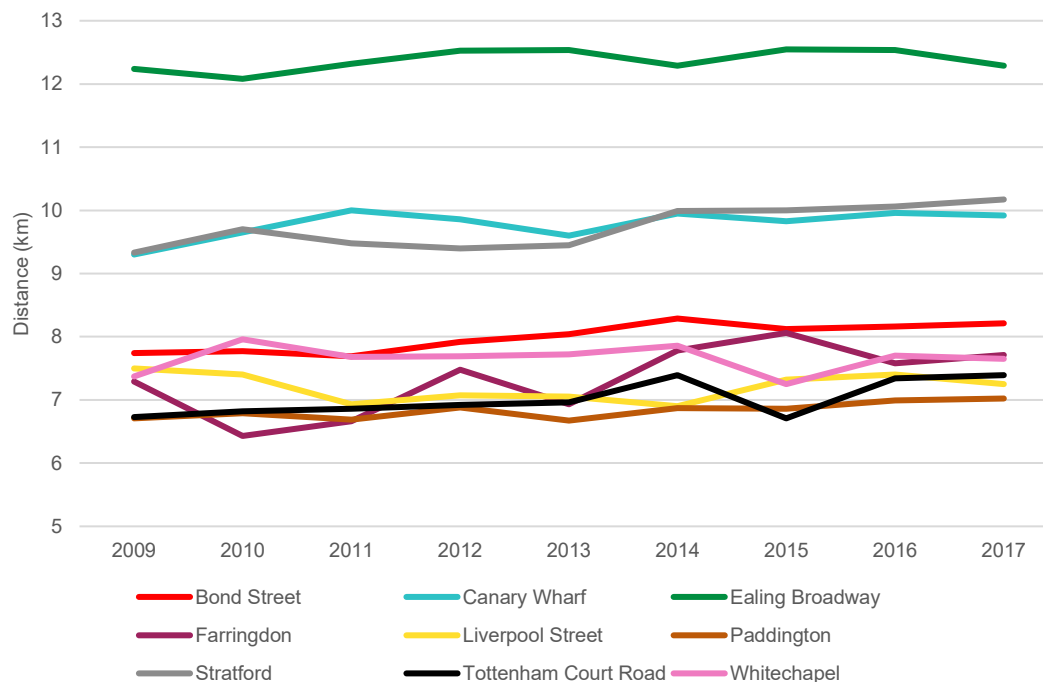
5 Journey characteristics

5.1 Average Journey Times from Key Underground Stations

Average journey times from future Elizabeth line stations have been assessed to ascertain whether journey length might increase with the Elizabeth line. Ealing Broadway stands out with an average 12km journey length reflecting its relatively long distance from central London (13km to Tottenham Court Road, 17km to Liverpool Street) and its importance as an interchange station. Canary Wharf and Stratford have similar journey lengths of around 10km, reflecting their relative proximity to central London; the journey lengths associated with both these stations has gradually increased over time reflecting the increased catchment areas of these locations. Central London stations have the shortest journey time reflecting the prevalence of 'short hop' journeys.

Average trip lengths on the Elizabeth line are expected to be significantly longer at around 14km, which equates to a journey between Ealing Broadway and Farringdon on the Elizabeth line. The longest average trip length is predicted to be just over 17km on the Shenfield to Reading service group which equates to a journey from Romford to Liverpool Street. The shortest average trip length is nearly 11km on Abbey Wood to Paddington services which is equal to a Canary Wharf to Bond Street journey.

Figure 32: Average journey length by station



Source: TfL Rolling Origin and Destination Survey (2009-2017)*

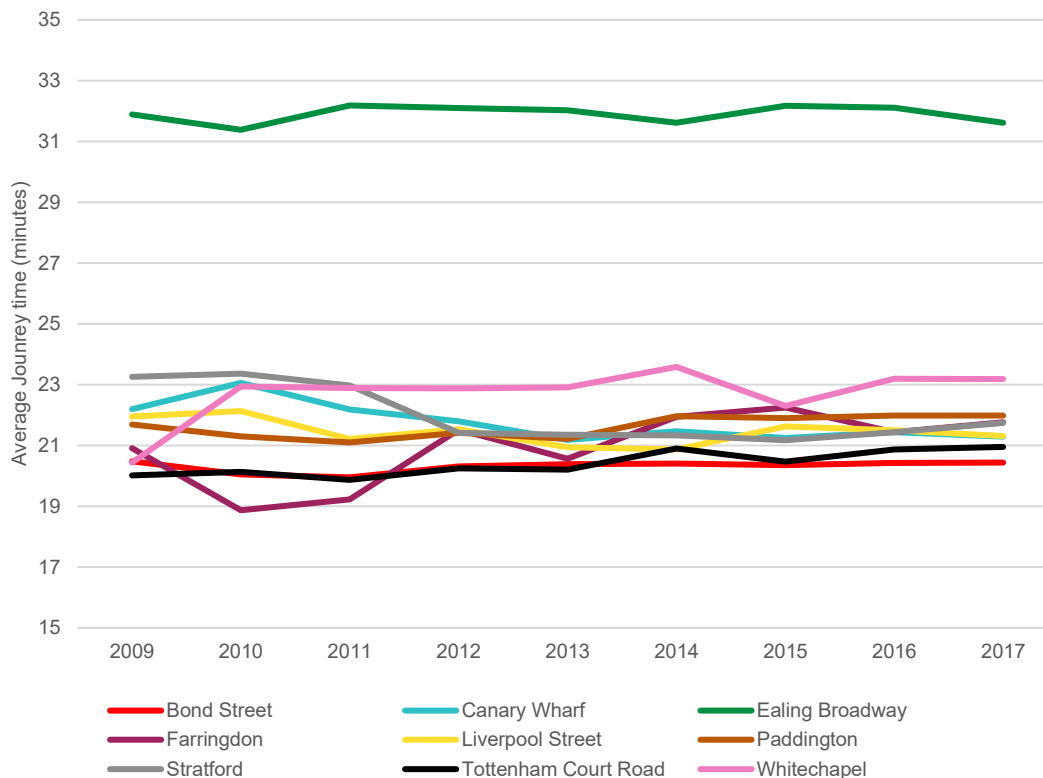
* data has been presented with the earliest and latest years available for RODS data. Currently, unable to update to 2019/2020 with NUMBATS data.

Average Journey Times from Key Underground Stations (continued)

The average journey time per station is available from RODS for 2009 to 2017 as shown in the figure opposite. The general trend for key future Elizabeth line stations is static, with most stations maintaining similar journey times over this period. However, the exception to this over this period is Whitechapel, which sees an increase in journey time of around 13%.

The journey times from 2016 for key routes that are relevant to the Elizabeth line are presented on the next slide.

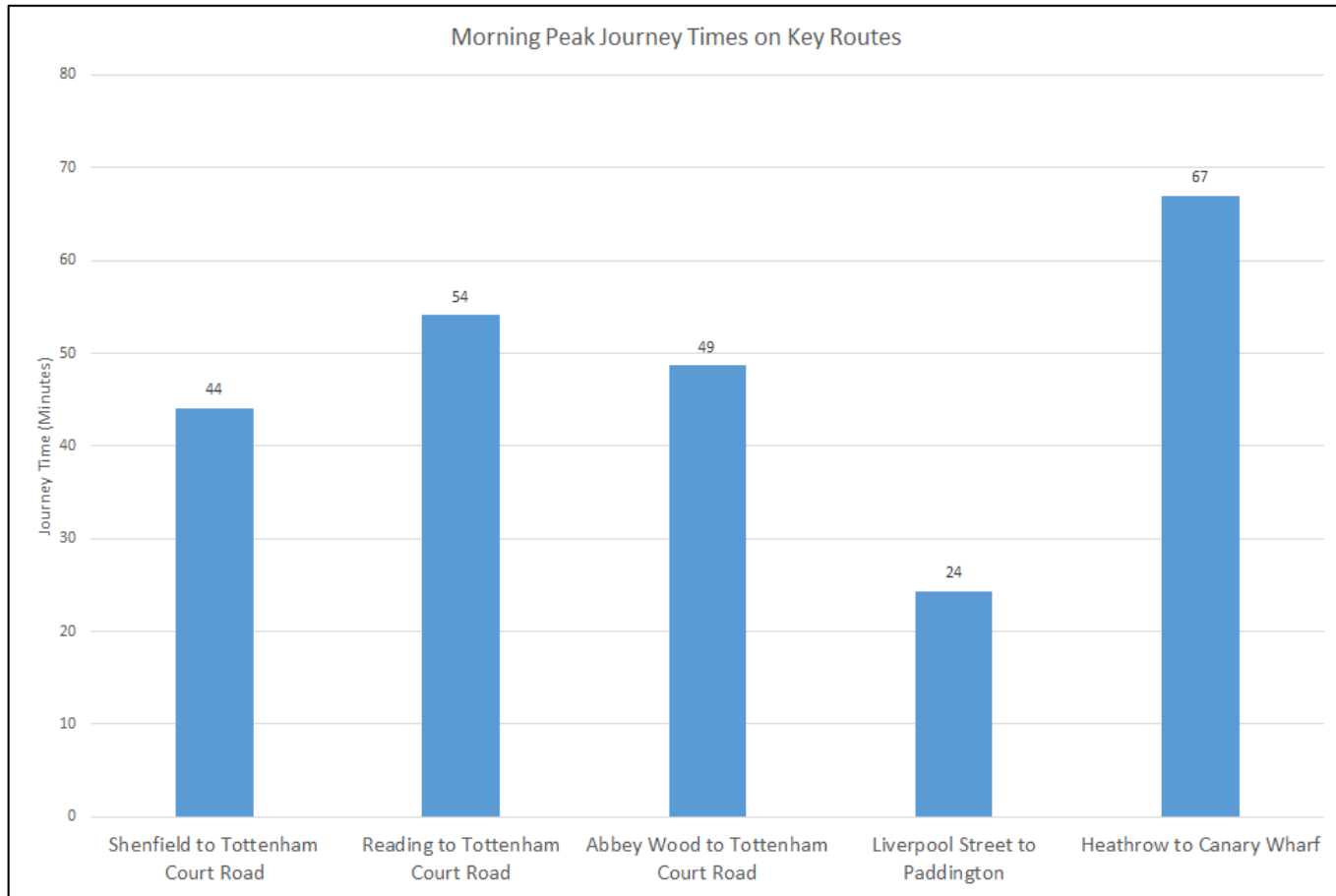
Figure 33: Average journey time by station



Source: TfL Rolling Origin and Destination Survey (2009-2017)*

* data has been presented with the earliest and latest years available for RODS data. Currently, unable to update to 2019/2020 with NUMBATS data.

Figure 34: Morning peak journey times



Source: Journey times from Google Directions API (Application Programme Interface)

6 Transport supply

Rolling stock capacity (seated and standing) for a number of key lines by leg are set out opposite. Line capacities by leg have been derived from train frequencies and capacities. These values are indicative of the capacities available in the weekday morning peak (for trains arriving into London at 09:00) from the May 2021 timetable.

With the implementation of Crossrail, new rolling stock and additional train services are expected to supplement the existing train capacity in the network.

The net impact of the changes in supply will mean that Crossrail will add 10 per cent to the overall capacity of London's rail network, which will help deliver the capacity needed to support more jobs in Central London and the Isle of Dogs and support new jobs in growth areas such as the Thames Gateway.

Shenfield to Tottenham Court Road via Liverpool Street

Leg	Route	Rolling Stock	Train Capacity (pax per train)	Trains per hour	Line Capacity (pax per hr)
Shenfield – Liverpool Street	TfL Rail	Class 345	1,166*	11	12,826
Liverpool Street – Tottenham Court Road	Central line	1992 Tube	892	32	28,544

*Note: For Class 345 RLU (7 Car) assumed 9 Car Class 345 divided by 9 and multiplied up by 7

Reading to Tottenham Court Road via Paddington

Leg	Route	Rolling Stock	Train Capacity (pax per train)	Trains per hour	Line Capacity (pax per hr)
Reading – Paddington	TfL Rail	Class 345 FLU	1,500	4	6,000
Paddington – Oxford Circus	Bakerloo line	1972 Tube	730	21	15,330

*Note: Includes seated + standing capacity for a six-car (2x Cl.165) train.

Abbey Wood to Tottenham Court Road via Charing Cross

Leg	Route	Rolling Stock	Train Capacity (pax per train)	Trains per hour	Line Capacity (pax per hr)
Abbey Wood – London Charing Cross	Southeastern	Class 465	926*	4	3,704
London Charing Cross – Oxford Circus	Bakerloo line	1972 Tube	730	21	15,330

*Note: Includes seated + standing capacity for an eight-car (2x Cl. 465) train.

Paddington to Liverpool Street

Leg	Route	Rolling Stock	Train Capacity (pax per train)	Trains per hour	Line Capacity (pax per hr)
Paddington to Liverpool Street	Hammersmith / Circle	'S' Stock	865	12	10,380

Heathrow Airport to Canary Wharf via Green Park

Leg	Route	Rolling Stock	Train Capacity (pax per train)	Trains per hour	Line Capacity (pax per hr)
Heathrow Airport – Green Park	Piccadilly line	1973 Tube	684	12	8,208
Green Park – Canary Wharf	Jubilee line	1996 Tube	817	30	24,510

7 Journey Time Accessibility

Journey time accessibility is essentially a way of measuring the density of the public transport network at any location within the study area. Studying it helps to understand the impact of the Elizabeth line on the transport system of London and the wider South East. Its assessment has been undertaken using the TRACC public transport accessibility software* using data from 2016 (for more details please see the Transport Technical Report Supplement document). The source data is public transport timetables.

In order to gauge the change in accessibility with the Elizabeth line in place, its current planned timetable has been added manually based on best available information. This has then been used to develop accessibility indices for over 1,000 stations in the south east, based on the average travel time in minutes from that station to all others. The figures overleaf illustrate the top 100 stations with the largest change in average journey time.

A comparison of the 2007 and 2016 accessibility indices shows very few underground stations had a discernible improvement in accessibility, primarily because these already have good accessibility due to relatively high frequencies.

The key observation is the improvement in accessibility either along the route of South Eastern high speed services or for lines with interchange to these services with the largest improvements at Ebbsfleet International, Northfleet, Charing, Gravesend, Snodland, Appleford and Strood. Other improvements are evident on the North London line and Metropolitan line on the two branches west of Harrow-on-the Hill, due to service improvements.

We have also compared a future year with and without the additional Elizabeth line accessibility which indicates that outlying Elizabeth line stations (not served by LU services) are the main beneficiaries of

increased accessibility, again because LU stations already have good levels of accessibility and because some of the outlying stations, particularly on the western section, will benefit from much larger improvements in journey time. Taking Bond Street as the destination, a selection of Elizabeth line stations on the western section (<http://www.crossrail.co.uk/route/western-section/>) will see an average journey time reduction of around 40%, compared to closer to 20% for a selection of Elizabeth line stations on the eastern section.

* Specifically [National Public Transport Data Repository \(NPTDR\)](#) for 2007, and [Traveline National Dataset](#) and TfL data for 2016.

Figure 35: Changes in journey time accessibility between 2007 and 2016

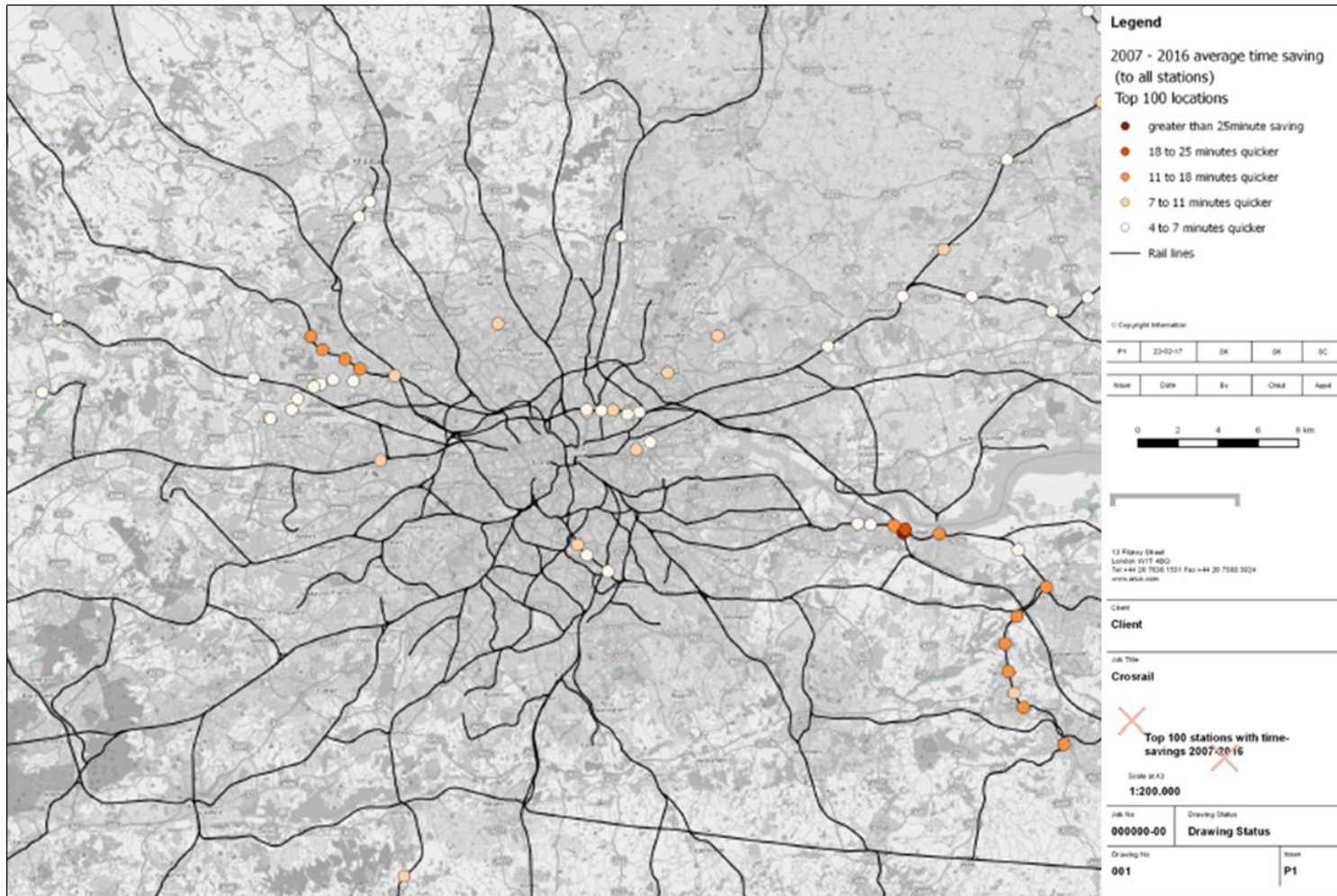
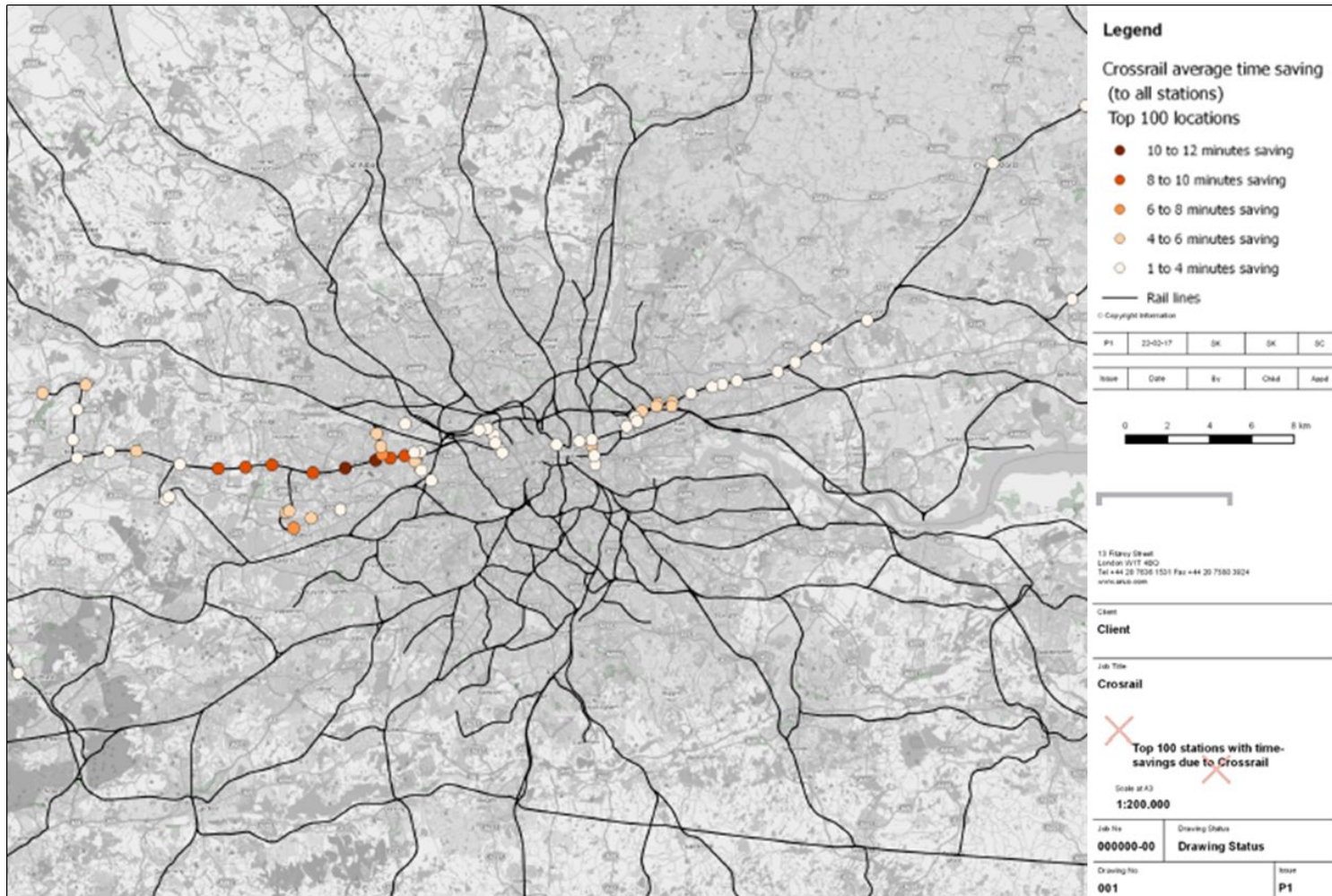


Figure 36: Planned future changes in journey time accessibility with Crossrail



8 Crime

8.1 Baseline of on-network crimes on London Underground, DLR and Overground

Data for reported crime, on LU, DLR and London Overground and around Elizabeth line stations, has been assessed to ascertain trends. It should be noted however, that in recent years there have been campaigns to report crimes by the police which could skew the data. However, they remain a useful baseline for measuring against for post-opening analysis.

TfL publishes the data on reported crime number and crime rate (crime number per million passenger journey) in the Crime Statistic

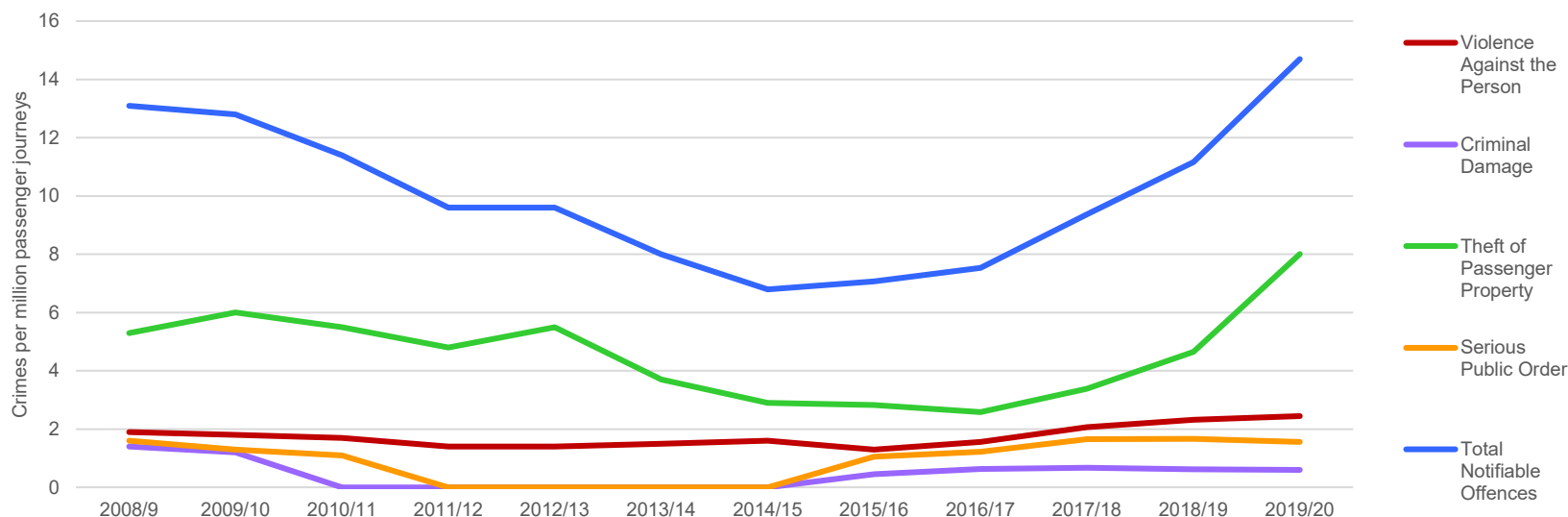
Bulletin, on an annual basis.

Overall, London Underground and DLR (see Figure 37) have higher crime rates than London Overground. London Underground and DLR saw crime rates drop from 2008/09 to a low in 2014/15 before continually rising to 2019/20. The largest increase has been in the theft of personal property with other crime rates fairly static, probably reflecting increased ownership and use of mobile phones and other portable technology. Overground crime rates (see Figure 38 overleaf) have risen fairly steadily

from 2008/09 to 2019/20 with the exception of criminal damage.

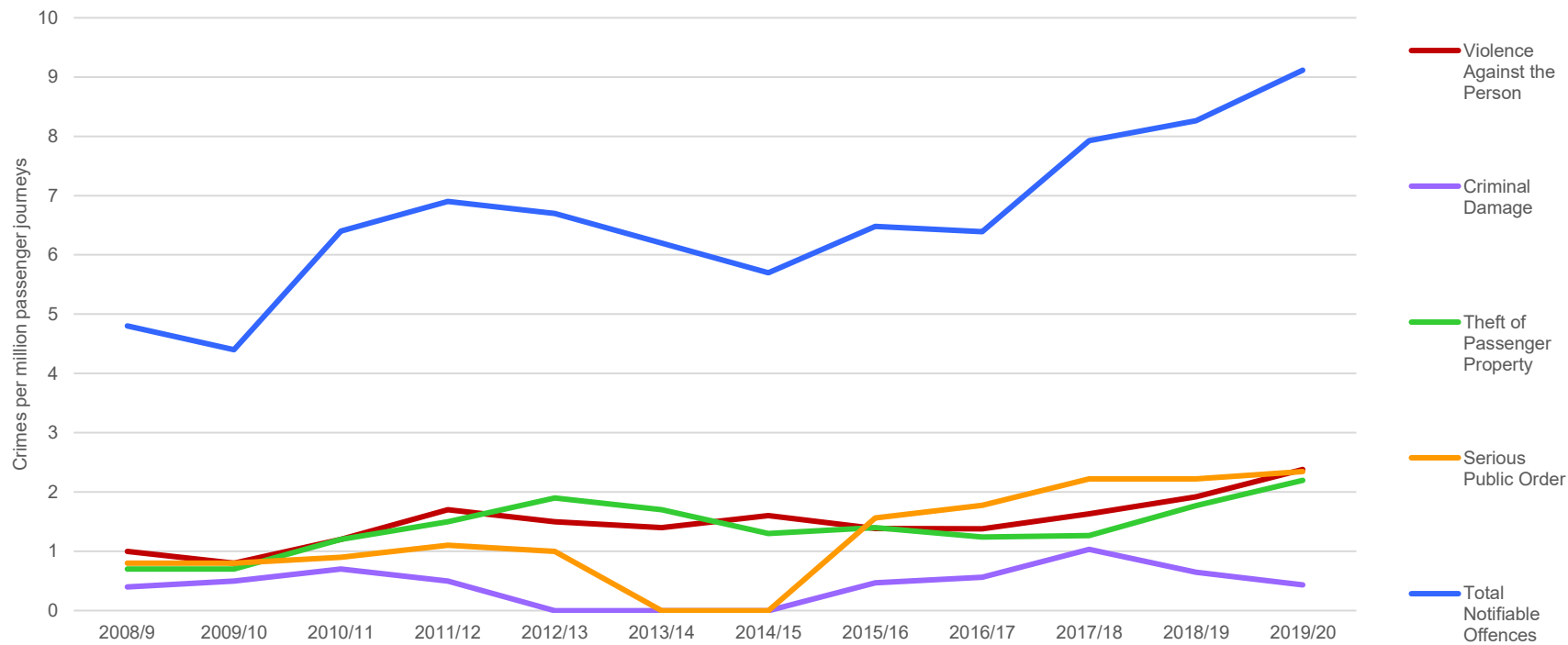
Violence Against the Person, Theft of Passenger Property, and Serious Public Order are generally the most common crimes. Other types of crime on transport, including Sexual Offences, Criminal Damages, Line of Route, Motor Vehicle/Cycle Offences, Robbery, Theft of Railway Property/Burglary, Serious Fraud, Drugs and Other Serious Offences, which all had crime rates less than 1.

Figure 37: LU and DLR crime rates



Source: [TfL Crime Statistic Bulletin](#)

Figure 38: London Overground crime rates



Source: [TfL Crime Statistic Bulletin](#) (2011/12 is earliest available data for London Overground)

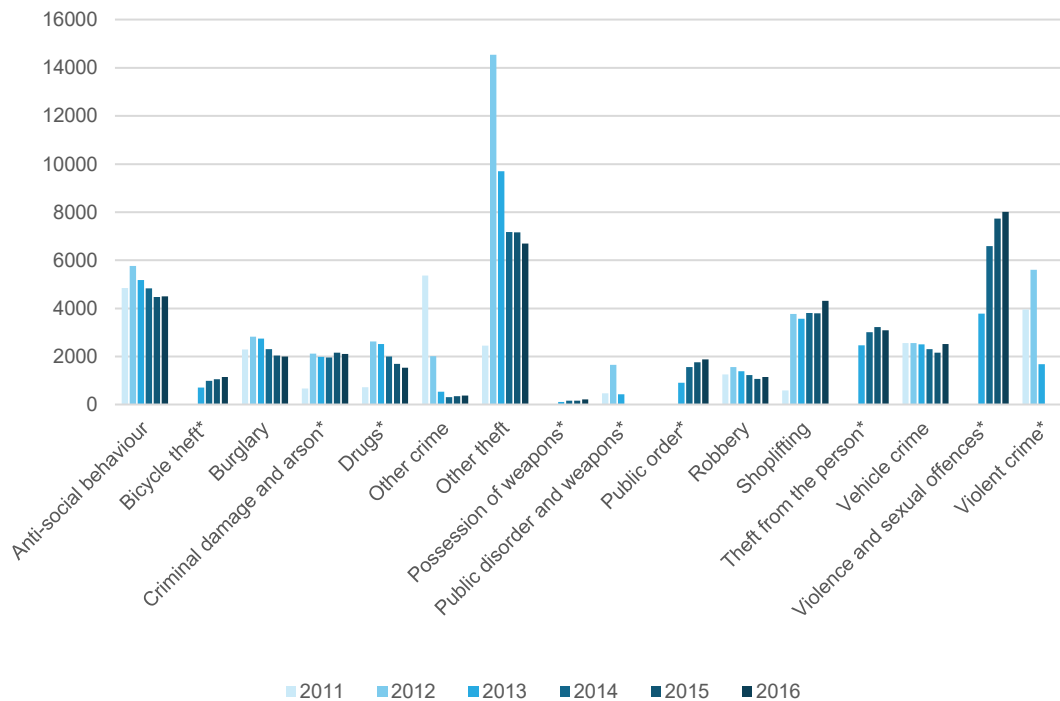
8.2 Breakdown of crimes around future Elizabeth line stations (within 500m)

Anti-social behaviour, other theft and violence and sexual offences are the most common types of crime in areas within 0-500 metres of future Elizabeth line stations.

During the period between 2011 and 2016, there was a decrease in anti-social behaviour and ‘other theft’ crimes. Over the same period, there was a big increase in violence and sexual offences, with smaller increases in shoplifting and theft from the person.

Data were not available for years after 2016. however, all other things being equal, one could expect an increase in total crimes due to the increase in theft of personal property experienced on LUL, DLR and London Overground lines over the same period.

Figure 39: Crime by types for 0-500m from any Crossrail station, 2011-2016



(* Data not available for certain years. 2011 earliest data available, 2016 latest data available)

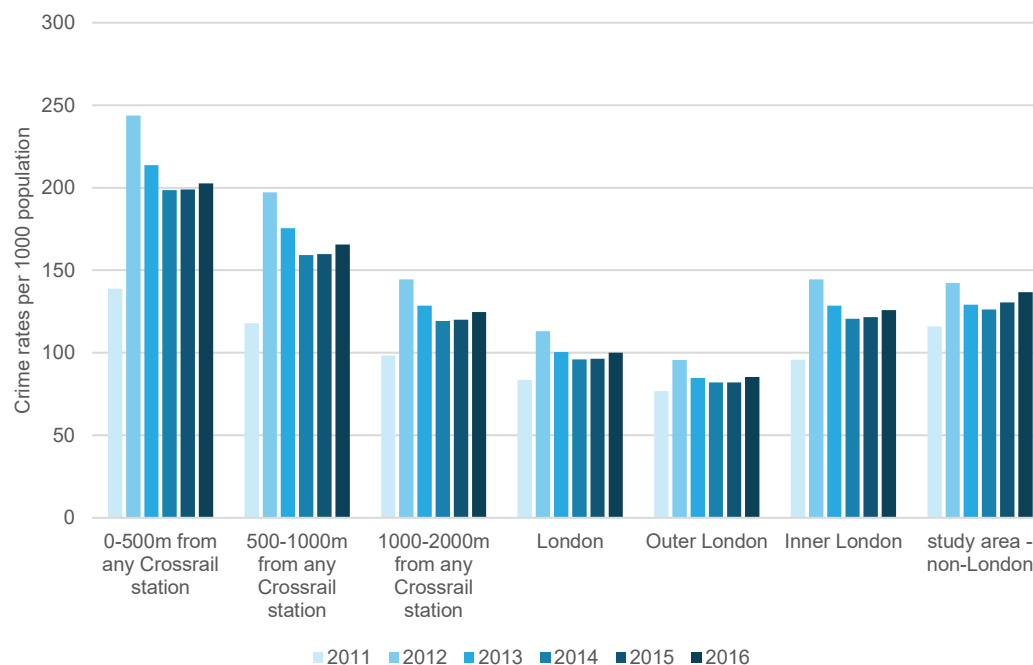
8.3 Crime rates

Crime density is the number of total crime counts per year per 1000 population in a given area. For each of the areas analysed, a similar trend has been observed which shows a rise from 2011 to 2012, a decrease to 2014, and then a slight increase to 2016.

From the available data, the crime rates decrease as the distance from the future Elizabeth line stations increases. It can also be seen that Inner London has a higher crime density than Outer London.

Overall, London has a lower crime rate per head of population compared to non-London areas within the Crossrail study area.

Figure 40: Crime rates per 1000 population



(* Data not available for certain years. 2011 earliest data available, 2016 latest data available)

9 Financial

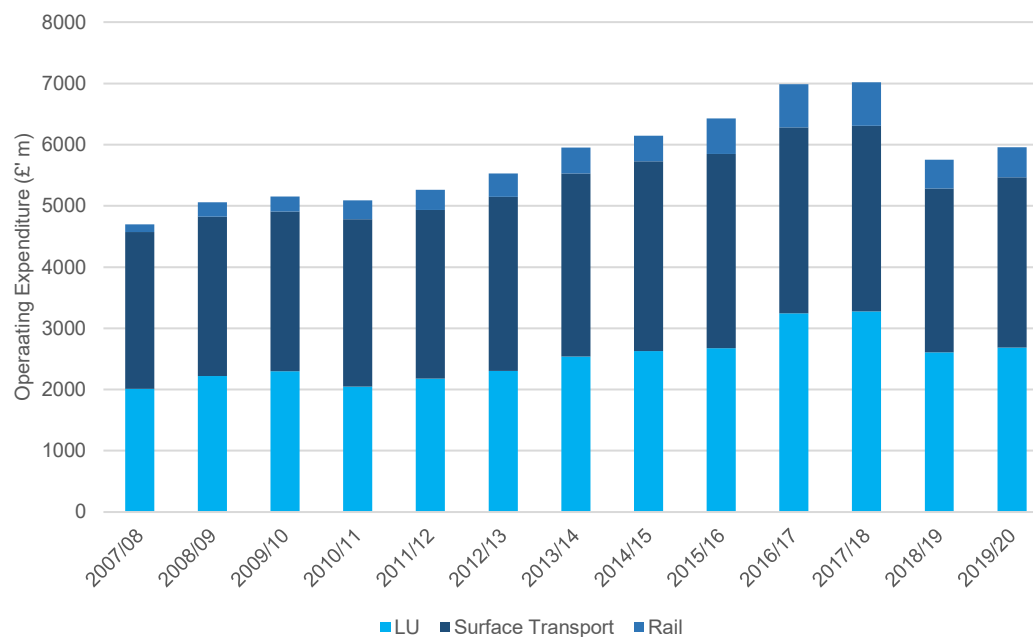
9.1 Operating expenditure

TfL total operating expenditure on London Underground, Surface Transport (bus) and Rail (Overground and DLR) grew steadily from £4,698 million in 2007/08 to £7,022 million in 2017/18, after which, expenditure has declined by around 15% to 2019/20.

This has been achieved through a drive to reduce management costs, merge functions, renegotiate contracts and deliver transport improvements in a more efficient manner.

Underground and Rail account for the majority of the operating expenditure.

Figure 41: TfL Operating expenditure (2007 to 2020)

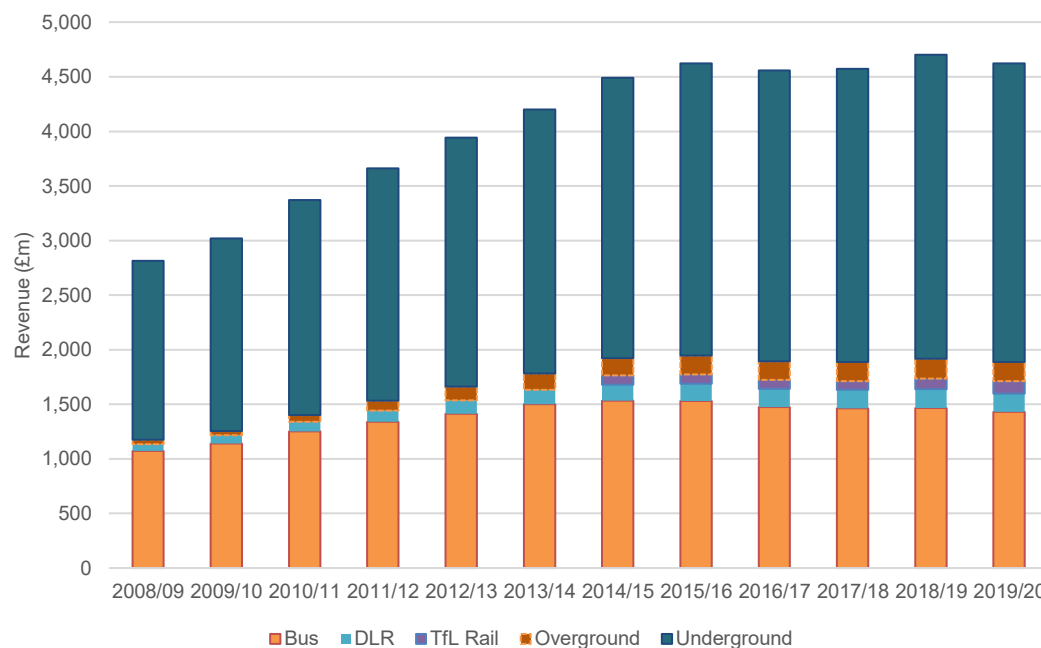


Source: [Transport for London annual reports](#), 2007/8-2019/20 (nominal)

9.2 Passenger Revenue

Total passenger revenue for TfL services has grown steadily from £2,800 million in 2008/09 to £4,600 2019/20. The majority of passenger revenue is attributed to London Underground followed by bus; in 2019/20 these accounted for 90% of passenger revenue. However, since 2008/09, there has been a small but growing contribution to passenger revenue from London Overground, DLR and TfL Rail services.

Figure 42: TfL Revenue by mode (2008 to 2020)



Source: Transport for London Historical Fare Income Data (nominal), earliest available

Transport baseline evaluation

Conclusion

The transport baseline report has analysed a number of data sources, either publicly available or from organisations including transport for London and the Department for Transport, in order to present time series data from Crossrail Royal Assent in 2008 up to the present day.

The impact of the Covid-19 pandemic complicates this assessment as transport demand was severely impacted from the end of March 2020 through a series of lockdowns and associated travel restrictions with underground flows in the first week of April 2020 around 5%¹ of their pre-pandemic level. Whilst demand for transport is slowing recovering (during the first week of February 2022, Underground use averaged 57% of pre-pandemic levels) it is not possible to forecast if and when levels of demand will fully recover. For these reasons, our data analysis covered the period up until the end of the 2019/2020 financial year.

Unlike the analysis addressing economy, planning and regeneration, which shows how Crossrail is having an impact pre-opening, most changes in the transport metrics set out in this report are not a result of Crossrail but rather, are due to changes in transport supply and demand resulting from a range of other underlying changes.

The wide geographical coverage of Crossrail, from Reading in the west to Shenfield in the east, means that it will traverse fundamentally different geographical areas including rural, suburban, outer and inner London, all of which exhibit different usage and patterns of travel. Our data analysis indicates that car mode share is significantly higher in outer London with cycling and walking attracting a much higher proportion in inner London (46% compared with 32% in outer London).

This suggests that the Elizabeth line is more likely to influence mode choice in outer London and route (or sub-modal public transport mode) choice in inner London.

The increase in rail capacity afforded by the Elizabeth line of around 10% into central London is likely to further increase the public transport mode share, which is likely to be at the expense of car, motorcycle and taxi.

The transport baseline indicates that those London Underground lines with some of the highest levels of demand and crowding, (and consequential low customer satisfaction scores), are precisely those lines that will be relieved by the Elizabeth line, namely the Central, District, Jubilee, Hammersmith & City/Circle, District, and Bakerloo lines.

The total number of people entering central London in the morning peak has grown steadily from 2007-08 with an overall increase of almost 28%. The increase in rail capacity into central London of around 10% that will be delivered by the Elizabeth line is likely to further increase the public transport mode share, which is likely to be at the expense of cars, motorcycles and taxis.

The stations with the most significant growth are in the east of London, including Stratford, Whitechapel, Canary Wharf, and Liverpool Street. This growth coincides with the high ridership of the Jubilee and Central lines, and is indicative of the development that has taken place in the areas surrounding these stations.

The analysis contained in this transport baseline report and the underlying datasets therefore provides a rich data source leading up to the opening of the Elizabeth line. When the Elizabeth line has opened, and allowing for any time lags over which transport usage and behaviour might change, the analysis undertaken for this transport baseline can be repeated in order to provide a true picture of the impacts of Crossrail.

There are further topic areas which could be analysed post-opening of the Elizabeth line and included in future reports. These could include; CO2 impacts, road safety impacts, changes in air quality, and active travel.

¹ <https://www.gov.uk/government/statistics/transport-use-during-the-coronavirus-covid-19-pandemic>

Appendix A

Current travel patterns – national trends

How many trips do people make?

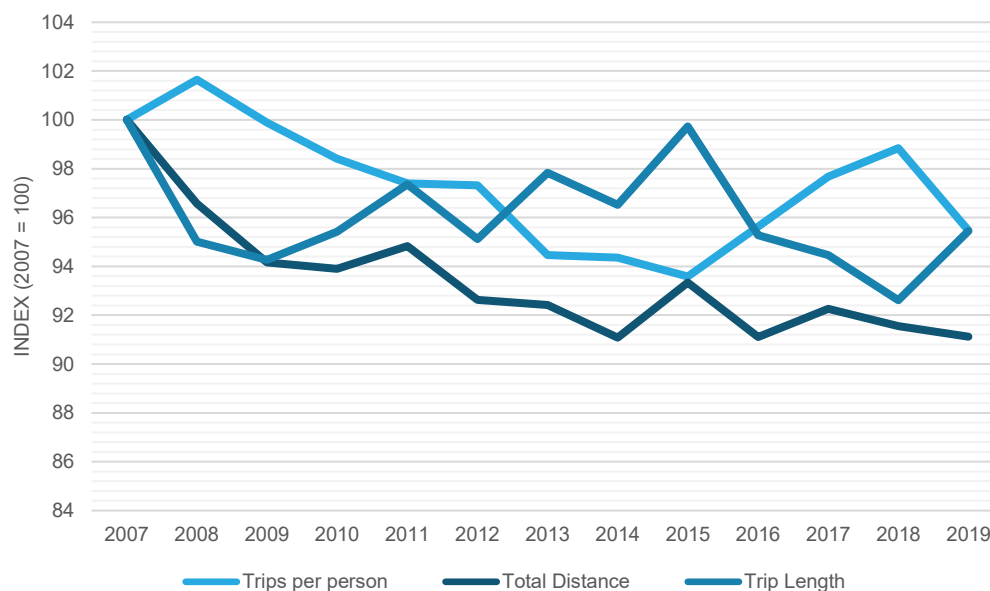
How long are these trips?

This section sets out a number of transport indicators at a national level in order to provide some context for later sections covering indicators at a London, or sub-London, level.

From 2007 to 2015, the trend has been for people to make fewer trips, with the length of trips dropping and then rising back to 2007 levels by 2015. From 2015, to 2018, more trips were made, but over shorter distances. By 2019 the trend had reversed with the length of trips increasing and number of trips decreasing.

In 2019, the average number of trips per person per year was 953, around 5% less than in 2007. These trips are on average just under 7 miles long, which is 5% shorter than trips made in 2007. This is part of a longer term broader trend that has seen national trip rates decreasing since the late 1990s.

Figure A1: Trends in national trip making



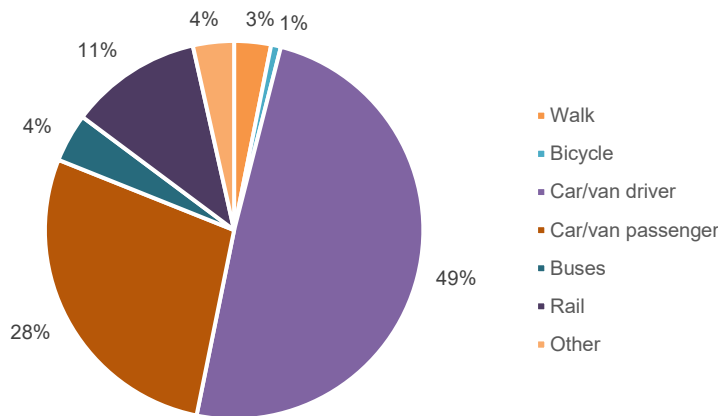
Source: [DfT National Travel Survey](#), NTS0101 (2007-19)

How do people travel?

The majority of trips on a national level in 2019 were completed by car, with 61% of trips as a driver or passenger. The mode with the next highest share is walking at just over 26% which shows an increase of 2 percentage points from 2007. There has been very little change in national mode shares between 2007 and 2019/2020 although rail has slightly increased by 1 percentage point and the car modes and buses have each fallen by 1 percentage point over this period.

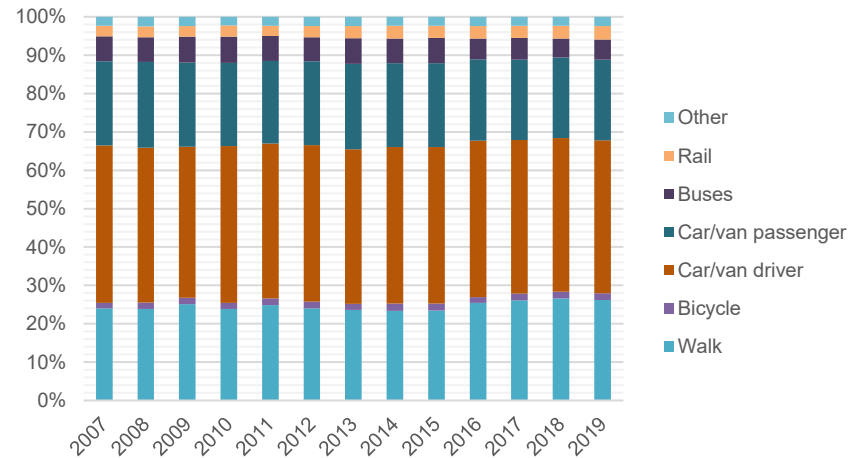
When comparing mode shares based on distance travelled, journeys made by car or van constitute 77% of total distance travelled, whilst rail has a modal share of 11%. Unsurprisingly, walking and cycling mode shares are lower at 3% and 1% respectively. The dominance of car and rail, accounting for 88% of mode share by distance, reflects their importance for longer distance trips.

Figure A3: 2019 mode share (based on distance)



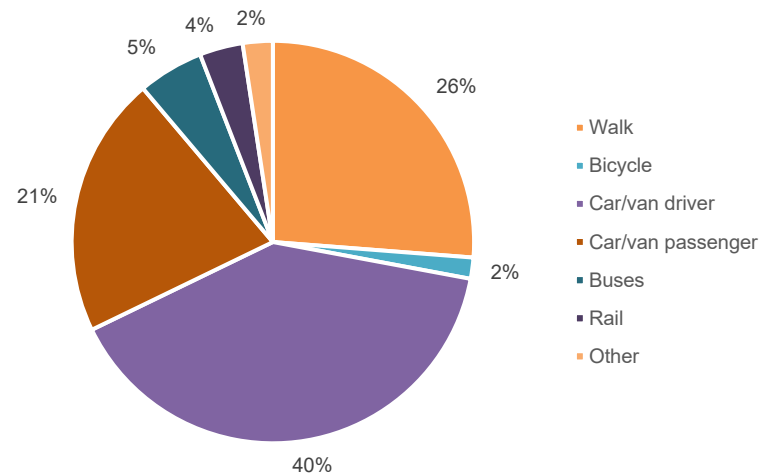
Source: [DfT National Travel Survey](#), NTS0303 (2019)

Figure A2: Mode share trends



Source: [DfT National Travel Survey](#), NTS0303 (2007-19)

Figure A4: 2019 Mode share (based on number of trips)



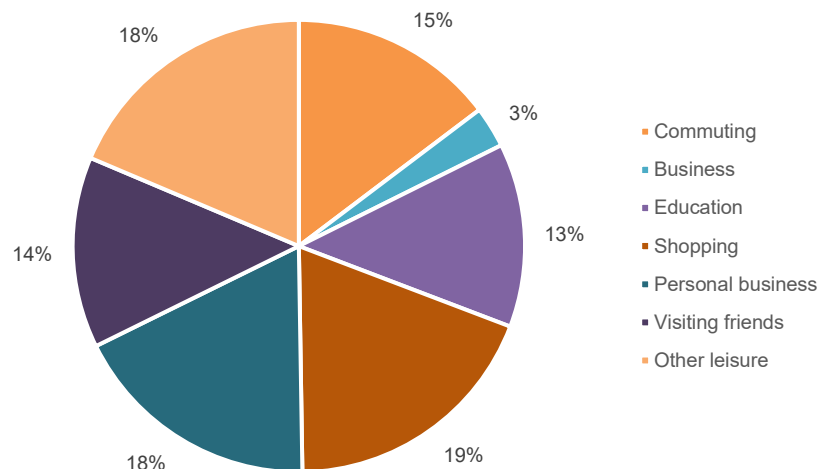
Source: [DfT National Travel Survey](#), NTS0303 (2019)

Why do people travel?

Within England in 2019, people travelled most often for shopping (19%), personal business or leisure (both 18%). The largest increase between 2008 and 2019 is for leisure trips which increased by 3.7% followed by education trips which increased by 2.3%. However, overall, the journey purpose¹ percentages have remained relatively constant between 2009 and 2019/2020, with no activity significantly increasing or decreasing in frequency.

¹ For the purposes of the National Travel Survey, a trip is defined as a one-way course of travel with a single main purpose. Outward and return halves of a return trip are treated as two separate trips. A trip can only have one purpose, and if a single course of travel involves a mid-way change of purpose then it is split into 2 trips each with its own purpose. Trivial subsidiary purposes (for example, a stop to buy a newspaper) are disregarded. Therefore trip purposes are not multi-modal.

Figure A5: Journey purpose



Source: [DfT National Travel Survey](#), NTS0403 (2019)