REVEALING REALITY

frontier economics

ACCESSIBILITY REVIEW OF THE PTAL INDEX

A report for Transport for All

JANUARY 2024

TRANSPORT FOR ALL

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1 Executive Summary

1.1 Background and scope

Public transport accessibility is a broad term which is used in multiple ways in different studies and contexts. The UK's Office for Statistics Regulation (2022) notes that a transport network is accessible when it "***allows all users equal opportunity to travel when they want, where they want, how they want, at a price they can afford***."

Accessible public transport is important for all Londoners. Current official measures of accessibility often focus on distance to the nearest routes and services available. They do not measure ease of use of the service. Ease of use is particularly important for disabled users.

This report explores the possibility of developing a new metric of access that would be more meaningful for disabled users and for those planning transport services with their needs in mind. Such a measure could also be applied to transport systems elsewhere in the UK or more widely.

Our work is not intended to generate conclusive findings or a policy-ready proposal/assessment. The purpose of this exploratory study is to characterise the need to take disability accessibility into account within standardised accessibility metrics and provide a broad evidence base of initial findings, which can be built upon in the future. In other words, the purpose of our work is to demonstrate what does not work well within current measures and to establish how to better measure what matters, rather than carrying out detailed testing and refining of alternatives.

This work was commissioned by Transport for All.[1] Transport for All's vision is transport justice for all disabled people. Transport for All's focus is the ways in which disabled people make trips from their place of residence for any purpose. This includes public transport, active travel and door-to-door transport. Justice in this context goes beyond access and Transport for All seek to ensure that disabled people have meaningful involvement in the design, delivery, and evaluation of services.[2]

Transport for All therefore have an interest in driving change in the policymaking process to better account for the experience of disabled public transport users, which motivated this work.

This research has been funded by the Motability Foundation. The Motability Foundation fund, support, research and innovate so that all disabled people can make the journeys they choose.

[1] https://www.transportforall.org.uk/about-us/our-mission/

[2] While also ensuring that when the expertise of the disabled community is sought out, it is believed, and appropriately compensated.

1.2 PTAL

Public Transport Access Level (PTAL) is a measure of access to the public transport network in London. The PTAL calculation is based on:

- Walking distance to the nearest stations/stops;
- Waiting times at the nearest stations/stops;
- Number of services at the nearest stations/stops; and
- Distance to major rail stations.

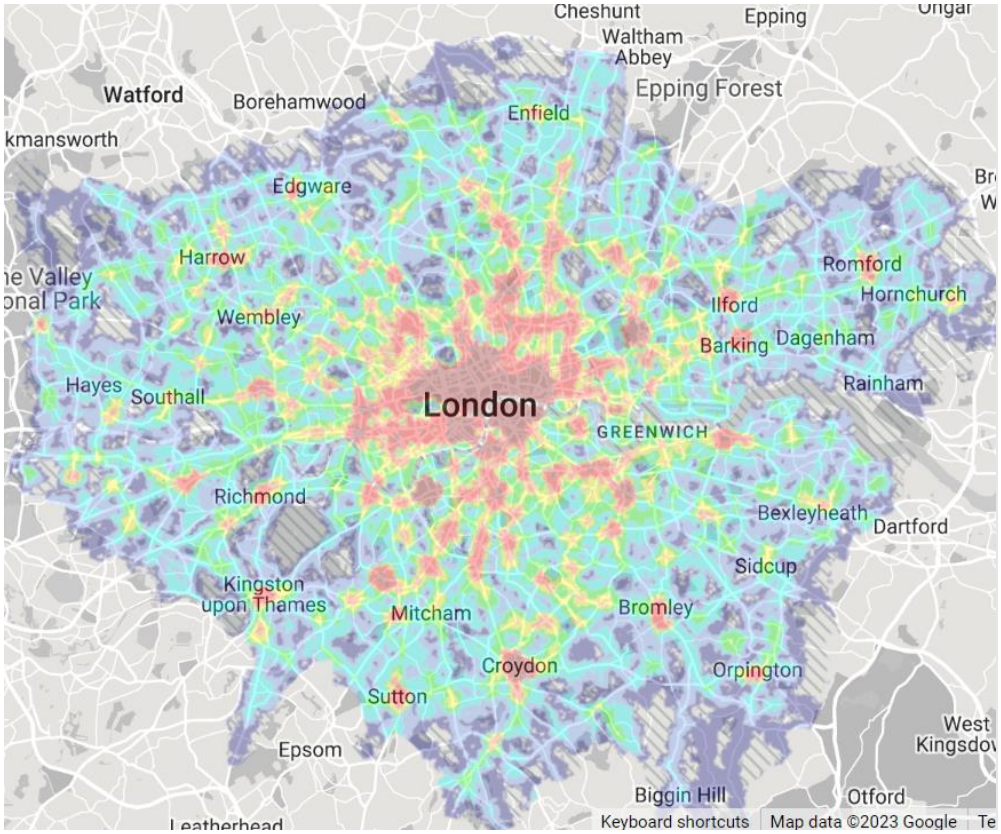
These inputs are combined into an index (a continuous number) that is then converted into a summary rating that can have 9 different levels, including a rating of 0 indicating no access to public transport. These ratings can be generated for any location.

Figure 1 PTAL ratings

PTAL	Range of Index	Map Colour	Description
1a (Low)	0.01 – 2.50		Very poor
1b	2.51 – 5.00		Very poor
2	5.01 – 10.00		Poor
3	10.01 – 15.00		Moderate
4	15.01 – 20.00		Good
5	20.01 – 25.00		Very Good
6a	25.01 – 40.00		Excellent
6b (High)	40.01 +		Excellent

Source: TfL 2010. Measuring Public Transport Accessibility Levels

Figure 2 PTAL map of London



Source: *https://tfl.gov.uk/info-for/urban-planning-and-construction/planning-with-webcat/webcat*
Note: *Retrieved 21 Jan 2023*

The measure does not consider the accessibility or utility of transport services to disabled users. In other words, factors like physical design of the stop/station, crowding, provision of information, customer services, and reachable destinations from particular stops/stations are not included in the measure. The method assumes that nearly all destinations can be reached within a 'reasonable' amount of time (Transport for London 2010).

We have focused our analysis on PTAL because:

- It is the only transport access measure that is used on a statutory basis in the UK (Inayathusein and Cooper 2018). PTAL has been used by Transport for London (TfL) beginning in the early 2000s to determine parking levels in new residential developments[3], housing provision, and public transport timetabling; and
- An Accessible Public Transport Access Level (APTAL) may exhibit a substantially different pattern to the existing PTAL. These differences would reflect the distinct and

[3] According to this logic, an area with a higher PTAL (greater public transport access) requires fewer parking spaces per housing unit.

varying transport service needs of disabled users. An APTAL measure could be a useful tool for decisionmakers in planning, timetabling, and allocating local investment.

The study explored options for creating an APTAL measure that reflects the accessibility of public transport in London for disabled users. The study focused on London, and used data from local areas that will be selected during the project. London has the most available data among UK cities, which will allow us to construct a wider range of candidate APTAL measures. Additionally, London is frequently used as a model for transport planning for the rest of the UK. Influencing London planning processes can therefore influence processes across the UK.

1.3 Approach

We have illustrated the steps that we undertook during this work below.

Figure 3 Summary of approach

Source: Frontier and Revealing Reality

We want to build on existing work rather than duplicating previous research. To facilitate this we carried out a rapid evidence assessment review to ensure our work reflects current best practice in regards to transport accessibility.

We then drafted a conceptual framework that assessed the benefits and disbenefits of a change to the existing PTAL measure. This framework is informed by our review of existing evidence and the outputs from the focus groups.

We carried out two distinct waves of user engagement to asked disabled public transport users for their views on:

- What is currently missing from the PTAL measure from the perspective of a disabled audience?
- What are the most impactful barriers currently to public transport use in London?
- How would it be best to refine the candidate APTAL measures that we developed?

We firstly carried out modelling to ensure that we could replicate the current PTAL calculation using TfL data. We then used the outputs from the review of existing data as well as user insights on the highest priority barriers to agree a shortlist of candidate APTAL measures.

In order to make this analysis tractable the distribution of these candidate APTAL measures was then mapped and compared against the baseline version for specific areas of London.

Following the second round of engagement with disabled transport users we refined our modelling assumptions and produced final results.

1.4 User feedback

In this study, in a set of focus groups, disabled TfL users provided feedback on the extent to which PTAL and candidate APTAL measures captured their experiences of public transport in London. These participants were selected in order to draw on a wide range of experiences with different physical, informational, attitudinal, and structural barriers. Several themes emerged from their feedback:

- Respondents favoured measures that were not subject to change, such as step-free access, to measures like crowding that would vary at different times of the day.
- Step-free access was widely agreed to be the most useful measure to be added to the APTAL. This was because for many disabled people, it is the difference between being able to access a station versus not at all. However, participants had different interpretations of what 'step-free' meant and also to what degree the station was actually 'step-free'. For some, a few steps throughout the station would be manageable.
- Crowding was recognised as the second most important measure of those presented to respondents to be added to APTAL because disorientation, noise levels, and difficulty finding space in lifts were acknowledged as affecting a diverse range of people.
- Most participants would use APTAL when making longer-term decisions, such as moving house or getting a new job. It seemed less relevant for shorter-term decisions like social plans.

1.5 Quantitative analysis

Based on focus group feedback and the data sources available, we constructed three APTAL measures incorporating information on (1) step-free access, (2) crowding, and (3) toileting facilities, and example maps are included in this study. We found that:

- Many different APTALs can easily work within the logic of PTAL (measuring volume of public transport services), and can maintain the simplicity of the measure. In particular, disabled users found step-free access to be a useful and interpretable addition to PTAL;
- Accessibility is composed of many barriers, and it is not easily quantified. Any accessibility measure included in an APTAL could be incorporated in many different plausible ways, and will require expert judgment through lived experience. In particular, the degree to which inaccessible services are down-weighted in the measure is a key area of expert judgment. The severity of the accessibility downrating can be controlled by the designer. This flexibility could be useful in balancing the requirements of different stakeholders; and
- APTALs can be constructed so that the overall distribution of high and low ratings remains similar to PTAL, but the precise locations of higher or lower rated areas is adjusted. In our example APTALs, stations had different relative crowding, step-free access, and toilet

facilities. Because our APTALs focused on station accessibility measures and the highest rated areas, our APTALs did not affect areas of low transport accessibility without Underground/Overground/rail access.

The feedback from focus groups emphasised the value of TfL's publicly available data on accessibility. It also highlighted several areas in which additional public data from TfL or other data providers could be beneficial:

- Underground/overground/rail station architecture details, e.g. including distance from street to platform, and floorspace;
- Data about station staffing (anonymised appropriately to avoid staff identifiability); and
- Data that can be used to measure barriers to walking/wheeling to/from the service access point (e.g. pavement obstructions).

The post-pandemic reduction in commuter traffic has introduced questions around how to increase the value of public transport to users, to encourage the recovery in patronage. Better understanding the user value of public transit requires evidence collection, of which accessibility measures are an important component. Accessibility data is useful for many types of initiatives beyond APTAL, for example developing accessibility information for users, or to inform advocacy.

APTAL measures are also potentially useful across a wide range of applications and with different stakeholders, including transport planners and developers, to better understand the case for different development investments, or to understand how different accessibility investments would affect overall local public transit accessibility. In particular, because APTAL aims to measure accessibility at a transport system level, it could be useful for understanding which investments are priorities because the local area has no other accessible public transit options.

2 Background and context

In this section we provide a summary of the objectives of our work and the ordering of remaining report sections. We also provide a glossary of key terms used throughout the report.

2.1 Policy context

Public transport accessibility is a broad term which is used in multiple ways in different studies and contexts. The UK's Office for Statistics Regulation (2022) notes that a transport network is accessible when it "***allows all users equal opportunity to travel when they want, where they want, how they want, at a price they can afford***" (Office for Statistics Regulation 2022). This is the definition that we will adopt throughout the remainder of the study.

There are commitments and legal requirements across the transport sector to involve disabled people in decisions regarding transport design, planning and delivery. The Disability Discrimination Act 1995[4] and its successor The Equality Act 2010[5] sought to protect disabled people from discrimination. In particular The Equality Act says that companies that provide public transport services, such as buses, trains, the underground and taxis cannot discriminate against disabled people and requires them to take steps to make their services accessible for disabled people.[6]

The Department for Transport (DfT) published an Inclusive Transport Strategy in 2018 which articulated the Government's ambition for inclusive transport, whereby disabled people have the same access to transport as everyone else by 2030 (Department for Transport 2018). This means that everyone can travel ***confidently***, ***easily*** and ***without extra cost***. This is in line with international commitments. For example, Action 11 of the United Nations Sustainable Development Goals refers to the provision of safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, disabled people and older persons.[7]

In February 2023 the parliamentary Transport Committee launched a new inquiry to examine ways to make different modes of transport, public and private more accessible to disabled people and those with access needs. The inquiry examines the effectiveness of legislation

[4] https://www.legislation.gov.uk/ukpga/1995/50/contents

[5] https://www.legislation.gov.uk/ukpga/2010/15/contents the Equality Act 2010 defines disability as follows: (1) A person (P) has a disability if—

(a) P has a physical or mental impairment, and

(b) the impairment has a substantial and long-term adverse effect on P's ability to carry out normal day-to-day activities.

[6] https://www.disabilityjustice.org.uk/learn-more-and-take-action/public-transport-discrimination-guide/#:~:text=the%20Equality%20Act%202010%20says,services%20accessible%20for%20Disabled%20people.

[7] https://sdgs.un.org/goals

that should require transport providers to make services accessible, how the legislation is enforced and any gaps in it that need to be filled.[8]

In London, TfL have previously stated that they "***want to do everything possible***" to make the journeys undertaken by disabled Londoners and visitors to the city a pleasant experience and accessible from end to end (TfL 2012). TfL have more recently stated that they are "***committed to improving transport in London by making it more accessible, safer and reliable***"[9] and are "***making improvements across London to help make it more accessible for all.***"[10]

While our work is focused on the UK and London specifically this is not an issue which is confined to the UK. Previous research has noted that there is also a lack of EU-level data on the accessibility of public transport for disabled people and the impact this has on the employment and social integration prospects of disabled people.[11]

2.2 Role of Transport for All

This work was commissioned by Transport for All.[12] Transport for All's vision is transport justice for all disabled people. Transport for All's focus is the ways in which disabled people make trips from their place of residence for any purpose. This includes public transport, active travel and door-to-door transport. Justice in this context goes beyond access and Transport for All seek to ensure that disabled people have meaningful involvement in the design, delivery, and evaluation of services.[13]

Transport for All therefore have an interest in driving change in the policymaking process to better account for the experience of disabled public transport users which motivated this work.

This research has been funded by the Motability Foundation. The Motability Foundation fund, support, research and innovate so that all disabled people can make the journeys they choose.

2.3 Current usage of PTAL

Public Transport Access Level (PTAL) is a measure of access to the public transport network in London, and is the only transport access measure that is used on a statutory basis in the

[8] https://committees.parliament.uk/committee/153/transport-committee/news/185876/are-transport-services-accessible-to-all-transport-committee-to-investigate-legal-obligations-enforcement-and-redress/

Transport for All's response is also available here: https://www.transportforall.org.uk/news/accessible-transport-legal-obligations/

[9] https://tfl.gov.uk/corporate/about-tfl/corporate-and-social-responsibility/equality-and-inclusion#on-this-page-1

[10] https://tfl.gov.uk/corporate/about-tfl/corporate-and-social-responsibility/equality-and-inclusion#on-this-page-1

[11] https://www.accessibletourism.org/resources/ptaccess_brochure.pdf

[12] https://www.transportforall.org.uk/about-us/our-mission/

[13] While also ensuring that when the expertise of the disabled community is sought out, it is believed, and appropriately compensated.

UK (International Transport Forum 2017). PTAL has been used by Transport for London (TfL) beginning in the early 2000s to determine parking levels in new residential developments,[14] housing provision, and public transport timetabling. The measure aims to capture the volume of transport options that a given user would face if they departed from a particular point during weekday peak hours. The PTAL calculation is based on:

- Walking distance to the nearest stations/stops;
- Waiting times at the nearest stations/stops; and
- Number of services at the nearest stations/stops.

These inputs are combined into an index (a continuous number) that is then converted into a summary rating that can have 9 different levels, including a rating of 0 indicating no access to public transport. These ratings can be generated for any location.

2.4 Rationale for this work

The measure does not consider the accessibility or utility of transport services to disabled users. In other words, factors like physical design of the stop/station, crowding, provision of information, customer services, and reachable destinations from particular stops/stations are not included in the measure. The method assumes that nearly all destinations can be reached within a 'reasonable' amount of time (Transport for London 2010).

An Accessible Public Transport Access Level (APTAL) may exhibit a substantially different pattern to the existing PTAL. These differences would reflect the distinct and varying transport service needs of disabled users. An APTAL measure could be a useful tool for decisionmakers in planning, timetabling, and allocating local investment.

2.5 Purpose of this report

This project has been carried out jointly by Frontier Economics and Revealing Reality. Each stage of the work has been overseen by Transport for All.

The study explored options for creating an APTAL measure that reflects the accessibility of public transport in London for disabled users. The study focused on London, and used data from specific areas. London has the highest volume of available data among UK cities, which allowed us to construct a wider range of candidate APTAL measures. Additionally, London is frequently used as a model for transport planning for the rest of the UK. Influencing London planning processes can therefore influence processes across the UK.

The aim of this study was to characterise the need for taking accessibility into account in PTAL, and provide a broad evidence base of initial findings, that Transport for All can use in order to focus future research and advocacy. The study is not intended to recommend one particular

[14] According to this logic, an area with a higher PTAL (greater public transport access) requires fewer parking spaces per housing unit.

future (A)PTAL. Every candidate measure generates a mix of benefits and dis-benefits for different groups of users/stakeholders.

This report summarises all the work we have undertaken on this project. The conclusions reflect the independent views of Frontier Economics and Revealing Reality.

2.6 Structure of this report

The remainder of the report is structured as follows:

- In Section 3 we outline the methodology that we have employed throughout this work;
- In Section 4 we outline the results from our review of existing evidence;
- In Section 5 we outline our conceptual framework for the work;
- In Section 6 we present the conclusions from our review of secondary data and define candidate APTAL measures; and
- Finally, in Section 7 we set out our conclusions and recommendations for future work.

3 Methodology

This report explores the possibility of developing a new metric of access that would be more meaningful for disabled users and for those planning transport services with their needs in mind.

Our approach was designed and implemented with that objective. This section sets out the methodology that we have used to scope out options for a more accessible version of the PTAL index.

Frontier Economics carried out the quantitative side of the project, identifying relevant data and undertaking modelling to recreate the existing PTAL calculation and explore the impact of specific changes to the distribution of values. Revealing Reality conducted the qualitative side of the research, recruiting disabled research participants and interviewing carrying out 8 focus groups in two waves.

We provide further detail below.

3.1 Overview

We illustrate the steps that we undertook below.

Figure 4 Summary of approach

Source: Frontier and Revealing Reality

3.2 Evidence review

We wanted to build on existing work and avoid duplicating previous research. We carried out a rapid evidence assessment review to ensure our work reflected current best practice in regards to transport accessibility.

Our evidence review covered the following areas:

- Current PTAL methodology, rationale, and input datasets, in order to replicate the current measure. To replicate the current measure we require (1) service access point locations, (2) walking distance API, (3) service frequency data;
- New datasets that could be used in an APTAL;

- Existing user research that summarises and prioritises different types of user barriers to using public transport in London or comparable urban areas. This included physical, communication/information, attitudinal, and systemic/institutional barriers, but may focus on certain types of barriers that are more straightforward to incorporate in PTAL (physical, communication);
- Relevant academic articles on methods for assessing public transport accessibility; and
- Current and recent uses of PTAL, and the organisations involved with and affected by PTAL, in order to identify the set of stakeholder organisations to engage with.

The results of this review are summarised in Section 4. The insights we identified are also reflected in our choice of candidate APTAL measures and the questions we put to focus group participants.

3.3 Conceptual framework development

We then drafted a conceptual framework that assessed the benefits and disbenefits of a change to the existing PTAL measure. This framework was informed by our review of existing evidence and the outputs from the focus groups (see below).

3.4 User engagement

We carried out two distinct waves of user engagement. During the first wave Revealing Reality asked disabled public transport users for their views on:

- What is currently missing from the PTAL measure from the perspective of a disabled audience?
- What are the most impactful barriers currently to public transport use in London?

This in turn informed our quantitative analysis (see below). During the second wave of engagement users[15] were asked for their views on:

- How should the candidate APTAL measures that we have developed to date be refined?

In both waves, participants were divided into four separate focus groups depending on their impairment type (mobility impairments, invisible disabilities, hearing loss, visual impairments). The focus groups were delivered using a mixture of in-person and remote sessions. Materials were developed in advance of the session to maximise accessibility and help structure discussions.

[15] There was considerable overlap in the users who participated in Wave 1 focus groups and the users who participated in the Wave 2 focus groups.

3.5 Generate candidate APTALs

We firstly carried out modelling to ensure that we could replicate the current PTAL calculation using TfL data.[16]

There are a very wide range of potential changes to the PTAL measure which could be considered. Broadly speaking these fall into two categories:

- Changes that do not require additional information (e.g. alteration to walking speed / distance, relative scoring of transport modes, changing assumed reliability of busses and trains, switching focus of index away from weekday peak); and
- Changes that do require additional information (e.g. incorporating measures of physical accessibility of stops/stations, the 'connectedness' or 'centrality' of the station could be included in the measure, the busyness of the stop/station could be considered).

We then used the outputs from the review of existing data as well as user insights on the highest priority barriers to agree a shortlist of candidate APTAL measures.

3.6 Calculation and mapping of APTALs

In order to make this analysis tractable the distribution of these candidate APTAL measures was then mapped and compared against the baseline version for specific areas of London. These examples were selected to all include subareas that achieve the highest PTAL rating and so highlight the discrepancy between PTAL ratings and disabled accessibility. Moreover, these areas are familiar to many users and are a mix of common commuting and leisure destinations.

The following three areas were chosen:

- King's Cross;
- Soho; and
- Southwark.

3.7 Refining analysis and reporting

Following the second round of engagement with disabled transport users we were able to refine our modelling assumptions and produce final results.

We have also included further detail on this modelling approach in the Annex. All the quantitative modelling work was subject to detailed quality assurance (in line with HMT's best

[16] https://tfl.gov.uk/info-for/urban-planning-and-construction/planning-with-webcat/webcat

practice Aqua Book) by experienced Frontier modellers who were not directly involved in designing and developing the model.

This report summarises all of our findings.

4 Rapid evidence review and outputs from first round of focus groups

We conducted a rapid evidence review to ensure that the study is grounded in existing research and we have gathered all relevant and accessible data.

Our first round of engagement with disabled transport users allowed us to focus the remainder of our analysis on accessibility barriers which were judged to be most impactful.

4.1 Key findings from the evidence review

- A transport network is accessible when it "***allows all users equal opportunity to travel when they want, where they want, how they want, at a price they can afford***".
- There are multiple ways in which accessibility can be conceptualised and measured empirically.
- Increasing accessibility for disabled public transport users can have a host of benefits both for disabled transport users and others (e.g. temporarily encumbered passengers and operators).
- Several high level drivers of accessibility have been consistently identified in previous literature. These include (but are not limited to) safety, convenience, comfort and affordability.
- We have identified a long list of potential barriers to accessibility which are divided into four categories, physical barriers, attitudinal barriers, information barriers and systematic barriers.
- The current PTAL measure only includes walk time and service frequency explicitly in the calculation. Therefore improvements in station capacity, service access point physical accessibility, reliability, or vehicle capacity will have no impact on the score.
- There are multiple examples of other indices which attempt to create quantitative measures of transport accessibility for disabled users or users with some form of assistance requirement. The vast majority of these indices focus exclusively on physical accessibility and associated infrastructure barriers.
- Key barriers identified as part of our primary research with disabled London transport users include: step-free access, overcrowding, lack of staff presence, inability to secure wheelchairs on buses or trains, lack of priority seating, inappropriate driver attitudes, inadequate information provision, inappropriate attitudes of other passengers, poor quality pavements and road surfaces.

4.2 Role and importance of accessibility

4.2.1 What do we mean by accessibility?

Accessibility of public transport networks can be conceptualised in a variety of ways. This includes (Albacete et al., 2017):

- Infrastructure-based accessibility or proximity measures which focus on times, congestion and operating speed within a transport network;
- Utility-based accessibility is measured at the individual level assuming that the users aim to maximise the benefits of their travel (after accounting for cost);
- Person-based measures focus on the availability of the activities for a person within a given time; and
- Location-based accessibility measures account for the spatial distribution of opportunities and the demand for them.

Given that the focus our of work is on accessibility from the point of view of ***disabled public transport users***[17] we have accounted for both user characteristics (e.g. barriers which affect groups of disabled travellers) as well as overarching infrastructure factors.

Public transport accessibility is a broad term which is used in multiple ways in different studies and contexts. The UK's Office for Statistics Regulation (2022) notes that a transport network is accessible when it "***allows all users equal opportunity to travel when they want, where they want, how they want, at a price they can afford***" (Office for Statistics Regulation 2022). This is the definition that we will adopt throughout the remainder of our work. This is broadly in keeping with Repetto et al. (2022) who concisely define accessibility as "***getting there easily***". In a similar vein Verseckienė et al. (2016) consider accessibility as the combination of "***the quality of transit serving a particular location and the ease with which people can access that service***".

4.2.2 Why is measuring accessibility important?

Increasing accessibility for disabled public transport users would have a host of benefits. The specific benefits realised will depend on the change made to a specific aspect of the transport network. However, previous work has identified a range of different beneficiaries and benefits (e.g. DfT 2016, Verseckienė et al., 2016 and Casullo 2016). Relevant beneficiary groups include:

- **disabled transport users** (and other passengers who may be temporarily encumbered) whose ability to get to work, stay in touch with friends and family, contribute to society and access vital services will be directly enhanced;.

[17] While our focus on accessibility for disabled public transport users, there may also be direct implications for other groups such as encumbered passengers who may be travelling with small children or heavy luggage, whose needs overlap in some cases with disabled transport users.

- **all other passengers** who will also benefit from certain accessibility enhancements including greater comfort, safety, reliability and improved provision of information;
- **potential passengers** who will have an increased option value for future usage of public transport even if they do not rely on it currently;
- **operators** who may generate additional revenue from the higher number of passengers who use their more accessible services. Operators may also incur fewer costs if a more accessible network means reduces the need for dedicated assistance staff (the extent of this benefit will vary significantly depending on the accessibility improvement undertaken); and
- **society** who will also benefit from the higher propensity to work amongst disabled people who can now access public transport to a greater extent.

Casullo (2016) noted that previous attempts to appraise economic benefits of improved accessibility often concluded that the benefits are large enough to offset all of the financial costs of doing so. However, holistic appraisal efforts in this context are relatively rare.

A precondition for improving accessibility in an efficient way is to understand current barriers and quantify the accessibility of transport networks (and how this varies across small geographical areas). This measurement can facilitate comparisons between neighbouring locations and highlight areas where policy makers are (or are not) living up to their commitments to promote access to transport for disabled users.[18] Accessibility measures can be used to identify poorly served areas which could benefit the most from development of new infrastructure and also help to evaluate previous investments in accessibility (Al Mamun and Lownes, 2011). This type of performance measure can therefore assure that steps taken towards accessible public transport are focused where they will be most effective (Access Exchange International, 2005).

4.2.3 Determinants of accessibility

The definition of accessibility that we are using for this study is broad. This implies that there are a range of relevant accessibility drivers and determinants.

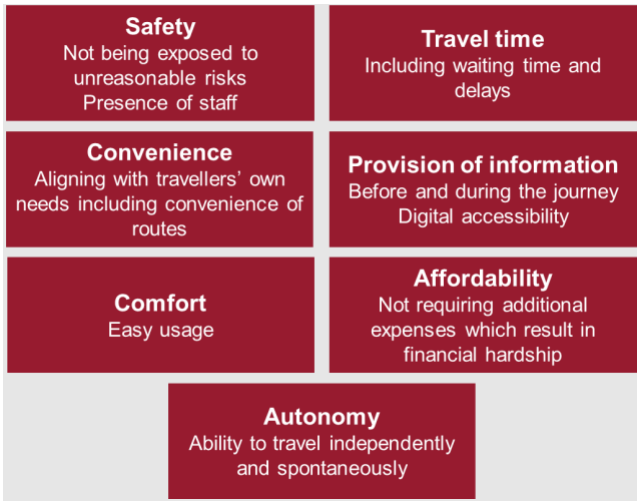
Accessibility differs among individuals and each disabled transport user has their own combination of barriers and preferences (City of London 2022). However, we are able to identify categories of factors which influence accessibility for disabled transport users, even if the factor has a different impact on accessibility for some disabled transport users than for others. We have categorised drivers that have been identified as relevant in previous literature below. These drivers are: safety, travel time, convenience, provision of information, comfort, affordability, and autonomy.

The performance of any public transport network across these accessibility drivers will itself be driven by a range of factors including awareness of user needs, extent of co-production

[18] See below for discussion of UK current policy ambitions and targets

with disabled users, financial investment and prioritisation of disabled transport users' needs (European Commission, 2010).

Figure 5 Drivers of public transport accessibility



Source: Frontier based on Repetto et al. 2022, Urban Agenda for the EU 2019, DfT 2018.

4.3 Potential accessibility barriers

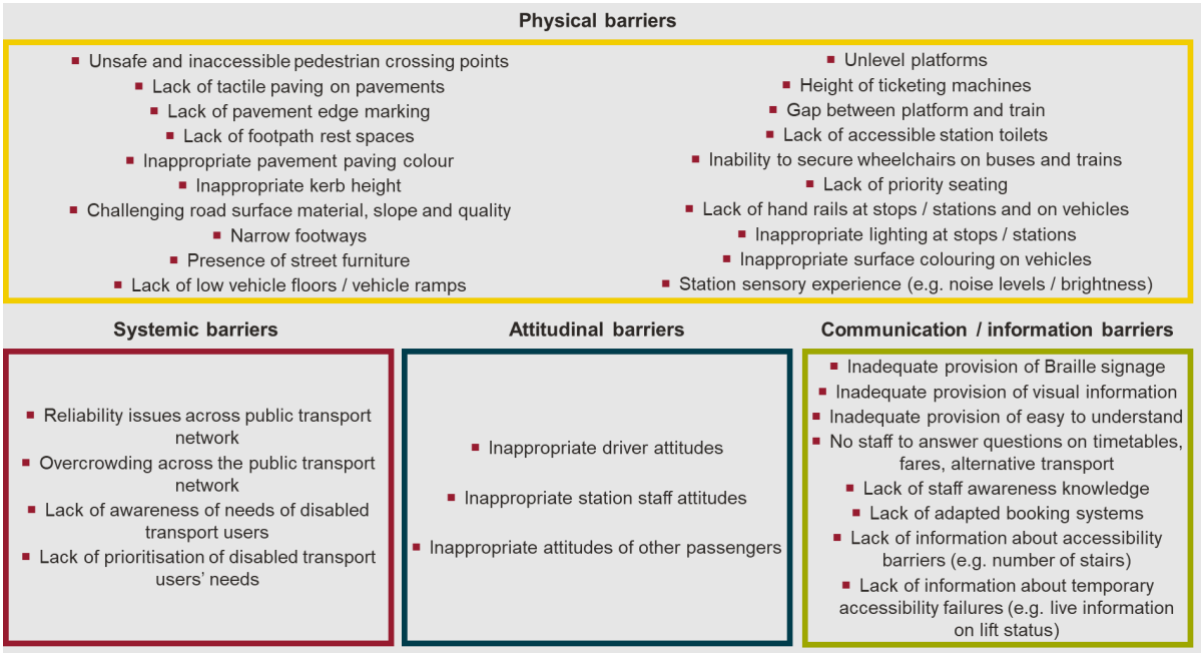
Numerous studies both in the UK and internationally highlight how specific barriers (which relate to the accessibility drivers we have listed above) can reduce accessibility of public transport networks.

Barriers can cover any factor that affects people's motivation or capacity to travel and can relate to any stage of a journey including preparation for a trip as well as obstacles encountered during the journey itself (Repetto et al., 2022).

We have summarised below barriers experienced by disabled transport users, categorised by impairment grouping, which are frequently cited in existing literature. The four groups are:

- **physical barriers** (e.g. design of vehicles, station infrastructure);
- **communication / information barriers** (e.g. how changes in schedules are communicated to users);
- **attitudinal barriers** (e.g. staff attitudes); and
- **systemic barriers** (e.g. policies and practices which lead to unequal access).

Figure 6 Longlist of potential barriers



Source: Frontier based on review of Repetto et al. 2022, Verseckienė et al. 2016, Bezyak et al. 2017, City of London 2022, EC (2010), Fatima et al. (2022), International Association of Public Transport, Walk21 Foundation and VKB (2019)

As we noted above, disabled people are a diverse group and each disabled transport user will differ in terms of their requirements, barriers and preferences (City of London 2022).

- Users with a **mobility impairment** (e.g. electric / manual wheelchair user, mobility scooter users, walking aid user) are likely to be affected primarily (but not exclusively) by physical barriers.
- Users with **visual impairments or deaf users** (e.g. cane user, guide dog user, residual sight user, deaf of hearing impaired user) and **neurodiverse users** (e.g. users with an acquired neurological impairment, autism, or developmental impairments) may be affected primarily by communication barriers (as a specific method of information sharing may not be accessible to them).

Systemic and attitudinal barriers are more likely to be cross-cutting and lead to obstacles for multiple groups of users.

Previous international research has noted that interventions designed to improve accessibility for people with motor impairments were highlighted most often, followed by those measures aimed at visually impaired people. The fewest examples were found for passengers with cognitive/learning impairments (EU Urban Mobility Observatory 2009).

4.3.1 Current PTAL measure

PTAL can be calculated for any given origin point in London. Walk times are calculated from the origin point to all public transport access points: bus stops, rail stations, light rail stations, underground stations and Tramlink halts, each of which has a pre-defined catchment.

PTAL then incorporates a measure of service frequency by calculating an average waiting time at each access point. This time is based on the frequency of services during morning peak. A reliability factor is added to reflect unexpected service delays; and the total access time is calculated. A measure known as an Equivalent Doorstep Frequency (EDF) is then produced for each point, to estimate the average time to board the service that would be required if the individual wanted to depart from their doorstep at a random point in time (i.e. if the service arrives more frequently or is nearby, then the EDF is lower). The EDF for each service is summed for all routes within the catchment and the PTALs for the different modes (bus, rail, etc) are then combined into an index (a continuous number greater than zero). This index value is in turn converted into a summary rating that can have 8 different levels (ranging from Very Poor Access to Excellent Access), or a rating of 0 indicating no access to public transport. These ratings can be generated for any location.

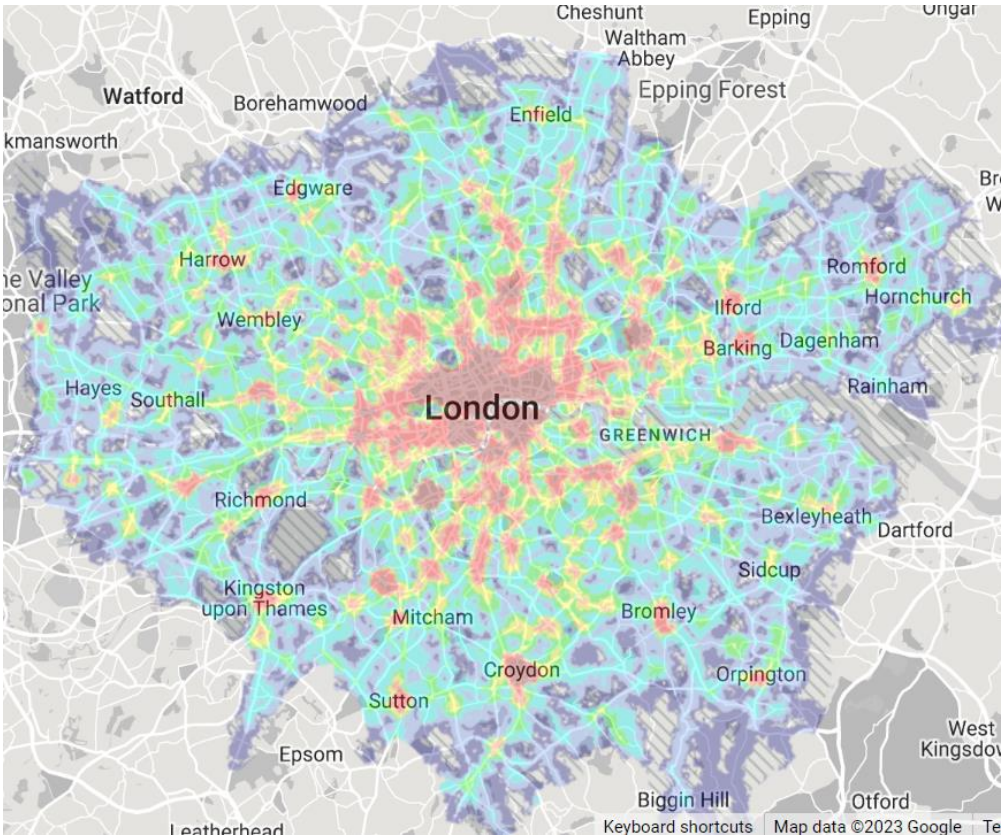
The below figures show the index categorisations and the corresponding map of London coloured by PTAL rating.

Figure 7 PTAL ratings

PTAL	Range of Index	Map Colour	Description
1a (Low)	0.01 – 2.50		Very poor
1b	2.51 – 5.00		Very poor
2	5.01 – 10.00		Poor
3	10.01 – 15.00		Moderate
4	15.01 – 20.00		Good
5	20.01 – 25.00		Very Good
6a	25.01 – 40.00		Excellent
6b (High)	40.01 +		Excellent

Source: TfL 2010. Measuring Public Transport Accessibility Levels

Figure 8 PTAL map of London



Source: *https://tfl.gov.uk/info-for/urban-planning-and-construction/planning-with-webcat/webcat*
Note: *Retrieved 21 Jan 2023*

PTAL captures the volume of public transport services departing from within a catchment area of the origin point. PTAL does not consider anything about the destinations to which these services provide access.

The measure does not consider the accessibility or utility of transport services to disabled users. An Accessible Public Transport Access Level (APTAL) may exhibit a substantially different pattern to the existing PTAL. These differences would reflect the distinct and varying transport service needs of disabled users (and the distribution of barriers we have cited above). An APTAL measure could be a useful tool for decisionmakers in planning, timetabling, and allocating local investment. For example, currently the PTAL metric is used to inform the number of parking spaces required for a new development in a given area, based on how well connected the area is to public transport. However, currently this may not be appropriate if disabled residents cannot use the public transport which is in their area.

The current PTAL calculation is based on (TfL, 2010):

- walking distance to the nearest stations/stops (based on an individual without an impairment);
- waiting times at the nearest stations/stops;

- number of services at the nearest stations/stops; and
- distance to major rail stations.

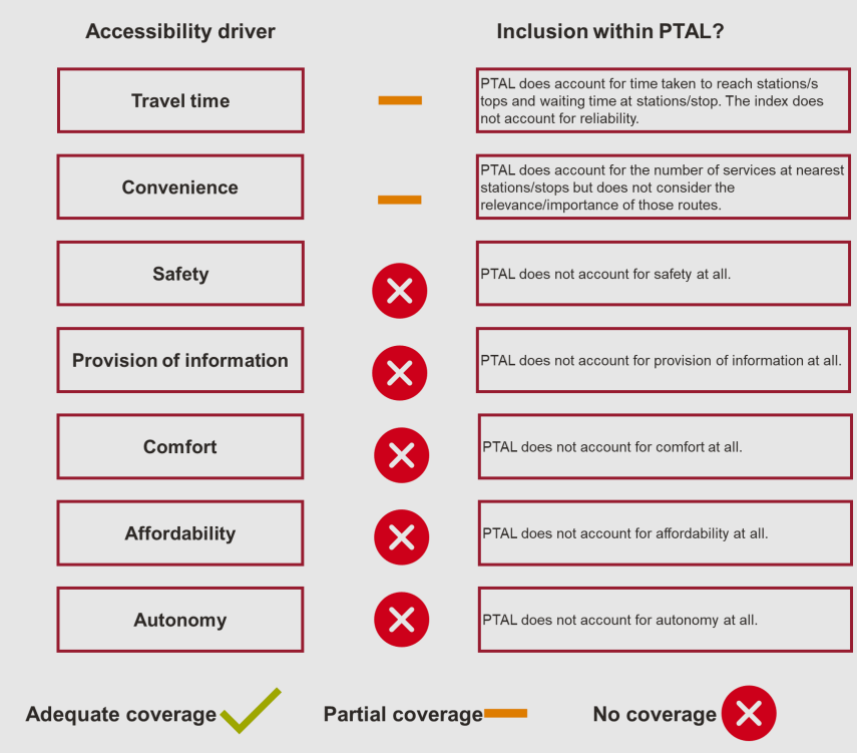
These inputs are combined into an index (a continuous number) that is then converted into a summary rating that can have 9 different levels, including a rating of 0 indicating no access to public transport. These ratings can be generated for any location.

A review of the current PTAL measure authored by Inayathusein and Cooper (2018) noted that it produces intuitive outputs which are relatively easy to interpret. PTAL also compares the level of transport provision across London in a simple yet consistent manner. Despite focusing only on access and not taking into consideration the convenience or usefulness of nearby routes PTAL does act as a good proxy for access to services and jobs in urban areas. In other words, those areas with a higher PTAL score will in most cases be able to reach a wider range of service locations than those with a low score. Changes in the provision of public transport (e.g. creation of a new bus stop) will be picked up via the PTAL measure at a local level via easy to interpret output.

However, the review also highlighted several limitations of PTAL. Most relevant for our work is that PTAL only includes walk time and service frequency explicitly in the calculation. Therefore any schemes or interventions that improve factors such as ***station capacity***, ***service access point physical accessibility***, ***reliability***, or ***vehicle capacity*** will have no impact on the score. As we discussed above all of these factors could be examples of accessibility barriers and are therefore worthy of explicit measurement and consideration within a London wide public transport access metric. Therefore, PTAL currently only covers a relatively narrow subset of all possible accessibility drivers.

Likewise PTAL assumes that areas which are close to more than one transport line are better connected than areas which only have access to a single line. However, for disabled users it may be that a single line which is accessible to them is far more useful than proximity to multiple inaccessible modes/lines.

Figure 9 Current coverage of PTAL



Source: Frontier based on review of evidence

In order to understand the current picture regarding transport accessibility for disabled users, high quality data is needed. The UK's Office for Statistics Regulation (ONS 2022) noted that statistics on the topic should reflect this importance. However, currently this may not be the case. The ONS's Review of Transport Accessibility Statistics highlighted concerns from users that statistics are not adequately reflecting the lived experiences of those who rely on transport to be accessible, nor are they useful to those who want to better understand whether the transport network is meeting the needs of users. This is in line with research carried out by Church and Marston (2022) who conclude that traditional measurements of accessibility are flawed as they fail to directly account for mobility and physical differences among people and ignore structural barriers and individual mobility limitations.

It may be that our exploration of a broader APTAL measure which is guided by the direct lived experience of disabled people could help to fill some of these informational gaps and ultimately help to remove barriers to access.

4.4 Examples of other accessibility indices

There are examples in the literature of efforts to create quantitative measures of transport accessibility for disabled users or users with some form of assistance requirement. We can learn from these measures when proposing potential APTAL indices. For example:

- Verseckienė et al. (2016) explored urban public transport accessibility for people with movement disorders in Vilnius and identified a range of additional requirements which need to be taken into account depending on the type of disability. Each of these needs are reflected in our list of potential barriers above;
- The EU-funded Transport Innovation for Disabled People Needs Satisfaction (TRIPS) project attempted to address a lack of metrics which measure accessibility for individuals with different access needs by designing a multi-dimensional index. This Mobility Divide Index, helps to measure the gap that citizens with access needs must overcome to use public transport in the same way non-disabled citizens do (Bridge et al 2021);
- Fatima et al. (2022) developed a public transport accessibility index for older travellers using total travel time. This was based on average walking times of older people as well as their likely travel destinations;
- Grisé et al. (2019) developed a methodology to quantify the performance of the public transport network in a region, in terms of providing transit services for wheelchair users, and compared that to the service offered to an individual not in a wheelchair. This method is based on the ability of wheelchair users to access jobs in specific locations;
- Lope and Dolgun (2020) estimated the current access of the disabled population to trams services in Melbourne. The approach compares the total and accessible tram service network which can be accessed from different locations. Accessibility is measured in terms of physical characteristics such as tram floor height and station platform height;
- The International Association of Public Transport, Walk21 Foundation and VKB published Urban Mobility Indicators on behalf of the Urban Agenda for the EU (2019). This work identified a range of factors which could be relevant for an APTAL which again are reflected in our list of potential barriers above;
- Berlingerio et al (2014) considered the time savings associated with making specific London Underground stations accessible. The authors used actual journey data to rank currently inaccessible stations in terms of their potential to save disabled transport users time if they were to be made accessible. The final ranking highlighted both central London stations which serve as major interchange points as well as stations outside of central London which are currently inaccessible and require disabled users to undertake very time consuming alternative routes;
- Kwon and Akar (2022) examined the links between neighbourhood walkability and transit use. The most relevant aspect of this for our work is the walkability index they create using a variety of factors such as residential density, street connectivity, and land use mix within a certain radius of each location;
- Ferreira and Penha Sanches (2007) focus specifically on the accessibility of pavements in Brazil. They create a pavement accessibility index based on a range of characteristics including level of gradient, surface quality, pavement material used, effective width, and presence of intersections; and
- The European Commission has proposed an indicator of accessibility of public transport for mobility-impaired groups (2010). This is a weighted average of (1) the accessibility of moving assets and vehicles (2) accessibility of stops and stations and (3) accessibility of

ticket machines and offices. Relevant factors have been included in our list of potential barriers above.

Two overarching insights can be drawn from our review of these measures:

1. The vast majority of the metrics and indices we have cited above focus exclusively on **physical accessibility** and associated infrastructure barriers.
2. Unsurprisingly the most common **use cases** identified within the studies above related to measuring of barriers in order to raise awareness and help catalyse effective improvements in the public transport networks. Specific uses for the metrics such as improved planning of new housing stock were identified far less frequently.

4.5 Insights from round 1 of the focus groups

As we set out in Section 3 during the first wave Revealing Reality asked disabled public transport users for their views on:

- What is currently missing from the PTAL measure from the perspective of a disabled audience?
- What are the most impactful barriers currently to public transport use in London?

4.5.1 Current issues with PTAL

Overall, focus group participants agreed that there were significant issues with the current PTAL measure which aligns with the rationale for this project. They reported that current criteria do not give enough specificity on accessibility, and raised multiple factors which could potentially be included to improve this. These included:

- The walking distance to the nearest step-free station;
- The length and accessibility of interchanges within stations (e.g. between different lines, or between platform and exit);
- The availability of seating along the walking route to the station or bus stop;
- The safety of the nearest bus stop (e.g. 'will I need to cross a cycle lane to access it?'); and
- Ease of access of the nearest stations (e.g. disabled parking).

4.5.2 Priority barriers

Participants across the four round 1 focus groups raised multiple barriers which we have grouped below into four categories (the same barrier can appear in multiple categories which reflects the multifaceted way in which a certain issue can affect a traveller).

Barriers that mean they need to seek alternative routes / transport

We were told that the barriers which put off disabled transport users from using a specific route or mode of transport are:

- Lack of step-free access. Often the nearest step-free station is not the nearest station, causing some users to change or take longer journeys. For example, a wheelchair user in Enfield said that only 1 of 4 stations in her area is accessible, meaning she relies on buses which take longer. This is completely consistent with previous research carried out by Transport for All (2023) which concluded that lack of step-free access and level boarding was the second most significant barrier to using trains for disabled people, and for light rail it was the most significant barrier.
- Lack of staff presence. We were told that there are not always staff available to help passengers (particularly those with visual impairments or with mobility needs) on or off trains, so they have to wait for help. For example, we were told that Putney Bridge is often unmanned in the evenings and one participant said until a member of staff arrives (which can take up to 30 mins) they have no way of getting on the train.
- Lack of wheelchair space or priority seating. On buses, especially during busy times, we were told that buggies are often placed in wheelchair spaces. A wheelchair user said bus drivers had refused her entry due to buggies already using the wheelchair space. This can put disabled transport users off using certain routes and/or modes at certain times. Again this is consistent with Transport for All's own research (2023) which indicated that over half of respondents experienced issues with priority seating and spaces when travelling by bus, such as seats being occupied or not clearly defined, or there being too few spaces.
- Inadequate information provision. Participants generally felt that buses are worse than trains for information provision, leading some participants to avoid them altogether. A visually-impaired respondent specifically told us that they try not to travel on buses because they do not know where they are on a long journey.

Barriers that cause physical discomfort

We were told that other barriers can lead to physical discomfort:

- Inaccessible stations. For example, long interchanges require people with mobility needs or health conditions to stand or walk for long periods. This may require some transport users to take breaks during the walk which during rush hour causes other passengers to bump into them.

Barriers that cause delays

We were told that certain barriers can lead to passengers experiencing delays:

- Inappropriate driver attitudes. This was most prevalent in relation to buses and included drivers not stopping at bus stops when passengers were waiting, or starting to drive

without checking that passengers had sat down. Visually impaired respondents stand by the front of the bus stop, but some drivers may stop at the back of the queue if there are multiple buses at once. This can mean that passengers miss the bus and have to wait for a later service.

- Inadequate information provision. We were told that information may not always be up to date or accurate when describing the next service details. For example, electronic signs on bus stops may not update as required.

Barriers that cause anxiety or stress

The final category of barriers creates anxiety or stress for disabled transport users:

- Overcrowding in stations. Across all groups, people told us that (usually larger interchange stations) can be overwhelming. For example, we were told that Kings Cross can be confusing as it is busy, loud and there is a sense of urgency amongst passengers. This means that people need to plan their route through the station in advance.

- Lack of staff presence. Lack of staff means it can be difficult to get help when needed. Multiple participants told us that ticket offices closing would mean they would lose a point of staff contact, which previously provided reassurance. In some cases we were told by participants that staff 'hide away', so people have to make their way around the station concourse to get staff attention.

- Inappropriate attitudes of other passengers. We were told that this is particularly an issue on buses during busy times as other passengers do not always give up their seats. Those with invisible disabilities felt they 'cannot' ask for a seat. One wheelchair user avoids using buses at rush hour after being mistreated for using the wheelchair space on a crowded bus.

5 Objectives for public transport accessibility measurement

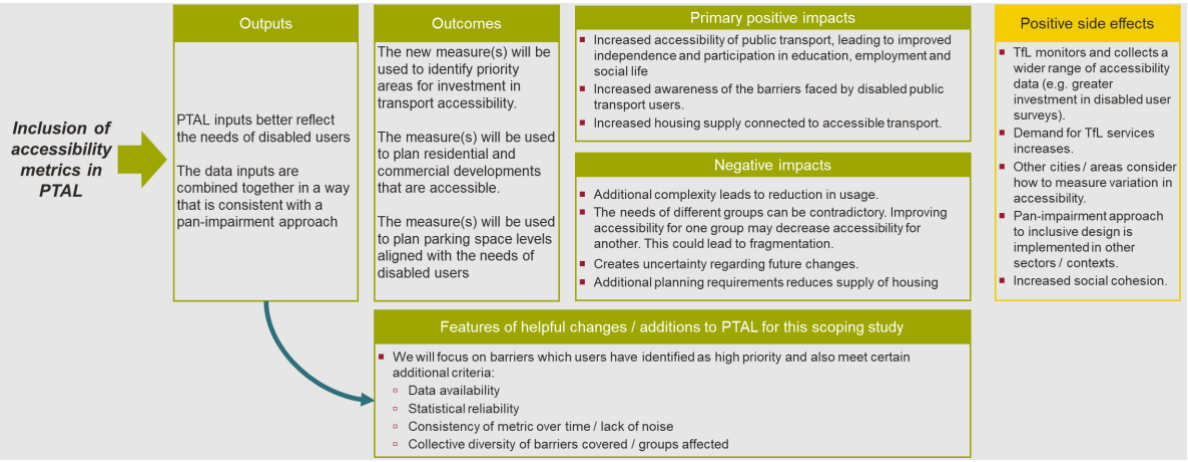
We have drafted a conceptual framework that assesses the benefits of a change to the existing PTAL measure. Insights from focus groups are incorporated into this section as well as evidence from our review of existing work. In subsequent sections of this report we use the conceptual framework to assess the conceptual benefits and practical feasibility of including a subset of these barriers in our quantitative calculations.

We also describe the current PTAL measure in this section.

5.1 Conceptual framework

Below is the full framework. It illustrates in a conceptual way how a more rounded PTAL measure which takes into account accessibility metrics would better reflect the actual needs of disabled users. This would help to ensure that investment to improve accessibility is targeted at the right areas and other infrastructure (e.g. housing) is deployed in the most appropriate way.

Figure 10 Conceptual framework



Source: Frontier

Our framework then outlines the longer term outcomes and impacts (both positive and negative). The positive effects relate to promotion of more accessible public transport and knock-on impacts on disabled people's ability to participate in society. The negative impacts cover risks such as increased complexity of PTAL and the potential for the needs of different groups to be contradictory.

We also highlight additional positive side effects which may occur (beyond the primary aims listed above). These could include greater monitoring and collection of a wider range of accessibility data and spillover impacts on other sectors and contexts.

Finally, our framework provides specific criteria that informs our choice of the barriers to include within our quantitative modelling. We focus on priority barriers for which reliable high quality data is available. Ideally the barriers could be targeted by future investment but will also exhibit some degree of stability over time. We also considered the collective scope of the shortlist of barriers, including in our modelling, to ensure that we cover a diverse range of metrics that impact a range of different groups.

6 Candidate APTAL measures

In this section we outline the results of our dataset scoping exercise, and use these results (along with the insights generated from the focus groups) to define a shortlist of candidate APTAL measures.

6.1 Review of secondary data

We reviewed public data on accessibility of TfL services and Greater London. Our key findings are below.

Table 1 Candidate secondary data

Topic	Subtopic	Available measures	Comments
Stations	Step-free access measures	Whether station platforms have level access and designated level access points (categorised by line and station)	The step-free access measures were used in one of the candidate APTALs
		All paths between two points inside/outside London stations that have a ramp and are considered traversable by wheelchair	
		Distance in meters of a step-free interchange within London stations	
		Same-level routes connecting two points inside/outside a station	
		Number of lifts present in a station and presence of limited-capacity lifts	
		Accessible platforms	
	Toilets	Toilets, accessible toilets, if inside the gate and if a fee is charged to use it	The toilet data was used in one of the candidate APTALs

	Crowding at stations	Annualised entry/exit counts by day of week or 15 minute time frame (also non-annualised)	Crowding data was used in one of the candidate APTALs
Roads and pavements	Pavement widths	If a pavement's width is 0-2 metres, 2-3 metres or wider than 3 metres	This data would potentially be relevant, but is proprietary analysis of satellite imagery
	Traffic	Average annual daily flow of traffic along a selected link i.e. 'Count Point' (also available by direction)	Traffic and road measures do not capture pavement accessibility
	Roads	Scores the quality of 'A Roads' (roads that connect towns, cities and significant destinations) which fall under a Local Authority	Traffic and road measures do not capture pavement accessibility
Safety	Crime	Instances of crime by type; for on-street, station, and by mode	This was tested in a candidate APTAL, but not found relevant by disabled transport users
Demand	Guiding travel statistics on disability and accessibility	Average number of distance and trips travelled by mode with disability status and age	This data was not detailed enough to be used to check whether a particular route was accessible
Passenger satisfaction	Passenger satisfaction	Customer satisfaction scores	This data was not detailed enough to be used to assess satisfaction in a particular local area

Source: Frontier Economics

A full list of data sources is provided in the Annex.

6.2 Candidate APTAL measures

There are many different barriers to public transport use that are experienced by different individuals. However, in order to be feasible to calculate, an APTAL must make use of the available data. Candidate APTAL measures were constructed through a multi-stage selection process, as discussed in greater detail in Section 3:

1. An evidence review informed an initial long list of potential barriers;
2. Direct and detailed engagement with disabled transport users provided input on priority barriers to London public transport in via a series of focus groups. To measure the majority of these barriers in a granular way, additional data beyond the information currently in PTAL was needed;
3. We identified the most relevant public data on accessibility barriers in London, combining transport users' feedback with the results from the review of data;
4. We constructed example APTALs and gathered user feedback on the candidate data additions from the focus groups;
5. We constructed a final set of candidate APTALs, presented in this report.

This process is summarised in the table below.

Table 2 Selection of candidate APTAL measures

	1. Key barriers for disabled transport users	2. Most relevant public data identified*	3. Disabled transport users' feedback on available data	4. Final candidate APTAL measures
1	Inaccessible stations / lack of step-free access	Step-free access of stations, toilet facilities	Reported that the measures from Step (2) are relevant	Step-free access; Rail station toilet facilities
2	Lack of staff presence (particularly to help passengers on / off services, and to provide help and information)	No granular data on staff levels or staff quality identified	Reported that this area is a priority for data collection	
3	Inability to secure wheelchairs on buses or trains	No public data suitable for APTAL use identified		

4	Lack of priority seating	No public data suitable for APTAL use identified		
5	Station fooTransport for Allll and overcrowding / overcrowding on services	FooTransport for Allll and crowding by station	Reported that the measures from Step (2) is relevant	Station crowding
6	Inappropriate driver and/or passenger attitudes	No public data suitable for APTAL use identified		
7	Inadequate information provision	No public data suitable for APTAL use identified		
8	On-street barriers (e.g. pavement obstructions)	On-street crime	Reported that crime is not a key accessibility barrier	

Source: Frontier Economics and Revealing Reality

Below we summarise the refined list of candidate measures. Insights from focus groups are incorporated throughout this section.

6.3 Candidate changes to PTAL

Below we describe the candidate APTAL changes we calculated, before presenting maps of the resulting measures.

6.3.1 Increasing the threshold for the highest category

Disabled users agreed that the high PTAL rating in central London did not match their experiences of accessibility in this area. Some focus group individuals found it challenging to interpret the PTAL rating at all because it diverged so strongly from their personal experience.

To reflect this feedback, in all APTAL candidates, we raised the threshold for the highest category (6b) from an index ‘greater than 40’ to ‘greater than 70’. The index does not have a natural scale, and so changes in the category thresholds is a matter of judgment. This change in threshold is an illustrative example, and many other threshold changes would have been equally plausible.

6.3.2 Crowding

As discussed in Section 4, crowding on public transport can affect accessibility in a range of ways, including:

- Physical barriers to navigating areas with spatial constrictions, e.g. station and vehicle entry/exit, and due to longer waiting times;

- Makes it harder to engage with key information;
- Attitudinal barriers from staff and other transport users during busy periods; and
- Mental discomfort from noise and crowding.

Disabled transport users reported that crowding affected accessibility for a diverse range of people, due to disorientation, noise levels, and difficulty finding space in lifts. Some noted that crowding varies by time of day, and some disabled users will travel out of peak hours in order to avoid crowding, and that off-peak crowding would potentially more directly measure some users' personal experience. Others noted that the time-varying nature of crowding was different to the components of PTAL, which are 'fixed' or 'scheduled'.

We have explored a potential APTAL candidate measure, which measures crowding in terms of the sum of the number of boarders and number of passengers alighting per station platform, between 7am and 10am on weekdays (from TfL's NUMBAT dataset). This measure of crowding was applied as a scaling factor to the volume of services measured at a station.

There were several key design choices in incorporating the crowding measure:

- We focused on Underground/Overground/Rail station crowding, rather than vehicle crowding on light rail, surface rail, and/or buses. This was a function of data availability, but other measures could be useful to investigate in the future; and
- We chose to linearly rescale crowding. However, it may be that crowding has little effect on accessibility until crowding reaches a certain threshold, at which point the effect on accessibility is more severe (non-linear effect).

Incorporating crowding into PTAL has several advantages:

- Measuring spare capacity in stations is a natural extension of the logic of the current PTAL;
- Crowding affects both disabled and non-disabled users; and
- Crowding may be related to other barriers that users identified (inappropriate staff attitudes, inadequate information provision, inadequate staff presence, inappropriate attitudes of other passengers).

A disadvantage of this measure is that it is time-varying and can fluctuate from week to week, or year to year. Some users noted that they avoid peak hours in order to avoid crowding.

6.3.3 Step-Free access

Step-free access stations have lifts, ramps, or a combination of both, to remove the need to navigate steps and stairs within stations. Additionally, some reduce the gap size between the platform and train.[19]

[19] https://tfl.gov.uk/transport-accessibility/wheelchair-access-and-avoiding-stairs

Step-free access metrics resonated with disabled participants relatively more than many other barriers, and it was highly regarded as a measure of accessibility. Step-free access was seen to accommodate a wide range of people (e.g. wheelchair users, people with buggies, people with luggage), and for some individuals is necessary in order to be able to use the station. Different focus group participants had different interpretations of step-free (which in a sense is consistent with TfL's different definitions and components of step-free). Disabled users reported that clear definitions of step-free access were important for the measure to be usable.

We received feedback from disabled users that it is more useful to view step-free access on a continuum ('more or less step-free') than as a binary ('either step-free or not step-free'). For example, relevant features could include the presence of a lift, the number of steps users might have to take at interchanges / from street to platform and the number of physical steps that are present at stations. In the candidate APTAL measure, we used data on different aspects of step-free access from TfL's Step-free Tube Guide map.[20] A step-free score was calculated based on the gap size between the platform and the train, the step colour at platform-to-train transition, and lift availability. A 'perfect' score is given to stations with a green step, gap size A or R (ramp), and a lift available. The lowest score is given to stations with a red step and without a lift. Details of this rating are provided in the Annex. The volume of services available at each station was downscaled according to the step-free access score; a station with a perfect step-free score contributed 100% of its services to the APTAL score, whereas a station with the worst step-free score contributed 10% of its services to the APTAL score.

In order to construct this APTAL, we needed to make assumptions about the relative value of different step-free elements, and the value of step-free stations vs. non-step-free stations vs. buses. These assumptions could be varied in future work.[21]

6.3.4 Toileting facilities

London rail stations have a range of types of toileting facilities, some of which are accessible.[22] Focus group participants noted that measures of toilet availability and accessibility can be unreliable, as many toilets are out of order or not staffed (if stations are not staffed, the toilet will generally be locked). In general we were told that improving toileting facilities could have a very significant impact, but on quite a small sub-group of disabled people.

In this APTAL, we assume that rail services without toileting facilities at the departing station are inaccessible. This APTAL requires a judgment call about the extent to which a lack of toilets reduces accessibility, which could be adjusted. For illustrative purposes, we have

[20] : https://content.tfl.gov.uk/step-free-tube-guide-map.pdf

[21] Transport for All has access to the code for this analysis, and the code can be shared on request.

[22] An accessible toilet has design features (e.g. layout, features, space) to meet the majority of needs of independent wheelchair users* and people with mobility impairments, as well as the additional requirements of people with bowel and bladder conditions (such as colostomy bag users). For design details, please see https://cae.org.uk/wp-content/uploads/2017/01/CAE-Managing-Accessible-Toilets-Factsheet-Jan-2017.pdf

assumed that a complete lack of toilets renders a station inaccessible; however were this measure to be used we would suggest that the accessibility of a station is only partly reduced by a lack of toilets. A key disadvantage of this measure is that disabled users found other aspects of accessibility that were not included as candidate measures due to lack of data availability (e.g. staff and passenger behaviour) to be more important.

6.4 Comparing APTAL candidates

Below we compare APTAL maps by local area. We have used three example local areas in central London: King's Cross, Soho, and Southwark. These examples were selected to all include subareas that achieve the highest PTAL rating and so highlight the discrepancy between PTAL ratings and disabled accessibility. Moreover, these areas are familiar to many users and are a mix of common commuting and leisure destinations.

All maps use the following colour scale:

Figure 11 PTAL ratings

Map Colour	Description
	Very poor
	Very poor
	Poor
	Moderate
	Good
	Very Good
	Excellent
	Excellent

Source: TfL 2010. Measuring Public Transport Accessibility Levels

The first map presented for each local area is the current PTAL measure, followed by the three candidate APTAL variants. Each APTAL includes the increase in the highest level threshold described in Section 6.3.1.

In all cases, APTAL alters the gradient of ratings in the area, but retains the overall pattern of low and high ratings. In other words, the APTAL does not relocate loci of public transport connectivity, but it does shrink higher ratings areas and expand lower ratings areas.

The step-free access APTAL can have larger effects on individual areas. For example, in the King's Cross map, Great Portland Street and Russell Square do not have step-free access, and so the APTAL reduces the rating in the area around these stations.

6.4.1 King's Cross

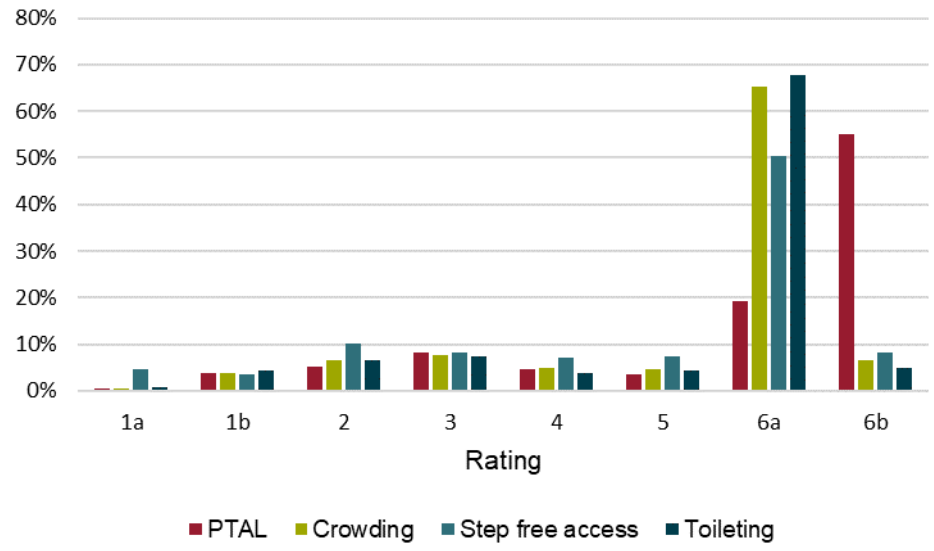
Below are maps of the King's Cross area, for the baseline PTAL and for the three candidate APTAL measures. All maps exhibit the same overall patterns, which are driven by the volume and location of public transport services.

All APTAL options (relative to the baseline PTAL) reduce the area rated at the highest level to the areas around King's Cross / St Pancras and Euston Stations, reflecting the increase in the threshold for the highest category.

The step-free access APTAL reduces the accessibility ratings particularly around the Underground stations Regent's Park, Great Portland Street, and Russell Square. The toilet access and crowding APTALs show similar patterns. The single largest impact on overall ratings was due to changing the highest rating threshold (see Figure 12).

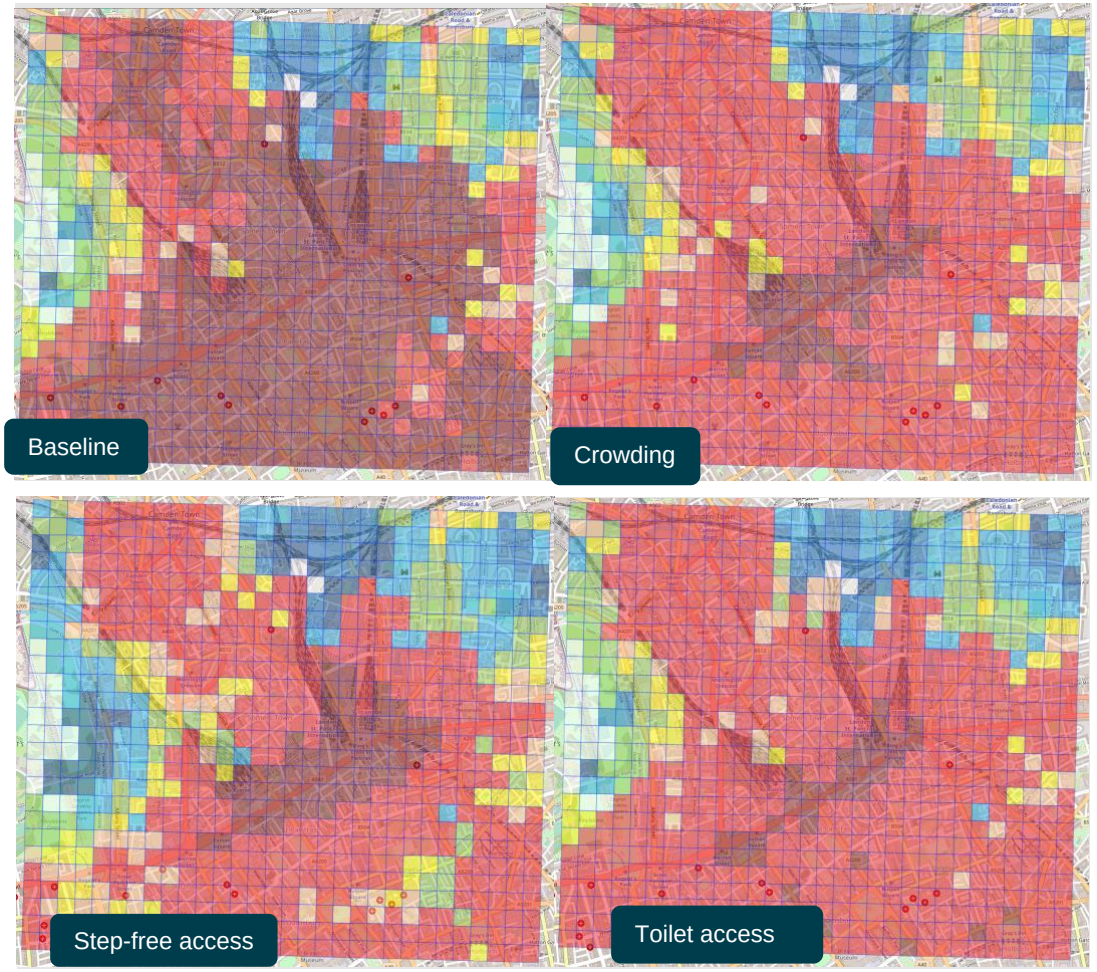
Overall, this demonstrates that step-free access, crowding and toileting information can be included in an APTAL so that the overall distribution of ratings is not substantially affected, however particular locations are moderately uprated or downrated depending on station features.

Figure 12 Distribution of ratings for PTAL and candidate APTAL



Source: Frontier Economics
Note: Squares containing no rating (in parks and in traffic intersections) are omitted from this chart

Figure 13 King's Cross APTALs



Source: Frontier Economics

6.4.2 Soho

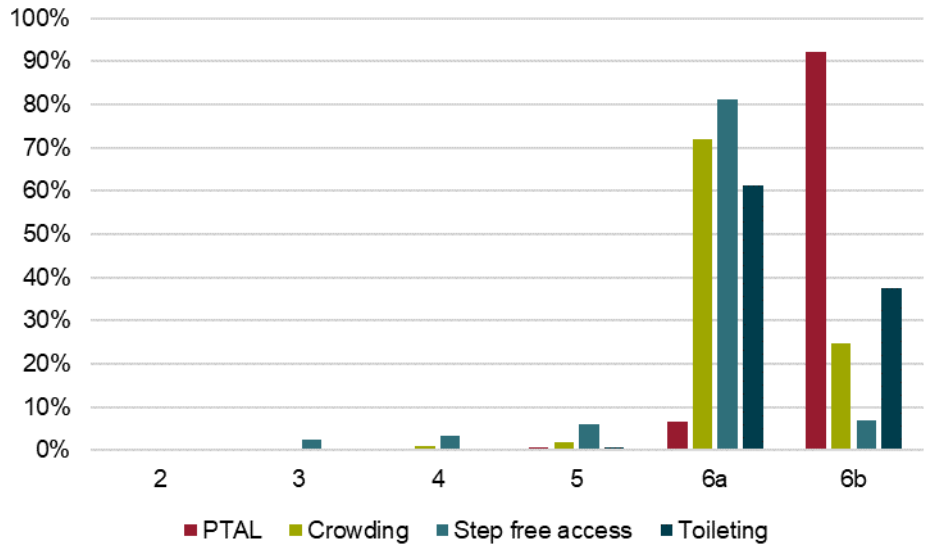
Below are maps of Soho, for PTAL and for the three candidate APTAL measures. PTAL rates for Soho nearly universally have the highest rating. As in the King's Cross maps, the candidate APTALs reduce the area rated highest, and lead to slightly different parts of the map being downrated.

The step-free access APTAL led to the highest overall downrating of accessibility level, reducing the percentage of the area receiving the highest rating from 92% to 7%. In particular, Oxford Circus, Leicester Square, Covent Garden, Holborn, Piccadilly Circus, Regent's Park, and Bond Street all have the worst step-free access rating.

The most crowded stations in this map are Oxford Circus and Tottenham Court Road, and Green Park, and the crowding APTAL exhibits somewhat lower ratings for these areas than the other APTALs.

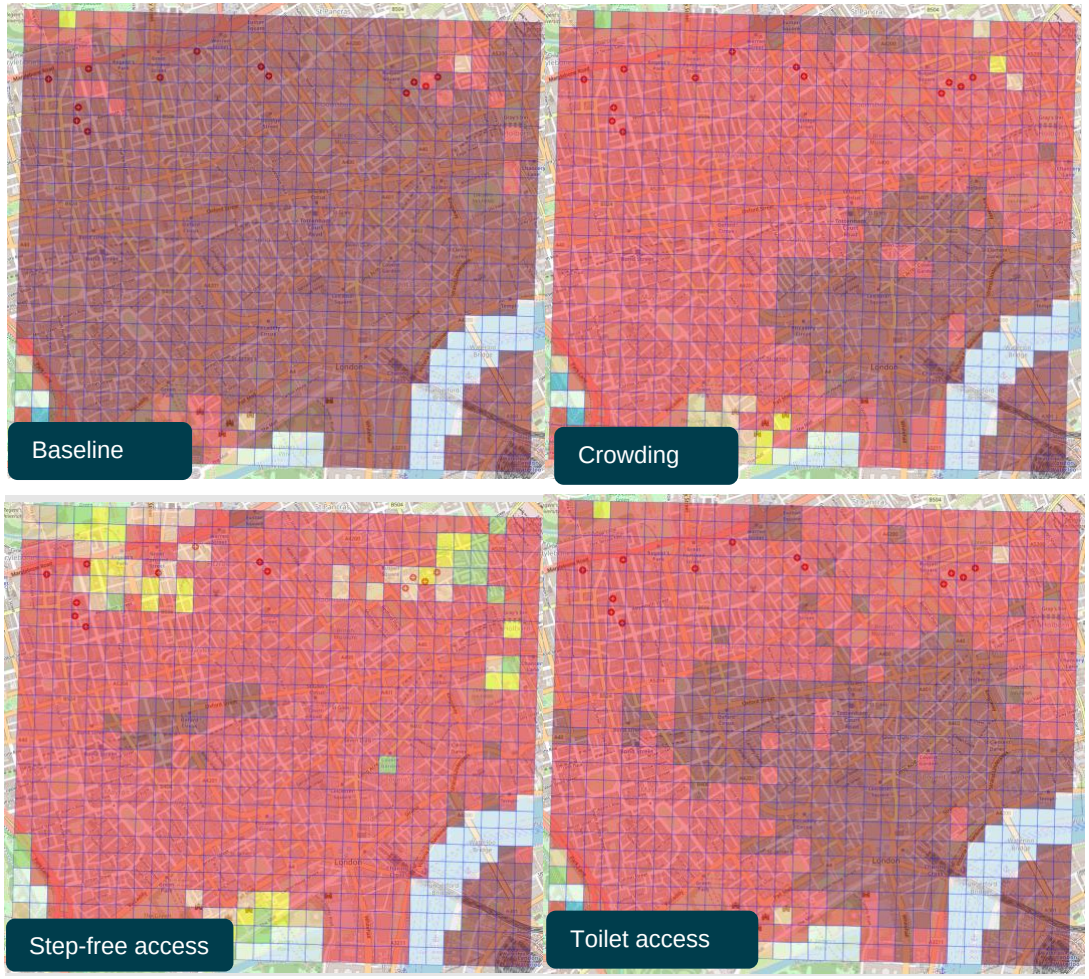
This map does not include any rail stations, and so the toileting APTAL measure only reflects the change in threshold for the highest category.

Figure 14 Distribution of ratings in Soho



Source: *Frontier Economics*
Note: *Cells with no PTAL rating (e.g. in the Thames) are omitted)*

Figure 15 Soho APTALs



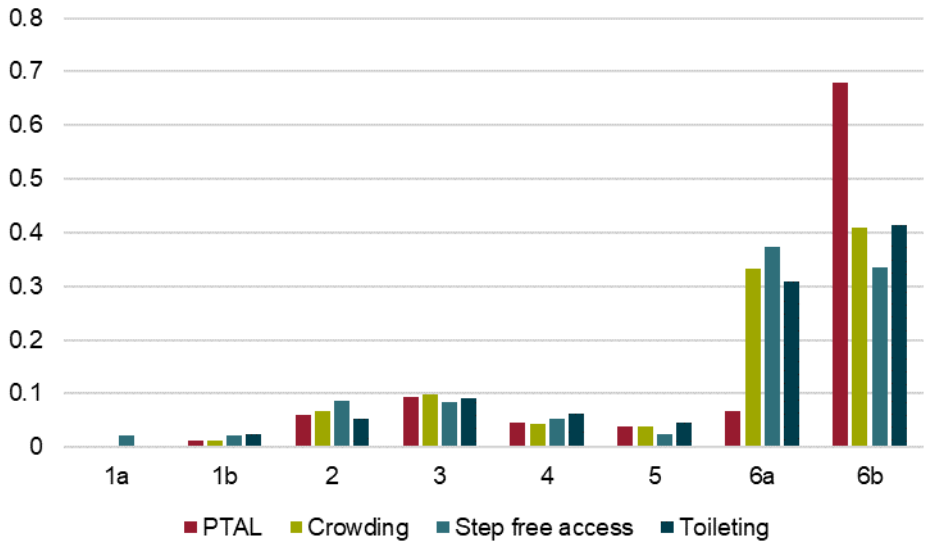
Source: Frontier Economics

6.4.3 Southwark

Below are maps of the Southwark area, for PTAL and for the three candidate APTAL measures.

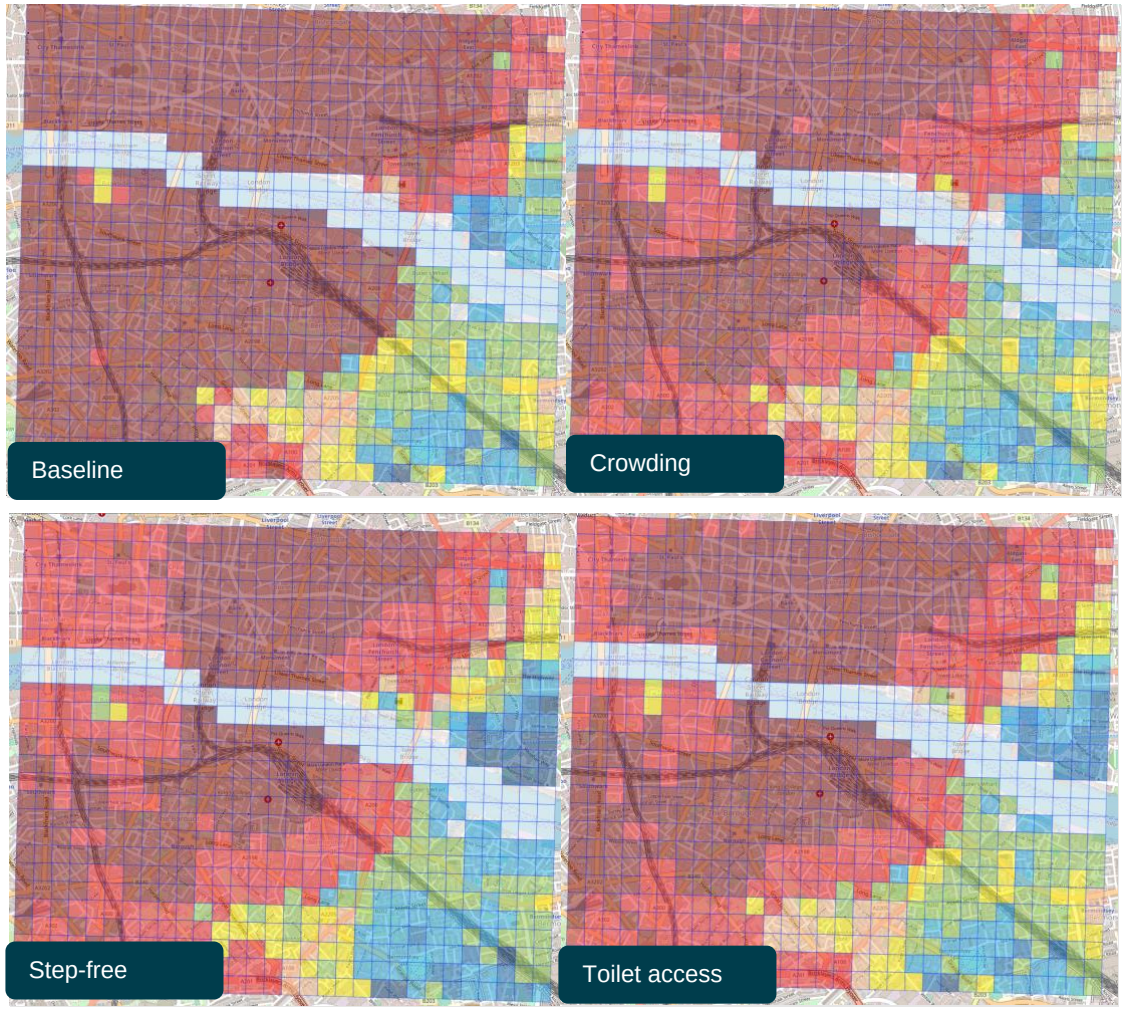
All APTALs reduce the area rated at the highest level to the areas around London Bridge, Borough, Elephant and Castle, and a number of stations in the City. The baseline accessibility in this area is lower than in the other examples, as there is lower public transit connectivity in the area to the south and west of the Northern line. The different APTAL ratings produce fairly similar ratings in this area. Because the candidate APTALs affect the areas around stations which tend to be the areas with the highest PTAL rating, areas with lower PTAL ratings outside of station catchment areas are not affected by the APTAL changes.

Figure 16 Distribution of ratings in Southwark



Source: *Frontier Economics*
Note: *Cells with no rating (e.g. in the Thames) are not included in this distribution*

Figure 17 Southwark APTALs



Source: Frontier Economics

7 Recommendations

Public Transport Access Level (PTAL) is a measure of access to the public transport network in London, and is the only transport access measure that is used on a statutory basis in the UK (International Transport Forum 2017). PTAL has been used by Transport for London (TfL) beginning in the early 2000s to determine parking levels in new residential developments,[23] housing provision, and public transport timetabling.

This study aimed to explore how PTAL could be adapted in order to better capture the public transport accessibility experienced by disabled users, and to deliver benefits to disabled transport users. Our work was not intended to generate conclusive findings or a policy-ready proposal/assessment. The purpose of this exploratory study is to characterise the need for taking accessibility into account within standardised accessibility metrics and provide a broad evidence base of initial findings, which can be built upon in the future. In other words, the purpose of our work was to demonstrate what does not work well within current measures and to establish how to better measure what matters rather than carrying out detailed testing and refining of alternatives

PTAL aims to have a simple methodology compared to other types of transport metrics. The benefit of simplicity is greater transparency and interpretability among public and industry stakeholders. At the same time, PTAL does not capture the variation in individuals' experiences of public transport, and PTAL was not designed to be used by individual transport users.

7.1 User priorities for APTAL

In this study, in a set of focus groups, disabled TfL users provided feedback on the extent to which PTAL and candidate APTAL measures captured their experiences of public transport in London. These participants were selected in order to draw on a wide range of experiences with different physical, informational, attitudinal, and structural barriers. Several themes emerged from their feedback:

- Respondents favoured measures that were not subject to change, such as step-free access, to measures like crowding that would vary at different times of the day.
- Step-free access was widely agreed to be the most useful measure to be added to the APTAL. This was because for many disabled people, it is the difference between being able to access a station versus not at all. However, participants had different interpretations of what 'step-free' meant and also to what degree the station was actually 'step-free'. For some, a few steps throughout the station would be manageable.

[23] According to this logic, an area with a higher PTAL (greater public transport access) requires fewer parking spaces per housing unit.

- Crowding was recognised as the second most important measure of those presented to them to be added to APTAL because disorientation, noise levels, and difficulty finding space in lifts were acknowledged as affecting a diverse range of people.
- Most participants would use APTAL when making longer term decisions, such as moving house or getting a new job. It seemed less relevant for shorter term decisions like social plans.

The difficulty for individual users highlighted that APTAL is likely more useful for planning and decisions. For example, when deciding between different possible investment options, APTALs could be used to understand which investment would be best from an accessibility perspective.

The feedback from focus groups on important barriers emphasised the value of TfL's publicly available data on accessibility. It also highlighted several areas in which additional public data from TfL or other data providers could be beneficial:

- Underground/overground/rail station architecture details, e.g. including distance from entry to platform and floorspace
- Data about station staff attitudes (anonymised appropriately to avoid staff identifiability)
- Data that can be used to measure barriers to walking/wheeling to/from the service access point (e.g. pavement obstructions)

These sources of information would potentially be useful for initiatives beyond APTAL, for example developing accessibility information for users, or to inform advocacy. In particular, the post-pandemic reduction in commuter traffic has introduced questions around how to increase the value of public transport to users, to encourage the recovery in patronage.

7.2 Conclusions

In our review of other accessibility metrics, we found that vast majority of the metrics and indices focus exclusively on physical accessibility and associated infrastructure barriers. We aimed to take a more expansive view of accessibility in proposing candidate APTALs. We created an initial list of APTALs that included physical barriers and non-physical barriers. We then gathered focus group feedback and constructed a shortlist of APTALs, which incorporated step-free access information, toileting, and station crowding levels. Many different variants of APTALs are possible, and those included in this report are illustrative examples. Key features of these APTALs are:

- Many different APTALs can easily work within the logic of PTAL (measuring volume of public transport services), and can maintain the simplicity of the measure. In particular, disabled users found step-free access to be a useful and interpretable addition to PTAL.
- Accessibility is composed of many barriers, and it is not easily quantified. Any accessibility measure included in an APTAL could be incorporated in many different plausible ways, and will require expert judgment. In particular, the intensity with which inaccessible

services are down-weighted in the measure is a key area of expert judgment. The severity of the accessibility downrating can be controlled by the designer. This flexibility could be useful in balancing the requirements of different stakeholders

- APTALs can be constructed so that the overall distribution of high and low ratings remains similar to PTAL, but the precise locations of higher or lower rated areas is adjusted. In our example APTALs, stations had different relative crowding, step-free access, and toilet facilities. Because our APTALs focused on station accessibility measures and the highest rated areas, our APTALs did not affect areas of low transport accessibility without Underground/Overground/rail access.

7.3 Opportunities for future work

Most accessibility metrics are used to raise awareness and help catalyse effective improvements in the public transport networks. In our evidence review, we identified specific uses for the metrics--such as improved planning of new housing stock--far less frequently. Understanding the most effective way to incorporate public transport accessibility into planning and investment decisions is an important area for further work.

7.3.1 Additional data collection and analysis

A key limitation of this analysis was the lack of granular data on user satisfaction, particularly user satisfaction with TfL staff. The need to better understand user requirements is an opportunity to improve market research in public transport. There is not only value in market research for improving equity, but also for commercial purposes, to understand mechanisms for increasing post-pandemic patronage. High quality research is able to capture varying preferences and requirements of different types of TfL passengers, including accessibility of services to disabled users, which is closely related to ease of use of services for non-disabled passengers.

In this study we used public data to construct a simple measure of station crowding. With additional data, this measure could be more accurate and useful for planning and for individuals planning journeys. Crowding information could also improve the accuracy of PTAL, as it is useful to understand the spare public transport capacity available when planning new developments.

7.3.2 Additional engagement

This work has highlighted that PTAL does not accurately reflect the transport accessibility experience of disabled users and there are a broad range of accessibility issues which are currently causing major challenges for disabled transport users.

In order to further develop a specific and finalised accessibility metric it may be beneficial to undertake a series of case studies. These case studies could examine how PTAL is actually

used in real planning decisions and what could have happened differently if different candidate versions of APTAL were used instead.

7.3.3 Step-free access dashboard

In addition, a future piece of work could aim to improve the information available to Transport for All and to disabled users on the value of new candidate step-free access upgrades.

To choose stations for step-free access investment, TfL constructs a shortlist of candidate stations, and then holds a public consultation before choosing the station to receive an investment.[24] TfL have made efforts to make the process more transparent, and this transparency has been valuable for Transport for All.

Assessing the benefits of step-free access improvements is complex. It depends on many factors, including:

- Whether alternate routes (e.g. buses) provide an acceptable substitute for using the given station (which is currently inaccessible for a subset of users);
- Whether the station is completely inaccessible to the user without the investment; and
- Which parts of the underground/overground network (which destinations) are made accessible through the upgrade, which depends on step-free access in other stations.

All of these factors affect value, i.e. the improvement in different kinds of journeys:

- Journeys that disabled passengers already made through the station, that become easier;
- Journeys that reroute through the station because it is now accessible; and
- Journeys that are only possible because the station was upgraded.

It would be possible as part of future work to construct an interactive dashboard map that would allow stakeholders to experiment with different station access upgrades, to quickly understand where and how different upgrades would affect the whole network.

A. System level summary

The dashboard user would input:

- The accessibility requirements of a hypothetical public transport user (the Model User): e.g. maximum length of trip, interchange length, step-free access requirements; and
- The step-free access investment (which stations, which types of upgrades).

[24] https://tfl.gov.uk/info-for/media/press-releases/2023/july/tfl-announces-the-next-tube-stations-to-be-prioritised-for-step-free-access-to-meet-the-mayor-s-bold-accessibility-targets

The dashboard would then display (with figures and graphically):

1. Summary statistics for the whole network:
   a. how many underground/overground journeys were made in the last year (among all users)
   b. how many of these journeys would have been accessible to the Model User
   c. how many more of the journeys would be accessible to the Model User with the station upgrade
2. Summary statistics over each station in the map:
   a. The number of trips that destinated at that station
   b. the proportion of trips destinated at that station that are currently accessible to the user; not accessible to the user; only accessible because of the station upgrade

B. Station summary

The user would additionally input:

- The origin station (which may or may not be the station with the upgrade).

The dashboard would then display the above statistics in (A), but specifically among trips that originated at the chosen station.

Annex A – Further detail on user engagement

A.1 Methodology

The qualitative approach to the study consisted of two rounds of focus groups. Focus groups were chosen for this research as they allow the researcher to observe a wide range of reflections in a limited amount of time. Focus groups also allow for a variety of stimuli and detailed concepts (like the PTAL and APTAL measures) to be tested with more people than would be possible with other qualitative methods. Recruitment was conducted through both Transport for All's internal networks and an external recruitment agency. A total of 33 people took part in the study. Across both waves, Groups 1 and 2 were conducted remotely on Teams and Groups 3 and 4 were conducted in person.

Groups were split by disability. Group 1 was participants with mobility needs, Group 2 was participants with visual impairments, Group 3 was participants with invisible disabilities, and Group 4 was participants with hearing loss. The size of the groups remained roughly the same across both waves.

A.2 First round of engagement

The first wave of focus groups were conducted between 8th August – 10th August 2023. In the first half of the focus group, researchers wanted to understand how different environments and elements of travel might present unique challenges for respondents. To achieve this, groups were tasked with ranking various travel obstacles, encompassing ticketing, station/bus stop experiences, pavements/surfaces (including escalators), onboard transport experiences, service provision, and information about travel. Each barrier was then broken down into individual challenges, and respondents were invited to contribute any barriers that hadn't previously been mentioned.

The study also incorporated a hypothetical scenario component, where respondents were presented with three locations: a busy high street, an outer London neighbourhood, and a housing and leisure development scheme. Participants were then prompted to evaluate their comfort level in navigating each of these hypothetical locations, and describe the kinds of challenges they would anticipate facing in accessing transport in these environments.

The researcher then introduced the concept of the PTAL measure, providing an overview of how locations were scored based on this metric. This was to gauge whether the measure was comprehensible, and whether it was a useful measure given their challenges. A map of Greater London and also a map of Brixton with PTAL rankings overlayed were shown to participants.

Participants were asked to rank their top three barriers to travel, considering those that they had previously discussed but also through evaluating the PTAL maps they had been shown.

A.3 Second round of engagement

The second wave of focus groups were conducted between 16th October – 27th October 2023. The objectives of the second round of focus groups were to help refine ideas for APTAL options through capturing views of disabled transport users, alongside collecting additional detail related to questions and issues raised in data processing for APTAL options. The structure of the focus groups followed similar patterns, and all groups were shown the same stimuli, but in rotated ordering as to prevent order effect bias.

The first half of the focus group focused on testing five possible additions to the PTAL measure – the impact of crowding, the prevalence of step-free access, on-street crime, the prevalence of accessible toilets and assuming all underground stations to be inaccessible. Participants were asked to what degree they believed the measure would be a useful method of calculating the accessibility of a location, later ranking them in order of preference.

The second half of the focus group was used to capture initial reflections on the representation of APTAL maps with data from each of the additional criteria calculated. Initially, participants were shown the current PTAL map for the wider Soho area (see annex for reference). Afterwards, each map was shown individually, and participants debated to what degree the map reflected their personal experience of the area's accessibility. For those with visual impairments, the map was described using the key of 1a being the 'worst' accessibility rating and 6b being the 'best'.

A.4 Stimuli used

The follow maps were used to prompt discussion during the focus groups.

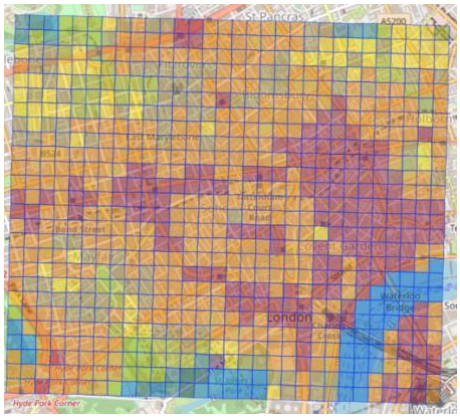
Figure 18 Baseline PTAL map

Source: Frontier

Figure 19 Crowding APTAL map

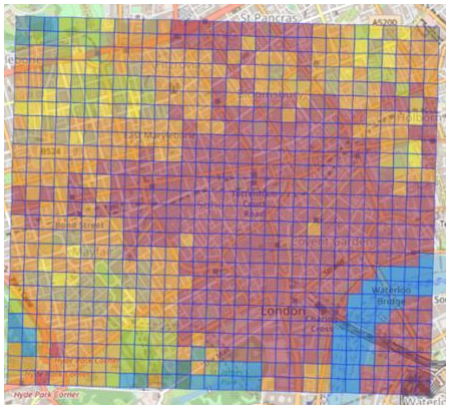
Source: Frontier

Figure 20 No tube access APTAL map



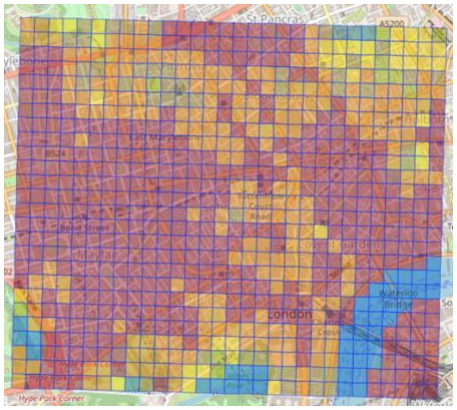
Source: Frontier

Figure 21 Accessible toilets APTAL map



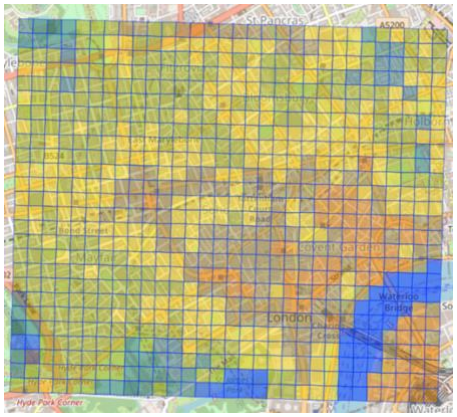
Source: Frontier

Figure 22 Step-free access APTAL map



Source: Frontier

Figure 23 Crime prevalence APTAL map



Source: Frontier

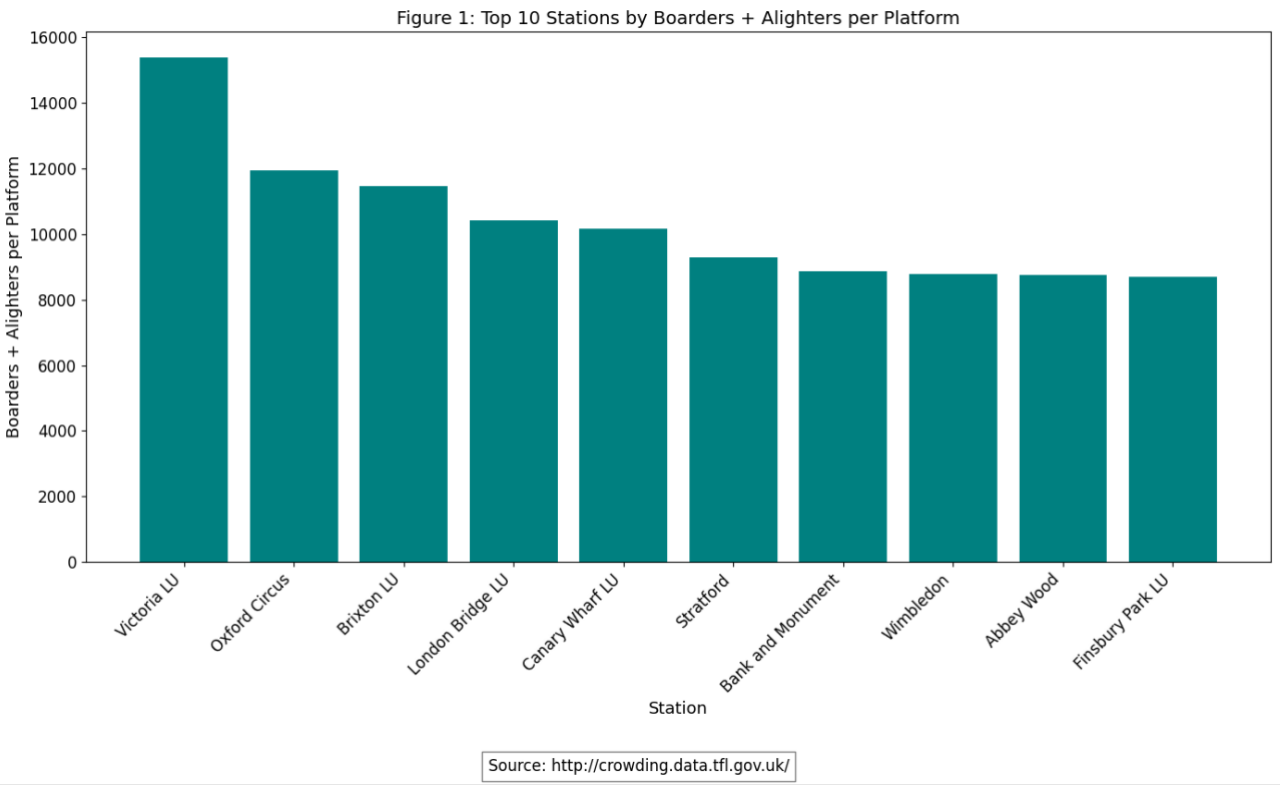
Annex B Details of APTAL calculations

7.3.4 Crowding

The ideal measure of crowding would calculate people per square metre of floorspace in stations or in vehicles, during morning peak times. An alternative measure could use TfL's estimated person capacity in stations and vehicles. However, the floorspace or person capacity of stations and vehicles was not publicly available, and so we constructed a measure of station crowdedness that used number of platforms as a proxy for capacity.

We used TfL's NUMBAT dataset,[25] which included station platforms, station alighters and boarders by time of day and day of week for London Underground Line and Overground services in 2022. We calculated (boarders + alighters)/(number of station platforms) for the time-period AM Peak which comprises of 7am-10am to reflect the busiest time-period for commuting.

Figure 1: Top 10 Stations by Boarders + Alighters per Platform



By this measure, Victoria LU was the busiest station in the network (Figure 1). We linearly rescaled the measures so that Victoria LU had 100% crowding, i.e. the crowding metric measured how crowded the station was with respect to Victoria. The station information was merged into PTAL data using fuzzy matching on station name.

[25] *http://crowding.data.tfl.gov.uk/*

Stations with zero crowding have unchanged contributions to the PTAL calculation. Stations with 100% crowding (i.e. Victoria) have their EDF reduced by 100% (assumed completely inaccessible). All other stations' EDFs are scaled linearly by the crowding measure, e.g. a station with a 20% crowding measure has its EDF scaled down by 20%. This is equivalent to implying that a station that is 20% less crowded provides 20% less 'connectivity'.

7.3.5 Step-free access

The step-free access calculation assesses stations based on three key factors: the gap size between the platform and the train (categorised as A, B, C, R, with R indicating a ramp), the step colour at the platform-to-train transition (Green or Red), and the availability of a lift (Yes or No). The resulting accessibility scores are:

- Best Accessibility (Score = 1): Stations with a green step, gap size A or R (ramp), and a lift available. These stations maintain their existing contribution to the PTAL score, as they represent the ideal accessibility scenario;
- Good Accessibility (Score = 0.75): Stations with a green step and gap size B with a lift, or a green step and gap size A or R without a lift. Their contribution to the PTAL score is slightly reduced, reflecting good but not optimal accessibility;
- Moderate Accessibility (Score = 0.5): Includes stations with a green step and gap size C with a lift, a green step and gap size B without a lift, or a red step and gap size A or R with a lift. The PTAL contribution of these stations is moderately reduced;
- Poor Accessibility (Score = 0.25): Stations with a red step and gap size B with a lift, or a green step and gap size C without a lift. These stations have a significantly reduced contribution to the PTAL score; and
- Worst Accessibility (Score = 0.1): Stations with a red step and gap size C without a lift, a red step and gap size A or R without a lift, or a red step and gap size B without a lift. They contribute minimally to the PTAL score due to their poor accessibility.

Stations lacking in step-free accessibility features will see a decrease in their contribution to the overall PTAL score, reflecting their limited accessibility. The assessment of bus services in the PTAL remains unchanged, assuming that bus access is adequately step-free.

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