steer davies gleave

Mobile connectivity research study

Final report
March 2016

Department for Transport

SDG ref: 22853201

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Executive Summary

Overview

This report describes research to measure the benefits to rail passengers of improvements to mobile phone and internet connectivity on trains. The specific objectives of the brief were:

To carry out a detailed research study to understand how rail users use and value on-train mobile connectivity, to provide more detailed valuations of the benefits of on train mobile connectivity disaggregated by level of provision and journey type.

Over 2,000 interviews were carried out with rail travellers between November 2015 and January 2016, using a mix of face-to-face interviewing and self-completion online interviews. The surveys were designed to capture a mix of journey purposes and journey lengths across the network.

The interviews used a specialised market research technique called Stated Preference (SP). Widely used in transport research, SP presents interviewees with a series of choices between alternative scenarios, in which they are implicitly asked to make trade-offs between fares and varying service levels. In this case the trade-offs were between fares and levels of internet access and phone connectivity on the trains. Statistical analysis of the responses then provides estimates of how much people are willing to pay for specific levels of internet and voice connectivity; these are the 'willingness to pay' values.

Voice connectivity

Respondents were asked about their use of mobile phones while on the train. Up to 45% had either made or received a call when they were interviewed or expected to by the end of their trip. Of those who did, just under half talked for under ten minutes during their trip. 53% of the respondents said their phone connectivity was always or mostly good.

Willingness to pay values were measured for voice connectivity at varying levels of reliability. These levels were:

- No connectivity at all, for the entire journey[1];
- 50% (Intermittent connection) in which it is possible to make/receive phone calls for around half of the journey, with interruptions spread randomly through the journey;
- 80% (Mostly good connection) in which it is possible to make/receive phone calls for most of the journey, with interruptions spread randomly through the journey;
- 100% (Always good connection) in which it is possible to make/receive phone calls for the whole of the journey.

The table below show the results, split by journey purpose. The values tabulated are the percentage uplift in fare people were willing to pay in order to have the corresponding improvement in phone signal reliability.

[1] Not, of course, a situation anyone is likely to experience in practice, but necessary here in order to measure the value of providing a service at all.

Improvement in reliability:	Business	Commute	Leisure
0% to 50%	17%	15%	13%
50% to 80%	8%	10%	6%
80% to 100%	4%	0%	0%

These results show:

- People in all three segments are willing to pay a significant uplift on their fare to get mobile phone provision at 50% reliability;
- They are willing to pay another 6%-7% to gain a further improvement to 80% reliability;
- Commute and leisure travellers do not attach a measurable value to moving from 80% to 100% reliability, but business travellers do.

Internet Connectivity

Respondents were asked about the devices they used on the train and the type of internet connection they employed. Up to 65% of respondents had either used the internet before they were interviewed or expected to do so by the end of their trip (i.e. more than had made phone calls). Usage was high across all three trip purposes, but was higher among business travellers and commuters than leisure travellers. Of those who had used the internet, 79% did so via 3G or 4G. The most commonly used device was the smartphone (compared to tablets and laptops). Email, social media and general browsing were the most common activities.

54% of internet users perceived the quality of their connection to be poor or intermittent; 49% were dissatisfied with the internet speed ('unusable' or 'slow').

The Stated Preference research measured willingness to pay for different levels of internet service provision at varying levels of reliability.

The service levels were defined in terms of what it was possible to do while on the train. This functionality is closely related to connection capacity and speed, but was described to respondents as follows:

- **None** - No internet activity, by any means, for the whole of your journey[2];
- **Low Data** - Activities with low data use including: Emailing and Online Messaging (e.g. WhatsApp) and basic browsing (no audio/video) (e.g. Wikipedia);
- **Medium Data** - Activities with medium data use including: Emailing and Online Messaging (e.g. WhatsApp), Browsing (e.g. BBC website), Social Media (e.g. Facebook);
- **High Data** - Activities with high data use including: Emailing/Online Messaging (e.g. WhatsApp) Browsing (e.g. BBC website), Social Media (e.g. Facebook), Audio/Video Streaming (e.g. Netflix).

Reliability was offered at three levels, described as follows:

- 50% (Intermittent connection) in which it is possible to connect to the internet for around half of the journey, with interruptions spread randomly through the journey;
- 80% (Mostly good connection) in which it is possible to connect to the internet for most of the journey, with interruptions spread randomly through the journey;

[2] As for voice, not a situation anyone is likely to experience, but necessary here as a reference point so that the value of providing a service at all can be measured.

- 100% (Always good connection) in which it is possible to connect to the internet for the whole of the journey.

The tables below show the results, split by journey purpose and for short and medium distance commuters (the boundary was a journey time of 30 minutes). The values tabulated are the percentage uplift in fare people were willing to pay in order to have the corresponding internet service provision and reliability. For example, compared to no provision at all, business travellers valued the provision of a low data service level (i.e. email and basic browsing) with 80% reliability, for their entire journey, at 15% of the one-way fare.

Willingness to pay for improved internet service and reliability, business

Service level/Reliability	0% to 50%	0% to 80%	0% to 100%
Nothing to Low	13%	15%	17%
Nothing to Medium	17%	19%	21%
Nothing to High	18%	21%	21%

Willingness to pay for improved internet service and reliability, commuting short

	0% to 50%	0% to 80%	0% to 100%
Nothing to Low	7%	8%	9%
Nothing to Medium	13%	15%	16%
Nothing to High	14%	16%	16%

Willingness to pay for improved internet service and reliability, commuting medium

	0% to 50%	0% to 80%	0% to 100%
Nothing to Low	12%	14%	15%
Nothing to Medium	18%	20%	22%
Nothing to High	20%	22%	26%

Willingness to pay for improved internet service and reliability, leisure

	0% to 50%	0% to 80%	0% to 100%
Nothing to Low	10%	12%	13%
Nothing to Medium	15%	17%	18%
Nothing to High	16%	18%	18%

These values are for the provision of connectivity at a given level of reliability, but are not conditional on the type of connectivity, such as Wi-Fi or 4G, or the type of device used. Care was taken in the interviews to separate the degree of connectivity from the means through which it was provided. The values also apply when the service is provided for the entire duration of a journey. No tests were made of the values that would apply if service provision was only for part of a journey, but a reasonable assumption would be that they would be scaled down proportionally.

1 Introduction

This study

1.1 We have been commissioned by the Department for Transport (DfT) to carry out a detailed research study to understand how rail users use and value on-train mobile connectivity. The purpose of this research study is to provide more detailed valuations of the benefits of on train mobile connectivity disaggregated by level of provision and different types of journey.

1.2 Our approach to this study was first to review existing research into the use of phones and the internet on trains and the associated charges and willingness to pay for them. We then designed a Stated Preference (SP) survey, which asked respondents to trade between costs and levels of connectivity provision.

1.3 We piloted the survey in October and collected 42 responses (18 online and 24 face to face). The analysis showed that people understood the survey and that the survey was working broadly as expected. However there were two issues which we identified:

- The survey took too long to complete and we recommended that it be shortened;
- We were not sure if respondents understood that the different levels of internet use presented were cumulative, i.e. that the high level included email, browsing, and streaming rather than just streaming.

1.4 We addressed both of these issues before the main survey. We then carried out the main survey between late November and mid-December with a further couple of weeks in January. This main survey used a combination of online recruitment through handing out postcards and face-to-face on-train surveys during November and December, while the January survey period consisted of online panel surveys. We targeted a sample of 2,000, with approximately half face-to-face and half online and had achieved in excess of this by the end of January.

Context

1.5 Before carrying out this primary research we reviewed several sources of existing information to get a better understanding of how people spend their travel time and how the introduction of mobile connectivity on similar environments has had an impact on passenger or customer demand and their use of technology in this environment.

1.6 As part of the inception phase we commissioned research fellows from the Centre for Transport and Society at the University of the West of England, Bristol (UWE) to carry out a literature review. This literature review is included in Appendix C. It provides an excellent overview of the current use of travel time and particularly internet use on the move.

1.7 In addition to this we also reviewed several relevant documents. A summary of the sources we reviewed is included in Appendix D.

1.8 The main findings from these were that several factors affect the way people access and use mobile connectivity whilst travelling. These include: the devices they possess; the activities they use connectivity for; and the provision of connectivity.

1.9 When evaluating the value of mobile connectivity, research suggests that internet access is important and can influence mode choice; however it is not normally as central to that choice as other journey aspects like journey time, price and reliability. The connection quality and reliability is also important; in some cases poor quality connectivity can have a negative impact on passenger satisfaction and journey experience. Research suggested that the value of mobile connectivity is likely to vary by journey purpose, journey duration, age and gender.

1.10 Despite the recent increase in Wi-Fi provision on public transport and at stations, there is limited recent revealed preference research about its perceived value.

Independent review

1.11 As part of this study, we worked with John Bates, an independent practitioner, who acted in an independent review and challenge role. John has been a leading figure in the development of stated preference techniques within the transport field, and has considerable expertise in evaluation methodology.

1.12 John Bates reviewed the inception report to observe the proposed survey methodology and design, provide comments and raise any potential issues. John Bates also reviewed an initial draft of this report and we have responded to his comments in this final issue.

Report structure

1.13 This report summarises the specification, survey methods and results of this study.

1.14 The report is structured as follows:

- In Chapter 2 we describe the sample specification, the initial approach to the fieldwork and the revisions made as a result of the pilot survey.
- In Chapter 3 we detail the design of the surveys. This is split into the qualitative questionnaire and a full description of the SP exercises. We comment on any amendments as a result of the pilot survey and initial analysis in this chapter.
- In Chapter 4 we present the results of the research. This looks at the distribution of the sample and evaluates the willingness to pay and qualitative responses for voice calls and internet usage.

1.15 In the appendices we include the survey questionnaire, the literature review carried out by the Centre for Transport and Society at the University of the West of England, Bristol (UWE), and more detail of the SP analysis and models.

2 Fieldwork

Introduction

2.1 We carried out a mixture of online and face-to-face surveys targeting rail users in the UK.

2.2 We designed the surveys to understand how passengers value and use on-train mobile connectivity, differentiating between voice calls and data/internet use.

2.3 To test the method for this survey we piloted it in October and assessed the effectiveness of the process.

2.4 This chapter details the sample we targeted, the approach we used to recruit respondents, any modifications to this approach as a result of a pilot survey and details of the methodology for the main survey.

Sample

2.5 We targeted rail users across the country. We ensured that we surveyed a range of rail users to be able to understand the differences between different users and to have a sample that is representative of rail users.

2.6 We aimed to collect a total of 2,000 responses, approximately half of them face-to-face and half online. We used a mix of recruitment methods, each of them with a different balance of strengths and weaknesses, to increase the likelihood of reaching the total sample size and the quota totals. These quotas were chosen to differentiate between people and types of trip that we expected, a priori, to have different valuations. We expected the primary differentiators to be trip length and trip purpose, leading to the quota groups shown in Table 2.1.

Table 2.1: Sample quotas

Up to 30 minutes	30 minutes to two hours	More than two hours
-	Business	Business
Leisure	Leisure	Leisure
Commute	Commute	-

2.7 We specified quotas to ensure a minimum of 200 in each of the categories listed in the table. This was to give a total of 1,400 responses spread equally across the quotas, with the remaining 600 being distributed randomly across these segments.

Initial approach

2.8 We commissioned Field and Fab (F&F) to carry out the fieldwork. Field and Fab are a market research company with experience of Stated Preference and of surveying on the UK rail network.

2.9 We carried out the surveys on train services run by three Train Operating Companies:

- Southwest trains – targeting short and longer distance commuters, and shorter distance leisure trips;
- East Midlands Trains –targeting business and leisure, regional and mid distance trips;
- Virgin West Coast mainline –targeting high speed, long distance business and leisure travellers.

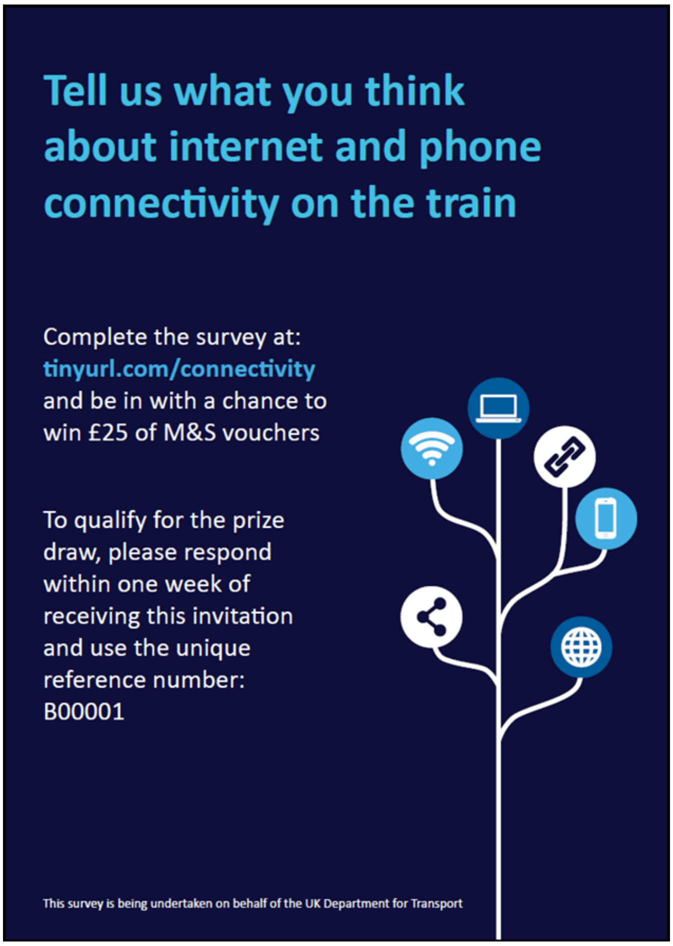
2.10 The basis for selecting these Train Operating Companies was that between them they ran services that would enable us to interview travellers in each of the quota groups set out in Table 2.1.

2.11 There were two methods of contact: face-to-face and online. For face-to-face interviews on trains, interviewers recruited respondents and carried out the interviews on iPads. The interviewers followed F&F procedures for surveying, which are designed to minimise selection bias.

2.12 For online interviews, people were recruited during their journey and invited to complete the questionnaire online. They were handed a postcard with a short description of the survey, a clear statement that it was being done on behalf of the Department for Transport, a web address to go to (a URL) and a unique access code. The code was unique to each card, and once activated was valid for one week. This was to control who had access to the survey and prevent misuse, such as people making multiple entries.

2.13 We distributed the postcards at the same time as carrying out the face-to-face interviews and monitored the response rate and quotas. The postcard design is shown in Figure 2.1.

Figure 2.1: Postcard design



2.14 To incentivise rail users to respond to the survey, in the pilot we offered a prize draw of £25 M&S voucher prizes. It was hoped that that this would give a response rate of between 2% and 5% for the postcards, based on our experience of previous surveys.

Pilot survey and revised approach

2.15 We piloted each of the fieldwork methods to test for practical problems and determine if changes to the survey were necessary. This took place during October on three East Midlands Trains services.

2.16 We had targeted a sample size of 70 responses and received a total of 42 responses. This consisted of 24 complete responses from face to face surveys and 18 complete responses from online surveys from the postcard distribution.

2.17 One reason for the shortfall was that the questionnaires took longer to complete than expected. The feedback from F&F was that the 30 minute Grantham – Nottingham journey was too short to get the two interviews that were planned for this journey. This was rectified through changes to the survey design to reduce its length. More details of the specific modifications are given in Chapter 3.

2.18 The response rate for the online survey was also lower than anticipated. 1,150 postcards were distributed and 18 replies received - a response rate of 1.6%.

2.19 We expect that one reason for this, as with the face to face interviews, was the time it took to complete the questionnaire; as noted, this was addressed by shortening it. We also tried to increase response rates by changing the balance of the incentive offered, from twenty prize vouchers worth £25 each, to five prize vouchers worth £100 each. The recruitment postcards told respondents the value of the incentives.

Main survey

Face-to-face and online surveys

2.20 Following confirmation of the modifications to the survey after the pilot, the fieldwork for the main survey began on November 19th. This included face-to-face surveys and postcard distribution.

2.21 The following services were used for the face-to face surveys:

- East Midlands Trains:
  - Sheffield to London (return) service, leaving Sheffield to get into London for the morning rush hour, targeting commuters on the outbound journey, and business and leisure passengers on the return journey.
  - Grantham to Nottingham (return) service, leaving Grantham to get into Nottingham for the morning rush hour, targeting commuters on the outbound journey, and work and leisure passengers on the return journey.
  - Lincoln to Nottingham (return) service, leaving Lincoln to get into Nottingham for the morning rush hour, targeting commuters on the outbound journey, and business and leisure passengers on the return journey.
  - Norwich to Liverpool (return) service, leaving Norwich on a weekend morning, targeting leisure passengers.

- Virgin West Coast:
  - London to Manchester (return) service, leaving London early or late in the day, targeting business and leisure passengers.
  - London to Birmingham (return) service, leaving London early or late in the day, targeting business and leisure passengers.
  - London to Glasgow (return) service, leaving London early or late in the day, targeting business and leisure passengers.

- South West Trains
  - Various hour-long services getting into London for the morning rush hour, targeting shorter commuter journeys.

2.22 We collected 1,150 complete face-to-face interviews between November 19th and December 11th.

2.23 The online survey through postcard distributions proved more challenging. At the time of completing the face-to-face interviews, we had only 34 complete online responses with a response rate of 0.6%. This level of engagement was far lower than expected both from the pilot and from previous studies.

2.24 The feedback we received from the survey company was that many postcards were ignored and left on the train. We are unsure why this was so different from the pilot, particularly given the increase in incentive and shortening of the questionnaire and therefore can only speculate. One possible reason might be the time of year; approaching Christmas people may be less likely to make time for these surveys. However, this would not explain the low online response rate during November.

2.25 To collect the required 1,000 online responses in this way would have required distribution of over 150,000 postcards, which was unfeasible on the grounds of cost and timing, without any guarantee on the number of responses.

2.26 In a change of approach, we arranged for approximately 1,000 of the remaining postcards to be distributed at Leeds Station on 17th December rather than on-board trains. This performed no better, and in total we collected only 49 responses from online surveys between November 19th and December 21st.

2.27 We were able to introduce a third collection method through hosting our online questionnaire on the East Midlands Trains website, which went live on November 27th. This was essentially an experiment, where there was no level of expectation and any responses would be a bonus. However, this was not well advertised on the site and produced only three responses in total.

2.28 Given the low response rates we paused the survey recruitment on 17th December. At this point we had 1,200 responses, well short of the target of 2,000, and some of the quotas in Table 2.1 were unfilled.

2.29 Analysis of the responses was carried out, but we found that when segmenting the sample by two or more factors, some sample sizes were too small to give robust results. We therefore introduced a new method of collecting responses, using an online panel survey.

Further collection methods

2.30 Online panels consist of large numbers of people who, for a small payment, have signed up and agreed to take part in online surveys from time to time. Our fieldwork partners Field and Fab drew an online panel sample for us, targeting people who have recent experience of travelling by rail.

2.31 To ensure that respondents were suitable for this survey, we added a screening question to the start of the questionnaire asking when their most recent UK rail journey was. Only respondents selecting a time within the last three months were able to continue. Respondents were asked to consider their most recent journey when answering the survey.

2.32 The advantage of an online panel survey is that it is possible to guarantee that quotas will be filled from pre-screened respondents and gather the responses quickly and efficiently. A potential disadvantage is uncertainty about the motivation and care taken by online panel respondents, although this is applicable to all survey responses to some extent. To guard against this, we undertook a data cleaning process to exclude respondents whose replies were of doubtful quality. Table 4.3 (in Chapter 4) lists the exclusions and the reasons for exclusion.

2.33 We launched the panel survey using the same questionnaire as for the online survey on January 20th and had filled the quotas by January 29th. Using this method we received an additional 1,039 responses, taking our final sample to 2,241.

3 Design

Introduction

3.1 In this chapter, we set out the design of the survey. Firstly, we describe the different sections of the questionnaire and explain what information they are designed to obtain. Secondly, we focus on the Stated Preference exercises included in the survey. Finally, we detail any revisions made to the main survey as a result of the pilot.

3.2 The survey was designed taking account of existing research categories, and reviewed internally by SDG, and externally by the DfT. As described in Chapter 2, we piloted the survey to test the design. This pilot survey highlighted the need to make minor changes to the design and this was iterated following review and discussion both internally and with DfT. What follows in this section is a description of the final survey design.

Questionnaire

3.3 The questionnaire contained around 50 questions, although the typical number answered by any one respondent was around 35, and could be as low as 24, depending on the responses given to some questions. There was also an SP section with three exercises.

3.4 The full questionnaire can be found in Appendix B. The version of the questionnaire presented in this appendix is for the online survey. We made some wording changes and removed unnecessary questions for the face-to-face version, but the information collected was the same. For the online panel survey, we made similar edits.

3.5 In all cases, the questionnaire was broken down into a number of sections, each with a different purpose. These were:

- Screening;
- Reference trip – profiling questions
- Reference trip – fare
- Reference trip – voice
- Stated Preference - voice
- Reference trip – data use
- Stated Preference – data use
- Attitudinal questions
- Respondent information

3.6 The specific purpose of each of these question sections is described in the table below.

Section	Description
Screening	This section was designed to ensure that only respondents who were in scope for the survey progressed to the next stages, and to identify a target trip to build the questionnaire around. It began with an introduction to explain purpose of the questionnaire, that the responses would only be used for research purposes, and to explain the incentives. Screening questions were used to filter out people aged 16 or under and those who travelled for free. The latter were excluded because the SP was designed to measure willingness to pay, based on incremental changes to the fares actually paid. People who did not pay would still value connectivity, but a different approach would be needed to address them. We did not expect this to account for a very large proportion of potential respondents and therefore agreed that their exclusion would not affect the results very much. Note that this exclusion does not include people whose fare was paid by someone else, such as business travellers. We also asked the respondent about their journey purpose for the selected trip. This was because we expected people with different journey purposes to value connectivity differently and asking this here allowed us to ensure we fulfilled the quotas sufficiently.
Reference trip-profiling questions	This section focused on asking the respondent about the target trip. This consisted of four questions, all concerning the train on which they were contacted, rather than the journey as a whole, to avoid confusion about different levels of Wi-Fi provision across different legs of a journey. These questions were about start and end stations, departure time and duration.
Reference trip-fare	This section looked at the fare paid by, or for, the respondent. The purpose of these questions was to estimate a one-way fare for the journey, to be used in the SP exercises. Where return or season tickets were selected, we divided this down using ORR multipliers to get an approximate one way fare. If the respondent did not know their fare, they were offered a price band selection, where they could choose an approximate fare. Before the SP exercises, the respondents were shown the calculated one-way fare and asked to confirm it, or to select another value to ensure that we had interpreted their response correctly. Fares were rounded down to the nearest £5, with a minimum of £5 and a maximum of £200.
Reference trip-voice	This section continued to focus on the reference trip. It was typically made up of three questions relating to the respondent's use of a mobile phone on the train. For the reference trip, this included questions about call duration, purpose and quality of connection. The subsequent SP was structured around the same levels, allowing the results to be related to reported experience.
Stated preference-voice	This SP exercise traded cost against the reliability of the phone signal for voice calls, and is described in more detail in the next section. Following the SP exercise there were follow-up questions for respondents who always selected either the cheapest or most expensive options, asking them why they did so.
Reference trip-data use	This section looked at data usage during the reference trip. We asked up to twelve questions about: if and how the respondent connected to the internet while on the train; how much they paid, if this was via Wi-Fi; what online activities they undertook while on the train and on what devices; the time spent online on the train; the quality of the internet connection they experienced; and their current ownership of a personal or business mobile phone. The questions about phone ownership included the respondent's payment plan and type of phone, split by their personal and business phone if applicable. The purpose of this section was to allow us to understand the respondent's current level of mobile connectivity.
Stated preference-data use	The final two SP exercises were introduced at this point. The first SP traded the type of internet activity (which was a function of connection speed and data allowance) that was possible against the reliability of the internet connection. The second SP traded the type of internet activity against cost. Following the first of these SP exercises respondents were asked directly which was the most important to them: speed/data or reliability. After the second, there were follow-up questions for people who always selected either the highest or lowest fare, asking why they had done this.

Section	Description
Attitudinal questions	This was a short section of three questions asked of every respondent about how their phone and internet usage on trains might change in general with improved connections and no restrictions on usage. The purpose of these questions was to get an idea of how the network might be used in the future if upgrades were made.
Respondent information	The final section asked questions about the respondent: gender, age, occupational status and income.

Stated preference exercises

Objectives

3.7 The focus of the SP surveys was to understand how rail users value on-train mobile connectivity. In particular we aimed to understand how they value:

- Use - what they can do (regardless of what device and what technology is used):
  - Emailing/messaging
  - Internet browsing
  - Social media
  - Streaming
  - Voice calls
- Reliability of the service:
  - No connectivity
  - Intermittent connectivity - 50% of the journey
  - Mostly connected - 80% of the journey
  - Always connected - 100% of the journey

Issues

3.8 During the designing of the SP exercises we have had to address three main issues:

1. How to ask people to compare to a 'no connectivity' position, when they probably had some level of connectivity on their reference journey;
2. How to deal with the interdependencies between use (e.g. streaming) and reliability. For example it is quite likely that streaming is only valued highly when you also have a reliable service;
3. Whether to estimate the value of mobile connectivity in units of time or money, and how to present the trade-offs.

3.9 The first issue was unavoidable. The objective of this study was to understand how people value mobile connectivity, and this has to mean valuing it relative to a reference case of 'none'. To do this, we needed to have some questions which asked people to trade having connectivity against having none, even if 'none' may not be a common experience now. As is often the case in SP, we needed to test scenarios with which the respondent is familiar against scenarios with which they are unfamiliar, and the key to making this work lies in the explanation put to respondents before the SP begins, the framing of the questions and the clarity of the text in the explanation and the SP options. More detail of the framing is given in the descriptions of the SP exercises in the next sections and in the questionnaire given in Appendix B.

3.10 The second issue can, technically, be dealt with by including interaction terms in the SP designs, but this leads to impractically large and complicated designs. We have therefore split the SP concerned with internet use into two simpler exercises, one to examine use and reliability at a fixed price, and the other to compare use and cost at a fixed level of reliability. Taken together, this provided enough information to understand the trade-offs between internet use, reliability and price, while allowing for interactions between use and reliability.

3.11 The third issue, in theory, need not have an impact on the results, as time and money units can be converted. However, it was decided to carry out the SP using money as the value metric, mainly because people are used to the idea of paying for connectivity, so this trade-off would be familiar to many of them, but also because it delivers monetary willingness to pay values, which were required by the brief. To try to avoid any protest bias, where respondents say they are not willing to pay for something that they already get for free or think should be provided for free, we presented the cost increments on top of the one-way fare, and not as a separate charge. This meant that respondents were asked to choose between two journeys with different levels of connectivity at different fares.

3.12 There were three SP exercises, described in the remainder of this section.

1. Phone Reliability
2. Internet Reliability
3. Internet Use

SP exercise 1: Phone reliability

Framing

3.13 The first SP exercise was designed to see how users value the reliability and consistency of their phone signal for making or receiving a phone call while on the train.

3.14 In each case, the respondents were asked to imagine a choice between two similar rail journeys and to say which they would prefer for their journey. The alternatives varied in terms of the following elements:

- The fare for the journey; and
- the reliability of phone signal for voice calls.

3.15 In each case, the respondents were asked to assume that:

- The two scenarios shown are the only scenarios available regardless of the internet provision that was experienced on the reference journey.
- They have access to a mobile phone, and there would be no additional costs from the mobile phone operator.
- The fares shown would be the total one way fare for their journey.
- The reliability percentage refers to the proportion of their journey that they are able to have voice calls and that his would be randomly spread through their journey rather than in concentrated blocks of time.
- All other factors in their journey are identical to avoid introducing bias.

3.16 The way this exercise was introduced and framed can be found in question 24 of the questionnaire in Appendix B.

Levels

3.17 Table 3.1 shows the levels of each attribute in the SP design. In the case of the 'fare' attribute, these are percentage increments on the one-way fare stated by the respondent earlier in the questionnaire, but displayed as a total fare. These values therefore looked different for each respondent.

Table 3.1: Exercise 1 attribute levels

Attribute	Option 'A' Levels	Option 'B' Levels
Reliability of phone signal	**3 levels:** 0% (No connection), 50% (Intermittent connection), 80% (Mostly good connection) ,	**3 levels:** 50% (Intermittent connection), 80% (Mostly good connection), 100% (Always good connection)
Fare	**2 levels:** 0%, +2%	**3 levels:** +2%, +6%, +12%

Design

3.18 Exercise 1 was made up of eight cards, but each respondent was shown six cards that were randomly selected from the eight and shown in a random order[3]. Each card asked the respondent to choose between option 'A' and option 'B'. Each option described a scenario in terms of the attributes described above.

3.19 Table 3.2 below shows the full design of Exercise 1 for a respondent whose one-way fare is £50. Costs for people who had paid other fares were calculated automatically by the questionnaire.

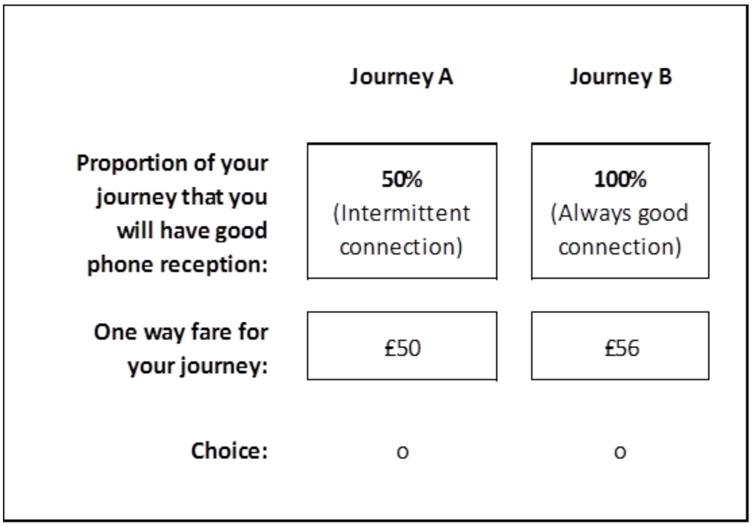
Table 3.2: Exercise 1 SP design with a base fare of £50

	Option 'A'		Option 'B'	
Choice	Reliability	Fare	Reliability	Fare
1	50%	£50	100%	£56
2	80%	£51	100%	£53
3	80%	£50	100%	£51
4	0%	£50	50%	£51
5	50%	£51	80%	£53
6	0%	£50	50%	£56
7	50%	£50	80%	£51
8	0%	£51	100%	£56

3.20 An example of how card 1 was displayed is shown in Figure 3.1.

[3] This was one of the measures used to shorten the questionnaire, following the pilot.

Figure 3.1: Card 1 for SP1



Simulation and pilot

3.21 We first tested the design using simulation. In order to do this we assumed prior wtp values for levels of reliability, shown in Table 3.3, along with the range of values we expected the design to be able to capture for the £50 one-way fare example.

Table 3.3: Exercise 1 SP outputs (£50 one way fare example)

Output	Assumed WTP	Range of WTP
0 to 50% reliability	£2	£0-£4
0 to 80% reliability	£3	£1-£5
0 to 100% reliability	£4	£2-£6

3.22 The simulation generated synthesised samples of 150 respondents with pre-defined preference structures, simulated their responses to the SP exercise, and carried out an analysis of the results obtained. We tested whether the original preference structures could be recovered from the synthesised response data. We tested not only that the designs could recover the assumed values listed in Table 3.3, but also values in the ranges shown in that table.

3.23 After the pilot we assessed the responses received to test how well the design was performing. No changes were required, other than reducing the number of choices for each respondent from eight to six to reduce the survey length.

SP 2: Internet reliability and use

Framing

3.24 The second SP exercise asked users to trade off the reliability of their internet connection with the range of activities they could use the internet for, on the train. The results from this exercise were combined with those from SP3, described below, to provide monetary values.

3.25 In each case the respondents were asked to imagine a choice between two similar rail journeys and to say which they would choose for their journey. The alternatives varied in terms of:

- The type of internet activity available; and

- The reliability of the internet connection for these activities.

3.26 In each case, the respondents were asked to assume that:

- The two scenarios shown are the only scenarios available regardless of the internet provision that was experienced on the reference journey;
- Their ability to engage in different activities would not be constrained by the device they actually had with them on the reference trip. This was to ensure they gave values for the activity itself, without being limited by the technology they happen to own now;
- The fare would be the same as their reference fare;
- The reliability percentage is the proportion of their journey that they are able to use the chosen online activity and that this would be randomly spread through their journey;
- All other factors in their journey are identical.

3.27 The way this exercise was introduced and framed can be found in question 38 of the questionnaire in Appendix B.

Levels

3.28 Table 3.4 shows the levels of each attribute in the SP design. The 'internet activity' levels are cumulative, with each higher level including all the activities available at the lower levels.

Table 3.4: Exercise 2 attribute levels

Attribute	Option 'A' Levels	Option 'B' Levels
Internet activity	**3 levels:** Low Data (Emailing, messaging, basic browsing) Medium Data (Emailing, messaging, browsing, social media) High Data (Emailing, messaging, browsing, social media, audio/video streaming)	**3 levels:** Low Data (Emailing, messaging, basic browsing) Medium Data (Emailing, messaging, browsing, social media) High Data (Emailing, messaging, browsing, social media, audio/video streaming)
Reliability of internet connection	**3 levels:** 50% (Intermittently connected), 80% (Mostly connected) , 100% (Always connected)	**3 levels:** 50% (Intermittently connected), 80% (Mostly connected) , 100% (Always connected)

Design

3.29 This mix of attribute levels generates a large number of 'dominant' choices, in which one option is better on all factors than the other. For example, a card showing option 'A' with "Low data" at 50% and option 'B' with "Medium data" at 80% could not usefully be shown since there is no trade-off and every respondent would choose option 'B'. Removing all combinations of this type leaves only 18 non-dominant pairings. For this exercise therefore, each respondent was shown a random selection of six out of the 18 possible non-dominant cards.

3.30 Table 3.5 below shows the design of Exercise 2, showing six of the 18 possible cards.

Table 3.5: Exercise 2 SP design

	Option 'A'		Option 'B'	
Choice	Reliability	Activity	Reliability	Activity
1	50%	Medium Data	100%	Low Data
2	80%	Medium Data	50%	High Data
3	100%	Low Data	50%	High Data
4	50%	High Data	100%	Low Data
5	80%	Low Data	50%	Medium Data
6	100%	Medium Data	80%	High Data

3.31 An example of how card 1 for this exercise was displayed is shown in Figure 3.2 below.

Figure 3.2: Card 1 for SP2

	Journey A	Journey B
Proportion of your journey that you will have good internet connection:	**50%** (Intermittent connection)	**100%** (Always good connection)
What you will be able to use the internet the connection for:	**Medium Data** · Emailing · Messaging · Browsing · Social Media	**Low Data** · Emailing · Messaging · Basic Browsing
Choice:	o	o

SP 3: Internet use

Framing

3.32 The third SP exercise was designed to obtain monetary values for the ability to perform different online activities while on the train. It complements the second SP exercise in that it uses the same levels of internet activities, trading them against fares increases, but in this case the reliability was assumed to be perfect.

3.33 In each case, the respondents were asked to imagine a choice between two similar rail journeys and to say which they would choose for their journey. The alternatives varied in terms of the following elements:

- the fare for the journey; and
- the type of internet activity they were able to engage in.

3.34 In each case, the respondents were asked to assume that:

- The two scenarios shown are the only scenarios available regardless of the internet provision that was experienced on the reference journey;
- Their ability to engage in different activities would not be constrained by the device they actually had with them on the reference trip. This was to ensure they gave values for the activity itself, without being limited by the technology they happen to own now;
- The fares shown would be the total one way fare for their journey, with no additional charges from their mobile operator;
- They have 100% reliability for types of activity;
- When 'No connectivity' is presented it means they are unable to access any online functions by any means for the whole of their trip;
- All other factors in their journey are identical to avoid introducing bias.

3.35 The way this exercise was introduced and framed can be found in question 41 of the questionnaire in Appendix B.

Levels

3.36 Table 3.6 shows the levels of each attribute in the SP design. In the case of the 'fare' attribute, these are percentage increments on the fare stated by the respondent earlier in the questionnaire, but displayed as a total fare.

Table 3.6: Exercise 3 attribute levels

Attribute	Option 'A' Levels	Option 'B' Levels
Internet activity	**3 levels:** No connectivity Low Data (Emailing, messaging, basic browsing) Medium Data (Emailing, messaging, browsing, social media)	**3 levels:** Low Data (Emailing, messaging, basic browsing) Medium Data (Emailing, messaging, browsing, social media) High Data (Emailing, messaging, browsing, social media, audio/video streaming)
Fare	**2 levels:** 0%, +2%	**3 levels:** +2%, +10%, +20%

Design

3.37 Exercise 3 was made up of eight cards, but as in Exercise 1, each respondent was shown six cards, randomly selected from the eight and shown in a random order. Each card asked the respondent to choose between option 'A' and option 'B,' each of them made up of a combination of the levels for attribute described above.

Table 3.7 below shows a typical design for Exercise 3 for a respondent whose one way fare is £50.

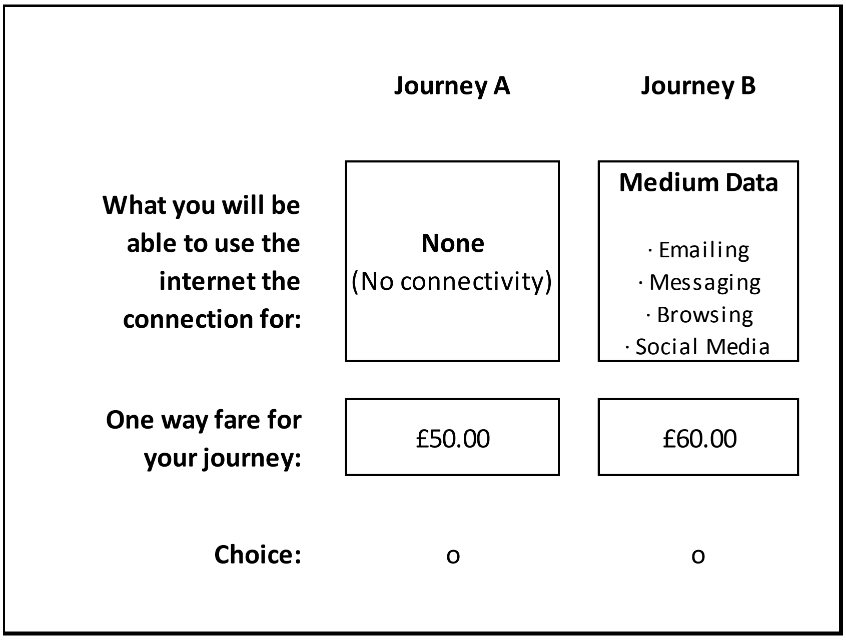
Table 3.7: Exercise 3 SP design with a base fare of £50

Choice	Option 'A'		Option 'B'	
	Activity	Fare	Activity	Fare
1	None	£50	Medium Data	£60
2	None	£50	Low Data	£55
3	Medium Data	£50	High Data	£51
4	Low Data	£51	Medium Data	£55

	Option 'A'		Option 'B'	
5	None	£50	Low Data	£51
6	Low Data	£51	High Data	£60
7	None	£50	High Data	£60
8	Medium Data	£51	High Data	£55

3.38 An example of how card 1 was displayed is shown in Figure 3.3 below.

Figure 3.3: Card 1 for SP3



Simulation and pilot

3.39 We first tested the design using simulation, as described for Exercise 1. In order to do this we assumed prior values as shown in Table 3.8 below, along with the range of values we expected to be able to capture using this design; the example is for a £50 one way fare.

Table 3.8: Exercise 3 SP outputs (£50 on way fare example)

Output	Assumed WTP	Range of WTP
Low Data	£1	£0-£2
Medium Data	£5	£2-£8
High Data	£10	£6.5-£13.5

3.40 The tests showed that the designs were able to recover the target values, and worked satisfactorily for values in the ranges shown in the table.

3.41 After the pilot we assessed the responses received and made some adjustments to the fares increments used. This is discussed in the next section.

Revisions from pilot survey

3.42 As described in Chapter 2, we piloted the survey to test both the fieldwork procedures and the technical performance of the questionnaire and the SP designs. As a result some changes were made to the questionnaire. The designs described above are the final designs, after these changes were made.

Questionnaire design

3.43 Firstly, as discussed in 2.17 the questionnaire took longer to answer than we had hoped. This would have been problematic for the main survey in three ways:

- It would have meant logistical changes for the face-to-face surveys for Field and Fab. We received fewer responses in the pilot survey than we had expected and would have needed to use more shifts to get the 1,000 face-to-face responses in the main survey;
- It was thought to be a factor in the lower than expected response rate for online interviews. There was also the risk, particularly in the online survey, that respondents would become tired and select responses with less thought towards the end of the questionnaire;
- It would have made it very difficult to survey respondents face-to-face for trips less than 30 minutes, as the questionnaire would take up a substantial part of their journey, leading to lots of incomplete questionnaire as they left the train before completion. Given that we were targeting at least 400 such people, this needed to be changed.

3.44 We therefore decided to remove thirteen questions from the main questionnaire. These were questions that were potentially useful for profiling or segmentation, but not questions that were fundamental to the analysis.

3.45 We also added three questions as a result of the analysis of the pilot survey to ask people why they always chose the most expensive option in the SP1 and SP3 and to ask whether they valued speed and data or reliability more. These are included in Appendix B as Q26, Q39 and Q43.

3.46 Finally, we changed the order of some of the questions in the survey to improve the overall flow.

SP exercises

3.47 For the stated preference exercises, we did not make any fundamental changes but made modifications to exercises 2 and 3.

3.48 Firstly, to have more confidence in the values for internet connectivity we were calculating from exercise 3, we narrowed the gap between the largest and second largest increase in fares. This meant we used fare multipliers of 2%, 10% and 20% in the main survey instead of 2%, 8% and 20% as in the pilot.

3.49 The pilot showed that the vast majority of respondents understood the SP exercises, but some of the results for Exercises 2 and 3 that showed higher provision of data (ie streaming) was sometimes being valued less than lower provision, even though it included the lower levels. We judged that this may have been a result of the descriptions of the levels for these exercises and respondents not understanding that they were cumulative. To make this clearer for the main survey, we changed the activity descriptions on the cards to “low,” “medium” and “high,” with a list of the activities each of them supported.

3.50 To help reduce the length of time it took to complete the questionnaire, it was decided to reduce the number of choices each respondent was asked to make in the SP exercises. Exercises 1 and 3 used eight cards, and it was decided to randomly select six cards for each respondent, and to show them in a random order.

3.51 All revisions to the designs were discussed and agreed with the DfT before launching the main survey.

4 Results

Introduction

4.1 Using a combination of face-to-face surveys, online surveys and panel surveys, we achieved a total sample of 2,241 responses, higher than the target sample of 2,000. We surveyed:

- 1,150 face-to-face respondents from passengers on three Train Operating Companies;
- 49 respondents from passengers on the same services who recruited via postcard distribution;
- Three respondents via the East Midlands Trains website; and
- 1,039 respondents from an online panel survey using respondents who had made a rail trip in the last three months.

4.2 We made changes to the survey between the pilot and the main survey. The responses from the pilot survey are excluded from these totals and were not included in the analysis presented in this chapter.

4.3 This chapter presents the survey results under the following sections:

1. Sample and data cleaning;
2. Respondent characteristics;
3. Value of voice calls ;
4. Value of internet connectivity.

4.4 The journey purpose definitions used in this report are:

- Business – On company business (or own if self-employed);
- Commute – Commuting to/from work;
- Leisure – All other responses.

4.5 The definitions of journey lengths throughout the remainder of this report are:

- Short – up to 30 minutes;
- Medium – 30 minutes to 2 hours;
- Long – over 2 hours.

Sample and data cleaning

4.6 The breakdown of the sample between recruitment methods is summarised in Table 4.1. There is roughly an equal split between face-to-face and online responses.

Table 4.1: Respondents and recruitment methods

Sample Method	Number of respondents	Proportion of responses
Face-to-face	1,150	51.3%
Online (postcards)	49	2.2%
Online (EMT website)	3	0.1%
Online panel survey	1,039	46.4%
Total	**2,241**	**100%**

4.7 The survey quotas called for at least 200 interviews in each of the seven categories shown in Table 2.1. The quotas were met in five of the categories, falling slightly short in two cases. Table 4.2 shows the interview counts.

Table 4.2: Achievement of Quotas

journey purpose	Up to 30 minutes	30 minutes to two hours	More than two hours
Business	31	210	178
Leisure	231	702	366
Commute	192	238	93

4.8 Leisure trips have been oversampled quite significantly. We did not set quotas for the two greyed cells (business trips up to 30 minutes, and commuting trips of over two hours) on the grounds that we expected them to be too rare to justify treating them as separate quotas.

4.9 However the 93 commuters of over two hours may be a result of a misunderstanding by respondents of the difference between commuting and business; we therefore reassigned 28 trips in this category where the employer or business had paid the fare to Business travel over two hours.

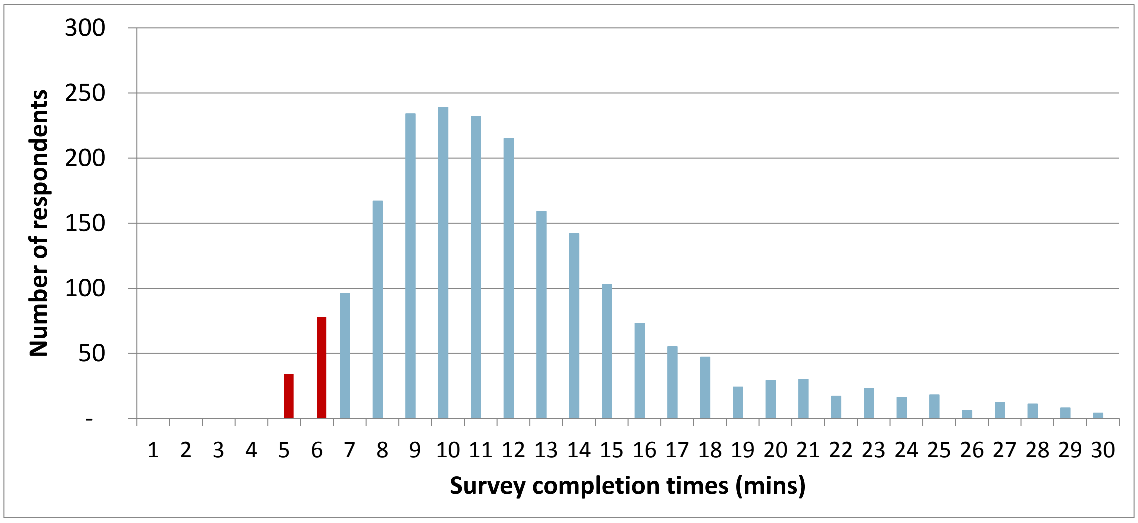
4.10 A further 164 respondents were excluded due to concerns about the quality of their responses. A breakdown of the reasons for exclusion is given in Table 4.3. The remaining sample was 2,077.

Table 4.3: Reasons for excluding interviews

Reason for removal	Responses removed
Journey time of over 8 hours	24
Phone time of over 6 hours	4
Phone time greater than journey time	10
Wi-Fi cost above £30	1
Fares above £150 which are inconsistent with trip taken e.g. short distance flows	16
Survey completion time of less than 6 minutes	109
Total for removal	**164**

4.11 The majority of exclusions were due to the questionnaire being completed too quickly, raising doubts about whether respondent had read the questions fully or given enough consideration to their answers in the SP exercises. The distribution of survey completion times is shown in Figure 4.1 with the red bars indicating the respondents who were excluded from the analysis. More than 109 responses are shown in the chart because there were other respondents with completion times less than six minutes but who were first excluded for the other reasons in Table 4.3.

Figure 4.1: Survey completion times



4.12 The adjusted quota breakdown, after exclusions and re-assignment of long distance commuter trips, is shown in Table 4.4.

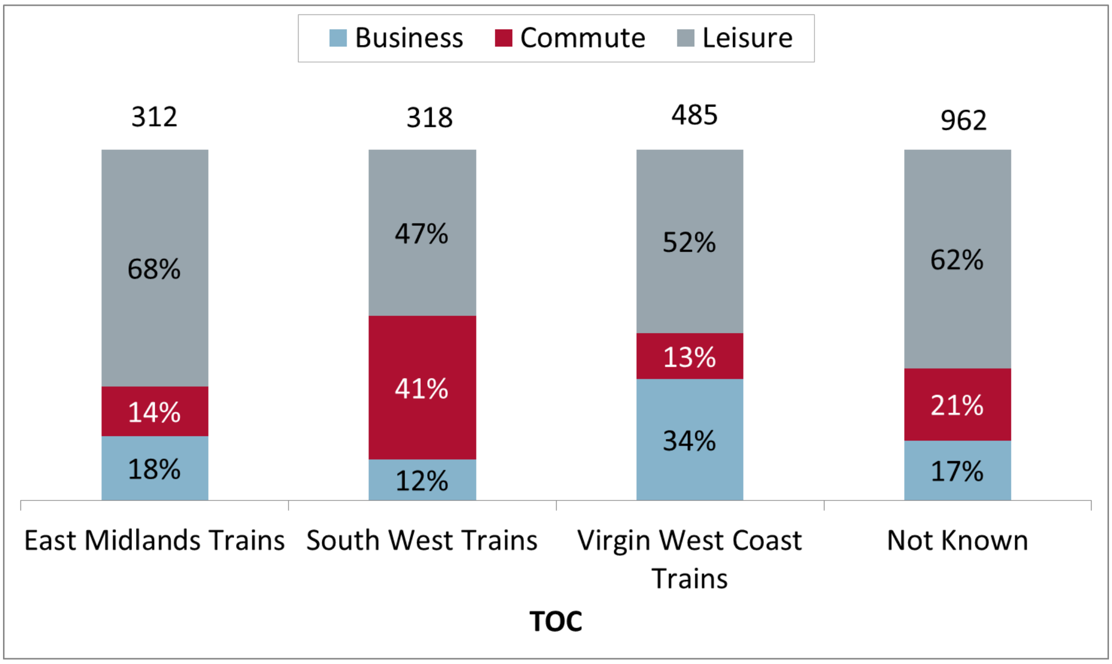
Table 4.4: Quotas after exclusions and re-assignment

Journey purpose	Up to 30 minutes	30 minutes to two hours	More than two hours	Total
Business	28	204	193	**425**
Leisure	215	666	335	**1,216**
Commute	165	215	56	**436**
Total	**408**	**1,085**	**584**	**2,077**

4.13 This full sample of 2,077 responses is what has been used for the main analysis. The SP analysis focuses on the 7 main cells, excluding the business up to 30 minutes and commute more than 2 hours responses. The following sections provide some profiling information about the sample.

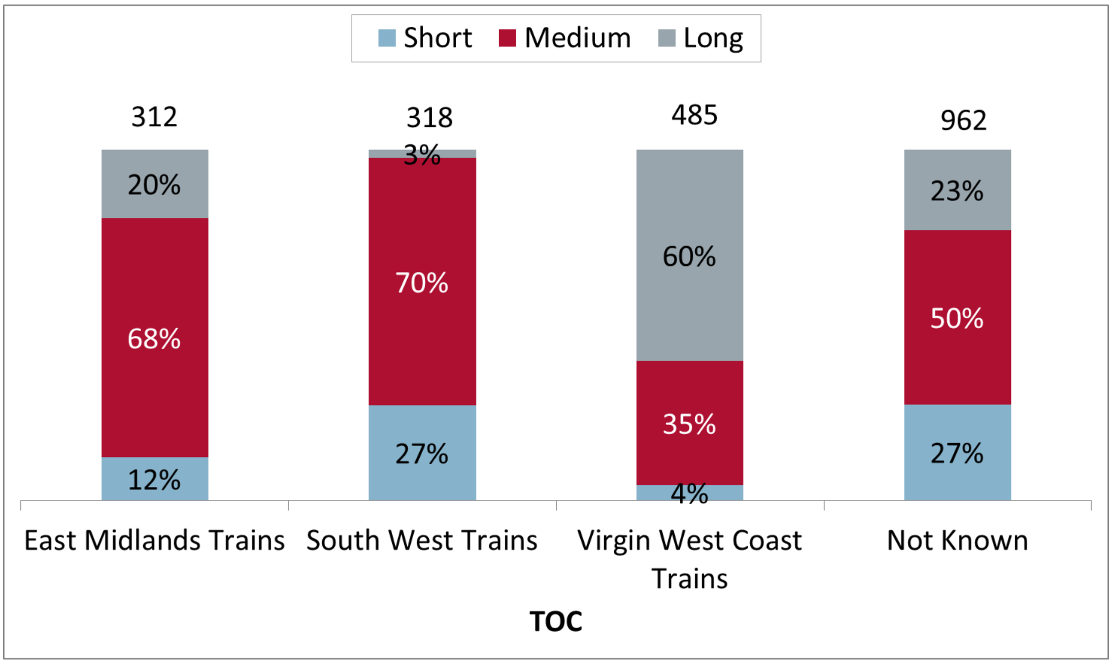
4.14 Figure 4.2 shows the breakdown of the sample between the three TOCs by journey purpose. The totals number of respondents for each TOC is displayed above the bars. The final unknown column of consists of the online sample, where we did not ask which TOC the respondent used. Since the majority of online responses were from the panel survey this would cover a broad range of TOCs, but shows a large proportion of leisure passengers.

Figure 4.2: Respondents by TOC and journey purpose (N=2,077)



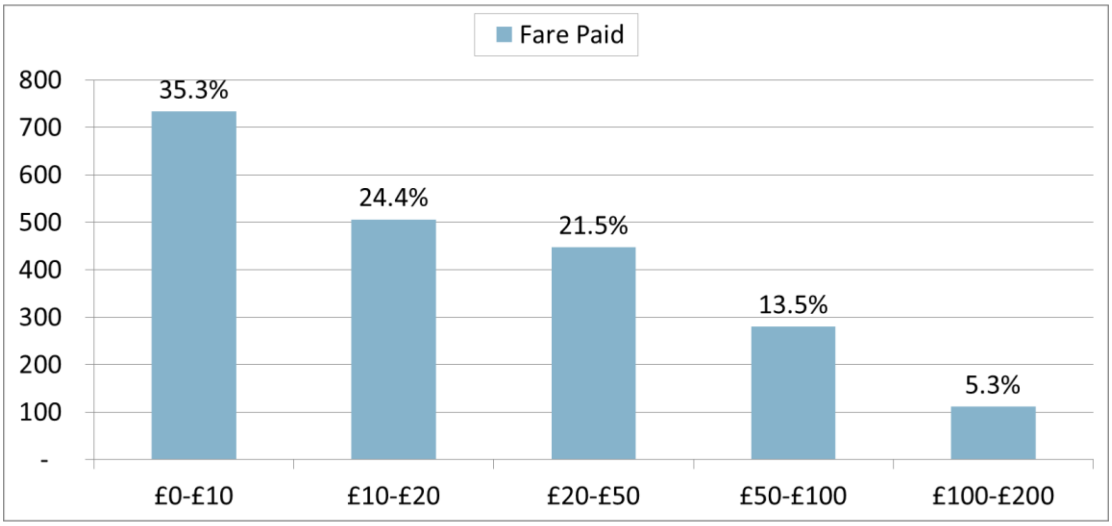
4.15 Figure 4.3 shows the breakdown of the face-to-face sample by TOC and journey length. As might be expected, Virgin West Coast has the highest proportion of long distance journeys, while South West Trains has the highest proportion of short distance journeys and vice-versa.

Figure 4.3: Respondents by TOC and journey length (N=2,077)



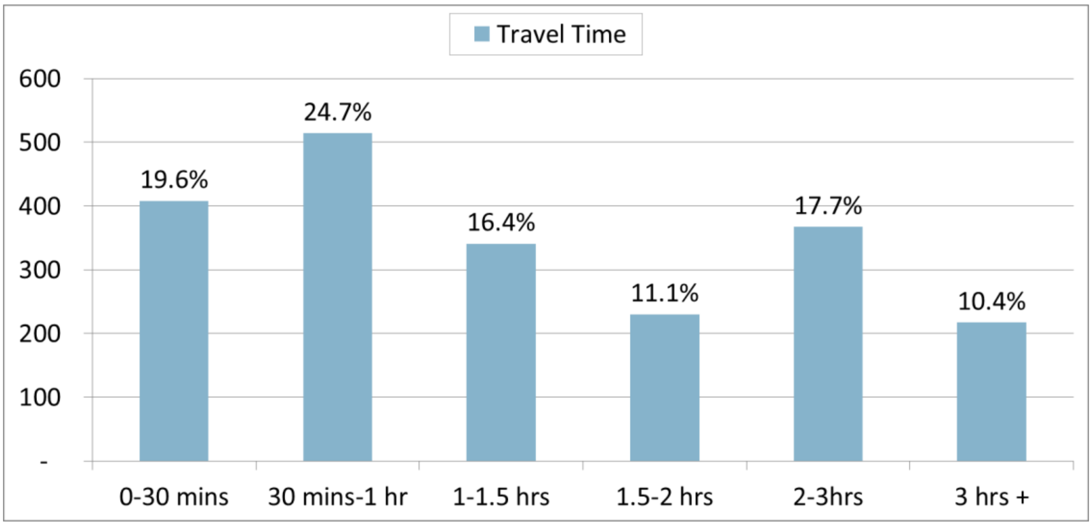
4.16 The distribution of one-way fares is shown in Figure 4.4; in each column the lower bound is included in the group.

Figure 4.4: Respondent one way fares



4.17 The sample included journey times of between 5 minutes and 8 hours. The distribution of these is shown in Figure 4.5; in this case the upper bound is included in each group.

Figure 4.5: Respondent travel times



4.18 Other factors that may affect willingness to pay for improved connectivity are shown in the following four charts, which look at:

- Ticket type, showing a large majority of respondents were travelling on return tickets;
- Who paid for the ticket, where it can be seen that 28% of the sample did not pay for their own fare;
- The time of day that the journey was made;
- Whether the respondent was travelling to/from London, or not.

Figure 4.6: Respondent ticket types

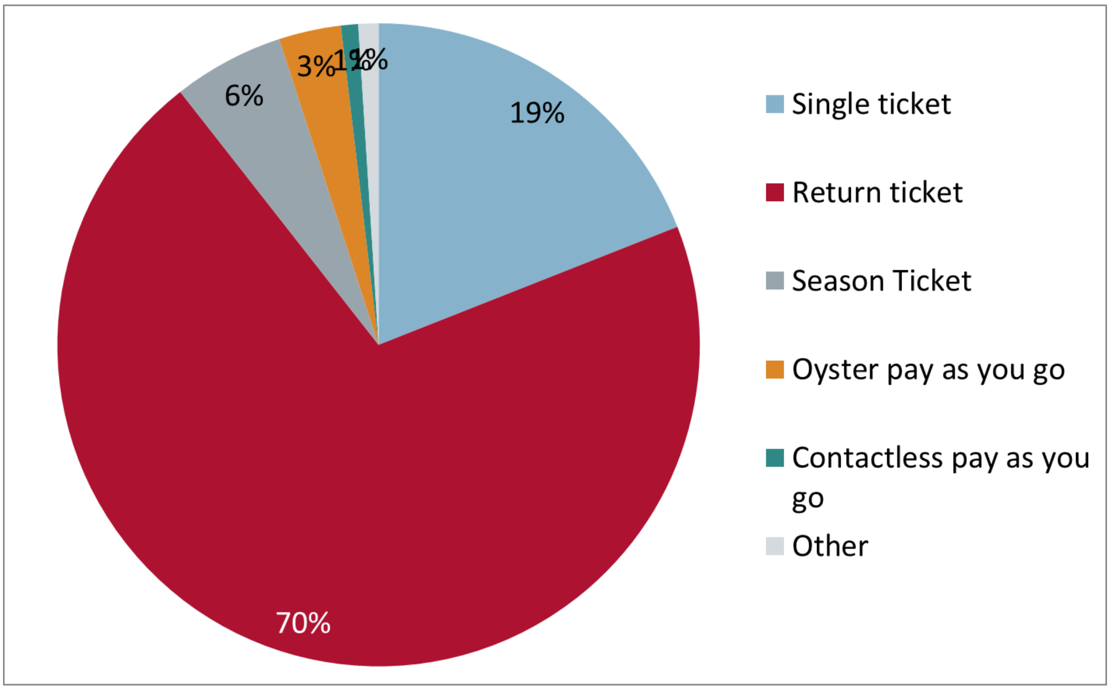


Figure 4.7: Who paid for the fare

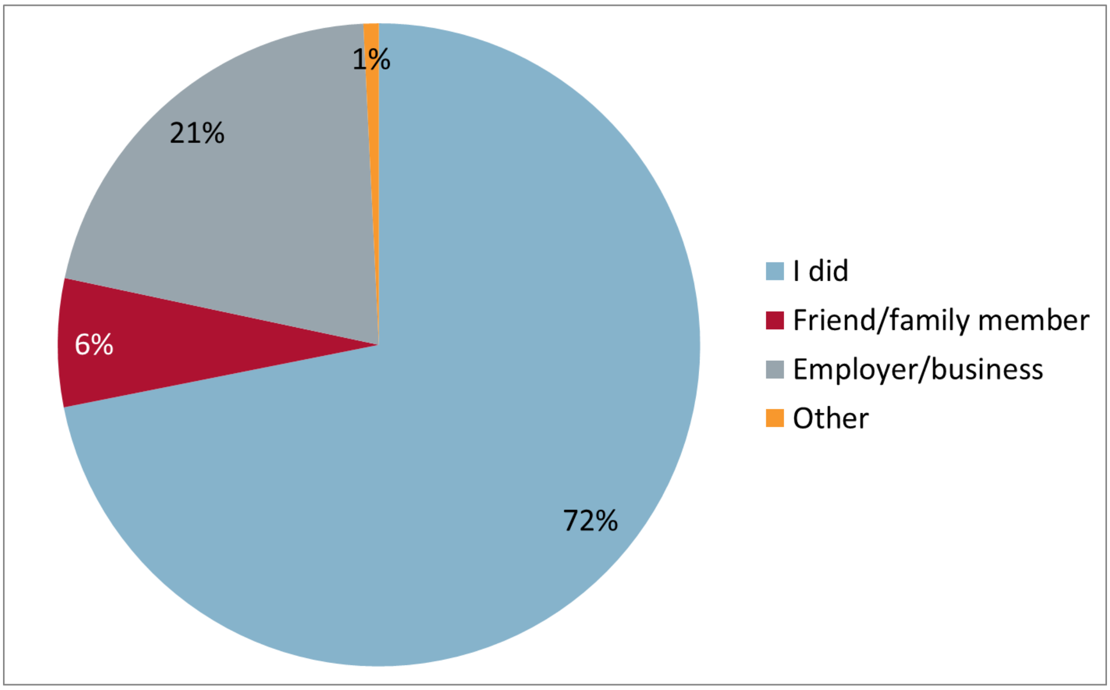


Figure 4.8: Departure times

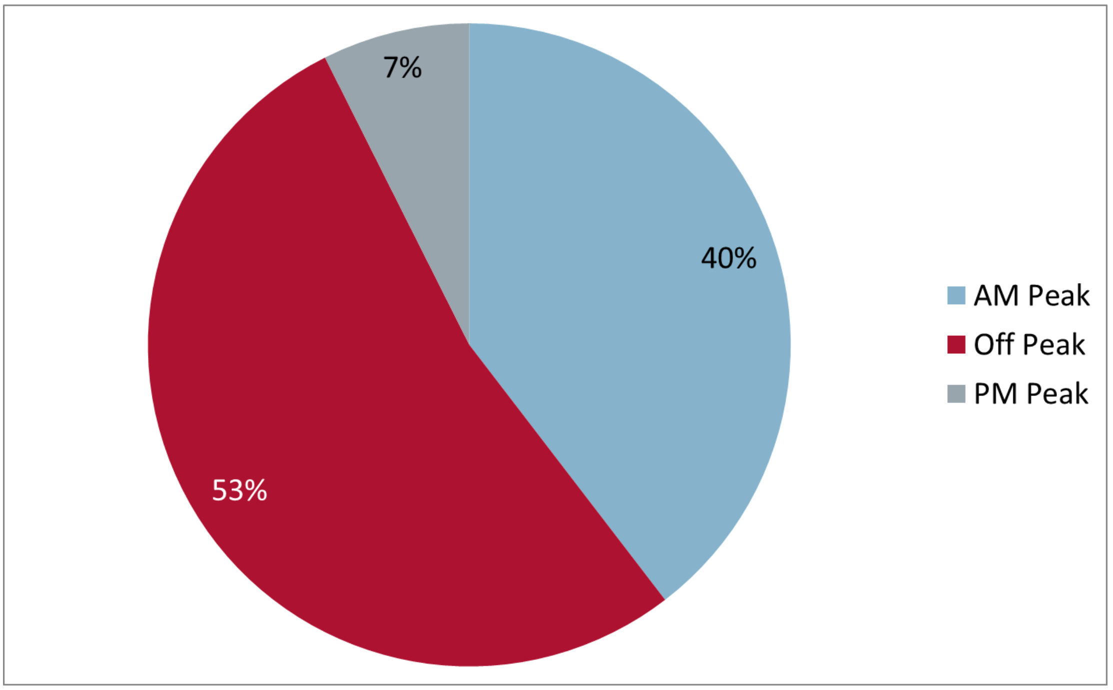
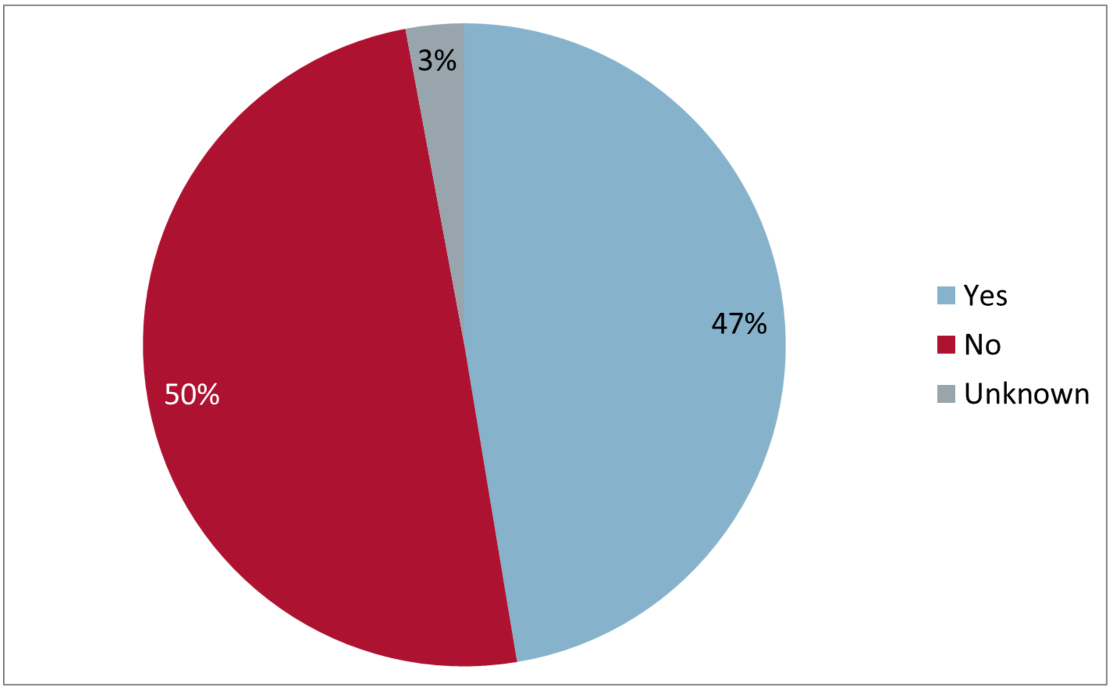


Figure 4.9: Respondents travelling to/from London



Respondent Characteristics

4.19 The following charts show a breakdown of respondents by a variety of socio-economic variables.

4.20 19% of respondents preferred not to give their household income, and 1% preferred not to state their occupation status. They are excluded from Figure 4.12 and Figure 4.13.

Figure 4.10: Respondent age distribution

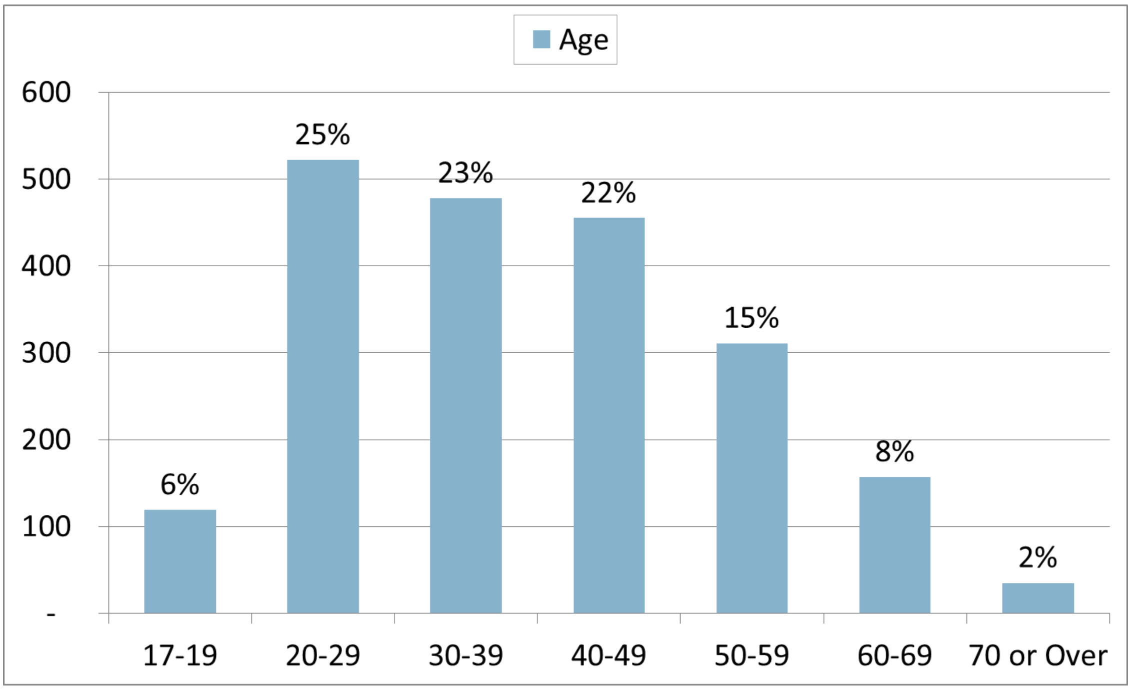


Figure 4.11: Respondent gender segments

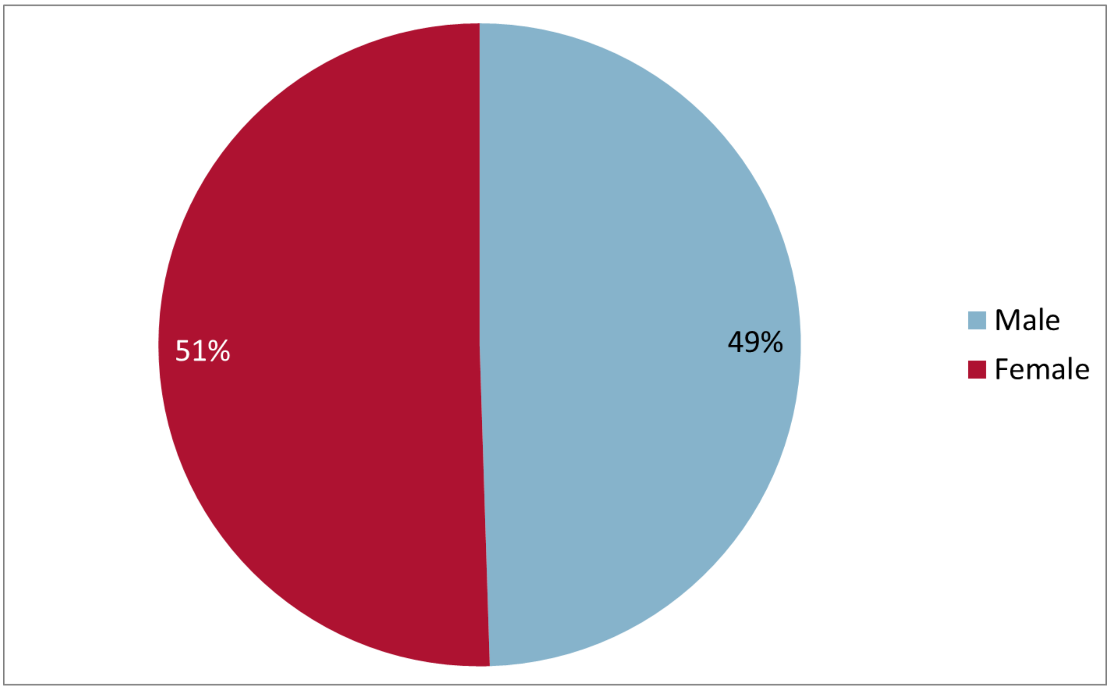


Figure 4.12: Respondent income distribution

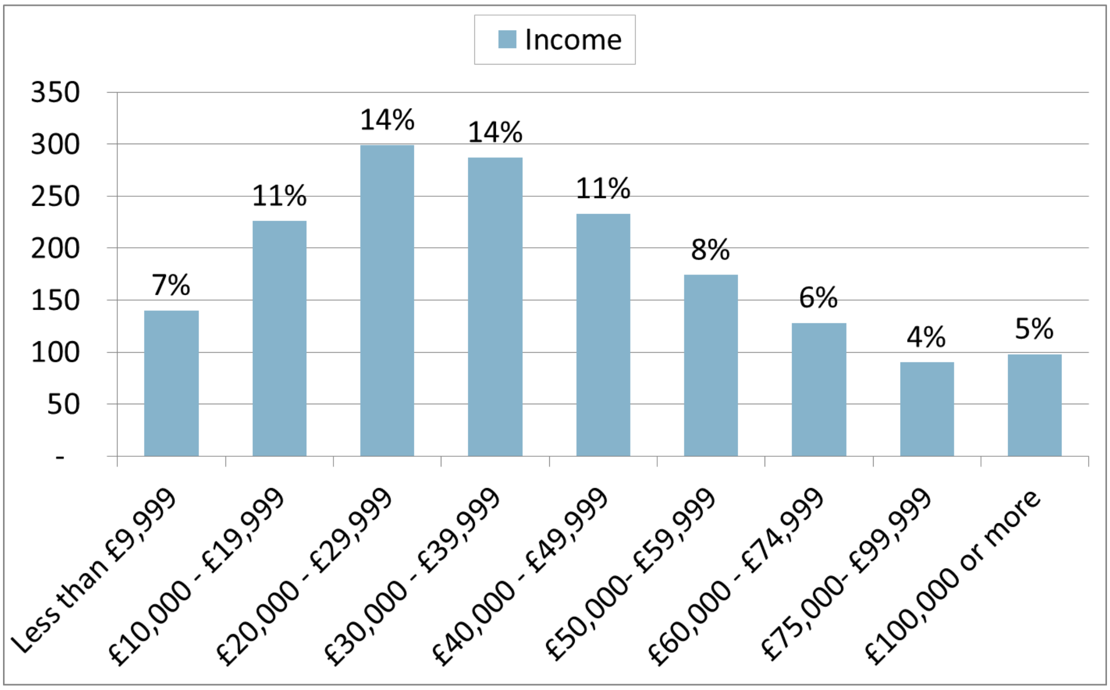
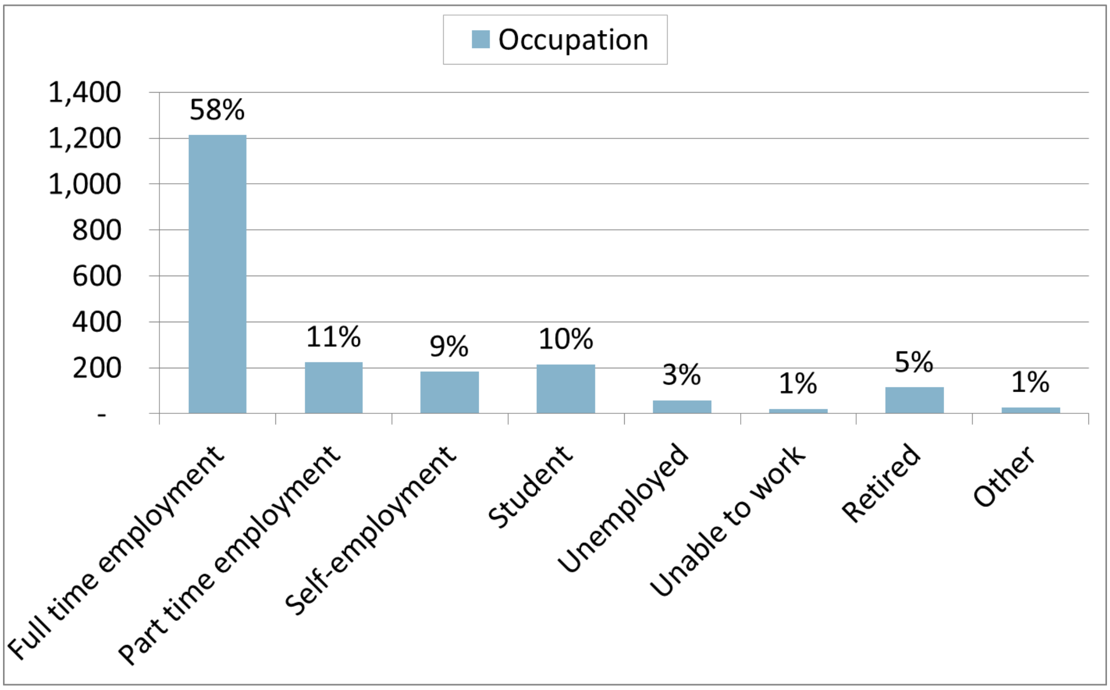


Figure 4.13: Respondent occupation



Voice calls

Current use

4.21 34% of the sample had used their phone on the journey before answering the questionnaire and a further 11% were face-to-face respondents who said they were likely to use it on the train once the survey was over.

4.22 Table 4.7 and Table 4.8 show how phone usage on the train varied by journey purpose and journey time. The percentages shown represent the proportion of use within each purpose. This shows that phone usage is more prevalent among business travellers and commuters.

Table 4.5: Phone use and journey purpose

	Business	Commute	Leisure	Total	Total use %
Yes	170 (40%)	180 (41%)	347 (29%)	697	34%
No - but I am likely to	73 (17%)	41 (9%)	124 (10%)	238	11%
No - I am unlikely to	99 (23%)	86 (20%)	301 (25%)	486	23%
No	79 (19%)	119 (27%)	415 (34%)	613	30%
Don't remember	4 (1%)	10 (2%)	29 (2%)	43	2%
Total	425	436	1,216	2,077	100%

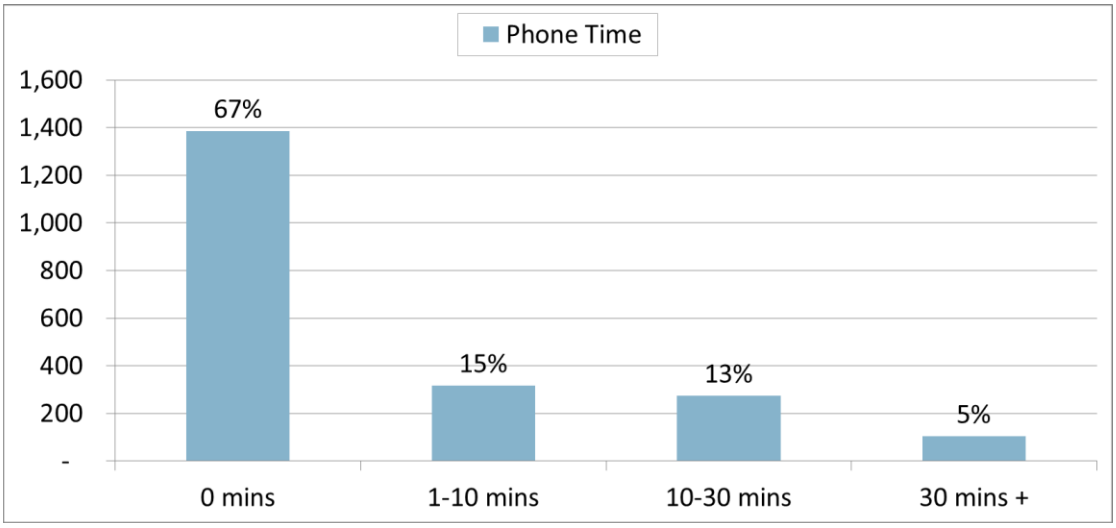
Table 4.6: Phone use and journey time

	Short	Medium	Long	Total	Total use %
Yes	78 (19%)	366 (34%)	253 (43%)	697	34%
No - but I am likely to	22 (5%)	136 (13%)	80 (14%)	238	11%
No - I am unlikely to	93 (23%)	262 (24%)	131 (22%)	486	23%
No	202 (50%)	300 (28%)	111 (19%)	613	30%
Don't remember	13 (3%)	21 (2%)	9 (2%)	43	2%
Total	408	1,085	584	2,077	100%

4.23 Figure 4.14 below shows the numbers of respondents using their phone to make or receive calls and how long they had spent on the phone in total on their journey so far. For online responses this included the whole journey, whereas for face to face surveys this was the time spent up to the point of being surveyed.

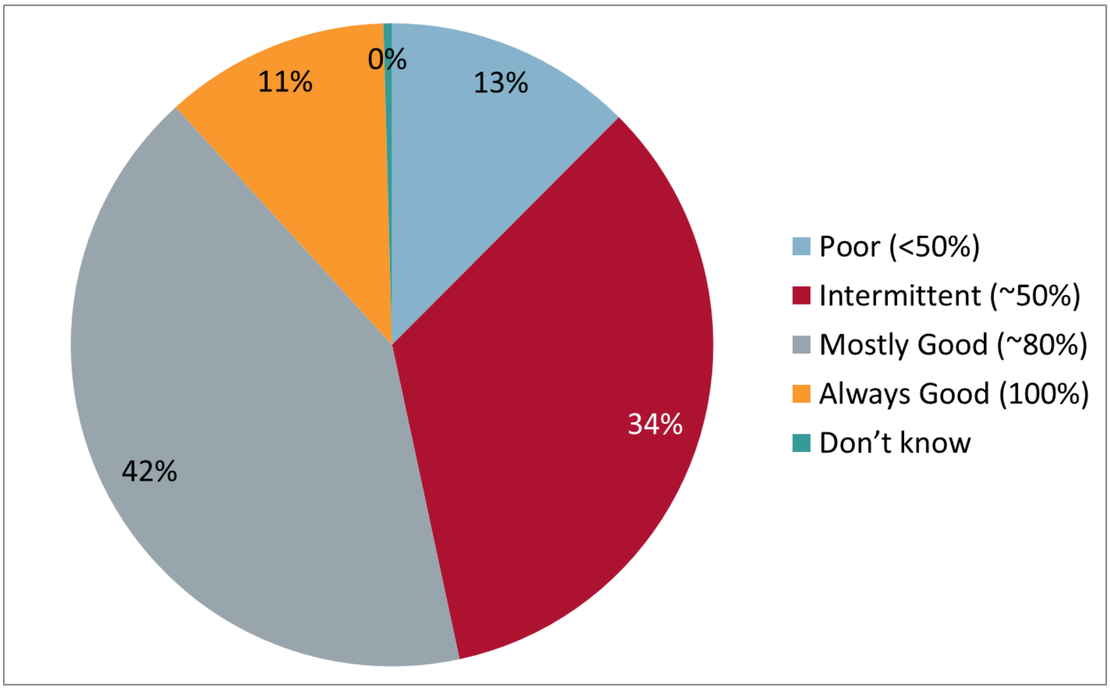
4.24 This shows that two thirds of respondents had not made a call on their surveyed journey so far. Of those who had used their phone before being surveyed, just under half spent less than 10 minutes on the phone. Over 85% of those using the phone used it for less than 30 minutes in total.

Figure 4.14: Time spent making or receiving a call on board the train



4.25 Figure 4.15 shows the perceived quality of phone calls for the 697 respondents who made a call on the train. Over half (53%) found the connection to be either mostly or always good.

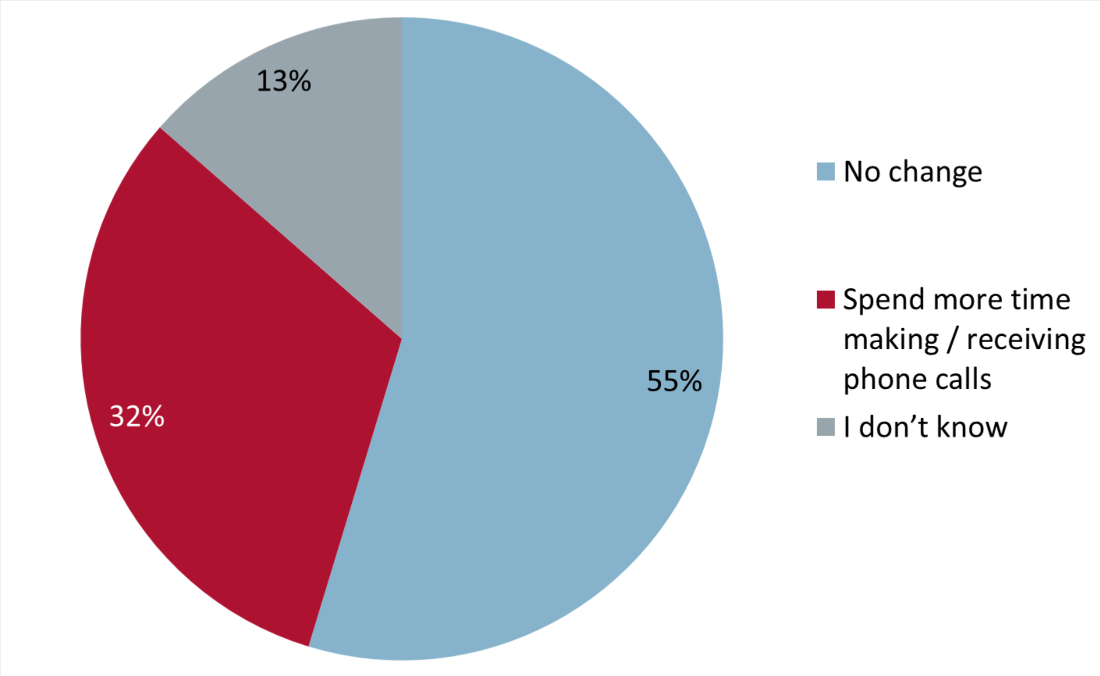
Figure 4.15: Phone connection quality



Future use

4.26 Figure 4.16 shows how respondents said they would change their mobile phone usage if the quality of connection was improved. The majority (55%) said this would not change their behaviour. These proportions are fairly consistent when segmenting by journey purpose and time.

Figure 4.16: How people would change their mobile phone usage if the quality of connections improved



Stated Preference: Phone connectivity

4.27 The first SP exercise (SP1) was designed to quantify the value that respondents place on phone connectivity while on the train. Each respondent was asked to make six choices between two similar rail journeys, selecting the one they would prefer. The journeys varied in terms of:

- The fare for the journey, which ranged between a +2% and +12% increase on the respondent's current fare;
- The reliability of the phone signal for voice calls, where the levels shown were:
  - No connectivity at all, for the entire journey;
  - 50% (Intermittent connection) in which it is possible to make/receive phone calls for around half of the journey, with interruptions spread randomly through the journey;
  - 80% (Mostly good connection) in which it is possible to make/receive phone calls for most of the journey, with interruptions spread randomly through the journey;
  - 100% (Always good connection) in which it is possible to make/receive phone calls for the whole of the journey.

4.28 The first step was to carry out an analysis of 'trading' patterns: in other words, how many people changed their choice at least once, or not. The trading proportions are summarised in the table below.

Table 4.7: Phone reliability SP trading analysis

	Business	Commute	Leisure	Total
Traders	55%	56%	58%	57%
Non traders (always the cheapest)	13%	20%	20%	19%
Non traders (always the most expensive)	32%	24%	22%	24%

4.29 This shows that:

- 57% of respondents traded; these are the respondents who provide the most information about the value placed on reliability for voice calls;
- 19% of respondents always selected the cheapest option regardless of what level of reliability was shown; this suggests that their willingness to pay was less than the minimum increase offered (2%);
- 24% of respondents always selected the most expensive option regardless of what level of reliability was shown; this suggests that their willingness to pay was greater than the maximum offered (+12%). This proportion was higher for business users (32%) than for leisure (22%).

4.30 Non-traders were asked why they made their choices. The reasons for always selecting the cheapest option are shown in Figure 4.17 and the reasons for always selecting the most expensive option are shown in Figure 4.18.

Figure 4.17: Reasons for non-traders who always selected the cheapest journey

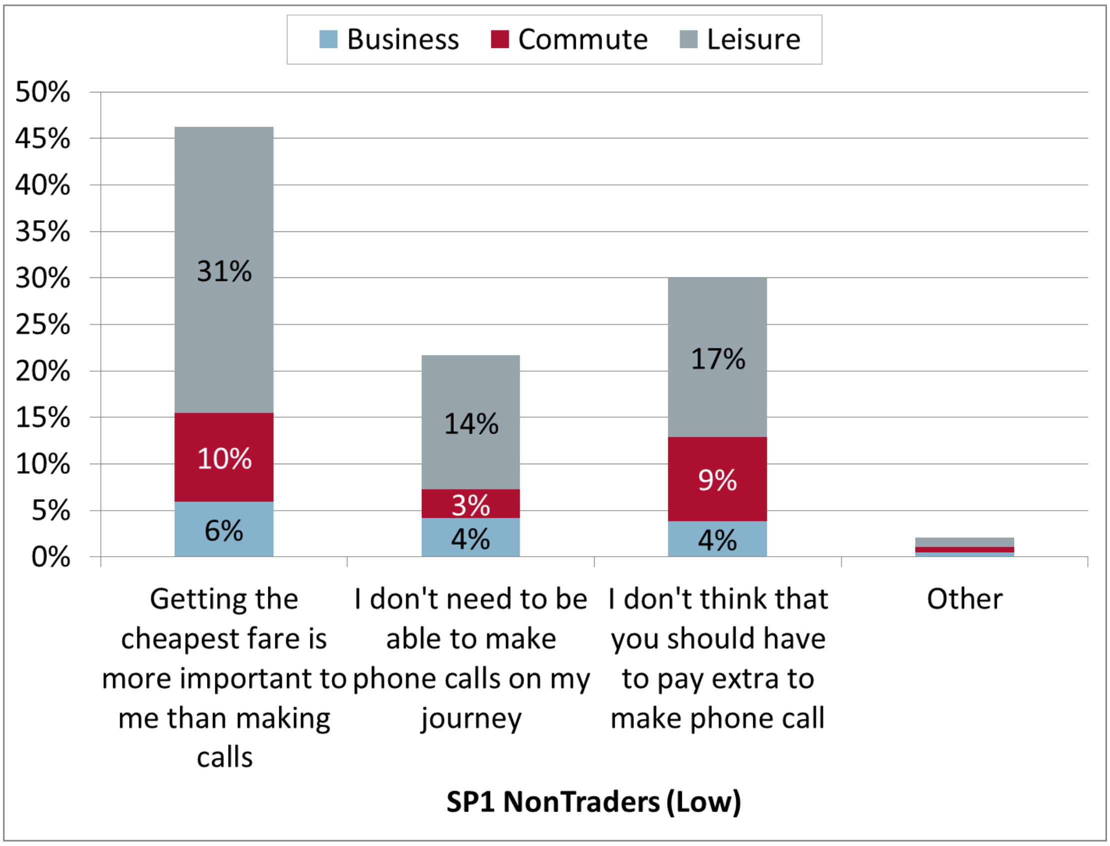
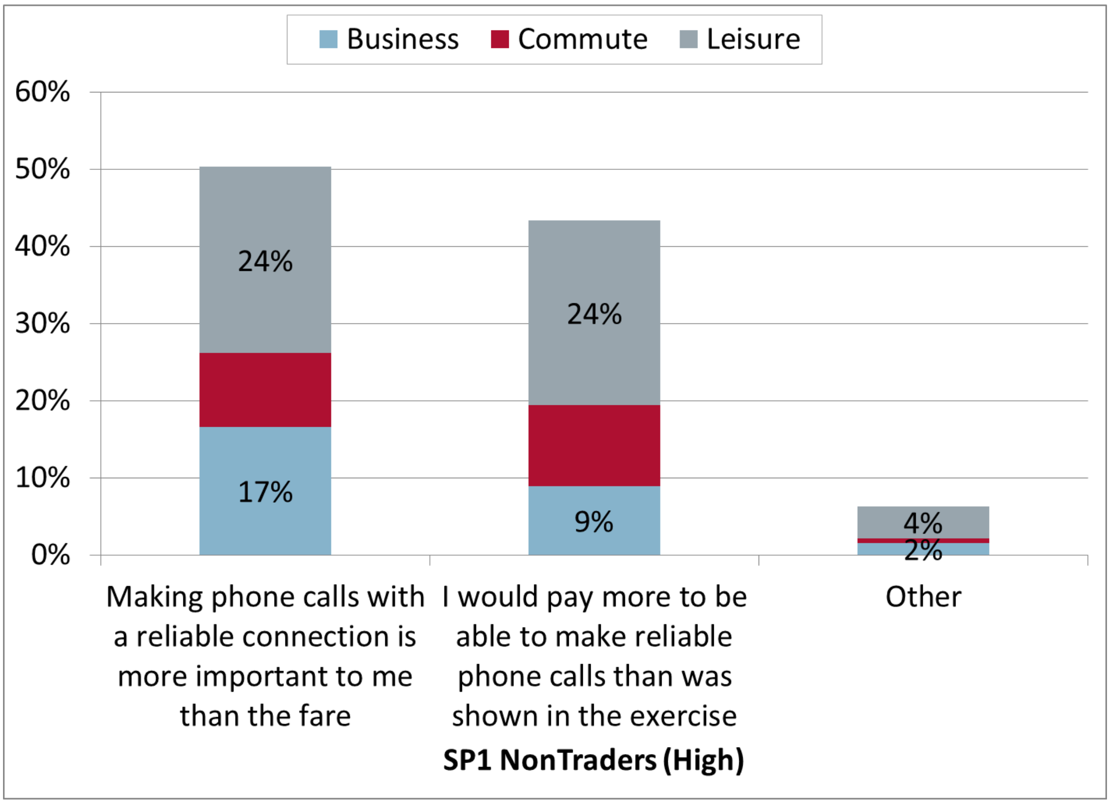


Figure 4.18: Reasons for non-traders who always selected the most expensive journey



4.31 The technical details of the analysis of the Stated Preference responses are described in Appendix A. Logit models were estimated to explain the SP choices made in terms of fare and level of reliability. We tested whether the results differed by journey length and/or trip purpose (the factors used for the survey quotas) and found that trip lengths did not affect the results, but journey purpose did.

4.32 The table below show the results split by journey purpose. The values tabulated are the percentage uplift in fare people were willing to pay in order to have the corresponding improvement in phone signal reliability.

Table 4.8: Willingness to pay for improved phone reliability

Improvement in reliability:	Business	Commute	Leisure
0% to 50%	17%	15%	13%
50% to 80%	8%	10%	6%
80% to 100%	4%	0%	0%

4.33 These results show:

- People in all three segments are willing to pay a significant uplift on their fare to get mobile phone provision at 50% reliability;
- They are willing to pay another 6%-7% to gain a further improvement to 80% reliability;
- Commute and leisure travellers do not attach a measurable value to moving from 80% to 100% reliability, but business travellers do.

Data use

Current use

4.34 Internet use was more prevalent than phone calls, with 56% of respondents having used the internet on the train before being surveyed and a further 9% expecting to use it after the survey. The corresponding figures for phone calls were 34% and 12%.

4.35 Table 4.9 and Table 4.10 show the breakdown of internet use by journey purpose and journey time.

Table 4.9: Internet use and journey purpose

	Business	Commute	Leisure	Total	Total use %
Yes	270 (64%)	286 (66%)	604 (50%)	1,660	56%
No - but I am likely to	38 (9%)	38 (9%)	102 (8%)	178	9%
No - I am unlikely to	68 (16%)	50 (11%)	212 (17%)	330	16%
No	45 (11%)	55 (13%)	263 (22%)	363	17%
Don't remember	4 (1%)	7 (2%)	35 (3%)	46	2%
Total	425	436	1,216	2,077	100%

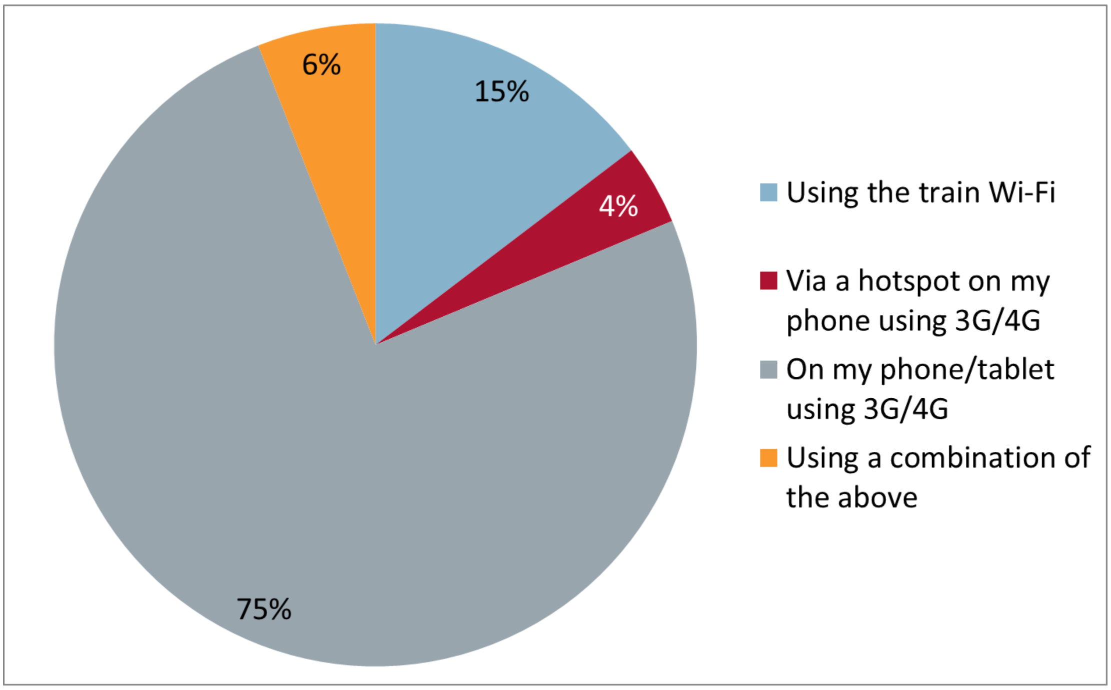
Table 4.10: Internet use and journey time

	Short	Medium	Long	Total	Total use %
Yes	196 (48%)	586 (54%)	378 (65%)	1,660	56%
No - but I am likely to	21 (5%)	116 (11%)	41 (7%)	178	9%
No - I am unlikely to	61 (15%)	178 (16%)	91 (16%)	330	16%
No	118 (29%)	178 (16%)	67 (11%)	363	17%
Don't remember	12 (3%)	27 (2%)	7 (1%)	46	2%
Total	408	1,085	584	2,077	100%

4.36 As with phone use, internet use was more common among business passengers and commuters in the sample, with 73% and 75% having used the internet, or expecting to use it, compared to 58% of leisure passengers. There is also a similarly sized difference by journey length. 72% of respondents with a journey length over two hours either used, or were likely to use the internet, compared with 53% of respondents with a journey length of less than 30 minutes.

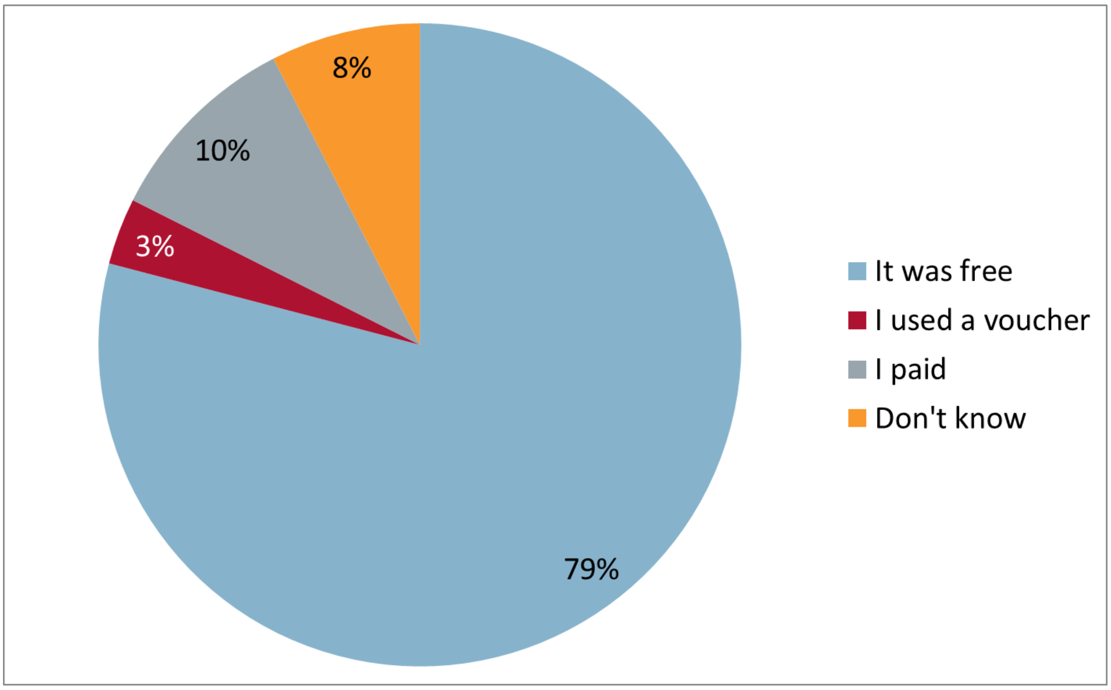
4.37 Figure 4.19 displays how each respondent connected to the internet on the train for the 1,160 respondents (56% of the sample) that had done so. This shows that a large majority (79%) used 3G or 4G, and did not use the on-board Wi-Fi.

Figure 4.19: How the respondent connected to the internet



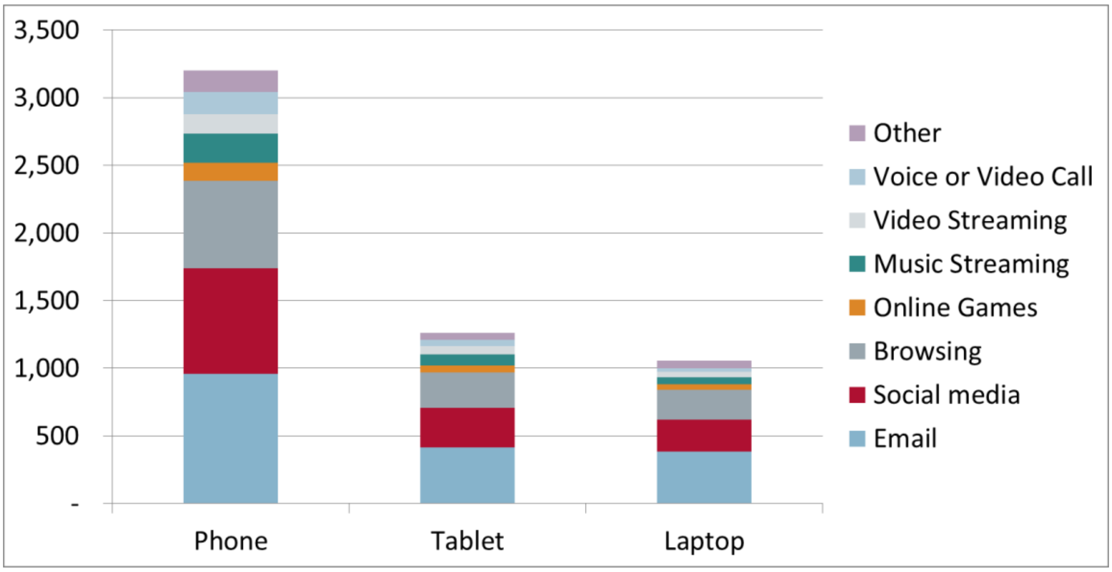
4.38 The 21% who used the on-train Wi-Fi at some point in their journey accounts for 239 respondents. How these respondents acquired Wi-Fi is shown in Figure 4.20 below. For the 24 respondents that paid, the cost ranged from £2 to £15.

Figure 4.20: How respondents paid for on-train Wi-Fi



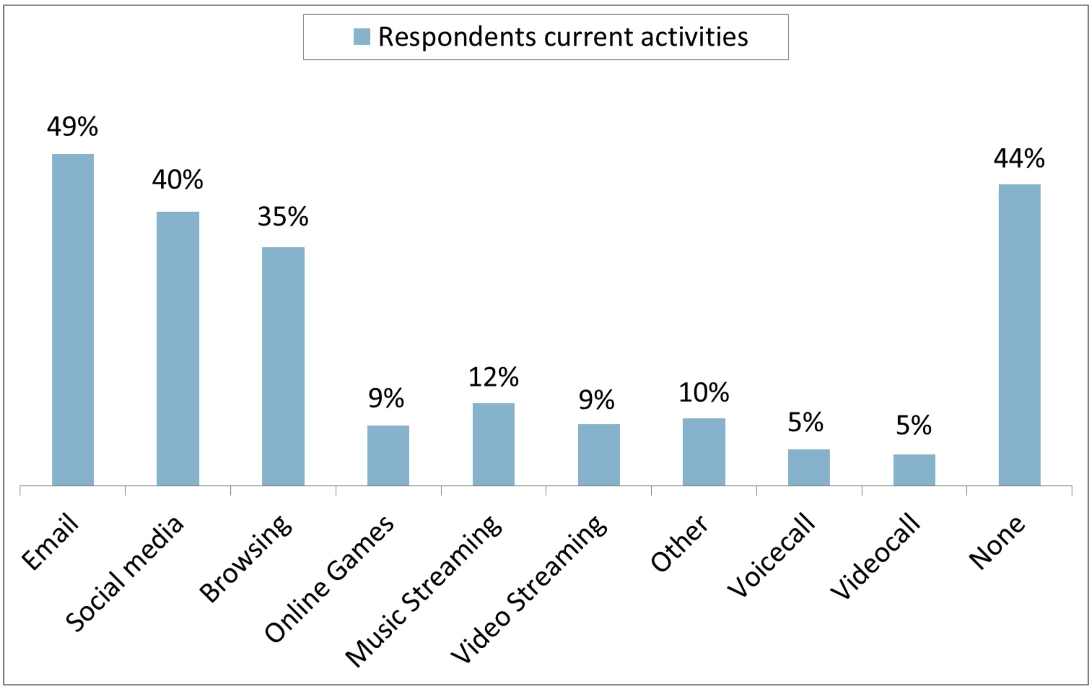
4.39 Figure 4.21 shows what activity each respondent used the internet for while on their journey and on which device. Email is consistently the most common use across all devices, followed by social media and browsing. Streaming music and/or videos was much less prevalent. It is also clear that phones were the most commonly used means of accessing the internet. The totals for each activity are higher than the total number of respondents because respondents were able to select multiple activities on multiple devices.

Figure 4.21: Current internet use on trains by device (people reporting)



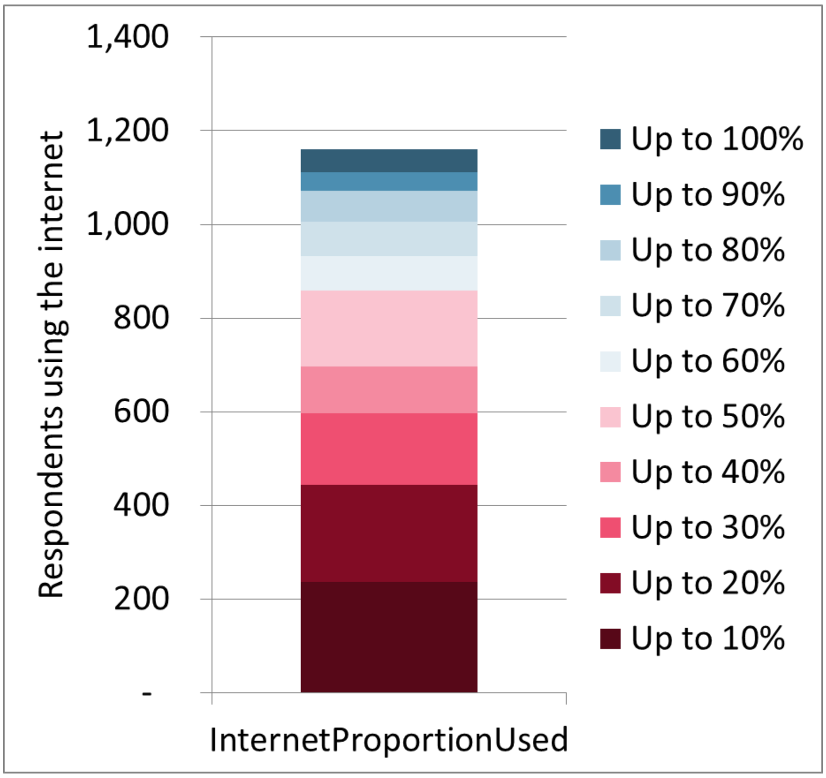
4.40 Figure 4.22 shows the proportion of respondents doing each online activity regardless of device. This shows the prevalence of email and social media and the lower incidence of high data-usage activities (streaming, etc.).

Figure 4.22: Current internet use on trains by respondent



4.41 Figure 4.23 below shows the proportion of their journey that each of the 1,160 respondents who connected to the internet during their journey spent on the internet. Answers to this question could be affected by when in their journey people were asked this question (at least for face-to-face interviews) so the lower proportions might be over-represented.

Figure 4.23: Proportion of time spent on the journey using the internet



4.42 Figure 4.24 and Figure 4.25 show the perceived internet connection quality and speed for respondents who used the internet on the train. This may be through Wi-Fi, mobile data or a combination of the two. The results show that over half of respondents (54%) perceived the quality of their connection to be poor or intermittent; 49% of respondents were dissatisfied with the internet speed (taken to be 'unusable' or 'slow').

Figure 4.24: Perception of internet connection quality

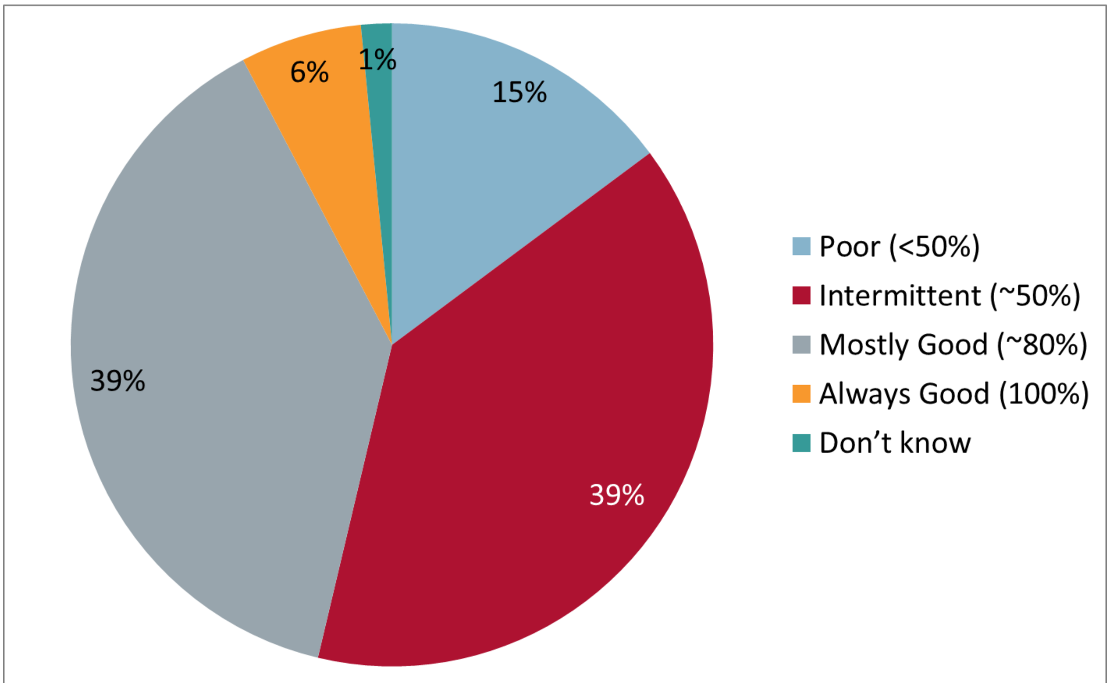
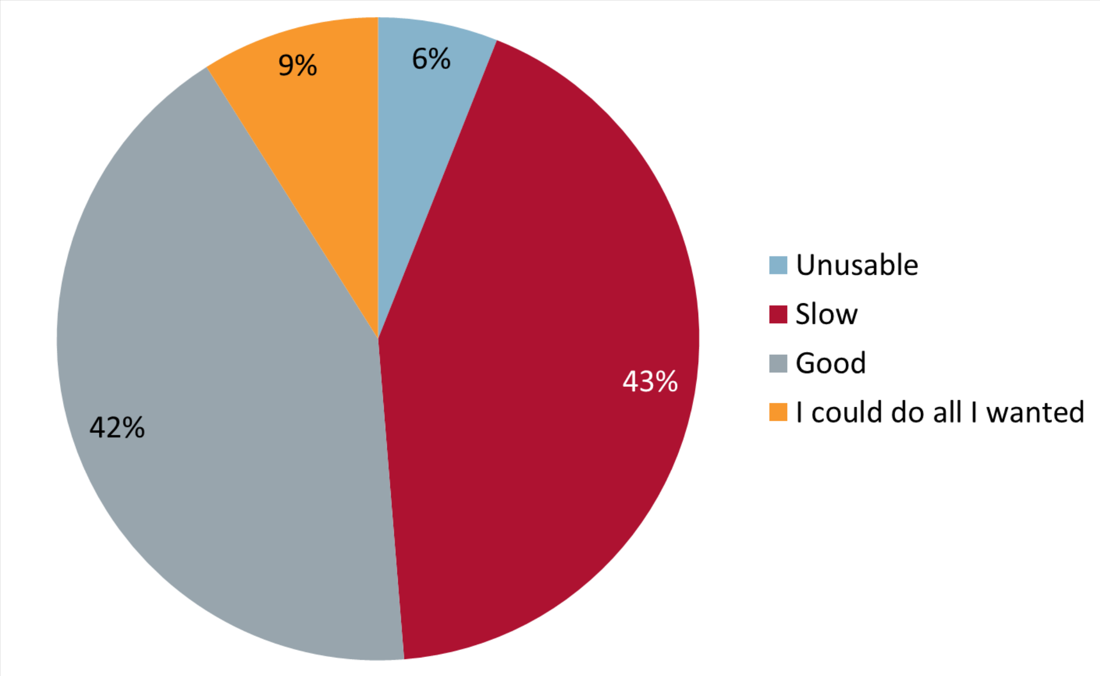
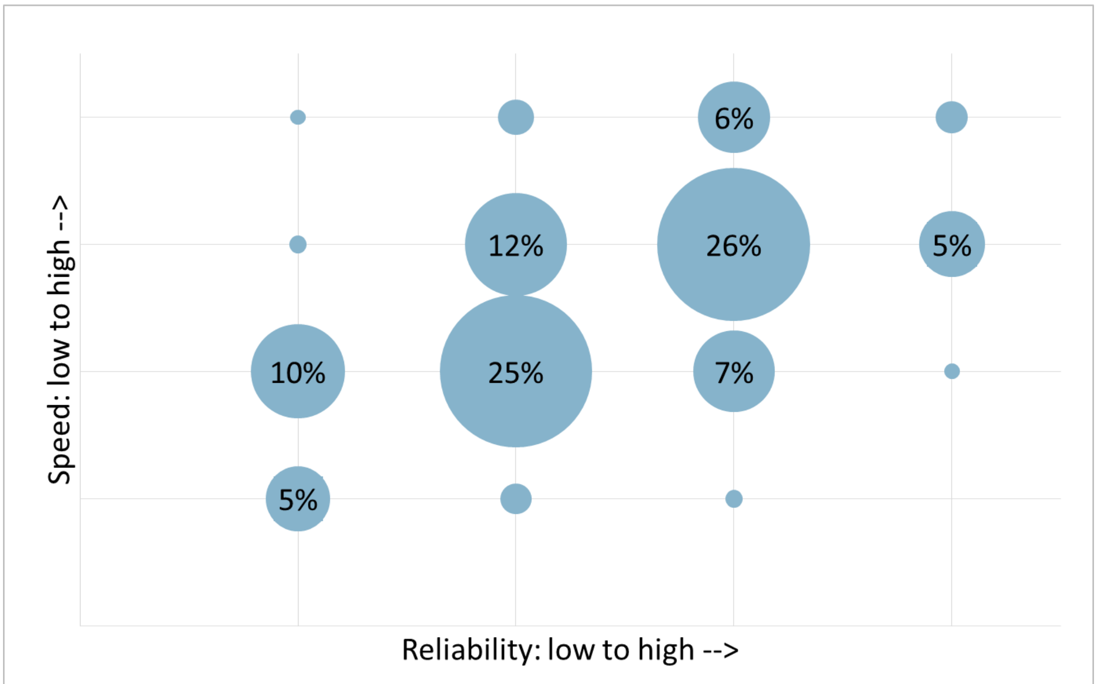


Figure 4.25: Perception of internet speed



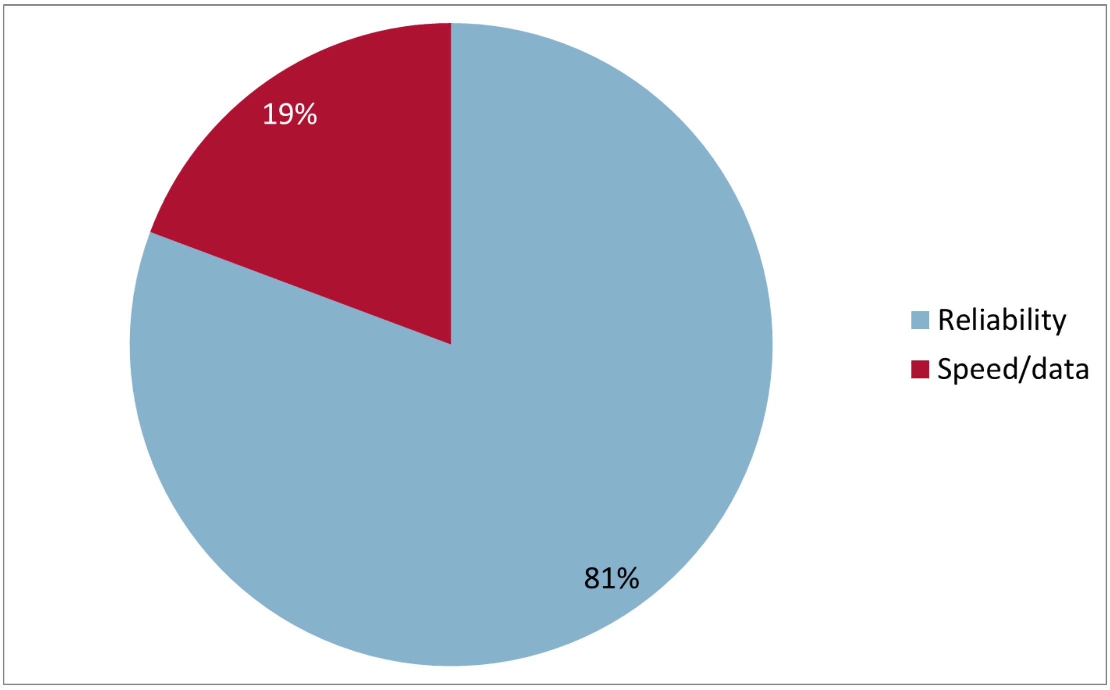
4.43 The relationship between satisfaction with connection quality and with speed is shown below in Figure 4.26. This is derived from answers to Q34 and Q35 from the questionnaire (see Appendix B). This shows that when a respondent thought the connection reliability was good, they usually thought the same for speed and vice-versa. However there is some spread; there are a few respondents who were dissatisfied with the reliability but thought the speed was good.

Figure 4.26: Correlation of perceived speed and reliability



4.44 Although the respondents were asked to trade off reliability against speed in the second SP exercise, we also asked this directly. Figure 4.27 shows an overwhelming majority of respondents valued reliability and consistency of connection more than the speed of the connection while on the train.

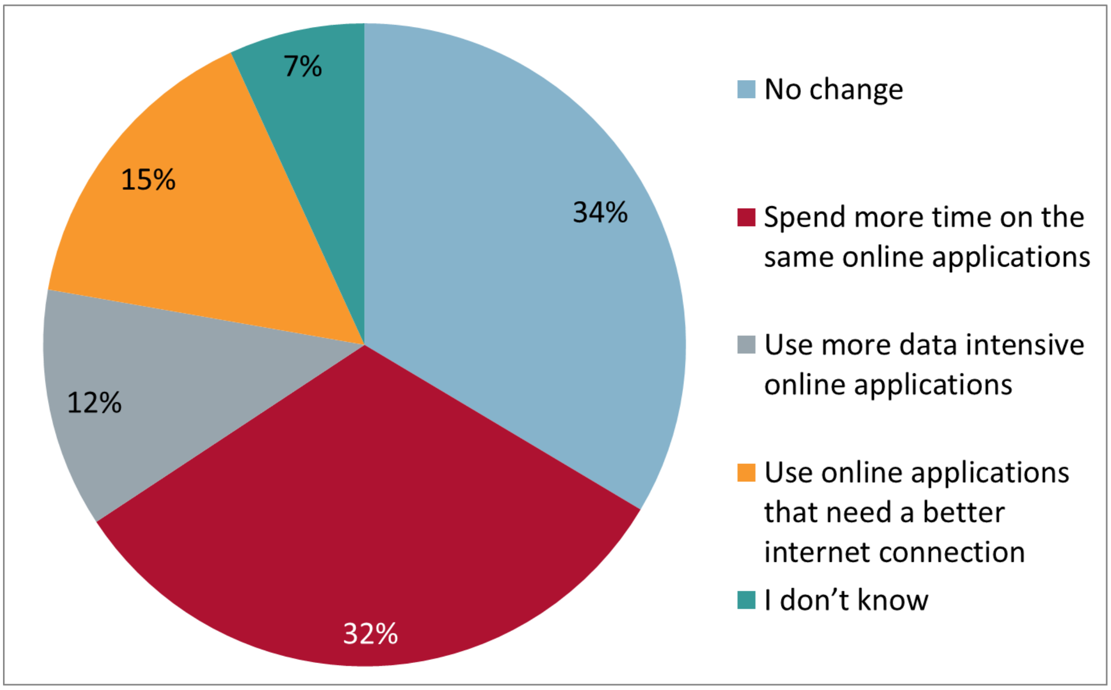
Figure 4.27: Preference of reliability vs speed/data



Future use

4.45 Figure 4.28 shows the response from the total sample when asked how their internet usage on trains would change if the quality of connections improved. Around a third of respondents said this would not affect their internet usage. Another third said they would spend more time using the same applications. The remainder said that they would use other and/or more data intensive applications, or were unsure.

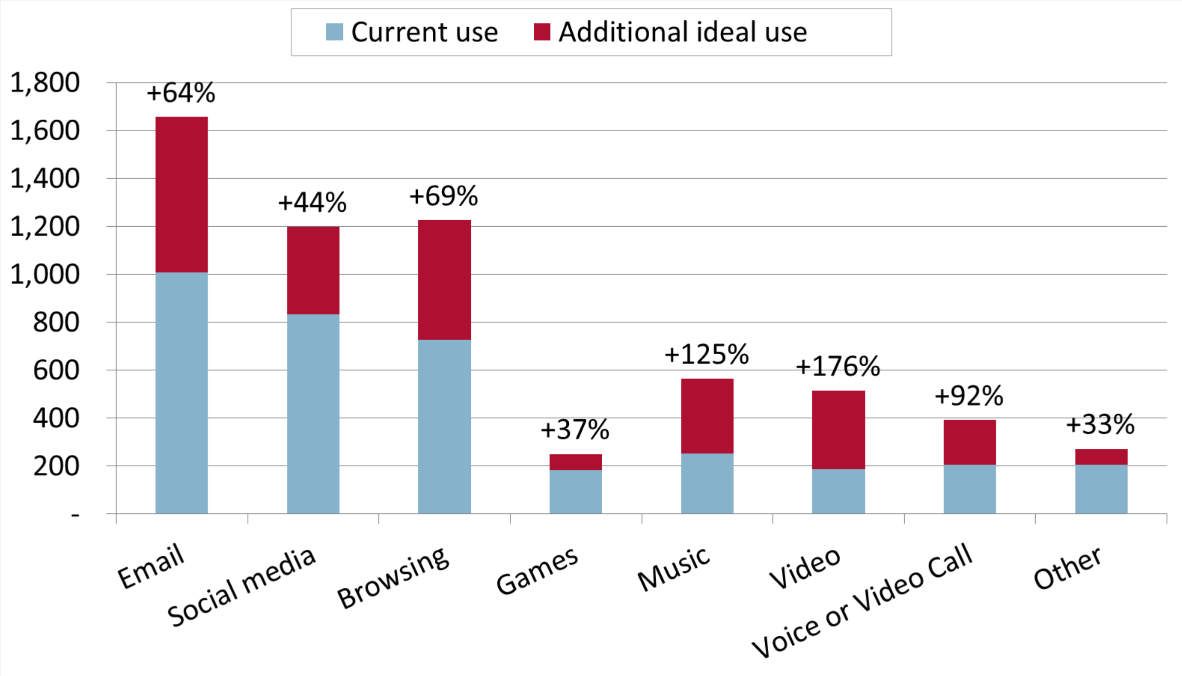
Figure 4.28: How people would change their on-train internet usage if the quality of connections improved



4.46 Figure 4.29 shows respondents' ideal online activities compared with their current online activities. That is, their preferences for internet activity if cost, speed, reliability and data restrictions did not exist. The figure shows the total number of responses for each ideal activity compared with the total number of responses for each current activity, which comes from Figure 4.22. In both cases, each respondent could select more than one choice.

4.47 The percentage shown is the percentage increase over the current use. Even without restrictions, while the proportions of data intensive activities such as music and video streaming have increased by a large percentage, the overall demand is still relatively low compared with the less data intensive activities.

Figure 4.29: Ideal internet use



Stated Preference: Data Use

4.48 We designed an SP exercise (SP3) to quantify the value that respondents place on what they are able to do on the internet while on the train. Each respondent was asked to make six choices between two similar rail journeys and asked to select which one they would prefer. The journeys varied in terms of the following elements:

- The fare for the journey, where the fare differences ranged between a +2% and +20% increase in the respondent's current fare;
- The internet service level available, where the levels shown were:
  - None - No internet activity, by any means, for the whole of your journey;
  - Low Data - Activities with low data use including: Emailing and Online Messaging (e.g. WhatsApp) and basic browsing (no audio/video) (e.g. Wikipedia);
  - Medium Data - Activities with medium data use including: Emailing and Online Messaging (e.g. WhatsApp), Browsing (e.g. BBC website), Social Media (e.g. Facebook);
  - High Data - Activities with high data use including: Emailing/Online Messaging (e.g. WhatsApp) Browsing (e.g. BBC website), Social Media (e.g. Facebook), Audio/Video Streaming (e.g. Netflix).

4.49 Respondents were asked to assume that the service reliability was 100% in all cases (except, of course, when there was no connection).

4.50 The first step in the analysis was to carry out trading analysis. The trading proportions are summarised in Table 4.11 below.

Table 4.11: Internet level of service SP trading analysis

	Business	Commute	Leisure	Total
Traders	63%	61%	61%	61%
Non traders (always the cheapest)	20%	19%	23%	22%
Non traders (always the most expensive)	17%	20%	16%	17%

4.51 This shows that:

- 61% of respondents traded; these are the respondents who provide the most information about the value placed on what people can do on the internet;
- 22% of respondents always selected the cheapest option regardless of what level of service was shown; this suggests that their willingness to pay was less than the minimum fares increase offered (+2%);
- 17% of respondents always selected the most expensive option regardless of what level of reliability was shown; this suggests that their willingness to pay was greater than the maximum fare increase shown (+20%).

4.52 Non-traders were asked why they had chosen in that way. Figure 4.30 shows the reasons given by non-traders who always selected the least expensive option and Figure 4.31 shows the reasons given by non-traders who always selected the most expensive option.

Figure 4.30: Reasons for non-traders who always selected the cheapest journey

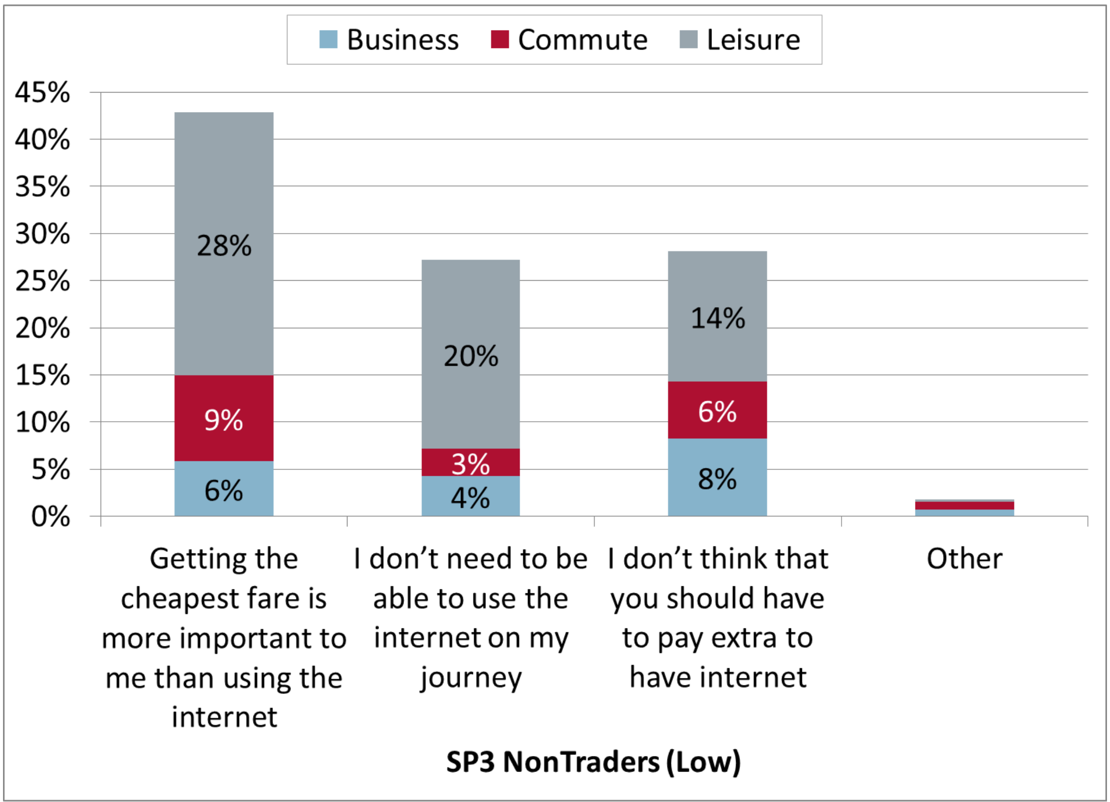
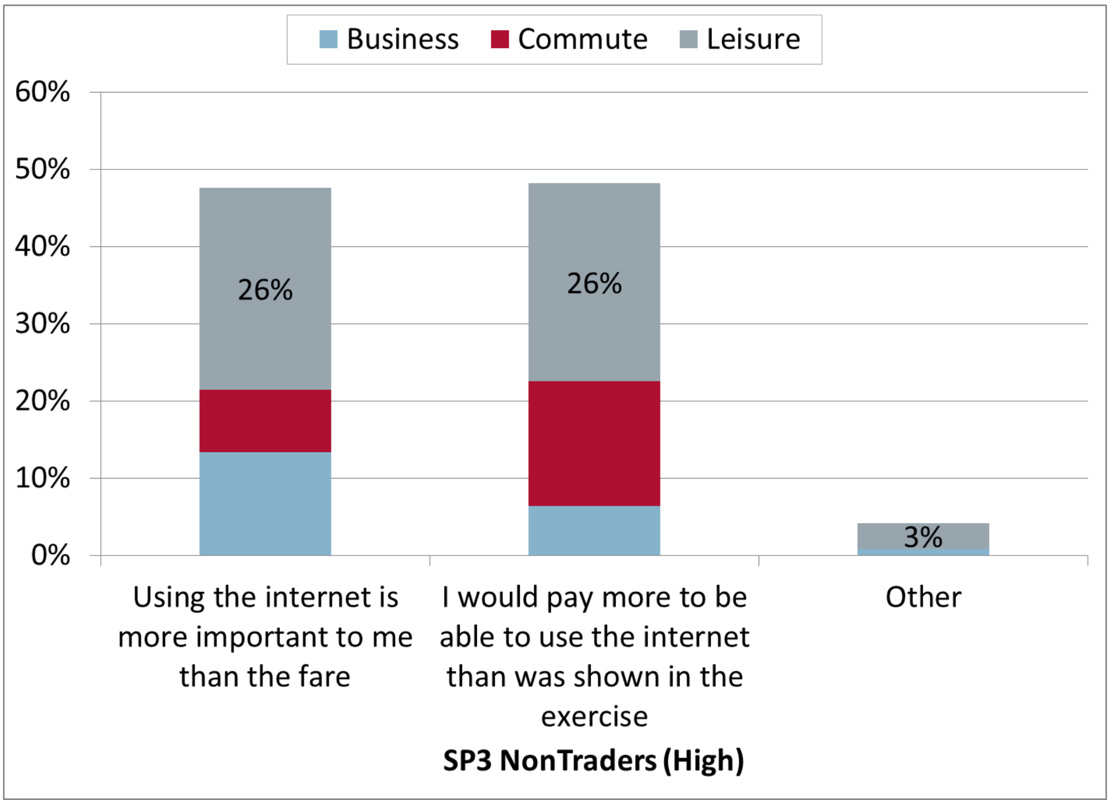


Figure 4.31: Reasons for non-traders who always selected the most expensive journey



4.53 The technical details of the analysis of the Stated Preference responses are described in Appendix A.

4.54 Logit models were estimated to explain the SP choices made in terms of fare and level of reliability. We tested several models to explain the SP choice in terms of fare and level of internet service, and tested for differences by both journey purpose and journey time. We found that business users and leisure travellers placed the same value on internet use regardless of trip length while the value for commuters varied by trip length.

4.55 The table below shows the results, split by the segmentation groups that were found to differentiate most between respondents. The figures tabulated are the percentage change in fare that people were willing to pay the receive each of the increases in internet service provision.

Table 4.12: Willingness to pay for improved internet service

Change in service provision:	Business	Commute, short	Commute, medium	Leisure
Nothing to low	17%	9%	15%	13%
Low to Medium	4%	7%	7%	5%
Medium to High	0%	0%	3%	0%

4.56 These results show:

- People in all segments were willing to pay a significant uplift on their fare (between 9% and 17%) to get a basic level of internet provision, but smaller additional increments to reach the higher levels of service;

- Only Commuters (medium trips) were willing to pay extra to achieve the highest level of service.

4.57 Another way to look at these results is to see how much respondents are willing to pay to go from no connection to each of the low/medium/high levels of service. This is achieved by summing the increments people are willing to pay to go from one level to the next. The table below show the results in this format.

Table 4.13: Willingness to pay for improved internet service from a zero connection situation

	Business	Commute, short	Commute, medium	Leisure
Nothing to low	17%	9%	15%	13%
Nothing to Medium	21%	16%	22%	18%
Nothing to High	21%	16%	26%	18%

4.58 We designed an additional SP (SP2) to understand how the reliability and consistency of the internet connection may affect respondents' willingness to pay. In the exercise described above we asked respondents to assume that they had 100% connection reliability for all levels of internet use, and that the internet speed was good enough for the activities described. In the next exercise we tested how respondents' choices would be affected by changes to reliability.

4.59 Each respondent was offered six choices between two similar rail journeys and asked to select which one they would choose. The journeys varied in terms of the following elements:

- The internet service level available, where the levels shown were the same as in the above (SP3);
- The reliability of the internet service, where the levels shown were:
  - 50% (Intermittent connection) – Able to connect to the internet for around half of the journey, with interruptions spread randomly through the journey;
  - 80% (Mostly good connection) – Able to connect to the internet for most of the journey, with interruptions spread randomly through the journey;
  - 100% (Always good connection) – Able to connect to the internet for the whole of your journey.

4.60 Appendix A provides technical details of the analysis of the responses to this exercise. This section provides a summary, and the values recommended for use.

4.61 We tested for differences by journey purpose and length, and found preferences were significantly different between journey purposes, but not by trip length.

4.62 This SP exercise did not include changes to the fare; instead it was designed to measure how preference weights for each type of service fell as the reliability worsened. These weights were on an abstract utility scale, not money; however, because we had measures of the willingness to pay for each service level at 100% reliability, it was possible to scale down those values for lower levels of reliability using the abstract utility weights. The tables below show the willingness to pay for different levels of reliability and use. In each case the last column corresponds to a column in Table 4.13; the other columns have been calculated by scaling down these values using the results of SP2.

4.63 All of the results below show the willingness to pay to move from a situation without any internet connection to a specified level of service and reliability. For example, the value to business travellers, of having a high capacity service with 80% reliability is 21% of the one-way fare. Full model outputs are given in Appendix A.

Table 4.14: Willingness to pay for improved internet service and reliability, business

Service level/Reliability	0% to 50%	0% to 80%	0% to 100%
Nothing to Low	13%	15%	17%
Nothing to Medium	17%	19%	21%
Nothing to High	18%	21%	21%

Table 4.15: Willingness to pay for improved internet service and reliability, commuting short

	0% to 50%	0% to 80%	0% to 100%
Nothing to Low	7%	8%	9%
Nothing to Medium	13%	15%	16%
Nothing to High	14%	16%	16%

Table 4.16: Willingness to pay for improved internet service and reliability, commuting medium

	0% to 50%	0% to 80%	0% to 100%
Nothing to Low	12%	14%	15%
Nothing to Medium	18%	20%	22%
Nothing to High	20%	22%	26%

Table 4.17: Willingness to pay for improved internet service and reliability, Leisure

	0% to 50%	0% to 80%	0% to 100%
Nothing to Low	10%	12%	13%
Nothing to Medium	15%	17%	18%
Nothing to High	16%	18%	18%

4.64 These results suggest that people are willing to pay a relatively high amount to get a basic internet service, and after this the marginal value of further improvements to service levels or reliability is smaller but still positive (with one or two exceptions at the highest levels).

4.65 We note here that these values are for the provision of connectivity at a given level of reliability, but are not conditional on the type of connectivity, such as Wi-Fi or 4G, or the type of device used. Care was taken in the interviews to separate the degree of connectivity from the means through which it was provided. The values also apply when the service is provided for the entire duration of a journey. No tests were made of the values that would apply if service provision was only for part of a journey, but a reasonable assumption would be that they would be scaled down proportionally.

A Stated Preferences models

SP1 – Voice reliability

A.1 The objective of this exercise was to estimate people's willingness to pay (WTP) for reliability improvements in phone calls. The SP asked respondents to make choices between pairs of alternatives. were assumed to make their decisions based on the following utility function for each alternative:

$$U_i = \beta_1 R50_i + \beta_2 R80_i + \beta_3 R100_i + \beta_4 Fare_i + e_i$$

where:

U_i represents the utility of option *i*;

$R50_i, R80_i, R100_i$ are 1-0 dummy variables used to code up the level of reliability offered for option *i*; 50% reliability would be represented as 1,0,0, and so on. When all three are zero, this means there is no service;

$Fare_i$ is the fare for option *i*;

β_1, β_2 etc are weights that represent the importance (the contribution to utility) that each level of reliability or fare level brings; these are the parameters to be estimated;

e_i represents an additional random error term that reflects other unobserved factors affecting the respondent's perception of an option.

A.2 The utility functions were estimated by fitting logit models to the choice data using the STATA software package. The SP designs were formulated around percentage changes in fare, so in practice the fares term is actually the *percentage change* in fare.

A.3 The tables below show the parameters of the models that were estimated. We have estimated separate models for each journey purpose segment – Business, Commute and Leisure. The following tables show the model results for these three segments; in each case the column 'Coef.' reports the estimated values for β_1, β_2 etc.

A.4 In all cases the parameter estimates are significantly different to zero (z-ratios larger than 1.96 and confidence intervals that do not include zero) and have the correct sign (positive for the reliability measures since they add to utility, negative for the fares increments because higher fares reduce utility).

Table A.1: Model to estimate the WTP for improved phone reliability, business

	Coef.	Std. Err.	z	P>z	95% Confidence Interval	
					Lower bound	Upper bound
R50	1.140	0.104	10.920	0.000	0.935	1.344
R80	1.655	0.160	10.370	0.000	1.342	1.968
R100	1.923	0.201	9.550	0.000	1.528	2.317
fare_percent	-6.665	0.905	-7.360	0.000	-8.439	-4.891

Table A.2: Model to estimate the WTP for improved phone reliability, commute

	Coef.	Std. Err.	z	P>z	95% Confidence Interval	
					Lower bound	Upper bound
R50	0.772	0.096	8.010	0.000	0.583	0.960
R80	1.260	0.148	8.540	0.000	0.970	1.549
R100	1.175	0.186	6.310	0.000	0.810	1.540
fare_percent	-5.108	1.013	-5.040	0.000	-7.093	-3.122

Table A.3: Model to estimate the WTP for improved phone reliability, leisure

	Coef.	Std. Err.	z	P>z	95% Confidence Interval	
					Lower bound	Upper bound
R50	0.928	0.057	16.410	0.000	0.817	1.039
R80	1.354	0.084	16.050	0.000	1.188	1.519
R100	1.287	0.103	12.440	0.000	1.084	1.490
fare_percent	-6.946	0.567	-12.250	0.000	-8.057	-5.834

A.5 The tables do not provide willingness to pay values. These values can be calculated as the ratio of the reliability and fares coefficients, but in order to derive significance statistics they have been estimated directly in STATA. These willingness to pay values are reported in the following tables (under the 'Coef.' column) along with standard errors and significance statistics for the ratios.

Table A.4: Increments in WTP between phone reliability levels, business

	Coef.	Std. Err.	z	P>z	95% Confidence Interval	
					Lower bound	Upper bound
0 to 50%	17%	0.020	8.500	0.000	0.132	0.210
50% to 80%	8%	0.012	6.270	0.000	0.053	0.102
80% to 100%	4%	0.011	3.560	0.000	0.018	0.062

Table A.5: Increments in WTP between phone reliability levels, commute

	Coef.	Std. Err.	z	P>z	95% Confidence Interval	
					Lower bound	Upper bound
0 to 50%	15%	0.026	5.820	0.000	0.100	0.202

50% to 80%	10%	0.019	5.030	0.000	0.058	0.133
80% to 100%	-2%	0.017	-0.970	0.330	-0.050	0.017

Table A.6: Increments in WTP between phone reliability levels, leisure

	Coef.	Std. Err.	z	P>z	95% Confidence Interval	
					Lower bound	Upper bound
0 to 50%	13%	0.009	14.510	0.000	0.116	0.152
50% to 80%	6%	0.006	9.850	0.000	0.049	0.073
80% to 100%	-1%	0.007	-1.460	0.144	-0.022	0.003

A.6 The results above show that the increment in WTP to go from 80% to 100% is not significant, for both commute and leisure. We have therefore concluded that the value for this increment is 0%, for these two segments.

4.66 Before finalising the models we tested the different trip length segments within each journey purpose to see if there are any significant differences in the value placed on the fare contribution to the utility. The tables below show the change in fares coefficient for the different journey lengths. The definitions of journey lengths throughout the remainder of this report are:

- Short – up to 30 minutes (commute and leisure);
- Medium – 30 minutes to 2 hours (all three purposes);
- Long – over 2 hours (business and leisure).

A.7 These are formatted as bold and italics and show the difference on the fare coefficient compared to the base journey length. For business this compares the base of medium with the other segment of long. For commute this compares the base of short with the segment of medium. For leisure this compares the base of short with the medium and long segments. If any of the z-statistics in bold are significant (above 1.96) this implies that this segment would have a significantly different WTP than the base journey length segment.

Table A.7: Model to estimate the WTP for improved phone reliability for different trip lengths, business

	Coef.	Std. Err.	z	P>z	95% Confidence Interval	
					Lower bound	Upper bound
R50	1.141	0.104	10.930	0.000	0.936	1.345
R80	1.657	0.160	10.380	0.000	1.344	1.970
R100	1.925	0.201	9.560	0.000	1.530	2.320
fare_percent	-7.003	1.343	-5.210	0.000	-9.636	-4.370
xLong-Med	***0.628***	***1.838***	***0.340***	***0.732***	***-2.973***	***4.230***

Table A.8: Model to estimate the WTP for improved phone reliability for different trip lengths, commute

	Coef.	Std. Err.	z	P>z	95% Confidence Interval	
					Lower bound	Upper bound
R50	0.771	0.096	7.990	0.000	0.582	0.961
R80	1.260	0.148	8.530	0.000	0.970	1.549
R100	1.175	0.187	6.300	0.000	0.809	1.541

fare_percent	-6.629	1.483	-4.470	0.000	-9.535	-3.723
xMed-Short	***2.699***	***1.879***	***1.440***	***0.151***	***-0.983***	***6.381***

Table A.9: Model to estimate the WTP for improved phone reliability for different trip lengths, Leisure

	Coef.	Std. Err.	z	P>z	95% Confidence Interval	
					Lower bound	Upper bound
R50	0.929	0.057	16.430	0.000	0.818	1.040
R80	1.354	0.084	16.060	0.000	1.189	1.519
R100	1.287	0.103	12.440	0.000	1.085	1.490
fare_percent	-9.080	1.302	-6.970	0.000	-11.632	-6.528
xMed-Short	***2.406***	***1.464***	***1.640***	***0.100***	***-0.463***	***5.275***
xLong-Short	***2.908***	***1.589***	***1.830***	***0.067***	***-0.207***	***6.022***

A.8 The results above show that within each journey purpose segment, respondents with different trip lengths did not have significantly different willingness to pay values.

A.9 This means that the WTP for the different reliability levels are given are given in the previous tables and summarised in the table below.

Table A.10: Willingness to pay for improved phone reliability

Improvement in reliability:	Business	Commute	Leisure
0% to 50%	17%	15%	13%
50% to 80%	8%	10%	6%
80% to 100%	4%	0%	0%

SP3 – Internet use

A.10 The objective of this exercise was to estimate the willingness to pay for different levels of internet service. The SP asked respondents to make choices between pairs of alternatives. Respondents were assumed to make their decisions based on the following utility function for each alternative:

$$U_i = \beta_1 Low_i + \beta_2 Medium_i + \beta_3 High_i + \beta_4 Fare_i + e_i$$

where:

U_i represents the utility of option *i*;

Low_i, $Medium_i$, $High_i$ are 1-0 dummy variables used to code up the level internet service offered for option *i*; low internet service would be represented as 1,0,0, and so on. When all three are zero, this means there is no service;

$Fare_i$ is the fare for option *i*;

β_1, β_2 etc are weights that represent the importance (the contribution to utility) that each level of internet service or fare level brings; these are the parameters to be estimated;

e_i represents an additional random error term that reflects other unobserved factors affecting the respondent’s perception of an option.

A.11 As with SP1, the utility functions were estimated by fitting logit models to the choice data using the STATA software package, and the SP designs were formulated around percentage changes in fare.

A.12 We followed the same methodology used in SP1 to analyse SP3. The tables below show the parameters of the models that were estimated when segmenting by journey purpose.

A.13 In all cases the parameter estimates are significantly different to zero (z-ratios larger than 1.96 and confidence intervals that do not include zero) and have the correct sign (positive for the internet measures since they add to utility, negative for the fares increments because higher fares reduce utility).

Table A.11: Model to estimate the WTP for improved Internet service, business

	Coef.	Std. Err.	z	P>z	95% Confidence Interval	
					Lower bound	Upper bound
Low Data	1.342	0.126	10.660	0.000	1.095	1.588
Medium Data	1.652	0.224	7.390	0.000	1.213	2.090
High Data	1.650	0.279	5.910	0.000	1.103	2.197
fare_percent	-7.827	1.174	-6.670	0.000	-10.128	-5.526

Table A.12: Model to estimate the WTP for improved Internet service, commute

	Coef.	Std. Err.	z	P>z	95% Confidence Interval	
					Lower bound	Upper bound
Low Data	1.156	0.118	9.770	0.000	0.924	1.388
Medium Data	1.821	0.215	8.470	0.000	1.400	2.243
High Data	1.989	0.280	7.100	0.000	1.440	2.538
fare_percent	-9.215	1.132	-8.140	0.000	-11.433	-6.997

Table A.13: Model to estimate the WTP for improved Internet service, leisure

	Coef.	Std. Err.	z	P>z	95% Confidence Interval	
					Lower bound	Upper bound
Low Data	1.269	0.067	18.910	0.000	1.138	1.401
Medium Data	1.787	0.123	14.580	0.000	1.547	2.027
High Data	1.845	0.157	11.790	0.000	1.538	2.152
fare_percent	-9.770	0.647	-15.100	0.000	-11.039	-8.501

A.14 These tables do not provide willingness to pay values. These values can be calculated as the ratio of the internet service and fares coefficients, but in order to derive significance statistics they have been estimated directly in STATA. These willingness to pay values are reported in the following tables (under the 'Coef.' column) along with standard errors and significance statistics for the ratios.

Table A.14: Increments in WTP between Internet service levels, business

	Coef.	Std. Err.	z	P>z	95% Confidence Interval	
					Lower bound	Upper bound
Nothing to Low	17%	0.018	9.550	0.000	0.136	0.207
Low to Medium	4%	0.012	3.310	0.001	0.016	0.063
Medium to High	0%	0.011	-0.020	0.982	-0.022	0.022

Table A.15: Increments in WTP between Internet service levels, commute

	Coef.	Std. Err.	z	P>z	95% Confidence Interval	
					Lower bound	Upper bound
Nothing to Low	13%	0.011	11.520	0.000	0.104	0.147
Low to Medium	7%	0.008	8.710	0.000	0.056	0.088
Medium to High	2%	0.009	2.030	0.043	0.001	0.036

Table A.16: Increments in WTP between Internet service levels, leisure

	Coef.	Std. Err.	z	P>z	95% Confidence Interval	
					Lower bound	Upper bound
Nothing to Low	13%	0.006	21.120	0.000	0.118	0.142
Low to Medium	5%	0.005	10.280	0.000	0.043	0.063
Medium to High	1%	0.005	1.220	0.222	-0.004	0.015

A.15 The results above show that the increment in WTP to go from Medium Data to High Data, is not significant, for both commute and leisure. We have therefore concluded that the value for this increment is 0%, for these two segments.

4.67 Before finalising the models we tested the different trip length segments within each journey purpose to see if there are any significantly differences in the value placed on the fare contribution to the utility. The tables below show the change in fares coefficient for the different journey lengths. The definitions of journey lengths throughout the remainder of this report are:

- Short – up to 30 minutes (commute and leisure);
- Medium – 30 minutes to 2 hours (all three purposes);
- Long – over 2 hours (business and leisure).

A.16 The rows are formatted as bold and italics and show the difference on the fare coefficient compared to the based journey length. For commute this compares the base of short with the segment of medium. For leisure this compares the base of short with the medium and long segments. If any of the z-statistics in bold are significant (above 1.96) this implies that this segment would have a significantly different WTP than the base journey length segment.

Table A.17: Model to estimate the WTP for improved Internet service for different trip lengths, business

	Coef.	Std. Err.	z	P>z	95% Confidence Interval	
					Lower bound	Upper bound
Low Data	1.341	0.126	10.670	0.000	1.095	1.587
Medium Data	1.651	0.223	7.390	0.000	1.213	2.088
High Data	1.648	0.278	5.920	0.000	1.102	2.194
fare_percent	-7.681	1.241	-6.190	0.000	-10.112	-5.250
xLong-med	***-0.285***	***1.104***	***-0.260***	***0.796***	***-2.449***	***1.879***

Table A.18: Model to estimate the WTP for improved Internet service for different trip lengths, commute

	Coef.	Std. Err.	Z	P>z	95% Confidence Interval	
					Lower bound	Upper bound
Low Data	1.162	0.119	9.740	0.000	0.928	1.396
Medium Data	1.842	0.216	8.520	0.000	1.418	2.265
High Data	2.012	0.281	7.150	0.000	1.461	2.564
fare_percent	-11.259	1.332	-8.450	0.000	-13.871	-8.648
xMed-short	***3.398***	***1.146***	***2.960***	***0.003***	***1.152***	***5.644***

Table A.19: Model to estimate the WTP for improved Internet service for different trip lengths, Leisure

	Coef.	Std. Err.	Z	P>z	95% Confidence Interval	
					Lower bound	Upper bound
Low Data	1.270	0.067	18.900	0.000	1.138	1.401
Medium Data	1.788	0.123	14.580	0.000	1.548	2.028
High Data	1.847	0.157	11.790	0.000	1.540	2.154
fare_percent	-10.690	0.937	-11.410	0.000	-12.526	-8.854
xMed-Short	***1.059***	***0.880***	***1.200***	***0.229***	***-0.667***	***2.784***
xLong-Short	***1.194***	***0.969***	***1.230***	***0.218***	***-0.707***	***3.094***

A.17 These results suggest that within business and leisure, respondents with different trip lengths behaved in a similar way. However, when looking at commute, we can see that the fare parameter is less negative (-11.259 plus +3.398 = -7.861 for medium compared to -11.259 for short) on medium length trips compared to short.

A.18 This means that we do not need to differentiate business and leisure by distance but we should do so for commute. The tables below show the WTP values for the two commute segments.

Table A.20: Increments in WTP between internet service levels, commute short

	Coef.	Std. Err.	z	P>z	95% Confidence Interval	
					Lower bound	Upper bound
Nothing to Low	9%	0.013	6.840	0.000	0.064	0.116
Low Data to Medium	7%	0.014	5.300	0.000	0.045	0.099
Medium to High	0%	0.015	-0.140	0.887	-0.031	0.027

Table A.21: Increments in WTP between Internet service levels, commute medium

	Coef.	Std. Err.	z	P>z	95% Confidence Interval	
					Lower bound	Upper bound
Nothing to Low	15%	0.017	8.960	0.000	0.116	0.182
Low Data to Medium	7%	0.010	7.260	0.000	0.054	0.094
Medium to High	3%	0.011	3.080	0.002	0.012	0.056

A.19 The final table in this section summarises the resulting WTP values estimated for improved internet service.

Table A.22: Willingness to pay for improved internet service

Change in service provision:	Business	Commute, short	Commute, medium	Leisure
Nothing to low	17%	9%	15%	13%
Low to Medium	4%	7%	7%	5%
Medium to High	0%	0%	3%	0%

SP2 – Reliability and internet use

A.20 The objective of this exercise was to estimate how respondents valued simultaneously different levels of internet service and reliability. The SP asked respondents to make choices between pairs of alternatives. Respondents were assumed to make their decisions based on the following utility function for each alternative:

$$U_i = \beta_1 R80_i + \beta_2 R100_i + \beta_3 Medium_i + \beta_3 High_i + R80Medium_i + R80High_i + R100Medium_i + e_i$$

where:

U_i represents the utility of option *i*;

$R80_i$ and $R100_i$ are 1-0 dummy variables used to code up the level of reliability of internet service offered for option *i*. When both are zero, this means there is 50% reliability;

$Medium_i$ and $High_i$ are 1-0 dummy variables used to code up the level internet service offered for option *i*. When both are zero, this means there is low internet service;

$R80Medium_i$ $R80High_i$ and $R100Medium_i$ are 1-0 interaction dummy variables used to code up the interaction between the reliability and service variables for option *i*;

$Fare_i$ is the fare for option *i*;

β_1, β_2 etc are weights that represent the importance (the contribution to utility) that each level of internet service or reliability level brings; these are the parameters to be estimated;

e_i represents an additional random error term that reflects other unobserved factors affecting the respondent's perception of an option.

A.21 The estimated models include interaction variables to pick up the interdependencies between internet service and reliability.

A.22 This exercise did not include fares, which means that it could only measure the relative importance of service level and reliability on an abstract utility scale. In order to translate these preferences into willingness to pay we combined the findings of SP2 with the results from SP3.

A.23 In addition to the six cards that each respondent was shown, the dominant cards which showed improvements (or reductions) in both reliability and internet service were re-introduced (27 cards in total). These are cards present in the original SP design where one option was better than the other on all attributes (for example - a better internet service at a higher level of reliability). They were not put to respondents because they would provide no choice preference information, but they have been used in the analysis, assuming people would have replied to them correctly, in order to restore the balance of the original design. This increases the sample size artificially, so to correct for this we have reduced the z-statistics accordingly to ensure the fit of the models are not overstated.

A.24 The tables below show the parameters of the models that were estimated for each of the three journey segments.

Table A.23: Model to estimate the trade-off between improved internet service and reliability, business

	Coef.	Std. Err.	z	Significant at 95%?	95% Confidence Interval	
					Lower bound	Upper bound
r80	19.380	0.684	28.317	Yes	18.038	20.721
r100	21.463	0.904	23.730	Yes	19.691	23.236
Medium Data	18.566	0.687	27.027	Yes	17.220	19.912
High Data	20.273	0.528	38.370	Yes	19.238	21.309
r80Medium Data	-16.548	0.578	-28.610	Yes	-17.682	-15.415
r80High Data *	-16.301	.	.	.	.	.
r100Medium Data	-16.287	0.636	-25.603	Yes	-17.533	-15.040

* This parameter is estimated from the responses to dominant cards. These responses were assumed always to be correct (i.e. the dominant card was always chosen) so there is no error associated with the parameter estimate.

Table A.24: Model to estimate the trade-off between improved internet service and reliability, commute

	Coef.	Std. Err.	z	Significant at 95%?	95% Confidence Interval	
					Lower bound	Upper bound
r80	18.997	0.666	28.544	Yes	17.693	20.302
r100	20.827	0.731	28.483	Yes	19.393	22.260
Medium Data	18.865	0.768	24.573	Yes	17.360	20.369
High Data	20.563	0.636	32.307	Yes	19.316	21.811
r80Medium Data	-16.605	0.606	-27.391	Yes	-17.793	-15.417
r80High Data *	-16.179	.	.	.	.	.
r100Medium Data	-16.255	0.644	-25.240	Yes	-17.517	-14.993

* This parameter is estimated from the responses to dominant cards. These responses were assumed always to be correct (i.e. the dominant card was always chosen) so there is no error associated with the parameter estimate.

Table A.25: Model to estimate the trade-off between improved internet service and reliability, leisure

	Coef.	Std. Err.	z	Significant at 95%?	95% Confidence Interval	
					Lower bound	Upper bound
r80	19.100	0.280	68.160	Yes	18.551	19.649
r100	21.035	0.435	48.308	Yes	20.181	21.888
Medium Data	18.757	0.232	80.829	Yes	18.302	19.212
High Data	20.524	0.349	58.856	Yes	19.840	21.207
r80Medium Data *	-16.588	.	.	.	.	.
r80High Data	-16.281	0.340	-47.877	Yes	-16.948	-15.615
r100Medium Data	-16.407	0.311	-52.761	Yes	-17.017	-15.798

* This parameter is estimated from the responses to dominant cards. These responses were assumed always to be correct (i.e. the dominant card was always chosen) so there is no error associated with the parameter estimate.

A.25 This shows that all coefficients are significant, including the interaction terms.

A.26 Next we tested the different trip length segments within each journey purpose to see if there are any significantly differences in the value placed on the contribution to the utility of any of the main effects (reliability and internet service) at different trip lengths. The tables below show the change in fares coefficient for the different trip length segments.

A.27 These are formatted as bold and italic and show the difference on the fare coefficient compared to the based journey length. For commute this compares the base of short with the segment of medium. For leisure this compares the base of short with the medium and long segments. If any of the z-statistics in bold are significant (above 1.96) this implies that this segment would have a significantly different WTP than the base journey length segment.

Table A.26: Model to estimate the trade-off between improved internet service and reliability, business and trip length

	Coef.	Std. Err.	z	Significant at 95%?	95% Confidence Interval	
					Lower bound	Upper bound
r80	19.290	0.613	31.491	Yes	18.089	20.491
xLong-med	***0.186***	***1.174***	***0.158***	***No***	***-2.116***	***2.488***
r100 *	21.295	.	.	.	.	.
xLong-med	***0.358***	***1.659***	***0.216***	***No***	***-2.893***	***3.609***
Medium Data	18.564	1.231	15.077	Yes	16.151	20.978
xLong-med	***0.007***	***0.759***	***0.009***	***No***	***-1.480***	***1.494***
High Data	20.306	1.263	16.074	Yes	17.830	22.782
xLong-med	***-0.067***	***0.924***	***-0.073***	***No***	***-1.878***	***1.744***
r80Medium Data	-16.545	1.167	-14.175	Yes	-18.833	-14.257
r80High Data	-16.295	1.134	-14.372	Yes	-18.518	-14.073
r100Medium Data	-16.286	1.045	-15.578	Yes	-18.335	-14.237

* This parameter is estimated from the responses to dominant cards. These responses were assumed always to be correct (i.e. the dominant card was always chosen) so there is no error associated with the parameter estimate.

Table A.27: Model to estimate the trade-off between improved internet service and reliability, commute and trip length

	Coef.	Std. Err.	z	Significant at 95%?	95% Confidence Interval	
					Lower bound	Upper bound
r80	19.056	0.860	22.160	Yes	17.370	20.741
xMed-short	***-0.102***	***0.929***	***-0.110***	***No***	***-1.924***	***1.719***
r100	20.799	0.999	20.811	Yes	18.840	22.758
xMed-short	***0.055***	***1.172***	***0.047***	***No***	***-2.242***	***2.353***
Medium Data	18.930	0.958	19.763	Yes	17.053	20.807
xMed-short	***-0.114***	***0.934***	***-0.122***	***No***	***-1.946***	***1.717***
High Data	20.519	0.878	23.366	Yes	18.798	22.240
xMed-short	***0.083***	***1.090***	***0.077***	***No***	***-2.053***	***2.219***
r80Medium Data	-16.606	0.606	-27.398	Yes	-17.794	-15.418
r80High Data *	-16.179	.	.	.	.	.
r100Medium Data	-16.256	0.643	-25.288	Yes	-17.516	-14.996

* This parameter is estimated from the responses to dominant cards. These responses were assumed always to be correct (i.e. the dominant card was always chosen) so there is no error associated with the parameter estimate.

Table A.28: Model to estimate the trade-off between improved internet service and reliability, leisure and trip length

	Coef.	Std. Err.	z	Significant at 95%?	95% Confidence Interval	
					Lower bound	Upper bound
r80	19.103	0.499	38.274	Yes	18.125	20.082
xMed-short	***0.021***	***0.771***	***0.026***	***No***	***-1.490***	***1.531***
xLong-short	***-0.052***	***0.833***	***-0.063***	***No***	***-1.684***	***1.581***
r100 *	21.219	.	.	.	.	.
xMed-short	***-0.190***	***1.024***	***-0.185***	***No***	***-2.197***	***1.818***
xLong-short	***-0.284***	***1.109***	***-0.256***	***No***	***-2.459***	***1.890***
Medium Data	18.738	1.037	18.069	Yes	16.706	20.771
xMed-short	***0.003***	***0.701***	***0.003***	***No***	***-1.372***	***1.377***
xLong-short	***0.063***	***0.774***	***0.082***	***No***	***-1.454***	***1.579***
High Data	20.545	1.042	19.725	Yes	18.504	22.587
xMed-short	***-0.002***	***0.858***	***-0.003***	***No***	***-1.683***	***1.678***
xLong-short	***-0.073***	***0.940***	***-0.077***	***No***	***-1.915***	***1.770***
r80Medium Data	-16.587	0.921	-18.005	Yes	-18.393	-14.781
r80High Data	-16.279	0.934	-17.429	Yes	-18.109	-14.448
r100Medium Data	-16.406	0.903	-18.162	Yes	-18.176	-14.635

* This parameter is estimated from the responses to dominant cards. These responses were assumed always to be correct (i.e. the dominant card was always chosen) so there is no error associated with the parameter estimate.

A.28 This shows that there are no significant differences between different journey length segments within the journey purpose segmentations.

A.29 To convert these values into WTP values we took the results of SP3, which represent the WTP for improved internet services at 100% reliability, and scaled down the WTP values for lower reliability levels using the utility weights set out in the previous tables. The following tables summarise the resulting WTP values.

Table A.29: Willingness to pay for improved internet service and reliability, business

Service level/Reliability	0% to 50%	0% to 80%	0% to 100%
Nothing to Low	13%	15%	17%
Nothing to Medium	17%	19%	21%
Nothing to High	18%	21%	21%

Table A.30: Willingness to pay for improved internet service and reliability, commuting short

	0% to 50%	0% to 80%	0% to 100%
Nothing to Low	7%	8%	9%
Nothing to Medium	13%	15%	16%

Nothing to High	14%	16%	16%

Table A.31: Willingness to pay for improved internet service and reliability, commuting medium

	0% to 50%	0% to 80%	0% to 100%
Nothing to Low	12%	14%	15%
Nothing to Medium	18%	20%	22%
Nothing to High	20%	22%	26%

Table A.32: Willingness to pay for improved internet service and reliability, Leisure

	0% to 50%	0% to 80%	0% to 100%
Nothing to Low	10%	12%	13%
Nothing to Medium	15%	17%	18%
Nothing to High	16%	18%	18%

B Survey questionnaire

Screening

1. Good {morning, afternoon, evening} and many thanks for taking part in this survey.

   As a thank you for taking 15 minutes to give us your opinions, you have the opportunity to be entered into a prize draw with the chance to win one of twenty M&S vouchers worth £25.

   The answers you give will be used for research purposes only, looking at potential future improvements to on-train mobile and internet connectivity. This survey is being carried out across the UK on behalf of the Department for Transport.

   All information received is strictly confidential, and will be dealt with in accordance with the Market Research Society Code of Conduct.
   Your details will not be passed to any third party and you will receive no marketing material as a result of completing this questionnaire. *Go to 2*

   To be entered into the prize draw, you must have responded within one week of receiving the invitation to do the survey. The prize draw will take place on November 30th.

   If you would prefer not to enter your email address and not be entered into the prize draw, please select "Do not wish to be entered into the prize draw." Your email **will not** be used for any other purposes.

   If you are happy to continue, please click below.

   - {email free entry}
   - Do not wish to be entered into the prize draw

2. Which of the following age groups are you in?
   - 16 or Under
   - 17-19
   - 20-29
   - 30-39
   - 40-49

   If 16 or under Go to 6

   All others Go to 3

- 50-59
- 60-69
- 70 or Over

3. We would like to ask some questions about the rail journey you were making when you were given this postcard.

   If this journey took place on more than one train, please answer only about the train you were on when you were given this postcard. *Go to 4*

4. What was the main purpose of your journey? *Go to 5*
   - Commuting to/from work
   - On company business (or own if self-employed)
   - Education (University, school or college)
   - Shopping
   - Visiting/meeting friends or relatives
   - Personal business
   - Leisure
   - Other (please specify) {free text}

5. Who paid for the cost of the journey?
   - I did *Go to 7*
   - Friend/family member *Go to 7*
   - Employer/business *Go to 7*
   - There was no cost (concessionary or other pass) *Go to 6*
   - Other *Go to 7*

6. Thank you for your time. You do not meet the criteria of this survey, but we thank you for your interest. *End*

Reference Trip – Standard Questions

7. At which station did you get on this train? *Go to 8*
   {drop down selection/restricted text}

8. At what time did your train depart?
   {24hr clock format} *Go to 9*

9. At which station did you get off this train?
   {drop down selection/restricted text} *Go to 10*

10. For how long were you on this train?
    {HH MM} *Go to 11*

Reference Trip – Fare

11. What type of ticket did you have for your journey?
    - Single ticket *Go to 13*
    - Return ticket *Go to 14*
    - Season Ticket *Go to 15*
    - Oyster pay as you go *Go to 17*
    - Contactless pay as you go *Go to 17*
    - Other *Go to 12*

12. How would you describe the type of ticket you had for your journey?
    {free text} *Go to 18*

13. How much did you pay for this single journey? Please state the value printed on the ticket.
    - {currency format} *Go to 20*
    - Don't know *Go to 19*

14. How much did you pay for this return journey? Please state the value printed on the ticket.
    - {currency format} *Go to 20*
    - Don't know *Go to 19*

15. What type of season ticket do you have?
    - Weekly *Go to 16*
    - Monthly *Go to 16*
    - Annual *Go to 16*
    - Other *Go to 18*

16. How much did you pay for this season ticket? Please state the value paid for the ticket.
    - {currency format} *Go to 20*
    - Don't know *Go to 18*

17. How much did you pay on your Oyster/contactless card for this journey?
    - {currency format} *Go to 20*
    - Don't know *Go to 19*

18. Approximately how many journeys will this ticket be used for?
    {number format} *Go to 19*

19. Which price band would you say your ticket was in?
    {drop down} *Go to 20*

20. For the purposes of the next exercise, we estimate your fare to be £XX rounded down to the nearest £5. *Go to 21*

    Do you agree this sounds about right, or would you like to select from the fare

bands below?
{drop down}

Reference Trip – Voice

21. Did you make or receive a phone call on the train?
    - Yes — *Go to 22*
    - No — *Go to 24*
    - Don't remember — *Go to 24*

22. How long did you spend on the phone in total during your journey?
    - {HH MM} — *Go to 23*
    - Don't know

23. How would you rate the reliability of connections for your phone calls?

    - Poor - I had signal and could make/receive calls for a small amount of my journey (less than 50% of the time)
    - Intermittent - I had signal and could make/receive calls for only some of my journey (around 50% of the time)
    - Mostly good connection - I had signal and could make/receive calls for most of my journey (around 80% of the time)
    - Always good connection - I had signal and could make/receive calls for the whole of my journey (100% of the time)
    - Don't know

    Go to 24

Stated Preference – Voice

24. SP exercise 1

In this section, we are going to offer you some choices between two similar rail trips. In each case, please imagine that these are the only options available, and say which journey you would choose.

The two alternatives will vary in terms of the following elements:

- The one way fare for the journey. This will be similar to your one way fare.
- The reliability of your phone signal for voice calls. This will be one of the following:

Reliability level	Description
0% (No connection)	No connection for the entire journey so unable to make/receive phone calls
50% (Intermittent connection)	I can make/receive phone calls for around half of my journey, spread randomly through the journey

If ALL A, Go to 25

If ALL B, Go to 26

ELSE Go to 27

80% (Mostly good connection)	I can make/receive phone calls for most of my journey, spread randomly through the journey
100% (Always good connection)	I can make/receive phone calls for the whole of my journey

For each question please assume:

- You have access to a mobile phone and there would be no additional costs from your mobile phone operator.
- The fare shown would be the total one way fare for your journey.
- The reliability percentage means the proportion of your journey that you are able to have voice calls. Any interruptions would be randomly spread through your journey.
- All other factors in your journey are the same (e.g. time of day, who you are with and purpose of trip etc.).

25. You have always picked the cheapest option. Why is this?
    - Getting the cheapest fare is more important to me than being able to make phone calls with a reliable connection
    - I don't need to be able to make phone calls on my journey with a reliable connection *Go to 27*
    - I don't think that you should have to pay extra to make a phone call with a reliable connection
    - Other

26. You have always picked the most expensive option. Why is this?
    - Making phone calls with a reliable connection is more important to me than the fare
    - I would pay more to be able to make reliable phone calls than was shown in the exercise *Go to 27*
    - Other (please specify)

27. We would now like to ask some more questions about the rail journey you were making when you were given this postcard. *Go to 28*

    Again, please answer only about the train you were on when you were given this postcard.

Reference Trip – Data

28. Did you connect to the internet while on the train (including checking emails on phone or streaming videos)?
    - Yes *Go to 29*
    - No *Go to 36*
    - Don't remember *Go to 36*

29. How did you connect to the internet while on the train?

- Using the train Wi-Fi — *Go to 30*
- On my phone/tablet using 3G/4G — *Go to 31*
- Via a hotspot on my phone using 3G/4G — *Go to 31*
- Using a combination of the above — *Go to 30*

30. How much did you pay for Wi-Fi on the train?
    - It was free
    - I used a voucher — *Go to 31*
    - Paid {currency format}

31. Which of these online activities did you do while on the train and on what type of device (select all)?

Activity	Phone	Tablet	Laptop
Emailing / online messaging (e.g. WhatsApp)	o	o	o
Accessing social media (e.g. Facebook, Twitter)	o	o	o
Browsing other web pages	o	o	o
Online gaming	o	o	o
Music streaming	o	o	o
Video streaming	o	o	o
Other online activity	o	o	o
Voice call through apps (e.g. Skype)	o	o	o
Video call through apps (e.g. FaceTime)	o	o	o
Did not use	o	o	o

Go to 32

32. What was the proportion of time you spent online on this journey? {sliding scale of 10% intervals} — *Go to 33*

33. Did you lose connection to the internet on the train for longer than a 2 minute period?
    - Yes — *Go to 34*
    - No

34. How would you rate the reliability of internet connection?
    - Poor – I could connect for a small amount of my journey (less than 50% of the time)
    - Intermittent - I could connect for some of my journey (around 50% of the time)
    - Mostly good connection - I could connect for most of my journey (around 80% of the time) — *Go to 35*
    - Always good connection - I could connect for the whole of my journey (100% of the time)
    - Don't know

35. How would you rate the speed of internet connection?
    - Unusable
    - Slow — *Go to 36*
    - Good

- I could do all I wanted

36. What type of mobile phone payment plan do you have?

Payment Plan	Personal Phone	Business Phone
Monthly Contract – with data	o	o
Monthly Contract – no data	o	o
Pay as you go	o	o
Other	o	o
Don't know	o	o
Don't own	o	o

Go to 37

37. What type of phone do you have?

Data	Personal Phone	Business Phone
4G Smartphone (e.g. Apple, Samsung)	o	o
3G Smartphone (e.g. Apple Samsung)	o	o
Blackberry type	o	o
Basic Phone		
Don't Own	o	o

Go to 38

Stated Preference - Data

38. SP exercise 2

In this section, we are going to offer you some choices between two similar rail trips. In each case, please imagine that these are the only options available, and say which journey you would choose.

The two alternatives will vary in terms of the following elements:

- The internet service level available, this will be one of the following:

Service level	Description
Low Data • Emailing • Messaging • Basic browsing	Activities with low data use including: • Emailing/Online Messaging (e.g. WhatsApp) • Basic Browsing (no audio/video) (e.g. Wikipedia)
Medium Data • Emailing • Messaging • Browsing • Social media	Activities with medium data use including: • Emailing/Online Messaging (e.g. WhatsApp) • Browsing (e.g. BBC website) • Social Media (e.g. Facebook)
High Data • Emailing • Messaging • Browsing • Social media • Audio/video streaming	Activities with high data use including: • Emailing/Online Messaging (e.g. WhatsApp) • Browsing (e.g. BBC website) • Social Media (e.g. Facebook) • Audio/Video Streaming (e.g. Netflix)

Go to 3940

- The reliability of the internet service, this will be one of the following:

Reliability level	Description
50% (Intermittent connection)	You can connect to the internet for around half of your journey, with interruptions spread randomly through the journey
80% (Mostly good connection)	You can connect to the internet for most of your journey, with interruptions spread randomly through the journey
100% (Always good connection)	You can connect to the internet for the whole of your journey

For each question please assume:

- You have access to a mobile phone, tablet or laptop with internet functionality and you will not incur any additional costs from your mobile operator.
- The fare is the same as you paid for your journey.
- The reliability percentage is the proportion of your journey that you are able to use the internet and that any interruptions would be randomly spread through your journey.
- All other factors in your journey are the same (e.g. time of day, who you are with and purpose of trip etc.).

39. Which is more important to you for using the internet on a train?
    - Reliability
    - Speed/Data

Go to 40

40. Thanks for your responses. We would now like you to assume that you have 100% connectivity and would like you to answer some questions about what fare you would pay for different levels of internet service

Go to 41

41. SP exercise 3

In this section, we are going to offer you some choices between two similar rail trips. In each case, please imagine that these are the only options available, and say which journey you would choose.

The two alternatives will vary in terms of the following elements:

- The fare for the journey.
- The internet service level available, this will be one of the following:

If ALL A, Go to 42

If ALL B, Go to 43

Else Go to 44

Card Description	Possible scenarios
None	No internet activity, by any means, for the whole of your journey.

Low Data • Emailing • Messaging • Basic browsing	Activities with low data use including: • Emailing/Online Messaging (e.g. WhatsApp) • Basic Browsing (no audio/video) (e.g. Wikipedia)
Medium Data • Emailing • Messaging • Browsing • Social media	Activities with medium data use including: • Emailing/Online Messaging (e.g. WhatsApp) • Browsing (e.g. BBC website) • Social Media (e.g. Facebook)
High Data • Emailing • Messaging • Browsing • Social media • Audio/video streaming	Activities with high data use including: • Emailing/Online Messaging (e.g. WhatsApp) • Browsing (e.g. BBC website) • Social Media (e.g. Facebook) • Audio/Video Streaming (e.g. Netflix)

For each question please assume:

- You have access to a mobile phone, tablet or laptop with internet functionality and you will not incur any additional costs from your mobile operator.
- The fares shown would be the total one way fare for your journey.
- You have 100% reliability for all levels of internet use shown and the speed of the internet is good enough for the activities described.
- All other factors in your journey are the same (e.g. time of day, who you are with and purpose of trip etc.).

42. You have always picked the cheapest option. Why is this?
    - Getting the cheapest fare is more important to me than using the internet
    - I don't need to be able to use the internet on my journey
    - I don't think that you should have to pay extra to have internet
    - Other

Go to 44

43. You have always picked the most expensive option. Why is this?
    - Using the internet is more important to me than the fare
    - I would pay more to be able to use the internet than was shown in the exercise
    - Other (please specify)

Go to 44

44. We would now like to ask some questions about your communications on general rail journeys.

Go to 45

Attitudinal Questions

45. How would you change your mobile phone usage if the quality of connections improved?

Go to 46

- No change
- Spend more time making/ receiving phone calls
- I don't know

46. How would you change your internet usage behaviour if the quality of connections improved?
    - No change
    - Spend more time on the same online applications
    - Use more data intensive online applications
    - Use online applications that need a better internet connection
    - I don't know

Go to 47

47. If cost, speed, reliability and data restrictions did not exist, how would you use internet services on a journey? Select all that apply
    - Emailing/online messaging (e.g. WhatsApp)
    - Accessing social media (e.g. Facebook, Twitter)
    - Browsing other web pages
    - Online gaming
    - Music streaming
    - Video streaming
    - Other online activity
    - Voice call through apps (e.g. Skype)
    - Video call through apps (e.g. FaceTime)

Go to 48

Respondent Information

48. Thank you. Finally, we need to ask a few questions about you to ensure that we have received a representative sample

Go to 49

49. Are you…
    - Male?
    - Female?

Go to 50

50. What is your occupational status?
    - Full time paid employment
    - Part time paid employment
    - Self-employment
    - Student
    - Unemployed
    - Unable to work
    - Retired
    - Other
    - Prefer not to say

Go to 51

51. Which category corresponds to your annual **household** income? (before tax)
    - Less than £9,999

Go to 52

- £10,000 - £19,999
- £20,000 - £29,999
- £30,000 - £39,999
- £40,000 - £49,999
- £50,000- £59,999
- £60,000 - £74,999
- £75,000- £99,999
- £100,000 or more
- Prefer not to say

52. Do you have any further comments either for the survey or about the survey? {free text entry} *Go to 53*

53. The answers you have given will be used for research purposes only and will inform work looking at potential future improvements to on-train mobile and internet connectivity.
    Please note that the exercises are designed to understand how you value connectivity and not planned to be used to increase rail fares. *Go to 54*

54. This concludes the survey. We greatly appreciate your participation and thank you for your time. *End*

C SDG review of documents

	Publication	Summary
1	*Public Wi-Fi networks in a 4G world*, by Tom Rebbeck and Matt Yardley of Analysys Mason, published by Arqiva, 19 November 2014	Arqiva commissioned a survey exploring how UK consumers perceived public Wi-Fi services. The results showed that: • Both 4G and non-4G mobile subscribers place a significant value on public Wi-Fi networks. • Non-4G subscribers value public Wi-Fi networks more highly than cellular connectivity. • 4G subscribers, more than the average subscriber, place a high value on public wireless data access (either cellular or Wi-Fi).
2	*Connectivity Matters*, published by Arqiva	Arqiva studied the impact of mobile connectivity on consumer attitudes. They found that businesses enabling customers to connect on their premises led to over half of customers enjoying their visits more, 31% of customers being more likely to recommend the business, and 46% of customers being more likely to visit again. Arqiva also states the importance of offering quality Wi-Fi, saying a poor service was as likely to frustrate customers as offering no service at all.
3	*Understanding and Valuing the Impacts of Transport Investment – Progress Report 2014*, published by Department for Transport	Section 5 of this report sets out the DfT's approach to using direct survey evidence to determine the value of travel time savings. DfT believe it is important to test and pilot surveys before rolling them out.
4	*The death of the featurephone in the UK – and what's next*, by Charles Arthur, published by The Guardian, 30 April 2014	This article uses a range of consumer data to predict that the UK will have reached smartphone "saturation" – with 90% of mobile phone owners using a smartphone, rather than an old Nokia-style "featurephone" – between mid-2016 and the end of 2017.
5	*Stats and Facts, 2014*, published by Mobile Operators Association	A range of statistics and figures relating to mobile handset use and mobile network coverage. In June 2014, 99.5% of UK premises had outdoor 3G mobile coverage from at least one operator; 73% had 4G coverage.
6	*Productive Use of Rail Travel Time and the Valuation of Travel Time Savings for Rail Business Travellers*, published by Mott MacDonald for the Department for Transport, June 2009	This 2009 study was the first to provide empirical data on the amount of time spent working on trains by UK rail business travellers. It concluded that: • A growing proportion of business travellers (0.76) were working or studying during their journeys. • The percentage of journey time spent working had also grown to 57% by 2008. • A wide variety of factors affect whether business travellers did work on the train (including availability of Wi-Fi). Also suggests some distance bands based on NRPS.

7	*National Rail Passenger Survey: Autumn 2014 Main Report*, published by Passengerfocus	Section 6 of this study looks at passenger satisfaction with mobile phone reception and data coverage: • 49% of passengers were satisfied with their mobile reception, while 32% were not. • 40% were satisfied with their data coverage, while 42% were not.
8	*Nonlinearities in Discrete Choice Attribute Valuations*, by Nigel Tapley, Mark Wardman and Gerald Whelan, published by the Institute for Transport Studies, University of Leeds	This study looks to establish the extent of nonlinearities in the valuations of a range of travel time and cost attributes.
9	*Adults' Media Use and Attitudes Report, 2014*, published by Ofcom, April 2014	This study on media use, attitudes and understanding among UK adults aged 16+ finds that: • More UK adults, especially older adults, are now going online, using a range of devices. • The range of mobile activities has increased, particularly across communication and entertainment activities, and particularly among 25-34s and 45-54s.
10	*Mobile Phone Usage: Attitude towards mobile phone functions including reception*, published by Ofcom, January 2013	This 2013 study finds that: • The two most common uses of a mobile phone are voice calling and text messaging. • Among those who use mobile data, using the internet on a mobile phone is the most commonly used function. • The ability to make or receive texts is the most important aspect of mobile phone reception. • The most important place for users to be able to access the internet on their mobile is outdoors around places they go regularly. • Regular rail users are more likely to include a higher proportion of younger people compared to the overall population, who are more likely than older people to use their phones to access the internet.
11	*The highest average per-capita mobile data use among our comparator countries was Sweden in 2013*, published by Ofcom	Average mobile data use in the UK in 2013 was 251MB per person per month. This had increased by 68% between 2008 and 2013.
12	*Techie teens shaping communications,* published by Ofcom, 6 August 2014	A summary of some key findings from Ofcom's Communications Markets Report. Findings include: • 12-15 year-olds spend only 3% of their communications time on voice calls; the vast majority (94%) is text-based – instant messaging or social networking. • In contrast, 20% of adults' communications time is spent talking on the phone. • The average adult now spends more time using media or communications than they do sleeping. • 44% of households now own a tablet device, and smartphone take-up continues to increase rapidly.

13	*Technology Tracker – Main Set – Wave 2 2014, 12 May to 26th July 2014*, published by Ofcom	A full set of data tables setting out technology use in the UK, broken down into different segments. Can give figures on: • Network operator • Smartphone owners • What phones are used for • Laptop/tablet use outside the home • 3G/4G use • Wi-Fi voice calling use
14	*Internet Access – Households and Individuals 2014*, published by Office for National Statistics	This statistical bulletin from the ONS shows that access to the internet using a mobile phone more than doubled between 2010 and 2014, from 24% to 58%. In 2014, 68% of adults had used portable devices to access the internet away from home or work over the last 3 months.
15	*Estimating the value of mobile telephony in mobile network not-spots*, by Hui Lu, Charlene Rohr, Peter Burge, Alison Grant, published by RAND Europe	A study of the value people living in mobile phone 'not-spots' – areas without mobile reception – place on mobile telephony. Key findings include: • People who live and work in, and travel to, not-spot areas are willing to pay for the provision of mobile services. • The potential visual impact of additional mobile phone masts was not a major concern for residents in 'non-spot' areas.
16	*Five major European traveller tech trends – think devices*, published by Tnooz.com, August 2015	This is an online article exploring trends in booking travel using mobile and tablet devices. Tablet ownership peaks among the 35-44 year-old leisure travellers in the UK, at 55%.

D UWE literature review

University of the West of England
BRISTOL

Literature Review informing -

'On Train Mobile Connectivity Benefits'

The Centre for Transport & Society
University of the West of England, Bristol

7 September 2015

Centre for Transport & Society

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CONTENTS

1 Introduction

The Department of Transport are investigating how on train mobile connectivity is valued by rail passengers, and what the future trajectory of such services should be. This report has been prepared by the Centre for Transport and Society to inform the development of Steer Davies Gleave's research that aims to quantify the benefits of on train mobile connectivity for the Department for Transport. The focus of the research is on the value of a mobile phone signal and Wi-Fi connection on board trains in Great Britain.

The aim of this report is to provide insights into the needs and desires for mobile connectivity on board trains from current research. The report sets out some context to current trends in mobile ICT use from Ofcom, as well as examining existing international and national research that demonstrates how people are using their travel time on board public transport, with specific reference to mobile technologies, and what types of technologies are being used. It considers recent international research examining the impact of mobile connectivity (e.g. Wi-Fi provision) on passengers, and their willingness-to-pay.

The Centre for Transport and Society (CTS) has been at the forefront of 'travel time use' research, with specific reference to the use of information and communication technologies. The report is able to report some relevant details from data collected through National Rail Passenger Survey 2004, 2010, and 2014 from questions designed as part of the original ESPRC funded research project[1] on this topic (see also Lyons *et al.* 2007, 2013). Data collection and analysis of the travel time use questions in 2010 and 2014 has been funded by Transport Focus and the University of the West of England, Bristol. At the time of writing this report CTS are in the early stages of analysing the three datasets, which has enabled some preliminary interpretation of summary data to be included in this report. It should be understood that interpretation of these data sets may change in future publications by CTS once a full analysis has been undertaken.

The report's conclusions purposefully direct Steer Davies Gleave to issues to consider in the design of the stated preference survey and associated qualitative research.

[1] The EPSRC project 'Travel Time Use in the Information Age' was a collaboration between the Centre for Transport and Society (UWE Bristol), and Lancaster University (see http://sand14.com/archive/traveltimeuse/index.html). The questions were updated by Professor Glenn Lyons and Dr Juliet Jain at the Centre for Transport and Society, UWE Bristol as a further collaboration with Transport Focus for the autumn 2010 and 2014 survey waves, with research time funded by the UWE.

2 Current UK trends in mobile technology and internet use

2.1 Introduction

Predicting future demand for on board connectivity is linked to wider trends of technological change and uptake of new communication services. Ofcom research reports[2] give industry wide insights into user trends across the UK, relating to existing communication networks. It is important to recognise from Ofcom's research that 4G will have an impact on future demand for mobile connectivity and Wi-Fi. This section summarises some of the relevant insights from Ofcom's recent research reports.

2.2 Trends from Ofcom

The internet has become an incredibly popular and important resource in modern UK society. Ofcom (2015a) shows that nine out of ten adults go online, and on average, people are spending 20 hours per week on the internet. Since 2005 there has been a 27% rise in the proportion of people who go online, and the number of hours people go online in an average week has doubled.

How and when people use the internet is also changing. Current UK communications data show that more adults than ever are using the internet away from 'traditional' fixed locations, with 69% of respondents reporting using the internet outside of the home which is a response to technology change and infrastructure provision (Ibid). Flexibility has been made possible by the advent of more user-friendly mobile internet on smartphones and tablets, and facilitated by mobile data and Wi-Fi hotspots. 51% of adults now use a smartphone to go online outside of the home. The use of tablet computers to access the internet rose from 30% to 39% over the period 2013-14 (Ibid).

Thus, Ofcom (2015b) report that the UK has now become a 'smartphone society'. Smartphones have become the device which internet users report being the most important for them in connecting to the internet (33% of those questioned); previously laptop computers were the most important. In addition, smartphones are also 'the most widely-owned internet-enabled device' accounting for 66% of all internet users (Ibid, pp. 6).

People are using their mobile devices for a range of different purposes. The most commonly reported of these relate to communication. Data from 2015 shows that 72% of the time people spend on their smartphones is dedicated to communication – text messages, emails, instant messages, calls, and social media (Ibid). It is evident that whereas before, communication on mobile phones relied solely on mobile phone signal (for texts and calls), communication increasingly now relies on a mobile internet connection – with emailing, instant messaging, and social media all requiring mobile internet connectivity. Indeed, emailing has been found to be the most popular of all forms of communication on smartphones, with 81% of users reporting this (Ibid).

This shift towards smartphone use is significant as it demonstrates the potential of current internet use to be consumed at any time in multiple locations, including on the move, providing that connection is possible through network coverage or Wi-Fi provision.

The more recent availability of high-speed mobile internet coverage through 4G networks is further changing the ways in which people access the internet on-the-move. Ofcom (2015b) report that 30% of adults now have access to high-speed 4G mobile internet. This represents 45% of smartphone users, and is an increase of 28% over the period 2014-15 alone. Users with access to 4G have different online behaviours to those with a slower mobile internet connection. Smartphone users with 4G access are more likely to use mobile internet than those without. In addition, those with 4G access are more likely to use audio-visual content, make online purchases, and use online banking. Over 25% of 4G users say they access audio-visual content more often than they did before they had access to the service. These

[2] See http://stakeholders.ofcom.org.uk/market-data-research/

findings demonstrate that a high-speed mobile internet connection facilitates a broader range of online activities for people, and that people will use it if it is available.

2.3 Summary

Ofcom's research indicates the rapidly accelerating pace of technological change in relation to mobile internet use. The trends point toward greater numbers of people using mobile internet on-the-go, and suggest that demand is rising. The availability of mobile internet is enabling people to communicate through email, instant messaging, and social media outside of the home or the office, and as mobile internet speeds increase, users are engaging in a broader range of activities than ever before. Thus, any shift from voice and text on the move, to email and social networking may impact on expectations of types and quality of mobile connectivity in multiple locations. In the future mobile coverage may have more value to individual users than access to Wi-Fi.

The following sections consider these trends in mobile internet use in the context of how people use their time on public transport and the types of devices they are using. However, rapid changes in technology and the growth of ownership in tablet computers suggested by the Ofcom research above indicates the dynamic nature of potential travel time use in relation to emergent technologies.

3 Context of Travel Time Use and Technology

3.1 Introduction

How travel time is used, especially on public transport, has received a great deal of attention over the past 10-15 years. There has been a steadily growing interest among transport academics, operators, and authorities in people's use of time on the move and the *value* of this time.

Travel time on the train has been found to be valuable to passengers in a number of ways. The main way in which the value of travel-time has been articulated is through the opportunity it provides for *economic utility* – i.e. a passenger's time on a train can be spent doing work-related activities (Lyons & Urry, 2005; Mokhtarian, 2005; Holley et al., 2008; Lyons et al., 2007; Ohmori & Harata, 2008). Translating the positivity utility of travel time use into appraisal debates is not examined in this report as it is out of scope of the project. Instead the underlying principle that time may have value is focused on individual travellers' perspectives, expectations and desires for using their time, whether for work or personal tasks, so that the potential value of on train mobile connectivity can be assessed more accurately. Thus the consideration of travel-time from a more subjective *experiential* perspective is important here.

Several studies have focussed on the experience of the journey in relation to passengers' use of time, and the role of mobile technology, demonstrates that individuals perceive the value of travel time in a variety of ways, which may depend on the trip purpose and mode, but also on the context of other activities in the individuals' lives (Jain and Lyons, 2008; Holley *et al.*, 2008; Gripsrud and Hjorthol, 2012). The discussion below specifically explores the importance of technology in the context of travel time use and individual values of travel time.

3.2 Mobile technology use during travel

Personal Information and Communication Technologies (ICT) devices have become a ubiquitous sight in the spaces of public transport, and most rail operators have responded by considering ways to improve mobile connectivity, incorporating passenger power supplies and providing Wi-Fi on long distance services, while similar offerings on suburban and rural rail links are much more limited[3]. In line with the trends shown by Ofcom above, initially it was laptop computers and mobile phones that expanded passengers' opportunity to work and communicate on-the-move; more recently it has been smartphones and tablet computers which have extended this ability much further, providing advanced mobile internet connectivity through mobile data networks and Wi-Fi hotspots (Line at al., 2011).

There are a number of case-studies examining Wi-Fi provision on public transport, that incorporate a range of funding mechanisms and partnerships, and are driven by different purposes; for example:

- First Great Western has begun providing free on-board Wi-Fi on its High Speed Train fleet and Night Riviera Sleeper service. A part of the rationale for this is that, "research from First Great Western has found that time spent working on First Great Western services contributes an estimated £150million each year to businesses across South West England and London": https://www.firstgreatwestern.co.uk/about-us/media-centre/2015/march/time-spent-working-on-train-contributes-millions-to-uk-businesses
- Oxford City Council used funding from the Department of Culture, Media, and Sport to install free Wi-Fi on all Oxford buses operated by the Oxford Bus Company and Stagecoach. The scheme – a part of the Super Connected Oxford programme – launched in November 2014, and initial reports suggest use is steadily increasing: http://www.oxford.gov.uk/PageRender/decB/Wi-FionPublicTransport.htm

[3] For the full list of Wi-Fi availability, and associated charges, by train operator see http://www.nationalrail.co.uk/stations_destinations/44866.aspx

- As a part of the London 2012 Olympics, Virgin Media provided free Wi-Fi across the London underground. Currently this service is provided at 150 stations, therefore does not provide a continuous service to passengers on board trains. It is only free for customers of a number of main mobile providers, and users of other networks need to pay: https://tfl.gov.uk/campaign/station-wifi
- Transport for London has begun a small-scale trial of free Wi-Fi on two London bus routes: https://tfl.gov.uk/info-for/media/press-releases/2014/august/tfl-to-trial-new-bus-technology
- Amtrak California launched a free Wi-Fi service on their trains serving the California Capitol Corridor, which research by Dong *et al.* (2015) suggests has a positive impact on passengers, especially new passengers..

These case studies illustrate the assumption that Wi-Fi in particular is thought to encourage patronage of the service, as well as enhance the travel experience. Notably FGW indicates how this increases the opportunity to work, linking back to the value of travel time for business.

Existing studies into the use of mobile technology and the importance of mobile connectivity on public transport provide a context for why having greater mobile connectivity may be important, although it does not indicate the best way in which this should be delivered. Further evidence from commercial operations, such as those above, would be required to evaluate the costs and benefits to the operator/network supplier have been. However, the main conclusions from these studies provide relevant insights into how improved mobile connectivity might affect passenger patronage and the broader customer experience:

3.2.1 Trends in mobile technology use on public transport

Mobile technology use during travel time on public transport is increasing. The key mobile devices driving this trend in recent years are smartphones and tablet computers. These devices make use of mobile internet and Wi-Fi, and some models can also act as Wi-Fi hotspots for other devices such as laptop computers.

i. Research into the UK Rail Passenger Survey by Lyons *et al.* (2007; 2008; 2013), using one of the largest samples of rail passengers, demonstrates that the use of mobile devices and engagement in 'technology-dependent' activity (making calls/texts, browsing the internet, checking emails, accessing social media) have increased between 2004-2010. Further discussion of this research in relation to 2014 data is presented in section 4.

ii. Gripsrud and Hjorthol (2012) demonstrated that by 2008 ICTs had a significant impact on how travel time was valued by commuters and business rail travellers in Norway with "nearly half of the commuters and a little more than one-third of business travellers say[ing] that having access to the Internet on board is important" (2012, p. 951).

iii. Hislop and Axtell (2015) note that business travellers are more likely to use laptop computers than of mobile phones on trains, and suggest this may be due to the unreliability of mobile network coverage during the journey.

iv. Mobile phone use on suburban trains in Melbourne was also researched by Berry and Hamilton (2010), with the under 40s reporting the highest frequency of use. They note a wide range of activities undertaken on mobile phones including calls, texts, surfing the internet, playing games, and taking photos/videos reported.

v. Research by Schwieterman *et al.* (2013) has demonstrated the large increases in personal technology use on intercity buses, planes, and trains in the US. Over the period 2012-2013, mobile technology use grew by: 28.6% on conventional buses, 25.0% on commuter trains, 24.1% on airlines, 18.0% on intercity trains, and 5.2% on discount bus services (Megabus, etc.).

vi. A number of other studies cite high levels of mobile technology use during travel on public transport. For example, Frei *et al.* (2015) report 66.7% of passengers surveyed using a mobile phone or PDA, and 40.8% using an audio/visual device. Guo *et al.* (2015) report 26.9% of passengers using a smartphone during local bus journeys. Clayton (2012) found that 52.7% of bus passengers were using mobile phones during their journeys. Gripsrud & Hjorthol (2012) report that 58% of business travellers and 56% of commuters used their mobile phones on the train, whilst 25% of both commuters and business passengers used a laptop computer. Ettema *et al.* (2012) found that between 14.5% and 24.1% of public transport commuters were using ICTs. Russell *et al.* (2011) recorded 27.2% of bus passengers and 39.6% of train passengers using ICTs during their journeys.

3.2.2 Wi-Fi as an opportunity

There is latent demand for mobile internet access during travel.

i. Connolly *et al.* (2009) noted that at the time of their study, approximately two thirds of respondents to a survey of rail passengers in Ireland would have used Wi-Fi access once or more per week if it were available on the train.

ii. Susilo *et al.* (2012) conducted an analysis of rail passengers' assessment of their travel-time use, and found that mobile connectivity-dependent activities such as internet browsing, accessing social media, and checking emails all had a positive impact on passengers appreciation of their time use, suggesting that these are popular activities which passengers have a desire to engage in when possible – which is contingent on the availability of an internet connection. (This was based on a re-analysis of NRPS.)

iii. Gripsrud and Hjorthol (2012) conducted a study of commuters and business travellers on rail services in Norway They found that 31% of business travellers and 36% of commuters reported the technical facilities (including the availability of a network connection) necessary to make use of ICTs during travel were inadequate, and that this was a barrier to engagement in technology-dependent work activities during travel.

3.2.3 Impact of Wi-Fi on modal choice

Travel-time use (and increasingly the availability of mobile connectivity) is a popular reason people choose to use a mode.

i. Frei *et al.* (2015) have explored this issue, and in a study into the use of train passengers in Chicago, US, found that the opportunity to make use of travel time was one of the main factors that people reported when asked why they had chosen public transport over driving.

ii. 45.7% of US bus users said that Wi-Fi availability was an important factor in making travel plans (Fischer and Schwieterman, 2011).

iii. The availability of Wi-Fi has been cited as one of the contributing factors to a 32% increase in the use of public intercity buses in the US during 2011 (figures from combined infographic incorporating data from: US Census Bureau, American Public Transportation Association, and the U.S. News and World Report: http://visual.ly/bus-Wi-Fi-and-changing-face-public-transportation).

iv. Dong *et al.* (2015) investigated the availability of free Wi-Fi in relation to US rail passengers' trip frequencies on California's Capitol Corridor route. Their study identified a significant positive association between trip frequency and free Wi-Fi availability. The authors note that this effect is limited in magnitude, with free Wi-Fi provision accounting for a 2.7% increase in the number of trips the sample expected to make. However, they go on to explain that the finding "still constitutes an example of how ICT can facilitate and generate travel" (Ibid, p. 140).

3.2.4 Impact on journey experience

Using mobile devices can sometimes have a positive impact on journey experience. A number of studies have shown positive associations between travel-time use and public transport passengers' experience of their journeys.

i. The classic conceptualisation of the positive value of travel time is through the opportunity it provides for economic utility – i.e. work. A large number of studies have explored travel-time from this perspective, and there has been a particular focus on the experiences and needs of business passengers (e.g. Holley *et al.*, 2008; Axtell *et al.*, 2008; Gripsrud and

Hjorthol, 2012; Lyons, 2013; Hislop and Axtell, 2015). Improvements in mobile technology are changing possibilities (and consequently expectations) surrounding certain types of work – particularly knowledge work. It is now increasingly possible to engage in a broad range of work-related activities on the move, and when the traveller is equipped the right mobile technology the spaces of public transport can be transformed into a mobile office. Mobile connectivity is important in facilitating work during travel, and a poor internet connection can severely restrict the range of work-related tasks possible on-the-move (Axtell et al, 2008). However, there are aspects about the train environment that can impact on the use of technology and the ability to undertake work such as vibration, noise, spatial restrictions and climate control that go beyond the immediate issue of mobile connectivity (Lyons et al., 2008; Gripsrud and Hjorthol, 2012; Hislop and Axtell, 2015).

ii. Positive aspects of travel-time have also been explored from a more subjective perspective – with a focus on the passengers themselves. In many cases travel-time provides a number of broader subjective benefits to the traveller beyond providing an opportunity to be economically productive. Travel-time can be used as 'time-out', which is often articulated as a valuable piece of free time in between hectic work and home schedules (e.g. Jain and Lyons, 2008; Clayton, 2012). This down-time has been shown to have positive impact on passengers' health and well-being more generally (Russell, 2012). Travel-time can also be used as 'time-for' personally productive tasks (Jain & Lyons, 2008). Passengers often value this time as a chance to catch up on home admin or other things which they might not have found the time for otherwise (Clayton, 2012).

iii. Travel time as time to socialise has changed. Talking to other passengers on the train or bus is in decline while mobile ICTs enable socialising through social media, emails, instant messaging, and also phone calls and text messages (Clayton, 2012). The increasing number of personal calls on mobile phones during the rail journey, identified by *Lyons et al.* (2013), demonstrates the desires of passengers to be connected during their journeys not just for work purposes.

3.2.5 Travel time in a hierarchy of needs

The use of mobile devices does not constitute a good experience in-and-of-itself. Other factors (punctuality, frequency, space, etc.) must be taken into consideration if the positive benefits of travel-time activity are to be realised. Travel time use may be a way of mitigating a bad, mediocre or routine travel experience.

i. A study into the journey experience of bus passengers in Bristol by Clayton (2012) demonstrated that whilst mobile technologies can often be beneficial to the traveller in allowing them to conduct an expanded range of activity, at the same time their use is not a *guarantee* of a positive journey experience. First, travel-time activity has been found to sit relatively low down within a hierarchy of factors which are important in influencing journey experience. Punctuality, reliability, sociality, and passenger demographics were all found to be more significant than travel-time activity. Second, passengers often use mobile technologies such as music players and smartphones simply to try and distract themselves from what they perceive as a negative experience – be this the aural or visual intrusion of other passengers into personal space, or the boredom often encountered in routine journeys.

ii. Camacho *et al.* (2012) have discussed a similar conclusion in their study into pervasive technology and public transport. Focussing on the passenger experience of travel in relation to the use of technology during travel, the study found that whilst technology has an increasingly important role to play, nonetheless the basic service factors are of primary importance, where technology use is of secondary importance.

3.2.6 Willingness to pay for Wi-Fi

There are a number of sources which focus on passengers' willingness-to-pay for free Wi-Fi, and these return mixed findings.

i. Connolly *et al.* (2009) used a stated preference survey to explore rail passengers' willingness-to-pay for Wi-Fi in different scenarios on the train. Their study found that passengers were willing to pay more for Wi-Fi that was provided within a designated Wi-

Fi coach on the trains, and less for Wi-Fi that was provided generally throughout the entire train. This study was conducted before the advent of smartphones and widespread mobile internet, and focussed on the provision of Wi-Fi for the use of laptop computers. The rapid technological shifts in mobile devices since the time of this study makes the idea of having a single Wi-Fi zone within a train seem a little dated considering that large proportions of travellers now have the opportunity to go online with their handheld devices. This further emphasises the pace of technological change, and the importance of understanding future trends when planning the provision of new infrastructure for passengers.

ii. An article discussing the provision of mobile connectivity on public transport has identified a number of challenges in monetising on-board Wi-Fi. Where operators or authorities have sought to charge passengers for their mobile internet use, it has been necessary to provide a consistent and high-speed connection to maintain customer satisfaction. Another scenario would be a hybrid model, which would offer free Wi-Fi for a limited amount of time, and charge once passengers had reached that limit (http://www.zdnet.com/article/wi-fi-on-public-transport-faces-access-monetization-road-bumps/).

iii. A number of other articles have explored the provision of free Wi-Fi on existing services – often focussing on specific trials, such as that on buses on Oxford, UK (http://www.oxford.gov.uk/PageRender/decB/Wi-FionPublicTransport.htm), Transport for London's trial of free Wi-Fi on buses (http://www.independent.co.uk/life-style/gadgets-and-tech/transport-for-london-trials-free-Wi-Fi-on-buses-9653244.html), and First Great Western's provision on their train fleet in the southwest UK (https://www.firstgreatwestern.co.uk/about-us/media-centre/2015/march/time-spent-working-on-train-contributes-millions-to-uk-businesses).

3.2.7 Segmentation and mobile technology use

Different groups of passengers are using mobile technology differently. There is a strong case for a segmentation of different users to better understand the needs of particular groups, and the ways in which different types of technology use might impact on other passengers.

i. **Journey purpose:** There has been an assumption that journey purpose is likely to impact on what people do on the train and how the time might be valued that is implicit in the work by Lyons *et al.* (2007, 2013), as data has been disaggregated by business, commuter, leisure. Grisprud and Hjorthol (2012) note that the differences between commuting passengers' and business passengers' evaluations of their use of travel-time use is small, with many undertaking similar activities (i.e. work related)**.**

ii. **Journey duration:** Journey duration was identified as having an impact on the types of activities undertaken by rail passengers by Lyons *et al.* (2007). They note that it is "surprising that the use of mobile information and communication technologies (ICTs), such as phones and PDAs, is not more important during short journeys" (2007:112), and that nearly a third of people on the shortest journeys spend their time looking out of the window/people watching. Similarly, Susilo *et al.* (2012) using 2010 NRPS data identify journey duration as an important factor in directing travel-time use. In this study, activities such as working/studying increased as journey lengths increased, and there was a concurrent increase in the opportunity for multitasking. Hislop and Axtel (2015) also indicate that time constraints can affect activity choice on the move. Connolly *et al.* (2009) have identified a longer journey duration as a significant factor in determining the benefit from a Wi-Fi connection. There is some evidence however that developments in mobile technology could change this pattern on trains. New mobile devices such as smartphones allow for activity even on short journeys. Passengers no longer need the time and space to 'unpack' (for example a laptop) to go online. Clayton's (2012) study into bus passengers found that the bus is a very 'technologically active' space, despite generally only representing short (10-20 minute) journeys. At the time of the data collection in 2011, 52.7% of passengers were using their mobile phone, with 21.3% accessing the internet, and 16.4% using social media, which was also linked to the age of passengers.

iii. **Age:** Clayton (2012), Ettema *et al.* (2012), and Frei *et al.* (2015) have all identified the importance of age as a factor in public transport passengers' use of travel-time, and in particular their engagement with mobile technologies. Younger passengers were significantly more likely to use the internet and mobile ICTs during travel, and also more likely to multi-task during a journey, conducting a number of different activities for a short amount of time before moving on to something else. Older passengers were more likely to engage in lower-tech activity such as window-gazing, reading, and chatting to other passengers. Interestingly however, it was the older, "less-active" passengers who reported a more positive journey experience, with younger passengers reporting greater levels of boredom and stress (Clayton, 2012).

iv. **Gender:** A number of studies have identified gender differences in people's use of travel-time and mobile technologies. Frei *et al.* (2015) found a difference between men and women in terms of the types of activity/item they were likely to engage in during travel. Generally, women were more likely to be using printed materials during travel-time, whilst men were more likely to be using a mobile phone or PDA, although it's worth noting that high proportions of people of both genders fell into both of these categories. Lyons *et al*. (2013) identified a similar disparity by gender: men were more likely to be working/studying, using a mobile phone for work, checking emails, playing games, and internet browsing, whilst women were more likely to be using a mobile phone for personal business and chatting to other passengers. Again in this study the authors noted gender differences were marginal, and suggested this finding "may be linked to employment structures, as well as social trends in technology ownership and use" (Ibid, p. 569). In relation to this point, Connolly *et al.* (2009) found that men were more likely to derive a benefit from accessing Wi-Fi during travel than women, however it is likely that this finding is influenced by extant gender imbalances in particular sectors of employment too.

3.2.8 Technology trajectories

Mobile Wi-Fi may *already be obsolete* in the face of the popularity of smartphones and tablet computers, which can make use of improvements to high-speed mobile internet (3G/4G) coverage and speed. This has not been explored yet in the academic literature, however there are examples of articles in the grey literature which discuss this possibility, and it is worth considering this point when exploring the best routes via which to deliver mobile internet to travellers.

i. An article focussing on bus services in the US back in 2011 claimed that for urban passengers, mobile internet coverage was sufficient, and that both Wi-Fi use and provision was actually in decline, with one public transport operator instead entering into agreements with mobile phone companies to improve mobile data coverage over their network. See: http://www.geekwire.com/2011/smartphones-killed-Wi-Fi-public-transportation/

3.3 Summary

In summary, there is a range of evidence demonstrating an increasing use of ICTs in the course of travelling on public transport, especially travelling by rail. Mobile connectivity and the ability to connect by Wi-Fi has become more of an expectation of travel, especially when conducting work on many routes in the UK and internationally. The quality of mobile connectivity and Wi-Fi remains important to have value for business travellers, and commuters, although research has not yet specifically looked at the needs of leisure travellers and related leisure/social activities. However, the quality of such on board connections needs to be reliable to be used and have value. Finally, there are other instrumental factors about the journey that need to be in place first (e.g. having a seat, quiet, etc.) before on board activities can be undertaken. The next section looks more specifically at the proportions of travellers undertaking activities that are technologically mediated in Great Britain.

4 Insights from the National Rail Passenger Survey

4.1 Introduction

The introduction to this report indicated that since 2004, Lyons *et al.* (2007, 2013) have been researching travel-time use by rail passengers in the UK. Their study has included a set of questions in three of the Rail Passenger Surveys (NRPS – conducted bi-annually by Transport Focus), with the aim of being able to understand what people are doing with their travel-time, what they use, and how they value of their travel time. The study has collected data through the autumn waves of the NRPS in 2004, 2010, and 2014, each of which has a sample size of around 25,000[4].

The most recent paper published from this research (2013) explains how travel-time use changed between 2004 and 2010; the relevant findings from this were:

- Levels of engagement in 'traditional' (non-technology-dependent) activities has been relatively stable from 2004-2010: reading for leisure, window-gazing/people watching, working/studying, sleeping/snoozing, and eating/drinking[5].
- Levels of engagement in technology-dependent activities all increased over the period 2004-2010: text messages/phone calls, listening to music/radio/podcast
- Some passengers are actively seeking to make their travel-time worthwhile, and mobile technology and connectivity is expanding opportunities for such 'worthwhile' activity
- Travel time use and how travel time is valued are changing over time. The continued advancement of the functionality of mobile ICTs is likely to mean that it changes more rapidly and fundamentally in the years ahead
- Increasing capacity and opportunity for mobile technology, and supporting this time use, may improve the prospects of rail travel.

Following the 2013 paper, the 2014 survey data has been made available by Transport Focus to the CTS research team and who are currently in early stages of analysis. The third data set provides additional insight into the way in which travel time activity on the train is changing over time – particularly in relation to the recent growth in ownership of new mobile technologies which were only just becoming popular at the time of the previous 2010 survey.

The following sections present some descriptive data from these surveys that inform the potential value for on train mobile connectivity. Therefore it focuses on technologies, and activities that are technologically mediated. Interpretation of this data is preliminary, and future publication from the full datasets may have different outcomes.

4.2 Use of travel-time on trains

The NRPS provides an indication of how rail passengers are using their time during the journey; however, it is limited as to the detail it can show. It does not quantify how much time is spent on each activity and which activities are concurrent. Therefore the data presented in this section relates to activities that have been undertaken for *some* of the journey time.

Table 1 compares data on travel-time use from three previous Rail Passenger Surveys – in 2004, 2010, and 2014. For clarity, only activities related to the use of mobile ICTs or mobile connectivity have been included. In table 2 the 2014 results have been disaggregated by journey purpose, i.e., business travellers, commuters, and leisure travellers.

The most consistent finding in each of the tables is that levels of engagement in all activities which require the use of mobile ICTs have increased since they were first measured. Such an

[4] http://www.transportfocus.org.uk/research/publications/national-rail-passenger-survey-methodology

[5] Lyons et al., (2013) demonstrate that window gazing/people watching and reading for leisure are the most common activities undertaken.

increase has been noted by other research such as Gripsrud and Hjorthol (2012), and Schwieterman et al. (2013).

Table 1 - Activities people doing some of the time, 2004-2014 (all passengers/%)?

	2004	2010	2014	% +/- 2004-2014	% +/- 2010-2014
Text/phone (work)	8.2	14.4	12.8	56.1	-11.1
Text/phone (personal)	18.7	28.6	27.6	47.6	-3.5
Checking emails		16.1	25.1	N/A	55.9
Internet browsing		10.0	18.0	*N/A*	80.0
Accessing social media		5.8	12.2	*N/A*	110.3

Amongst all passengers, making phone calls/texts for both personal and work purposes all increased over the period 2004-2014, but peaked in 2010, suggesting there has been a slight decrease in their occurrence over the period 2010-2014. This trend may be due to issues around mobile connectivity, which is suggested by other research (e.g. Axtell and Hislop, 2008), but further research would be required to confirm such a hypothesis.

In contrast to this, checking emails, internet browsing, and accessing social media have all increased over the period 2010-2014. These are all activities which require the use of a mobile internet connection, demonstrating the current importance of this resource to an increasing proportion of passengers. Passenger may be using on board Wi-Fi or utilizing personal mobile data connections.

These findings suggest that passengers' use of ICTs and mobile connectivity is evolving as the functionality of their devices develops. As mobile devices such as smartphones have made internet access more user-friendly, and mobile internet connections have become faster and more reliable (be this through Wi-Fi or 3G/4G), people's usage patterns have changed. Other comparative data is not recent enough capture this technological change.

This is particularly relevant in relation to virtual communication. At this point of the analysis the data suggests there has been a shift away from people making calls and text messages towards people using social media and emailing. The latter activities are only possible through a mobile internet connection, and balance between phoning and emailing for instance may be an outcome of personal preference, issues around space and privacy, and/or the reliability of mobile or internet connection.

Table 2 – Activities people are doing some of the time, 2014; disaggregation by journey purpose (%)

	Business	Commuting	Leisure
Text/phone (work)	30.1	15.0	3.5
Text/phone (personal)	24.8	30.5	25.4
Checking emails	41.4	30.4	12.9
Internet browsing	17.0	23.1	12.5
Accessing social media	9.7	15.5	9.3

Table 2 compares activities by journey purpose. It demonstrates that Business travellers are much more reliant on mobile phone and internet connectivity while travelling in terms of making calls and checking emails than other groups of passengers. However, there are commuters who are undertaking some work calls while travelling to/from work. Gripsrud and Hjorthol (2012) indicate a higher level of commuters and business travellers using technology and the internet than reported by Lyons et al 2007, and note in their sample of Norwegian travellers' similar activities performed by these two groups. Hislop and Axtel (2015) report that from a survey of 350 business travellers on the train, 25% frequently use their mobile phone for business calls when travelling by train, and 29% some of the time, suggesting a higher figure than reported in the NRPS. This variation may indicate issues with recall and the focus of the questionnaire in terms of reporting.

While the table above might suggest that commuters are working while travelling, i.e. checking emails, interpretation needs to be more cautious as they may well be undertaking personal business or social communication. However, from the perspective of the value of mobile connectivity, it may be that commuters may value accessing the internet (by whatever mechanism) for social and personal reasons, as much as for work. It therefore seems a relevant question for this project to investigate further values of on train connectivity to all passengers, not just business travellers, and why.

4.3 Use of mobile technology on trains

Table 3 and Table 4 present data related to passengers' use of different ICT devices during travel. As with the data from the previous section, only the results related to mobile technology are included here.

Table 3 - What mobile devices are people using 2004-2014 (all passengers/%)?

	2004	2010	2014[4]	% +/- 2004-2014	% +/- 2010-2014
Laptop computer	2.0	3.2	3.8	90.0	18.8
Mobile phone (calls and texts)	23.9	35.2	26.9	12.6	-23.6
Smartphone			26.5	*N/A*	*N/A*
MP3 player	6.3	11.7	5.6	-11.1	-52.1
eBook reader/tablet		1.2	8.1	*N/A*	575.0

The results from the three surveys provide sufficient data to see indications of trends within technology-related activities. The data suggests that there have been two 'waves' of ICT use on the train. The first of these was mobile phones and personal music players, which saw increases in use between the 2004-2010 surveys, but which have declined in use between the 2010 and 2014 surveys. The explanation for this appears to be that they have been supplanted by the 'second wave' of mobile ICTs – smartphones and tablet computers noted by the Ofcom research presented earlier. These devices are able to perform the functionality of both mobile phones and portable music players, in addition to having more advanced mobile internet connectivity. This marks these newer devices out as distinct in terms of their functionality and the activities they make possible for the traveller. The increase in their use is accompanied by the aforementioned increase in internet browsing and social media use.

In contrast the use of laptop computers has remained constant, and the proportions of passengers using these have been low but steadily increasing over the period 2004-2014. This can be explained by these devices offering broad functionality – particularly for undertaking work tasks, and indeed it is clear that laptop use was highest amongst business travellers in all three of the surveys. However, it should be noted that the size of the proportional increase between 2010 and 2014 was considerably smaller than that between 2004 and 2010, whilst eBook reader/tablet computer use increased dramatically from 2010 to 2014. This might suggest that these devices are supplanting laptop computers as tablets' functionality improves to match that of laptops, the amalgamation of these two quite distinct devices in one category is problematic for interpretation of any trend.

This point of how to categorise technology is an issue for survey design. Earlier discussion has highlighted how tablet computers are becoming more popular, and the results from the 2014 NRPS survey appear to confirm this trend. However, the decision to combine eBooks with tablet computers has meant that it is not possible to say with certainty that this is the case. The issue is largely one of technological evolution. It is evident that the survey design has been based around the earlier models of tablet computers, which were more similar in form to eBooks; the development of tablet computers in subsequent years from this initial niche into distinct mainstream pieces of mobile technology was not predicted. Care should be given to question design surrounding both mobile technology devices and the activities they facilitate, to ensure as far as possible that a survey remains relevant in the face of future developments in mobile technology.

Table 4 - What mobile devices are people using (2014)? Disaggregation by journey purpose (%)

	Business	Commuting	Leisure
Laptop computer	11.1	3.4	1.5
Mobile phone (calls and texts)	33.9	28.2	22.7
Smartphone	33.9	30.6	18.9
MP3 player	4.4	7.5	4.0
eBook reader/tablet	9.5	9.7	5.6

While laptop computers are used more by business travellers, there is not much to distinguish between business travellers and commuters in terms of their mobile technology use. Only slightly higher proportions of business travellers are using mobile phones and smartphones than commuters, and more commuters are using eBooks/tablets that business travellers.

4.4 Summary

Analysis of the questions connecting travel time use and technology use on the NRPS demonstrate the importance of ICT use across all passenger types in terms of journey purpose, although these appear to be more important to commuters and business travellers. The data also shows that devices and activities needing a connection to the internet are increasing. What is not shown in this data is the actual time spent using devices, and the functional purpose of these activities (e.g. work, leisure, idling time, etc). The individual value attached to these types of activities may be as important for commuters as the business value for activities undertaken for work on work related trips. However, for all travellers there may be some blurring between work and non-work time and types of activities undertaken. Future research for understanding the willingness-to-pay for services will need to unpick some of these issues, as is suggested in the next section.

5 Conclusions

The review indicates that the use of technology on trains is changing, but this may not be solely for the domain of work, as many technologies enable multiple forms of social interaction. Rail passengers are using different forms of connectivity while travelling for a range of activities and through a number of different devices. The boundaries between work and non-work time and activities are likely to be blurred in the use of travel time across journey purposes, but especially for commuters and business travellers. On board Wi-Fi has potential to enable work requiring internet connectivity, as well as personal and social communication, to occur in the course of travelling. Providing free Wi-Fi may increase the attractiveness of rail travel across journey purpose. However, there is a knowledge gap in the current literature in terms of who should pay for different types of mobile connectivity, and customers' expectations of types of provision. The advent of 4G may change the needs and expectations of on board Wi-Fi for many passengers in the future, and focus more on geographic network coverage.

What is important for the research on the future of mobile connectivity is to unpick some of the different factors that might be driving levels of technology use on the train. To this end, a number of questions to prompt thinking about the survey design are presented below.

5.1 Key points to inform the research design

Having looked at the available literature, it has been possible to make recommendations for consideration when designing questions for a survey to collect data on mobile connectivity:

- **Technology types:** care should be given to deciding which types of technology to include in the survey. Existing studies have shown that trends in mobile technology change rapidly and are difficult to predict. For example, Lyons et al. (2013) combined eBooks with tablet computers when designing their survey questions, and this has now made it impossible to focus solely on tablet computer use, despite data from other studies suggesting this is has become important new piece of mobile technology in-and-of itself.

- **Connection types:** there are a number of routes through which passengers can be provided with mobile internet connectivity. Wi-Fi is one, however there is also the increasing availability of high-speed mobile data through 4G networks. There is merit in asking passengers about their preferences for different types of mobile connectivity. The impact of unreliable mobile connection on mobile usage needs further investigation too.

- **Benefits of mobile connectivity:** whilst some studies have linked passengers' travel-time use to their experience of the journey, little has been done to explicitly ask people what the benefits of mobile connectivity are to them. Asking this question would enable a deeper understanding of why people use mobile internet and technology during travel.

- **Willingness-to-pay:** very little is known about passengers' willingness-to-pay for mobile connectivity. There is an opportunity to understand more about what value passengers place on different types of connectivity, and how this can be translated into a cost, and who should bear the cost.

- **Segmentations:** existing studies show that there are a number of important segmentations of passengers. In particular:
    - Journey purpose: the NRPS data suggest that commuters and business passengers are using similar types of technologies and undertaking similar types of task. While mobile technologies and connectivity are changing the ways in which people can work on-the-move, it needs to be ascertained, who

is working and when, and the relative value of connectivity for non-work tasks.

- Journey duration: longer journeys have 'traditionally' been suggested to provide a better opportunity for travel-time activity. However, new mobile technologies such as the smartphone and tablet might be changing this, removing the need for passengers to unpack, and negating some of the activity benefit of a longer journey. There is an opportunity to understand more about how these new 'hyper-mobile' technologies are being used by people on shorted journeys.
- Age: technology use and travel-time activity is suggested to vary significantly by age, and this may impact on journey purpose.
- Gender: there is some evidence there is a difference in the amount that women and men engage with mobile technology on-the-move.

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