TRAIN OVERCROWDING: INVESTIGATING THE USE OF BETTER INFORMATION PROVISION TO MITIGATE THE ISSUES

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ABSTRACT

Crowded trains are a feature of many railway networks, and adversely affect both train passengers and rail operators. For passengers, the lack of space or inability to get a seat can lead to a lack of physical comfort, reduced productivity and increased stress. Crowded trains can also lead to problems boarding and alighting, increasing dwell times and making it harder for operators to provide a reliable service. It is therefore desirable to reduce crowding levels, but it isn't always practical to achieve this by increasing capacity and other measures need to be considered. Some passengers have shown willingness to change their behavior to avoid crowding, for example by waiting for a later train, and measures to encourage such behavioral changes more widely could be beneficial overall. Better information provision could be one such measure, and a stated preference survey was undertaken on a commuter and airport service in order to investigate this further. It was found that the provision of information about crowding levels and seating availability on alternative trains would encourage some passengers to wait for a less crowded train. While the willingness of passengers to wait for a later train varied with both trip purpose and with the origin station, the findings suggest that real-time information would improve the passenger experience and could form the basis of a revenue neutral demand-management system. The implications for station design are particularly pertinent for countries such as the USA where significant investment in new passenger rail systems is expected.

Keywords: Rail, Crowding, Information Provision, Behavior Change

INTRODUCTION

Crowded trains are a feature of many railway networks; overcrowding of rail services in major cities has become a worldwide problem (*1*). From a passenger perspective, crowding can have a number of negative effects – including the inability to get a seat or even to board a train at all (*2*). Crowding is also problematic for rail operators and not just because it reduces passenger satisfaction.

Providing necessary capacity increases to combat crowding can be challenging and may not always be cost effective. In Great Britain, passenger rail usage has seen growth across all measures since 2002 (*3*), but there is limited scope to increase capacity; most of the UK rail network was developed during the 19th Century to suit trains at the time, and radical infrastructure alterations would be necessary (*4*). Although there is ongoing investment in projects to improve capacity (*5*), they take a significant amount of time to implement. Other measures to combat crowding must therefore be considered.

It is clear from the literature that passengers may react to crowding by adapting their travel behavior (*6*). This paper seeks to investigate whether the relatively simple step of providing better information could encourage such behavioral change and help mitigate crowding issues. Rail operators around the world are just beginning to provide crowding information; in the Netherlands, the Dutch Railways have recently launched a smartphone application (*6*), and JR East are developing something similar in Japan (*7*). In the UK, at least one operator, London Midland, provides non-real-time data based on historical figures (*8*), but real-time information are not yet widely available. To investigate the potential benefits of real-time information, a stated preference survey was conducted on-board a busy commuter and airport service. The findings are presented and discussed here.

LITERATURE REVIEW

For passengers, the evidence clearly indicates that crowded conditions influence the value of time spent seated and standing (*9*). Even when some seats are available, crowding can have a negative impact – studies suggest that when between 50% and 70% of seats are occupied then passengers experience a disutility (*6*), which may include reduced physical comfort or lower productivity. In the UK a Passenger Demand Forecasting Handbook has been produced which gives some guidelines for accounting for this disutility (*10*). Studies have also shown that crowded trains can increase stress levels, especially if passengers are unable, for example, to control their proximity to others (*4*).

Crowding has a negative effect on rail operators also. For example, it can slow down boarding and alighting at stations, thereby increasing dwell times and making it harder to provide a reliable service; studies have shown that delays on commuter trains invariably increase with passenger density (*4*). This in turn has a further negative effect on passengers.

Passengers may react to crowding by adapting their travel behavior (*6*). Observed behavioral responses include departing earlier or later to avoid crowding, or waiting for a less crowded service. It is not just those passengers who are willing and able to make such choices who benefit, because they contribute – if only in a small way – to a reduction in crowding levels elsewhere. Hence any measure which encouraged such behavioral change could be used to combat crowding. Although choosing a different train would seem to be an attractive option when faced with having to stand, such behavior is not currently as typical as might be expected

(*9*). Reasons for this are likely to include a lack of sufficient flexibility as passengers may be constrained by time (for example, needing to arrive for an appointment) or by a lack of service frequency (for example, the gap between trains may be too long). However, insufficient information is also likely to be a key factor. It is hard for passengers to make a reasoned choice about whether it is worth taking an alternative train when crowding levels are rarely communicated.

Existing research has shown that provision of crowding information can influence passenger behavior; for example, the communication of expected crowding levels achieved favourable results at the Sydney Olympic Games (*1*). Considering other modes, stated preference surveys undertaken on buses in Korea showed that crowding information influenced passenger decisions about whether or not to wait for a later service (*11*). Previous choice experiments have also shown that the size of station and available facilities are significant factors (*12*).

METHODOLOGY

In order to further investigate the potential benefits of real-time crowding information in the context of busy rail services, a stated preference survey was conducted in the UK on-board Gatwick Express trains; a frequent service between London, London Gatwick Airport and Brighton. The Gatwick Express is operated by Govia Thameslink Railway (GTR) who co-operated fully in this research. The route was chosen for several reasons. Firstly, the high service frequency; trains between London and Gatwick run throughout the day at 15 minute intervals. Between Gatwick and Brighton, Gatwick Express trains run on a half-hourly basis with additional peak time services, and the whole route is also served by other train services. This means that it would be feasible for passengers to consider waiting for a later train. Secondly, it has a mix of passengers and carries a number of commuters in the peak periods. Routes in and around the South East of the UK are notoriously problematic for crowding on commuter services (*4*) and the London to Brighton mainline is a key route in this area. Thirdly, the Gatwick Express is a limited-stop service with the three major stations already mentioned only being supplemented by a handful of smaller stations between Brighton and Gatwick during peak times. As well as being advantageous practically (it is easier to conduct surveys when there is more time between stops), it limits the number of possible journey permutations.

Passengers were asked to complete a self-guided survey using tablet PCs. The survey comprised two main sections: a set of questions which asked passengers about themselves and their journey (without collecting any personally identifiable information) and a set of three stated preference exercises designed to ascertain how the participant might react to crowding information. The focus of this paper is one of the stated preference exercises, which was designed to gauge the possible reaction to the placement of real-time crowding information on displays at stations. Research shows that passenger information displays at stations are "actively consulted by passengers, whether they are commuters … or infrequent travellers using the train for the first time" (*13*). Hence this is a reasonable context to describe when investigating whether information about crowding would encourage passengers to wait for less crowded trains.

Each participant was shown a set of example passenger information displays, which were representative of a typical display they might see at the station. In each case, two trains were listed: one which was said to be 'Due' and one which was given to arrive a number of minutes subsequently. Crowding information was provided alongside each train, and participants were explicitly asked whether they would board the first train or wait at the station for the second train. In each case, the parameters of the first train remained fixed – it was always 'Due' and it was always shown as having no seats available. In this stated preference experiment, there were two variables. The first was the waiting time for the subsequent train, which had three levels (15 minutes, 30 minutes and 45 minutes). The second was the level of crowding on the subsequent train, which had two levels (40% of seats available and 90% of seats available). The first crowding level was chosen because it corresponds to the threshold at which crowding is typically thought to have an effect (*9*). The experiment was designed to be fully factorial, and each participant responded to six different displays. The survey software, SnapSurvey, allowed the order of the questions to be randomised.

The participants were split in to two groups, allocated randomly by the survey software. In the first group, denoted here as 'Graphical Observations', participants were shown display boards with crowding information shown graphically whilst in the second group, 'Textual Observations', participants were shown display boards with the same crowding information written in terms of number of available seats (FIGURE 1). This was to investigate whether the presentation of information has an important effect.

The statistical package Stata was used to generate a set of logit models from the data collected.

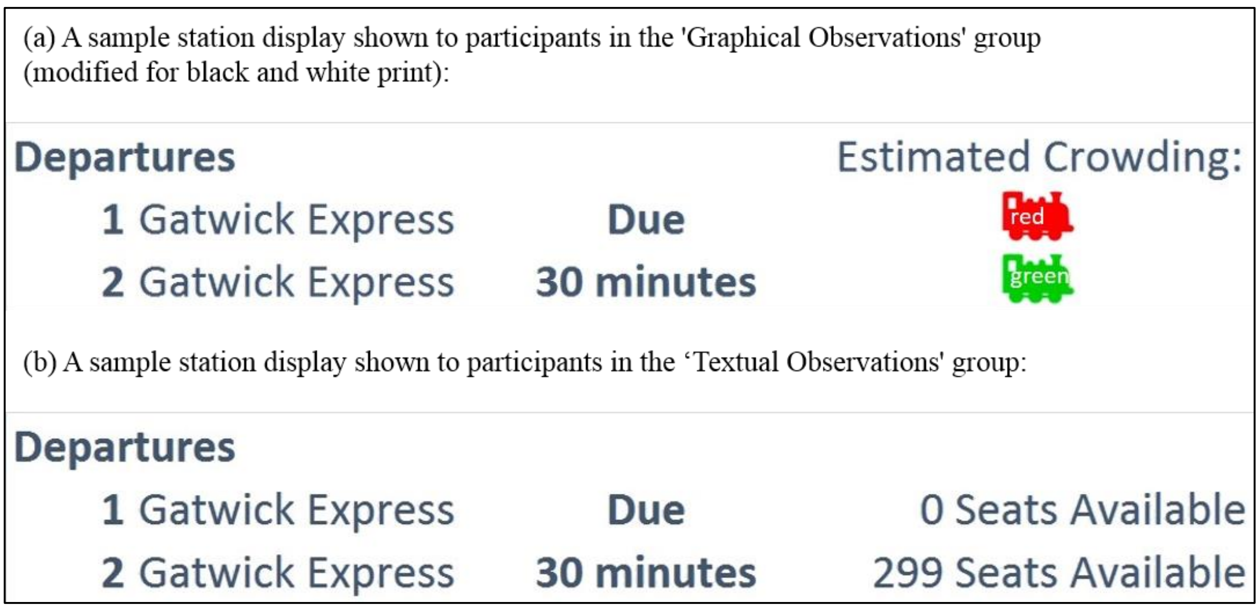

FIGURE 1 - Sample station displays shown to survey participants

A SUMMARY OF THE DATA COLLECTED

On-train surveys were conducted over four days in April 2016. A total of 319 participants completed the stated preference exercise about information boards at stations. Breaking the data down by journey purpose, 25% of respondents were leisure passengers, 24% were business passengers (not commuting) and 51% were commuters. Although this might be slightly atypical of UK rail travel as a whole – the 2014 National Travel Survey found that 37% of UK rail trips were made for leisure (*14*) – this survey focussed on peak-time crowded trains, which are not as popular with leisure passengers.

ANALYSIS OF THE STATED PREFERENCE DATA

Between them, the 319 respondents generated 3828 stated preference observations which were fed in to Stata for the generation of a logit model. Because there were multiple observations per respondent, jack-knife resampling was specified to help reduce bias.

The model assumes that, given a choice of trains i, the probability of choosing train T is described by:

$$P(T) = \frac{e^{U_T}}{\sum e^{U_i}} \quad (1)$$

where U_i is the utility function of train i. This utility function was initially thought to depend on the number of seats available on the train, the time of departure of that train (with respect to the desired time of travel), the duration of the journey on the train and the format of the crowding information presented. In this case, the choice was binary, between a train at the desired time of travel with no available seats and a later train with available seats. The earlier train was chosen as the base alternative, with a utility function given by:

$$U_{FirstTrain} = 0 \quad (2)$$

The utility function for the later train was constructed as follows:

$$U_{LaterTrain} = \beta_{some\_seats}s1 + \beta_{many\_seats}s2 + \beta_{offset}t + \beta_{text\_based}x + \beta_{short\_journey}l \quad (3)$$

s1 is a Boolean which is 1 when the crowding information displayed 40% of seats on the later train as being available, and 0 otherwise.

s2 is a Boolean which is 1 when the crowding information displayed 90% of seats on the later train as being available, and 0 otherwise.

t is the time offset of the later train, in minutes

x is a Boolean which is 0 when crowding information is displayed graphically, and 1 when text-based crowding information is given.

l is a Boolean which is 1 when the journey time is 30 minutes or less, and 0 otherwise (this was based on the origin and destination stations, with a maximum journey time of 1 hour).

Initial Model Outputs

Stata was used to fit the coefficients β to the entire data set, and the outputs from the initial run are shown in TABLE 1. It can be seen that $\beta_{short\_journey}$ is not statistically significant. This is somewhat unexpected, given the suggestion that the perceived cost of crowding increases with journey time between 30 minutes and one hour (*10*), but there are plausible reasons for this, including the fact that journey time may be linked with journey purpose (those using the airport would only ever spend 30 minutes on-board whilst a lot of commuters to London board further afield). Additionally, there may be an expectation of a seat becoming available at an intermediate stop on a longer journey.

All other coefficients are statistically siginificant. As expected, there is a positive utility associated with seats being available. The difference between β_{some_seats} and β_{many_seats} is small; the difference between getting a seat (of any kind) and standing is greater than the difference between a seat in a fairly crowded environment and one on an almost empty train. This could be based on participants viewing available seats on the train as a guarantee of a seat for them.

Similarly, the negative value of β_{offset} is expected, in line with the fact that waiting for a later train is a disutility.

The positive value of β_{text_based} implies that the later train has a greater utility if the crowding information is displayed in a text-based format, in terms of number of seats available.

TABLE 1 Initial parameters from Stata for logit model

Coefficient	Value	Jackknife Std. Error	t-statistic	P > |t|	95% Confidence Intervals	
β_{some_seats}	1.339661	0.1591023	8.42	0.000	1.027629	1.651693
β_{many_seats}	1.655061	0.1653801	10.01	0.000	1.330717	1.979405
β_{offset}	-0.0868775	0.0053211	-16.33	0.000	-0.097313	-0.076442
$\beta_{short\_journey}$	-0.0882343	0.1096993	-0.80	0.421	-0.303377	0.126909
β_{text_based}	0.5691598	0.111349	5.11	0.000	0.350781	0.787538

More Detailed Analysis – a Look at Different Passenger Groups

After the initial analysis, the data were divided by different five different passenger groups as follows, which were analysed in turn:

1) Morning Commuters. Commuters travelling in the morning peak period between 6am and 9am. Airport users were excluded.
2) Evening Commuters. Commuters travelling in the evening peak period between 4pm and 7pm. Airport users were excluded.
3) Other Business Travellers. Non-commuting business travellers, irrespective of time of day. Airport users were excluded.
4) Non-airport leisure travellers. Leisure travellers who were not airport users.
5) Leisure Travellers with a flight to catch. Leisure travellers who had specifically stated that they were flying out of Gatwick Airport.

The term “airport users” includes those who were flying in or out of Gatwick Airport, but not those who used the station at Gatwick for other reasons.

In line with the findings in TABLE 1, $\beta_{short\_journey}$ was found to be insignificant across all passenger groups. β_{text_based} was also found to be insignificant for both groups of commuters. Hence, for commuters, Equation 3 was re-written as follows:

$$U_{LaterTrain} = \beta_{some\_seats}s1 + \beta_{many\_seats}s2 + \beta_{offset}t \quad (4)$$

For the other business travellers and non-airport leisure travellers, the utility function for the later train was chosen to be:

$$U_{LaterTrain} = \beta_{some\_seats}s1 + \beta_{many\_seats}s2 + \beta_{offset}t + \beta_{text\_based}x \quad (5)$$

Finally, for leisure travellers with a flight to catch, β_{some_seats} was not found to be significant, and the utility function was therefore re-written as:

$$U_{LaterTrain} = \beta_{many\_seats}s2 + \beta_{offset}t + \beta_{text\_based}x \quad (6)$$

Final values of the coefficients are given in TABLE 2.

TABLE 2 Utility Function Coefficients for the Different Passenger Groups

Passenger Group	**Morning Commuter**	**Evening Commuter**	**Other Business Travellers**	**Non-airport leisure travellers**	**Leisure Travellers with a flight to catch**
β_{some_seats}	1.283382	1.643466	1.748217	1.318212	-
β_{many_seats}	1.780717	1.693881	2.009459	1.654997	0.7413683
β_{offset}	-0.0888886	-0.0986809	-0.090568	-0.07547	-0.0866451
β_{text_based}	-	-	0.5471758	0.777475	1.625882

By dividing $|\beta_{offset}|$ by β_{some_seats} or by β_{many_seats}, it is possible to generate a time value of some seats available and a time value of many seats available respectively. These values could be viewed as the number of minutes participants would be willing to wait for a later train with some (40%) or many (90%) seats available. They are shown in FIGURE 2, assuming that crowding information is presented graphically; there would need to be some adjustment for text-based information.

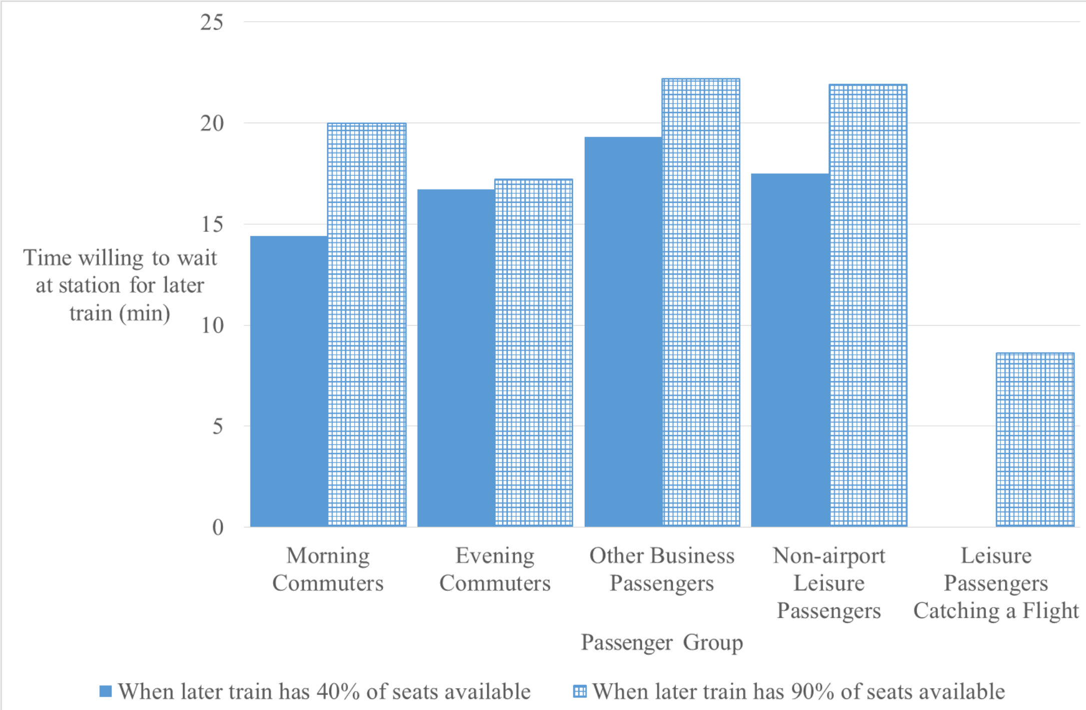

FIGURE 2 Willingness of Different Passenger Groups to Wait for a Later Train

From the values shown in FIGURE 2, the value-of time multipliers associated with a crowded train can be estimated. They can be interpreted as the time weighting associated with standing on a crowded train compared with having a seat. On the premise that the time values in FIGURE 2 are the length of time travellers would be willing to wait for a train with available seats, value-of-time multipliers for a 30 minute journey are given in TABLE 3.

TABLE 3 Estimated Value-of-Time Multipliers for a 30 Minute Journey

Passenger Group	**Morning Commuter**	**Evening Commuter**	**Other Business Travellers**	**Non-airport leisure travellers**	**Leisure Travellers with a flight to catch**
Time Weighting: 100% Load Factor vs 60% Load Factor (30 minute journey)	1.48	1.56	1.64	1.58	-
Time Weighting: 100% Load Factor vs. 10% Load Factor (30	1.67	1.57	1.74	1.73	1.28

minute journey)					

The values in TABLE 3 compare favourably with those already found in the literature and are are – with the exception of the weighting for leisure travellers with a flight to catch – within the range of standing multipliers given by Wardman & Whelan (*9*) for load factors of between 110% and 250%. Similarly, the Passenger Demand Forecasting Handbook (Section C6.3.10) uses data from another stated preference study in London to estimate that the time weighting associated with standing (compared with "sitting in normal conditions") varies from 1.55 for "standing uncrowded" to 2.15 for "standing crowded" (*10*). It was found elsewhere that "crowding is perceived by transit users as an extra weight on in-vehicle time that becomes quite significant (1.62) at the extreme crowding level" (*15*).

More Detailed Analysis – the Effect of Different Stations

When considering whether it is desirable to wait at the station for a less crowded train, the waiting environment is presumed to be important. To investigate this, the morning commuters were divided by origin station. As already stated, Gatwick Express services call additionally at some smaller stations between Brighton and Gatwick during peak times. Whereas Brighton is a terminus with eight covered platforms and a range of amenities (including shops and refreshment outlets), the smaller stations comprise a smaller number of through platforms with less shelter and fewer amenities. The data for morning commuters boarding at Brighton are compared with the data for morning commuters boarding at one of the smaller stations (which, due to the number of respondents, are considered collectively).

The utility function given in Equation 4 was assumed, and the coefficients generated by Stata are given in TABLE 4. They were used to estimate values of time indicative of willingness to wait at each station, and these are shown in FIGURE 3.

TABLE 4 Utility Function Coefficients for the Different Stations of Origin

Passenger Group	**Commuters from Brighton**	**Commuters from intermediate stations to Gatwick**
β_{some_seats}	1.686251	0.614799*
β_{many_seats}	2.161827	1.13133
β_{offset}	-0.0931169	-0.0737

*not significant (p|z| = 0.187)

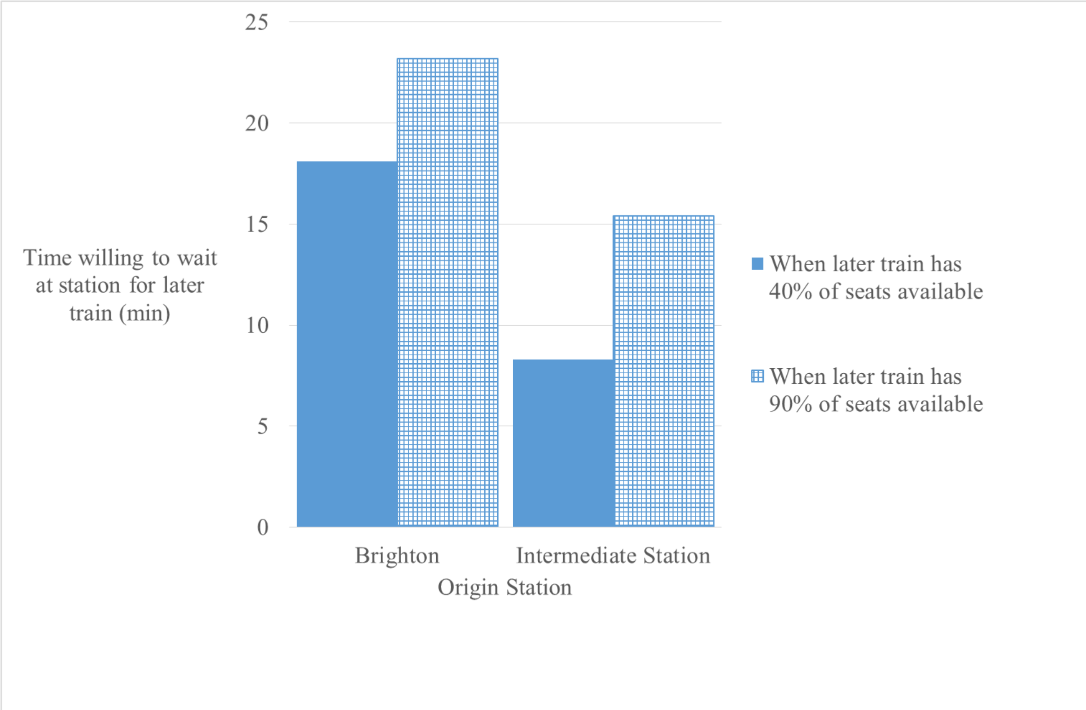

FIGURE 3 Willingness of Morning Commuters to Wait for a Later Train by Station Origin

DISCUSSION

General Observations

The results from the stated preference survey fit with the literature, and participants showed willingness to trade-off the inconvenience of waiting at the station for the benefit of getting a seat for the journey. Given a 15-minute service frequency, the willingness of most passengers to wait would theoretically be sufficient for them to consider waiting for the subsequent train. The margins are quite tight, however, and the tendency of stated preference surveys to overstate the likely reality because of non-commitment bias needs to be considered. Previous work which has been able to make use of both stated preference and revealed preference data in this area suggests that passengers might not be as willing to wait in practice as they state in advance (6). Should such a system be implemented, there will also be other factors which influence the willingness of passengers to wait for a later train. There is also the possibility that passengers may assume that if they catch the first, crowded, train, they won't have to stand for the whole journey. This will be especially true for evening peak services out of London where the load factor decreases with every stop.

An important issue is the reliability of the information provided. It is presumed that participants' existing perception of the reliability of information at the station formed part of their decision making process, but there was no precedent on this route for the provision of real-time crowding information. If the reliability of the information does not meet expectations, then the willingness of passengers to change their behavior would be expected to drop. Reliability concerns can be broken in to two main areas – the ability to trust that the next train will arrive at the time shown and the accuracy of the crowding information.

There are a range of technologies which could be used to count passengers on-board trains, including weight sensors, CCTV, WiFi and infra-red sensors in the doors, but they can be distorted; for example, using weight data assumes a mean weight of a person, making it hard to distinguish between two smaller people and one larger person carrying luggage. Similarly, WiFi routers can be used to estimate the number of mobile devices in a carriage, but this does not necessarily correlate directly with the number of people. The more detailed the information required (for example, providing specific numbers of empty seats rather than more general crowding levels), the greater the requirement for accuracy if the system is to be relied upon. The provision of crowding information is hindered if the gap between intermediate stops is shorter than the service frequency. If the subsequent train is due to stop again before it arrives at the platform in question, crowding levels are subject to change.

Finally, the perceived benefits of the system are affected by the scale of behavior change it induces. If passengers assume that "available seats" is given to mean "a guaranteed seat" then disappointment and a lack of trust in the system will ensue if more passengers than there are seats decide to wait.

The benefits for different passenger groups

Unsurprisingly, leisure travellers with a flight to catch would be the least willing to wait for a later train. TABLE 2 shows that $\beta_{\text{some\_seats}}$ is insignificant, whilst $\beta_{\text{text\_based}}$ is greater than it is for other passenger groups. The colors on the graphical displays may have had some influence here, especially since airport users tend to be less familiar with the route than regular commuters. Amber was used to indicate that 40% of the seats on the later train were available and may have been interpreted as a caution. Similarly, the green used to indicate that 90% of seats were available may also have contrasted with the red used for the first crowded train and encouraged waiting for other reasons.

Of the remaining passenger groups, commuters appeared to be the least willing to wait. Given the prevailing culture of a standard working day with peak travel periods at each end, this stands to reason; many of those with enough flexibility in their working day to travel on a less busy train may already have chosen to do so, especially since off-peak tickets are cheaper. Morning commuters are slightly less likely to wait for a later train. This may reflect pressures to get to work on time, although evening commuters are not without pressures to get home for family or other evening commitments. It is worth noting that many of the morning commuters board at one of the intermediate stops between Brighton and Gatwick, where the willingness to wait has been shown to be lower.

The difference between waiting for a train with some seats available (60% load factor) and many seats available (10% load factor) is greatest for morning commuters, which may be an indication that waiting for a seat is more justifiable if there is sufficient space to be productive and begin the working day ahead of arriving in the office. The Gatwick Express has predominantly airline style seating, with a small number of full tables with four seats around them. Having a table seat makes working much more practical, and regular travellers who know the train layout may be enticed to wait if they think they have more chance of a full table.

Non-commuting business travellers showed the most willingness to wait. A need to use the journey productively may to be a factor in this; $\beta_{\text{text\_based}}$ is both significant and positive, which says something about the importance of having an available seat over simply knowing that the next train is less crowded. Leisure travellers without a flight to catch also stated a high willingness to wait, but it is noted that this is to do with a lower value of β_{offset}; unsurprisingly, journeys made by leisure passengers appear to be less time-critical.

Different stations

There was a marked difference between passengers boarding at different stations, with participants boarding at Brighton – a well equipped, covered terminus – being much more willing to wait than those at small intermediate stations. All participants were asked whether various additional facilities – including WiFi, seating and refreshements – would encourage them to wait at the station. 48% of those from intermediate stations selected "none of the above" compared with 21% of those from Brighton. This suggests that although available facilities may be important there are other reasons for the differences. These may include the overall design of the station (the smaller stations currently have a relatively high amount of exposed outdoor space) and the fact that there are other benefits of a terminus such as Brighton. Firstly, at a terminus station, the subsequent train is typically at the platform for longer before departure than at a through station. This means that passengers are likely to only have to wait a fraction of the time between trains before they can board the subsequent one, with the added advantage of being one of the first to board and having the widest choice of seats. Secondly, some of the reliability concerns discussed above are less relevant – although, in reality, there is less value in having real-time crowding information for a train which hasn't yet begun its journey.

Wider applicability of the findings

The literature showed a range of values of time associated with crowding. This will partly be because of differences between passengers. However, contextual variations are also important. On short commuter journeys where trains are designed for standing passengers and load factor is measured in terms of people per unit area rather than seat occupancy, there is unlikely to be an expectation of having a seat and using the journey productively. Concerns about crowding are much more likely to be focussed on physical discomfort and stress. At the other end of the scale, space to relax and use the journey productively is likely to be much more important on a long-distance service, especially one with a premium image. Between the two are the suburban services where getting a seat is valued for reasons of comfort, but – in the absence of a table – less likely to affect productivity.

An important benefit of this particular study is that has encompassed a range of passenger needs and expectations. The Gatwick Express may be viewed as a premium service, and with journeys of 30 minutes or more and few intermediate stops, using the journey productively is a reasonable expectation. The willingness of non-commuters to wait for a less crowded train has shown the importance of space on such a journey, and similar trends may be observed on short- and medium-length intercity services using comparable rolling stock. An important caveat, however, is that service frequencies on intercity services may be lower, reducing the likelihood that the willingness to wait will be sufficient to justify waiting for the next train.

The popularity of the Gatwick Express with commuters, many of whom have to stand during peak time, suggests that the findings could be applicable to commuter journeys of a similar length elsewhere. Caution should be exercised, however, when considering high-frequency metro style journeys. In addition to different passenger expectations, there are likely to be situations where encouraging people to wait at the station for a later train would cause more harm than good. Crowding at stations can also be a problem and many metro stations do not have the facilities to comfortably hold passengers. In a busy urban environment, it may not be desirable to encourage passengers to remain at the station longer than is necessary.

CONCLUSIONS

Crowding on trains is an increasing problem, and research to date clearly shows that it adversely affects the passenger experience. Alternative methods of reducing crowding and improving the passenger experience need to be considered where increased capacity is not cost effective or practical. Existing literature has shown that passengers perceive crowding as equivalent to extra time on their journey, and are in some cases willing to change their behavior to avoid crowding. A range of emerging technologies make it possible to report on-train crowding information in real-time, and this research has sought to understand whether this could be used to exploit the time-weighting associated with crowding and further encourage behavioral change.

Stated preference surveys were undertaken on a train service in the UK which is used by a range of different passengers. The length of journey and design of rolling stock means that using the time productively would be a reasonable expectation, whilst the high service frequency means that waiting for a later train is plausible. This work has been able to offer a unique insight into how different passenger groups might respond to the provision of train crowding information at the station.

Using logit models, it was possible to estimate the willingness of different passenger groups to wait at the station for a less crowded train. Time weightings for crowded trains were inferred, and were found to fit with existing literature. As could be expected, those with a flight to catch were the least willing to wait, whilst other leisure journeys were the least time-critical. Regular commuters showed willingness to wait, but it is not clear whether they would, in reality, be sufficiently willing to wait for the subsequent train.

Station design could play an important role in encouraging passengers to wait, and should be considered where there is investment in new and upgraded passenger rail facilities.

As a measure to reduce peak-time crowding, information provision might have some effect, but it is unlikely to be significant – many of those who can be flexible with their working hours have already been financially incentivised to avoid the peaks. However, investment in real-time crowding information is nonetheless recommended on suburban and inter-urban routes, because it has the potential to improve the overall passenger experience. Firstly, by enabling travellers to make more informed choices, it enhances their sense of control (an important consideration when considering stress (*4*)). Secondly, it particularly benefits those who really need a seat, such as those who intend to use the journey productively. As well as enhancing their experience of rail travel, it may be an important consideration in their modal choice.

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