RETAIL TRAVEL BEHAVIOR ACROSS SOCIO-DEMOGRAPHIC GROUPS: A CLUSTER ANALYSIS OF BRISBANE HOUSEHOLD TRAVEL SURVEY DATA

Maryam Shobeirinejad, PhD candidate, Urban Research Program, Nathan campus, Griffith University, ***Phone:*** *+61 7 3735 5534* ***Email:*** *s.shobeirinejad@griffith.edu.au*

Associate Professor Neil Sipe, Urban Research Program, Nathan campus, Griffith University, ***Phone:*** *+61 7 3735 4189* ***Email:*** *n.sipe@griffith.edu.au*

Dr Matthew Burke, Senior Research Fellow, Urban Research Program, Nathan campus, Griffith University, ***Phone:*** *+61 7 3735 7106* ***Email:*** *m.burke@griffith.edu.au*

ABSTRACT

Retail travel comprises about a quarter of all trips made in Australian cities, however these trips gain far less attention in transport planning than do journeys to work/school. Accessibility is a major factor affecting travel behaviour, but socio-demographic characteristics are also important given research on factors influencing mode-choice. This paper explores retail travel behaviour in Brisbane, Australia, to identify differences in the influence of socioeconomic characteristics. The study uses the 2009 South East Queensland Travel Survey (SEQTS) 7-day household travel survey conducted in Brisbane to illustrate the quantity and characteristics of retail travel for different socioeconomic groups. The sample data has been divided into groups using cluster analysis techniques, which help inductively identifying meaningful subgroups (Hair et al., 1995). The data is analysed to show the major travel characteristics including: trip frequency; trip complexity; destination choice; and the mode share for each subgroup, allowing for comparative analysis. The results show that retail travel is the most unsustainable travel in terms of the proportion of car trips involved. Walking and public transport accounts for very few trips, but the number of these trips are subject to variations based on accessibility, type of trip, day of the week and socio-demographic characteristics. Shopping centres and supermarkets capture almost 50 percent of all shopping trips suggesting special attention on them is needed in terms of their function and location in the city. Low socioeconomic groups travel more frequently by walking and public transport to retail destinations. Young adults and families make significant numbers of trips to major shopping malls. This research underlines the role that retail form, urban form and socioeconomic characteristics play in determining retail travel behaviour. The results

highlight notable differences in retail travel by subgroup. The implications are that interventions seeking to encourage sustainable retail travel behaviour, including spatial interventions and social marketing programs, should be carefully crafted to respond to these behaviours.

Keywords: *Retail trips, socio-demographic grouping, cluster analysis, travel behaviour*

INTRODUCTION

Sustainable transport debates and transformation of the present travel patterns overwhelmed with motorised mode share into more active means of transport have notably come into consideration because of people's health problem, environmental threats and also the unreliable fuel price. Different policies have been developed considering various aspects of travel pattern in the cities. Developing public transport policies and active transport facilities as part of this procedure have ended up into different programs focusing on the commuting trips, the trips to school and shopping destinations. But in terms of Australian cities and particularly Brisbane city, as the focus of this study, travel demand management (TDM) program has put lots of financial and intellectual efforts concentrating mostly on making changes in the travel behaviour of commuters and school students, while in terms of trips to retail destinations no significant attempts can be mentioned. This is a major gap, since shopping trips are the most imperative group among the trip types in terms of the number of trips as it is the largest on Weekends by 29 percent and the second largest on Working days by 15.6 percent following the work trips (Shobeirinejad, Burke, & Sipe, 2012).

In addition, recent changes in the form and location of retail in Australia during the last fifty years along with planning regulations supporting these transformations have resulted in dramatic changes on people's retail travel behaviour. One stop, car based, weekly retail trips in the more attractive, far distance located, easily car accessible shopping centres embracing big supermarkets, famous brand shops, big food courts and ample parking facilities have all changed the retail travel behaviour in terms of frequency of trips, duration of trips, mode share and travel distances. This is not limited to shopping centres but also big specialty super stores supplying household and personal appliances increasing in number are the other catalysts helping in this procedure. Following the marketing forces, each of these shopping establishments are trying to keep their catchment areas as big as possible in order to service larger population and attract greater numbers of consumers and funds by providing personal services and facilities.

A number of recent planning documents, such as Connecting SEQ 2031 ("Connecting SEQ 2031 – An Integrated Regional Transport Plan for South East Queensland," 2011), have tried to give residents more chances of taking public transport or active transport to access retail. These include the decrease in the destinations' distances by about 10 to 15 minutes walk. Other policies, such as connecting the Bus-way routs to major shopping centres, are other ways trying to connect these destinations to even far distances by providing bus stations next to these shopping centres.

While providing active and public transport facilities and making changes in the physical urban form and land use aspects of the city to shorten the trip distances still need a great consideration,

socioeconomic characteristics of the residence has to be considered simultaneously. People with different socio-demographic aspects are expected to behave differently; the travel pattern of young and elderly people or households with children or without children seems to be a lot different regarding the limitations and expectations in each group. Large numbers of studies have tried to study the impacts of socio-economic factors on trips to work and non-work destinations, "...income (Bruton, 1986; Koppelman and Pas,1984; Pas; 1986), age (Boarnet and Crane, 2001), gender, employment status (Koppelman and Pas; 1984; Pas;1986), auto ownership (Martin et al., 1961; Levinson, 1976; Bruton; 1986), and household size (Levinson, 1976; 54 Bruton; 1986), population, density (Martin et al., 1961; Levinson, 1976; FHWA, 1985; Bruton, 1986; Boarnet and Crane, 2001; Hobbs, 1979), and employment (Hobbs, 1979)" (Cubukcu, 2001). But again the number of related studies is not considerable in Australian cities.

This research is initiating the more detailed scrutiny of retail travel behaviour of people considering their socioeconomic characteristics as an essential basis for any further attempt to change people's modal choices and trip preferences. It uses the 7-day South East Queensland Household Travel Survey (SEQ-HTS) data for 2009 detained from the QLD department of Transport and Main Roads to identify major socio-demographic groups of people in two parts of Brisbane city: the Inner and Outer suburbs, applying the cluster analysis methods and finally study the retail travel characteristics of each group.

The paper begins with a review of the literature on socio demographic characteristics and travel behaviour. This is followed by exposition of the cluster analysis methodology; justifications for using this approach; and the socio-demographic groups that are revealed by the analysis. This is ensued by providing an analysis of the retail travel patterns for each of these groups. The final part of the paper discussed the implications of the results followed by the future research directions.

BACKGROUND

Different methods have been proposed and studied to reduce people's dependency on private motor cars to enhance human and environmental wellbeing by decreasing fuel consumption, reducing air pollution and rising the level of physical activity for people. Urban form and its elements, including density, land use distribution and street pattern, have been the major focus of researchers' attempts to explain people's travel behaviour. Much of this work has been deductive in nature and use household travel surveys and similar techniques to establish if New Urbanist neighbourhoods, which have higher residential densities, mixed land uses and connected grid street patterns, or other improvements to urban design lead to more sustainable revealed travel behaviours in urban populations (Cervero, 2002; Cervero & Kockelman, 1997; Ewing, 1995; Frank & Pivo, 1994; Meurs & Haaijer, 2001). But Boarnet and Sarmiento (1998) were just one set of authors to find little relationship between land-use variables and travel behaviour in their study on non-work car trips for Southern California. Other studies disputed that even travel patterns in neighbourhoods sharing similar urban settings were in some cases entirely different. This is because people with diverse socio economic or demographic characteristics may have different attitudes and preferences and behave differently (Frank, Kavage, & Litman, 2006). The

spectre of residential self-selection lies over much of this earlier research, and recent studies have shown some limited self-selection biases exist in populations, that can be controlled for in study design (Cao, Xu, & Fan, 2010).

Aside from the built environment, many personal and household factors in the social and economic domains also impose limitations on the way people travel in cities. Predictive factors are known to include culture, income, social status, old age, traditional sex roles, auto availability and employment status, which can variously affect mode share, travelled distance, the number of stops made on a home-to-home trip, the types of visited destinations, frequency of travel, the amount of time dedicated to different activities, and the frequency of undertaking each of these activities (Hanson & Hanson, 1981). There is still much disagreement as to how important each of these factors may be on an individual's travel behaviour decision-making, as opposed to the importance of the built environment (see Handy, 1996). Several papers have focused on the socio demographic characteristics, others have focused on the urban form elements, while a considerable number of studies combine the elements of urban form and socio demographic factors (Curtis & Perkins, 2006). Amongst these, Best and Lanzendorf (2005) suggest that gender, household composition and income, habit and car ownership are the most significant factors influencing people's travel behaviour. Kattiyapornpong and Miller (2011) suggest age, income and life-stage have significant differential and interactive effects on travel behaviour in Sydney. In line with most assumptions, Dieleman, Dijst, and Burghouwt (2002) showed the probability of owning and using of a private motorcar is much higher in higher income families rather than the lower income families and private car reliability for trips are much more common in families with kids in comparison with one-person household types. Similarly, Hanson (1982) showed trip frequency is connected to the household income in that people with higher income levels make more trips than people with a lower level of income, whilst Prillwitz, Harms, and Lanzendorf (2006) found predictors such as age, the number of cars owned by a household and monthly income had a strong influence on car ownership growth. Women (in general), the elderly, and low income groups make less trips by private cars in comparison to men, the middle-aged, and high income groups in Sweden, with young people and women more interested in using public transport (Carlsson-Kanyama & Linden, 1999). Inductive studies of household travel survey data from Edinburgh have also found that those who are at working age, male, have children and higher income levels have the greatest tendency to drive (Ryley, 2006).

But what about trips to shopping? Differentiating between diverse trip types and 'tours' (which travel to multiple destinations for multiple purposes) and understanding the interactions amongst household members make, so as to untangle residential travel behaviour, is not always easy. Trip-chaining behaviours such as leaving from home, going to work, travelling on to shop at a store, and going back home, weaken the power of trip-based analysis. However, a number of studies have tried to figure out the impacts of socio-economic/socio-demographic characteristics of people focusing on the way people travel toward retail destinations. The body of this research and the number of studies is much less than studies considering the influences of socio-demographic characteristics on the trips to other destinations, such as work. This can be explained by the fact that in many cases retail trips are sharing almost comparable factors affecting people's travel behaviour in general (Cubukcu, 2001). These socioeconomic factors

include income, car ownership, household size, number of licensed drivers in the household, the number of workers, the number of vehicles, licence holding, age, sex, etc. (Cubukcu, 2001). Socio economic factors are believed to essentially influence the degree of consumer spatial mobility. It is believed that people who have a higher level of income and social affordability are more likely to own an automobile, which provides them the ability to travel to distant retail destinations. They are also more ready to bear the costs involved in shopping at multiple destinations (Hubbard, 1978). Though now dated, Murdie (1965) disputed that and cultural background differences will make people take different decisions about their trips to answer their retail needs. He found that the lower income shoppers prefer to shop at local centres, with only infrequent visits to larger regional centres for more specialized goods. Conversely, high income consumers will travel farther for both convenience and other shopping goods. Potter (as noted in Hanson & Hanson, 1981) reported similar results by categorising people into higher status and lower status individuals and he also found that those in the advanced stages of their life cycle travel shorter distances for shopping. There are also clear equity concerns about access to the goods that people acquire in stores to support their daily lives. Bromley and Thomas (1993) examined the travel behaviour of carless disadvantaged groups in the UK and argued that retail destinations were increasingly car-based which was unfair to poor mobility groups while providing advantages to middle or upper income groups. However research by Robinson and Vickerman (1976), Vickerman and Barmby (1984) and Badoe and Steuart (1997) focused on socio-demographic factors (i.e., income, car ownership, household size, number of licensed drivers, number of workers and number of vehicles) and found weak evidence to explain retail trip distance (Cubukcu, 2001). So what might be the case today in the changing retail landscape of the twenty-first century, where technological changes and structural changes in retailing are surely influencing residential travel behaviour?

METHODOLOGY

To try to build on previous knowledge, the present research aims to inductively study the retail travel patterns of the main socio-demographic groups living in Brisbane, Australia, the nation's third largest city. The paper's intention is to look into the travel behaviour of different socio-demographic groups of people living in Brisbane and to make comparisons between the way these people behave in different urban contexts, especially between the inner and outer parts of Brisbane city where urban form and structure differ significantly (Dodson, Li, & Sipe, 2010). Inner Brisbane is more compact, has higher residential density, more mixed land uses and contains a higher number of retail establishments as compared to outer Brisbane, which features lower residential density, more homogenous land use patterns and less connective street designs, all of which will presumably lower residents' accessibility to shopping destinations in the outer areas.

Two key sets of variables are implicit in this approach: first, the location of people in either inner or outer Brisbane, and secondly their socio-demographic characteristics. The approach was to identify these groups inductively and then identify their travel behaviour, including such measures as trip rate, mode share and distances travelled per person, to better understand

differences in retail travel behaviour. The seven-day SEQ-HTS data for 2009 was selected for this study due to the availability of a rich set of 1,925 reported and previously weighted trips, attributed either to weekdays or weekend days. An inductive cluster analysis technique was selected to identify the groups based on approaches pioneered by Ryley (2006). This is partly because cluster analysis gives us the chance to make different taxonomies regardless of the predetermined definite characteristics for each group (Kattiyapornpong & Miller, 2011). Using this method to identify and extract dominant groups in a dataset is becoming more common, for example identifying groups of customers or viewers of a particular TV show for the purposes of developing advertising or categorising people with the same pattern of past purchase in order to improve marketing strategies for different groups (Mooi & Sarstedt, 2011) or to understand low socio-economic status groups and their travel (Dodson, Burke, Evans, & Sipe, 2011). Cluster analysis is a significant tool for data extraction. The aim of this method is to divide the whole dataset into groups that are sharing a high degree of similarity and have a high degree of dissimilarity to the adjacent groups (Shih, Jheng, & Lai, 2010). It is based on measuring the statistical distances between different cases, with higher separation distances meaning the cases are less similar, whereas lower separation distances infer cases that are more similar and which may be grouped. This paper used *SPSS* software for applying the cluster analysis for SEQ-HTS dataset (Mooi & Sarstedt, 2011). SPSS software contains three different methods for clustering the data including: hierarchical clustering, K-means and finally two-step clustering.

Each of these methods is based on different algorithm and is useful for different types of datasets. Hierarchical clustering is mostly useful for small datasets. It creates a similarity matrix between all pairs of cases, which can results in massive and confusing matrix for datasets including more than 500 cases (Norusis, 2003). The use of the second method, K-mean clustering, is also confined to the continuous variables based on the Euclidian distances for grouping datasets (Şchiopu, 2010). Finally two-step clustering is not only useful for large datasets but also for both continuous and categorical variables. It uses an agglomerative hierarchical clustering method (Şchiopu, 2010), which starts with every case as an individual cluster and then merging these clusters based on their similarities (Mooi & Sarstedt, 2011). In two-step clustering, there are two methods of measuring the distance "Euclidian' and 'log-likelihood'. The Euclidian distance is used for continuous variables, and if or when a categorical variable is encountered the method switches to log-likelihood distance (Şchiopu, 2010).

This study is using the two-step clustering for extracting the socio-demographic groups inside the dataset. This approach was used as the large number of cases in the dataset could not be easily assign to a hierarchical clustering method, and due to presence of both categorical and continuous variables for clustering.

Previous studies using cluster analysis to analyse people's travel behaviour may be limited to two studies by Ryley (2006) and Dodson et al (2010). Ryley (2006) categorised people into six socio-economic groups based on the differences in the number of adults in the household, household income, dwelling type, individual life stage, gender and the number of children in households. He tried to study the link between the life stage and the travel behaviour of people in these different socio economic groups. The other study by Dodson et al (Dodson, Burke, Evans, Gleeson, & Sipe, 2010) followed the same methodology but applied it to the travel behaviour of different disadvantaged groups living in Gold Coast City, Australia. They applied eight different

socio-economic characteristics to the personal and household records within an existing HTS dataset, and extracted six groups of disadvantaged people for further analysis.

As it has been mentioned before, two step cluster analysis was used to find out the most dominant taxonomies in SEQHTS data set.

Several steps were required to refine and finalise these clusters for the next stage of analysis. A total of 1,099 individual retail trip-makers were identified. Seven socio-demographic characteristics were identified and applied, namely: age; sex; household structure; household size; household income; license holding, the main activity (occupation status) of the individual, and also the location of travellers (resident within inner or outer Brisbane). Different numbers of clusters were tested sequentially to identify any differences between the characteristics of the resultant groups. Comparing all the results, 20 clusters was chosen as the most efficient and practical number, representing a significant diversification of the retail travel market in Brisbane. The software was then used to determine how important each of the socio-demographic characteristics was in grouping the clusters. Figure 1 shows that income played the least important role in our taxonomies, followed by sex. Main activity, household structure and household size are the most important factors in identifying our socio economic groups, followed by age, car licence, and region of residence.

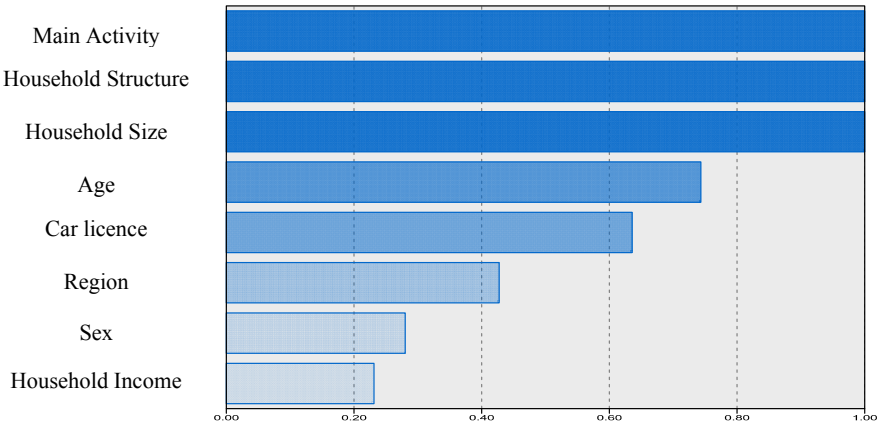

Figure 1 Predictor Importance

Further scrutiny revealed a few groups that share very similar characteristics; so these were (re)joined and defined them as new groups. At the same time, almost half of the groups resulting from the clustering process were located in inner Brisbane while the others were in Outer Brisbane. Almost every group in inner Brisbane had a peer in outer Brisbane sharing the same socio-demographic characteristics. After rejoining these groups, the total number of groups came to nine major groups, each of them divided into two groups in inner and outer Brisbane (18 groups in total). Each group was scrutinised to determine if they were homogenous, with cases not consistent with other group members excluded. After all groups were identified; weightings previously developed by the Queensland Department of Transport and Main Roads were applied to generalise the data for the whole population of inner and outer Brisbane. The nine major pairs (inner and outer) are shown in Table 1. These groups were allocated into one of four major

categories, based on the main activity of people, identified as the primary factor in group clustering. The main activities were summarized into work, education, retired and at home.

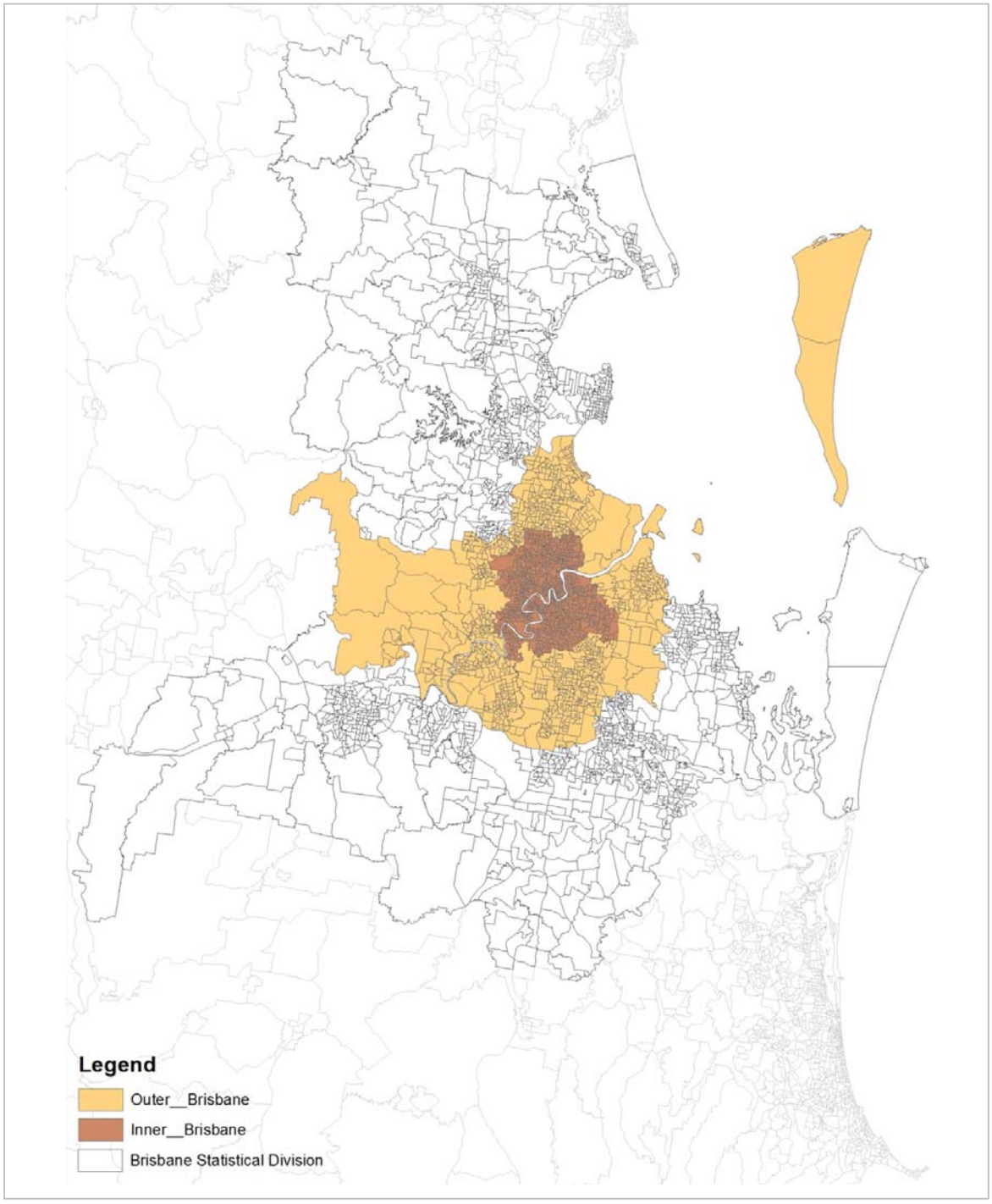

Figure 2 Brisbane Inner and Outer areas

Table 1: The most common socio-demographic groups in Brisbane for 2009

	Group	Region	Group's Name	Weighted Trip No.	Sex	Age	Main Activity	Household Size	Household Structure	Car License	Household Income
Housekeepers/ Unemployed	G1	Inner	Housekeepers/unemployed female	WD 6519 WE 9084	F	18-65	Keeping house & Unemployed	2=<	Couple with kids/ Couple with no kids	Have	1000< & =<4000
		Outer	Housekeepers/unemployed female	WD 10131 WE 11796	F	18-65	Keeping house & Unemployed	2=<	Couple with kids/ Couple with no kids	Have	1000< & =<4000
Retired	G2	Inner	Single Retired	WD 4404 WE 3205	F & M	55 =<	Retired	1 person	Sole Person	Have	=<2000
		Outer	Single Retired	WD 5129 WE 4356	F & M	55 =<	Retired	1 person	Sole Person	Have	=<2000
	G3	Inner	Retired Couple	WD 15360 WE 9444	F & M	55 =<	Retired	2 persons	Couple with no kids	Have	=<4000
		Outer	Retired Couple	WD 24356 WE 13115	F & M	55 =<	Retired	2 persons	Couple with no kids	Have	=<4000
Working	G4	Inner	Single Workers	WD 9939 WE 21647	F & M	18-65	Full time/Part time/Casual Workers	1 person	Sole Person	Have	=<2000
		Outer	Single Workers	WD 4580 WE 14690	F & M	18-65	Full time/Part time/Casual Workers	1 person	Sole Person	Have	=<2000
	G5	Inner	Working Couple with no kids	WD 29725 WE 66856	F & M	18-65	Full time/Part time/Casual Workers	2 persons	Couple with no kids	Have	=<4000
		Outer	Working Couple with no kids	WD 14910 WE 49892	F & M	18-65	Full time/Part time/Casual Workers	2 persons	Couple with no kids	Have	=<4000
	G6	Inner	Working Couple with kids	WD 32053 WE 107460	F & M	18-65	Full time/Part time/Casual Workers	3=<	Couple with kids	Have	=<5000
		Outer	Working Couple with kids	WD 17052 WE 57112	F & M	18-65	Full time/Part time/Casual Workers	3=<	Couple with kids	Have	=<5000
	G7	Inner	Working group various types	WD 11815 WE 18600	F & M	18-65	Full time/Part time/Casual Workers	2=<	Other except single and couples with kids or without kids	Have	=<6000
		Outer	Working group various types	WD 9486 WE 7606	F & M	18-65	Full time/Part time/Casual Workers	2=<	Other except single and couples with kids or without kids	Have	=<6000
Students	G8	Inner	School Student	WD 5953 WE 4614	F & M	=<18	Primary & Secondary Students	2=<	Couple with kids / One parent	Don't have	=<4000
		Outer	School Student	WD 6137 WE 6919	F & M	=<18	Primary & Secondary Students	2=<	Couple with kids / One parent	Don't have	=<4000
	G9	Inner	University Student	WD 9967 WE 19523	F & M	18-65	F/T TAFE/Uni, P/T TAFE/Uni, or other Education	All type	All type	Have	=<6000
		Outer	University Student	WD 5889 WE 7501	F & M	18-65	F/T TAFE/Uni, P/T TAFE/Uni, or other Education	All type	All type	Have	=<6000

ANALYSIS

The preliminary analysis of these grouped pairs focused on trip rate, trip mode share and vehicle kms travelled (VKT) to compare each group's travel behaviour. Table 2 shows the weighted number of retail trips that has been made in each group, the weighted number of people who has made these trips and finally the Trip rate for each group.

Table2: Retail trip frequencies, persons who made retail trips, SEQTS-HTS 2009

Groups	Location	Number of people	Number of people making Retail Trips[1]		Number of Retail Trips[2]	Number of Retail Trips[1]		Number of Retail Trips per person	
			WD[3]	WE[4]		WD[3]	WE[4]	WD[3]	WE[4]
Housekeepers/ unemployed female	Inner	37	5849	8247	48	6519	9085	1.11	1.10
	Outer	47	8,370	8,090	54	10131	11796	1.21	1.46
Single Retirees	Inner	23	4,508	3,311	29	4405	3205	0.98	0.97
	Outer	25	5,134	3,862	28	5129	4356	1.00	1.13
Retired Couple	Inner	51	12,831	8,908	65	15360	9445	1.20	1.06
	Outer	32	16,496	9,991	36	24356	13116	1.48	1.31
Single Workers	Inner	160	8,756	20,014	201	9939	21647	1.14	1.08
	Outer	103	3,839	12,207	132	4581	14690	1.19	1.20
Working Couple with no kids	Inner	62	22,946	20,212	90	29726	66857	1.30	3.31
	Outer	79	12,115	42,889	103	14911	49892	1.23	1.16
Working Couple with kids	Inner	208	26,545	69,633	264	32053	107461	1.21	1.54
	Outer	93	12,790	32,654	118	17052	57112	1.33	1.75
Working group various types	Inner	36	10,956	17,178	39	18600	11815	1.70	0.69
	Outer	27	8,085	5,495	28	9487	7607	1.17	1.38
School Student	Inner	57	4,912	3,067	67	5953	4614	1.21	1.50
	Outer	21	4,943	4,897	25	6137	6919	1.24	1.41
University Student	Inner	66	8,285	14,473	81	9967	19524	1.20	1.35
	Outer	40	3,350	5,939	50	5889	7501	1.76	1.26

[1] Weighted [2] Not weighted [3] Weekdays [4] Weekends

Figure 3 shows the number of trips per person per weekdays and per weekend day. Since we used the weighted data both for the number of trips and the number of people who made these trips, it should be generally representative of the travel behaviour of the greater populations of inner and outer Brisbane. The retail trip rate is changing from the lowest point of 0.69 for workers with various household patterns in inner Brisbane (G7-inner, which includes non-family members who are sharing a house together) to the highest rate of 3.31 for working couples with no kids in inner Brisbane (G5-inner). The latter group surprises, but further scrutiny revealed this group's trip frequency to be relatively homogenous, with no outlier effects from a single trip-maker on numerous shopping trips. Except the considerable difference in the case of these two groups, trip rates for all other groups were confined between 0.97 to 1.75, whether on week days or weekend days.

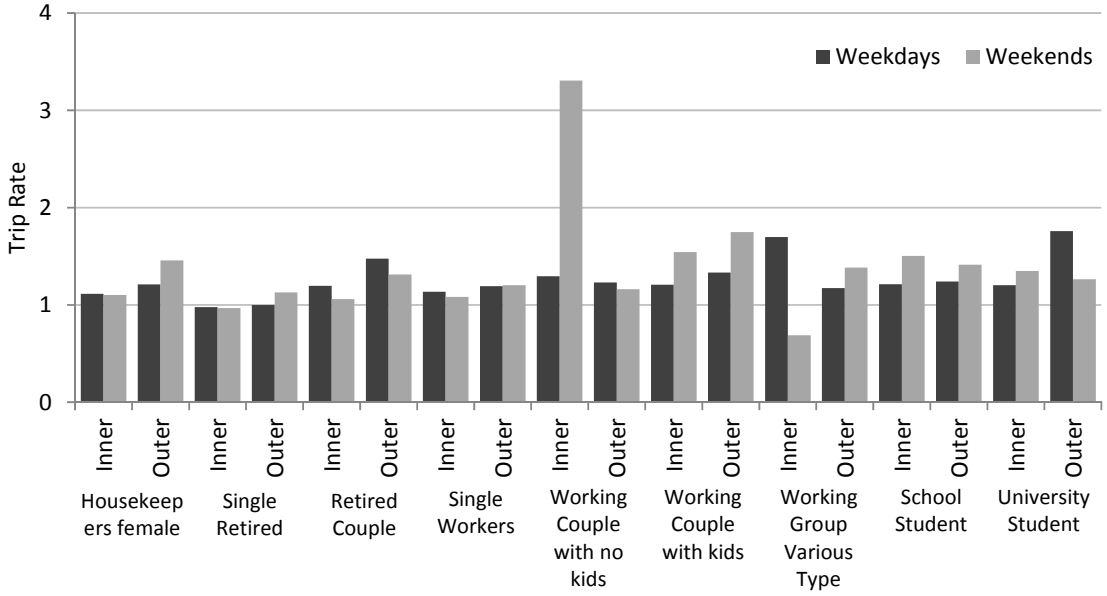

Figure 3: Retail Trip Ratio for inner and outer Brisbane, persons who made retail trips by group, SEQTS-HTS 2009

In more than half of the groups (G1, G2, G3, G4, G6) the retail trip rate is higher in outer Brisbane both during the weekdays and weekend days, in comparison to Inner Brisbane. This means people with similar socio-demographic characteristics are making more trips in outer Brisbane in comparison to inner Brisbane. While for the four other groups inner Brisbane is experiencing higher number of trips mostly during the weekend days. Working couples with children (G6) in Outer Brisbane are having the second highest rate of trips to retail destinations after working couple with no children (G5).

MODE SHARE:

The mode share was calculated separately for both weekdays and weekend days. In general, private cars were used for more than 60 per cent of trips on any given days, except for single retired persons in inner Brisbane (G2-inner) on weekends and school students in inner Brisbane on weekdays (G8-inner). In addition, the role of public transport is more visible during weekdays, although it makes a very low contribution for some groups. During the whole week, housekeepers/unemployed females in outer Brisbane (G1-outer) are almost totally dependent on the private motor vehicle for their retail trips, accounting for more than 95 per cent of all their retail trips. This number drops into about 70 per cent for the same group in inner Brisbane (G1-inner) for weekend days and about 80 per cent for weekdays.
Single retirees (G2-outer) and retired couples in outer Brisbane (G3-outer) have much higher levels of dependency on private cars in outer Brisbane. During the weekends, more than 60 per cent of trips to retail destinations in inner Brisbane are happening by non-motorised modes, while this number drops to around 20 per cent in outer Brisbane. Similar to what was observed for housekeepers/unemployed females, we can see that the role of public transport is more pronounced during weekdays, but only for inner Brisbane.

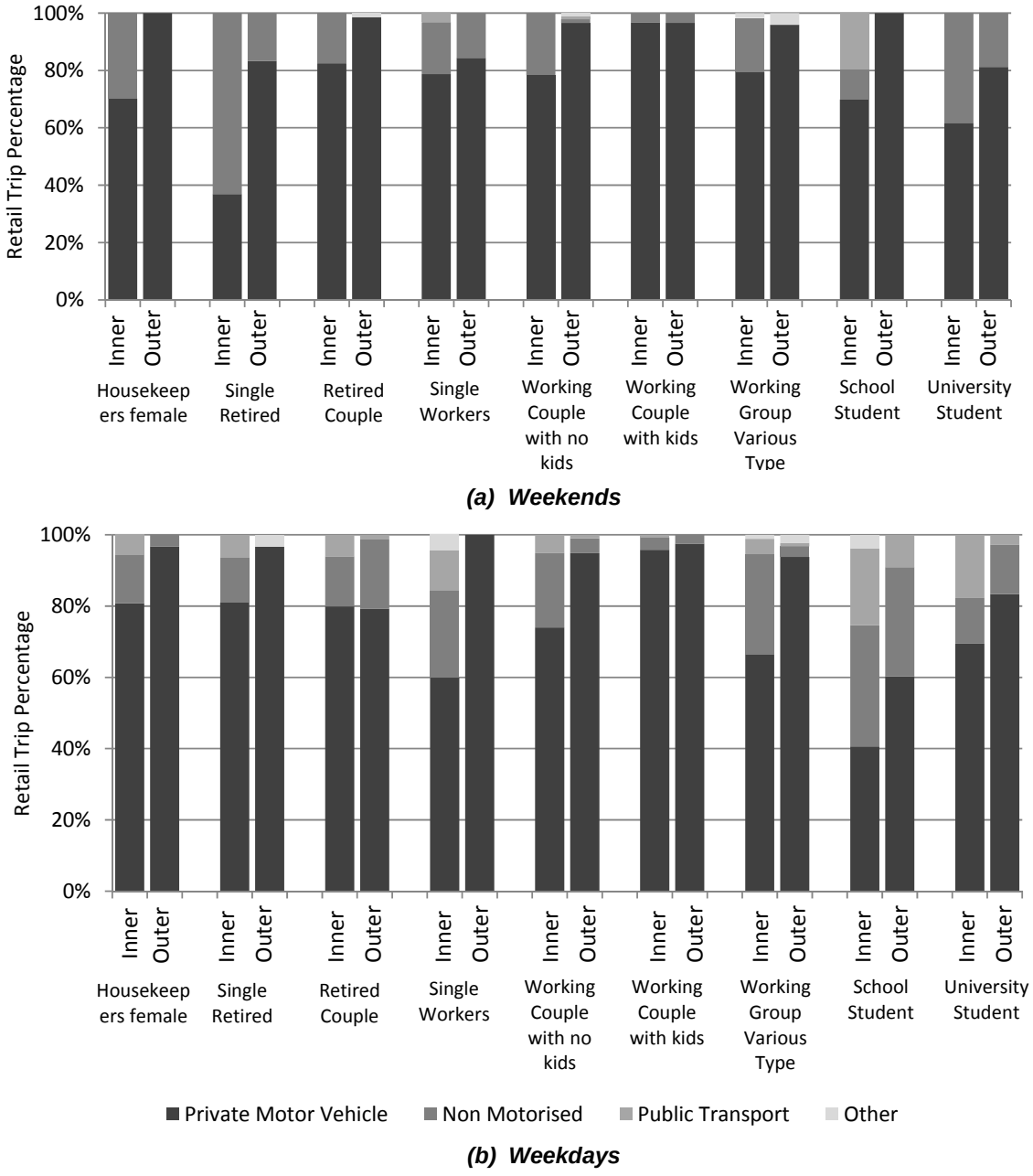

FIGURE 4 Retail trip mode-share, persons who made retail trips by group, SEQTS-HTS 2009

Intriguingly, for retired couples, inner and outer Brisbane have roughly the same mode split for private cars during weekdays. These results raise the question why retired couples who are living in inner Brisbane with a relatively higher level of access to retail are still very much reliant to their private cars, accounting for more than 80 per cent of their trips? Among the working groups, all four groups display similar mode shares across the whole week with a small increase in the percentage of non-motorised and public transport trips on week days. Non-motorised and public transport trips comprise about 40 per cent of all retail trips for single workers and workers with various household types on weekdays. For working people

Outer Brisbane is vastly dependent on private cars, except for single workers (G4) who are still making more than 15 percent of non-motorised trip on weekends. Working couples with children (G6) do not show any difference in terms of mode split across the whole week. School students (G8) travel behaviour shows a dominance of non-motorised and public transport on weekdays, but the majority of retail trips reverting to car on weekends. Finally, university students (G9) display high mode shares for non-motorised travel during weekdays, but less so for public transport.

DISTANCE TRAVELLED EACH WEEK PER CAPITA BY MODE

Figure 5 shows the mean distances travelled to retail destinations per person, per weekdays/weekend day by mode share. This is not a distance travelled per trip, but the total distance travelled for all retail trips by that mode for that person. The results show that the highest mean distance is made by private car, as expected. Each mode is considered separately, but low numbers of trips made by public transport (none in the case of some groups, on weekends especially) suggest the non-motorised and public transport figures should be used with much caution. Of what can be seen, two key trends may be observed. Outer Brisbane tends to have a higher mean distance travelled by private car per weekdays than inner Brisbane, for almost all groups. And weekdays tend to have higher mean distances travelled by private car, than do weekend days, across the groups. For non-motorised trips, mean distances travelled does not exceed 600m for any group. For housekeepers/ unemployed females (G1), a mean distance of 5km per person is observed for both on Weekday and Weekends. For retired groups both single and couples with no kids (G2, G3) number of VKT is below the average during the whole week, while outer Brisbane, is having a higher level. For working groups working couples with kids (G6) are exceeding the average line both for inner and outer Brisbane during the week, which shows the high level of their dependence on the private cars. Working couples with no kids (G5) are making long distances trips to retail destinations, but it is worth to mention that in inner Brisbane VKT increases to 15 km which is about 7 km more than the average. For the student groups, Working days are following the same trend with an increase in VKT for Outer Brisbane, while Weekends is showing a high level of VKT for primary and secondary students who are mostly travelling with their parents, since they do not have the driving licence.

In terms of the non-motorised trips, working couples with no kids (G5) are still keeping their high record by travelling about 500 meters on weekends only in inner Brisbane. Retired couples (G3) are making the highest number of non-motorised trips during the working days in Outer Brisbane by more than 400 meters. In Inner Brisbane retired couples (G3) and school students (G8) are walking and cycling more than the average during the Weekends.

Public transport is hardly playing a part in trips to retail on Weekends. Only school students (G8) are travelling about 2 km on Weekends in inner Brisbane by public transport. During the working days, more groups seem to be interested to use public transport for their trips to retail destinations. Retired couples (G3), single workers (G4) and students (G8, G9) in inner Brisbane are making about 2 km trips by public transport which is higher than the average number of trips for all other groups. People in Outer Brisbane does not show the tendency to use public transport for their retail trips and the maximum distance travelled by this mode share is allocating to University students (G9) by about 700 meters.

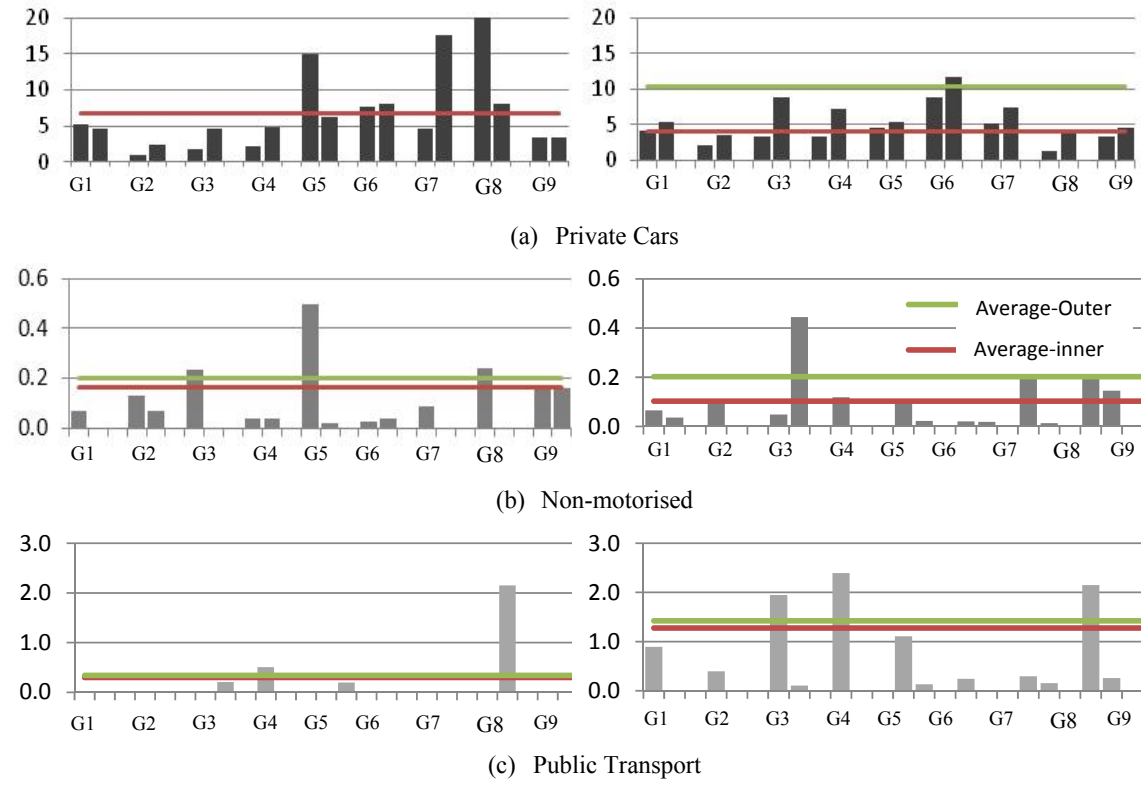

FIGURE 5 Distance (KM) Travelled for retail per capita by Mode-share during weekends and weekdays *

* G1 (Housekeepers/unemployed female), G2 (Single Retired), G3 (Retired Couple), G4 (Single Workers), G5 (Working Couple with no kids), G6 (Working Couple with kids), G7 (Working group various types), G8 (School Student), G9 (University Student),

Another way to consider this data is to explore what the mode shares of trips are for each of these groups, at different trip distances. Less than 1 km is generally considered a walkable distance and should reveal more non-motorised travel, distances between 1 to 3 km, 3 to 5 km and more than 5 km would tend towards motorised travel, both public and private. Figures 6 and 7 illustrate the variation in retail trip mode share, by trip length, for each group, for weekend days and weekdays respectively. Again, there are small numbers of trips in certain categories, so the figures should be used with caution. But what they illustrate is that non-motorised retail travel is indeed primarily a short distance activity, mainly less than 1km, whereas public transport is mainly a longer distance activity, with trips made in most groups by public transport commonly more than 5km.

For housekeepers/unemployed female (G1) non-motorised trips comprise about 70 per cent of trips in Inner Brisbane, while in Outer Brisbane all the trips in the same distance are taking place by private cars. Distances more than 1 km are heavily reliant on private car trips for this group. Single retired (G2) mostly travel by non-motorised modes for distances less than 1 km in Inner Brisbane, but this drops to around 25 per cent in Outer Brisbane. Similarly to G1, private cars dominate trips of more than 1 km. In the case of Retired couples (G3), the percentage of trips by non-motorised mode shares drops almost a quarter compared to Single retired (G2). But for the Retired Couples there is an increase of 25 per cent in non-motorised trips for distances between 1 to 3 km in inner Brisbane.

Among the four working groups, Single workers (G4) tend to take non-motorised trips for distances less than 1 km both in inner and outer Brisbane, while working couples with no kids and workers in various household types are using non-motorised modes for about 55 per cent of all retail trips in inner Brisbane. Working couples with kids (G6) are highly dependent on their private cars across all distances.

The only group that seems to rely on public transport as a major mode on weekends is school students, with about 50 per cent of all trips of distances more than 5 km made by public transport. University students (G9) use walking and cycling as their main mode share only for their trips less than 1 km.

During weekdays some notable comparisons can be seen in the different group's travel behaviours, especially in the distances less than 1 km and more than 5 km. Non-motorised mode shares are very common both in inner and outer Brisbane for distances less than 1 km. But the Single retired and Single workers show a tendency to only use the private motor vehicle in Outer Brisbane. More Females who are keeping house or are unemployed take public transport for trips of more than 5 km.

There is almost a higher share of trips by non-motorised modes made on working weekdays as compared to weekends. There are some exceptions such as the lower levels observed for Females keeping house and University students in inner Brisbane, and the lower levels for Single retired both in inner and outer Brisbane.

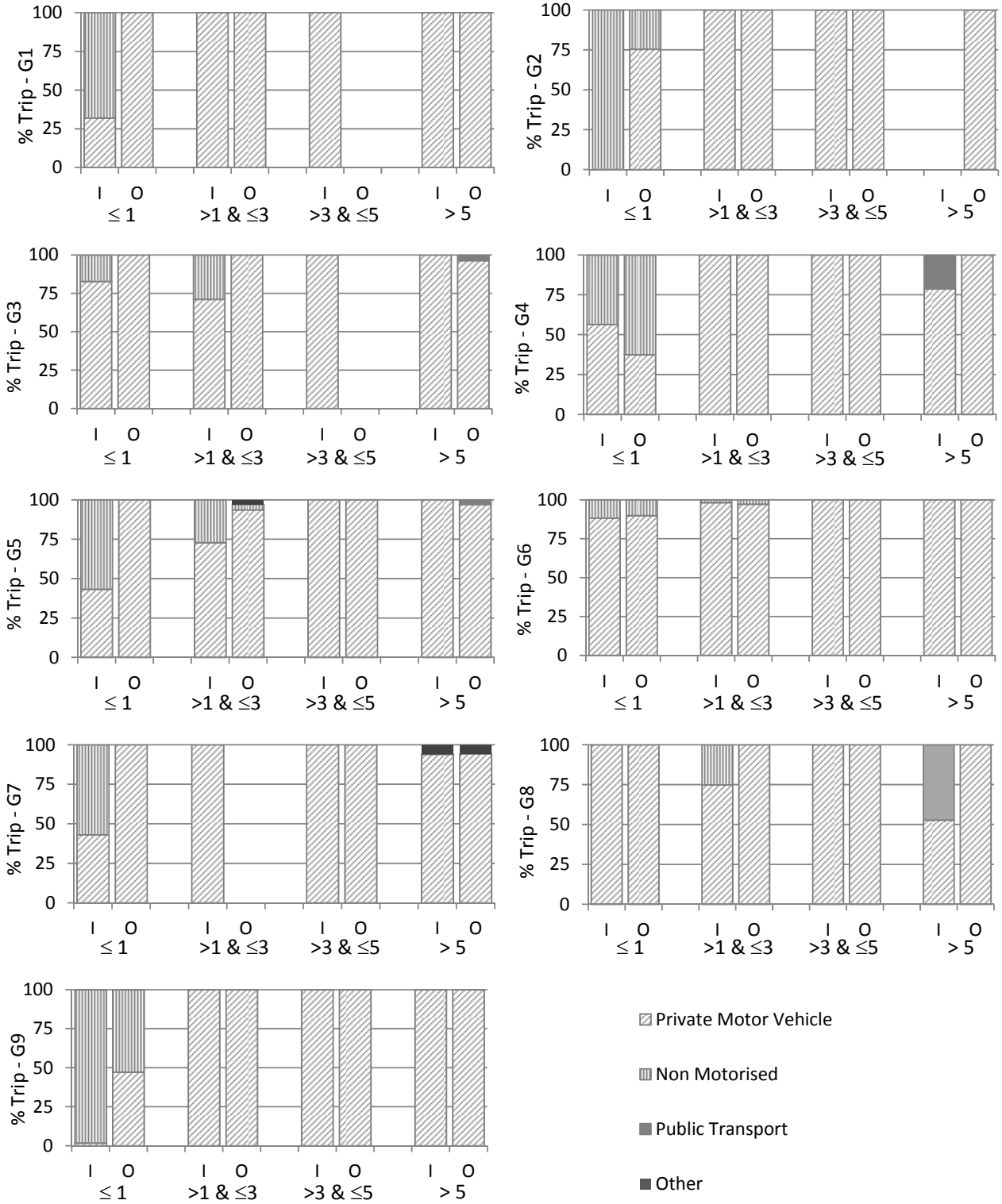

Figure 6 Retail trip percentage by mode share for specific distance intervals (KM)- Weekends *

* G1 (Housekeepers/unemployed female), G2 (Single Retired), G3 (Retired Couple), G4 (Single Workers), G5 (Working Couple with no kids), G6 (Working Couple with kids), G7 (Working group various types), G8 (School Student), G9 (University Student)

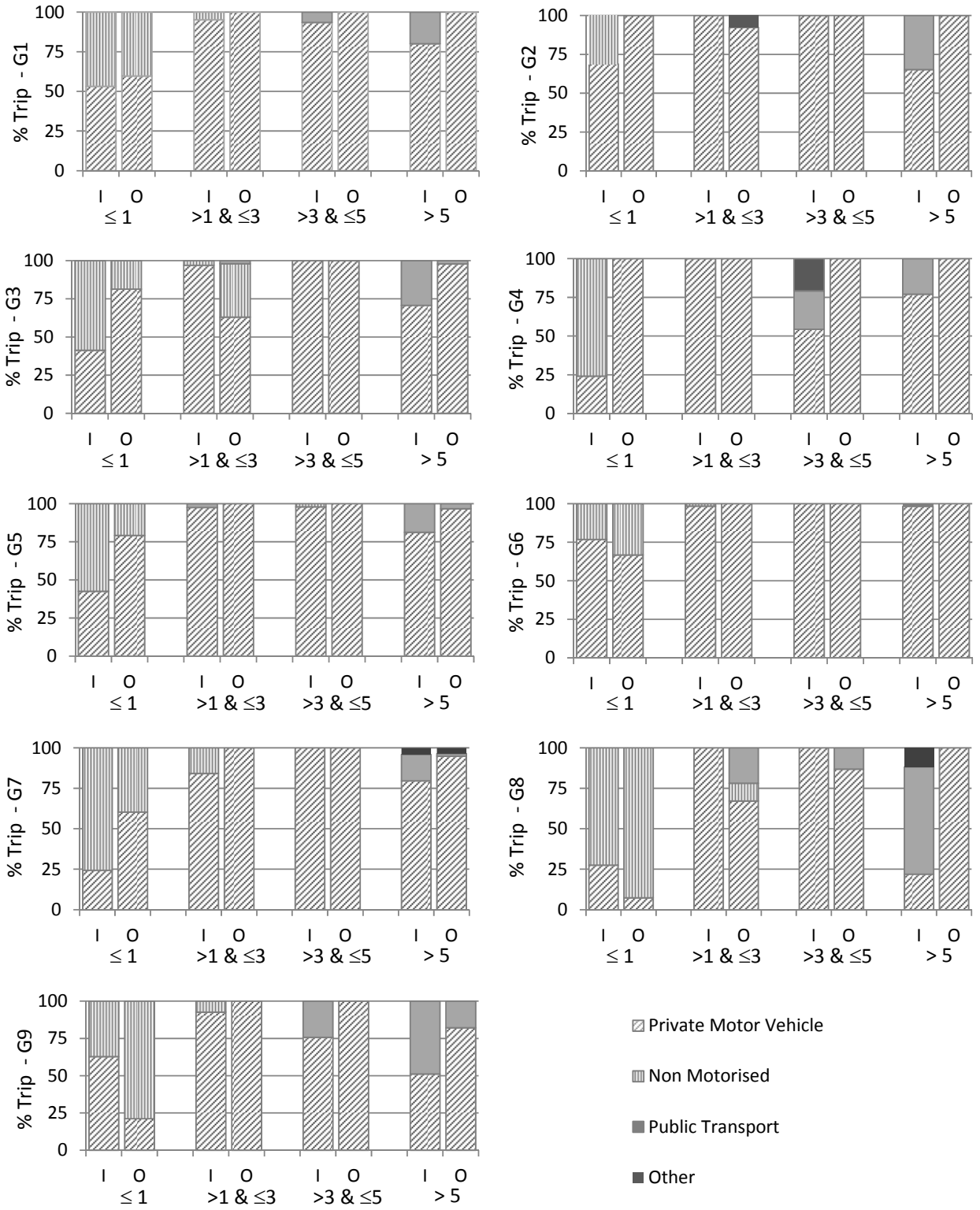

Figure 7 Retail trip percentage by mode share for specific distance intervals (KM)- Weekdays *

* G1 (Housekeepers/unemployed female), G2 (Single Retired), G3 (Retired Couple), G4 (Single Workers), G5 (Working Couple with no kids), G6 (Working Couple with kids), G7 (Working group various types), G8 (School Student), G9 (University Student)

DISCUSSION AND CONCLUSION

This study of the retail travel behaviour of different socio-demographic groups in inner and outer Brisbane helps us gain a better understanding of travel to shops in a major Australian city. The analysis shows that retired, student and working groups, except for couples with children (G6), appear to have some potential to use public and active transport, especially in inner Brisbane. This finding should help planners and policy-makers formulate better policies, help better target travel behaviour change interventions, and make retail travel both more sustainable and more equitable. This paper found many differences between the socio-demographic groups, especially between inner Brisbane and outer Brisbane. More retail trips are made, per capita, in outer Brisbane than inner Brisbane on weekend days. Major differences were also observed between weekday and weekend day retail travel behaviour, across the groups, with weekend retail travel being both more frequent across most groups (except for students and working couples with no children) and having a higher mode share for the car. The results suggest that initiatives to change retail travel behaviour in outer suburban areas will be fraught, and we hypothesise that these differences are primarily due to variation in the built environment between the inner and outer areas of Brisbane, including variations in public transport provision, albeit there may be some residential self-selection effects apparent. Regardless, retail trips are dominated by the private car for most groups, especially on weekends. Attention should be placed on this weekend retail travel behaviour if we are serious about sustainability (as opposed to congestion reduction). It is hoped that the disaggregate data for each group may help develop more practical policies for achieving sustainable transportation, targeted at the needs of specific socio-demographic groups.

Another contribution of the paper is in again demonstrating the value of inductive cluster analysis of the form used by Ryley (2006) and Dodson et al. (2011). A set of groups can be readily identified from within an existing HTS dataset, on this occasion solely focused on retail travel, without the prior biases of the researcher influencing the search for groups, and in a way that allows for later comparative analysis. Such inductive approaches offer much to travel behaviour scholarship.

There are numerous limitations with the work, including the limited sample size in some groups identified. The nature of the cluster analysis somewhat subsumed income behind other variables in allocating cases to groups, limiting the capacity of the results to show income's effects on retail travel behaviour, per se. But the main limitation is that this analysis, which is tied to a broader project on Brisbane and its retail travel, was conducted for one city in Australia, and not on a major national HTS dataset. This may be a fruitful avenue for future research. Other research imperatives include evaluations of the travel behaviour change initiatives that are explicitly targeting and prioritising retail travel, and establishing if changes to retail structures in existing cities can change behaviour significantly, via either modelling or longitudinal surveys.

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REFERENCES

Best, H., & Lanzendorf, M. (2005). Division of labour and gender differences in metropolitan car use: An empirical study in Cologne, Germany. *Journal of Transport Geography, 13*(2), 109-121.

Boarnet, M. G., & Sarmiento, S. (1998). Can land-use policy really affect travel behaviour? A study of the link between non-work travel and land-use characteristics. *Urban Studies, 35*(7), 1155-1169.

Bromley, R. D. F., & Thomas, C. J. (1993). The retail revolution, the carless shopper and disadvantage. *Transactions of the Institute of British Geographers*, 222-236.

Cao, X., Xu, Z., & Fan, Y. (2010). Exploring the connections among residential location, self-selection, and driving: Propensity score matching with multiple treatments. *Transportation Research Part A: Policy and Practice, 44*(10), 797-805.

Carlsson-Kanyama, A., & Linden, A. L. (1999). Travel patterns and environmental effects now and in the future:: implications of differences in energy consumption among socio-economic groups. *Ecological Economics, 30*(3), 405-417.

Cervero, R. (2002). Built environments and mode choice: toward a normative framework. *Transportation Research Part D: Transport and Environment, 7*(4), 265-284.

Cervero, R., & Kockelman, K. (1997). Travel Demand and the 3Ds: density, diversity and design. *Transportation Research D: Transport & Environment, 3*(2), 199-219.

. Connecting SEQ 2031 – An Integrated Regional Transport Plan for South East Queensland (Q. Government, Trans.). (2011): Qeensland Government.

Cubukcu, K. M. (2001). Factors affecting shopping trip generation rates in metropolitan areas. *Studies in Regional and Urban Planning, 9*, 51-68.

Curtis, C., & Perkins, T. (2006). Travel Behaviour: a review of recent literature. Perth, WA: Urbanet, Curtin University of Technology.

Dieleman, F. M., Dijst, M., & Burghouwt, G. (2002). Urban form and travel behaviour: micro-level household attributes and residential context. *Urban Studies, 39*(3), 507-527.

Dodson, J., Burke, M., Evans, R., Gleeson, B., & Sipe, N. (2010). Travel Behavior Patterns of Different Socially Disadvantaged Groups. *Transportation Research Record: Journal of the Transportation Research Board, 2163*(-1), 24-31.

Dodson, J., Burke, M., Evans, R., & Sipe, N. (2011). How will we get there? New approaches to analyzing low-Socio-Economic Status Household access to destinations in Australian cities. *Transportation Research Record, 2242*.

Dodson, J., Li, T., & Sipe, N. (2010). Urban Structure and Socioeconomic Barriers to Consumer Adoption of Energy-Efficient Automobile Technology in a Dispersed City: Case Study of Brisbane Australia. *Transportation Research Record: Journal of the Transportation Research Board, 2157*, 111-118.

Ewing, R. (1995). Beyond Density, Mode-Choice, and Single-Purpose Trips. *Transportation Quarterly, 49*(4), 15-25.

Frank, L., Kavage, S., & Litman, T. (2006). Promoting public health through smart growth: Building healthier communities through transportation and land use policies and practices.

Frank, L., & Pivo, G. (1994). Impacts of Mixed Use and Density on Utilization of Three Modes of Travel: Single-Occupant Vehicle, Transit and Walking. *Transportation Research Record, 1466*, 44-52.

Handy, S. (1996). Methodologies for exploring the link between urban form and travel behavior. *Transportation Research Part D: Transport and Environment, 1*(2), 151-165.

Hanson, S. (1982). The determinants of daily travel-activity patterns: relative location and sociodemographic factors. *Urban Geography, 3*(3), 179-202.

Hanson, S., & Hanson, P. (1981). The travel-activity patterns of urban residents: dimensions and relationships to sociodemographic characteristics. *Economic Geography, 57*(4), 332-347.

Hubbard, R. (1978). A review of selected factors conditioning consumer travel behavior. *Journal of Consumer Research*, 1-21.

Kattiyapornpong, U., & Miller, K. E. (2011). *Understanding travel behavior using demographic and socioeconomic variables as travel constraints*.

Meurs, H., & Haaijer, R. (2001). Spatial Structure and Mobility. *Transportation Research Part D: Transport and Environment, 6*(6), 429-446.

Mooi, E., & Sarstedt, M. (2011). *A Concise Guide to Market Research, The Process, and Methods Using IBM SPSS Statistics*: Springer.

Murdie, R. A. (1965). Cultural differences in consumer travel. *Economic Geography, 41*(3), 211-233.

Norusis, M. J. (2003). *SPSS 12.0 statistical procedures companion*: Prentice Hall.

Prillwitz, J., Harms, S., & Lanzendorf, M. (2006). Impact of life-course events on car ownership. *Transportation Research Record: Journal of the Transportation Research Board, 1985*(-1), 71-77.

Ryley, T. (2006). Use of non-motorised modes and life stage in Edinburgh. *Journal of Transport Geography, 14*(5), 367-375.

Şchiopu, D. (2010). Applying TwoStep cluster analysis for identifuing bank customers' profile. *Buletinul, 62*, 66-75.

Shih, M. Y., Jheng, J. W., & Lai, L. F. (2010). A Two-Step Method for Clustering Mixed Categroical and Numeric Data. *Tamkang Journal of Science and Engineering, 13*(1), 11-19.

Shobeirinejad, M., Burke, M., & Sipe, N. (2012). *Analysing retail Travel behaviour using an Australian dataset*. Paper presented at the Australasian Transport Research Forum (ATRF)