# Investigating the effect of train occupancy information 

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#### Abstract

Reducing the negative effects of train crowding could improve passengers' travel experience by moderating stress, and enhancing comfort. Although crowding seems unavoidable due to an increase in the number of passengers, it should be handled effectively. Thus, this study aims to help improve overcrowding issues by exploring the effects of occupancy information developed to encourage passenger behaviour change. This will be achieved by identifying factors affecting their decision making regarding selection of carriage, and measuring their intentions to board a less occupied carriage as a response to occupancy information. An online questionnaire was conducted, and 119 rail users participated in the study. The majority of them reported that the information was helpful ( $91 \%$ ), and they were willing to move to board an emptier carriage if they had been informed (93\%). Additionally, the occupancy information was a significant predictor of a passenger's intention to move to board less busy carriages for proposed travel scenarios as verified in ordinal logistic regression models.


## KEYWORDS

Train occupancy information, train crowding, passenger behaviour change

## Introduction

Passengers' travel experience on public transport can be negatively affected by overcrowding (Passenger Demand Forecasting Council (PDFC), 2017). The influences are stress and anxiety, fatigue, perceived risk to personal safety and security, invasion of privacy, reduced productivity, inefficient use of time (Tirachini et al., 2013; Haywood et al., 2017), and discomfort (Pel et al., 2014). Furthermore, crowding elicits passengers' behavioural reactions. They adjust route choices to avoid crowding and associated delays (Kim et al., 2015), depart earlier or later or select different lines or stations. They wait longer for less busy services and move along the platform to board a less busy carriage (Pel et al., 2014; PDFC, 2017). This study further discusses passengers' choice of carriage as it involves no extra costs nor requires amendment of travel plans. Positive effects in terms of comfort evaluations are expected when informed passengers board less busy carriages (Hirsch and Thompson, 2014). Changing passengers' behaviour is one method for distributing passengers more evenly among carriages (Kim et al., 2014). Therefore provision of occupancy information could be used as a tool to motivate passengers to move on the platform. The impacts of occupancy information on passenger behaviour change have been well documented. Ahn et al. (2016) present that occupancy information helped improve passenger distribution on the platform, and equalisation of passengers boarding per door. Preston et al. (2017) verify that the participants were willing to wait longer for the next train when informed about its level of occupancy and seat
availability. Fukusawa et al. (2012) examine the effects of information about train arrival times and level of crowding on train selection. The information directed respondents to choose several carriages rather than a single specific carriage to meet their different needs. Zhang et al. (2017) investigate the effects of real-time occupancy information. It helped achieve more equal passenger distribution across carriages, and a downstream moderating effect on in-vehicle crowding. However, the actual behaviour change stimulated by the information was lower than the reported usefulness of the information, highlighting that other factors may affect the decision. This presents the need to consider occupancy information in combination with additional factors when investigating how passengers choose a carriage. Factors influencing the decision include: positions of entrance and exit (Lee et al., 2018; Rail Safety Standards Board (RSSB), 2018; Kim et al., 2014), location of seats, size and shape of baggage, size (RSSB, 2018) and layout of platforms, length of trains (Kim et al., 2014), carriage and platform design (Hirsch and Thompson, 2014), occupancy of carriages, and distance between platform entrance and train doors (Lee et al., 2018). This study seeks to identify and verify the influences of occupancy information in combination with other factors on passenger behaviour change. In addition, the effects of key factors are confirmed in ordinal logistic regression models. The findings are expected to give insights to the service providers to tailor occupancy information to better assist passenger behaviour change to support enhanced comfort for passengers.

## Methodology

An online questionnaire was used to investigate factors affecting positioning and selection of carriage on the platform, and intentions to board less busy carriages. The method was chosen because it enabled access to rail users from a wide range of regions by approaching rail user groups scattered across the UK (Robson and McCartan, 2016). Furthermore, stated preference survey techniques have widely been applied in the field of transport to analyse travellers' decision and travel behaviour (Jones and Bradley, 2006; Hensher, 1994), especially using hypothetical scenarios (Devarasetty et al., 2012). Thus, behavioural intentions were examined by asking participants’ response to occupancy information in travel scenarios because they are a strong predictor of actual change in behaviour (Ajzen, 1991). This study was approved by the Ethics Committee of the University of Southampton on the $8^{\text {th }}$ of June, 2018 (ID: 41385).

## Structure of the questionnaire

The questionnaire consisted of three sections: 1) demographic questions; 2) general questions about occupancy information (Fig. 1); 3) scenario-based questions about intentions to move to board less busy carriages in two hypothetical travel situations. In the scenarios, description about the travels was provided as follows: 1) route: Gatwick Airport to London Victoria calling at London Victoria; 2) departure time: $08.20 \mathrm{am} ; 3$ ) journey duration: 30 minutes; 4) platform crowdedness (Fig. 2 \& 3); and 5) platform diagram (Fig. 4). The differences in the scenarios were trip purposes: commute and leisure travels, and the amount of luggage: one briefcase, and two suitcases (Fig. 5). In the settings, participants' intentions to move to carriages 6,9 , and $12(23 \mathrm{~m}, 84 \mathrm{~m}$, and 140 m away) from the point 'You are here' were asked (Fig. 4). A five-point Likert scale ranging from 'highly unlikely' to 'highly likely' was used. Lastly, open-ended questions were asked to enable respondents to give their own views about the decision making.


Figure 1. Images of the mobile App: Service Information (Left), Passenger loading key (Right)


Figure 2. Views at the station


Figure 3. Platform situation (views from the platform entrance)


Figure 4. Platform diagram


Figure 5. Images of a commuter (Left), and leisure traveller (Middle) in the scenarios, An example of a train with visualised occupancy in a question for asking intention to board (Right)

## Participant recruitment

Rail users were recruited through online channels, such as a survey platform for members of the University of Southampton, the University's intranet, and the University's Student Communication Facebook page. In addition, an official invitation email was sent to members of the University. Further, 27 UK rail user groups were contacted, and three of them concerning rail services connecting London with Southern areas of the UK showed an interested in the study, and publicised the form on their websites or twitter pages to encourage participation of rail users.

## Data collection and analysis

The data were collected from the $8^{\text {th }}$ of June, 2018 to $4^{\text {th }}$ of July, 2018. Overall, 119 completed forms were used for data analysis conducted on IBM SPSS Statistics 24 . Open-ended responses were analysed following Braun and Clarke's (2006) guidance. For example, the data was read thoroughly and tentative patterns, codes, and themes were found. Initial codes were identified, and those had similar meanings were collated and themed. The candidate themes were refined, and they were further refined to seize the essence of the themes that described passengers' decision making about selection of carriage on the platform.

## Result and discussions

## Demographic information

Overall, 70 male and 47 female rail users participated in the study ( N of missing=2). Males represented a larger proportion, in part because males conduct more rail trips than females (Department of Transport (DfT), 2017). Age distributions were as follows: 18-24 ( $\mathrm{N}=23$ ), 25-34 $(\mathrm{N}=49), 35-44(\mathrm{~N}=25), 45-54(\mathrm{~N}=9), 55-64(\mathrm{~N}=8), 65-74(\mathrm{~N}=4)$, and missing $(\mathrm{N}=1)$. The greatest proportion of the respondents was between the ages of 25-34, followed by 35-44. Together this supports the generalisability of findings given the largest number of rail journeys were made by males aged between 30 and 39 (DfT, 2018). A total of 43 respondents ( $36.1 \%$ ) had used rail services from Gatwick Airport to London Victoria.

## Perceived helpfulness of occupancy information (see Fig. 1)

The majority of the participants rated that the information was very helpful ( $\mathrm{N}=50$ ), or helpful ( $\mathrm{N}=58$ ). Neutral $(\mathrm{N}=8)$, not helpful $(\mathrm{N}=2)$, and not at all helpful ( $\mathrm{N}=1$ ) responses were also found. The helpfulness may be linked to willingness to accept the information service when launched as it is one of the contributing factors to measure the efficacy of a website (Sciamanna et al., 2002).

## Intention to move to board a less busy carriage according to occupancy information (see Fig. 1)

A considerable proportion of the respondents reported that they were highly likely ( $\mathrm{N}=68$ ), or likely $(\mathrm{N}=43)$ to try to board a less busy carriage. The rest of the responses were neutral $(\mathrm{N}=2)$, unlikely $(\mathrm{N}=4)$, and highly unlikely $(\mathrm{N}=2)$.

## Factors considered in selection of carriage in general rail travel



N of respondents=119
N of total responses $=242$
Figure 6. Factors considered in choice of carriage (Multiple-choice responses)
The respondents tended to choose a carriage by checking train crowding, and platform crowding. Train crowding cannot be seen until the train arrives at the platform, thus occupancy information could be helpful for passengers to decide to move to board a less busy carriage before it arrives.

Factors considered in positioning on the platform to get a seat in the train in general rail travel


N of respondents $=119$
N of total responses $=277$
Figure 7. Factors considered in positioning on the platform to get a seat (Multiple-choice responses)
Platform crowding was rated as the most important factor, and this may explain that it can help estimate how busy the carriages in the next train will be. However, this may not be reliable because there are passengers waiting for different trains on the same platform. Distance between where they are and the carriage was selected as the second factor, and this may represent that passengers think about how practical it is to get to the required carriage once they have a goal to get a seat.

## Additional information required to locate and board a less busy carriage in general rail travel

Three examples were offered in the question: train stopping points at platform, direction of train, carriage number. Both the a priori, and emergent codes were identified in the analysis as seen in Table 1.

Table 1. List of identified codes and themes

|  | Code | Type | N of occurrence | Theme |
| :--- | :--- | :--- | ---: | :--- |
| 1 | Carriage numbers | A priori | 44 |  |
| 2 | Train stopping points | A priori | 44 |  |
| 3 | Travel direction | A priori | 20 |  |
| 4 | Mixed information | Emergent | 5 |  |
| 5 | Numbers of seats | Emergent | 13 | B. Quantified occupancy levels |
| 6 | Train facilities | Emergent | 14 | C. Fulfilment of on-board requirements |
| 7 | Train formation and <br> platform information | Emergent | 13 | D. Positioning on-board |
| 8 | Exit information | Emergent | 3 | E. Quick exit |
| 9 | Other information | Emergent | 19 |  |

Interpretations were provided based on the themes. Theme A: the first four codes were themed as navigation as they were needed to identify their position and how to locate the carriage in relation to
the position. The mixed information included: positions of the respondents in relation to the train, carriage numbers marked on the platform that match carriage numbers, carriage numbers visualised on the App, subdivided platform sections shown on the App, carriage stopping points in relation to the platform layout. Theme B: numbers of reserved or available seats were themed that could be useful to find and secure a seat. Theme C : a need for information on train facilities: tables, charging points, first class carriages was expressed to easily board a carriage meeting their needs. Theme D: information on train/platform formations, that helps board a carriage and complete the trip without repositioning, was mentioned. Theme E: the number of occurrences related to quick exit was small, but this is one of the important factors affecting waiting position on the platform (Kim et al., 2014).

## Intention to move to board empty carriages (6, 9, and 12) in the scenarios (see Fig. 5)



Figure 8. Intentions to move to board carriage 6, 9, and 12 in the scenarios
The gradual decrease in highly likely responses as the distances increased were found in both scenarios. However, this pattern was not seen in the likely responses. The higher numbers of likely responses were rated about the intentions to board carriage 9 than those of the intentions to board 6 despite the longer distance to carriage 9 . This might indicate that passengers would not want to choose middle carriages because they are usually fuller than others (Karekla and Tyler, 2012). The gradual increase in unlikely and highly unlikely answers were observed as the distances increases except for the unlikely response in the commuter's scenario although the difference was minor. Greater numbers of unlikely or highly unlikely responses were recorded in the leisure traveller's scenario than those in the commuter's scenario. This could be interpreted that luggage is a barrier to moving on the platform.

Most important factors affecting the decisions to move in the scenarios


릍 Commuter 늘 Leisure traveller

Figure 9. Most important factors for the decision to move in the scenarios
Participants were asked to select the most important factor considered for the decision to move in the scenarios. Occupancy information was chosen as the most important factor in the both cases, but a greater number of responses were rated in the commuter's scenario. A possible reason is that commuters were more mobile as they carried smaller luggage. The information and the distance were selected as equally important factors in the leisure traveller's scenario. This shows that the walking distance had more of an effect on the responses in the leisure traveller's scenario because the mobility is limited due to heavy luggage. The influences of the chosen factors are tested, and the results are discussed in the next section.

## Testing the effects of the influencing factors in the scenarios

The effects of selected factors on the intentions to move to board empty carriages in the scenarios were tested (See Fig. 9). Ordinal logistic regression was used because the outcome variables included more than three categories rated by ordinal scale (Gümüş et al., 2012). The information about six tested models is presented in Table 2.
Table 2. List of models and variables

| Model | Explanatory variable | Outcome variable |  |
| :---: | :---: | :---: | :---: |
|  |  | Scenario | Intention to move to board |
| 1 | Occupancy information, Distance to carriage, and Platform crowding | Commuter | Carriage 6 |
| 2 |  | Leisure traveller |  |
| 3 | Occupancy information, Distance to carriage, Platform crowding, and Exit information | Commuter | Carriage 9 |
| 4 |  | Leisure traveller |  |
| 5 |  | Commuter | Carriage 12 |
| 6 |  | Leisure traveller |  |

Exit information was included in the models from 3 to 6 because the location of the exit at London Victoria station is closest from the front carriage (carriage 1), which means the distances are longer from carriages 9 and 12 to the exit. Exit knowledge could be more influential in decisions to move to the further carriages, as travellers want to shorten walking distance at destination (Kim et al., 2014; RSSB, 2018). All six models presented a good model fit, with $p<0.0001$ (models $1,4,5$, and 6 ), $p<0.001$ (model 3), and $p<0.01$ (model 2). The significant $p$-values demonstrate that the models with the explanatory variables explain better than the null models without the predictors (Liu and Koirala, 2012). Also, they showed non-significant Pearson chi-square goodness-of-fit statistics $(p>0.05)$ whose null hypothesis is that the model fits the data well (Fagerland and Hosmer, 2017). Additionally, the non-significant results for the test of parallel lines were produced, and this indicates fulfilment of the proportional odds assumption (Frangos et al., 2011). In the analysis, the responses about the most important information were dummy coded. Marked, and unmarked responses were coded as 1 , and 0 (Field, 2009). The marked ones were assigned as reference variables.

Table 3. Summary of ordinal logistic regression (including significant predictors only)

| Mo <br> -del | Explanatory <br> variable | Regression <br> coefficient | SE | Sig. | Lower bound <br> $95 \%$ CI | Upper bound <br> $95 \%$ CI | Odds <br> ratio |
| :---: | :--- | ---: | :---: | :---: | ---: | ---: | ---: |
| 1 | Occupancy info | -1.592 | 0.638 | 0.013 | -2.842 | -0.341 | 4.914 |
|  | Distance to carriage | -1.535 | 0.708 | 0.030 | -2.923 | -0.148 | 4.641 |
| 2 | Occupancy info | -1.628 | 0.612 | 0.008 | -2.829 | -0.428 | 5.094 |
| 3 | Occupancy info | -1.937 | 0.686 | 0.005 | -3.282 | -0.592 | 6.938 |
| 4 | Occupancy info | -2.057 | 0.639 | 0.001 | -3.309 | -0.805 | 7.822 |
| 5 | Occupancy info | -2.201 | 0.665 | 0.001 | -3.504 | -0.897 | 9.034 |
| 6 | Occupancy info | -2.424 | 0.627 | 0.000 | -3.654 | -1.195 | 11.261 |

The results are shown in Table 3. Occupancy information was a significant predictor in all the tested models. The odds ratios were computed by taking the exponential of the absolute figure of
the regression coefficients. For model 1, the respondents who selected the information were 4.9 times more likely to move to board carriage 6 than those who did not. For model 5, where the distance to walk is longest, this increases to over 9 times. The coefficients decreased as the distances increased, and this can be interpreted that the intentions to move to carriages further distances away can be better predicted by occupancy information. This might represent that if the effects of the distances had affected the respondents significantly, they would not have been willing to walk to the further carriages if they were not stimulated by the information. The effect of the information seems to be strongest in the model 6, and this describes that the information may be able to encourage passengers to move longer distances.

## Conclusion

This study aimed to seek solutions to moderate crowding issues by encouraging passenger behaviour change on the platform by providing occupancy information. A questionnaire was used to identify factors affecting passengers' decision making about selection of carriage, and to measure the intentions to move to board less busy carriages on the platform as a response to the information. Descriptive results showed that train crowding, platform crowding, and exit information were considered for the selection of carriage. When the respondents wanted to move, distance also mattered to estimate the practicality to get to the carriage in time. In total, 91 and 93.3 percent of the respondents answered that the information was helpful, and they were highly likely or likely to move to board a less busy carriage respectively. However, they expressed in open-ended responses that additional information would be needed aside from the occupancy information. It included information that supports wayfinding and locating on the platform/station, quantified occupancy level (e.g. numbers of available/occupied seats), on-board requirements/positioning, and quick exit at destination. Ordinal logistic regression models tested using responses elicited from scenariobased questions demonstrated that occupancy information was a major significant predictor of the decisions to move to board emptier carriages. In conclusion, it is recommended to inform carriage occupancy which has potential positive impact on passengers' behaviour change, however, in order for the intention to be better connected to actual behaviour change, passengers' various information needs should be supported. It would be useful to suggest when and how the information could be provided by identifying when the decisions are made, and what barriers exist to provide relevant information in a timely manner, and to reduce the impacts of the barriers to behaviour change.

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