

Research in-progress

Tarzan travellers: Australian rail passenger perspectives of the design of handholds in carriages

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Abstract

Background: The efficiency of running a metropolitan railway in part relates to the number of people that can be accommodated on trains and platforms and the time taken for boarding and alighting. However, the crowd density tolerance and experience of rail-users is not well understood, especially in an Australian context. In particular, there has been little consideration of the impact of small features, such as handholds within the larger scope of carriage design on passenger tolerance and engagement within the physical carriage environment during peak periods. **Aims:** This paper provides an understanding of the ways in which passengers experience crowding and make crowding-related choices with regards to the design and location of handholds as a cheap, yet effective way of upgrading rolling stock. **Method:** A mixed-methods study of platform and carriage crowding was undertaken across five Australian capital cities between 2009- 2010. A qualitative phase used participant-observation and focus groups to gain an understanding of passenger experiences and travel opinions. In total 179 people participated in the focus groups. A quantitative phase followed the qualitative research. There were 1,800 respondents who participated in an online stated preference choice experiment. This paper draws from the results from the qualitative phase. **Results and conclusions:** We found that handholds had a significant impact on passenger experience and tolerance of crowding. In particular, passengers preferred secure, hygienic and evenly-distributed holds within the carriage. It was found that these features maximised both their physical and emotional safety.

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Background

The efficiency of running a metropolitan railway in part relates to passenger density and loading efficiency, or the number of people that can be accommodated on trains and the time taken for boarding and alighting. Whilst the maximisation of passenger fares is important for a sustainably funded industry, it is often promoted to the disadvantage of other factors, such as passenger experience. One issue that is a growing problem in Australia is passenger crowding, particularly during peak and shoulder peak times. Apart from a decline in passenger ridership growth during the global financial crisis (1, 2), ridership across Australia is otherwise recorded as patronage growth. Since 2006, for example, Sydney's passenger ridership has increased by 12% or approximately 32 million passenger journeys per annum. Projections for the next five years forecast a further growth of 7-13% (1, p.36). Between 2005 and 2010 Melbourne's rail ridership rose by 43% (3, p.36). Similar trends can be seen across Australia. Currently, many networks around Australia run at capacity during peak and report overcrowding of passengers during these times (1, 4, 5). Therefore, a further increase in ridership and passenger demand as projected would create significant difficulties for rail authorities, and additionally, would affect passenger's commuting experience.

Currently, the crowd density tolerance of rail-users is not well understood, especially in an Australian context. In particular, there has been little consideration of the impact of carriage design on Australian passenger behaviour and their travel experience during peak periods.

Studies examining the importance of design to complement the user's personal needs, their physical, physiological and personal reactions to the environment (6) is an important characteristic of the ergonomic literature, particularly in the ergologist, Branton's writings. Branton accepts that 'modern mass systems... cannot select some people as users and reject others' (6, p.111) and adds that due to this, designers of public spaces must cater to all members of the public who are of 'a statistical significance' (6, p.111). Indeed, as Fulton Suri claims, '[d]esigning "for the user" means accommodating a broad range of characteristics of individual people' (7, p.154). Considering the 'optimal' carriage design for user comfort is discussed by Branton as being so well designed that '... the person loses all awareness and so can give his undivided attention to whatever activities he may wish to pursue' (6, p.114) and in this way, a well-designed carriage is one that is not noticed.

Aims

The aim of this paper is to provide an understanding of the ways in which Australian rail passengers experience crowding and make crowding-related choices in relation to handholds. This paper will explore passenger reactions to different handhold types, makes and locations within the carriage and how their experience of crowdedness is affected by this. The analysis for this research is still underway and this paper will therefore provide an extended methods section and some initial findings from the study.

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Method

Background to methods

A measure of crowding levels that is used by a number of rail industries around the world, and by some industries in Australia is passenger density per metre squared of floor space (8). This metric, which measures the number of standing people in a defined space, such as a metre squared (m²) is common not only to Australia but a number of rail systems around the world (8). These density measurements allow industries to set a definition of crowding that can be related to figures and statistics, limiting their reference to the physical (9) and thereby encapsulating their definition in an objective and quantitative manner.

Density measurements allow industries to set a definition of crowding that can be related to figures and statistics. For industry, the advantage of using density is that they can limit their reference to the physical (9), thereby encapsulating their definition in an objective and quantitative manner. The disadvantage of this methodology is that an in-depth understanding of how passengers feel in the crowded space is lacking. The methods employed in our study and described in this paper were designed to assess the passenger experience beyond the measured number of people in space.

To gain an understanding of passenger perceptions and tolerance of railway crowding and the impact of carriage design and passenger behaviour on the crowding experience, qualitative (Stage 1) and quantitative (Stage 2) fieldwork was undertaken. Stage 1 of data collection involved five days of ethnographic participant-observation in carriages during morning and afternoon peak. Following this, observations were clarified with passengers during four focus groups in each site. The combination of participant-observation followed by focus groups was designed to gain a comprehensive understanding of not only what passengers say, but also what they do (i.e. attitudes and behaviours). This methodology is based on the assumption that experiences of crowding are more than physiological; they are psychological (10, 11), social (12, 13) and cultural (14, 15). The results of this component of the study informed Stage 2, the quantitative phase which was conducted in the second half of 2010 through a national online stated preference choice experiment. Stage 1 was complemented by the positivistic epistemology of Stage 2. This paper describes findings from Stage 1 of the research based around passenger perceptions of handhold design and their placement within the carriage.

Participant-observation in carriages

A fieldwork schedule to concentrate observations in target areas was devised with assistance from a representative from the rail industry in each state. To ensure consistency within data collection, observations in carriages were undertaken by the same field researcher in each state. This approach allowed the researcher to address state specifics as well as to ensure maximum consistency between states. Observations were conducted for five consecutive days during morning and afternoon peak times.

The 'research' carriage for observations was chosen through three pre-devised criterion. These ensured consistency in data

collection as the number of carriages on rolling stock varies, not only within individual rail operations, but also between states. Thus, the three strategies for carriage selection were important for a reliable method base. They are listed below:

1. The carriage to which most passengers entered from the platform, or
2. In the absence of passengers on the platform, the most crowded carriage, or
3. In the absence of other cues, the middle carriage

To ensure the capture of crowding-related data, strategies one and two were necessary. Strategy three ensured consistency for data collection when the other two cues were absent. In addition to carriage selection, the researcher's location varied within the carriages to guarantee that a comprehensive understanding of crowding in different areas of the carriage was gained.

Observations were systematically recorded by the field researcher and included the time of day, the line, and the estimated number of people in the researcher's section of the carriage. They were orientated around:

- People's behaviour on trains (individual and social),
- Physical structures of carriages (design factors).

The purposes of the observations were:

- To understand crowding in the context of each site,
- To identify behaviours around crowding,
- To gain a contextual understanding for focus groups (the incorporation of focus groups with passenger attitudes, observations of passengers and the field researcher's personal observations allowed for an understanding of passenger experience from more than one point of view.),
- To experience crowding first hand (auto-ethnographic approach).

Observations followed a number of pre-devised topics, relevant to the original project aims. However, they were not restricted to those topics to allow for unanticipated findings. This paper will report on those observations surrounding the physical design of the carriage and the ways that passengers interacted with that environment.

Field notes surrounding the topics mentioned above were 'written up' immediately after each observation. The field researcher also kept auto-ethnographic notes about her own experiences as a passenger on trains. Auto-ethnographic studies on trains can also be seen in work by David Bissell (16, 17). These auto-ethnography notes gave the field researcher an insight into the typical commuter's crowding experience. By combining these two methods of observations and auto-ethnography, the field researcher's ability to create rapport with focus group participants was enhanced. In addition, once combined with focus groups, the data was triangulated (18) and, in this way, focus group members were able to provide confirmation of, and further insight into, the observations, thus decreasing the chance for observer bias by the field researcher in the observation phase.

Focus Groups

In the week following observations, focus groups were held with passengers to gain a regular commuter's perspective on crowding and the rail service during peak travel. Participants were engaged through a private recruitment company and were screened prior to the focus groups to ensure that they were a regular range of train users in their city. Four focus groups were held in each site arranged around the following age and sex variables:

- younger males (13-17 years of age);
- older males (18 years and over);
- younger females (13-17 years of age);
- older females (18 years and over).

In total, 179 rail users participated. The groups were divided by age and gender and were homogenous to ensure a balanced perception of crowding from various sectors of the community (19), and to assist with data analysis.

The aim of the focus groups was to gain a rich, first-handed, emic understanding of Australian rail passengers and their perceptions of everyday crowding, passenger behaviour and carriage design at the 'grass roots' level. Additionally, this was to ensure that the Stage 2 quantitative survey questions were not based on researchers' assumptions, rather, the qualitative findings were used to identify factors to be included in Stage 2. The majority of views expressed in the final focus groups at the last site raised little new data regarding the crowding experience (local issues excluded), indicating that we had reached saturation in data collection, suggesting that an increase in the sample size of focus group participants would have yielded little benefit.

Focus group participants were engaged in a guided group conversation for approximately 90 minutes around their train use in each state. The groups were interactive, innovative and engaging and included the following:

- A written activity where passengers listed the three most important factors (positive and negative) that influence their enjoyment of travelling by train;
- Discussion surrounding passenger's perception of the rail service and crowding with reference to their individual daily ridership;
- A hypothetical carriage-filling exercise participants were asked to mark on an aerial-view diagram of an empty, then crowded carriage where they would like to be located and why. This exercise was designed to assess passenger reasons behind seating and standing choice;
- A written 'magic wand' activity which was designed to determine changes that passengers would like to see made to their rail service;
- In the final two sites, a crowding perception and tolerance exercise was carried out. Participants were asked to stand in a metre square area and invited to talk through their 'feelings of being crowded'. The number of people in the square was gradually increased until all of the focus group participants were in that area. They were continually asked to alert the moderators to their levels of comfort,

discomfort and thresholds of crowding. This exercise was effective as their reactions to crowding were based on immediate reactions, rather than reflections on their typical commute, and in this way, the emerging emotions were described more accurately than if they had been discussed from memory. This exercise was an effective resolution to practical and ethical research difficulties of doing this *in vivo*.

Results

Thompson et al.'s study on the socio-economic impact of crowding on the Australian metropolitan rail industry (20) found that a variety of factors influence the crowding experience. These can be seen in Figure 1.

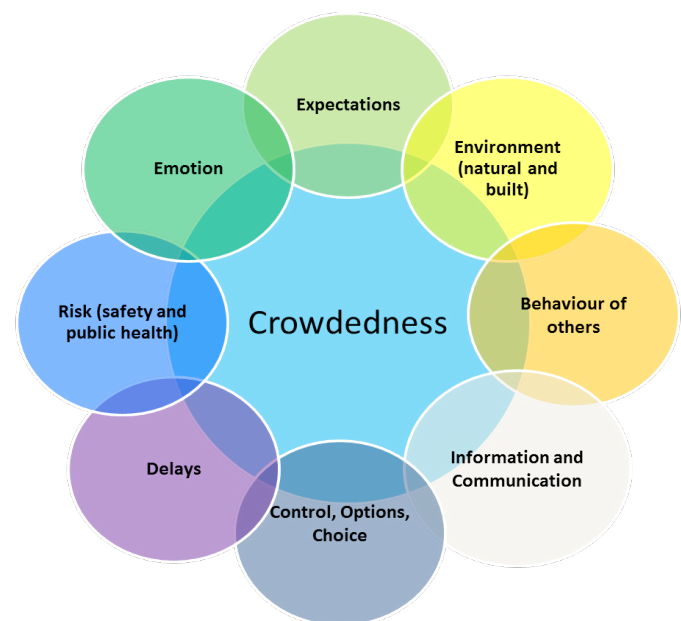


Figure 1. Impacts on passenger perception and tolerance of crowding. Originally cited in Thompson et al. (2011 forthcoming) (20).

Each theme mentioned in Figure 1 describes one aspect of the overall crowding experience and must, therefore, be approached with this in mind. The themes are not isolated and many act in conjunction, or have influence over, each other to impact passenger experience and tolerance of crowdedness. Thus, if one aspect is altered, it will have an effect on other factors in the model and ultimately on crowdedness itself.

The following section of this paper will focus on results surrounding the individual theme of 'environment (natural and built)', and within this, the design and placement of handholds in the carriage.

Both the focus groups and the observations on carriages found that passenger tolerance to, and perception of, crowdedness was strongly influenced by the design, location, make and cleanliness of handholds. Passengers were affected by the location of holds to such an extent that their chosen position within the carriage was often governed by the presence of handholds in that area. This is illustrated in Figures 2 and 3, which demonstrate passenger placement choices within a crowded carriage. Each passenger is marked by an X and focus group participant placement is signalled by a number.

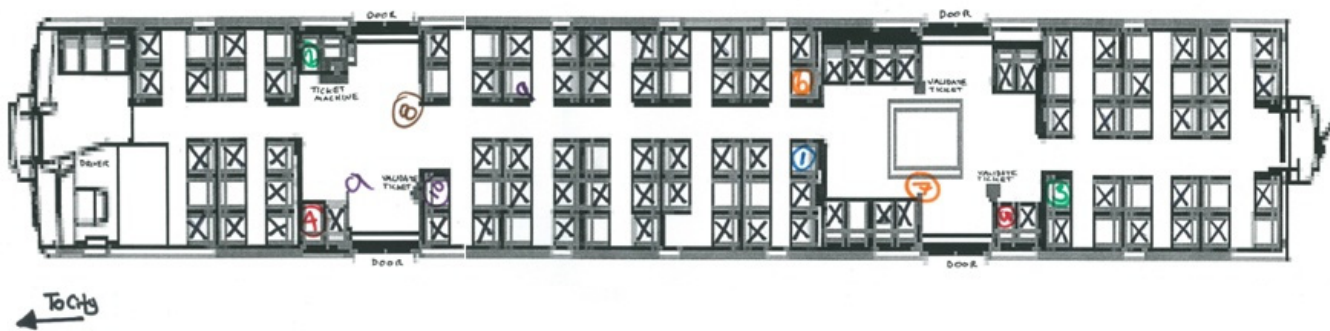


Figure 2. Younger female placement in a crowded carriage, Site 1

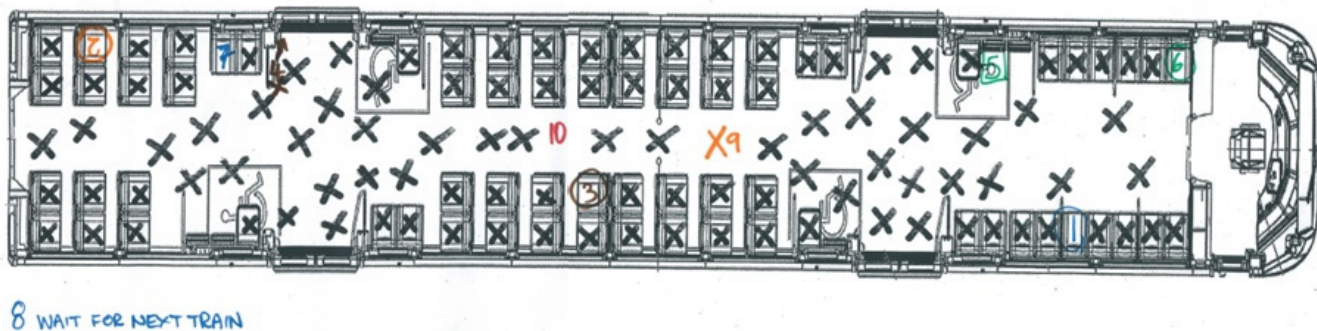


Figure 3. Older male placement in a crowded carriage, Site 4

It must be noted that the different crowding levels in each site correspond to observations of passenger density during peak times in those specific sites.

Whilst completing the hypothetical carriage-filling exercise, participants were encouraged to explain why they had chosen that specific location within the carriage. In the instances when a seat was not available, or was too difficult to reach, participants indicated the importance of securing a handhold: “need something stable to hold onto” [older female], “getting a hold when you are standing makes the journey more comfortable” [older male]. Coupled with their choices illustrated in Figures 2 and 3 and their annotations regarding these choices, it was found that passengers made choices with regards to handholds that govern their location within the carriage. This choice also impacted on their overall experience of the train journey and their perception and tolerance to being crowded.

Participants emphasised the importance of not only being able to access a clean handhold, but also the significance of the perceived security of the holds. Whilst there are a large variety of handhold designs and materials used in Australian metropolitan carriages, three general designs were common to all sites, however specific details within these designs differed between states. Participant reactions to and perceptions of these were discussed during focus groups:

1. **Hold behind seat:** These holds are places at the back of the seat closest to the aisle. Participants indicated that these holds increased their stability whilst standing. Depending on the state specific design, some participants claimed that they did not use these holds because they felt as though their hand was too close to the seated passenger’s head.

Due to the small size of the hold (except in one site), participants felt uncomfortable sharing the hold as their hands would touch. Subsequently, in crowded conditions a number of people would not be able to access a hold.

2. **Hanging hand strap:** These holds are often found in one or two rows running down the length of the corridor between the seats. There was a consensus amongst participants that these holds did not improve their stability on the train: “they move, so you like, fall anyway” [younger male]. In addition, a number of participants indicated that they could not reach the straps. Many participants claimed that to maintain balance, it was more effective to hold two straps, “like swinging in a tree” [younger male], however in crowded conditions, this was not possible. Complaints regarding the odour of fellow passengers using these holds were also raised.
3. **Vertical pole:** This design often occurs in the centre of the vestibule and around the perimeter of the vestibule. Participants identified the poles as secure and well placed: “When you get on and there are lots of people, you can normally reach that pole in the middle” [younger female]. They commented on the benefits of the poles as being accessible to people of all heights: “I’m really short, so at least I can reach the pole and not fall over” [younger female], that they allow for multiple people to hold them without their hands touching and the fact that they were secure and allowed for passenger stability.

As discussed earlier, a carriage is designed well when the passenger no longer notices the space that they are in (6). This was clearly demonstrated by discussions with focus group participants regarding handholds. A strong association in the focus groups

was found between the quality of handholds (size, location, material, cleanliness) and perceived passenger comfort, security, location in the carriage and the perception of crowdedness.

Discussion and conclusion

This paper has demonstrated the importance of the built carriage environment, particularly of handholds on passenger comfort and tolerance in crowded carriages. A strong association in the focus groups was found between handholds and perceived passenger comfort, security, location in the carriage and the perception of crowdedness.

It was found that handholds had a significant impact on passenger experience and tolerance of crowding. In particular, passengers preferred secure, hygienic and well-distributed holds within the carriage that could be reached during high crowding times. The brief descriptions of three common handhold designs, mentioned in the results section, demonstrate the variety of factors within the scope of handholds that must be considered when designing the internal structures within carriages. In addition to creating materials that may be easily cleaned, and holds that allow passengers to feel stable and secure, designers may also consider the impact of crowding on the positioning of handholds.

Further exploration into the optimal design of handholds in carriages is required to reduce passenger perception of crowdedness and to ensure the safety and comfort of passengers within this environment. Designing or refitting carriages with these requirements would assist rail companies in the alleviation of passenger perceptions of crowdedness.

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References

1. Rail Corporation. *Annual Report*. Sydney: Rail Corporation. 2009-2010.
2. Public Transport Authority Western Australia. *Annual Report*. Perth: PTA WA2009-2010.
3. Currie G. Quick and effective solution to rail overcrowding: free early bird ticket experience in Melbourne, Australia. *Transportation research record*. 2010; 2146(1):35-42.
4. Currie G. Research perspectives on the merits of Light Rail vs Bus. *BITRE Colloquium*; 18-19 June 2009; Canberra: BITRE Colloquium; 2009.
5. Hale C, Charles P. Managing peak demand for passenger rail: A literature review. *32nd Australasian Transport Research Forum (ATRF)*; Auckland, New Zealand: ATRF; 2009.
6. Osborne D, Branton R, Leal R, Shipley P, Stewart T, editors. *Person-Centred Ergonomics: A Brantonian View of Human Factors*. London: Taylor and Francis; 1993.
7. Fulton Suri J. Scenario building as an ergonomics method in consumer product design. *Applied Ergonomics*. 2000;31(2):151-7.
8. Turner S, Corbett E, O'Hara R, White J. *Health and safety effects of crowding: Hazard identification (T307)*. London: Health & Safety Laboratory 2005. Report No.: RAS/04/12/1.
9. Stokols D. On the distinction between density and crowding: *Some implications for future research*. *Psychological Review*. 1972;79(3):275-7.
10. Baum A, Paulus P. Crowding. In: Stokols D, Altman I, editors. *Handbook of environmental psychology*. New York: John Wiley & Sons; 1991.
11. Evans G, Wener R. Crowding and personal space invasion on the train: Please don't make me sit in the middle. *Journal of Environmental Psychology*. 2007;27:90-4.
12. Epstein Y. Crowding stress and human behavior. *Journal of Social Issues*. 1981;10:370-83.
13. Kaya N, Weber M. Cross-cultural differences in the perception of crowding and privacy regulation: American and Turkish students. *Journal of Environmental Psychology*. 2003;23(3):301-9.
14. Kim D-Y, Lee K-H. Cultural differences in the customer perception of crowded restaurant: emotions, intolerance and perceived price. *International Journal of Revenue Management*. 2010;4(3-4):420-31.
15. Whiting A, Nakos G. Functional density and its impact on retail satisfaction in cross-cultural contexts: Can crowded stores be a good thing for retailers? *Research, Teaching and Practice*. 2008;2(1):1-11.
16. Bissell D. Conceptualising differently-mobile passengers: geographies of everyday encumbrance in the railway station. *Social & Cultural Geography*. 2009;10(2):173-95.
17. Bissell D. Travelling vulnerabilities: mobile timespaces of quiescence. *Cultural geographies*. 2009;16(4):427.
18. Thurmond V. The point of triangulation. *Journal of Nursing Scholarship*. 2001;33(3):253-8.
19. Barbour R. Making sense of focus groups. *Medical Education*. 2005;39(7):742-50.
20. Thompson K, Hirsch L, Rainbird S. *A socio-economic study of carriage and platform crowding in the Australian railway industry: Qualitative research summary*. Brisbane: CRC for Rail Innovation & University of South Australia forthcoming, 2011.