Report
March 2021

Research into Parkways for Modelling and Appraisal

Two railway lines crossing over Worcestershire Parkway (open source).

Department for Transport
Our ref: 23847201
Client ref: TRO0188

steer

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1 Introduction

1.1 Steer was commissioned to support the Department for Transport (DfT) in its programme of research on parkway stations, specifically with the development and provision of a robust evidence base and methodological framework which would aid in the production of business cases, including supporting demand and benefit modelling, for parkway stations.

1.2 Parkway stations play an important role for the national, regional, and local rail networks. However, the role of a parkway station is varied and complex. Some stations named 'Parkway' may not provide a Park & Ride type of service, whereas others not called 'parkway' may do so.

1.3 Further, the evidence base underpinning the development of parkway stations specifically is not currently well established, which makes it more difficult to plan and assess the success of proposed parkway stations.

Aim of this research

1.4 Despite the number of parkway stations on the network, including new stations over recent years, there is an apparent lack of evidence and consistency in the approach to forecast, monitor and evaluate the impact of these stations.

1.5 This applies to their potential to generate rail journeys (both from/to that station and the net additional journeys on the whole railway network) and their capability to generate economic benefits, such as reduced congestion in city and town centres, the environmental benefits associated with a potential modal shift or support for local development.

1.6 Consequently, there is a requirement to develop a robust evidence base which:

- Explains the rationale underpinning the development of a parkway station (through a set of adaptable success criteria that support development of the Strategic Case), allowing scheme promoters to better develop their schemes;
- Provides a robust and TAG-consistent approach to estimate future usage potential and associated benefits and costs (which are used to inform the Value for Money assessment at the core of the Economic Case);
- Provides a framework for promoters to develop more robust business cases; and
- Supports benefits realisation, monitoring and evaluation activities consistent with the Magenta Book.

1.7 This study aims to bridge that evidence gap and determine what the criteria are which make a parkway station successful and, derived from these, develop a methodology which can be used to produce parkway station business cases in a robust and consistent manner.

Structure of this document

1.8 The document is structured as follows:

- Literature review (**Section 2**) – this section reviews existing literature and case studies on parkway stations and summarises the information into hypotheses.

- Development of the typology of parkway stations (**Section 3**) – this section presents the analysis conducted on existing parkway stations and analyses whether they support or contradict the hypotheses from Section 2.
- Definition of success criteria (**Section 4**) – this section draws on the previous two sections to define what a successful parkway looks like.
- Application to modelling (**Section 5**) – this section describes the existing modelling frameworks and compares the success criteria from Section 4 to these frameworks
- Sensitivity analysis and tests (**Section 6**) – presents the results of sensitivity analysis associated to inclusion of some of the criteria and parameters identified in Section 5.
- Conclusions and recommendations (**Section 7**) – this section summarises the main findings of the report and presents recommendations associated to these.

2 Literature review

2 Literature review

Objectives and approach for the review

2.1 This section reviews existing evidence on parkway stations, which combines academic papers with practical examples and case studies of existing parkway stations. This evidence has been used to inform the development of the success criteria framework and to develop a parkway stations typology as described in Section 3 of this report.

2.2 The review has included UK and international evidence, focusing on:

- understanding which factors are common to successful parkway stations;
- identifying the objectives that parkway stations seek to address;
- collating best practice and case studies, in particular around where to locate a parkway station and considerations for a successful pricing strategy; and
- informing the definition and role(s) or parkway stations.

2.3 The approach adopted has been to identify the key themes from each of the documents under review, compare and contrast the conclusions with the emerging trends from the parkway stations repository and draw conclusions of application for developing the success criteria framework.

Summary of evidence reviewed

2.4 Table 2.1 below presents the evidence which has been reviewed, outlining the nature of the document, the geography to which it refers, and a summary of the relevant lessons learned for this study.

Table 2.1: Summary of evidence reviewed

Document	Nature of document	Geography	Learning areas
Modelling passenger demand for parkway rail stations [1]	Academic paper	UK	Catchment area considerations, types of parkway stations, producer nature of parkway stations
Exploring the Mode Change Behaviour of Park-and-Ride Users [2]	Academic paper	Australia	Users' behavioural choices
Park and Ride: First principles assessment [3]	Academic paper	UK	Impacts on demand, contribution of parkways in alleviating problems, barriers to implementation
Guide for developing Park and Ride sites in Andalucía [4]	Policy document	Spain	Parameters to compare and select among P&R options

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Document	Nature of document	Geography	Learning areas
Synthesis of development plans of Park and Ride sites in the context of the Métro Grand Paris [5]	Case study analysis	France	Users' behavioural choices, barriers to success, pricing strategies
The effects of Park and Ride supply and pricing on public transport demand [6]	Case study analysis	UK (Scotland)	Impacts of additional parking spaces and changes in pricing strategy
Oxford Parkway case study [7]	Case study analysis	UK	Users' behavioural choices
Park and Ride: best practice review [8]	Case study analysis	Canada	Location of a parkway station, impacts of pricing strategies, affordability impacts
TACTRAN Park and Ride strategy [9]	Policy document	UK (Scotland)	Objectives of a parkway station

2.5 The summary of key findings presented below is organised by theme, rather than by document, where specific reference is made to the evidence identified to justify these findings.

Types and objectives of a parkway station

2.6 The **University of Leeds** [1] identify three main types of parkway stations according to the role they play in their local context. These are:

- Stations close to suburban populations located in a strategic position on the road network to complement existing urban stations where car access is impeded by road congestion. An example for this is Bristol Parkway[1].
- Stations that serve remote populations off the main lines, such as Tiverton Parkway and Bodmin Parkway stations.
- Expansions of car parking at an existing station where road access is good and the station can be re-marketed as a Parkway, such as Didcot.

2.7 All of these stations typically seek to address a similar set of problems and have common objectives. **ITS Leeds** [3] state that the primary reasons for developing a Park & Ride scheme are the following:

- reducing congestion within the city centre and along roads providing access to it; and
- reducing environmental externalities on these.

2.8 Other secondary reasons may include stimulating growth in the business and leisure sectors or improving road safety. They also identify how parkway stations contribute to alleviate the main problems associated to this type of stations.

[1] It should be noted that Bristol Parkway was originally planned largely as a rural station which, subsequent to land use change following the development of Bradley Stock north of Bristol, can be now considered as a station close to a suburban population.

2.9 These are summarised in Table 2.2 below, outlining the problems they address, the scale of the contribution and the rationale for this:

Table 2.2: ITS Leeds – Contribution to alleviation of problems

Problem	Scale	Notes
Congestion-related delay	✓✓	Due to transfer from car to car plus public transport
Congestion-related unreliability	✓✓	Due to transfer from car to car plus public transport
Community severance	✓✓ ✗	Positive impact due to transfer from car to car plus public transport but possible negative impact in site's catchment area.
Visual intrusion	✓ ✗	Positive impact due to transfer from car to car plus public transport but possible negative impact in site's catchment area.
Lack of amenity	✓✓ ✗	Positive impact due to transfer from car to car plus public transport but possible negative impact in site's catchment area.
Global warming	✓ ✗	Reduced CO_2 emissions due to transfer from car to car plus public transport but possible increased emissions in site's catchment area.
Local air pollution	✓✓ ✗	Reduced emissions of NOx, particulates and other local pollutants in urban area but possible increase in site's catchment area.
Noise	✓✓ ✗	Positive impact due to transfer from car to car plus public transport but possible negative impact in site's catchment area.
Reduction of green space	✗✗	Space required for the car park and also possible increase in traffic in catchment area may ultimately lead to pressure for more road building. Reduced traffic in urban area is less likely to have an impact on green space because major roadbuilding is rarely an option.
Damage to environmentally sensitive sites	✓✓ ✗	Positive impact due to transfer from car to car plus public transport but possible negative impact in site's catchment area.
Poor accessibility for those without a car and those with mobility impairments	✓ ✗	If the park-and-ride services serve other areas, then accessibility may be improved. On the other hand, park-and-ride may well make rural bus services less viable (due to transfer from bus to car plus bus) so reducing access in already poorly served areas.
Disproportionate disadvantaging of particular social or geographic groups	✓ ✗	As above.
Number, severity and risk of accidents	✓ ✗	Likely reductions in urban area due to transfer from car but possible increase in site's catchment area.
Suppression of the potential for economic activity in the area	?	Lower congestion frees up time for more productive work and may encourage businesses to locate in the area but if large subsidies are required, associated taxes may stifle economic growth.

2.10 According to ITS Leeds, the most significant impact of a parkway station is in addressing congestion-related delays and unreliability on the road network, due to the transfer from car to public transport in the dense urban areas.

2.11 ITS Leeds also outline another distinctive feature of parkway stations relative to other stations: they generate far more rail traffic than they attract. They note that the ratio of trips originating at parkway stations to trips with destinations at parkway stations was around 1.6 in 1999. This compares with ratios of 0.82 for London stations, 1.03 for the major regional commercial centre of Leeds, and 0.54 for the major tourist attraction of Stratford upon Avon.

2.12 Parkway stations also have the potential to address other externality issues, such as carbon emissions, air pollution or noise; however, they might contribute to a decrease in externalities in the urban areas while increasing them in the vicinity of the parkway station area.

Environmental policy and net zero carbon targets

2.13 The environmental objectives of a parkway station have become more prominent following recent global policy development which aims to decarbonise transportation and encourage more sustainable journeys.

2.14 The Paris Agreement[2] on climate change is an international, legally-binding commitment to limit the global temperature increase to below 2 degrees Celsius – and to pursue a limit of 1.5 degrees Celsius above pre-industrial levels in order to reduce the threat of climate change.

2.15 The UK ratified the Paris Agreement in 2016 with the UK Climate Change Act 2008 (2050 Target Amendment) Order 2019[3] carbon reduction target being amended in 2019. It was changed from a target of emissions to be at least 80% lower than 1990 levels to at least 100% lower than 1990 levels. Meeting the terms of the Paris Agreement and the UK's own target requires domestic transport to decarbonise, and parkway stations are an enabler to achieving this.

Markets served by parkway stations

2.16 A review into recent business cases for parkway stations is summarised below in Table 2.3. The aim of this review is to develop an understanding of the key objectives and markets these parkway stations aim to serve.

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[2] Paris Agreement, European Commission: **https://ec.europa.eu/clima/policies/international/negotiations/paris_en#:~:text=The%20Paris%20Agreement%20sets%20out,support%20them%20in%20their%20efforts.**

[3] UK Climate Change Act 2008 (2050 Target Amendment) Order 2019: **https://www.legislation.gov.uk/ukdsi/2019/9780111187654**

Table 2.3: Key objectives and markets served from recent parkway station business cases

Station	Key objectives	Markets served
Worcestershire Parkway[4] (opening: 2020; business case: 2013)	• Provide improved access to the railway for 93,000 passengers per annum, of which approximately 50% will be new to rail or transferred from road. • Improve rail connectivity by creating an interchange for users wanting to switch between the Cotswold line and Bristol to Birmingham lines. • Support the aspirations from the DfT and NR of wanting to increase the frequency and journey times between London and Worcester, in part by providing an increase in users with a minimal impact on the existing timetable. • Help to sustain the economic performance of the Cotswold Line following the opening of the competing Chiltern Railways Oxford-London service in 2014/2015, generating approximately £2.54 million of rail revenue per annum for the Cotswold Line. • Support economic growth and generate an increase of over £18 million in GVA for the Worcestershire economy and up to 1,100 new jobs.	**Long-distance journeys** • Improve journey times for locals of Worcestershire to: – London and the South East – Bristol and the South West – Birmingham and the Midlands – North West – North East • Allow for faster passenger interchanges travelling between these markets.
Stratford-upon-Avon Parkway[5] (opening: 2013; business case: 2010)	• To support the ambition of an increased frequency of off-peak train services between Stratford-upon-Avon and Birmingham; justified by the increases in passenger footfall and revenue projected to generated by the new Parkway Station. • To meet the suppression of demand associated with a reduction in the number of car parking spaces at the Town Station, due to local development. • To act as a strategic Parkway Station for Birmingham bound commuters, originating in Stratford-upon-Avon and its hinterlands. • To provide a local transport facility for residents of the north western areas of Stratford (including the Bishopton and Birmingham Road settlements), the station would be within a convenient walking and cycling distance for these residents. • To serve major new housing developments proposed for the north and western areas of the town. • To encourage a modal shift from the private car to a more sustainable transport mode and in doing so provide environmental and congestion reduction benefits on the local and strategic road networks.	**Regional commuter journeys** • Mainly act as an origin station for commuters into Birmingham that live to the north-west of the Stratford-upon-Avon and in the wider District areas.

2.17 Whilst modal shift is the one of the main objectives observed in the business cases for these parkway stations, with the reduction of carbon emissions as a secondary outcome linked to this,

[4] Worcestershire Parkway Business Case (2013): http://www.worcestershire.gov.uk/info/20453/worcestershire_local_transport_body_guidance_business_cases_and_technical_assurance/1512/local_transport_body_business_cases_and_technical_assurance_documents

[5] Stratford Parkway Outline Planning Application – Planning Statement (2010): https://planning.warwickshire.gov.uk/swiftlg/MediaTemp/7207-776.pdf

more recent parkway station business cases put a greater emphasis into the role of the parkway stations in reducing carbon emissions and achieving the net carbon targets.

2.18 In effect, access to the parkway stations by more sustainable modes (e.g. public transport or active modes) will contribute to this net reduction, however this objective was not as prominent as they would be in current business cases for the examples that have been reviewed.

Catchment area

2.19 The **University of Leeds** [1] undertook analysis on the catchment area of parkway stations compared to other types of stations.

2.20 They note that the average distance travelled to stations is around 10 km for longer distance, largely London-based, rail trips (Rail Operational Research, 1995) and around 5 km for medium distance regional trips (Wardman and Tyler, 2000). They undertook a comparison of the average distance travelled to the station for a number of parkway stations and comparable stations, as presented in Table 2.4 below.

Table 2.4: University of Leeds – Average distance travelled to station

Parkway station	Av. distance travelled	Reference station	Av. distance travelled
Tiverton Parkway	28	Taunton	20
Port Talbot Parkway	27	Swansea	21
Birmingham International	22	Birmingham New Street	12
Bodmin Parkway	16	Truro	9
Bristol Parkway	12	Bristol Temple Meads	7
Didcot Parkway	11	Oxford	10

2.21 The average distance that passengers travel to a parkway station is usually higher than to the reference station, which suggests that parkway stations do typically serve a larger more strategic catchment.

2.22 The proportion of travellers categorised as railheaders[6] was 92% at Birmingham International and 85% at Bristol Parkway. The figures at Bodmin Parkway, Didcot Parkway and Tiverton Parkway were 72%, 57% and 50% respectively, which is notably higher than at other stations.

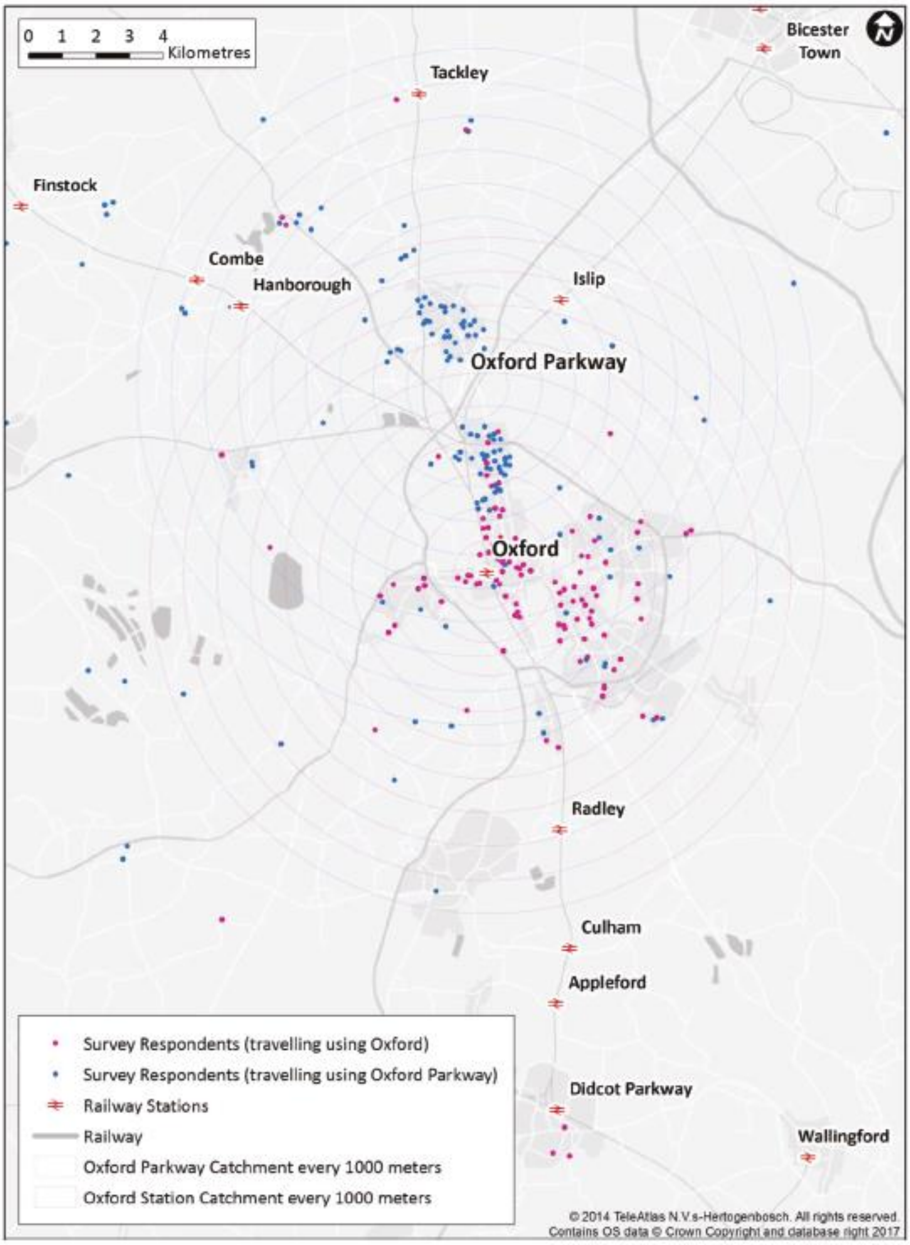
2.23 The **Department for Transport** [7] commissioned a study to Steer and Cambridge Econometrics in 2018 to explore the impact of the opening of Oxford Parkway station. This provides insight about the catchment area of this station and Oxford station, as presented in Figure 2.1 below.

2.24 The analysis shows that, while Oxford Parkway mainly attracts users from an area poorly served by Oxford station, it has also attracted passengers previously using Oxford station.

2.25 Likewise, it can be seen that there are a number of Oxford Parkway users travelling a significant distance from Oxford, including relatively rural areas and areas south of Oxford. This is an indication of the attractiveness of Oxford Parkway to drivers and car users who may not have access to good public transport (car access mode share in the study's user surveys was 9% for Oxford and 66% for Oxford Parkway).

[6] Railheading refers to the practice of travelling further than necessary to reach a rail service, typically by car.

Figure 2.1: Oxford Parkway – Catchment area analysis



Users' behaviour

2.26 Case studies from **Melbourne**, Australia [2] and Greater **Paris**, France [5] show the modal shift driven by the introduction of a parkway station within their suburban networks.

2.27 Figure 2.2 below presents, for the **Melbourne** case study, the mode of transport passengers used prior to switching to using the P&R station. 44% of users have switched from using car only; however, 19% of users previously used public transport only. Therefore, the reduction in car mileage from the previous car users is offset by this effect.

2.28 The main reason quoted for choosing P&R was mostly the ease and convenience of using P&R (68%) which includes no traffic congestion, no parking at work, infrequent bus timetable from home/trip origin, and convenience of reading books or official documents in transit vehicle.

– Users also identified other important factors, such as the level of public transport service or the walking time between the car park and the station platform. This is explored further for the parkway stations in the evidence base in section 3 of the report.

Figure 2.2: Melbourne case study – Interview results

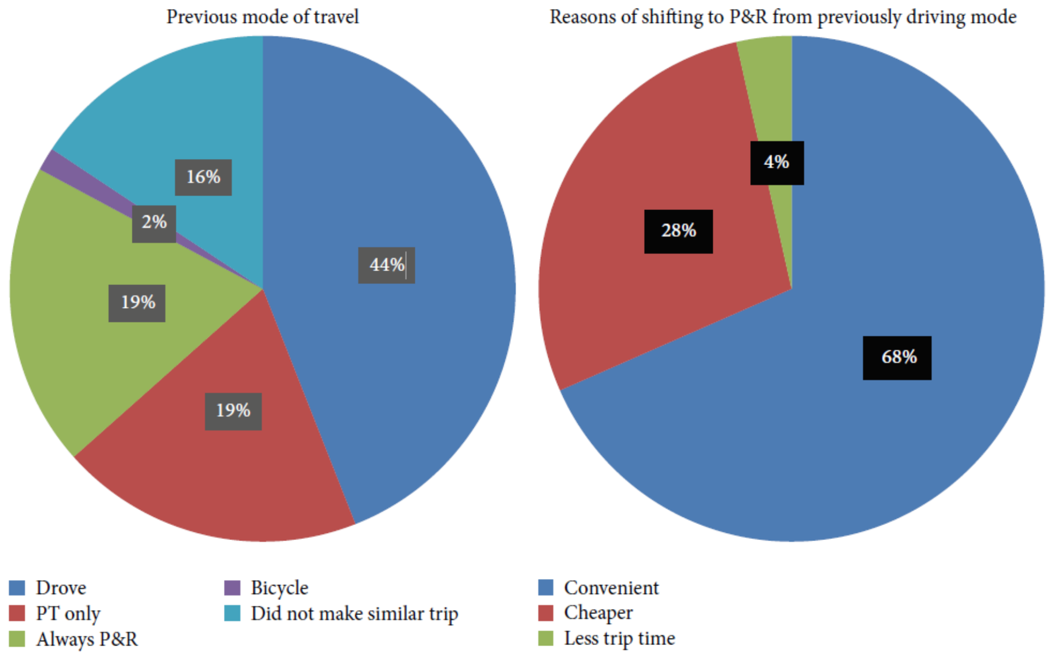


Figure 1: Previous travel mode and reasons of shifting.

2.29 In the case of Greater **Paris**, Table 2.5 displays the responses that users quoted for reasons why they decided to use a P&R station.

Table 2.5: Greater Paris study responses

Reason	Percentage response
Road congestion towards the city centre	63.6%
Lack of parking, or inconvenience of doing so at the destination	16.2%
Cost savings compared to using car only	10.6%
Parking at the destination being expensive	4.7%
Environmental reasons	0.7%
Other	4.2%

2.30 These findings are also in line with the surveys undertaken as part of the **Oxford Parkway** [7] case study, where a significant proportion of users highlight that “easier access to the new station”, “easier parking” and “easier to get to their preferred destination” are the main reasons to start using the parkway station.

2.31 It is worth noting that, despite the fact that parkway stations may have the reduction of road congestion as an objective, this does not always translate into a net reduction in car mileage. **ITS Leeds** [3] present some analysis on bus-based P&R sites undertaken between 1999 and 2000 which shows that in the majority of the cases under analysis, there was a net increment in car kilometres, as shown in Table 2.6 below.

Table 2.6: ITS Leeds – Changes in net car traffic per car intercepted (car km)

Urban area	Change in traffic within urban area	Change in traffic outside urban area	Combined change
Brighton	-1.1	+7.9	+6.7
Cambridge	-5.0	+13.8	+8.8
Coventry	+2.6	+6.7	+9.3
Norwich	-4.3	+25.0	+20.7
Plymouth	-4.3	+9.1	+4.8
Reading	-3.0	+7.5	+4.4
Shrewsbury	-6.0	+6.9	+0.9
York	-5.8	+8.5	+2.7

Location, access and connectivity

2.32 The best practice review of P&R in **North America** [8] identifies a number of criteria to optimise the selection of a location for a P&R station.

2.33 It is noted that P&R facilities are most successful where car travel to a popular destination such as a downtown is inhibited by congestion, tolls or a lack of affordable parking. Therefore, successful P&R sites should provide faster, reliable and cheaper journeys than driving.

2.34 P&R stations should therefore be located where one or more of the following factors apply:

- the main highway corridors are congested and P&R facilities can be provided in advance of the congestion
- the potential station catchment area is not well served by public transport
- population densities are too low to support frequent public transport services
- locations are at typically between 8 and 12 km from the city centre
- facilities are located near the confluence or terminal points of main highways
- locations are perceived as safe by users

2.35 Figure 2.3 below, extracted from the study, summarises the features of five P&R sites in North America that respond to these criteria.

Figure 2.3: North America case studies – Features of P&R sites

Urban Area		Calgary, AB	Dallas, TX	Edmonton, AB	Philadelphia, PA	Toronto, ON
Transit System		Calgary Transit	DART	Edmonton LRT	SEPTA	GO Transit
Station		Crowfoot	Mockingbird	Clareview	Cornwall Heights	Bronte
Straight Line Distance from:	City Centre	15km	5km	8.7km	23km	40km
	Approximate Edge of City Built Up Area	4km	40km	3.9km	10km	7km
	Highway	0.2km	0.5km	2.2km	0.3km	1km
Transit Service:	Mode	Light Rail	Light Rail, bus	Light Rail, bus	Commuter Rail	Commuter Rail
	Peak Hour Frequency	12 trains per hour	12 trains per hour	8 trains per hour	4 trains per hour	4 trains per hour
Lot Capacity		1,345	750	1,393	1,600	2,623
Weekday Lot Occupancy		1,200	750	1,393	725	2,100

2.36 They seem to be located outside the dense city built-up area (with the exception of DART in Dallas) where road congestion is expected to be lower.

2.37 Likewise, they are located between 5 and 20 km from the city centre, with the exception of GO Transit in Toronto, which is however at the outskirts of Mississauga, a densely urbanised area west of Toronto.

2.38 Finally, they are very closely located off the highway, typically under 1 km, boosting the attractiveness of car access. Similarly, they present very frequent peak transit services as well as large car park facilities that enable the car accessibility.

2.39 Lessons learned from Greater **Paris** [5] also highlight the importance of avoiding a location which is too close to the congested area, as well as a location in a dense urban area where public transport and active modes are privileged over car.

2.40 Similarly, evidence from **Andalusia**'s (Spain) guidance [4] for planning and developing P&R sites present a number of indicators and metrics to compare and assess the suitability of a new parkway station. These include, among others, access metrics (i.e. road congestion measured as average peak speed in nearby roads or distance to major highway) and connectivity metrics (i.e. number of services per hour during the peak and off-peak periods).

Parking facilities and pricing strategy

2.41 The best practice review of P&R in **North America** [8] also identifies a case study on car park pricing strategies from the city of Calgary.

2.42 Across Canada, analysis shows that while many cities offer some form of free parking for P&R customers, charges in the region of $2 to $4 per day[7] ($40 to $100 per month) are also common.

[7] 1 CAD = 0.59 GBP as of July 2020. Charges range between £1.15 and £2.35 per day and £23 to £59 per month.

Some cities also offer reserved parking, premium locations nearer the station and spaces for electric vehicles with charged parking.

Calgary pricing strategy case study

2.43 Historically P&R parking was provided free of charge in Calgary. Prior to the city's current parking charge structure, the City experimented with a daily $3 charge for all P&R lots in 2009.

2.44 Initially, following the introduction of the charge, P&R use declined from 100% capacity at many lots to approximately 55% capacity (compared to a decline in transit ridership of 1%).

2.45 Over the next 18 months, lot occupancy rebounded to 66% capacity providing $5 million in annual revenues (against $4.4 million operating costs). Evidence suggested LRT ridership remained similar and that customers were using alternative means such as feeder bus routes, walking and cycling to access LRT.

2.46 A survey of transit users at the time showed that 23% of former P&R users changed to parking in the areas surrounding the LRT Park and Ride lots. However, this was partially counteracted by 12% of users transferred from parking outside the lot to inside the lot as they could now find a stall.

2.47 Customer satisfaction was mixed with some customers reporting finding it easier to find a stall whilst others objected to paying for a service which was previously free.

2.48 By the end of 2010, lots were again filling up and customers were requesting the ability to reserve a stall. In 2011, city council switched to its current system whereby 50% of stalls can be reserved for a monthly charge of $85, with the remaining 50% becoming free on a first-come-first-served basis.

2.49 The city reports that in 2015, 65% of possible reserved stalls have been leased raising $4 million in revenue. In some lots there are now waiting lists for reserved stalls suggesting differential pricing could be introduced to control demand.

2.50 An additional reflection is that, given that P&R is mainly utilised by car-owning commuters, these systems typically benefit wealthier transit riders. The equity of P&R could be improved through the provision of free or subsidised parking for disadvantaged groups such as the unemployed, those on low incomes and those with accessibility needs.

2.51 Evidence from the Greater **Paris** [5] document is in line with these findings. It indicates that as parking charges are introduced on a previously free P&R, parking demand often halves.

2.52 In the Ile-de-France region, for the users who agree to pay, parking charges of 45 euros/month is a maximum threshold, although some P&R located in the better off areas may be an exception (e.g. 55 euros/month at Maisons Lafitte). This means an average daily charge of 2-3 euros would be acceptable for users.

2.53 Analysis for **Scottish parkway stations** [6], based on revealed preference analysis, indicates that rail demand seemed fairly inelastic (i.e. a change in parking charges from £1 to £2 resulted in a 4.9% demand reduction) because passengers had the chance to park elsewhere (55% of passengers would do so).

2.54 This study also shows that, while a lack of available parking spaces can constrain demand is parking elsewhere is not possible, expanding the size of the car park when demand is not constrained does not necessarily stimulate demand, with between 4 and 10 additional daily trips per 100 additional car park spaces.

Other considerations

2.55 **ITS Leeds** [3] highlights the main barriers to the opening of a new parkway station, summarised in Table 2.7.

Table 2.7: ITS Leeds – Main barriers for parkway stations

Barrier	Scale	Notes
Legal	×	Sufficient land and access rights are needed.
Financial	×××	Capital costs may be significant including land for a car park. Operating subsidies are also likely to be required as well as marketing campaigns.
Political	××	May be concerns with creating a large car park on the outskirts of a town. Significant ongoing subsidy funded by taxpayers may also fuel opposition.
Technical feasibility	-	Unlikely to present insurmountable technical feasibility issues.

2.56 The most significant one is the financial aspect, where typically the operating costs of a P&R are not covered by the parking charges, provided that capital funding is identified for the construction. Land availability and political pressures can also be a barrier to parkway stations.

2.57 The area of land and its distance from the city/town centre will affect the cost of its purchase as well as the cost of developing the land into a car park of sufficient size and quality.

2.58 Evidence from **Spain** [4] and **France** [5] indicates that some of the design aspects might have an impact on the success of a parkway station. Particularly, the average distance between the car park space and the station platform should be relatively short and ideally not exceeding 200 m. This can be challenging for car parks with large capacity (e.g. a multi-storey car park could provide an acceptable parking layout, but costs would increase significantly).

2.59 Similarly, the perception of safety at the P&R, personally and for their vehicles, can influence the decision of some users, which can be addressed by installing appropriate lighting or CCTV.

Conclusions

2.60 These findings have informed the analysis undertaken to develop a parkways station repository and the definition of success criteria and types of parkway stations. The evidence found under each theme has led to the development of initial hypotheses which are tested against a list of existing parkway stations in Great Britain in Section 3 of this report. These hypotheses are as follows:

Markets served

2.61 The above research has generated initial definitions for the following functions for a parkway station based on the markets they serve and their key objectives:

- **Long-distance parkways:** stations which allow users to easily access an interregional or intercity network which would otherwise involve travelling to a city centre first before continuing on by train. In these cases, the station aims to target users who can drive to the station and continue their journey on a long-distance service, such as to London.
  - This function means users can avoid driving and parking at a congested city centre station or get the bus to the city to make an intercity journey. They also attract those who may previously drive the full length of the long-distance journey.
  - Many of these parkway stations benefit from providing long-distance services which local stations cannot provide. They therefore abstract demand from local stations.

  - The key objective is to improve mobility on an interregional scale through improving journey times for long distance journeys resulting in a modal shift from road to rail. They allow users to access a larger network and allow for faster and/or more convenient journeys to key destinations such as London.
- **Regional commuter parkways:** stations which allow for local access to a nearby regional centre. They aim to target users who are attracted by the ease of parking and taking a train to the city centre rather than driving the full journey to the city centre or using less convenient local rail stations.
  - The key objectives are to improve mobility within a region through reducing congestion in regional centres through providing more competitive journey times by using the railway.

2.62 The above functions may be supplemented by other market functions:

- A station which aims to unlock a new potential catchment of users who were previously unable to access the rail network. This is generally the case for rural areas where alternative railway stations do not exist, and other mass transit options are not viable or competitive.
- A station which may previously exist and has a local market function. The redevelopment of a station as a parkway additionally generates users in addition to the existing users.
- A station which may consequently unlock the potential for new nearby developments, thus creating a new local market function. Given that parkway stations tend to be located away from urban centres and serve disperse populations [2.39], a higher proportion of journeys are produced at the station, rather than being attracted to the station.
- A station which aims to perform a secondary function such as to serve a nearby specific attractor, such as an airport or an international convention centre.

2.63 Based on the above functions and markets served, the literature suggests that these stations include some of the factors below to be competitive to other alternatives and therefore successful. These are factors which, if present, improve the attractiveness for the user.

Station accessibility

- Parkway stations are likely to be located near a strategic highway, typically under 1 km, boosting the attractiveness of car access. [2.38]
- The potential station catchment area is not well served by public transport and hence driving to the station is the primary option to access a wider catchment, because it is serving a disperse population as opposed to a dense, constrained population centre. [2.34]
- Parkway stations that attract rail users for longer distance journeys have larger catchment areas than parkway stations which attract rail users for regional trips. [2.14] This hypothesis will be tested in Section 3.
- The parking charges have to be proportionate to the nature of the trip being made so that the journey via the parkway station remains competitive.
- Station car park occupancy will be higher for stations that do not have competing car parking spaces within close proximity (both formal and informal).

Rail service

- Parkway stations are more likely to be strategically located along the rail network and can hence provide access to key destinations at higher frequencies and result in more competitive journey times when compared to local alternative stations. [2.38]

- Parkway stations need to provide a direct service to popular destinations which are unattractive for access by other modes due to congestion and lack of affordable parking. [2.33]

2.64 These hypotheses have been tested by analysing existing parkway stations in the evidence base in the next section. This has ignited the search to find further insights into what makes a successful parkway station. Therefore, the literature review and findings from Section 3 have both contributed towards the development of the success criteria framework in Section 4.

3 Parkway stations evidence base

3 Parkway stations evidence base

3.1 In this section of the report, an evidence base has been developed of stations in Great Britain which are commonly recognised as parkway stations, or have the word 'Parkway' in their name. Examining these stations in detail has provided further practical insight into what functions and markets a parkway station serves along with the key characteristics of a successful parkway station.

3.2 The literature review led to the identification of two types of parkway stations which serve different functions and markets. These have been categorised as:

- Long-distance parkways
- Regional commuter parkways

3.3 This section firstly summarises the findings of an exploratory analysis which includes a **market analysis** to understand the users of parkway stations, followed by a more in-depth analysis into the **generalised journey cost** which will quantify the benefits to the user.

3.4 This is followed by an investigation into the characteristics of each station in the list and an evaluation into how well it meets the needs of the market it serves.

3.5 In order to examine the market the station is trying to serve and investigate how well the station is positioned to serve this user base, the type of flows generated have been examined along with how these are influenced by their local characteristics. To support this, a few examples have been highlighted which illustrate these different functionalities and markets, along with how a parkway station improves the attractiveness for the user.

3.6 For example, for a station catering towards serving users who wish to travel to London, the comparable generalised journey time between what the parkway station can offer has been compared to journey times from competing alternatives, which may include driving the full distance by car or using a city-centre station as an interchange instead of a parkway. This allows to assess how a journey can improve for the user due to the development of the parkway station.

3.7 From this, the study can reassess how these stations align with the two functions defined in the literature review and/or add to these definitions, functions and objectives of a parkway station. This analysis provides the basis for defining the key objectives, characteristics and success criteria.

3.8 These findings are then synthesised in section 4 and a set of criteria have been defined depending on the role and function of the parkway station.

3.9 Accompanying this analysis are a set of appendices which detail the individual functions, characteristics and statistics for each of the parkway stations analysed. These appendices provide detailed information on the type of journeys generated by the station and provide additional context to why they may or not be successful.

Station selection

3.10 The parkway station repository currently consists of 28 railway stations, 22 of which contain the term 'Parkway' in the name. Note that some of these parkway stations are aimed to serve airports, such as Luton Airport Parkway (LTN) and hence may have qualities that are not typical of other parkway stations.

3.11 Along with these are 6 other stations which commonly act as parkway stations from a functional point of view, even if not explicit in the name of the station.

3.12 This includes stations such as **Ebbsfleet International** (EBD), which were designed with the thought of acting as parkway stations serving a large catchment and where access to the station will be predominantly by car. This is also the case for **Alfreton** (ALF), which was previously named 'Alfreton and Mansfield Parkway' as it served a nearby large town of Mansfield which until 1995 did not have its own station.

3.13 The repository also includes two stations potentially fulfilling this role – **Stockport** (SPT) and **Wakefield Westgate** (WKF) – to develop an understanding of how their nature and users' behaviours compare to the other stations in the repository.

3.14 It is noted that this is not exhaustive of all stations that might function as a parkway station, as there might be suburban rail stations that generate significant proportions of car access and might be considered comparable to parkway stations.

Market analysis

3.15 The initial step of this analysis was to look at the key destinations from each of the selected parkway stations. This was undertaken using ticket type data from MOIRA which indicated the volumes of journeys from/to each of the parkway stations.

3.16 Each of the destinations were then classified by the type of market they represent, as part of the following categories[8]:

- London-based flows
- Regional centre flows – although no strict definition was used, regional centres were assumed to be stations located in economic centres of activity which are typically attractive destinations for commuters[9].
- Local centre flows – likewise, no strict definition for a local centre was adopted, but these were assumed to be stations which attract commuters mainly from the local area[10].
- Other flows –where they do not fit the above categories.

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[8] Note that flows were assigned to the categories based on professional judgement and existing MOIRA data, however changes to these assignments would not materially affect the conclusions of the subsequent analysis.

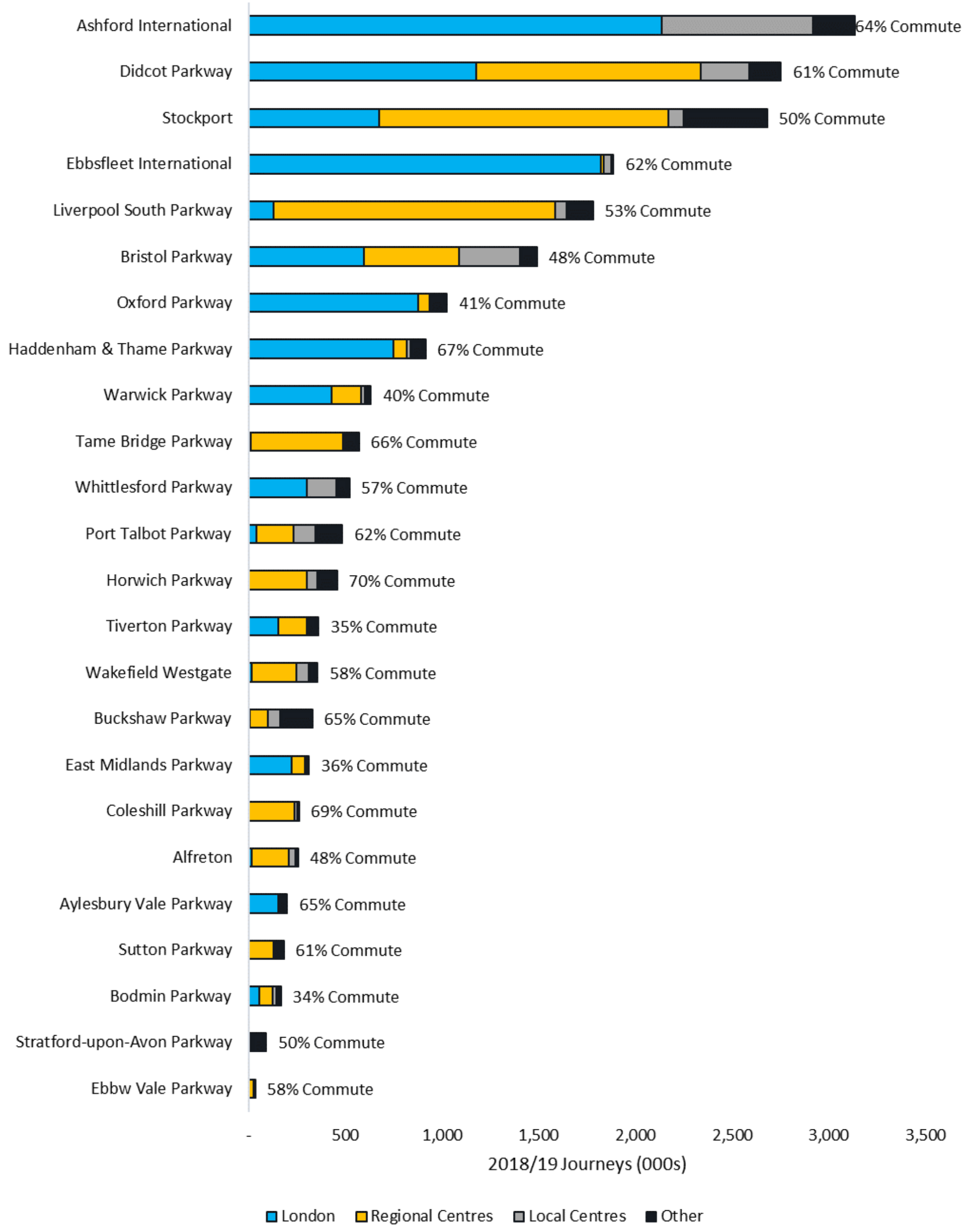
[9] Regional centres were assumed to be the following: Birmingham, Bristol, Cardiff, Edinburgh, Exeter, Glasgow, Leeds, Leicester, Liverpool, Manchester, Newcastle, Nottingham, Oxford, Plymouth, Portsmouth, Reading, Sheffield and Southampton.

[10] Local centres were assumed to be the following: Ashford, Banbury, Bath, Bedford, Blackpool, Bolton, Bradford, Cambridge, Canterbury, Cheltenham, Chesterfield, Coventry, Crewe, Croydon, Derby, Doncaster, Folkestone, Gloucester, Guilford, Lancaster, Luton, Maidstone, Middlesbrough, Milton Keynes, Norwich, Nuneaton, Peterborough, Preston, Stoke-on-Trent, Swansea, Swindon, Truro, Wakefield, Warrington, Watford, Wembley, West Hampstead, Wolverhampton, Worcester and York

3.17 This has provided an appreciation of the markets each station caters for. For instance, some stations have a clearly defined market they serve but others present a balanced mix of markets. This analysis equally shows the proportion of commuter journeys overall from each station, which was undertaken using ticket type data from MOIRA.

3.18 Figure 3.1 below shows the different sizes of each market type for the parkway stations in the evidence base.

Figure 3.1: Market sizes from/to selected parkway stations based on top 20 flows[11]



[11] Note that this analysis was conducted on the top 20 flows for each station and therefore the 2018/19 journeys do not reflect the total presented for the station.

3.19 The analysis above suggests that the largest parkway stations largely rely on serving passengers bound for London. The busiest stations tend to serve both London and other regional centres, such as Didcot Parkway, Stockport and Bristol Parkway. This reflects the fact that they are meeting their objectives to improve inter-regional connectivity, whilst also somewhat fulfilling a service for commuters to nearby regional centres.

3.20 The analysis also shows that smaller stations located in the Midlands and Northern regions are geared towards serving commuters to regional centres such as Manchester and Birmingham, such examples including Tame Bridge Parkway and Coleshill Parkway. This is also true for smaller stations surrounding London, such as Aylesbury Vale Parkway. For these stations, their core function is to serve these commuter flows to a nearby regional centre, and hence have very few flows to other centres. As seen in Figure 3.1, the majority of these smaller stations have a commuting share of around two-thirds.

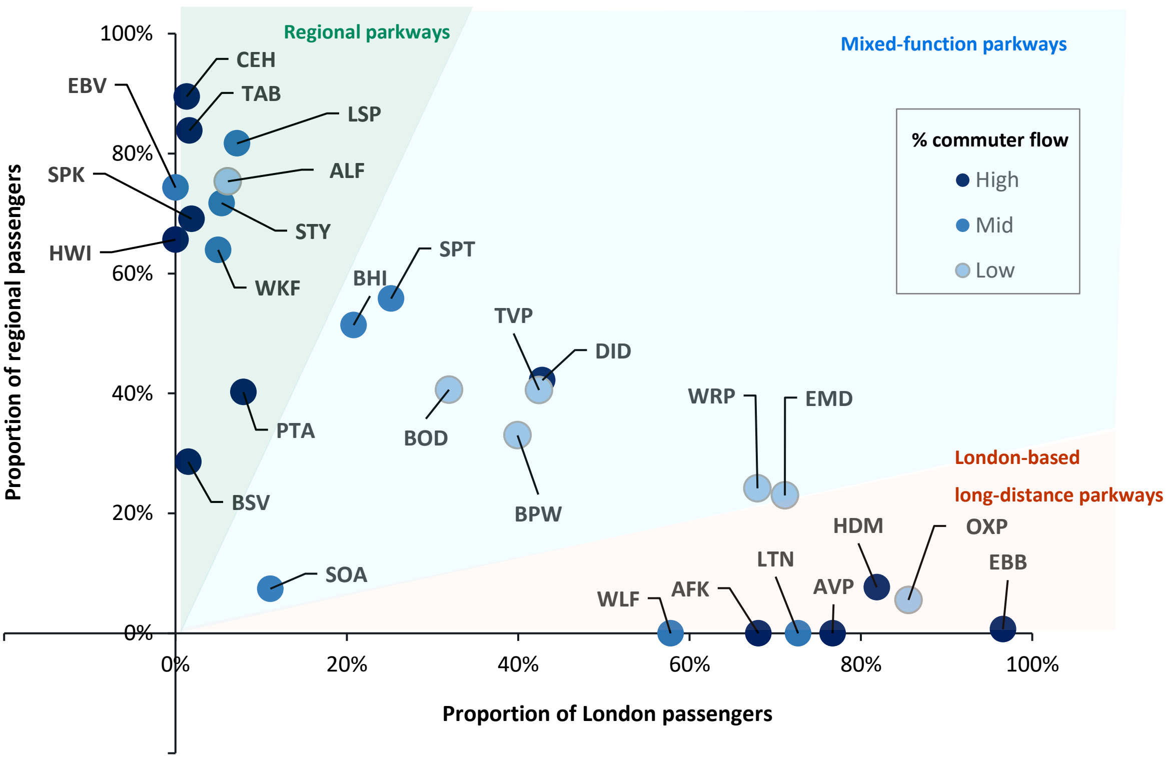
3.21 **The above analysis supports the hypothesis that parkway stations can be defined as either serving regional commuter markets or long-distance markets, typically London.**

Categorisation of parkway stations

3.22 The market analysis undertaken on existing parkway stations has informed the initial categorisation of these stations below.

3.23 Figure 3.2 below presents the selected parkway stations and the proportion of passengers travelling to London and travelling to regional urban centres, with the shade of the blobs representing the proportion of commuter trips from that particular station (note that trips to local centres or other purposes are not represented as they align less with the role of a parkway station).

Figure 3.2: Categorisation of parkway stations by function[12]



3.24 The trips visualised in Figure 3.2 can be broadly categorised under the following:

- London-based long-distance parkways, where the dominant flows are London-based
- Regional commuter parkways, where the dominant flows are to a regional centre
- Mixed-function parkways, where there is a certain balance between different flow types

3.25 A key conclusion from this analysis is that all parkway stations, to an extent, fulfil different roles; there will however be a dominant market they cater for, but it is inevitable that other markets may also be attracted by these stations.

3.26 A large proportion of parkway stations can be classed as regional commuter stations, which aim to serve **shorter distance flows** to nearby regional centres. There are no differentiators between the service between parkway stations and other stations along the line. They are typically served by only one local service which connects it to the nearest regional centre.

3.27 **The scope for a parkway station with commuter-heavy flows to improve its attractiveness is via improving accessibility to the station, e.g. being close to major roads, allowing the station to serve a wide rural catchment.**

3.28 There are some stations which primarily fulfil a local commuter service but are additionally served by longer distance services which allows for direct services to cities such as London.

3.29 The long-distance/London stations can be classed as those which can facilitate commuter flows but are also served by a range of longer distance services which allow for choice for the user. They have characteristics which distinguish their user attractiveness from local comparator stations, such as being able to **provide faster, more frequent or more direct services**. They may

[12] The proportion of commuter trips is categorised as follows: High >60%, Mid 50-60%, Low <50%.

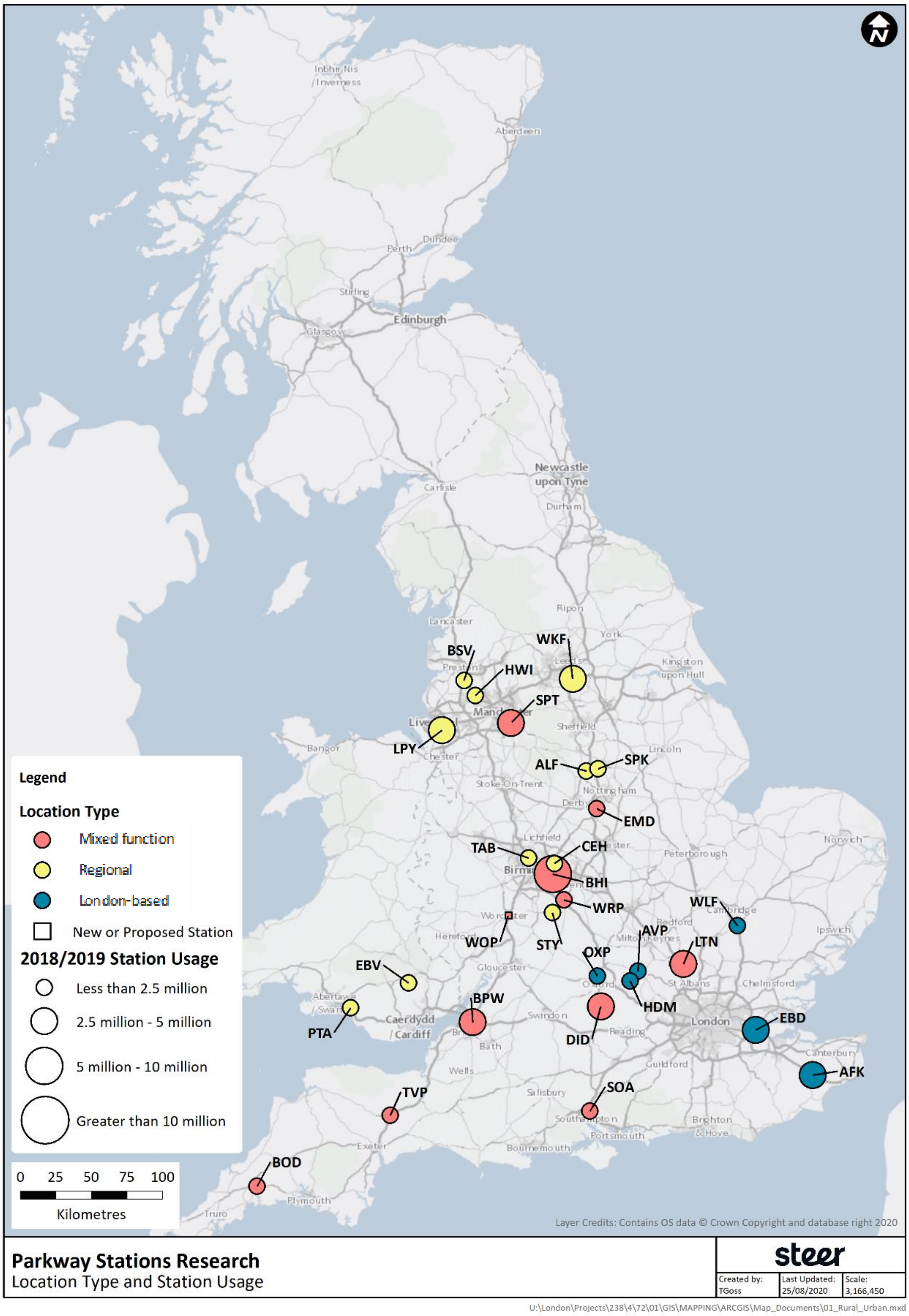
have a greater range of destinations, such as Ebbsfleet and Ashford international being connected via Eurostar to Paris and Brussels. The success and effectiveness of these stations is primarily due to the enhanced rail connectivity provided in comparison to commuter parkway stations, which typically are only served by one service. They also facilitate connectivity and act as new regional train hubs, allowing for passengers to transfer between different services.

3.30 **The scope for these parkway stations to improve its attractiveness is via both improving accessibility to the station to maximise the catchment potential and also by providing a greater rail connectivity through a faster more direct service to key destinations than local comparator stations.**

3.31 Lastly, there are parkway stations which may perform other functions. One such function is to serve airports. They may play some strategic role and benefit from both local and longer-distance services calling at the station such as Luton Airport Parkway but are generally not designed to function as long-distance parkways as others are in the selected list. Another function may be to unlock a new catchment which was previously unserved by the railway, with the aim of enabling a modal shift of users who previously drove the full journey. Other functions are examined on a station by station basis in the appendices.

3.32 Figure 3.3 below presents the location and volume of users of parkway stations across GB, along with the classification used above.

Figure 3.3: Location and annual users of Parkway stations across Great Britain

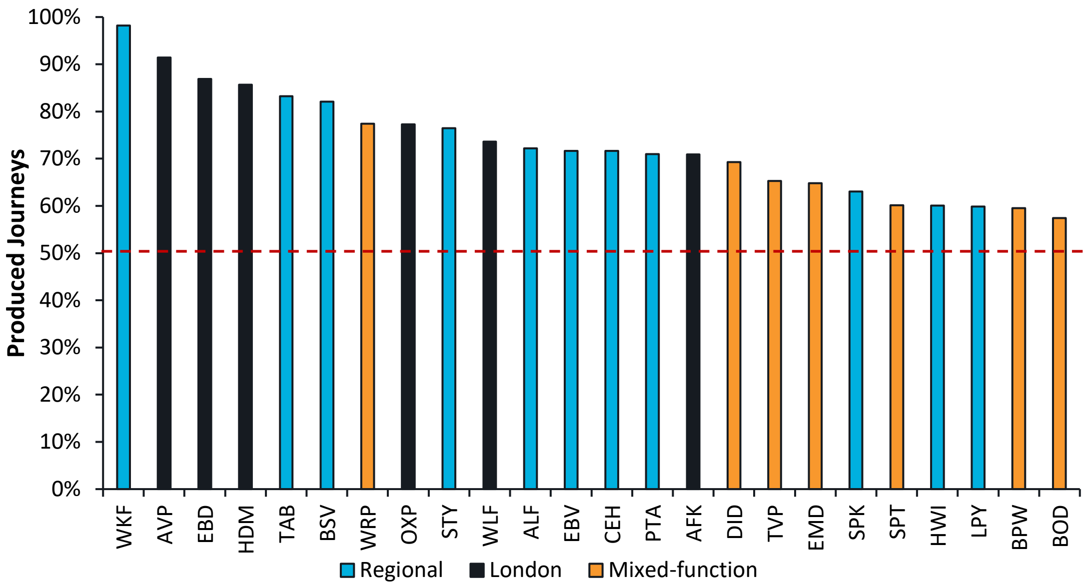


3.33 It is important to note that Ebbsfleet international and Ashford International are served by Eurostar services, which does not appear in the data analysed. They are unique in nature as they fulfil both providing a commuter service to London and long-distance services to Paris and Brussels.

3.34 In conducting further analysis on the selected stations, journeys data for 2018/19 was extracted from the MOIRA revenue and journeys matrix. This allowed the extraction of key flows for each of the parkway stations. The information comes in producer-attractor format (as opposed to origin-destination), which allows to observe the extent to which journeys are generated from the parkway stations or from elsewhere.

3.35 Figure 3.4 displays the proportion of demand that is produced at each parkway station.

Figure 3.4: Proportion of produced journeys at each parkway station



3.36 As seen in the chart, most stations act as producers of journeys. Around two-thirds of stations analysed in the evidence base have over 70% of their journeys produced at the station. This aligns the function of a parkway station, where typically there is not much demand being attracted to the station as they are usually not a destination on their own right. Instead, people who live in close proximity to the station are able to access them and continue their journey elsewhere.

3.37 It is also worth noting the stations that are attractors tend to have an attraction nearby, such as an airport or arena. This is because they do not solely act as 'parkway' stations, but also as attractors for people who want to travel by air or visit the place of interest.

3.38 **The above results support the hypothesis that given that parkway stations tend to be located away from congested areas [2.39], a higher proportion of journeys are produced at the station, rather than being attracted to the station.**

Another piece of insight that MOIRA analysis provided was the top destinations for each station.

3.39 Table 3.1 lists the parkway stations ranked by the average distance travelled to and from that station (weighted by journeys), and also lists the top two destinations and the proportion of demand they hold (amongst the top 20 flows).

Table 3.1: Station average travel distance and top destinations

Station	Average distance (miles)	Primary destination (% of demand)	Secondary destination (% of demand)
Bodmin Parkway	91	London (32%)	Plymouth (29%)
Tiverton Parkway	84	London (42%)	Bristol (17%)
East Midlands Parkway	80	London (71%)	Leicester (12%)
Warwick Parkway	63	London (68%)	Birmingham (23%)
Bristol Parkway	55	London (40%)	Bristol (19%)
Oxford Parkway	48	London (86%)	Bicester (6%)
Stockport	47	Manchester (48%)	London (25%)
Ashford International	38	London (62%)	Canterbury (13%)
Haddenham & Thame Parkway	36	London (82%)	Oxford (6%)
Aylesbury Vale Parkway	33	London (77%)	Amersham (7%)
Didcot Parkway	33	London (43%)	Oxford (21%)
Wakefield Westgate	32	Leeds (55%)	Doncaster (10%)
Whittlesford Parkway	30	London (58%)	Cambridge (28%)
Alfreton	30	Nottingham (29%)	Sheffield (24%)
Port Talbot Parkway	29	Cardiff (36%)	Swansea (22%)
Liverpool South Parkway	23	Liverpool (64%)	Manchester (15%)
Stratford-upon-Avon Parkway	21	Birmingham (72%)	Stratford-upon-Avon (6%)
Ebbsfleet International	20	London (97%)	Ashford (1%)
Ebbw Vale Parkway	17	Cardiff (74%)	Rhymney (6%)
Buckshaw Parkway	14	Blackrod (34%)	Manchester (29%)
Sutton Parkway	13	Nottingham (68%)	Mansfield (16%)
Horwich Parkway	13	Manchester (66%)	Chorley (8%)
Coleshill Parkway	11	Birmingham (85%)	Leicester (5%)
Tame Bridge Parkway	8	Birmingham (84%)	Walsall (2%)

3.40 It shows that passengers who travel for longer distances are those that go to London – the 10 stations with the longest average journey distances all have direct services to London, with London being a key destination The stations at the bottom end of the table offer more local services to the key cities surrounding them, and no direct service to London.

3.41 **This supports the hypothesis that parkway stations are more likely to provide a direct service to London or a regional centre, which are unattractive for access by car due to congestion and lack of affordable parking. [2.33]**

Catchment analysis

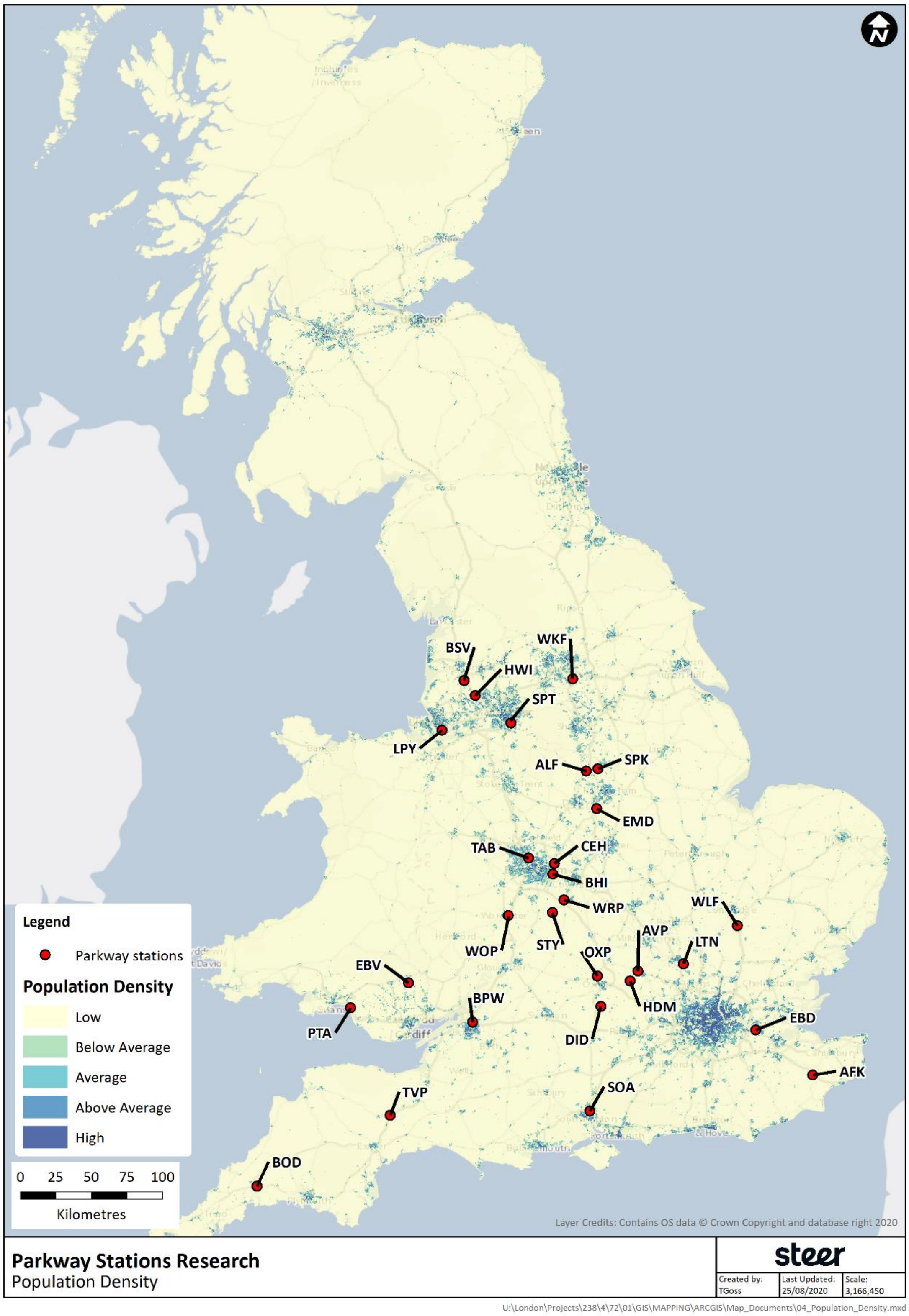
3.42 Evidence from the literature review showed that parkway stations tend to be located outside of densely built-up areas where road congestion is expected to be lower. [2.31] Depending on their local context, they appear to be located between 5 and 20 km from the city centre. [2.32]

3.43 Figure 3.5 shows the population density of the UK and how this relates with the location of parkway stations.

3.44 This figure supports the hypothesis that stations need to be located according to the function they provide, either at strategic rail locations to provide key intercity long-distance connectivity, outside regional urban centres providing a commuter function or in rural areas where other rail alternatives are not viable.

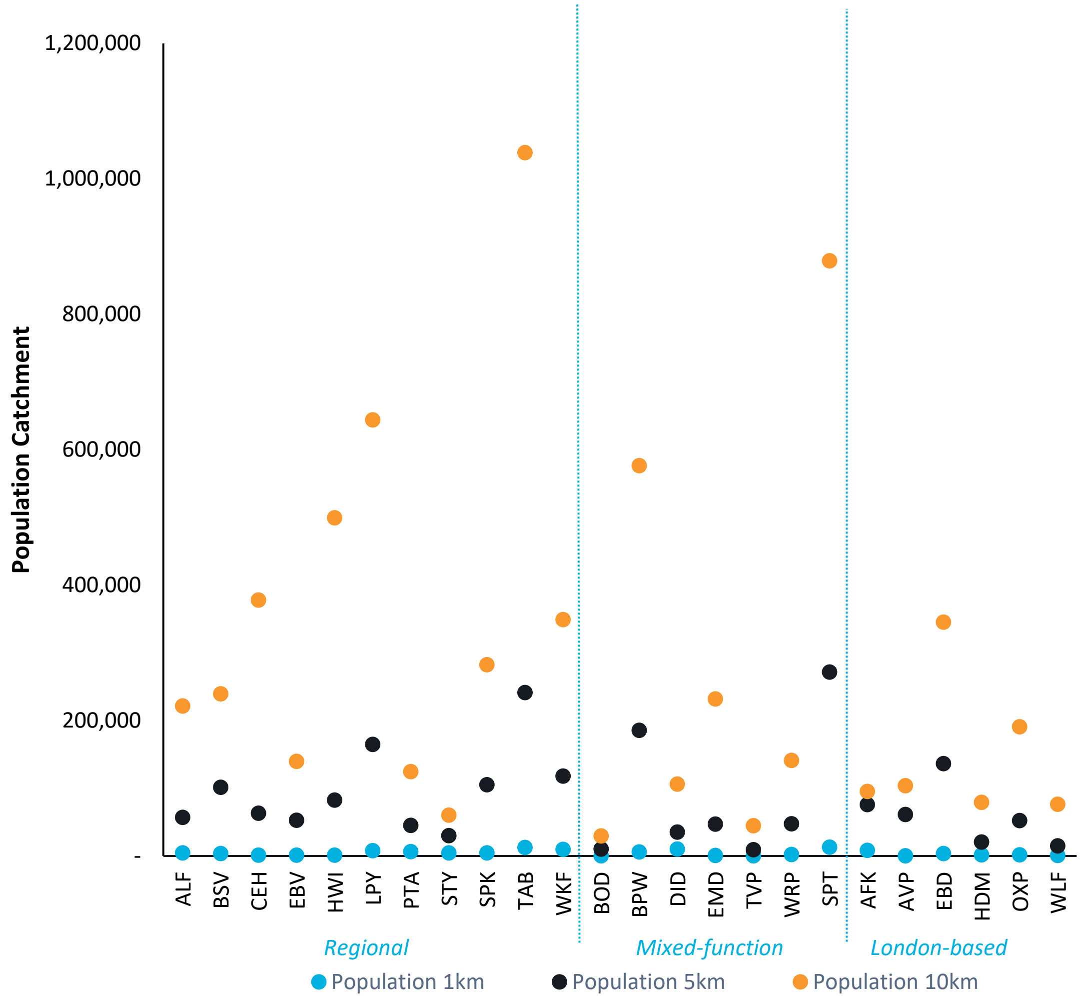
3.45 The detail of the location of each parkway station can be found in an appendix to this document.

Figure 3.5: Population density nearby parkway stations



3.46 RUDD data has enabled the analysis of population catchments around the selected parkway stations. Figure 3.6 presents the population catchment data of each station to a 1 km, 5 km and 10 km radius.

Figure 3.6: Differences in population catchments between selected Parkway stations at 1 km, 5 km and 10 km



3.47 This analysis shows that there is no clear correlation between the station categorisation and the population catchment area. **Tame Bridge Parkway** (TAB) has the largest catchment when observed at a 1 km, 5 km and 10 km catchment, benefitting from a large urban conurbation of the West Midlands. Other stations with smaller comparative immediate catchments but large 5 km and 10 km catchments include **Liverpool South Parkway** (LSP) and **Bristol Parkway** (BPW) which all serve the edges of their respective cities.

3.48 However, despite the larger immediate catchment, TAB has far fewer annual journeys than LSP and BPW (0.6m compared to 2.4m and 2.2m respectively). This suggests that other factors other than the station catchment have a strong influence in determining whether a parkway station is competitive against other alternatives and attractive to passengers, such as the access to the station or the rail service.

3.49 For instance, **Tame Bridge Parkway** (TAB) has many competing railway stations within a 5 km radius. Contrast this to **Alfreton** (ALF) station which stands out as being the only viable option for that catchment radius. This would suggest that Alfreton would be able capture a higher proportion of its catchment area, due to the lack of attractive alternatives.

3.50 Parkway stations in smaller urban centres such as **Wakefield Westgate** (WKF) have a large local catchment but smaller wider catchment when compared to other stations on the list.

3.51 It is interesting to note the relatively small size of the catchment area is for some of the stations in located in rural areas, namely **Bodmin Parkway** (BOD) and **Tiverton Parkway** (TVP), which even at the 10km level serve a sparse population. In reality, these stations serve an even larger catchment due to the lack of competing stations in their regions, coupled with good road accessibility in all directions.

3.52 Some stations such as **Didcot Parkway** (DID) and **Port Talbot Parkway** (PTA) have benefited from being existing stations on the Great Western Main Line railway network since the mid-19th century, and have thus the small villages have grown overtime and now have sizeable local catchments. However, a large portion of the railway users still travel to the station from a wider catchment.

Generalised journey cost analysis

3.53 Following the initial categorisation of parkway stations, this section explores how competitive journeys using parkway stations are when compared to other modes or local alterative stations.

3.54 This was explored by estimating the Generalised Journey Cost (GJC) for key flows from selected parkway stations using PDFH and TAG principles. The key components of the GJC are the following:

- Access time to station or bus stop (assumed to be 10 minutes, and perceived as 20 minutes as per PDFH walk time weighting assumptions);
- Frequency penalty (based on PDFH6);
- Interchange penalty (based on PDFH6);
- Journey time; and
- Direct costs (including car parking cost, rail or bus fare, and fuel cost for car).

3.55 Parkway stations unlock the opportunity for improving generalised journey cost in two ways:

- By being strategically located on the road network in proximity to major roads which allows for a wider catchment to access the station
- By being strategically located on the railway network, typically on main lines which allow for faster journey times from the parkway station to the destination, when compared to local alternatives.

Figure 3.7: Illustrative journey via parkway station

3.56 Below is a detailed analysis of three parkway stations to understand how they compete against other alternatives. These are Alfreton, Didcot and East Midlands Parkway. These examples were selected to observe different types of parkways across Great Britain with each station serving different types of markets and regions, particularly the differences between regional and London-based parkway stations

Alfreton

3.57 Alfreton provides access to disperse populations to nearby regional centres, namely Nottingham and Sheffield.

3.58 Alfreton was originally opened as Alfreton and Mansfield Parkway, offering local access for those in the vicinity of the station, as well as parkway rail access to Nottingham and Sheffield for those living further away in Kirkby and Mansfield. However, following the opening of passenger services on the Nottingham-Worksop line, including a station at Kirkby, Alfreton's role as a parkway station has changed.

3.59 The tables below show the comparison of the GJC via different alternatives to key destinations from Alfreton.

Table 3.2: Flows from Alfreton - GJC by mode

	Nottingham	Sheffield	Manchester	London	Leeds
Car	£24	£29	£57	£83	£37
Bus	£27	£37			
Rail	£22	£22	£44	£84	£40

Table 3.3: Alfreton and Kirkby in Ashfield to Sheffield – GJC by local station

Flow	Fare (Rail + Car Park)	Perceived Time	GJC
Alfreton – Sheffield	£11	75	£23
Kirkby in Ashfield – Sheffield	£9	212	£44

Table 3.4: Alfreton and Kirkby in Ashfield to Nottingham – GJC by local station

Flow	Fare (Rail + Car Park)	Perceived Time	GJC
Alfreton – Nottingham	£10	76	£22
Kirkby in Ashfield – Nottingham	£2	78	£15

3.60 Table 3.2 shows that for journeys to Nottingham, Sheffield and Manchester, using the parkway station is the best option. However, passengers that want to travel to London and Leeds would be better off using car, mainly because of the adverse rail perceived journey time due to a lack of direct services to these destinations.

3.61 Table 3.3 compares the GJC of Alfreton to Sheffield against another station within the local area. While the fare is similar for both flows, passengers travelling from Kirkby in Ashfield would have to interchange at Worksop, which means the perceived time is significantly worse than travelling from Alfreton.

3.62 On the other hand, Table 3.4 compares the GJC of the same stations but to Nottingham. While the GJC is similar from Alfreton to Sheffield and Nottingham, the journey from Kirkby in Ashfield to Nottingham is more attractive than from Alfreton. This reflects the direct service from Kirkby in Ashfield to Nottingham, following the opening of the Kirkby in Ashfield station.

3.63 This shows that the success of a parkway station is not only dependent on their location, access and rail service, but on the competing alternatives, as Alfreton is attractive for journeys towards Sheffield but not anymore to journeys to Nottingham.

Didcot Parkway

3.64 Didcot Parkway is a London-based long-distance parkway station that primarily aims to serve a wide catchment and connect them to both London and other centres. Didcot Parkway provides access to London for surrounding rural areas that do not have an adequate rail service, attracting many commuters to London and other regional centres.

3.65 The tables below show the comparison of the GJC via different alternatives to key destinations from Didcot Parkway.

Table 3.5: Flows from Didcot Parkway – GJC by mode

	London	Oxford	Reading	Swindon	Bristol TM
Car	£57	£23	£25	£27	£48
Bus		£21			
Rail	£38	£20	£19	£25	£46

Table 3.6: Didcot Parkway and Appleford to London – GJC by local station

Flow	Fare (Rail + Car Park)	Perceived Time	GJC
Didcot Parkway – London	£24	83	£38
Appleford – London	£21	155	£47

3.66 While a significant share of journeys from Didcot Parkway travel to London, the regional centres around it (such as Oxford and Reading) are also popular destinations for passengers. Didcot Parkway is situated in a prime location on the Great Western mainline, with high speed and direct services to the majority of the key locations around it. This is demonstrated in Table 3.5, which shows that rail is the least costly (in terms of GJC) mode of choice to all the chosen destinations. This is also why it is one of the more popular stations from the list of parkway stations.

3.67 Table 3.6 presents Appleford as an alternative local station. The journey time is almost twice that from Didcot, despite being just one stop away, and this is due to an adverse service frequency and the need to interchange (likely at Didcot).

3.68 This shows that the rail service to the primary destination is key to determine the success of a parkways station.

East Midlands Parkway

3.69 Similar to Didcot Parkway, East Midlands Parkway is a London-based long-distance station that primarily aims to serve a wide catchment and connect them to London and other national centres. East Midlands Parkway provides the local catchment with access to the rail network without the need to park in Derby or Nottingham city centre. It also provides access to the local airport.

3.70 The tables below show the comparison of the GJC via different alternatives to key destinations from East Midlands Parkway.

Table 3.7: Flows from East Midlands Parkway – GJC by mode

	London	Leicester	Nottingham	Manchester	Birmingham
Car	£75	£26	£21	£57	£36

	London	Leicester	Nottingham	Manchester	Birmingham
Bus					
Rail	£77	£23	£21	£75	£46

Table 3.8: East Midlands Parkway and Derby to London – GJC by local station

Flow	Fare (Rail + Car Park)	Perceived Time	GJC
East Midlands Parkway – London	£54	139	£77
Derby – London	£56	141	£79

3.71 East Midlands Parkway seems to be somewhat of an outlier amongst the list of parkway stations. This is because it has significantly lower passenger journeys associated with it than many of the other parkway stations that are located on principle route into London.

3.72 Table 3.7 points towards why this may be the case. The rail offer from East Midlands Parkway does not appear to provide significant GJC savings when compared to alternative modes and stations. In particular, passengers are slightly better off travelling by car into London, which is the station's most popular destination.

3.73 This is because the high direct costs driven by the rail fare, which supersede any time savings from the quicker perceived journey time. Additionally, for Leicester and Nottingham, while there are direct cost savings for travelling by rail, the perceived journey time for rail is increased by the frequency penalties (around 2tph to these destinations). For Manchester and Birmingham, car offers a significant GJC improvement, as there is no direct route to these destinations meaning the perceived rail journey time is significantly higher.

3.74 Table 3.8 presents the Derby to London flow as a comparator to the East Midlands Parkway to London flow. This showed very minimal direct cost savings, as well as perceived time savings. This may also provide some insight into why East Midlands Parkway does not have as many journeys as other London-serving stations, as there is no significant benefit in using this station over the other local stations on the same line.

3.75 The lack of significant journey time savings may also explain the low commuting share of passengers, as it is more likely that it will be used by leisure passengers travelling for the weekend, or who do not mind a slightly longer travel time if they can save on the fare. This station has one of the highest leisure passenger proportions (22%) amongst all the selected parkway stations.

Factors supporting the attractiveness of parkway stations

3.76 The following section summarises the additional research findings into how the two main factors that make the journey via a parkway station more attractive to other alternatives: road accessibility and rail connectivity.

3.77 It should also be noted that other factors may also have an impact on the attractiveness of parkway stations, such as car park charges. Appendix A presents a summary of the analysis conducted on the impact of car park charges.

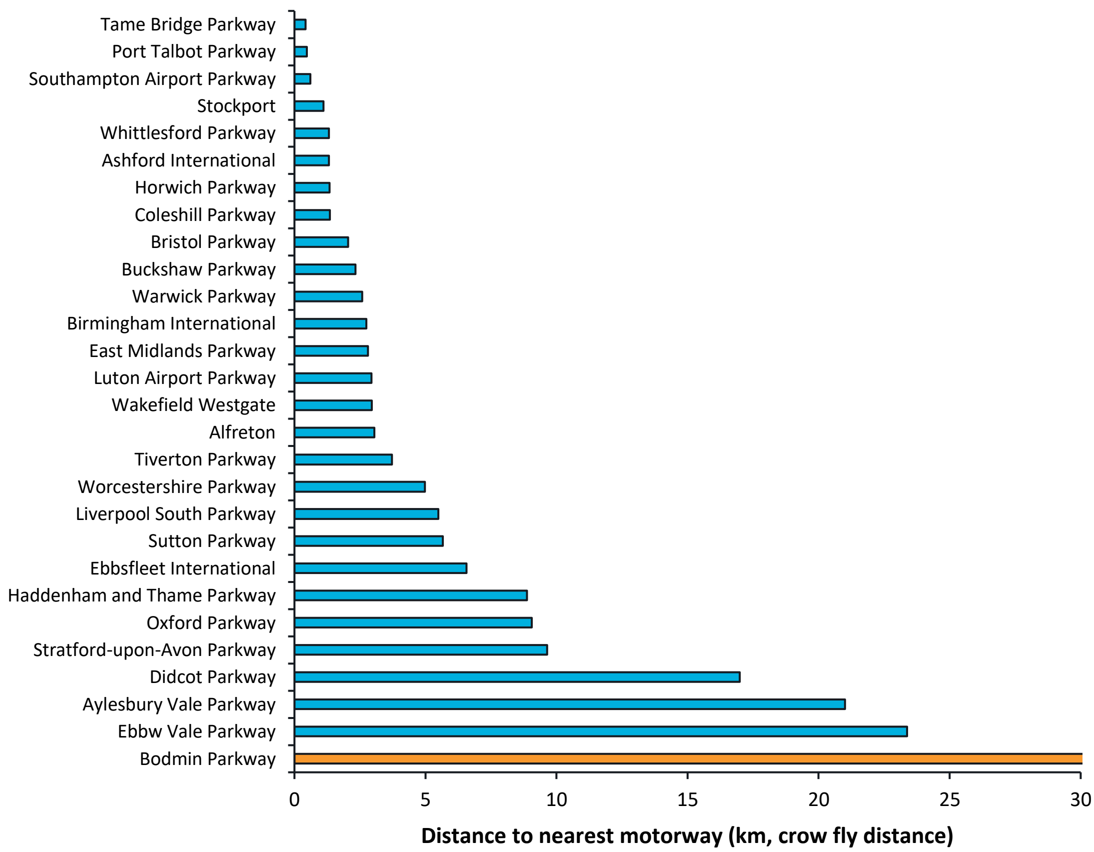
Road accessibility

3.78 Station accessibility is a very important criterion to assess the case for a new station. Most significantly, station accessibility for parkway stations has a strong focus on road access driven by the nature of these stations which induce car access from a wider catchment area.

3.79 The literature review indicates that parkway stations are likely to be located near a highway, typically under 1 km, boosting the attractiveness of car access. [2.38]. It was also found that the potential station catchment area is not well served by public transport and hence driving to the station is the only option to access a wider catchment. [2.34]

3.80 Figure 3.8 shows the distance from the parkway to the nearest strategic motorway.

Figure 3.8: Distance to the closest motorway (km, crow fly distance)



* Bodmin Parkway (BOD) which is situated in Cornwall has no motorway network. Nonetheless, it is strategically located near the key junction of the A30 and A38, two roads which form the spine of Cornwall.

3.81 One characteristic shared by almost all parkway stations analysed is that they are adjacent to a motorway. 15 of the stations are within 3km of a motorway and almost all are within 10km.

3.82 In many cases these stations are located at key road intersections, such as at a junction between two motorways or a motorway and a major A road, which further increase the driving catchment of these stations.

3.83 A good example of this is **Coleshill Parkway** (CEH), located near the M6, M42 and M6 Toll roads and **Tiverton Parkway** (TVP), located near a junction where the M5 meets the A361.

3.84 Of those stations not near motorways, they all tend to be near a significant A road for the region.

3.85 **Aylesbury Vale Parkway** (AVP) is located near the A41, a major corridor from London and the A418, providing road access from all four points of the compass.

3.86 **The evidence above supports the hypothesis that there is a strong relationship between the location of parkway stations and their proximity to major roads. The most successful parkway stations are strategically positioned at key junctions, enabling road access from all directions.** [2.38]

Rail connectivity

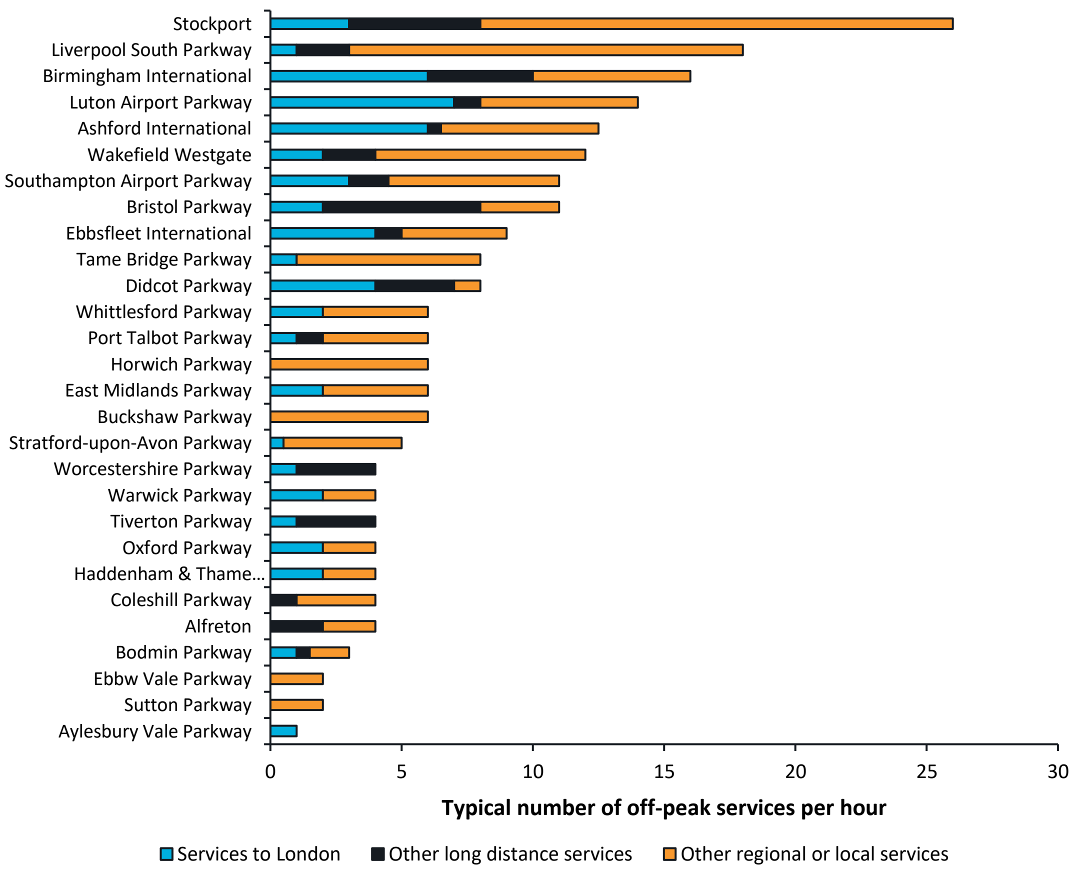
3.87 Equally as important in improving journey times for users is the level of rail connectivity from the station to the wider rail network.

3.88 The literature review indicates that parkway stations are more likely to be strategically located along the rail network and can hence provide access to more destinations at higher frequencies and result in more competitive journey times when compared to local alternative stations. [2.38]

3.89 From the exploratory analysis, 20 out of 33 existing parkway stations are located on main lines. 10 of these stations are also located at junctions where they also serve a minor line.

3.90 Figure 3.9 shows the typical number of off-peak services calling at each of the parkway stations analysed, categorised by type of service.

Figure 3.9: Typical number of off-peak services per hour, categorised by type of service[13].



*

Note that these frequencies may change during peak periods. However, for most services, the difference between peak and off-peak service patterns was not significant.

[13] Source: National Rail Enquiries Timetables and Live departure boards.

3.91 **These observations support the hypothesis that parkway stations are strategically located on the rail network and can hence provide a fast service to key destinations at higher frequencies when compared to local alternative stations [2.38]. This enables parkway stations to be well positioned to attract users who drive further to that station to specifically access fast and frequent, longer distance trains.**

Defining the functions of a parkway station

3.92 This exploratory analysis into the markets served by parkway stations has reaffirmed and added to the initial definitions and functions of parkway stations first hypothesised in the literature review. Each parkway station can be categorised as performing either one or both of the functions below:

Regional commuter parkway stations

Function: Stations which allow for local access to the regional centre. They aim to target users who are attracted by the ease of parking at the parkway station and take a train to the city centre rather than driving the full journey to the city centre. They normally serve semi-rural and suburban catchments on the fringes of regional centres where providing train stations for every individual settlement would not be viable, or where car parking at other local stations is not possible. They are focused on creating new shorter-distance flows from people who live on the edges of urban area and aim to create a fast and direct service into the closest city centre. They differ from London-based long-distance parkways in that they do not target interregional journeys, and key destinations directly served by the parkway station is typically limited to just one or two regional centres.

Objective: The key objective is to improve mobility within the region. This is achieved by providing more competitive journey times by using the railway which in turn also causes a modal shift away from the car, reducing congestion. They also aim to unlock new catchments which were previously unserved by the railway. These commuter parkway stations typically serve several smaller

London-based long-distance parkway stations

Function: Stations which allow users to easily access an interregional or intercity network who would otherwise have to travel to a city centre first before continuing on by train. In these cases, the station aims to target users who can drive to the station and continue their journey on a long-distance service to London. This function means users can avoid driving and parking at a congested city centre station or get the bus to the city to make an intercity journey. Many of the London-based parkway stations benefit from providing long-distance services which local alternatives cannot provide. They therefore abstract demand from local stations. In addition to the above, they may also serve commuters and allow for interchanges between local and long-distance services.

Objective: To improve mobility on a national scale through improving journey times for long distance journeys and causing a modal shift from road to rail. They allow users to access the national rail network and allow for faster and more frequent journeys to London or their primary long-distance destination.

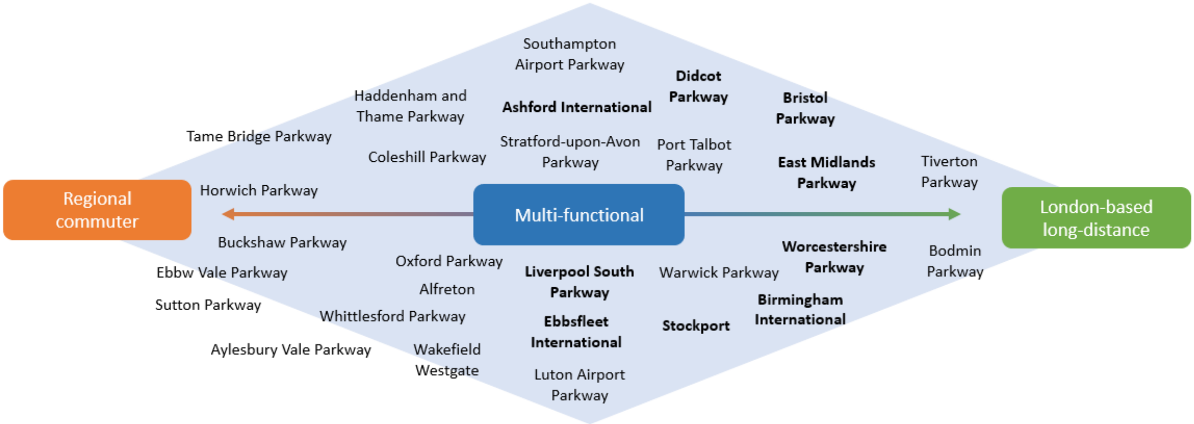
3.93 It is important to note that many stations may fall between these two groups, and provide multiple functions, for instance:

- **East Midlands Parkway** acts as a London-based long-distance parkway station improving journey times to London whilst also unlocking a new rural catchment which was previously unserved by the railway.

- **Liverpool South Parkway** acts as a London-based long-distance parkway station which allows for the greater Liverpool area to access fast services to Manchester and Birmingham whilst also providing a faster commuter service for locals to access Liverpool city centre and a faster regional commuter service to Manchester than local alternative stations.

3.94 Based on this classification, stations have been plotted in Figure **3.10** below according to this categorisation, where stations sharing several functions have been represented in between these categories:

Figure 3.10: Functional map of selected parkway stations



4 Success criteria

4 Success criteria

4.1 Based on the findings of previous sections, this section first defines what the intended role and objectives of the parkway station are, as well as what benefits that can be anticipated from it. This should also consider the perspectives of different stakeholders who will have varied interests.

4.2 Additionally, there will be an intrinsic relationship between the role (and the potential users) of the station, and what success looks like. This reinforces the idea that no one size fits all, and so any strategic case will need to carefully define the station's objectives.

4.3 A framework which links the benefits of a parkway station to appropriate drivers has been proposed. The relative importance of these drivers will be linked to the role of the station and needs to be assessed on a case-by-case basis.

Defining the outcomes of a parkway station

4.4 The literature review and investigation into existing parkway stations across Great Britain has led to the formulation of a list of key outcomes parkway stations aim to achieve. Each of these proposed outcomes have been mapped to different stakeholder groups, in terms of their importance for their decision-making processes.

Table 4.1: Outcomes and benefits of a parkway station by stakeholder type

Outcomes/Benefits	Railway users	Non-users	National policy	Local policy	Railway industry
Journey time savings from quicker travel between origin to destination	●		●		
Reduction in congestion in city centres, leading to quicker and more reliable journey times		●		●	
Modal shift from car only journeys to car + public transport trip journeys		●	●	●	
Redistribution of car kilometres from more to less congested areas				●	
Provision of **better accessibility** to poorly connected areas	●			●	
Improved overall **air quality** and **noise**, offset by worsening near the parkway station		●	●	●	
Net revenue generation linked to additional rail users and car park users					●
Improvements in amenity, severance or accidents		●	●	●	

4.5 In addition to the key outcomes and benefits listed above, there are several other benefits that may come as a knock-on effect of creating a functional parkway station. These include potential cost savings for users, which may come from cheaper parking at a parkway station when compared to parking in a city centre. Successful parkway stations may also unlock further housing and economic development opportunities through improving the accessibility and attractiveness of areas. However, these multiplier effects have not been considered for this study.

Railway users

4.6 When choosing to travel, railway users will consider several factors, which will be captured in their perceived generalised journey cost. This includes both, the overall **journey time** saving when compared to their current best available option, and their **perceived journey time**. The latter may be influenced by a range of factors, such as the comfort of being on a train and being able to work or read, when compared to driving and trying to find parking in a congested area. Also contributing to the generalised journey cost is the cost savings to the user through consuming less fuel, reduce car running costs and from the cheaper car parking costs at a parkway station relative to the city centres.

4.7 There are a number of reasons why the generalised journey time for users of parkway stations can be more attractive than alternative routes and modes. These include:

- The parkway station being strategically located on a major road which allows fast access from the journey origin to the parkway station.
- Faster railway journey from the parkway station to the destination station, as well as convenient egress time to the final destination, when compared to local railway alternatives that currently exist.
- A more competitive and convenient journey time (and cost) of using a combination of car and rail compared to car only travel.

4.8 For example, a user wishing to travel from a small town in the East Midlands to Central London could benefit from a faster journey time by driving to East Midlands Parkway and catching a direct service to London when compared to:

- Travelling to a station by car or public transport to a city centre, such as Derby, before continuing a journey to London by train.
- Driving the full distance to Central London, including travelling on the congested roads within inner London, as well as incurring additional costs in London such as the congestion charge and car parking.

4.9 A number of users can find parkway stations attractive compared to other options particularly where there is currently a lack of rail and public transport services. Better **accessibility** can therefore improve journey times for users, as well as offering more opportunities for both users and employers through improving the geographical reach of employees.

Non-railway users

4.10 Non-railway users will mainly benefit from **the reduction in congestion** on the main roads. This will be primarily driven by **modal shift** of other commuters opting to travel a portion of their journey by train. For example, additional use of park and ride stations, such as Coleshill Parkway and Birmingham International, would reduce congestion on the major access roads to Birmingham city centre.

4.11 Congestion can also be reduced in city centres through providing rail users with an alternative station for long-distance services, such as residents of Oxfordshire now having the option of driving to Oxford Parkway to access a fast service to London, instead of driving to Oxford city centre.

4.12 This will consequently reduce the traffic in urban areas, leading to quicker and more reliable journey times for commuters who still choose to drive to the city. This also extends to people who may travel by bus.

4.13 Residents and workers in urban areas will further benefit from the reduced congestion by experiencing a reduction in **noise** and improvement in **air quality** and the local environment. However, these benefits might partially be offset by air quality worsening near the parkway station as more people drive towards it. Nonetheless, any redistribution of car traffic away from urban areas where air quality levels are more likely to be at severe levels towards less polluted areas may have the potential to yield a net environmental benefit.

4.14 Users will also naturally benefit from **improvements in amenity, severance or accidents** from reduced road congestion. Reduced car traffic in urban centres can mean that more space can be dedicated to walking and cycling, making these modes of transport for attractive for shorter distance journeys within urban areas.

National policy

4.15 The national policy agenda seeks improvements for society as a whole, for instance through improving the overall efficiency of the economy and the environment or unlocking further development opportunities.

4.16 **Journey time savings** from faster and more reliable services for both railway and non-railway users will reduce lost time and generate higher productivity levels.

4.17 Likewise, improving the **accessibility** of poorly served areas will improve the geographic reach of rail users, and will provide local residents with access to different markets and industries, and consequently more job opportunities.

4.18 A parkway station can also improve the attractiveness of an area for businesses, as these locations are typically in proximity to road access and now also benefit from rail connectivity. Whilst the analysis observed that the parkway stations in the evidence base were primarily producers of journeys, the additional development triggered from the seed investment may also attract some journeys to the station. Coleshill Parkway is an existing example of an area which has complemented the development of an industrial area nearby the station. There are also plans for a new business park to be developed next to the newly opened Worcestershire Parkway station[14].

4.19 Equally, parkway stations contribute towards environmental goals to improve **air quality** and promote a **modal shift** from car only journeys to more sustainable travel modes.

Local policy

4.20 A local policy agenda is mainly focused in addressing local issues and improving the local attractiveness of their area, serving the local population and attracting new businesses and developments. They are driven to improve issues such as congestion and improving access to

[14] Business park plans near Worcestershire Parkway Station: https://www.godwingroup.co.uk/business-park-worcester-parkway/

poorly connected parts of their administrative boundary. This might be in contrast with regional and national bodies which take a wider stance on issues.

4.21 They are best placed to **evaluate and redistribute car kilometres** away from the more congested areas. They are responsible for ensuring improvements in local air quality and reducing congestion on key corridors, improving the overall mobility and therefore productivity of the local region.

Railway industry organisations

4.22 The railway industry looks to increase the number of passengers on the railway, thereby generating revenue. For parkway stations, this is achieved by encouraging those who currently drive to their destination, to consider shifting a portion of their journey to be on a train. The strategic positioning of a new parkway station can unlock a new population of potential users who fall within the catchment of the new station.

4.23 Additionally, if journey times for users improve significantly and the user costs remain relatively competitive, this will contribute to abstract users from other modes.

4.24 Train operating companies (TOCs) and Station Facility Owners (SFOs) are private entities which will look to increase their potential income through attracting new users. Furthermore, they are generally responsible for operating the station and ancillary services, including the station car parks, and can gain additional revenues from maximising their utility. On the other hand, TOCs will be cautious of minimising the negative knock-on impacts of a parkway station, by considering the adverse impact of a new station on the journey time for other rail users.

Measuring success

4.25 As discussed above, varying roles and objectives from different stakeholders will mean the success criteria may vary on a station-by-station basis.

4.26 For instance, the role of a parkway station could be to provide strategic long-distance journey opportunities from a largely rural area to major cities (e.g. between the East Midlands and London). In this case, the parkway station would enable passengers to avoid having to travel to a town-centre station (such as Derby) and then taking the train to London. Instead, it provides a quicker origin-destination connection for the parkway station users, as well as reducing the levels of urban congestion and air pollution for the rest of the non-rail users.

4.27 This type of parkway station could be claimed to be successful if it provides better travel opportunities than competing rail stations (which could be measured in total user generalised cost). Simultaneously, it should provide sufficient capacity for long-distance passengers, both on the trains and at the car park. This is to ensure that the ‘primary’ users that the station is intended to cater for (e.g. long distance passengers commuting to city centres) are not constrained by other ‘secondary’ types of users (e.g. passengers that use the car park but only travel to the next station).

4.28 In other cases, the role of the parkway station could be to simply avoid car journeys being made into town centres (which in this case could be the final journey destination). In this instance the parkway station could be perceived as successful if the combination of car and rail is more competitive than car only into the town centre.

4.29 There are a number of success drivers to support achieving these objectives, and these will depend on the role envisaged for the station. They will have to be considered on a case-by-case basis once the station’s key objectives and primary users of the stations are established.

4.30 In contrast, one can also focus on what 'failure' looks like in order establish a plan to mitigate for it. Beyond not attracting enough passengers, an unsuccessful parkway can be considered one where the intended users are constrained by other users. For example, some passengers may use the P&R services at the station, only to then carpool to their desired destination. In any case, the use of appropriate incentives can help overcome these potential sources of failure.

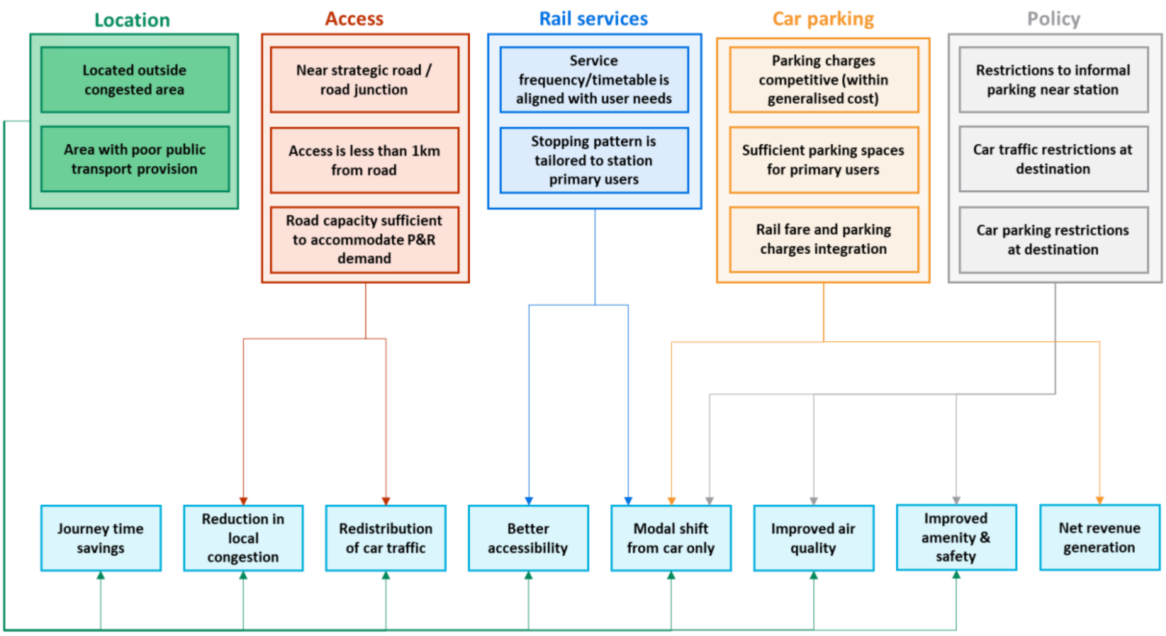
4.31 In short, success for a parkway station can be established as a two-fold assessment:

1. Travel opportunities need to be attractive with the main competitor mode, and
2. Sufficient capacity (on the trains and car park) is provided for the primary users.

Success criteria logic map

4.32 As stated above, there are various successful outcomes which are desirable for a parkway station, as well as numerous drivers which support them. Because of the multiple dimensions, which sometimes overlap, a logic map has been developed between the success factors and the benefits, as shown in Figure 4.1. This presents each of the key outcomes (or benefits), described earlier in Table 4.1, and connects them to the various drivers which enable them to be achieved.

Figure 4.1: Success criteria logic map



4.33 Each of the success drivers and their components illustrated in Figure 4.1 are described in further detail in Table 4.2 below:

Table 4.2: Summary of success themes and criteria

Theme	Commentary	Success Criteria
Location	This is the most significant of the drivers as it is directly linked to the majority of the outcomes.	Station should be located outside of congested areas to avoid traffic when accessing the station.
		Station should be in an area where there would otherwise be poor public transport provision.

Theme	Commentary	Success Criteria
Access	Refers to the ease in access and egress from the station for the users. It has key implications for the congestion on the roads within proximity of the stations.	Station should be located near a strategic road or junction to ensure cars can easily access it.
		The station should not be more than 1km away from a key road.
		The road capacity should be able to accommodate the park and ride demand for the station.
Rail services	This refers to the frequency and journey time of services to and from the parkway station. It has the capability to attract passengers away from their cars and onto the railway by reducing the user's generalised journey cost.	The timetabled service should be aligned with the users' needs e.g. if it primarily serves local commuters then it should provide an adequate peak service.
		The stopping pattern should be tailored to the station's primary users by stopping at key locations while also keeping in mind the journey time.
Car parking	The provision of sufficient car park spaces with an appropriate fare may reduce generalised journey cost, and consequently make the station more attractive. This will also generate revenue for the SFO.	Car park charges should be competitive (with respect to generalised journey cost). This will mean that the user is at least as well-off parking at the station rather than at the destination.
		Should provide sufficient car park spaces for the primary users so that they are not deterred from the difficulty (and time) to find a space.
		The parking charges should be integrated with the car park charge to some extent to ensure it is proportionate to the cost of travel.
Policy	The benefits generated from this driver are in line with the key national objectives reflected in Table 4.1 and involve making the station a more attractive (and sometimes cheaper) option	Restrictions to informal parking near the station to ensure the car park is utilised.
		Car traffic restrictions at the destination (e.g. congestion charge) will encourage using public transport as an alternative to driving.
		Car parking restrictions at the destination will encourage users to use the station car park instead.

Application of success criteria in strategic cases

4.34 The role of a strategic case is to demonstrate a robust rationale for a scheme. For this, the problem the scheme seeks to address needs to be identified and as well as to demonstrate why an intervention is required to address this.

4.35 The logic map above can be used in strategic cases to demonstrate how the policy objectives can be met with the development of a parkway station. In fact, it can be used to demonstrate how objectives of different stakeholder types can be met, meeting national, regional and local needs.

4.36 This framework will also help shortlist options from a long list, given that the success criteria/drivers can be used as a basis to select the options which align best with the policy objectives.

Conclusion

4.37 This chapter described the main outcomes and benefits which allow a parkway to be seen as successful. However, it also recognises that the definition of success will differ by stakeholder type. For example, a rail passenger may class a parkway station as successful if it provides them with a quicker and cheaper journey to their destination; however, the local authorities would hold more value towards a reduction in congestion in their local road network.

4.38 Additionally, it was pointed out that success, and how it is measured, will differ on a station-to-station basis, as they often present different objectives and serve different markets. For example, some stations may be aimed at abstracting demand from other modes, whereas others may seek to provide improved access to areas where rail demand already exists.

4.39 Furthermore, the development of a logic map which outlined how these outcomes can be achieved through various enablers and drivers and listed a number of success criteria which are expected to be present in successful parkway stations, according to the evidence from the literature review and the existing parkway stations.

4.40 The next stage of the project will involve taking into account the key factors discussed in this report and developing a methodology to quantify success, with the goal being to use this in forecasting demand at new parkway station and quantifying their benefits in business cases.

5 Application to modelling

steer

5 Application to modelling

Introduction

5.1 The previous Chapter has identified success criteria, drawn from a combination of the literature review and analysis of existing parkway stations in the UK, which appear to be common to all successful parkway stations. These have been summarised in Table 4.2.

5.2 There is currently no defined standard approach to model the demand response associated with the opening of a parkway station in TAG nor PDFH. Instead there is a variety of approaches used by practitioners, and these may not necessarily be adapted to the particular characteristics of parkway stations and the behaviours of their users.

5.3 Steer's report on "Station usage and demand forecasts for newly opened railway lines and stations"[15] indicates that the difference between the forecast and actual demand varies significantly, for example:

- The actual demand at Aylesbury Vale Parkway demand was 55% lower than forecast;
- The actual demand at Liverpool South Parkway was 27% lower than forecast;
- On the other hand, Warwick Parkway experienced 19% more passengers than forecast; and
- Ebbw Vale Parkway station experienced 451% more passengers than what was initially forecast.

5.4 This shows that the existing approaches may not fully take into account all the success factors identified in the previous Chapter.

5.5 This Chapter aims to analyse the existing modelling frameworks used to model parkway stations, identify any gaps in these frameworks with respect to the success factors. Then, in the next Chapter, sensitivity analysis is undertaken considering the impact of incorporating these factors. This Chapter is structured as follows:

- Review of available modelling approaches;
- Gap analysis of two specific approaches against the success criteria framework; and
- Identification of key modelling gaps.

[15] Station usage and demand forecasts for newly opened railway lines and stations (Steer, on behalf of the Department for Transport, 2010): **https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/3932/demand-forecasting-report.pdf**

Review of available modelling approaches

Key modelling principles and possible modelling approaches

5.6 The key principle that the literature review has identified is that the decision to use a Parkway station will be as much a function of access to the rail network and the cost of doing so (e.g. car parking costs) as the rail service offer from the station. The modelling frameworks analysed in this Chapter should therefore, fundamentally, reflect the relative cost and benefits of both the access/egress and rail legs of the overall journey.

5.7 This fundamental requirement shapes the modelling approaches that are available when modelling the demand and benefits of parkway stations. Table 5.1 below lists the different existing approaches used to forecast demand for new stations, along with their advantages and disadvantages to forecasting parkway stations.

Table 5.1: Approaches used to forecast demand at new stations

Model Type	Description	Advantages	Disadvantages
Trip rate modelling	Calculates the number of people living within the catchment area of the new station. Then applies a trip rate based on existing stations that are similar in terms of key destination, rail offer and local demographic.	• Very simple approach with little modelling involved; • Does not require any origin/destination data, which can be difficult to obtain.	• Method is reliant on having an appropriate comparator station. Given the unique role and geography of parkway stations it is difficult to find a station that will match all the criteria; • Method does not identify where people may travel further to access a station with a different service offer; • Does not explicitly look at to what extent demand is abstracted from other modes or stations.

Model Type	Description	Advantages	Disadvantages
Catchment or accessibility modelling approaches	Catchment modelling gives emphasis on how people will benefit from access to a new station as well as the rail leg opportunities. It considers the catchment in more detail, by using GIS methods to allocate small zones (sometimes called 'Hexcells'[16]) or Output Areas to consider journey opportunities. It will also apply a station choice aspect which is derived from catchment analysis to allocate zonal demand to stations.	• Defines catchment areas and identifies where a station can be expected to draw demand from; • Compares levels of accessibility with and without the new station and the transfer of existing rail passengers to the new station; • This is particularly useful for parkway stations where demand may come from a wide-reaching catchment.	• May not consider the full component of generalised cost, such as considering the extent of different rail services or fares offered by the station, instead only focusing on the generalised journey time from the origin to the station; • The allocation of a zone (for example in Hexcell analysis) to a specific travel mode may sometimes be binary, and not take into account the various preferences within each zone.
Multinomial modal choice logit model	Multinomial logistic regression modelling allows evaluation of influencing factors in mode choice behaviour and identifies the users who have a preference of the new rail choice over other modes.	• A modal choice model can allow for choice modelling of multiple competing modes in one model; • Considers a full generalised cost through considering the trip's origin to destination; • Factors about the potential user base, such as their income and travel time and cost preferences can be considered.	• The model is very complex and needs accurate input data to give an accurate representation of OD flows; • Needs detailed assumptions about the time and cost of other modes, which is difficult to derive; • Will take into account all modes at once, including those that do not change. For example, it may suggest that some car users will shift to bus, despite there being no change to the bus service assumed.

[16] One simple way to subdivide the catchment area of the station for modelling purposes is to do so in small hexagonal zones. These are referred to as 'hexcells' in this report.

Model Type	Description	Advantages	Disadvantages
Binary modal choice logit model	A binary logit choice model is similar to the multinomial approach but only involves a binary choice. This is applicable to new stations where the user faces a series of binary choices, such as switching from car to rail, bus to rail and from an existing station to a new station, where the existing choices are independent.	• The model still allows for generating and comparing different generalised costs from various modes; • This fits for parkway stations where the primary sources of demand are from car users and users of existing local stations.	• The model is still driven by detailed assumptions about the time and cost of other modes, as well as origin and destination information.

5.8 Having reviewed the different modelling options available, these following conclusions are derived:

- The trip rate method, relying on a fixed catchment area, is not robust enough to provide a forecast of demand and benefits at a future parkway station. This is because it will not capture and reflect overlapping catchments with other stations, abstraction from existing stations, and the willingness of people to travel further to access a station with a different service offer.
- In most cases a multinomial method is likely to be too complex for a parkway station business case, unless there are existing models available. Additionally, it will not necessarily treat the existing modes independent to each other, and so there may be some switching between car and bus, for example.

5.9 On this basis, the most suitable emerging modelling approach is a form of access/catchment modelling, either based on an all or nothing approach or binary choice logit-based model to reflect passenger station and mode choice on OD basis. Indeed, a key consideration is whether more detailed binary choice logit-based modelling provides more plausible modelling outputs than an all or nothing assignment or not. When developing a business case for a new parkway station, it is recommended that both options (i.e. a catchment model and a logit model) are analysed in the Appraisal Specification Report and advantages and disadvantages of each of them are presented and evidenced. However, it is worth noting that this study focuses on analysing the different parameters involved in the modelling process instead of refining the modelling approach.

Main steps to model demand and benefits of a parkway station

5.10 This section summarises that main steps involved in modelling the impact of opening a parkway station. The following points provide a summary of the logical approach to projecting the demand and benefits of a parkway station:

1. Definition of strategic objectives and station location

- Definition of the strategic objectives of the station, in line with rationale of Strategic Case
- This includes setting out the markets the station is expected to cater for and the location where the station needs to be to meet its strategic objectives

2. Identify data needs

- This includes establishing whether the data in existence (and accessible) is sufficient for the modelling exercise, and what new data needs to be collected.
- Deciding on what level of geographic disaggregation will be used.
- Creating parameters specific to the station and any necessary segmentation, such as business, commute and leisure splits.

3. Definition of the catchment area

- By considering the local context of the area and the function of the new parkway station, the next step would be to identify the potential catchment area.
- This includes identifying potential geographies where users may switch from existing methods of travel for the entire journey, or from existing stations, to use the parkway station. This should be considered in a dynamic fashion and not using a fixed catchment based on distance from the station. It may also require iteration with Step 4 below.

4. Construction of the Generalised Cost (GC) functions by mode by origin-destination (OD) pair

- From the catchment analysis, origin-destination pairs of existing journeys can be constructed, for which a GC for groups of people in each pairing can be estimated, as well as the mode preference before and after the development of a new parkway station.
- From this, a generalised cost of typical journeys by mode can be constructed to assess the effectiveness the GC of journeys which use a new parkway station.

5. Set up of the choice models

- The generalised cost functions will feed into a choice model which considers shift between modes or stations by users.
- The main options to set up the choice model are using a binary choice logit model or an all or nothing approach.

6. Model demand abstraction

- Next, demand abstracted from other rail alternatives, and other modes is relevant, to the new parkway station will be determined.

7. Induced/generated demand

- Lastly, induced/generated demand which is not abstracted from other modes should be considered.
- This includes users who wish to use the railway for a new purpose due to the availability of the new option.
- This step could also be used to overlay the potential for new developments around new stations and how it may attract economic activity in a previous area through better connectivity.

5.11 Additional detail is provided below about the definition of the catchment area and the choice modelling:

Defining the catchment area

5.12 Defining the catchment area will require comparison of the end-to-end generalised cost for different modes for different station choices. The main attributes involved in a passenger's end-to-end GC for a trip include:

- Generalised Journey Time (GJT) aspects, including, in-vehicle time and frequency/interchange penalties, plus Generalised Time (GT) elements including

access/egress to/from the station. Note that these are expressed in minutes and will need to be converted to monetary values using value of time.
- The costs associated with each travel option, including differential in rail fare or car parking charges where rail is the mode used, but also the costs associated with competing modes, such as car, where car fuel, maintenance or tolls need to be taken into account.

5.13 In addition, there are other aspects which are more difficult to quantify as they are linked to modal perception or convenience, which may be reflected in the modelling but cannot easily be captured as part of the GC function. For example, some people may find comfort in having their own space when travelling in a car, while others may find disutility in being stuck in traffic.

5.14 These factors can be reflected in the weightings of the components of the GC or in the parameters of the utility function, including the modal constant, in the case of a logit model.

5.15 Whilst PDFH v6.0 provides some insight into how the GC functions ought to be constructed, there is no strict definition as to what should and should not be included. PDFH suggests each of the key components of the GC should be incorporated, summarised as follows:

- **Journey time**: value of time factors from TAG/PDFH are applied to convert this into monetary terms, accessible via MOIRA;
- **Interchange penalties**: value of time factors from TAG/PDFH are applied to convert this into monetary terms, accessible via MOIRA;
- **Frequency penalties**: value of time factors from TAG/PDFH are applied to convert this into monetary terms, accessible via MOIRA;
- **Access time**: PDFH provides weightings for the different access modes to express preference of some modes more than others. Value of time factors from TAG are then applied to convert this into monetary terms. Access times can be calculated using GIS software;
- **Reliability**: average performance minutes, which measure average lateness on rail services, can be converted into monetary terms using value of time factors from TAG, noting that this detail may not be proportionate for a parkway station. Performance data can be accessed from Network Rail; and
- **Direct costs**: this includes rail fares (from MOIRA), fuel price (cost per mile driven), parking charges (based on public data) and tolls (public data, where applicable) which will be directly added on to the other GC components.

5.16 The process to define the catchment area involves a number of iterations in which the GC from a range of zones via different possible routes/stations is calculated. The catchment area is therefore defined based on the area which contains zones which present several viable options (in terms of comparable GC via different routes).

Choice modelling

5.17 A choice model (for the route or the mode) needs to be constructed. This involves three types of users that can potentially be captured by the new parkway station:

- Those who currently travel by car;
- Those who currently travel by bus; and
- Those who use an alternative rail station: this includes users who use different access modes, which should also be considered.

5.18 Treating these three as independent of each other is the preferred option to model the choice of switching to a parkway station as binary choices. This approach captures the change in behaviour for existing travellers on each mode while holding all else constant. For example, introducing a new parkway station in an area would not impact a car traveller to use the bus (and vice versa) as these options already existed before the station was introduced.

5.19 If choosing to model these choice via a logit model (one of the approaches reviewed above which could be well suited to estimate demand for a new parkway station), these will each need their own parameters in terms of value of time, journey purpose splits and the spread parameter (where for example those choosing car are less likely to switch than those already choosing rail). These parameters will need to be determined, as well as how they could potentially differ for the type of station and market served.

5.20 A range of geographically disaggregate information will need to be collected to capture as many journey opportunities as feasible and proportionate to calculate the GC for these different geographies. There are key pieces of information required to support the analysis:

- **Origin and destination data** – note that this refers to the origin and destination of the entire trip, not just the rail stations. It is necessary to have this in order to compare the GC for travellers on all modes. For parkway stations, with a higher trip production, the origin data is most critical. Where there is a single, or obvious, station choice at the destination, full destination detail may not be required.
- **Mode share information** – at the same level of disaggregation information on the mode share is required. This will inform the current (or Do Minimum) situation, and how these mode shares can then be reapportioned to account for the new station.
- **Station access information** – at a disaggregate level, the way current rail passengers travel to the existing rail station would be required. It can be assumed that they are likely to keep this access mode, and therefore treat those who use a car separately to those who use public transport.

5.21 While there will be other data that could be used to inform the analysis (such as journey time information and rail service quality), those listed above are instrumental to the approach, and may be obtained from various sources, including:

- **Census data** – This data is easy to access and can be quite disaggregate (e.g. at the Output Area geographical level). However, it does have weaknesses in that it will not always be up to date (last available one was in 2011, followed by the census update from March 2021, which takes into account the impact of the COVID-19 pandemic). Furthermore, census data focuses on journeys to work, and so will not provide insight into leisure and business journeys.
- **Surveys** – One can conduct their own surveys in order to capture trip origin and destination information for the catchment around where the parkway station would be built. This could be beneficial as the researcher can focus their questions to obtain the exact information they need, and for the appropriate geography. However, this is expensive and time consuming, and will need to be large enough to obtain a representative sample.
- **Other existing data sources** – These could include NTEM and mobile phone data, which could give accurate information on trip origins and destinations but may be expensive. However, these will not always provide the researcher with all the pieces of information they need. For example, with mobile phone data it may be difficult to infer the access mode and the preferred mode of travel. Additionally, there will be confidentiality issues to adhere to, and such data may be expensive or have limited availability.

5.22 It is recommended that in future business cases data is obtained through surveys. However, this data can be pursued at varying degrees of detail, and so the users must mindful to keep their research proportionate to the nature of the scheme.

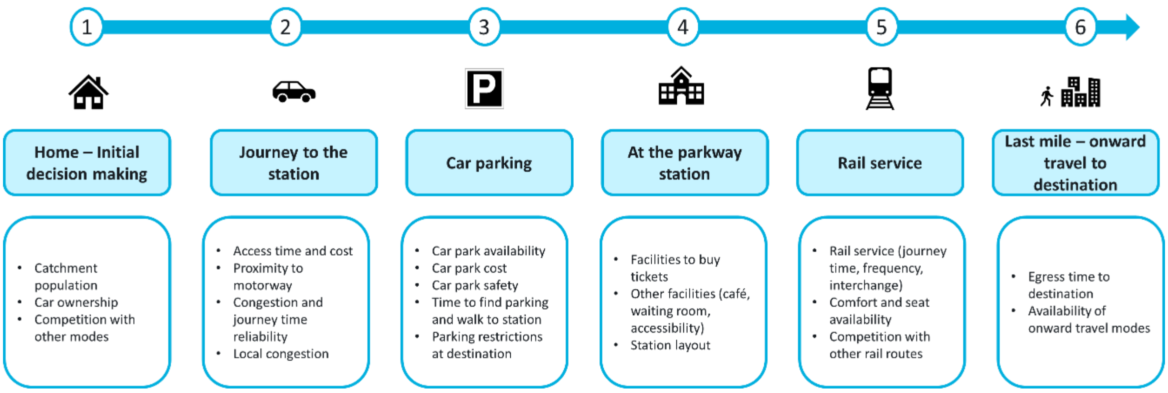
Gap analysis against success criteria framework

5.23 Once the general modelling approaches available have been reviewed, a more specific gap analysis has been undertaken comparing two 'real-world' modelling frameworks into the success criteria framework established in Chapter 4. The two modelling frameworks under review are the following:

- A spreadsheet-based catchment model:
  - This is a simple model used in the context of developing business cases for new stations which mainly focuses on comparing the Generalised Cost of travelling to a given destination using existing stations and a new station from a pre-defined catchment area, which is divided in small areas (e.g. Hexcells defined using GIS). The existing model is set up to estimate Generalised Journey Times but can be updated to include all the elements in the Generalised Cost. This has been chosen to represent a relatively simple level of models which can be used in the context of estimating demand for new stations. An anonymised version of this model was used for this gap analysis.
- The strategic model used in the North of England, NoRMS or Northern Rail Modelling System:
  - NoRMS is an assignment model, based on Cube, which uses demand and Generalised Cost matrices and assigns them to the transport network, following a number of iterations and estimating demand between the model zones by mode and route. This framework has been chosen to represent a complex assignment model which can be used to inform investment decisions, including around opening new stations. The NoRMS Station Choice Model Technical Note v4.2[17] was used for this gap analysis.

5.24 The gap analysis has been structured around the main journey six stages of a parkway station user. The success factors associated with each of the journey stages are shown in the boxes in white below each stage. These are presented in Figure 5.1 below:

Figure 5.1: Parkway station user's journey stages



[17] It should be noted that the analysis to inform this section of the report was limited to the information described in the above mentioned technical note, therefore it is possible that the model may include functionality for modelling some of the features present in the success criteria framework which do not become apparent in this technical note.

Table 5.2 and

5.25 Table 5.3 below present the gap analysis for the two modelling frameworks against the success criteria:

Table 5.2: Gap analysis summary for spreadsheet-based catchment model

Journey stage	Theme	Success factor	Success factor included in catchment model	Commentary
1. Home – Initial decision making	Location	Catchment population: size/demographic/journey purpose	Yes, catchment is considered, but there is still scope to go further into defining catchment characteristics (only population is considered)	The model generates many small hexagonal catchments (HexIDs) dividing the potential catchment of the study. HexIDs include the adult population which is used to apply weighted averages on demand. Each HexID within the wider area of the study is assigned to a station based on the lowest overall GJT (walk/drive time to the station and rail journey time) to a key destination.
	Location	Level of car ownership	No, but this model could be developed to consider car ownership factors	
	General	Generalised cost of rail vs alternative modes	While the model does not usually consider car demand, it can be set up to calculate generalised cost for car	The model only considers rail demand, not demand from other modes. It does however consider multiple rail options, from different origin stations. This model can be set up to calculate the generalised cost for other modes, such as car or bus, informing the competitiveness of rail options versus other modes.
2. Journey to the station	Access	Generalised access time/cost to the station	Yes, although accuracy depends on the quality of the data used	The driving distance and peak driving time is calculated between HexID origins and a range of stations. These are calculated with and without the new station to estimate demand abstraction. There is a similar mechanism to estimate those who may walk to the station for HexIDs within station catchment.
	Access	Proximity to motorway/SRN	No, but this is implicit in the access time calculations	
	Access	Congestion and journey time reliability (route to the station vs alternative route)	Only considers peak drive time, no added component on reliability	The model uses peak drive minutes (derived via GIS DriveTime tools such as TRACC) when modelling the overall GJT. There are no other considerations on journey time reliability. There is a future possibility to use congestion data, e.g. from Google,

Journey stage	Theme	Success factor	Success factor included in catchment model	Commentary
				which could provide a more realistic access time and better consider reliability.
	Access/wider policy	Redistribution of local congestion	No	
3. Car parking	Car parking	Car park availability	No, but it considers whether there is a paid or free car park. However, it can be adapted to model car park availability more in detail.	The model does consider whether there is a car park and whether it is paid or free. It does not to take into account car park availability.
	Car parking	Car park cost	Yes, but there is scope for more detail	For paid car parks, the model considers the car park fee and converts this into minutes for the GJT. Additionally, free car parks include an assumption that the walk time to the station will be higher on the basis that spaces are limited. The model does not explicitly consider informal, on street parking, but instead can penalise stations with no car parks by adding a higher walk time. The following car parking "penalties" are applied: 5 minutes for paid car parks, 10 minutes for free car parks and 99 minutes for car parks with no car parking facility thus removing it as an option for those who may drive to the station. This penalty can be easily adjusted.
	Car parking	Actual/perceived time to find parking and walk to the station	Yes, but there is scope for more detail	See above.
	Car parking/wider policy	How car parking options compare (e.g. at parkway vs. at city centre)	No, however the model can include the drive time to the ultimate destination (and car parking) as an option if necessary	
	Car parking	Car park safety	No	

Journey stage	Theme	Success factor	Success factor included in catchment model	Commentary
4. At the parkway station	The station	Buying a ticket	No	While it is not usually considered, it is likely to not be critical for passengers in the choice of rail station/route.
	The station	Crowding at the station	No	While it is not usually considered, it is likely to not be critical for passengers in the choice of rail station/route.
	The station	Facilities (toilets, café, waiting room/shelter, station accessibility)	No	While it is not usually considered, it is likely to not be critical for passengers in the choice of rail station/route.
	The station	Walking time to platform	No	While it is not usually considered, it is likely to not be critical for passengers in the choice of rail station/route.
5. Rail service	Rail service	Generalised cost of the rail journey - in-vehicle time, frequency, interchange, reliability of the service	Yes, considers the GJT of the rail journey, however does not to take into account the fare or other GC components	MOIRA inputs include the journey time between suburban stations and main city centre and can consider the frequency of service and penalise if there is a need for interchange. The rail GJT is adjusted depending on type of demand (full/reduced/season). This GJT can be added to the access time to provide an overall GJT. The model does not consider the Generalised Cost, not considering any fare component at all.
	Rail service	Seat availability and comfort, e.g. availability to work/relax on a train vs the car/other rail routes	No	
	Rail service	Generalised cost for other modal alternatives	While the model does not usually consider car or bus demand, it can be set up to calculate generalised cost for car and bus and test how rail compares with other modes	

Journey stage	Theme	Success factor	Success factor included in catchment model	Commentary
	Rail service	Impact on existing users	No, however this can be modelled in MOIRA for appraisal purposes	
6. Last mile - onward travel to the destination	Egress	Egress time to destination	Yes, at a simple level	The model can be adjusted to include several destinations but does not undertake any detailed modelling on the last mile.
	Egress	Availability of onward modes - bus/cycle/walk	No	

Table 5.3: Gap analysis summary for NoRMS

Journey stage	Theme	Success factor	Success factor included in NoRMS framework	Commentary
1. Home – Initial decision making	Location	Catchment population: size/demographic/journey purpose	Yes, undertaken on NoRMS station catchment module	Combines an offline Excel and Access process which is input into Cube to allocate the access/egress links between zones and stations. The technical note identifies a recent refinement of the process, which allows the user to dynamically generate catchments under a selected set of rules and represent them visually.
	Location	Level of car ownership	No explicit evidence on information reviewed	Could be part of the data part of the catchment module described above.
	General	Generalised cost of rail vs alternative modes	No, it appears that NoRMS does not model alternative modes for the full journey, but there appears to be a module which calculates highway impacts for appraisal purposes through the MECs externality approach in TAG	
2. Journey to the station	Access	Generalised access time/cost to the station	Yes, but detail of calculation not included in NoRMS Station Choice Model Technical Note v4.2	The technical note describes the principles for calculating the end-to-end generalised cost of a trip, including the access and egress legs. Where both ends are within the study area, a Variable Demand Model approach is used, whereas where one or more ends is outside the study area, an elasticity-based approach is used. The technical note did not include details about how generalised access time/cost is calculated.
	Access	Proximity to motorway/SRN	No, but this is implicit in the access time calculations	
	Access	Congestion and journey time reliability (route to the station vs alternative route)	Potentially partially included	Congestion impacts are likely to be included in the access time/cost calculation, but the review has not allowed to confirm this. The same applies for reliability, though it is less

Journey stage	Theme	Success factor	Success factor included in NoRMS framework	Commentary
				likely that this is included in comparison to what is normally included in similar models.
	Access/wider policy	Redistribution of local congestion	No	
3. Car parking	Car parking	Car park availability	No explicit evidence on information reviewed	
	Car parking	Car park cost		
	Car parking	Actual/perceived time to find parking and walk to the station		
	Car parking/wider policy	How car parking options compare (e.g. at parkway vs. at city centre)		
	Car parking	Car park safety		
4. At the parkway station	The station	Buying a ticket	No explicit evidence on information reviewed	
	The station	Crowding at the station		
	The station	Facilities (toilets, café, waiting room/shelter, station accessibility)		
	The station	Walking time to platform		
5. Rail service	Rail service	Generalised cost of the rail journey - in-vehicle time, frequency, interchange, reliability of the service	Yes	Considers the station to station GC and combines this with access/egress components to derive the cost of an end-to-end trip for a user. The note does not indicate if fare differentials are included, but NoRMS could be easily adapted to do so if it does not at the moment.
	Rail service	Seat availability and comfort, e.g. availability	Yes, considers crowding but not other 'soft' comfort aspects	The model considers the impact of crowding, and loops crowding iterations to define the probability of a user

Journey stage	Theme	Success factor	Success factor included in NoRMS framework	Commentary
		to work/relax on a train vs the car/other rail routes		travelling via a particular station and route. There is also damping of crowding applied.
	Rail service	Generalised cost for other alternatives (rail or other modes)	Yes, the Cube station to station assignment for NoRMS T2 which assigns catchment zones to a station considers an alternative GC using other modes	The CUBE station to station assignment for NoRMS T2 which assigns catchment zones to a station considers an alternative GC using other rail modes. CUBE has a functionality to turn these off for walk and alight choice models only. CUBE outputs a number of GC components considering in-vehicle time, wait time, walk time which are provided as probability weighted costs over the possible routing options and compares this to a derived GC of the alternative.
	Rail service	Impact on existing users	Yes, assumed impact of existing users is considered in the crowding aspect of the tool	
6. Last mile - onward travel to the destination	Egress	Egress time to destination	Yes, but detail of calculation not included in technical note	Same commentary as for access. NoRMS treats access and egress legs equally.
	Egress	Availability of onward modes - bus/cycle/walk	Yes, but detail of calculation not included in technical note	Model considers different modes of transport for the egress leg of the journey.

Conclusions of the gap analysis

5.26 Analysis of these two modelling frameworks has allowed the study to draw some conclusions about the success factors which appear to be well reflected in them and those which do not.

5.27 It is worth noting that the analysis was limited to the available information and that these modelling frameworks can, in some cases, be adapted to reflect some of the missing factors. The main observations are therefore the following:

- The station **catchment area** is modelled in an appropriate way in both modelling frameworks reviewed. It is divided in zones from which end-to-end generalised cost to the final destination, via existing and new stations, is calculated.
- Both modelling frameworks, however, are limited to demand **abstraction** from other rail alternatives, but not from **other modes** (e.g. car). While the modal shift might be small and the frameworks could be adapted to capture it, this is not present at the moment. Nevertheless, both modelling frameworks could be adapted to consider competition with other modes.
- **Access time** is modelled via GIS DriveTime tools such as TRACC and is usually considered for peak periods. Based on the review undertaken to inform this report, there is no evidence that the existing tools also compare the competitiveness of stations in the off-peak periods (where access time might be shorter to a parkway station but car parking availability might be lower). Equally, there is no evidence that journey time reliability is factored in the access time function.
- **Car parking** is included in the catchment model through car park charges and a binary parameter determining whether there is a paid or free car park. Based on the review undertaken to inform this report, there is no evidence that car park is included in NoRMS. It is important to include car parking in the modelling frameworks used to determine the demand response at a new parkway station, so it is recommended that it is included in future business cases for parkway stations.
- **Available facilities at the station** are not included in either of the two modelling frameworks. While these might be important for some users, it is acknowledged they are difficult to account for in the generalised cost function (except for through stated preference surveys).
- The **level of rail services** is reflected in both modelling frameworks. The catchment model does not include fare differences but could be easily adapted to do so. NoRMS includes this and also crowding penalties, which are important in determining users' choices. Comfort aspects, other than crowding, are not reflected in either framework.
- **Egress** to final destination is more finely accounted for in NoRMS than in the catchment model.

5.28 This allows to set out the following conclusions:

- The **most important parameters are included** in the modelling frameworks reviewed. These include modelling the catchment area, the station access time, the level of rail services and the egress time.
- **Access time** is a critical parameter, however the data and approaches used in the methodologies reviewed present limitations. Context-specific access time data should be used and benchmarked against other sources (e.g. Google Maps). Further, there should be more emphasis on access time weightings, both in existing guidance and in the modelling formulations.

- **Car parking** is an important element of the passenger decision-making and it is either not considered or very simplistically considered. While the modelling frameworks can be set up to consider it, they do not do so at the moment. This includes car park charges and car park availability.
- **Rail fares and level of service** are important to consider, especially if they differ substantially between alternative options. While the level of service is usually included via GJT, modelling frameworks should include a more detailed representation of rail fares to see how they drive decision-making.

5.29 The impact of incorporating these factors has been tested using the spreadsheet-based catchment model, to understand the scale of the potential impact of including them. The catchment model has been selected as a tool to test these impacts as it is simpler to trace back the impact of changes in individual parameters, and run diagnostics and sense checks on the results. This analysis is presented in the following section.

Additional considerations

Sustainable station access

5.30 Access to parkway stations was historically envisaged to be primarily by car. Evidence shows that users of parkway stations tend to drive further past their local station, increasing road mileage in the cases where they previously used a rail local station.

5.31 However, this view is no longer consistent with the national sustainability and environmental policy, including decarbonisation objectives, which requires a reduction of emissions. This requires a significant reduction in car trips in favour of public transport.

5.32 Future modelling approaches need to consider a range of transport access options, not just car, from within the catchment area.

Definition of markets served by parkway station

5.33 As part of the Strategic Case, the role a new parkway station and the markets it will aim to serve need to be clearly defined, so that the modelling can be aligned with them. These top priorities can be identified using the success criteria framework presented in this report.

5.34 For example, if a new parkway is designed to improve connectivity with London, demand may come from abstraction from local stations with slower and less frequent services. The modelling approach and assumptions need to be in line with this assumption.

5.35 In contrast, if a parkway is designed to improve connectivity to a nearby regional centre where no rail option currently exists, demand will primarily be abstracted from car or other public transport modes, or include a higher proportion of newly generated demand, which also impacts the modelling approach used.

5.36 Likewise, if a parkway station is designed as a enabler for new residential or commercial development, the modelling approach should place a particular focus on new generation of demand in addition to abstracted demand from other stations.

6 Sensitivity analysis and tests

6 Sensitivity analysis and tests

6.1 The gap analysis has identified a number of factors which are part of the success criteria framework presented earlier in this report and which might not be fully considered in some of the modelling frameworks used to determine the demand response and associated business cases for opening new parkway stations.

6.2 The purpose of the analysis conducted in this section is to assess the importance of various parameters on a parkway station's attractiveness. The station's attractiveness is measured by the extent to which they can abstract demand from neighbouring stations. This is done by including factors that have not been included in the demand analysis, and flexing assumptions that have been included but involve some uncertainty.

6.3 The section is structured as follows:

- Description of the tool used to test the impact of the parameters
- Parameters used in the sensitivity tests
- Choice of stations for which the tests have been undertaken
- Summary of the main results and findings

Use of the spreadsheet-based catchment model as a tool for the analysis

Introduction to the catchment model

6.4 A spreadsheet-based catchment model has been used as a tool to undertake the sensitivity tests in this part of the study. The catchment model is an appropriate tool for this exercise because of its simple, transparent and transferrable methodology, which enables users to run diagnostics and sense checks on the results. The model uses accessible and commonly used data (GIS, MOIRA, and publicly available car parking and fares data) to inform results.

6.5 Additionally, the use of 'hexcells' (a subdivision of the catchment area which segments the population willing to travel via the parkway station or alternative routes) allows the user to understand and assess at a disaggregated level where changes occur between the 'Do Minimum' and 'Do Something' scenarios, as well as areas which are sensitive to parameters relating to access time, GJT and fare.

Inputs and calculation process

6.6 The tool works by calculating the total generalised cost from the centroid of each hexcell to the destination station (e.g. London). This is calculated for a Do Minimum situation (where the parkway station does not exist) and a Do Something situation (where the parkway station is introduced). Results then display the hexcells that switch to using the parkway station in the Do Something where it provides a better generalised cost to their previous alternative.

6.7 The generalised cost function takes into account a range of factors set out in the bullets below:

- Car operating costs (i.e. fuel and non-fuel costs);

- Station access time – by applying a value of time to the drive/walk time and then applying a multiplier to express their disutility (e.g. a multiplier of 1.3 for driving and 2.0 for walking);
- Car parking costs – as well as the fare, this includes a penalty time associated with car parks availability as well as car park charges;
- Rail GJT – applying a value of time to the GJT from MOIRA;
- Rail fare; and
- Egress time – note that this is assumed to be identical for each hexcell.

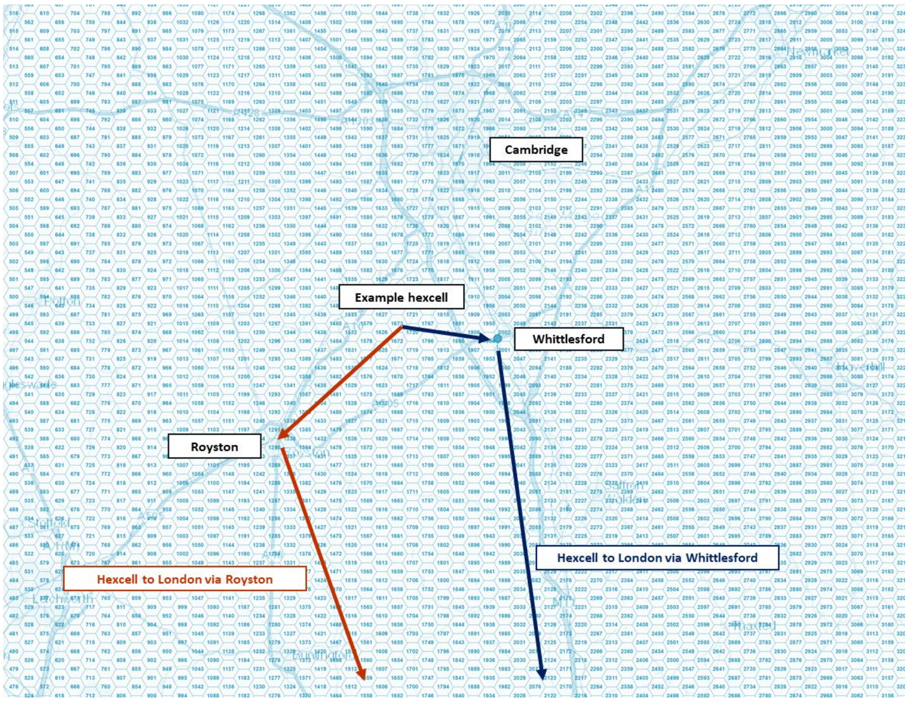
6.8 Once the catchment process has allocated hexcells to rail stations, current rail station demand is allocated to the hexcells that make up the catchment for each station. Station demand origins are allocated to individual hexcells weighted by population and based 'gravity' decay function. This decay function reflects the fact the further away the hexcell is from the rail station, the lower the propensity for demand to originate from it.

Illustrative example of use

6.9 Figure 6.1 displays the journey's generalised cost visually. It shows two routes to London for an example hexcell, one through Royston (red arrows) and another through Whittlesford (blue arrows). It shows that the journey can be broken down into two legs:

1. The access to the origin station – includes drive time and car parking.
2. The rail journey to the destination – includes the MOIRA GJT, rail fare and egress cost.

Figure 6.1: Whittlesford and Royston end-end GC

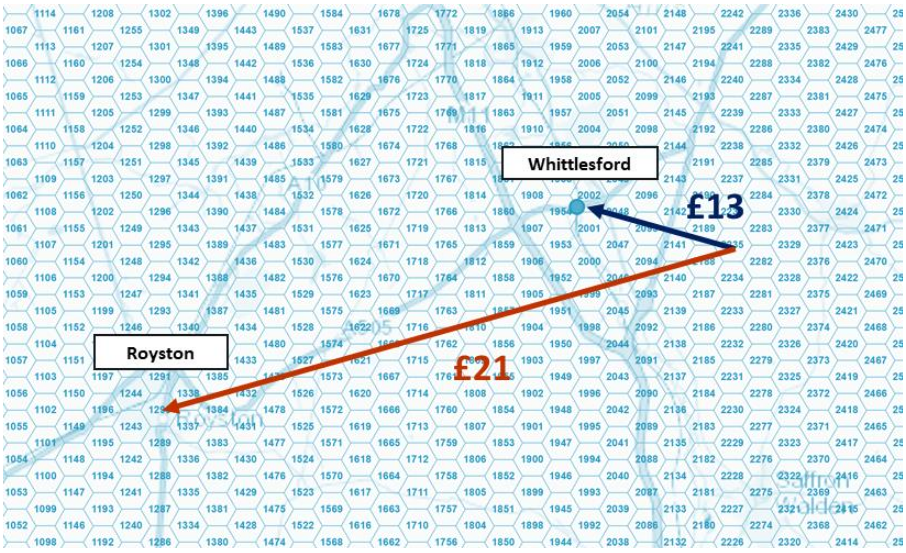


6.10 A breakdown of the calculation of the generalised cost for the access leg for an example hexcell is presented in Table 6.1, with a visual representation illustrated in Figure 6.2.

Table 6.1: Example of Whittlesford and Royston access generalised cost

Station	Car operating costs (A)	Car journey time (converted to cost using VoT)		JT with multiplier (B) (x1.7)	Parking penalty (C) (converted to cost using VoT)		Car park charges (D)	Total access GC (A+B+C+D)
Whittlesford	**£1.40**	12min	£3.20	**£5.50**	4 min	**£1.00**	**£4.75**	**£12.65**
Royston	**£3.30**	27 min	£7.10	**£12.40**	3 min	**£0.80**	**£4.35**	**£20.85**

Figure 6.2: Example of Whittlesford and Royston access generalised cost



6.11 The total generalised cost of the journey is presented in Table 6.2 below. This includes a breakdown of the remaining leg of the journey, which is in this example the journey between the origin station and London (represented by the first London terminal on a given flow).

6.12 It shows that, for this example hexcell, Whittlesford is a more attractive option, despite the half an hour lower rail GJT from Royston to London. This is largely due to the difference in the station access time. While the difference in generalised cost is only marginal, the tool will still allocate the entire demand from the hexcell to Whittlesford.

Table 6.2: Example of Whittlesford and Royston end-to-end generalised cost

Station	Access GC (E) (From previous table A+B+C+D)	Rail GJT/GC (F) (converted to cost using VoT)		Rail fare (G)	Egress GC (H) (converted to cost using VoT)		Total GC (E+F+G+H)
Whittlesford	**£12.65**	92 min	**£24.00**	**£15.20**	25 min	**£6.50**	**£58.35**
Royston	**£20.85**	66 min	**£17.40**	**£14.90**	25 min	**£6.50**	**£59.65**

Key tool caveats

6.13 While the catchment model is appropriate in that it is simple to use and the results can be easily traced, the following caveats need to be considered when analysing the results:

- The model captures the parkway station's **demand abstraction from other rail stations**, but does not have the functionality or parameters to estimate new rail demand either generated by a growth in the market or abstracted from other modes (e.g. car).

- The model is currently set up to capture journeys to a single destination, typically the parkway station's **prime attractor** (e.g. for East Midlands Parkway, the prime destination was London). The model can ultimately be adapted for more than one destination station through structural changes for each destination station, or by using multiple versions of the model for each destination.
- The model uses an **'all or nothing'** approach, where a hexcell is allocated to the station which gives it the lowest generalised cost, even if the difference between two alternatives is marginal. It is therefore likely that, where there are two viable choices, the margin of error involved in the demand estimation from the model is greater as a slight change in the parameters may change the demand response estimates significantly.
- Each hexcell differs solely on its geography. It is likely that there are **demographic and economic differences** that are not captured, which may mean using different parameters would be more appropriate (e.g. in terms of value of time or propensity to use rail).
- It is likely that there are other **factors that influence an individual's decision** that are difficult to introduce to the model. For example, some passengers may have a stronger disutility to crowding, and so may choose to take an alternative station, despite a longer rail GJT. However, incorporating crowding data to the model would be difficult.
- Changes to **parameters affect both the Do Minimum (without parkway station) and Do Something (with parkway station)**. For instance, reducing the access time multiplier may change the station choice from a given hexcell, both in the Do Minimum and Do Something scenarios, as the perceived penalty of driving further is lessened and users might be willing to drive longer distances. This means that, by changing these parameters, the demand allocation to other stations in the absence of the parkway station (Do Minimum) also changes. Therefore, once introducing the parkway station, demand might be abstracted from different stations depending on the set of parameters used.

6.14 For these reasons, this spreadsheet-based catchment model does not necessarily represent the best tool to model the actual demand response of a new parkway station. As such, the results of the tests do not match, or are necessarily close to, the demand observed at existing parkway stations, nor has the tool been specifically calibrated to calculate accurate demand responses. In this context it has been used as a tool to test the broad impact of changing of the underlying parameters.

6.15 While the all or nothing approach can lead to high sensitivity to changes in parameters, including where the difference in generalised cost between options is very small, it is a useful tool to test the assumptions in this study i.e. to identify which parameters have an impact on the demand response, not to quantify and scale of these changes, particularly given that the models were not calibrated to existing demand.

6.16 A logit model could be used as an alternative to an all or nothing approach. This model would allow to distribute demand between stations where there is only a marginal difference in generalised cost. The logit model functions would also reflect the importance of each of the elements in the decision-making in each of the elements of the generalised cost.

6.17 For example, a leisure traveller may directly incorporate the rail fare in their decision-making, which would drive their choice for a station, but would not do so with the car parking charge, (e.g. as this may come as an afterthought in their decision-making process). On the contrary, a commuter who frequently uses the car park charge would be more inclined to consider the annual cost of parking compared to other stations, when making their choice of where to buy a season ticket. These nuances could be captured using in the utility function of a logit model, but also possibly through the weightings of the generalised cost function on an all or nothing approach.

Parameters for the sensitivity tests

6.18 The spreadsheet catchment model described above was used to test the importance of different success criteria for a parkway station (as summarised in Table 4.2).

6.19 We conducted a series of sensitivity tests by changing different inputs and observing the impact on the catchment area's station choices for key flows via the parkway station. The factors tested were identified through our gap analysis (5.27), which acknowledged important considerations for a parkway station that are inappropriately modelled in the previous iteration of a spreadsheet catchment model or in the NoRMS station choice model.

6.20 The importance of these factors was confirmed by a study by the University of Leeds (Values of travel time in Europe: Review and meta-analysis, 2016), which concluded that the "Value of Time assumption and associated multipliers vary based on a wide range of influential variables, including journey purpose, mode used and mode valued, type of data, attribute, whether the trip was urban or inter-urban, and income represented by GDP per capita after adjusting for purchasing power parity." These factors are relevant for parkway stations modelling so different multipliers and value of time assumptions were tested as part of this study.

Summary of parameters

6.21 The aim was to understand the scale of impact these factors have on the catchment model. The factors tested in this study include:

Table 6.3: Factors tested in the sensitivity analysis

Factor	Description
Station access	
Access time multiplier	This is a multiplier to the driving access time to a station, which reflects the user's perception of the driving time involved in accessing the rail network. PDFH6 sets this multiplier as 1.3 for car access time and 2.0 for walk access time.
Urban access penalty	Assesses the impact of potentially further penalising alternative stations which may be located in urban centres, which make them unattractive to access in the peak, such as less reliable journey times due to traffic, and car parking options likely to be a further walk from the station. These penalties may make an out-of-town parkway station more attractive.
Walking to the station	Assesses the impact of changing how local demand within walking distance of their nearest station is modelled. Examines to what extent those within walking distance to a station will choose their local station, even if it offers a worse rail service.
Car parking	
Car park charges	Assesses the impact that different car park charges can have on the attractiveness of a parkway station.
Car park penalties	The model has been adapted to apply different car parking penalties based on the size of the car park, which influences the ability to find an unused parking space and impacts the potential walk time from the car parking space to the station, which impact the attractiveness of the parkway station.
Rail journey	
Rail leg assumptions	Assesses how improving the rail component of the journey, either by offering a cheaper fare or by improving the generalised journey time, has an effect on increasing the attractiveness of a parkway station.
Value of time assumptions	The catchment model uses generalised cost functions to assign rail users to a preferred route via their preferred station. A core assumption behind these generalised cost functions is the value of time used, which converts the time it takes a user to complete a journey into a cost. This varies by type of user.
Peak vs. off-peak	
Off-peak assumptions	The catchment model is set up for the peak period. The attractiveness of the parkway in the off-peak can be tested by changing some of the parameters, including access time, car park availability and charges, and rail fares.

Choice of stations

6.22 Two existing parkway stations were chosen to test these parameters:

- **East Midlands Parkway** was chosen due to its strategic location near major roads, including the M1, and its proximity to the large urban centres of Nottingham and Derby. A potential target market are the potential users living on the fringe of these urban areas who wish to travel to London (dominant destination as shown in MOIRA), who otherwise would have to travel into the respective city centres before catching a long-distance service to London.

- **Whittlesford Parkway** was investigated due to the potential large rural catchment of users who may wish to travel to London. We focused on examining how the demand between Whittlesford Parkway and London would change (dominant destination as shown in MOIRA). Furthermore, the station has a relatively small immediate catchment within walking distance of the station, hence mainly relying on potential rail users to drive to the station.

6.23 Additionally, a new proposed parkway station was investigated to examine the potential demand abstraction from nearby existing stations, and how this abstraction changes as different parameters, including car parking parameters and rail journey assumptions, vary:

- **Warrington NPR Station**: An option for the proposed new rail alignment between Manchester and Liverpool as part of the Northern Powerhouse Rail (NPR) programme includes a new station near the existing Warrington Bank Quay station. Warrington is currently served by two existing stations, Warrington Central and Warrington Bank Quay. The new proposed station and subsequent service is planned to halve the rail GJT of the journey to both Liverpool and Manchester, providing a significantly better service, not only compared to the two existing Warrington stations, but also to several other stations in the wider driving vicinity. Additionally, with a new station, there is scope to improve the car parking offer. By testing different car parking scenarios, it can be assessed to what extent a car parking improvement might have an impact on increasing potential railway demand for the new service.

6.24 It is important to note that in each of the above case studies, the demand generated will only comprise demand abstracted from nearby stations. As previously mentioned, this tool has been built to understand how changes in key parameters help determine the parkway station’s attractiveness amongst neighbouring stations.

6.25 The tool has not been built to forecast changes in demand, and thus does not currently estimate new demand generated from opening a new station and providing a new rail opportunity (e.g. demand abstracted from other modes). However, with the appropriate data available and calibration, the tool can be adapted to estimate the generative demand impact.

Summary of key results and findings

Base assumptions

6.26 This section presents the key findings from our sensitivity tests conducted on the three selected stations. The results identify how adjustments in parameters (e.g. access time multiplier) impact the amount of demand the example stations would abstract from the neighbouring stations. This will be presented relative to a base case, for which the parameters are presented in Table 6.4 below.

Table 6.4: Base case assumptions used in the sensitivity tests

Assumptions	Source	Value
Station access		
Access time multiplier	Assumption, based on PDFH6 [(a)]	2.0
Max walk to the station distance	Assumption	2.0 km
Walk time speed	Assumption	12 min/km
Car park charges	Various online sources	Existing charges
Journey purpose and Value of Time		
Commuting/Business/Leisure split	MOIRA, based on Full/Reduced/Advance split	Depends on station
Rail Values of Time (VoT)	TAG	Weighted VoT based on demand split
Rail leg assumptions		
Rail fares	RDG fares data [(b)]	Depends on flow
Rail journey time	MOIRA GJT	Depends on flow
Car parking availability penalty		
Car park with 0-99 spaces	Assumption [(c)]	Peak: 6 min Off-peak: 8 min
Car park with 100-299 spaces	Assumption [(c)]	Peak: 5 min Off-peak: 7 min
Car park with 300-499 spaces	Assumption [(c)]	Peak: 4 min Off-peak: 6 min
Car park with over 500 spaces	Assumption [(c)]	Peak: 3 min Off-peak: 6 min
No car park	Assumption [(c)]	999 min

(a) PDFH6 recommends, in Unit B9 (New and Competing Services and New Stations) Table B9.4, an access time multiplier for Car – Park and Ride of 1.3 and for Car – Kiss and Ride of 2.6, with a recommendation to derive a weighted value for Car. The value of the parameter where there is not mode-specific information is recommended to be 2.0.

(b) Source: Rail Delivery Group http://data.atoc.org/fares-data

(c) These assumptions are not based on any evidence, as there is no research available about this topic. The logic is that the smaller the car park, the more difficult it will be to find a free space, which translates onto longer driving time and walking time to the platform. Likewise, it is assumed that during off-peak times it would take longer to find a free car park. For any future new parkway business case, it is recommended that research is undertaken to derive a set of availability penalty values.

6.28 It should be noted that the table above only includes assumptions where sensitivity tests were undertaken. Other assumptions which remained constant across all scenarios (e.g. cost of driving per km, the egress time to the destination), are not included.

6.29 The findings of this section examine the extent to which changing assumptions impact demand at different stations and provides insight into why the impact on demand changes takes place. The three case studies are presented below:

East Midlands Parkway

6.30 This section presents the results for the tests undertaken for East Midlands Parkway (with London as the destination under analysis). It is structured as follows:

- Summary of the stations from where demand is abstracted;
- Access time multiplier analysis;
- Car parking analysis;
- Urban access penalty;
- Walking to the station;
- Rail journey assumptions; and
- Values of Time.

6.31 It should be noted that absolute volumes of demand are not shown throughout the section. This is because, as previously mentioned, the purpose of this exercise is not to demonstrate the tool's demand estimate. Instead, proportions or increments are presented to establish the impact of adjusting different parameters on the parkway's attractiveness.

Demand abstraction

6.32 Table 6.5 below presents a summary of the stations from which demand is abstracted towards East Midlands Parkway from the Do Minimum, once it is introduced as a new station in the Do Something (using the the base assumptions and parameters). The stations where most of the demand originates are Derby, Nottingham, and Tamworth.

Table 6.5: Summary of demand abstraction from stations near East Midlands Parkway

Demand abstraction	% demand abstracted
Derby	34%
Nottingham	16%
Tamworth	16%
Loughborough	12%
Lichfield Trent Valley	12%
Beeston	8%
Long Eaton	3%
Leicester	1%

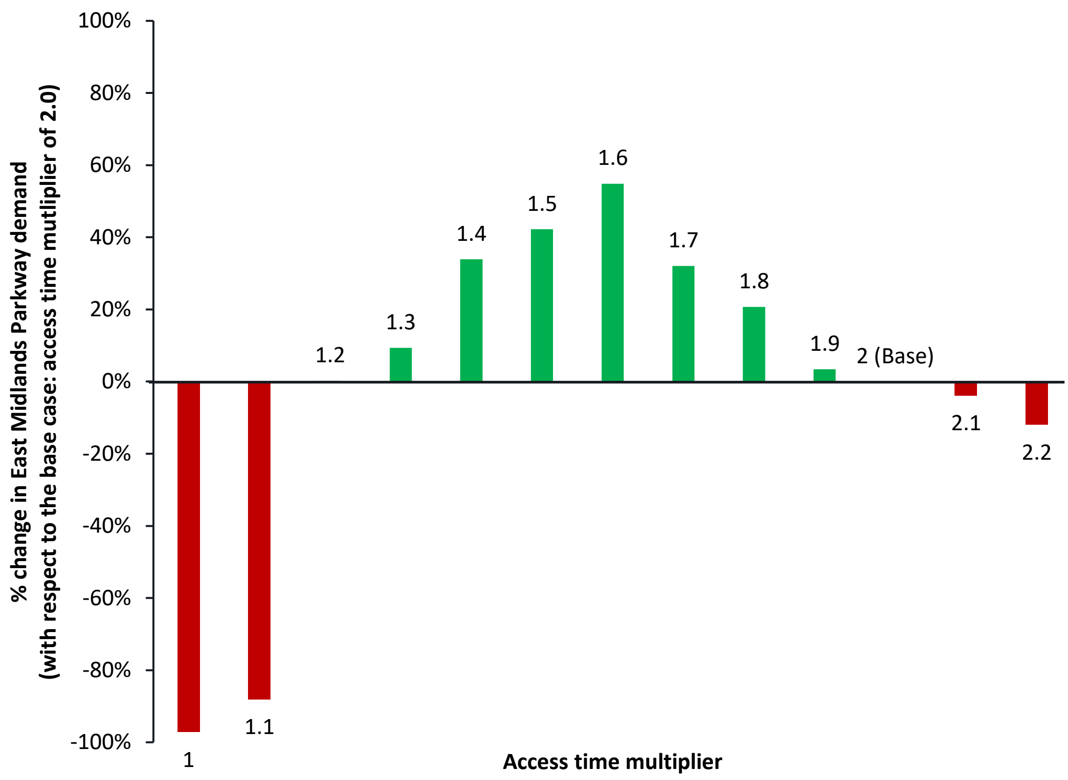
6.33 These stations have rail services which passengers use to go to London; however, for a number of hexcells, it would be more convenient to use East Midlands Parkways instead, therefore they would switch from existing stations.

Drive access time multiplier analysis

6.34 The access time multiplier is an assumption which reflects how a user perceives the access time to the parkway station. A higher access time multiplier puts a penalty on users travelling longer distances to access the station, and hence may result in users choosing a more local station instead.

6.35 Figure 6.3 below presents the impact of using different access time multipliers on the demand attracted to East Midlands Parkway, relative to the base case, where the access time multiplier in use is 2.0:

Figure 6.3: Access time sensitivity test on East Midlands Parkway



6.36 The analysis points toward two main conclusions:

- As **access time multipliers increase**, potential users become less willing to drive far distances to access a parkway station, instead preferring the option which involves driving a shorter distances to their nearest station, even if the rail offering at the parkway is more competitive. This is why for higher values of the access time multiplier the demand at East Midlands Parkway decreases.
- As **access time multipliers decrease**, potential users are willing to drive further to access the station which gives the most competitive rail option. In the figure above, this results in a lower proportion of users using East Midlands Parkway. This is because potential users are willing to travel beyond the parkway station to find the station with the most suitable rail service (e.g. Leicester, which offers a cheaper price and faster journey to London).

6.37 In this example, with a low access time multiplier of 1.0, many users residing to the South of Nottingham would rather drive for over 40 minutes to access the rail network at Oakham, which provides a significantly cheaper rail fare to London than Nottingham or East Midlands Parkway, but an adverse GJT to London. This result suggests that this multiplier is inappropriate, as passengers are willing to travel far distances and experience adverse journey times to obtain a cheaper fare. Therefore, an access time multiplier of 1.0 results in virtually no demand abstraction towards East Midlands Parkway.

6.38 For this case study, an access time multiplier of 1.6 generates the most demand towards East Midlands Parkway. In this case, users living on the outskirts of Nottingham and Derby are willing to drive further than their local station, and opt to use East Midlands Parkway station, but are not willing to drive over 40 minutes South to Oakham to access a significantly cheaper rail fare.

6.39 From this analysis, it is evident that **results are very sensitive to access time multiplier values, with two offsetting effects taking place**. It appears evident that particular attention should be placed to determining the right value of the access time multiplier (or equivalent in other modelling formulations).

Car parking analysis

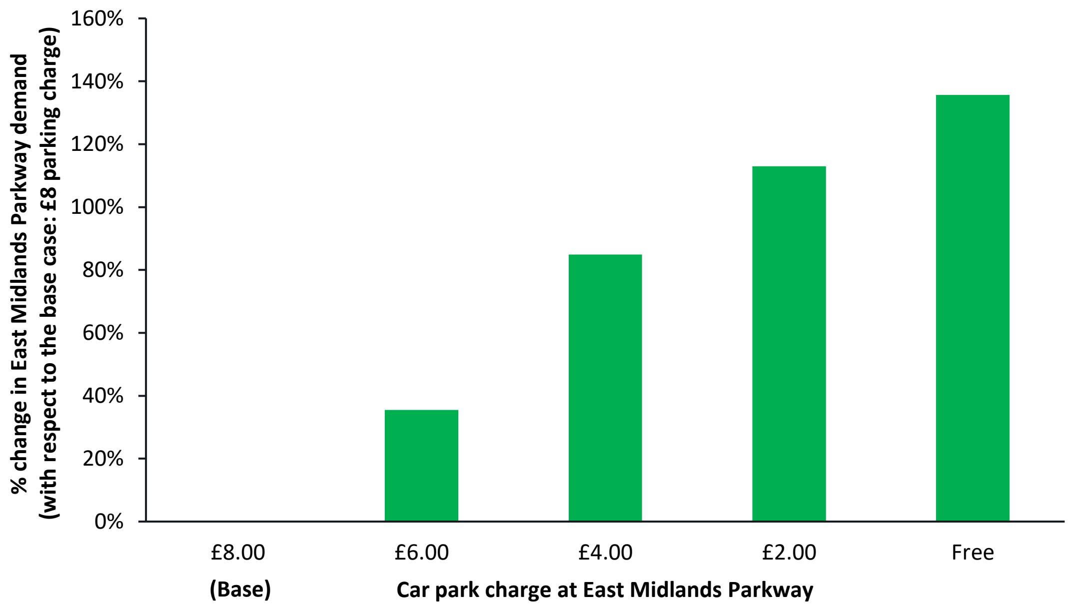
6.40 Analysis of car parking has been presented for two parameters:

- Car park charges; and
- Car park availability penalties.

6.41 Analysis into **car park charges** showed that pricing car park facilities differently (both the parkway itself and competing stations) has a significant impact on the demand the parkway station can attract.

6.42 Figure 6.4 below presents the impact on demand of changing the daily car park charges for East Midlands Parkway only while keeping the charges for alternative stations as they are. The black bar presents the demand in the base case, with the current parking charge, and the green bar presents the additional demand generated by lowering the car park charges at the parkway station.

Figure 6.4: Car park charges sensitivity test on East Midlands Parkway



6.43 Reducing the car park charges by £2 at East Midland Parkway (a 25% decrease) attracts 36% more passengers. By making the car park free, whilst keeping the car park charges of alternative stations as they are, East Midlands Parkway abstracts over double the demand compared to if the parkway charged what it currently does. This is due to the parkway now being a considerably better option than using city centre stations such as Nottingham and Derby, where car park charges remain high.

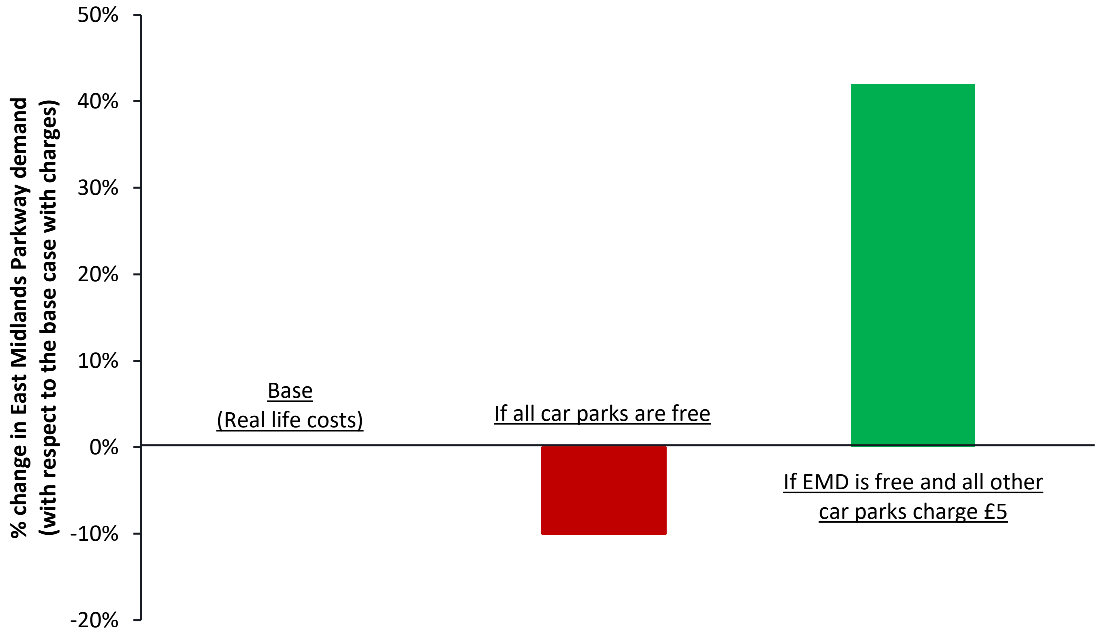
6.44 Figure 6.5 below presents some further sensitivity tests on car park charges.

6.45 By normalising the effect of car parking fees by making them all free at all stations within the catchment area, for this case study, East Midlands Parkway only loses a small proportion of its

Base
Case

base demand. This is because existing car park charges are similar at the main competing stations for journey to London. East Midlands Parkway is actually more expensive than some nearby stations such as Beeston, which charges £6.50 a day whilst East Midlands Parkway charges £8 a day, reflecting the better service its offers (25 minute better GJT to London than from Beeston). Equally, by making the car park offering at the parkway £5 cheaper than all other alternatives, the parkway can attract 42% more demand.

Figure 6.5: Impact of removing car parking charge parameters from the catchment model



6.46 From the above sensitivity tests, it can be seen that **changes in car park charges have a significant impact on the potential demand** this station can attract.

6.47 The following sensitivity tests are linked to **car park availability penalties**. As previously stated, due to the lack of research available, these assumptions are not based on evidence. The base scenario assumes a number of penalties for car parks, which consider an estimate of the time it takes to find a car park space and walk to the station, as well as the impact of smaller car parks being full. The penalties represent minutes that are added to the overall access time. Table 6.6 below presents the four tests undertaken against this base case. For reference, East Midlands Parkway car park has 850 spaces.

Table 6.6: Car park size and availability penalty (in minutes) scenario test results

Car park size			Base Assumptions S-0	No penalty S-1	No penalty for station car parks S-2	Double base penalties S-3	Penalise further smaller car parks S-4	New profile penalising smaller car parks S-5
0	to	99	6	-	-	12	20	20
100	to	299	5	-	-	10	5	10
300	to	499	4	-	-	8	4	5
500	+		3	-	-	6	3	2.5
No car park			999	-	999	999	999	999

Change in demand	-	**(80%)**	**(5%)**	**+9%**	**+28%**	**+59%**

6.48 The main findings for each test are presented below:

- **S-1**: Without any car park penalties at any stations, the demand for East Midlands Parkway falls by 80%; this is because the change makes competing stations, such as those with small or no car parks, equally competitive.
- **S-2**: By retaining a penalty for stations with no car parks, while removing all penalties for stations with car parks regardless of size, demand for East Midlands Parkway only falls by 5%. This is expected because the key competing stations such as Derby and Nottingham under our initial base parameters fall under the same category as East Midlands Parkway as they also offer over 500 car parking spaces, and hence have the same penalties applied.
- **S-3**: By doubling the penalties applied to the base assumptions, this made some difference to the overall impact on demand, which experienced a small increase of 9%.
- **S-4**: The results from previous tests led to conduct a scenario and observe what the impact would be for penalising smaller car parks more than larger car parks, as these are likely to fill up quickly and hence some users may arrive to a full car park. To reflect this, the penalty for stations with car parks with under 100 spaces was increased from 6 minutes to 20 minutes, whilst leaving penalties for larger stations the same. As expected, this did cause demand for East Midlands Parkway to increase by 28%, as stations with smaller car parks become less attractive.
- **S-5**: Taking this one step further, new set of assumptions were adopted which penalised smaller stations even further than larger stations. This caused East Midlands Parkway to become significantly more attractive, increasing demand for the station by 59%.

6.49 From the above sensitivity tests, the importance of **incorporating appropriate penalties for car parks based on their size** is shown. This penalty allows to model the ability to account for users finding parking, which helps determine whether they will drive to a particular station.

Urban access penalty

6.50 The model indicates East Midlands Parkway primarily abstracts demand from city centre stations in the region which also offer competitive, inter-city services to London. The largest of these are Nottingham and Derby, which both offer a similar generalised journey time by rail to London.

6.51 An urban access penalty was applied to users which reflected the unattractiveness of driving into a dense urban centre to access a train station of Nottingham and Derby. This aims to capture the perceived impact of users having to travel into a congested centre, where journey times are likely less reliable than driving out of town to the parkway, and also consider that city centre station car parking options may not be directly adjacent to the station.

6.52 This penalty has been applied in addition to the calculated peak drive time used in the base scenario, which to some extent incorporates the likely level of traffic a user will face to access these stations.

6.53 A 2.5-minute penalty applied to Nottingham and Derby increases the attractiveness of East Midlands Parkway, attracting 18% more demand. A 5-minute penalty applied to both stations increases demand to the parkway by 55%.

6.54 This demonstrates the **high sensitivity around East Midlands Parkway's competitive advantage,** where the attractiveness of the station can be significantly altered with a sight change in parameters.

Walking to the station

6.55 The model provides users that live within 2km of a station the option to walk to the nearest station if the overall generalised cost is competitive. The key assumption held is that the walking journey time is equivalent to 1km taking 12 minutes to walk.

6.56 Flexing these assumptions, such as changing the potential walk radius, and changing assumptions to make walking to their nearest station significantly more attractive, had little impact on changing the demand for the parkway station. This is likely due to the small amount of demand available in the hexcells that are within walking distance to stations. Additionally, where this is the case, they would likely use the closest station regardless to minimise the access time.

6.57 However, it is worth noting that this region has only a few local stations in the catchment, many of which do not have a direct service to London. We expect the results would be more significant in more urban areas with many competing stations which offer a good service for local residents.

Rail journey assumptions

6.58 For a long distance flow (such as East Midlands Parkway to London, which we have tested), the rail leg of the journey becomes a very large component of the overall journey time from origin to destination. In this case, the higher frequency of direct intercity services offered by the new parkway compared to local stations can be a key differentiator which enables it to attract demand from car users travelling from further afield.

6.59 For this case study, the peak fare for East Midlands Parkway to London is the same as that for Beeston and Nottingham to London. However, crucially, the fare is £6.75 cheaper than it is for Derby.

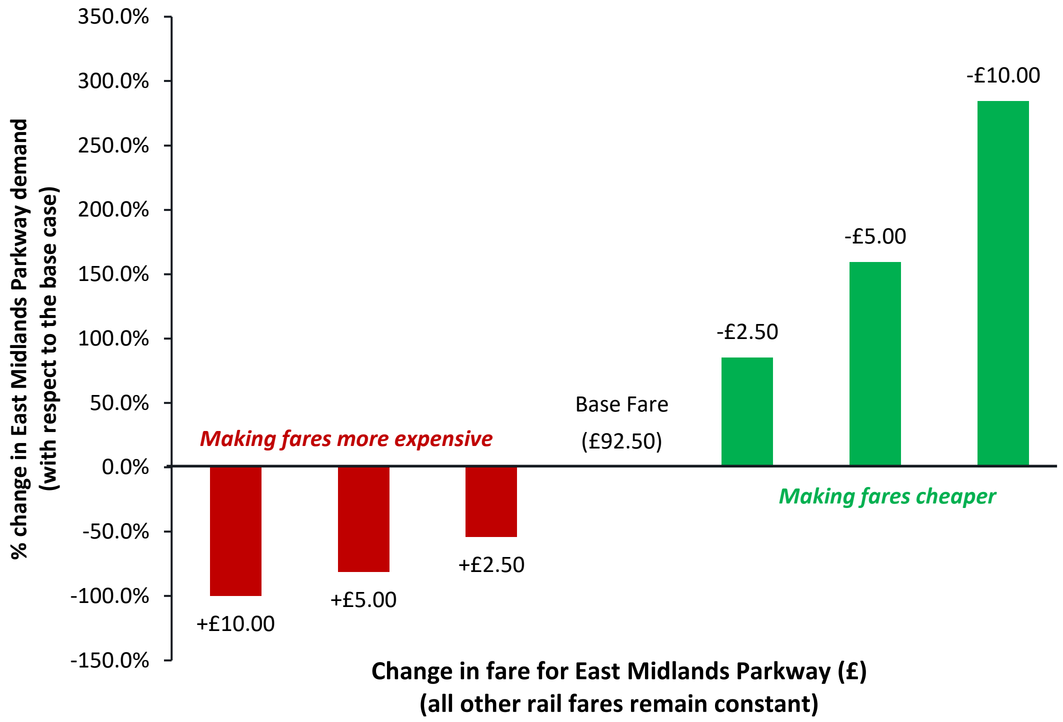
6.60 It was found that, through removing the rail fare component within the model, East Midlands Parkway lost its competitive advantage over Derby, abstracting less demand from this station. This was also the case for some other stations and overall demand for the parkway reduced by 42%. As found in previous tests, this model is very sensitive to small changes in generalised cost, and a significant fare difference of £6.75 can make one station more competitive than another. This again demonstrates that the competitive advantage of East Midlands Parkway is very sensitive on these parameters, and can easily be lost from changes to these.

6.61 Further tests surrounding fares were conducted to measure the impacts of changing the fare for East Midlands Parkway to London only, whilst keeping all other fares the same, were tested. This tested the extent to which additional demand can be attracted to a particular station through a cheaper fare than alternative stations, where fare regulation allows for it.

6.62 It should be noted that for the purposes of this analysis a weighted fare value was used for all journeys, whereas in practice there is a multiplicity of fares for different times of the day and product types, which would affect the conclusions of the analysis. This is displayed in Figure 6.6.

6.63 The results show that, for this case study, a relatively small change in the fare can have a large impact on making users switch from one option to another, given that the journey leg is the most important component of the end-to-end generalised cost. Making the fare £2.50 cheaper can attract almost twice as much demand to the station.

Figure 6.6: Rail fare sensitivity test on East Midlands Parkway



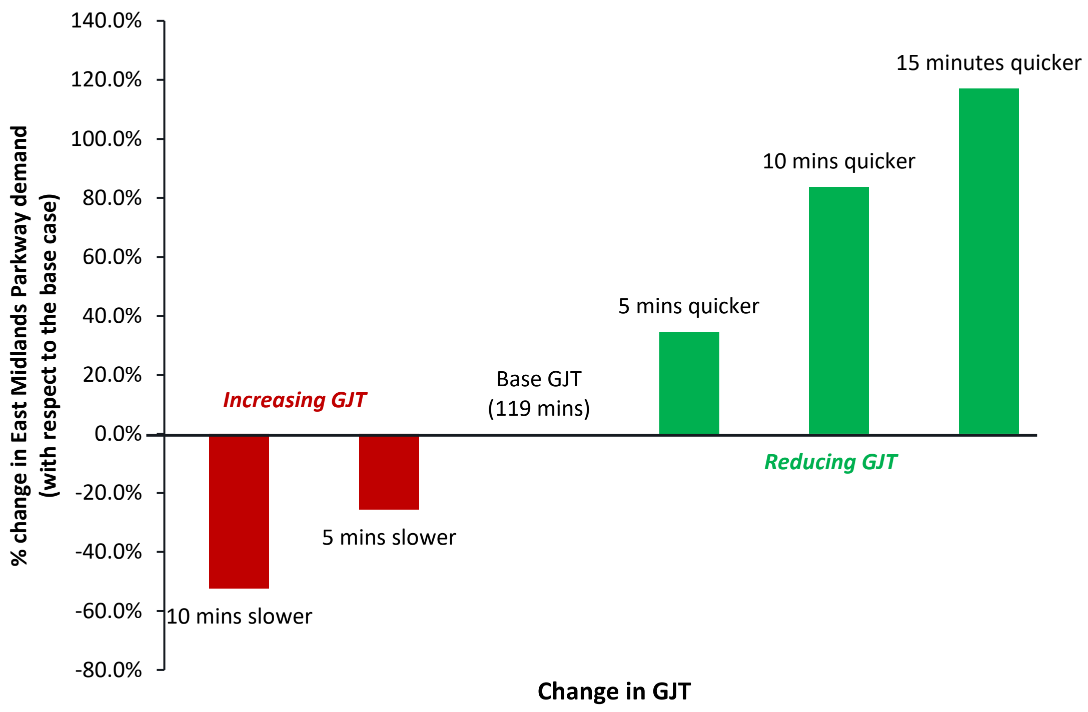
6.64 This confirms that the model is very sensitive to changes which make a material impact to the overall generalised cost of a journey. This suggests that the parkway's competitive advantage can easily be changed by even a slight change in fare, meaning that there are other stations with attractive journey options.

6.65 Another factor which can make a railway station more attractive is the rail journey it offers to the destination, specifically the generalised journey time (GJT) between the station and the final destination, which reflects the speed of the journey, the frequency of service and the need to make an interchange or not.

6.66 A further sensitivity test was undertaken, where the rail GJT for the journey was set equal from all stations to London (i.e. each rail journey has the same GJT and same fare). This was to determine how the popularity of the parkway station changes when the GJT's competitive advantage is taken away, and so other factors such as the access time and fare become more important. The results were similar to that seen from only removing the fare component; this is due to the GJTs between the main alternative stations being similar to that of East Midlands Parkway.

6.67 This was taken one step further by testing the impact of how well a parkway station can attract demand by providing a faster generalised rail journey time (GJT) for the rail leg of the journey to the destination.

Figure 6.7: Rail GJT sensitivity test on East Midlands Parkway



6.68 As with the fare component, making a small improvement to the GJT makes the station more attractive to users. A 5-minute improvement attracts 35% more passengers; a-15 minute improvement (which could be delivered by increasing the service frequency from two to three trains an hour to London in this example), has the ability to attract over double the number of users. This is because, for this case study, alternative stations in the East Midlands region all provide similar GJTs and if the parkway provides a significantly better option, it would abstract a higher proportion of demand.

6.69 This allows to see that **improving the rail offering of this parkway station (via a cheaper fare or faster GJT) has a significant impact on attracting more rail users from a wider catchment.**

Value of time

6.70 The catchment model uses generalised cost (GC) functions to assign rail users a preferred route via a rail station that gives them the cheapest cost of completing a journey from their origin to a destination. A core assumptions to calculate generalised costs is the value of time, which converts the time it takes a user to complete a journey into a cost, based on TAG values detailing by user type.

6.71 The generalised cost components that are influenced by the value of time parameter include:

- The drive or walk access time to the station;
- The car park penalty (as it is expressed in minutes); and
- The rail generalised journey time.

6.72 The generalised cost components that are not influenced by the value of time parameter (as they are already expressed in cash terms) include:

- The car parking charge; and
- The rail fare.

This model uses a weighted value of time assumption. Based on the journey purpose split, the base scenario assumes a weighted value of time per passenger to be £14.52 per hour. The results of this test are presented in Table 6.7 below:

Figure 6.8: Values of Time sensitivity test on East Midlands Parkway

6.73 For this case study, the largest demand abstraction occurs when using a value of time of around £13, which is close to the commuting value of time recommended by TAG, and only slightly lower than the weighted value of time used in the base scenario.

6.74 However, both increasing and decreasing this value has contrasting impacts on demand:

- East Midlands Parkway is **unable to abstract any demand from other stations if low VoT are used**, for instance, if the TAG recommended Leisure VoT (£6.06 per hour) is used. This is because passengers are willing to use slower services with poor GJTs from local stations that may involve an interchange or be convinced to drive further to access a station closer to London which has a much more competitive rail fare. This is evident with catchments to the South of Nottingham, which previously drove to East Midlands Parkway in the base scenario but now opt to drive further South to Oakham, which is an additional 30 minutes of driving and involves a rail interchange to get to London, but offers much cheaper car parking and rail fares.
- Likewise, by using **high VoT**, such as TAG recommended Business VoT (£32.70 per hour), passengers in the base scenario that live near Derby were previously attracted to drive further to East Midlands Parkway, which offers both a lower car parking charge and rail fare However, business passengers are less sensitive to these charges and will always choose the fastest option, which means they may go back to using Derby if it is closer, even if it costs them more in car parking and rail fare.

6.75 The conclusions are similar to those presented for the access time component of the journey. Therefore, **understanding how passengers value their time is key to reflect the potential catchment of this parkway station.** As seen, price sensitive leisure users may instead use a slower service if it is cheaper or drive further to access a much cheaper service. Similarly, business travellers may happily pay a premium, such as higher car parking charges, if the new station offers a competitive overall journey time.

Whittlesford Parkway

6.76 This section presents the results for the tests undertaken for Whittlesford Parkway (with London as the destination under analysis). It is structured in the same format used to display the results for East Midlands Parkway, as follows:

- Summary of the stations from where demand is abstracted;
- Access time multiplier analysis;
- Car parking analysis;
- Walking to the station;
- Rail journey assumptions; and
- Values of Time.

6.77 It should be noted that absolute volumes of demand are not shown throughout the section. This is because of the limitations of the tool in determining the choices between stations for a given user. Instead, proportions or increments are presented to establish the impact of different parameters.

Demand abstraction

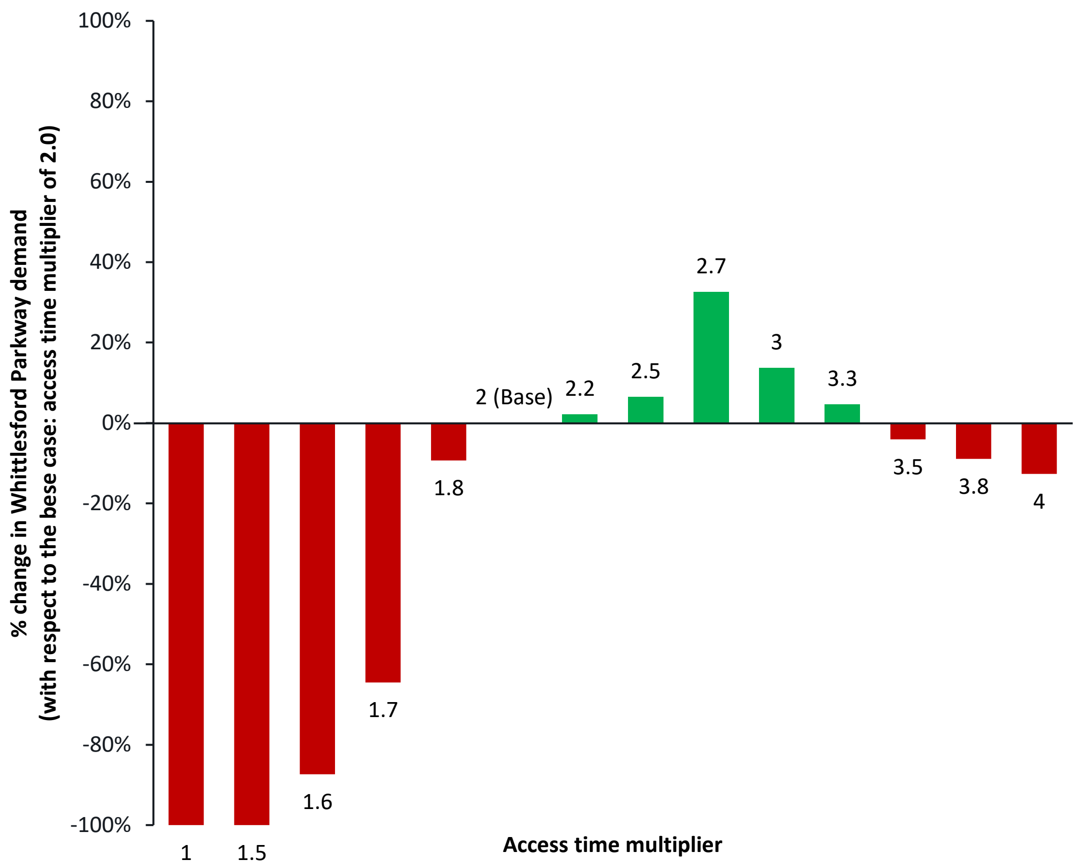
6.78 This model calculates the demand for Whittlesford Parkway through abstraction of demand to London from other alternative stations. In the base scenario, the stations where most of the demand is abstracted is from Audley End (69%) and Royston (25%).

6.79 In subsequent scenario tests, depending on how attractive the parameter makes the parkway station, additional demand may be abstracted from other stations including Cambridge and Cambridge North. In extreme scenarios, whereby the parkway station is made significantly more attractive (such as by offering free parking), the model captures abstraction from stations as far out as Huntingdon on the East Coast Main Line and Kelvedon on the Great Eastern Main Line.

Access time multiplier analysis

6.80 Figure 6.9 below presents the impact of using different access time multipliers on the demand attracted to Whittlesford, relative to the base case, where the access time multiplier in use is 2.0:

Figure 6.9: Access time sensitivity test on Whittlesford Parkway



6.81 A similar trend to East Midlands Parkway is observed:

- A **lower access time multiplier** means potential users are willing to drive further to access the station which gives the most competitive rail option. In this case, users are willing to drive as far South as Stevenage or Bishops Stortford to access a competitive fare and GJT.
- A **higher access time multiplier** attracts users to choose the best service, which may mean driving to Cambridge and paying a high car parking charge and higher fare to take advantage of the fastest overall journey time.

6.82 However, in this case, the optimal access time multiplier which generates the most demand is close to 2.7, which is much higher than that observed in the East Midlands case study (a multiplier of 1.6). This is due to the local context of where the urban areas are and where the best alternative stations offering a competitive rail journey are. The stations closer to London provide a much more attractive rail service than the Parkway and in many cases with a lower multiplier, it results in users driving further to access the aforementioned stations.

6.83 It can be seen that **results are very sensitive to access time multiplier values, with two offsetting effects taking place**. It appears evident that particular attention should be placed to determining the right value of the access time multiplier (or equivalent in other modelling formulations).

Car parking analysis

6.84 Analysis of car parking has been presented for two parameters:

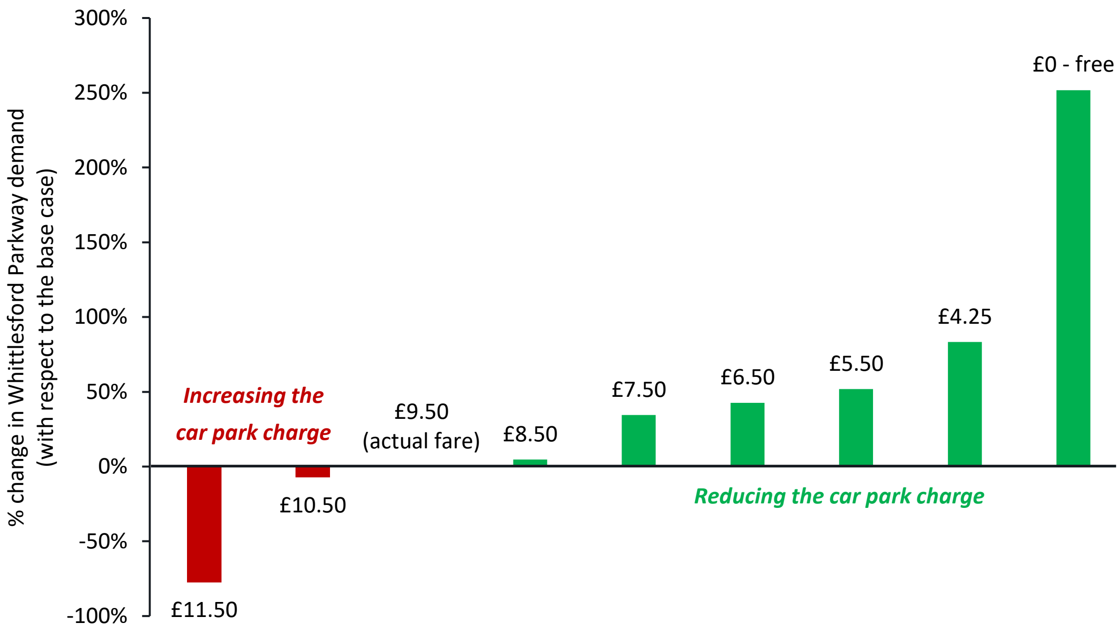
- Car park charges; and

- Car park availability penalties.

6.85 In line with what we found in the East Midlands Parkway case study, analysis into **car park charges** showed that pricing car park facilities differently (both the parkway itself and competing stations) has a significant impact on the demand the parkway station can attract.

6.86 Figure 6.10 below presents the impact on demand of only changing the daily car park charges for Whittlesford Parkway while keeping the charges for alternative stations as they are.

Figure 6.10: Car park charges sensitivity test on Whittlesford Parkway



6.87 As expected, reducing the car park charge makes the parkway more attractive. Reducing the car park charges by £2 (a 20% decrease) attracts 34% more passengers. By making the car park free, whilst keeping the car park charges of alternative stations as they are, Whittlesford Parkway abstracts over two and half times the demand compared to the what the current charge is. This is due to the parkway now being a considerably better option than using most alternative stations, where car park charges remain high.

6.88 By normalising the effect of car parking fees by having a £5 charge at all stations within the catchment area, for this case study, Whittlesford Parkway loses 26% of its demand. This is expected because Whittlesford Parkway does offer a cheaper car park charge (£9.50) than some alternative stations such as Cambridge (£12.00) and Audley End (£10.00).

6.89 From the above sensitivity tests, it can be seen that **changes in car park charges have a significant impact on the potential demand** this station can attract.

6.90 The following sensitivity tests are linked to **car park availability penalties**. The base scenario assumed a number of penalties for car parks, which considered an estimate of the time it takes to find a car park space and walk to the station, as well as considers the impact of smaller car parks being full. Table 6.7 below presents the four tests undertaken against this base case. Note that the penalties represent minutes that are added to the overall access time.

Table 6.7: Car park size and availability penalty (in minutes) scenario test results

Car park size			Base Assumptions S-0	No penalty S-1	No penalty for car park stations S-2	Double base penalties S-3	Penalise further smaller car parks S-4	New profile penalising smaller car parks S-5
0	to	99	6	-	-	12	20	20
100	to	299	5	-	-	10	5	10
300	to	499	4	-	-	8	4	5
500	+		3	-	-	6	3	2.5
No car park			999	-	999	999	999	999
Change in demand			-	-95%	+112%	-7%	-11%	-14%

6.91 The main findings for each test are presented below:

- **S-1**: Without any car park penalties, including no penalty for stations with no car park, the demand for East Midlands Parkway falls by 95%; this is because the change makes competing stations, such as those with small or no car parks, equally competitive. The potential catchment for Whittlesford Parkway is now shared with the nearby stations of Great Chesterford and Shelford, which have no car park but offer a very similar rail service.
- **S-2**: By retaining a penalty for stations with no car parks, however removing all penalties for stations with car parks regardless of size, demand for Whittlesford Parkway increases significantly. This is because in the base scenario, the key competing stations such as Royston and Audley End have over 500 spaces and hence have a reduced availability penalty, hence being perceived as more attractive than Whittlesford, which has 383 car parking spaces.
- **S-3**: By doubling the penalties applied to the base assumptions, this made some difference to the overall impact on demand, which experienced a small decrease of 7%. This is because this profile makes the largest car parks slightly more attractive than Whittlesford.
- **S-4**: The results from previous tests led to conduct a scenario and observe what the impact would be for penalising smaller car parks more than larger car parks, as these are likely to fill up quickly and hence some users may arrive to a full car park. To reflect this, the penalty for stations with car parks with under 100 spaces was increased from 6 minutes to 20 minutes, whilst leaving penalties for larger stations the same. Surprisingly, this caused demand to fall by 11%. This it is due to this change penalising smaller car parks in the do minimum scenario as well as the do something scenario, and the demand abstracted from these small stations in the base scenario is now being assigned to larger stations in the do minimum as well as the do something scenario.
- **S-5**: Taking this one step further, new set of assumptions were adopted which penalised smaller stations even further than larger stations. This caused Whittlesford Parkway to become less attractive, decreasing demand by 14% as it no longer abstracts from some hexcells that originally use larger station car parks (such as Royston which has 525 spaces).

6.92 The above sensitivity tests highlight the importance of incorporating sensible penalties for car parks based on their size. Furthermore, like the access time multiplier discussed previously, these parameters would impact both the allocation of demand in the do minimum (without the parkway station) and so something scenario, hence the importance of using parameters which closely reflect the perceived availability penalty of using different car parks.

Walking to the station

6.93 Simple sensitivity testing on the walking parameters, which in the base scenario gives the option for users who live within 2km of a station the option to walk to the nearest station if the overall generalised cost was competitive, were tested, with an assumption of the walking journey time equivalent to 1km taking 12 minutes to walk.

6.94 Just like when conducting these tests for East Midlands Parkway, changing these assumptions, such as changing the potential walk radius, and changing assumptions to make walking to their nearest station significantly more attractive, had little impact on changing the demand for the parkway station.

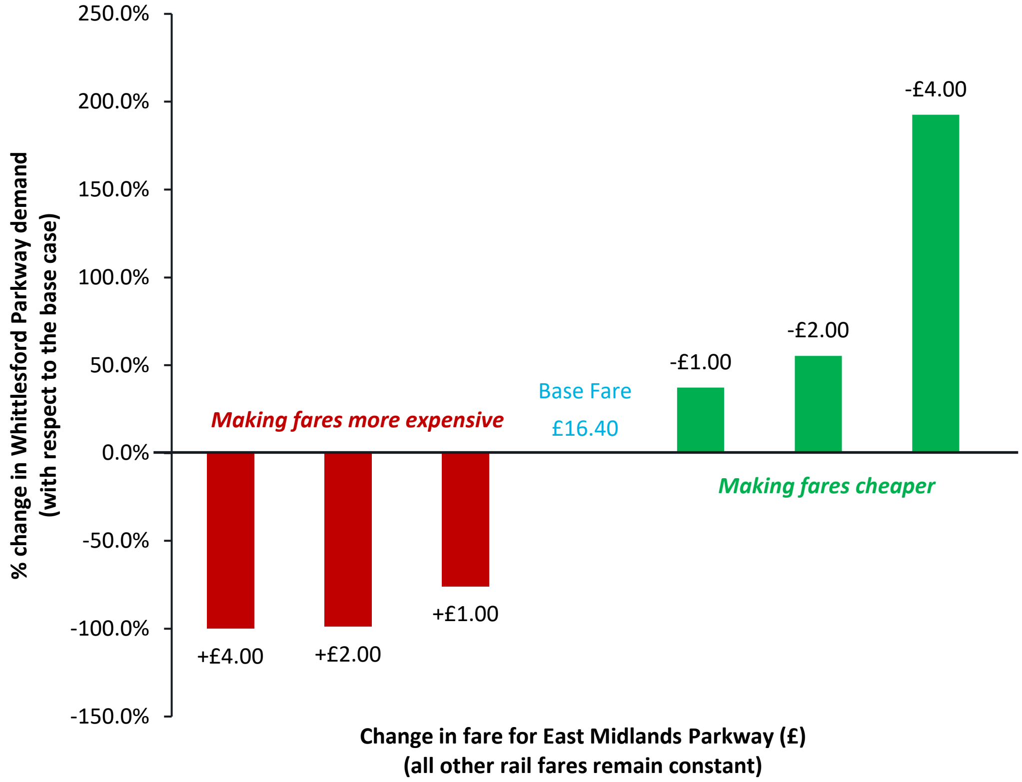
6.95 When comparing the wider catchments of Cambridgeshire and the East Midlands, both regions are relatively rural. However, unlike in the East Midlands, many of the alternative stations in Cambridgeshire do have direct and often comparable journey times to London. You would expect that this would mean changing walking parameters would have an impact on demand, but this doesn’t seem to be the case.

Rail journey assumptions

6.96 Rail fares between Cambridgeshire and London are generally similar, with stations slightly closer to London being priced fractionally cheaper than stations further away. Nonetheless, removing the rail fare component from the model still reduced the demand for the parkway station by 14%.

6.97 Figure 6.11 shows the results of only changing the fare between Whittlesford Parkway and London.

Figure 6.11: Rail fare sensitivity test on Whittlesford Parkway



6.98 As expected for this case study, a relatively small change in the fare can have a large impact on making users switch from one option to another, given that the journey leg is the most important component of the end-to-end generalised cost. Making the fare just £1 cheaper attracts 37% more demand to the station.

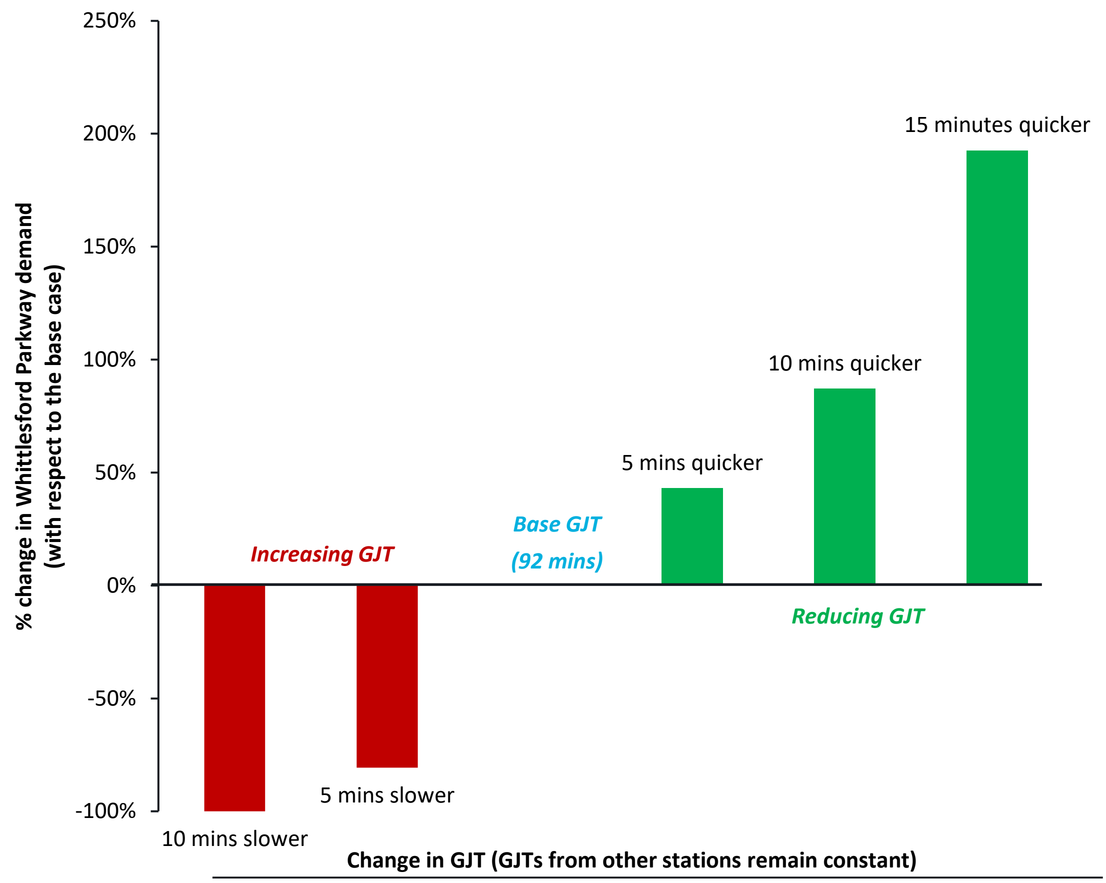
6.99 This confirms that this station's attractiveness is very sensitive to changes which make a material impact to the overall generalised cost of a journey. In many instances, **a small change can cause the station to lose its competitive advantage with a particular catchment**.

6.100 It should be noted that for the purposes of this analysis a weighted fare value was used for all journeys, whereas in practice there is a multiplicity of fares for different times of the day and product types, which would affect the conclusions of the analysis.

6.101 On the other hand, unlike where fares between different rail options are comparable, the generalised journey time can be very different between stations in Cambridgeshire to London. Most notably, stations on the West Anglia Main Line, such as Whittlesford Parkway, which are served by Greater Anglia services to London Liverpool Street (via Bishops Stortford and Harlow) have slower journey times than Thameslink or Great Northern services which operate services along the Cambridge and East Coast Main Line to London Kings Cross or St Pancras (via Royston and Stevenage).

6.102 The tests below demonstrate the potential demand increase to Whittlesford by providing a faster generalised rail journey time (GJT) for the rail leg of the journey to the destination.

Figure 6.12: Rail GJT sensitivity tests for Whittlesford Parkway



6.103 As with the fare component, making a small improvement to the GJT makes the station more attractive to users. A 5-minute improvement attracts 43% more passengers.

6.104 This confirms that **improving the rail offering of a parkway station (via a cheaper fare or faster GJT) has a significant impact on attracting more rail users from a wider catchment.**

Value of time

6.105 Based on the journey purpose split, the base scenario assumes a weighted value of time per passenger to be £15.76 per hour. The results of this test are presented in Figure 6.13 below:

Figure 6.13: Values of Time sensitivity test on Whittlesford Parkway

6.106 Interestingly, for this case study, the largest demand abstraction occurs when using a value of time of around £13, which is close to the commuting value of time recommended by TAG, only slightly lower than weighted value of time used in the base scenario. This closely resembles what we found for the East Midlands Parkway case study. However, the demand tends to drop significantly if either the TAG recommended Leisure VoT or Business VoT is used.

6.107 As observed with East Midlands Parkway, by using a Leisure VoT, this reflects that passengers are willing to use slower services with poor GJTs from local stations that may involve an interchange or be convinced to drive further to access a station closer to London which has a much more competitive rail fare.

6.108 Likewise, by using a Business VoT, these passengers are less sensitive to charges such as car parking and will always choose the fastest option, which means they are more attracted to Cambridge and Royston which provide a much faster rail service.

6.109 **Understanding how passengers value their time is key to reflect the potential catchment of a parkway station.** As seen, price sensitive leisure users may instead use a slower service if it is cheaper or drive further to access a much cheaper service. Similarly, business travellers may happily pay a premium, such as higher car parking charges, if the new station offers a competitive overall journey time.

Warrington NPR

6.110 Our final station example case study looks at the new proposed Warrington NPR station. Unlike the previous two examples (East Midlands Parkway and Whittlesford Parkway) this station does not yet exist, and so there are a few uncertainties surrounding it that this section will explore the sensitivities around. These include:

- Car park size;
- Car park fare; and
- Rail fare.

6.111 The destinations of interest for this station are Liverpool and Manchester. Note that this station is proposed to be located in close proximity to the other Warrington stations (Warrington Bank Quay and Warrington Central). We made some key assumptions in the model to capture this:

- Warrington Bank Quay and Warrington Central have been grouped as one existing station (Warrington BR) – this decision was taken due to the our demand data being grouped for both stations. In the base scenario, we ensured that the coordinates, drive time to the station, car park assumptions and rail fares are assumed to be the same;
- The coordinates of the proposed Warrington NPR station are the same as that for Warrington BR – this means that the access time to any of the Warrington stations is identical for a given hexcell; and
- As a base position, all attributes of Warrington NPR apart from the GJT (i.e. fare, car park size, car park cost) is equivalent to Warrington BR.
- GJT on the other hand is inferred based on the proposed Northern Powerhouse journey times and frequency[18], which suggests a 19-minute and 30-minute improvement in GJT to Manchester and Liverpool (respectively). Given the model's all or nothing allocation approach, these assumptions mean that all demand from Warrington BR will be abstracted by Warrington NPR.

6.112 Finally, as mentioned the model will test sensitivities around the listed uncertainties. The previous station examples provided insight into the parameters available in the model and how sensitive changes are to these (e.g. in terms of value of time and access time multipliers). We will not focus on these sensitivities for Warrington NPR, and will use the same base assumptions as for the previous stations.

Demand abstraction

6.113 Table 6.8 below presents a summary of the stations from which demand is abstracted towards the proposed Warrington NPR station.

Table 6.8: New demand make up of Warrington NPR (indicating where new demand has been extracted from)

Demand abstraction station	% demand to Liverpool abstracted	% of demand to Manchester abstracted
Existing Warrington Stations	47%	68%
Huyton	25%	-
Hunts Cross	15%	-

[18] GJT inferred from information sourced from https://transportforthenorth.com/wp-content/uploads/TFTN_-_NPR_At_a_Glance.pdf

Demand abstraction station	% demand to Liverpool abstracted	% of demand to Manchester abstracted
Newton-Le-Willows	2%	11%
Birchwood	7%	2%
Runcorn East	-	5%
Chester	-	5%
Helsby	-	3%
Lea Green	3%	1%
Other	-	5%
Total	**100%**	**100%**

6.114 The significant improvement in journey time sees the new station abstract all of the demand from the other Warrington stations, as well as significant amounts from other key destinations such as Hunts Cross, Huyton, and Newton-Le-Willows.

Car parking analysis

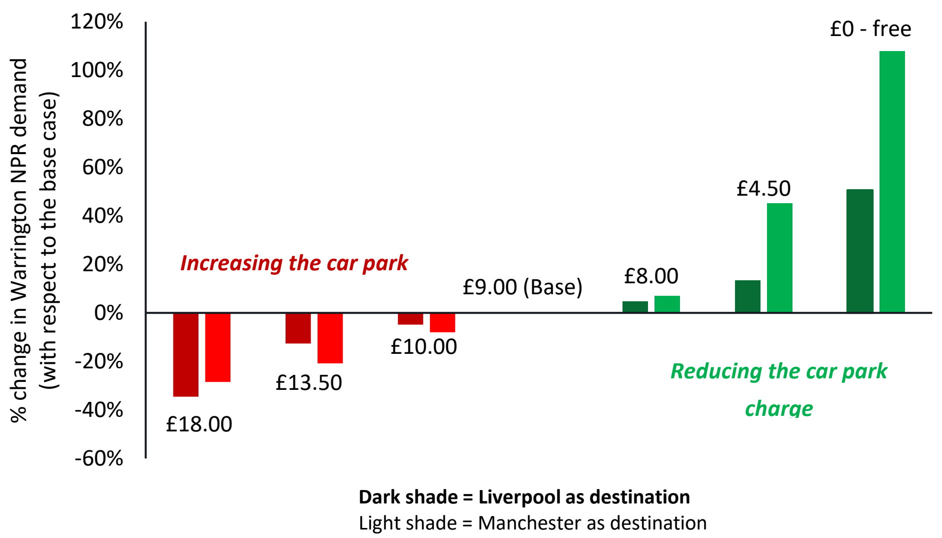
6.115 Sensitivities of car parking has been presented for two unknowns:

- Car park charges; and
- Car park size.

6.116 The base assumptions for the Warrington NPR car park is that it is equivalent to the Warrington Bank Quay size and price of 277 spaces, and a £9.00 for a daily ticket. Note that these are the same assumptions held for Warrington BR.

6.117 Figure 6.14 below presents the impact on demand of only changing the daily car park charges for Warrington NPR, while keeping the charges for alternative stations as they are.

Figure 6.14: Car park charges sensitivity test on Warrington NPR



6.118 The car park price analysis displays a similar trend to that seen in the previous examples, whereby reducing the car parking charge does have a significant impact in attracting more users to the new station.

6.119 However, it is interesting to note that reducing car parking charges have a much more influential impact in attracting more demand to Manchester than Liverpool. This may be due to the 30-minute generalised journey time improvement proposed by NPR is higher for Liverpool than Manchester which experiences a 19-minute improvement. Both of these changes are accounted for in our base scenario, therefore much of the demand abstraction from nearby stations has already been abstracted for Liverpool, and reducing the car parking to make the station more attractive has less of an influence.

6.120 It is also important to compare the results of this case study with our previous examples. The analysis shows that reducing or increasing the car park fare by 50% (from £9.00 to £4.50) gives a 13% increase in demand to Liverpool and 45% increase in demand to Manchester. These values are much lower relative to East Midlands Parkway and Whittlesford Parkway, where a 50% increase or decrease in price leads to changes in over 100% in demand in some instances. Thus, this suggests that the **benefit from the GJT saving provided by Warrington NPR outweighs the changes in car park fare**.

6.121 The next uncertainty is surrounding the size of the car park. Currently, it is assumed that the car park holds 277 spaces. As previously mentioned, the catchment model applies penalties that vary depending on the size of the car park. Table 6.9 sets out the impact of changes in the car park size on demand abstraction.

Table 6.9: Warrington NPR car park size assumption sensitivity results

Car park spaces	Park and walk time	Abstraction from flows to Liverpool	Abstraction from flows to Manchester
0 (no car park)	999	(88%)	(86%)
77	6	(1%)	(6%)
277 (base)	5	-	-
477	4	4%	4%
677	3	5%	7%

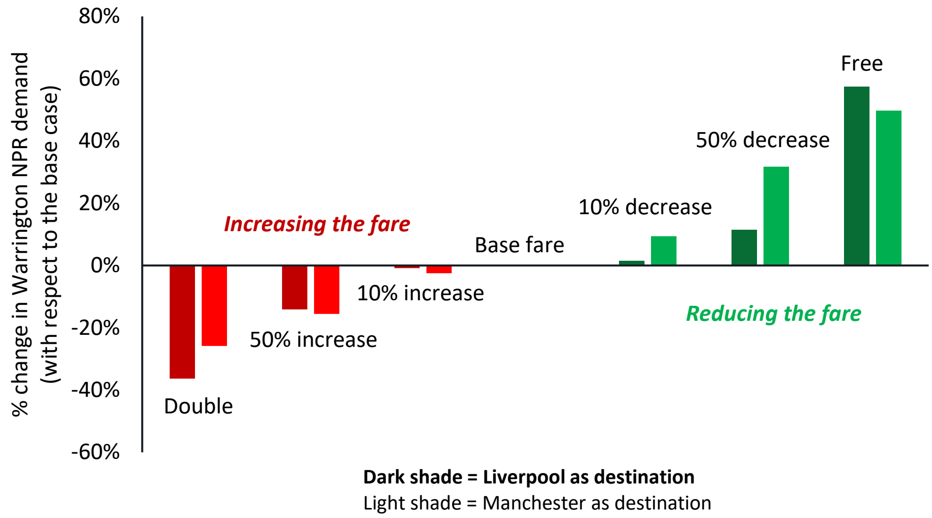
6.122 Table 6.9 shows that the assumed park and walk times for the different volume of spaces does not vary by much (1 additional minute for every 200 fewer spaces). For these cases, the change in demand is small because the **journey time benefits significantly outweigh the walk time penalty**. However, where there is no car park, the parkway station is no longer an attractive option as the majority of people will choose a station with an adverse journey time to avoid the large penalty.

Rail journey assumptions

6.123 Under the base, the rail fares are assumed to be equivalent to that from Warrington BR (£9.10 Anytime fare to Liverpool, £10.20 Anytime fare to Manchester).

6.124 Figure 6.15 demonstrates the sensitivity tests, relative to the base.

Figure 6.15: Warrington NPR rail fare sensitivity



6.125 Even when taking the extreme cases where fare is doubled or made free, the largest variation in demand abstraction is only 50%, which relative to previous case studies is not a large swing in demand.

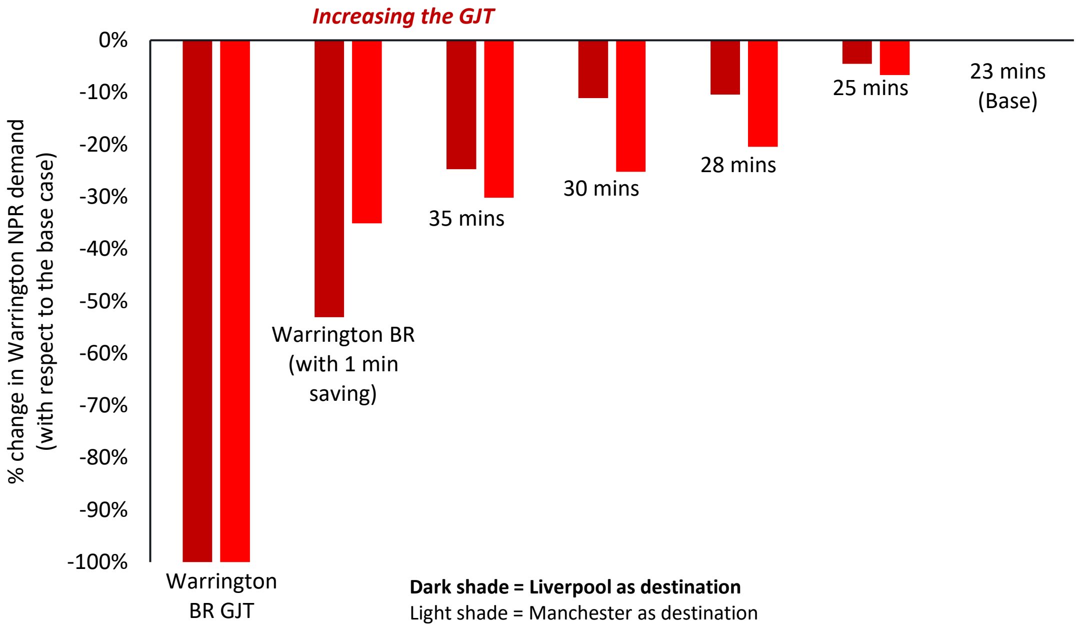
6.126 What is striking is that a small decrease in fare makes little difference to demand to Liverpool, but encourages more demand to Manchester. This is also the case when a 50% decrease is applied. However, when fares are made free, the flow to Liverpool is made the strongest.

6.127 Overall, the low relatively low variation in demand displayed highlights the extent to which the **large journey time improvements already abstract a lot of the nearby demand,** which is likely why any further improvements (such as fare reductions) do not have as much of an impact as with the other stations (where the choices between stations were likely more competitive).

6.128 The final sensitivity test is conducted on changing the GJT. As mentioned earlier, the base GJT assumption is likely to represent the best-case scenario and so the sensitivities look at how increases in the journey time would dampen the demand abstraction.

6.129 Figure 6.16 shows the results of applying varying GJTs to the model, and the impact on demand to Liverpool and Manchester.

Figure 6.16: Warrington NPR GJT sensitivity



6.130 In each of the scenarios undertaken for this case study, the only difference applied to the new station is the significantly better GJT proposed by the direct high-speed service to Liverpool and Leeds.

6.131 As expected, if this new station has no GJT benefit, and all other things being equal, the new station cannot abstract any demand from the existing Warrington stations (passengers would be indifferent). However, by applying just a 1-minute saving, all the existing users using Warrington BR will switch to the new station to access the faster service.

These results also clearly indicate that improving the GJT to Manchester is having a much larger impact on the demand attraction compared to improving the GJT to Liverpool. This is likely because the GJT to Manchester is faster than that to Liverpool for Warrington BR, and therefore the improvement in GJT with the new station is smaller in relative terms to Manchester.

7 Conclusions and recommendations

7 Conclusions and recommendations

7.1 The aim of this report was to develop an evidence base for the development of business cases for new parkway stations and modelling the demand response associated to them. The report is structured in two main blocks:

- Presentation of evidence base and determination of success criteria framework; and
- Application of this framework to modelling.

7.2 This Chapter presents the key conclusions from the report as well recommendations arising from the analysis.

Key findings and conclusions

7.3 The main conclusions from the report are the following:

Categorisation of parkway stations

7.4 Based on the literature review and analysis of existing stations, parkway stations can be broadly **categorised into two main groups**:

- **Long-distance parkways**: stations which allow users to easily access an interregional or intercity network which would otherwise involve travelling to a city centre first before continuing on by train. In these cases, the station aims to target users who can drive to the station and continue their journey on a long-distance service, such as to London.
- **Regional commuter parkways**: stations which allow for local access to a nearby regional centre. They aim to target users who are attracted by the ease of parking and taking a train to the city centre rather than driving the full journey to the city centre or using less convenient local rail stations.

7.5 However, it should be noted that, in practice, parkway stations tend to serve several markets at the same time, so they cannot be entirely categorised as just one of the two above categories.

Success criteria framework

7.6 The **success criteria** for a parkway station can be organised in the five following themes:

- **Location**: a successful parkway station is located within a non-congested area where car is the predominant access mode.
- **Access**: the location with respect to the road network is critical for its success, with the station being typically located near a strategic road/junction, with competitive access times and with sufficient capacity in the road network to accommodate demand at the parkway.
- **Rail services**: the level of rail services should be aligned with the passenger needs and the target market for the parkway station (including key destinations, journey times, frequencies and stopping pattern), but it also needs to be competitive with respect to other local rail alternatives.

- **Car parking**: the characteristics of the car park, including the number of car park spaces, the certainty to find a free space and the car park charges are important for the passenger decision-making
- **Wider policy**: other aspects have an impact on the success of a parkway station, such as restrictions to informal parking and access and parking restrictions at the destination.

Application to modelling and business cases

7.7 A comparison of **existing modelling frameworks** and the success criteria framework, as well as the **sensitivity tests** have allowed to derive the following conclusions, structured around three main topics:

- Parameters linked to the **access opportunities and onward transport offer** at the parkway station:
  - These are linked to the access opportunities to the station (e.g. its location and car park size) and the planned level of rail service (e.g. journey time and frequency), so they include station access time or rail GJT to the final destination.
  - These are typically well-known parameters to the business case (i.e. there is high certainty in determining the GJT or access time), therefore the focus should be in appropriately including them.
  - The recommendations are therefore the following:
    - Ensure that TAG/PDFH guidance is applied appropriately so that all success factors are included in the Strategic Cases for new parkway stations; and
    - Collect context-specific data to measure these parameters, with a particular focus on access time data.
- Parameters linked to the **rail fares and car park costs** of the parkway station:
  - These are linked to the rail fares and car park charges offered at the station.
  - In a geography which is already well served by rail, these can be changed to maximise/manage the demand and revenue attracted to the new station, so they are a lever that can be used by promoters to optimise the outcome of their business case.
  - The recommendation is therefore the following:
    - Develop a modelling framework which is able to adequately include rail fares and car park charges for the new parkway station and competing services/stations.
- Parameters linked to **modelling formulation**:
  - These are parameters used in the modelling formulation to determine the demand response at a new station and evidence suggest they can be critical in determining the demand response at a new parkway station. They include:
    - Weightings or multipliers linked with each modelled parameter (e.g. with access time); and
    - Value that passengers place on factors currently not included in modelling frameworks (e.g. value of car parking availability)
  - The recommendation is therefore the following:
    - Undertake research to estimate values for the weightings/multipliers and attributes involved in demand modelling for parkway stations
- Other relevant aspects include:
  - Consideration of the **egress** component of the trip, in particular at large cities such as London, where the choice of rail terminal is important for passengers.
  - Separate modelling for **peak and off-peak** periods might be relevant for certain parkway stations, especially where congestion during peak periods is severe and the

trade-offs between access time and car park availability might be different in the off-peak period.
  - **Softer aspects** related to the passenger experience, such as the available facilities at or near the station might have an impact on the station choice, but there is no evidence available and these aspects are likely to be less important than those presented above.

7.8 In addition, findings from this study have highlighted that, in markets which are well served by rail, there might be a marginal difference in competitiveness of a new parkway station with respect to existing stations. This means that all relevant factors, as described above, need to be taken into account so that a robust business case can be developed and a decision can be taken.

7.9 It should be noted that the conclusions of the study focus on the competition and abstraction of demand, between rail stations. However, new parkway stations also have the potential to abstract demand from other modes, such as car.

7.10 The rationale for modelling abstraction of demand from other modes would follow the same principles as the abstraction from other rail stations i.e. where rail is more competitive than car on an end-to-end journey basis, there would be potential for demand abstraction. All relevant factors presented above would also need to be incorporated in this analysis to truly reflect the competitiveness of rail.

Recommendations

7.11 Based on the findings presented above, a number of recommendations in relation to the development of business cases and modelling for new parkway stations are presented below:

- **Update of TAG and PDFH guidance**:
  - In line with the update of the Green Book late 2020, any new business case should place greater emphasis on the Strategic Case, particularly about how the scheme meets policy and objectives.
  - TAG and PDFH guidance should be updated to include the success criteria framework developed as part of this study can be used to demonstrate how a new parkway station can be successful in meeting its strategic objectives.
  - It is therefore recommended that the success criteria framework is used to inform the strategic cases of new parkway stations.
- **Data collection**:
  - The catchment area of a new station is typically segmented geographically and data from the 2011 Census can be used to characterise the population within the catchment, which is being updated to 2021 Census data. Equally, there are limitations on the sources for determining access time to stations.
  - It is therefore recommended that data is collected in relation to the origin zones for station users in the vicinity of the new parkway station area, covering a sociodemographic segmentation, preferred mode as well as access time to the stations.
- **Modelling framework**:
  - Consideration of a more complete definition of the end-to-end generalised cost would allow to fully capture the impact of important elements for the decision-making such as car parking charges or rail fare.
  - It is therefore recommended that any future approach adopted include all aspects involved in the station or mode choice as part a generalised cost (or equivalent) function.

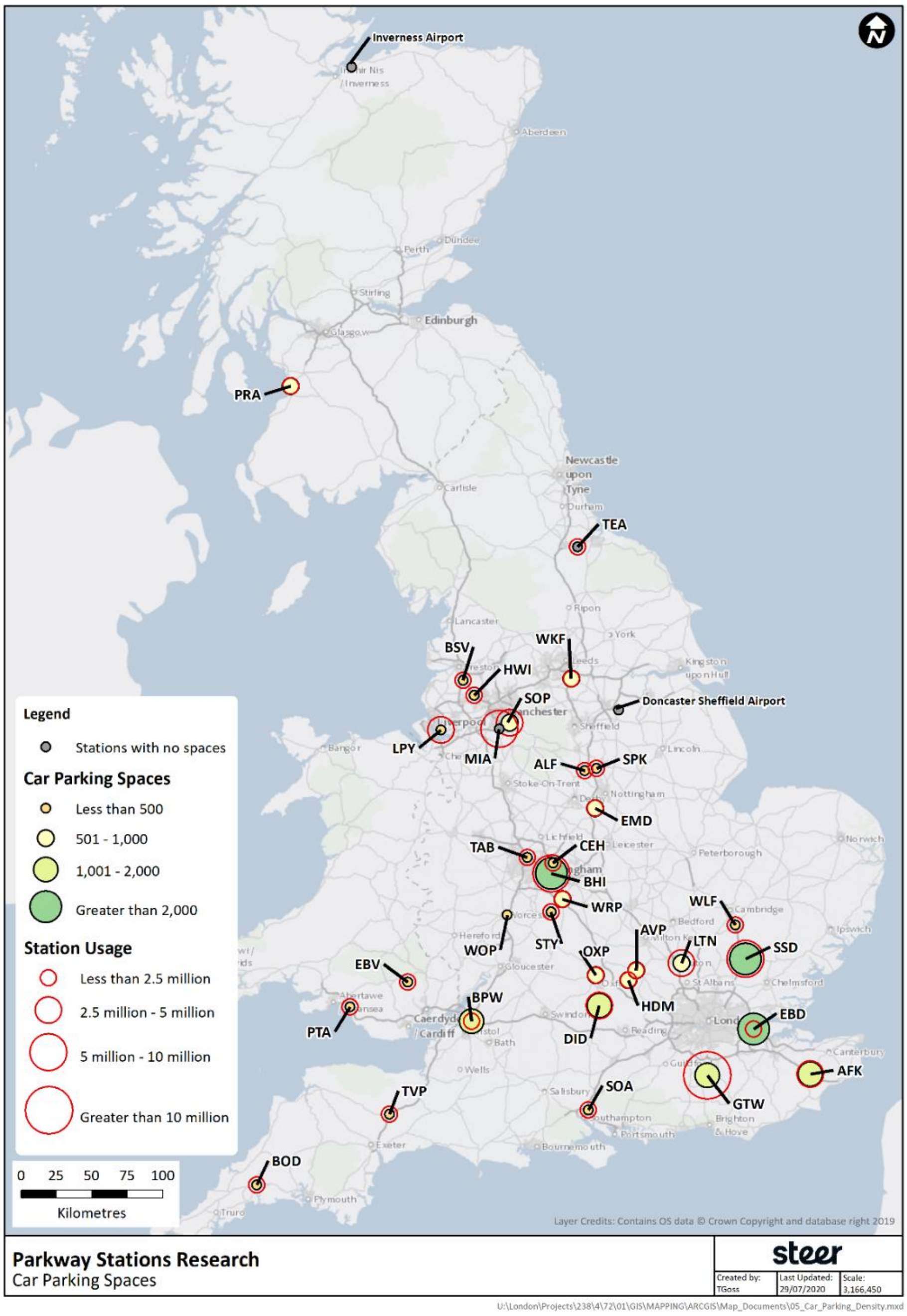
- **Research on parameter values and weightings**:
  - The current evidence base lacks detail in a number of aspects associated to the modelling formulation. These include the weighting or importance of a number of factors (e.g. access time), but also the value passengers place on other factors such as car park availability.
  - It is therefore recommended that a Revealed or Stated Preference survey that address the evidence gap described above is undertaken. It should target both current users and non-users of rail stations within the scope area and should seek to assess the importance placed on some of the attributed and to quantify the trade-offs users are willing to make (e.g. how much the value the certainty of finding a car park space, expressed in willingness to pay terms).

Appendices

A Car park analysis

A.1 This car park analysis is complementary to the evidence base developed in Chapter 3 and has been used to inform the success criteria framework presented in Chapter 4. Figure 7.1 below shows the number of car park spaces at parkway stations:

Figure 7.1: Car park facilities at parkway stations



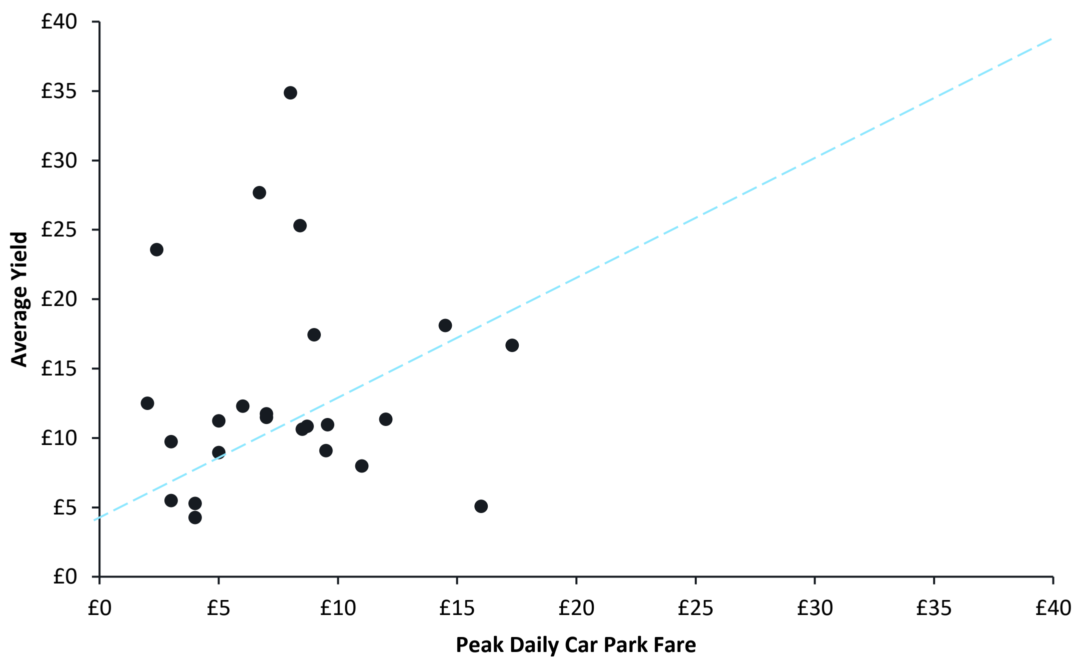
A.2 This is shown alongside the volume of annual users of the station, to provide an indication of the ratio between users and car parking facilities. There is not a clear trend between the volume of users at a parkway station and the number of parking spaces per user. However, it is noted that a lack of sufficient spaces might constraint the station demand and be a barrier to reaching its full potential.

A.3 This is supported by examining the current car park charges at different stations and comparing these to the average yield from that station. This analysis used the daily peak car park charges where available from the National Rail Enquiries website or derived an equivalent value from the annual cost where not available.

A.4 in addition, the average yield across all ticket types has been compared to the peak daily car parking charges. The results are displayed in a scatter plot in Figure 7.2.There does not seem to be any clear relationship between the average yield and the car park charges. Note that this analysis does not include stations with no car park pricing data, or those with free car parks.

A.5 However, it can be observed that in general car park charges represent a high proportion of the overall user cost, which could be a factor that deters potential users.

Figure 7.2: Car park charges and average yield



A.6 Additional analysis can be carried out to investigate the relationship between car park pricing and occupancy, however occupancy data is not easily accessible. This analysis should aim to capture the extent to which competing car parking options (including informal on-street parking) may abstract from the station's car park demand.

A.7 Figure 7.3 provides an example of competing car parking locations within walking distance of **Ashford International** (AFK) station. Users may alternatively choose to park at these locations (highlighted in yellow) which may provide a cheaper or more convenient alternative to the official car parking (highlighted in blue).

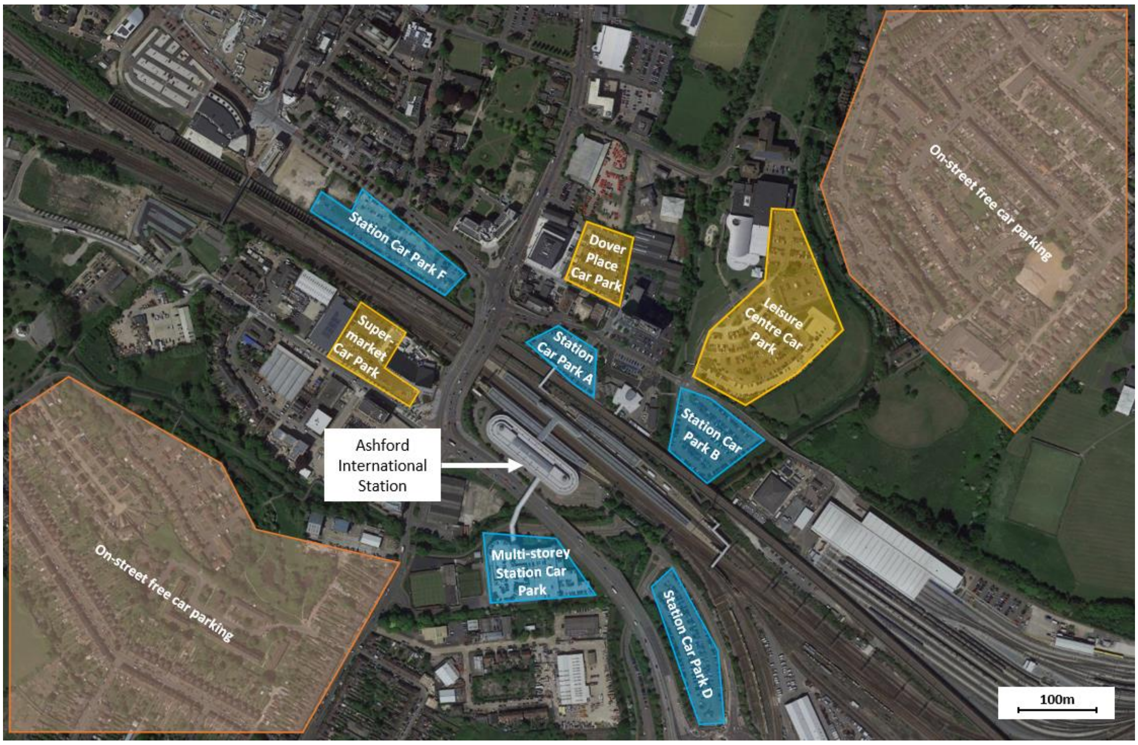
A.8 The Dover Place car park[19], operated by the local council, charges a low hourly rate attracting rail users who do short journeys and do not want to pay for a full day of parking. The day rate is also cheaper than what is offered by the official station parking.

A.9 The leisure centre car parking[16], also operated by the local council provides ample parking, also charging an hourly rate much lower than that of the official station car parks. However, for longer stays over 4 hours, the pricing here is comparable to the official parking.

A.10 The supermarket car park only has a maximum stay of 1½ hours which reduces the effectiveness of attracting rail users.

A.11 It is important to note there are also plenty of on-street car parking options available within walking distance of the station (highlighted in orange), with a residential zone on both sides of the station providing options for free parking for users.

Figure 7.3: Nearby car parking options to Ashford International Station



A.12 Car parking analysis shows no clear relationship between the car park price and the rail yield. Furthermore, without occupancy data, there is no way to conclusively state whether the hypothesis that the availability of other car park spaces around the station will have an impact on parking space usage. Additionally, the example above suggests that restrictions to these other car parks will limit the amount of abstraction from the station car park.

[19] Information collected from Ashford Borough Council website, as of July 2020.

B Parkways stations' evidence base

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