

Understanding public transport user behavior adjustment if public transport ceases - A qualitative study

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Abstract

The mode shift from public transport (PT) to private car when PT ceases causes an increase in the number of car trips on the road network that leads to a rise in the level of traffic congestion. To manage and propose measures to cope with this issue, it is necessary to assess the share of PT users who would shift to car and be aware of the flexibility of PT users to change their travel behavior if PT is no longer available. The share of PT users who would shift is also an important parameter used for assessing traffic congestion relief associated with PT.

This study seeks to uncover factors influencing the mode shift to car of PT users adopting a qualitative study. Semi-structured interviews were conducted with 30 PT users from Melbourne, Australia. Content analysis was performed using Nvivo10 software. Grounded theory was used to derive categories and subcategories of behavioral responses. Factors affecting the mode shift to car if PT ceases in the short term were classified in three main themes with several subcategories: individual-specific factors, context-specific factors and journey-specific factors. In the long term, the analysis reveals that only context-specific factors have an influence on mode shift. The findings show that the interplay between car access, low travel time, low travel cost, trip importance, non-central business district (CBD) trips, weather, flexibility and accessibility to PT stations are the most important factors in favor of choosing a car if PT ceases in the short term. The removal of PT in the short term acts only to increase traffic congestion due to the mode shift to car. However, in the long term, removing PT could result in an impact on land use, leading to individuals changing their residential and workplace location.

1. Introduction

With many advantages to the private car such as convenience, flexibility and safety, there has been a rapid growth in private car use, particularly in urban areas. This trend not only affects the environment but also contributes to many social problems such as traffic congestion and poor health (Greene and Wegener, 1997). Hence, several potential measures have been proposed and implemented, in which PT is considered to be a sustainable, viable alternative to the private car (Holmgren, 2007). So what will happen if PT ceases? Previous research has shown that a share of PT users would switch to car, either as a driver or a passenger, leading to an increase in the number of car trips on the road network (Exel and Rietveld, 2001, Aftabuzzaman et al., 2010b, Nguyen et al., 2015). As a result, the level of traffic congestion would increase and cause an increase in travel delay, travel cost, accidents and air pollution (Exel and Rietveld, 2009a).

Based on the assumption of “the removal of PT would lead to car mode shift”, researchers have proposed several models to estimate traffic congestion relief associated with PT. In 2012, the annual urban mobility report from the Texas Transportation Institute explored the effect of PT on saving travel time in 498 urban areas in America (Schrank et al., 2012). In

this report, all commuter rail travellers are assumed to shift to private cars travelling on freeways if a PT service shutdown occurs. Another study that measured the congestion relief benefit of PT at a corridor level came from Washington, D.C. (Federal Transit Administration, 2000). Both of these studies are aggregate in nature (citywide and/or corridor level), and their fundamental assumption for measuring congestion relief benefits is that all PT users switch to private vehicles when the PT service ceases. These methodologies are considered limited and simplistic because there are still many alternative transport modes that PT users can choose other than a car. Hence, Aftabuzzaman et al. (2010a) argued that in practice not all PT users would shift to using a car if PT is removed. Indeed, they assembled reliable evidence showing that only a percentage of PT riders could switch to driving a car. From secondary research, they suggested that on average 32% of PT users would shift to driving a car, with this figure fixed for all locations. Nguyen et al. (2015) suggested an improved method to vary the share of PT users who shift to driving a car based on the travel characteristics of each location.

The share of mode shift to car is considered a key parameter used for estimating traffic congestion relief associated with PT. Based on this transport management authorities can forecast the car mode shift share and then identify the benefit of a PT system in terms of traffic congestion relief. The mode shift share could also be used to investigate the increase in congestion in the event of a PT strike. Thus, measures could be targeted to better deal with congestion caused by PT strikes. However, identifying the share of PT users who would switch to a private car driving if PT does not exist is a complex process since it deals with the travel attitude and behavior of each PT passenger. Consequently, a better understanding of the flexibility of PT passengers when PT ceases is needed.

The paper presents the results of a qualitative survey of PT users in Melbourne, Australia. The key research questions addressed in this study are: How would people travel to their destinations if PT was no longer available (short term and long term)? What are the main factors affecting people's mode choice in this context? To explore these questions, a series of in-depth interviews were conducted.

This paper is structured as follows: the next section outlines previous studies regarding mode shift. This is followed by a description of the study methodology. The findings are then presented. The paper concludes with a discussion and conclusion.

2. Literature review

Qualitative research has been used widely to investigate issues of health, tourism, education and politics but used relatively little to explore studies of transport, particularly understanding the mode choice of transport users. Table 1 presents a summary of studies in this area with a particular emphasis on factors influencing mode shift to car. These studies are now briefly discussed. Hagman (2003) studied car users and investigated the advantages and disadvantages of using a car. Mann and Abraham (2006) stated that travel mode choice is not solely dependent on utility factors such as time, cost and reliability. By conducting semi-structured interviews with 18 car users in a UK university, they identified four main themes associated with decisions to drive or use PT. They included journey-based effects, personal space, autonomy and identity. Beirao and Cabral (2007) conducted in-depth interviews with PT users and car users to obtain an understanding of traveller's attitudes towards transport. Several factors influencing the choice of driving a car were identified, including travel time, attachment to cars, dependence on cars, car convenience and car status. Guiver (2007) undertook ten focus groups discussing bus and car travel. He found three themes affecting car use, including the nature of the vehicle interior (safe, private space), cost and time. Gardner and Abraham (2007) explored the reasons for driving to work and found five major motivations: journey based effects, journey time concerns, monetary cost, effort minimisation and personal space concerns. This study was focused on identifying factors influencing the choice of driving based on interviews with car users.

Table 1 Summary of previous qualitative research exploring factors affecting car mode choice

Authors	Factors influencing car mode choice	Methodology
Hagman (2003)	<ul style="list-style-type: none"> - Freedom - Convenience and flexibility - Travel time - Weather condition - Safety - Environment 	Semi-structured ethnographic interviews with 30 car users in Sweden.
Mann and Abraham (2006)	<ul style="list-style-type: none"> - Journey-based effects (comfort, enjoyment, stress) - Personal space - Autonomy (freedom) - Car ownership and identity 	Semi-structured interviews with 18 drivers who have journey to work at a university.
Beirao and Cabral (2007)	<ul style="list-style-type: none"> - Travel time - Attachment to cars - Dependence on cars - Convenience and flexibility - Car status - Environment 	In-depth interviews with the general public, including regular and occasional users of public transport and car users (27 users in total).
Guiver (2007)	<ul style="list-style-type: none"> - Vehicle interior (safe and private) - Timing - Costs 	10 focus groups with groups of 9–10 respondents, men and women, bus and car users.
Gardner and Abraham (2007)	<ul style="list-style-type: none"> - Journey time concerns - Journey-based effects - Minimising effort - Personal space concerns - Minimising monetary costs 	Semi-structured interviews with 19 regular private car commuters.

A number of other studies have explored factors influencing mode shift from private cars to PT using both qualitative and quantitative methods. Sen et al. (2007) indicated that PT price is a major factor that encourages car users to switch to PT. Fiorio and Percoco (2007) affirmed the importance of price in the attractiveness of PT services relative to private cars. The accessibility of the PT system is another factor affecting car use (Loader and Stanley, 2009). On the other hand, many studies have been conducted to investigate the quality attributes of PT such as reliability, frequency, speed, comfort and convenience (Wallin Andreassen, 1995, Hensher et al., 2003, Eboli and Mazzulla, 2008).

In contrast, there are few studies focusing on the impact of mode shift from PT to private car when PT ceases. From a theoretical perspective, when the preferred alternative of public transport users is removed from their choice-set, they are forced to try the next best alternative in their preference ordering (Exel and Rietveld, 2009a, Exel and Rietveld, 2001). Exel and Rietveld (2001) revealed that, in the short-term, PT strikes result in mode shift from PT users. In PT strikes that occurred in the Netherlands, on average 10% - 20% of their trips were cancelled and most PT travellers switched to car, either as a driver or a passenger, leading to an increase in traffic congestion. There has been only one attempt to examine the factors influencing the mode shift to car of PT users if PT ceases in the short-term. Exel and Rietveld (2009a) explored perceived travel possibilities of train travellers in Amsterdam in Netherlands based on traveller and trip characteristics. They analysed secondary data collected by a survey consisting of 7,950 train passengers. The main part of the questionnaire used closed questions which may deprive respondents of the opportunity to express characteristics affecting their choice. They found that trip destination, city centre, trip purpose, paying for the trip, public transport commitment, traffic congestion and parking problems were associated with consideration of the car as an alternative. However, the data was not collected for the specific purpose of their study so some variables of interest were not included in the dataset.

Research gaps

From the literature review, it is clear that there are a number of studies exploring factors influencing the mode choice of road users and the mode shift from car to PT. However, the mode shift to other alternatives for PT users has received very little research attention to date. There is no qualitative study investigating this research area. Therefore, given the scarcity of research on mode choice of PT users when PT ceases, the main purpose of the current research is to gain in-depth understanding of factors affecting the mode shift of PT users, particularly the mode shift from PT to private car, rather than to generalise outcomes from factors impacting on mode choice.

3. Methodology

Travel behavior is complex so an in-depth understanding of user perceptions and attitudes is necessary. A powerful tool to explore these complexities is qualitative research since it allows each individual to explain their own behavior and attitude in choosing an alternative mode for travelling or even cancelling the trip if PT ceases.

3.1. Sampling

A recruitment notice was published on the Monash University website in July 2015. PT users interested in participating in the survey sent an email to the researcher to indicate their interest along with information about their PT trips that they undertook the week before (such as the origin, destination and the time of PT trip). In order to diversify the sample, thirty interviewees from different age groups were selected from different areas of Melbourne. Most interviewees (24) were staff and students of Monash University who were living in metropolitan Melbourne. Only six participants were not from Monash University. Monash University has several campuses around Melbourne so the interviews were organised in three locations: Clayton campus, Caulfield campus and the National Library in Melbourne's CBD from August to October, 2015. The study protocol was approved by the ethics committee of Monash University. All participants agreed to take part in the study via consent forms and were rewarded with a \$30 gift card for their attendance.

Given that 80% of respondents were students and staff at Monash University, the results are unlikely to be generalisable to all public transport users. Furthermore, the interviews were conducted in a specific period of the year (winter/spring) in which the weather may influence PT users' decisions.

3.2. Research protocol and measures

The protocol included two parts: a semi-structured interview guide and a brief questionnaire. The semi-structured interviews took 35 minutes each on average. All interviewees agreed to have their interview audio-taped. The interview questions are shown in Table 2. The first two questions concentrated on the background of interview participants which helped to provide context for the remaining questions. The key questions focused on mode shift from PT to other alternative transport modes when PT ceases, and factors impacting that choice. Additionally, the reasons why PT users did not choose other alternatives were also explored in the interviews. Individual interviews were held rather than focus groups because they can investigate the flexibility of each PT user to change their behaviour if PT was no longer available in the short term and long term. In particular, the interviews addressed mode shift to car as car drivers or car passengers, since this is a major factor contributing to traffic congestion. After finishing the semi-structure interview, participants were asked to complete a brief questionnaire covering socio-demographic information such as age, income, occupation, car ownership, driving license and the origin and destination of their last PT trip.

Table 2 Semi-structured interview questions

Background

1. Can you remember your last public transport trip last week that started from your home in the morning peak hours between 7am and 9am?
2. Take a moment and think. Can you please tell me about that trip?

Possible subsidiary questions:

- How long did that trip take?
- How often do you use PT?
- Where is your destination? Can you describe your destination (e.g. traffic condition, parking...)
- Which services/modes (if you can recall) did you use to undertake this travel?
- What circumstances led to you undertaking this travel by public transport?
- Why did you choose to use public transport as opposed to other modes for this trip?
- What is the main purpose of that trip?
- How did you access PT? If you used a car to access PT, were you parking a car or getting a lift?
- Was there anything that you found particularly challenging about this trip?
- Have you travelled by another means for this purpose before or not?
- Will you still make this trip by public transport?

Short term impact of PT removal

3. We would like you to imagine that entire PT was no longer available for that day of your last PT trip. How would you travel to your destination for the trip?
4. Why would you choose to travel by that mode? If you would decide not to take that trip if entire PT was not available, why would you cancel the trip?
5. Of the factors affecting your mode choice if PT was not available, which do you think are the most influential (choose the top 3)?
6. Why would you not choose to travel by other modes (e.g. bike, walk, taxi or cancel the trip)?

Long term impact of PT removal

7. We would like you to imagine that entire PT was no longer available for next ten years. How would you travel to your destination for the trip?
 8. Why would you choose to travel by that mode? If you would decide not to take that trip if entire PT was not available, why would you cancel the trip?
 9. Of the factors affecting your mode choice if PT was not available, which do you think are the most influential?
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3.3. Data analysis

The interview recordings were transcribed verbatim. Transcripts of the interviews were entered into NVIVO software to facilitate the organisation and structuring of the process of coding and classification, and to develop relationships among concepts. Interviews were analysed independently to avoid imposing the beliefs of one participant on others. This qualitative study is based on “grounded theory” (Glaser and Strauss, 1967), which provides an interactive framework for data analysis. Grounded theory is a method of analyzing qualitative data which is grounded in the data without preconceived theories and is characterised by intensively analysing data, often sentence by sentence or phrase by phrase. Data obtained by the questionnaire was also entered into an SPSS file to calculate descriptive statistics.

According to Sandelowski (2001), the qualitative data should be reinforced by quantitative counts of participants discussing certain factors influencing their choice of transport mode. Hence, when a factor was discussed by more than 75% of participants, we refer to it as “almost all”, for between 50% and 75% we use the term “a lot of”, for between 25% and 50% we use “some” and for less than 25% we use “few”.

4. Findings

The interviewees were asked to talk about their flexibility to change their behaviour if PT was not available in the short term and in the long term as well as factors influencing their choices. Additionally, interviewees were also asked about their attitudes towards other transport modes that they did not choose.

Table 3 details characteristics of the interview participants (16 males and 14 females, aged between 18 and 50 years). Almost all participants were students and staff at Monash University (24 out of 30 participants). All participants were living in Melbourne with incomes ranging from \$0 to \$1999 per week.

Table 3. Profile of respondents (n=30)

No	Age	Gender	Employment status	Income (\$/week)	Residential area
Participant 1	25-30	M	Student	1-399	Monash
Participant 2	31-40	F	Unemployed	0	Monash
Participant 3	25-30	F	Student	400-699	Yara
Participant 4	25-30	F	Employed full-time	1400-1999	Knox
Participant 5	18-24	F	Student	400-699	Whitehorse
Participant 6	31-40	M	Employed full-time	1400-1999	Monash
Participant 7	18-24	F	Unemployed	0	Glen Eira
Participant 8	41-50	M	Employed casual work	700-999	Glen Eira
Participant 9	31-40	M	Employed full-time	1400-1999	Boroondara
Participant 10	25-30	M	Student	400-699	Monash
Participant 11	18-24	F	Student	1-399	Darebin
Participant 12	18-24	M	Student	1-399	Port Phillip
Participant 13	18-24	F	Student	1-399	Casey
Participant 14	31-40	M	Student	400-699	Monash
Participant 15	18-24	M	Student	1-399	Casey
Participant 16	25-30	F	Employed full-time	1000-1399	Stonnington
Participant 17	18-24	M	Student	1-399	Monash
Participant 18	25-30	M	Unemployed	1-399	Mornington Peninsula
Participant 19	18-24	M	Student	0	Monash
Participant 20	18-25	F	Student	1-399	Mornington Peninsula
Participant 21	25-30	M	Employed part-time	1-399	Monash
Participant 22	31-40	M	Student	400-699	Monash
Participant 23	25-30	F	Student	400-699	Monash
Participant 24	25-30	M	Student	400-699	Monash
Participant 25	25-30	F	Student	400-699	Monash
Participant 26	31-40	M	Employed full-time	1400-1999	Darebin
Participant 27	41-50	F	Employed part-time	400-699	Darebin
Participant 28	31-40	M	Employed full-time	400-699	Mornington Peninsula
Participant 29	25-30	F	Employed full-time	1-399	Boroondara
Participant 30	41-50	F	Employed full-time	400-699	Yara

The following results present an outline of key findings including verbatim quotes or comments from the participants identified by individual participant number (PNo. E.g. P29). The details of each participant are shown in Table 3. In addition where applicable results are compared to known findings in the published research literature to assess their place within the context of previous research.

4.1. Short term removal of PT

The results show that the choice of mode shift among PT users is influenced by several factors; after consideration these were classified into three major categories:

- 'individual-specific factors',
- 'context-specific factors' and
- 'journey-specific factors'.

Individual-specific factors included car ownership, driving licence ownership, number of cars available in the household, number of adults in the household, and income. Context-specific factors consisted of travel distance, travel time, travel cost, trip destination, weather and flexibility. Journey-specific factors included accessibility to PT stations and trip purpose. Result under each of these headings are now discussed.

4.1.1. Individual specific factors

4.1.1.1. Availability

When PT users choose an alternative mode in the event of a PT strike, they have to be aware that a particular mode is possible to use and is available as an alternative option. There are several sub-factors that affect the availability of a particular mode.

- *Car and driving license ownership*

Some participants mentioned that they would choose to drive a car if PT did not work in the short term because they already have a driving license and were able to have access to a private car.

P29: "I have a car, I have license so I will use it to travel if PT ceases."

Students have less ability to switch to a car because driving license and car ownership are relative low for this group. Hence, a lot of them would cancel their education-based trips as they are not able to find any appropriate alternatives.

P20: "I am student. I don't have a car and a license so I can't drive. If I have a car, I don't feel safe driving. I don't feel comfortable driving by myself."

P21: "I would cancel the trip", "I don't have a private vehicle. If I do have a private vehicle I might prefer to use it because it's much quicker and much more convenient compared to other modes."

The influence of the availability of transport options on mode choice is supported by previous studies. Exel and Rietveld (2009a) stated that the ability to use particular modes may also play a major role in mode choice. Ewing et al. (2004) showed that PT users tend to use private cars than walk and bike if they are licensed drivers and cars are available in their households.

- *Number of available cars in a household*

Few interviewees expressed that the number of cars available in their household might impact on car mode shift. They mentioned that they have only one car in their household but had to share this car with their partners on the day they took PT. Thus, they could not access a car if PT was not available.

P18: "I share a car with my partner so when they use the car, I am not able to use it. But if they aren't using the car that day and I need it, I could take it."

P28: "We have only one car in my house so we have to share it. If PT is not available, I would drive. I would have to take my wife to her workplace and drive to here."

Another participant who has a driving license but does not own a car thought that he could borrow a car from his relatives or friends in his household if it was available.

P30: "I don't have a car but I can borrow it from my wife."

The number of available cars in a household has been identified as having a significant relationship with car mode choice. Limtanakool et al. (2006) stated that car availability has a strong influence on mode choice for every trip purpose. Kim and Ulfarsson (2004) found that

the number of available vehicles significantly reduces the propensity to select transit as a travel mode and increases the propensity toward private vehicles.

- *Number of adults in a household*

Few PT users participating in an interview believed that car mode shift can be affected by the number of adults in a household. They mentioned that they do not have a driver's license yet, but relatives or friends in their household could access a car so they could ask them to give a lift if PT was not available. If there are more adults in a household, PT users have more chance to take a lift from them. Thus, they can travel by car as a passenger.

P20: "(if PT is removed) My dad has to drop me then, both my mum or my dad can drop me."

P25: "I believe my husband or my house mates would give me a lift. They have cars and can drive."

The number of adults in a household has an influence on the mode shift to car as car passenger. This supports the findings of Kim and Ulfarsson (2004). They argued that small households was therefore less likely to carpool or vanpool, which was not unreasonable since they had less opportunity to pool with their own household members.

4.1.1.2. Income

A relationship between income and travel mode shift of PT users was discussed by some interviewees. In fact, lower incomes limit the flexibility people have to consider using other (more expensive) modes.

P12: "I am a student. I don't have any money to pay for a car. I don't have a license."

In contrast, people with high incomes are likely to choose more expensive transport modes such as driving.

P28: "I can pay for parking cost. It's not my problem."

Income has been identified as having a significant relationship with the mode choice of car in previous studies. The probability of taking the car for chained trips increases with the household income (Hensher and Reyes, 2000). There is a relationship between income and car ownership (Golob, 1990, Dargay, 2001). The rising income leads to higher car ownership. Kim and Ulfarsson (2004) revealed that households with \$35,000 or higher annual income have a greater propensity toward selecting private vehicles or carpools and vanpools and a reduced propensity to use transit as compared with walking.

4.1.2. Context-specific factors

4.1.2.1. Travel distance

Almost all interviewees stated that travel distance is a critical factor affecting mode shift if PT is removed. If their trip distance is longer than typical walking or cycling distances they would tend to travel by private car or even cancel the trip if PT is no longer available.

P27 "I have to drive, there was no other option, I can't walk. If the hospital is closer I would bike or if the distance is a walking distance I would walk. But the distance is too far to any of those things."

P21: "Walking? It's very far, it takes too long. If I have to bike or walk, the distance is less than 10 kilometres. I don't think I can walk. I can bike 20-25 minutes but if it's more than that, 40 or 50 minutes I cannot bike."

Trip length is considered to be an important feature in the choice of travel mode (Bergström and Magnusson, 2003, McConville et al., 2011, Müller et al., 2008). Long distances are a barrier to pedestrian and bicycle travel so travellers tend to use a car for long trips. For shorter trips, the car can be replaced by several alternatives such as public transport, walking and cycling (Carse et al., 2013). Müller et al. (2008) indicated that distance is the most important factor for discrimination between modes of transport associated with larger costs (public transport and car/motorcycle) and those with lower costs (walking and cycling).

4.1.2.2. Travel time

A lot of interview participants highlighted travel time, suggesting that this might be one of the main factors affecting PT users' mode shift if PT does not exist. Travel time components generally consist of in-vehicle time, out-of-vehicle time, walking, and waiting time. For long distances, they were more likely to choose the fastest transport mode, usually the private car. Walking and cycling are generally not feasible for long distances because of the high travel time. However, for moderate distances in the CBD, cycling may be the fastest transport mode.

P27: "I think I would switch to bike because it is the fastest way to get to my destination. Driving a car you have to find parking. Especially in the CBD it takes a lot of time for that."

P5: "I have to drive because of the distance, 30km. I want to get to work quickly. Driving is quicker than cycling, walking"

The finding is supported by existing literature. Beirao and Cabral (2007) mentioned that travel time was an important reason for mode choice. Frank et al. (2008) investigated how relative associations between travel time, costs, and land use patterns where people live and work impact mode choice and trip chaining patterns.

4.1.2.3. Travel cost

Travel cost for almost all respondents is perceived as a key factor for choosing an alternative mode. If PT ceases in the short term, they tend to find an appropriate alternative mode with the lowest cost. Twenty five out of thirty interviewees indicated that they would not choose to use a taxi as an alternative because of the high cost. A few people would get a lift from their friends or relatives if PT is removed because they can share the travel cost. For medium and short distances, walking or cycling is generally the cheapest way to travel compared to taxi or private car.

P21: "I would choose my friend to drop me in his car. The cost. It's much cheaper for me to ask my friend to drop me. I do pay him some money but not as much as I would pay with taxi. He is living in my house. He is my house mate."

P9: "I would work at home because if I want to go to my office I have to hire a car. It is costly."

The effect of travel cost on mode choice has been noted in many previous studies (Simons et al., 2013, Cervero, 2002, Johansson et al., 2006). According to Simons et al. (2013), travel cost is considered a barrier for choosing transport modes. Cervero (2002) and Johansson et al. (2006) also found that travel cost is significant.

4.1.2.4. Trip destination

It was mentioned by some participants that the destination of a trip would influence the travel mode shift if PT ceases in the short term. They said that in the city centre it is difficult and expensive to park. Few interviewees said they would cancel their trips because they would not be able to find any suitable alternative.

P24: "I would cancel the trip" "I can drive, I can go by car. It's possible. But the problem is the parking cost. When I go to city I could not find any parking and the parking cost is really very high."

Traffic congestion was also perceived as a barrier by some interviewees. They believed that congestion often occurs on the way to the city centre and this is the main reason for using PT. If PT is removed, they said they would cancel their trip. Few participants would consider driving but would leave very early to avoid peak hours.

P15: "I can't drive to the city because I live too far, you must worry about parking in the city and traffic in the morning would probably take longer if you are travelling by car."

This finding is consistent with previous studies on how parking cost affects mode choice. According to Exel and Rietveld (2009a) trip destination is a particularly important determinant of people's mode choice set. Hess (2001) investigated the travel behaviour of

commuters in Portland, Oregon and argued that parking costs have a significant influence on mode choice.

4.1.2.5. Weather

Weather also played a role in mode choice, particularly choosing between motorised and non-motorised transport. Some participants felt that bad weather had a negative effect on active forms of transport (walking, cycling). However, it is noted that the interviews were conducted from August to October when the temperature was relatively cold and there were many wet weather days. Thus, participants may have been more likely to identify the influence of weather on mode selection than in other seasons.

P3: "If it is warmer I will cycle again, if the weather is very terrible I would call a taxi or ask my friends to pick me up."

P5: "The weather is a factor (affecting your choice) as well. You know, in a car you would be warmer."

Considering the effect of weather on mode choice, Sabir et al. (2008) revealed that in (extremely) low temperatures, people switch from biking to car and public transport, whereas people prefer walking and biking as temperatures increase. Saneinejad et al. (2012) explored the impact of weather conditions on the transport mode choice of commuters. They found that younger individuals' tendencies to walk and bike are more negatively affected by cold temperatures than older age groups. Müller et al. (2008) examined adverse effects of school closures on transport mode choice in urban areas. The results of the multivariate analysis illustrate that weather and season have a strong influence on transport mode choice for students' travel-to-school.

4.1.2.6. Flexibility

Flexibility has a significant influence on the choice of mode. Some respondents stated that if PT was no longer available, they would choose to use a car as it is more flexible than other modes, especially in suburban areas where congestion is not as severe. In contrast, in central areas such as the CBD, travelling by car is less flexible because of congestion and parking costs. Differences in flexibility are also noted between travelling by car as a driver and a passenger.

P26: "It's (driving a car) too convenient for time. I drop my children at school and then drive to my office and pick them up again. Another reason- I must go to my office and drive to another meeting."

P13: "It is convenient because it gets me where I want to go."

Existing literature has suggested that flexibility can play a major role in influencing PT users' mode shift. Beirao and Cabral (2007) indicated that convenience and flexibility are important influencing factors which have an impact on mode choice towards the car.

4.1.3. Journey-specific factors

4.1.3.1. Accessibility to PT stations

PT users can access PT stations by walking, cycling or using a private car as Park and Ride/ Kiss and Ride (PNR/KNR). PNR schemes generally aim to reduce car use to CBDs so PNR services are often subsidized to attract car users to use PT (Meek et al. 2008). Few PT users who participated in an interview parked their car at a station and took PT to their destination because they felt that PT is the best way to travel to their destination. However if PT were removed, they may shift to car since they had already used a car for part of the trip. On the other hand, few PT users mentioned that they used PNR because they drive their children to school on the way to work.

P26: "I took my children to school and I parked my car at the train station and took the tram to my office". "[If PT is removed] I would use my car, I drop my children at school and then drive to my office and pick them up again."

P25: "My husband took me to the train station and I take the train to my uni. If there is no PT I believe he would take me to the uni."

In this study, accessibility to PT stations can be recognised as a new factor affecting the shift from PT to car. This factor has not been explored in previous studies regarding mode choice.

4.1.3.2. Purpose of trip

If PT is not available, the purpose of the trip is a key factor affecting the decision of PT users to choose alternative modes or cancel the trip. Some PT users recognised that they would cancel their trip if it is not too important.

P10: "The purpose of my trip is socialisation (attending a club meeting) so I would cancel it if PT is removed."

P19: "The purpose of that trip is to sightsee in the city, that trip's not important, just for fun...I will cancel the trip (if PT is not available)."

For education-based trips, a lot of participants who are students stated that it would be difficult to arrive on time when shifting to other modes so they would study at home instead. With trips related to work, travel decisions are more complex. Some jobs can be undertaken from home so it is possible to cancel the trip.

P6: "I will just cancel that trip. I work in IT so it is okay if I work from home or alternative location in Clayton campus. I don't have to travel to my office in the city. In IT you can do that. I have laptop all the time. I can connect to internet from home."

However, some jobs require a face to face meeting so participants have to find an alternative mode to go to work.

P9: "I go to work. I need to be in my office because I need to interact with other people, to talk with other people so this trip is extremely important...I would hire a car if I really really have to go to my office."

Many interviewees travelling for working or business purposes stated that they would switch to a car, either their own car or a borrowed/rented one.

P27 "It's [a trip] for work, you have to go, you have to go"

Exel and Rietveld (2009b) found that the choice to cancel the trip in the scenario of a train strike was more likely for education-based trips. Kim and Ulfarsson (2004) indicated that trip purpose impacts on mode choice. The elderly are more likely to share a ride with others when chaining trips, doing errands, or going to a medical appointment and are less likely to use transit when going shopping or doing errands.

4.2. Long term removal of PT

Interview participants were asked which alternative mode they would choose for travelling if PT is not available for the next 10 years. No one considered cancelling their trips because they believed that they could plan and find alternative modes. Only a few respondents would choose to drive to their destinations as a car driver or a passenger due to long distance trips. Other participants mentioned that they would find someone who has the same route and carpool. They thought that this transport mode would be very popular if there is no PT in the long term.

P19: "In the future, ask for a lift because the cost problem and also it is more efficient if you go together with anyone. It's more fun."

From the data analysis for the long term removal of PT, only one main theme, context-specific factors, was mentioned to have an impact on mode shift. The context-specific factors consisted of travel distance, travel time, travel cost, trip destination and flexibility.

Some of interviewees with long distance trips or trips going to or across the CBD would consider relocating their place of residence near their workplace or find another job that is close to their home. They felt that residential relocation or finding another job would help them to reduce their travel time and avoid travelling a long distance with high traffic congestion.

P4: "I would consider not working in that location any more. I would try to work near my home because... thinking about traffic, driving to the city is going to get worse, the parking cost in the city is also going to get worse. So if PT is definitely never an

option, I would not want to work near the city.”

P12: “80% jobs is in CBD so I have to relocate my house near the city centre.”

5. Discussion of findings

This research used interviews to explore factors affecting mode shift if PT is not available. The first part of this section will discuss factors impacting mode choice when PT ceases in the short term. The factors that could influence PT users’ mode choice if PT ceases in the long term is discussed in the second part.

5.1. PT is not available in the short term

The findings show that when PT ceases in the short term, PT riders would switch to alternative modes such as car (driving or as a passenger), cycling, walking or cancelling the trip. These shifts are not influenced by one factor alone but by a combination of factors which affect each other. Factors influencing PT users’ mode choice when PT ceases are categorised into three major themes: Individual-specific factors (car ownership, driver’s license ownership, number of available cars in household, number of adults in household, income), context-specific factors (travel distance, travel time, travel cost, trip destination, weather, flexibility) and journey-specific factors (accessibility to PT stations, trip purpose). Figure 1 proposes a conceptual model of mode shift to car among PT users when PT ceases in the short term.

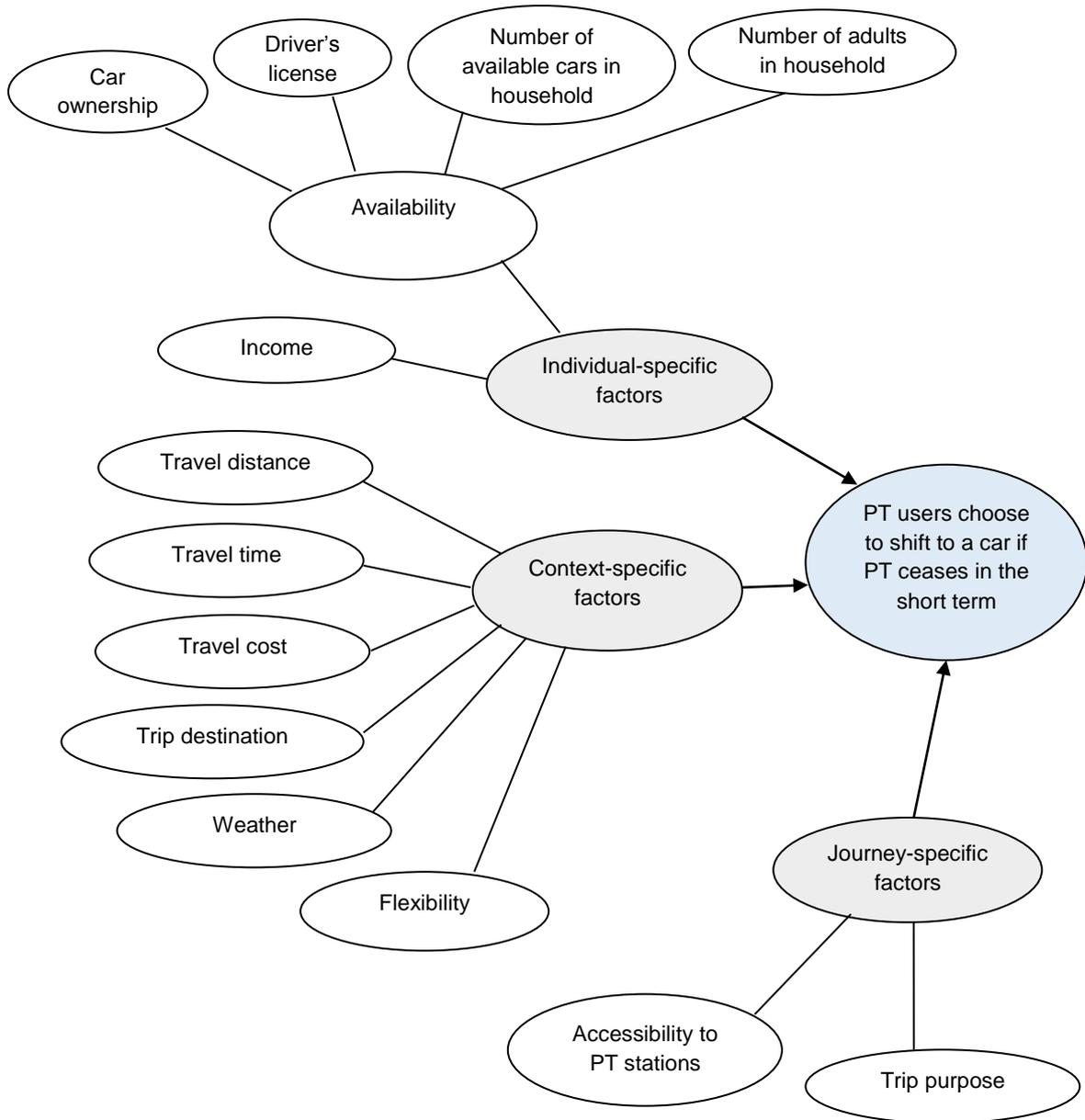
The interplay between good access to transport modes, travel time, travel cost, trip importance, non-CBD trips, weather, flexibility and PNR/KNR accessibility to PT stations are the most important factors in favour of choosing the car if PT is removed. In contrast, the choice of non-motorised modes (cycling and walking) is impacted by several key factors such as low access to transport modes, travel time and travel cost. Low access to transport modes, travel time, travel cost, trip importance, inflexibility, and safety are the most important factors affecting the decision to cancel the trip if PT ceases in the short term.

In this study, driving was the most popular alternative transport mode that PT users would choose. Throughout the interviews, it was clear that driving a car offered several benefits for PT users. The main barrier for driving identified by this study is the travel cost. However, a number of other factors were identified as influencing the decision of choosing a car if PT is not available such as access to a car and accessibility to a PT station. Someone who is accessing a PT station with PNR or KNR would tend to use a car as an alternative if PT stops working because they have already used it for part of their journey.

In this study a lot of participants would choose to cancel their trips if PT ceases in the short term. The main reason for not undertaking the trips is that they were not considered too important. Other participants felt that they could work from home so do not have to go to their workplace.

These findings have provided a basis for developing a conceptual model that attempts to structure the PT user’s mode shift process in the event of the removal of PT. The conceptual model will be used to design a questionnaire for a quantitative survey that investigates the relative importance of factors influencing mode shift to car. From this, transport managers can estimate the share of mode shift to cars from PT when PT ceases in the short term (e.g. during a PT strike). Thus, policies can be developed to manage these situations based on the predicted increase in traffic congestion. For instance, in Los Angeles in 1974, bus lanes were opened for carpools to reduce congestion during a 10-week bus strike (Crain and Flynn, 1975). In New York, on-street parking in the inner city was banned to ease the movement of traffic during a PT strike (New York City Transit Authority, 1967).

Figure 1 Conceptual model of mode shift to car among PT users if PT ceases in the short term



5.2. PT is not available in the long term

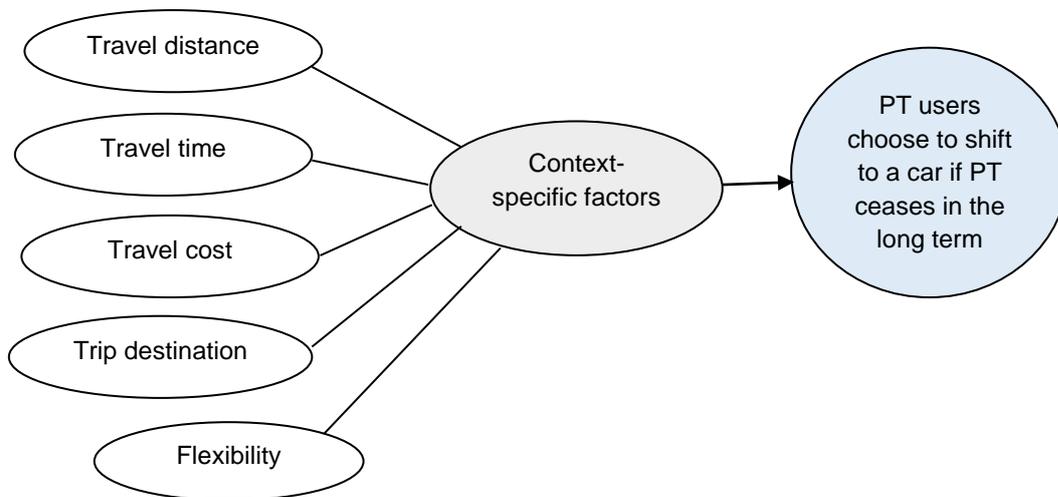
The flexibility of PT users to change their behavior when PT is no longer available in the long term is considerably different from that of the short term. Almost all the interview participants mentioned that they would continue to carry out their trips if PT ceases in the long term. If PT ceases in the short term, some of interview participants were likely to consider cancelling their trips temporarily if these trips were expensive and not too important. However, in the long term, almost all PT users indicated that they could find solutions to undertake their trips. Some of interviewees who decided to cancel their trips if PT ceases in the short term would consider buying a car for travelling if PT is not available in the long term. Interestingly, some of participants would choose to relocate their place of residence near their workplace while others would find another job near their home. If PT is not available in the long term, the relocation of PT users from suburban to CBD where employment is concentrated would result in a change in the city form from suburban sprawl

to dense, monocentric cities. Additionally, this trend would also lead to a reduction in low-density land development patterns. Thus, it is clear that the long term impact of PT is not only on traffic congestion but also on land use change.

In terms of long term effect of PT, only context-specific factors were found to have an impact on PT users' mode shift. These included distance, travel time, travel cost, trip destination and convenience. The individual-specific factors and journey-specific factors were not mentioned by any participant in this research. The reason may be that they cannot perceive any change in individual-specific factors in the future.

A conceptual model showing the process of mode shift to car when PT is not available in the long term has been developed based on the findings of this qualitative research (Figure 2). A quantitative survey can be carried out to determine the relative importance of these factors. The results can then be used to estimate the long-term impact of PT on relieving traffic congestion.

Figure 2 Conceptual model of mode shift to car among PT users if PT ceases in the long term



6. Conclusion

There are a number of studies that have investigated factors influencing mode shift from private vehicle use to PT. However, there has been very little research attention given to mode shift when PT ceases. Indeed, the mode shift to car among PT users is considered as an important input to estimate PT impacts in reducing traffic congestion. Additionally, mode shift to car can be used to determine the increase in traffic congestion in the event of a PT strike. Hence, authorities and traffic managers could propose measures to better manage this issue.

This is the first qualitative study to explore factors affecting the mode shift of PT users when PT ceases in the short term as well as the long term. Thirty PT users in Melbourne were recruited to attend personal interviews. Discourse analysis, an excellent method for listening to PT users and gaining an in-depth understanding of their choice if PT is not available, has been used in this research.

The main contributions of this paper are:

- An in-depth understanding of the flexibility of PT users in changing their behaviour when PT is not available.
- The identification of factors influencing mode shift from PT to private car.
- The development of two conceptual models of mode shift among PT users in the short term and long term.

The conceptual models consist of multi-dimensional factors which provide a tentative explanation of how PT users switch to a car. These models were theorised through the inductive method of grounded theory. Although the findings are not generalisable to all PT users, this research has explored the factors affecting the switch to private car if PT ceases.

In terms of short term effect of PT, there are a number of factors influencing the mode shift from PT to private car use. They are classified in three main themes with several subcategories: individual-specific factors, context-specific factors and journey-specific factors. The findings show that the interplay between good access to a car, travel time, travel cost, trip importance, weather, flexibility, safety and accessibility to PT stations are the most important factors in favour of choosing a car if PT stops working.

However, in the long term, only context-specific factors were found to have an impact on the PT users' mode shift. The individual-specific factors and journey-specific factors were not mentioned by participants in this research. This is because they may not perceive any change in individual-specific factors in the future. It can be seen that the removal of PT in the short term acts only to increase traffic congestion due to a mode shift to car. However, in the long term, removing PT also impacts on land use.

This study is a part of wider project exploring how to evaluate the impact of PT on traffic congestion. Based on the results of this study, quantitative research will be conducted to develop these findings into a definitive theory. According to this theory, the share of PT users who would shift to car can be estimated using a discrete choice model. This figure can then be used in a model to explore the traffic congestion relief associated with PT (Nguyen et al., 2015).

There are two key limitations to the findings reported in this paper. Firstly, most participants are students and staff at Monash University in Melbourne who used PT in the morning peak hours. More PT users from other areas would help to establish a stronger understanding of the factors affecting mode shift to car. Secondly, the interviews were conducted during winter/spring. Ideally, the interviews should be carried out in different seasons so that the effect of weather on PT users' choice can be understood more clearly. In closing, this paper has explored the process of mode shift to car when PT is not available in the short term and long term. Further research in this area will help in developing a richer understanding of mode shift choices when PT ceases.

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