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Understanding Passenger Perceptions and Behaviors During Unplanned Rail Disruptions

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Abstract

Due to aging infrastructure, increasing demand and limited capacity, unplanned failures of urban rail systems have become a major concern for cities worldwide. A key feature of unplanned rail disruption (URD) is the often chaotic and crowded conditions which arise. Passengers are placed in a situation of uncertainty and must often find their own way to react. Because rail staff are busy coordinating responses, little is known of how passengers actually behave during a URD; what alternative modes are used when passengers leave stations?. In addition, apart from often 'colourful' complaints, it is often unclear what passengers think of operator responses; what are passengers priorities for responding to URD's? This research aims to understand passenger behaviours, perceptions and priority interventions in response to unplanned urban passenger rail disruptions. It reports on a major survey of rider responses undertaken for users of the Metropolitan heavy rail system in Melbourne, Australia.

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Keywords: fare evasion; theory of planned behaviour; structural equation modelling

1. Introduction

Urban passenger rail systems have become a central part of the functioning of cities due to high capacity and speed advantages compared to congested urban road networks (Lane 2008, De-Los-Santos et al. 2012). Unfortunately rail services can be disrupted by unexpected events causing significant disruption (Jespersen-Groth et al. 2009) with significant impacts:

> "When no advance preparations are made, uncoordinated Government responses can combine with tremendous public confusion and uncertainty to leave the urban transportation system in a state of near paralysis" (Meyer and Belobaba 1982, p.1).

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This research paper aims to understand passenger behaviours, perceptions and priorities during unplanned passenger rail disruptions using a primary survey of rail users who have experienced unplanned disruptions. This is an under-researched area for a number of reasons. Firstly behaviours during disruptions are particularly difficult to capture; a high degree of confusion is apparent and frustrated passengers are not likely to be amenable to answering questions. Secondly rail staff have little interest in understanding behaviours or passenger perceptions during a disruption; since restoration of service and dealing with the most important passenger needs necessarily comes first. Finally rail disruptions are somewhat embarrassing to rail agencies and hence it rare to find an authority willing to delve into any depth regarding these situations.

This paper is structured as follows. The next section explores the context of the research including an outline of relevant literature and a description of the Melbourne rail service case study. This is followed by a description of the research methodology. The results are then detailed. A discussion and conclusions then follow.

2. Research Context

Of the limited research on customer needs and priorities during disruptions, almost all of it highlights a need for better passenger information. A UK study found that the highest priority information needs of customers during unplanned disruptions were :

- the length and reason for delays ;and
- alternative travel options

(Passenger Focus 2011).

This was also supported by a study of rail disruption on the London Underground (Harazeen 2011). This study highlighted data reliability as a major concern. Some quotes from passengers make clear the emotional context of disruptions

> "It's the lack of information I find really frustrating because if you know there's not going to be a train then you can make other plans for the day."
>
> "What frustrated me the most was not knowing what was going on."
>
> (London, Commuters, 2011)

While these studies highlight information as a key criteria, its unclear what the relative priority or importance of these needs are relative to others. In addition, passenger behaviours during disruptions is unclear. These were major areas for investigation in the Melbourne study.

Melbourne Case Study

MetroTrains Melbourne operate Melbourne's suburban railway network including 203 six-carriage electric trains across 830 track kilometres and 215 stations servicing more than 230 million annual customer journeys (MetroTrains 2013). Much of the infrastructure used on the rail system is old and the system is also vulnerable to extreme weather events hence unplanned disruptions to rail services occur reasonably often. To respond to this problem, Metro Trains has a system of bus replacement (or 'bus bridging') routes designed to carry passengers when rail services can no longer operate. However it takes time to get a bus bridging service into operation; commonly requiring 90 mins between cessation of rail service to full commencement of bus bridging service. Little is known about what passengers do during this time. Bus bridging is actually the most common response to rail service disruption identified in an international survey of rail authorities (Pender B et al. 2013). However most research on Bus bridging has focused on operational issues to do with route design (Kepaptsoglou and Karlaftis 2009), bridging termini location (Pender et al. 2012) or reserve bus depot location (Pender B et al. 2014). There have been some theoretical studies understanding how passengers may behave if they are frustrated with delayed bus bridging responses (Wang Y et al. 2014a, Wang Y et al. 2014b). However these studies have not considered primary research data on actual passenger responses; a major aim of the surveys developed and described in this research paper.

3. Methodology

The major element of the methodology was an on line web survey of a random sample of public transport users selected from a large market research panel. Quota sampling was applied to achieve a high share of respondents who :

- used public transport more frequently (travel 3-4 days per week or more); and
- had been involved in an unplanned rail disruption (URD) involving a bus replacement service at least once in the last 2 years.

The rationale for quota sampling was to ensure higher sampling of passengers who had URD experience. Higher frequency users in particularly were thought to be more likely involved in a URD. In addition higher frequency users represent a higher share of trips made (above 70% of actual public transport travel comes from high frequency users but they represent less than 20% of the population using public transport). Since the survey is sampling the population of users, it was important to include a high share of passengers who travel often.

Where results were required for a sample which represented the overall population of public transport users, the quota sample was adjusted using weights to represent trip frequency of the ridership population as a whole.

Table 1 shows the targeted quota sample and the result achieved from the actual survey which was undertaken in November 2013.

Table 1: Targeted and Outcome Sample Frame – Rail Opinion Survey (Nov 2013)

Sample Frame	Design Quota	Sample Outcome
High Frequency Train Users[1]	200	203
Low Frequency Train Users[1]	200	460
Respondent experienced an Unplanned Rail Disruption including Bus Replacement in the last 2 years[2]	200	427
Total	600	663[2]

[1]High frequency concerns users who travel 3-4 days a week or more

[2]There is double in the Sample Outcome of passengers who experienced a URD involving bus replacement and also were low and high frequency users.

A total sample of 663 was achieved more than 10% above that planned.

The survey questionnaire sought to explore the following research questions:

a. perception of the issue of URD's and authority responses to URD's with the context of other problems passengers perceived as issues with the rail service
b. rail service satisfaction as it varies between those with experience of URD's and those without
c. travel behaviours of those involved in a URD which includes a bus replacement service
d. passenger perceived priorities for attention in improving authority responses to URD's.

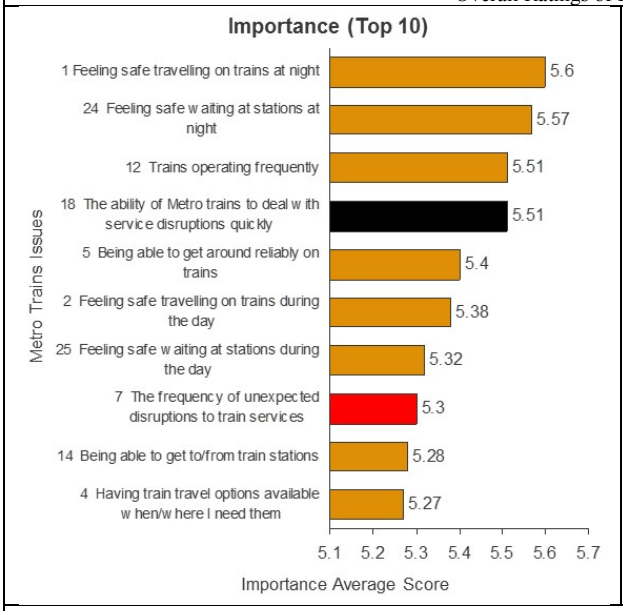
To explore passenger perceptions of URD's and URD response in more depth. An Importance/Performance Analysis framework (sometimes called a Quadrant Analysis) method (Martilla and James 1977, Weinstein 2000) was adopted to explore passenger perception of issues in terms of overall importance as well as the performance of the rail system in addressing these issues.

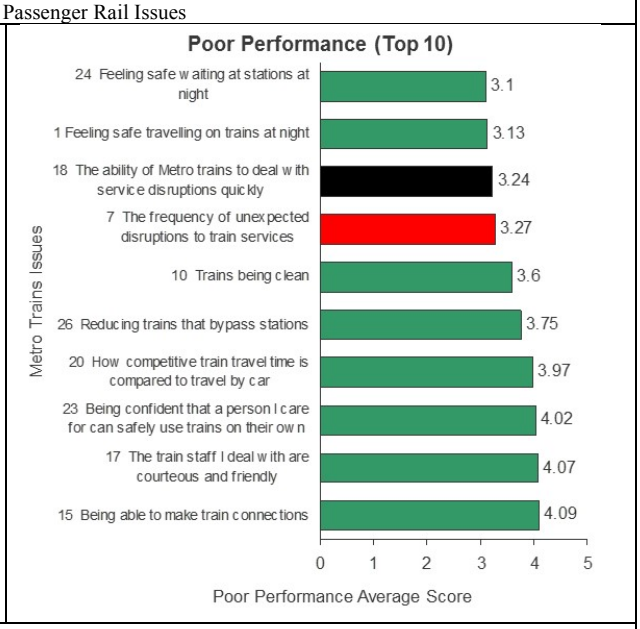
4. Results

a. The Perception of URD's in Perspective

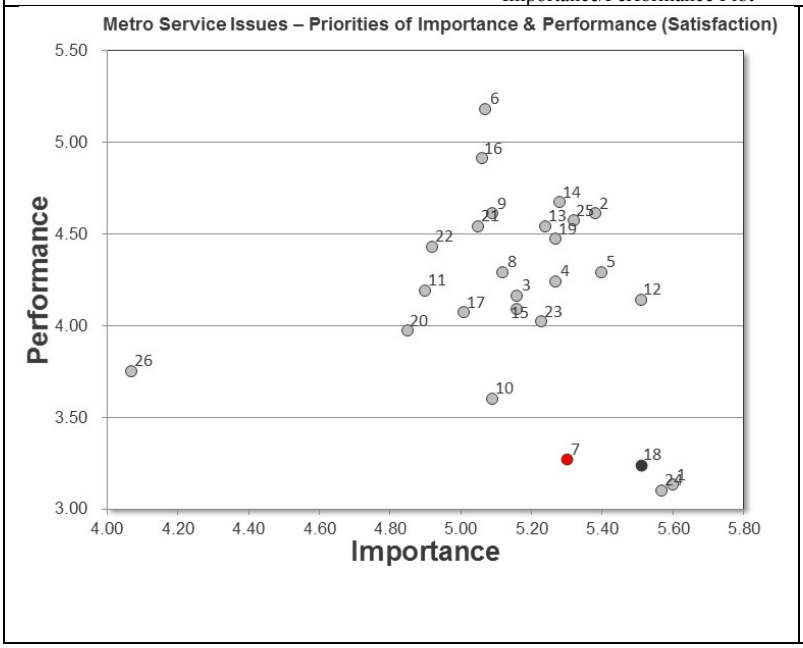
The first set of results concerns the perception of passengers regarding URD's relative to other issues in rail service use. Results concerning this area of the research used an Important/Performance framework to explore perceptions both from the point of view of their relative importance as well as the view of their performance. Figure 1 illustrates the result of this analysis.

Overall Ratings of Passenger Rail Issues





Importance/Performance Plot



Code/ Issue	Rank
24 Feeling safe waiting at stations at night	1
1 Feeling safe travelling on trains at night	2
18 The ability of Metro trains to deal with service disruptions quickly	3
7 The frequency of unexpected disruptions to train services	4
10 Trains being clean	5
12 Trains operating frequently	6
23 Being confident that a person I care for can safely use trains on their own	7
15 Being able to make train connections	8
20 How competitive train travel time is compared to travel by car	9
17 The train staff I deal with are courteous and friendly	10
3 Being able to meet train costs/fares	11
5 Being able to get around reliably on trains	12
4 Having train travel options available when/where I need them	13
8 Trains being available at night	14
11 Feeling comfortable being with people you don't know on trains	15
19 The quality of train travel information available to plan my journey	16
26 Reducing trains that bypass stations	17
25 Feeling safe waiting at stations during the day	18
13 Being able to get information about train services	19
2 Feeling safe travelling on trains during the day	20
22 Being confident to make trips to places I haven't been before by train	21
21 How easy it is to identify, buy and use the right train ticket	22
14 Being able to get to/from train stations	23
9 Trains being available at weekends	24
16 Overcrowding on trains	25
6 Being able to physically get onto/off trains	26

Note: Weighted Sample – Representative of the Market in terms of Ridership (frequent users have a higher weighting). Scores are ranked by importance score * performance score

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Figure 1: Importance Performance Analysis – Rail Passenger Concern Ratings Including URD Issues

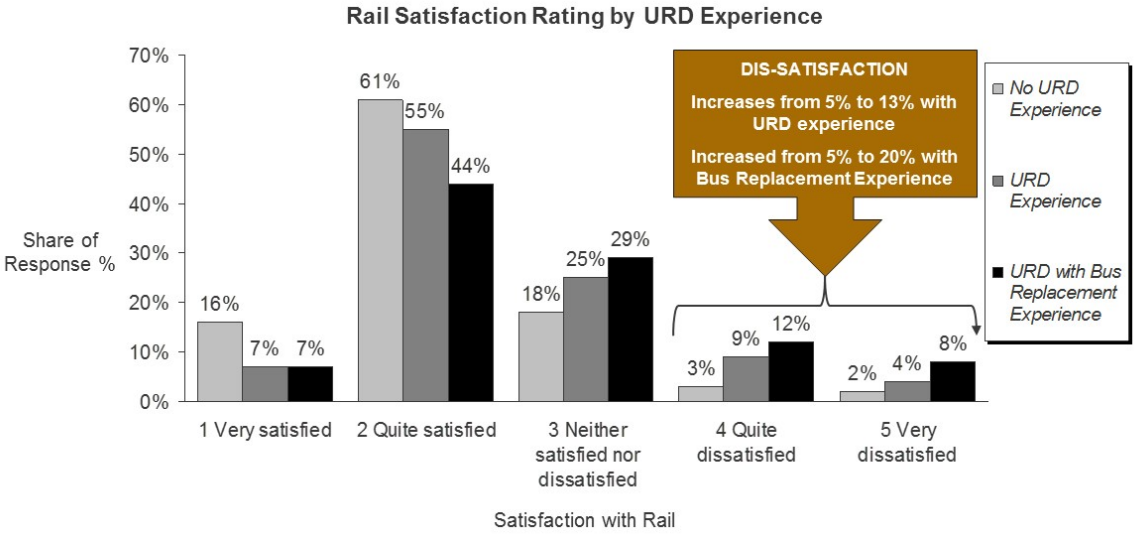
Figure 1 illustrates that:

- The occurrence of URD's is NOT a high ranked issue in terms of IMPORTANCE. Its ranked 7th well below other issues such as feeling safe on trains or train service frequency. However the ability to deal with disruptions quickly is considered a high importance issue (ranked 4th).

- In terms of (poor) PERFORMANCE, dealing well with disruptions and the occurrence of disruptions is ranked 3rd and 4th respectively. Feeling safe on trains at night on stations and trains is considered an issue of poorer performance than those associated with URD's.
- The Importance Performance analysis plot shows that URD related issues (occurrence and response) are amongst the top 4 priority concerns (they are at the bottom right of the plot in Figure 1; representing issues of higher relative importance and low relative performance). However again, safety at night is still considered a more significant issue to passengers.

b. Rail Satisfaction and URD Experience

Figure 2 shows the range of scores for overall satisfaction with rail services divided into those with no URD experience in the last 2 years, those with URD experience and those with URD experience involving bus replacement services.



Note: Weighted Sample – Representative of the Market in terms of Ridership (frequent users have a higher weighting).

Figure 2: Passenger Rail Service Satisfaction Ratings by URD Experience

Figure 2 illustrates that:

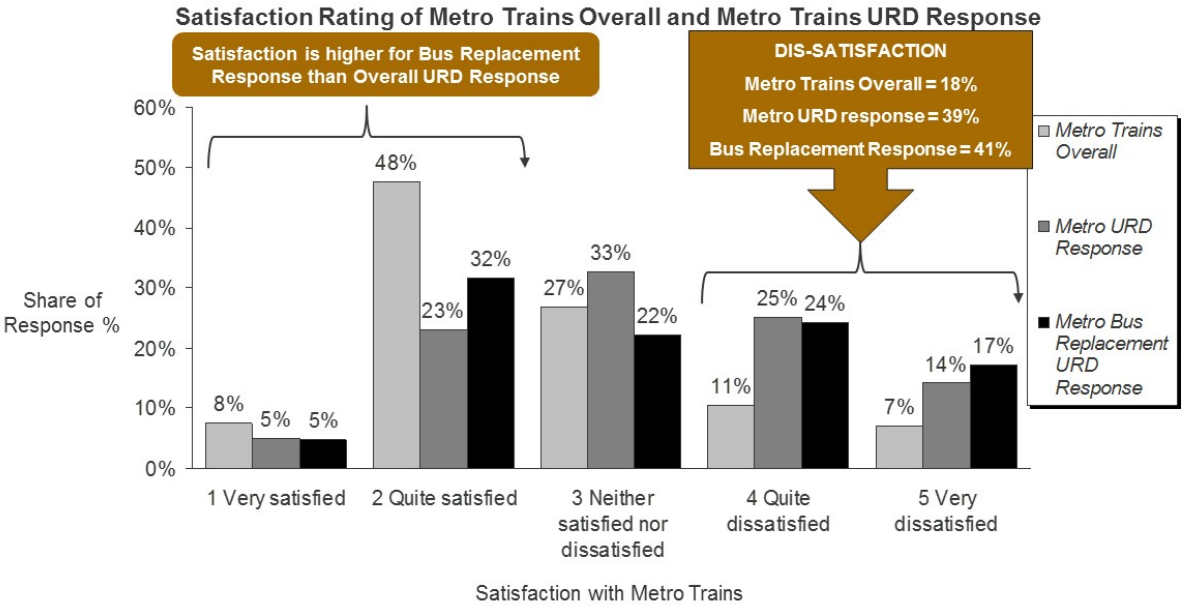
- Those without URD experience have a very high degree of satisfaction with rail services. Some 77% of rail users are quite or very satisfied. Only 5% are quite or very dissatisfied
- Passengers with URD experience also have on balance a high degree of satisfaction (62% are quite or very satisfied) however this share is less than those without URD experience. Also dissatisfaction increased for those with URD experience ; 13% are quite or very dissatisfied. More than double the level of dissatisfaction of those without URD experience.
- Passengers who have experienced URD's involving bus replacement have the lowest level of satisfaction. On balance a small majority are still quite or very satisfied (51%) however 20% are quite or very dissatisfied; more than four times the level of dissatisfaction of those with no URD experience.

Overall therefore URD experience acts to reduce rail service satisfaction; bus replacement experience acts to reduce satisfaction more than non-bus replacement responses to URD's. To explore the issue of satisfaction further; questions focused on satisfaction with rail service responses to URD's. Figure 3 illustrates the results on this issue divided by the overall sample, those with URD experience (all forms of response to URD's) and responses in the form of bus replacement.

Figure 3 indicates that:

- The overall market has a net level of satisfaction with rail services. Some 56% of rail users are quite or very satisfied. 18% are quite or very dissatisfied. Interestingly these degrees of satisfaction are much lower than those shown in Figure 2 for passengers with no URD experience.
- Passengers satisfaction with URD responses overall show a balance towards dissatisfaction (39% are quite or very dissatisfied; 28% are quite or very satisfied; a third neutral)
- Passengers satisfaction with URD responses involving bus replacement are also on balance dissatisfied (41% are quite or very dissatisfied; 37% are quite or very satisfied; 22% neutral) however a much higher share of passengers are satisfied with URDs involving bus replacement (37%) than with URD responses overall (38%)

These results suggest that while passengers show a slight bias towards dissatisfaction with URD responses, Bus Replacement responses are more highly valued. Exploration of these issues in focus groups held as part of the project suggests that passengers appreciate that the rail authority is trying to find a solution to problems, and appreciate when problem are not caused by the rail operator. Nevertheless overall passenger satisfaction is low with URD's probably because of the unexpected difficulties and disruptions they cause.



Note: Weighted Sample – Representative of the Market in terms of Ridership (frequent users have a higher weighting).

Figure 3: Passenger Satisfaction Ratings – Overall and also to URD Responses

c. Travel Behaviour During Bus Replacement URD's

Figure 4 shows the range of passenger behaviours respondents noted during their last bus replacement URD experience. This indicates that over 2/3^{rds} of the rail market wait and use rail replacement buses. This was something of a surprise to the researchers (and the rail operator) since as noted, usually it takes 90 minutes for a rail replacement service to fully respond. Nevertheless passenger will tend to wait for bus service. The high degree of use of rail replacement buses is also because many passengers don't have to wait at all; buses are already running when they arrive at their station (18% of responses in Figure 4). While on average it can take 90mins to have a full bus replacement operation in place URD's can often take over 4 hours to recover the rail service; hence a high share of passengers don't have to wait for long periods.

Figure 4 also shows that a high share (28%) find alternative transport either in the form of alternative parallel public transport or via taxis or asking friends to assist. Only 3% did not travel.

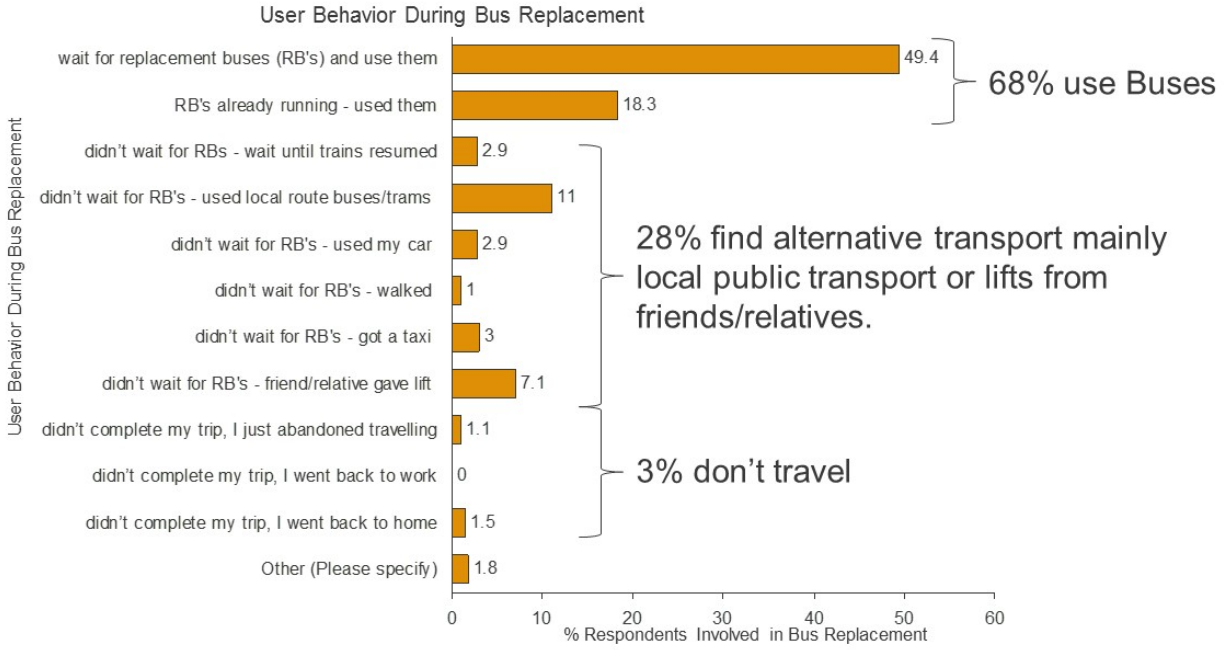


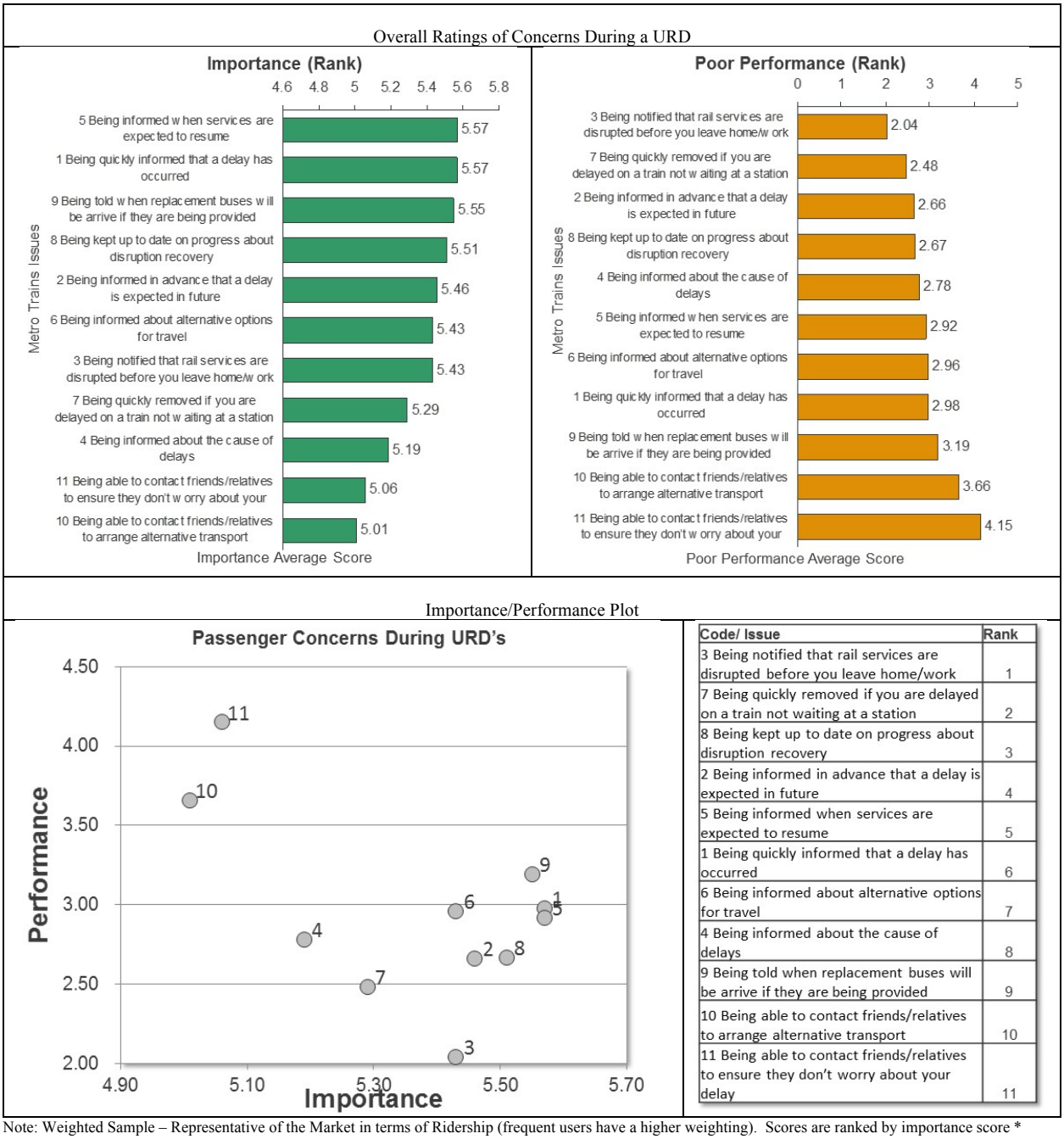
Figure 4: Passenger Travel Responses DuringTheir Last URD Involving Bus Replacement

d. Priorities for URD Response Planning

Figure 5 shows the results of the Importance Performance analysis of passenger major concerns during a URD. This indicates that:

- In terms of IMPORTANCE, passengers want to be notified when services will resume, be informed promptly that a delay has occurred and be told when replacement buses are to arrive if provided.
- In term of (Poor) PERFORMANCE, passengers were particularly concerned that they were not informed of disruptions before they left home/home (if this was possible). The third rated performance concern was related; being informed in advance if a delay is expected in future. Being quickly removed from a delayed train was also poorly rated in terms of performance.
- From the importance-performance plot, the top ranked issue is being informed of disruptions before they left home/work. This issue not only ranked 1st, it also stood out from the others in the importance /performance analysis.
- Being removed quickly from a stranded train and being kept up to date about disruption recovery were the third and fourth ranked concerns in the importance/performance analysis.

Overall results show a similar set of concerns regarding access to information as those shown in the UK studies (Passenger Focus 2011). However the concept of learning about disruptions prior to travel means a person can avoid or differ travel; is a new priority which is not apparent in previous studies.



Code/ Issue	Rank
3 Being notified that rail services are disrupted before you leave home/work	1
7 Being quickly removed if you are delayed on a train not waiting at a station	2
8 Being kept up to date on progress about disruption recovery	3
2 Being informed in advance that a delay is expected in future	4
5 Being informed when services are expected to resume	5
1 Being quickly informed that a delay has occurred	6
6 Being informed about alternative options for travel	7
4 Being informed about the cause of delays	8
9 Being told when replacement buses will be arrive if they are being provided	9
10 Being able to contact friends/relatives to arrange alternative transport	10
11 Being able to contact friends/relatives to ensure they don't worry about your delay	11

Note: Weighted Sample – Representative of the Market in terms of Ridership (frequent users have a higher weighting). Scores are ranked by importance score * performance score

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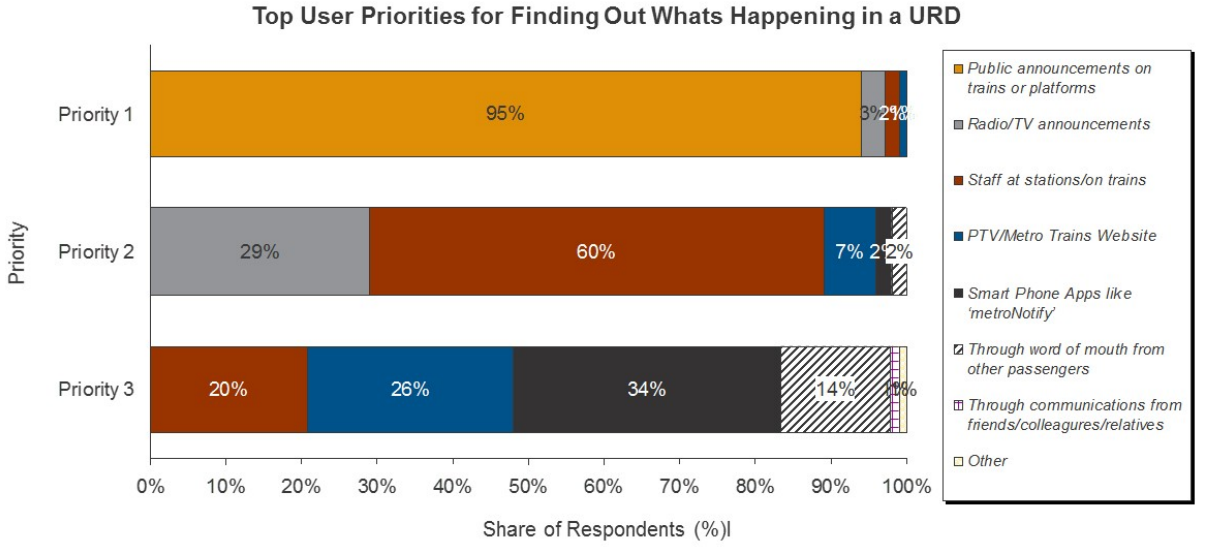
Figure 5: Importance Performance Analysis – Rail Passenger Concerns During a URD

Figure 6 shows the respondent ratings regarding preferred URD response measured from the opinion survey. This shows that:

- The first priority user suggestion by far (suggested by 95%) is better public announcement systems on trains or platforms
- The biggest second order priority was staff at stations or trains to assist (60%)
- Radio and TV announcements were rated as a second order priority for 29% of respondents
- Third order priorities were more mixed between groups. The largest of these was improved PTV/rail websites (34%), improved smart phone apps (34%) and staff at stations/on trains (20%).



Note: Weighted Sample – Representative of the Market in terms of Ridership (frequent users have a higher weighting). Scores are ranked by importance score * performance score

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Figure 6: Respondent Ratings for Measures to Improve URD Response for Customers

An interesting finding from these results is the desire for basic equipment (public address systems) and staff assistance rather than more sophisticated smart phone or web based solutions. Although smart communications and social media based applications have proven popular in recent research, passenger prefer basic systems and see these new applications as second order solutions; they still rate highly overall.

5. Conclusions

This research paper aims to understand passenger behaviours, perceptions and priorities during unplanned passenger rail disruptions using a primary survey of rail users who have experienced unplanned disruptions in Melbourne, Australia. A quota sample of some 631 respondents was adopted to explore a. perceptions of URD's relative to URD experienced, b. overall satisfaction with rail, relative to URD experience, c. travel behaviour during bus replacement URD events and d. passenger priorities for respondes to URD's. URD occurrence and authority response were ranked third and fourth most important issues with the poorest performance by rail users. Overall passengers had high satisfaction levels with rail services however those with URD experience had lower satisfaction and those who experienced URD with bus replacement had substantially lower satisfaction. Satisfaction with rail operator responses to a URD were relatively low but there was some relatively positive satisfaction for URD responses involving bus replacement services; mainly because the operator is being seen to ensure some degree of service is provided. Over 2/3^{rds} of passengers involved in a URD including bus replacement use the replacement buses despite long wait times (90mins) between rail failure replacement bus service full operation. Some 28% find alternative modes including

getting picked up by friends and relatives. The biggest concerns users have during a URD are being informed about disruptions before you leave work/home and being removed if you are delayed on a train. The main user priorities to improve URD responses are 1. Improved public announcement systems on trains and platforms, improved staff on stations/trains and better web site systems.

The research has reinforced concerns about passenger information during disruptions however a new issue; informing passenger of current disruptions before they leave home/work has been raised. With average disruption times of 4 hours current in Melbourne and an average rail travel time of about 40 mins, the implication is that most passengers who would be disrupted will not have left home/work yet. Informing them can act to "evaporate the peak" a phenomenon raised by rail planners in New York in an international survey of rail disruption planning (Pender B et al. 2013). By informing passengers of disruptions, they can plan to make their own arrangements. It also acts to remove the problem of handling large volumes of passengers from the rail operator. This research has found passenger believe this approach is their highest concern during URD's; so both users and optimal planning practice can converge as long a means to contact passengers can be found.

Overall the research has supported the case for better understanding user priorities and perceptions during URD's. Despite the often chaotic and long waits associated with the immediate response to URD's involving bus replacement, most passengers wait for buses to come and use them. There is some suggestion of appreciation from passengers of the rail authority that tried to find solutions like bus replacement. The use of social media applications is supported in users responses however basic simple needs like public announcements and staff help still rate highest.

Future research should involve more disaggregate assessment of performance including differentiation of good and bad URD responses and their implications for satisfaction and perceptions. Exploring who and why alternative travel responses are made during URD's would assist in better forecasting travel alternatives. To better respond to URD's research such as that described in this paper needs to be undertaken more widely into the future.

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