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DO DISSONANTS IN TRANSIT ORIENTED DEVELOPMENT ADJUST COMMUTING TRAVEL BEHAVIOUR?

MD. KAMRUZZAMAN, SCHOOL OF CIVIL ENGINEERING AND THE BUILT ENVIRONMENT, QUEENSLAND UNIVERSITY OF TECHNOLOGY, BRISBANE, QLD 400, AUSTRALIA. E-MAIL: MD.KAMRUZZAMAN@QUT.EDU.AU

DOUGLAS BAKER, SCHOOL OF CIVIL ENGINEERING AND THE BUILT ENVIRONMENT, QUEENSLAND UNIVERSITY OF TECHNOLOGY, BRISBANE, QLD 400, AUSTRALIA. E-MAIL: D2.BAKER@QUT.EDU.AU

GAVIN TURRELL, SCHOOL OF PUBLIC HEALTH, QUEENSLAND UNIVERSITY OF TECHNOLOGY VICTORIA PARK ROAD, KELVIN GROVE, BRISBANE, QLD 4059, AUSTRALIA. E-MAIL: G.TURRELL@QUT.EDU.AU

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Md. Kamruzzaman, School of Civil Engineering and the Built Environment, Queensland University of Technology, Brisbane, QLD 400, Australia. E-mail: md.kamruzzaman@qut.edu.au

Douglas Baker, School of Civil Engineering and the Built Environment, Queensland University of Technology, Brisbane, QLD 400, Australia. E-mail: d2.baker@qut.edu.au

Gavin Turrell, School of Public Health, Queensland University of Technology, Victoria Park Road, Kelvin Grove, Brisbane, QLD 4059, Australia. E-mail: g.turrell@qut.edu.au

ABSTRACT

Despite being identified as a significant behavioural element in the development of sustainable transport and land use policy options, residential dissonance is still a relatively unexplored theme in the literature. Using panel data from 2675 commuters, this research first identifies mode choice behaviour of four groups living in transit oriented development (TOD) and non-TOD areas in Brisbane: TOD dissonants, TOD consonants, non-TOD dissonants, and non-TOD consonants. The research then investigates the prevailing view that dissonants adjust their attitudes and lifestyle according to their surrounding land uses over time. The adjustment process was examined by comparing their mode choice behaviour between 2009 and 2011. Six binary logistic regression models were estimated, one for each of the three modes considered (e.g. public transport, active transport, and car) and one for each of the 2009 and 2011 waves. Results show that TOD dissonants and non-TOD consonants were less likely to use the public transport and active transport; and more likely to use the car compared to TOD consonants. Non-TOD dissonants use public transport and active transport equally to TOD consonants. The results signify that travel attitudes are more influential in transport mode choice compared to built environment factors; however, the latter factors do influence public transport and car use propensity. Evidences in this research support that dissonants adjust their attitudes towards surrounding land uses, albeit slowly. Both place (e.g. TOD development) and people based (e.g. motivational) policies are needed for an effective travel behavioural shift in Brisbane.

Keywords: residential dissonance, transit oriented development, commuting behaviour, travel attitudes, Brisbane

1. INTRODUCTION

Transit oriented development (TOD) is characterised by moderate to high residential density, diverse land uses (e.g. mix of residential, commercial, recreational etc.), well-connected street networks (e.g. grid or semi-grid street systems as opposed to cul-de-sacs) and centred around high frequency public transport (PT) stops (Cervero and Kockelman, 1997). TODs have been identified as a key policy tool worldwide because of their ability to foster the use of more sustainable transport modes (e.g. bus, train, walk, bicycle) and to reduce car-dependency; and consequently lowering greenhouse gas emissions and congestion level (Transportation Research Board, 2001). High residential density generates more passengers to support frequent transit services and increases the liveliness of a place (Lin and Gau, 2006). Mix land uses in station areas provide opportunities for people to live closer to their jobs and can generate transit trips throughout the day (The City of Calgary, 2004). In addition, transit supportive uses (e.g. shops) are high pedestrian generators that directly promote greater transit ridership and provide opportunities for multi-purpose trips (Cervero, 1996). Street connectivity facilitates walking by reducing walking time from transit stops to opportunities (destinations) or between opportunities. As a result, a combination of this flexibility (e.g. walkability and frequency) and speed of public transport services in a TOD makes them a logical competitor of private transport (Bertolini et al., 2009).

Despite the identification of positive associations between the urban form variables (e.g. density, diversity, connectivity) and the use of sustainable transport modes, research has questioned their causality because such an association could be caused by spuriousness – i.e. a third factor creates an accidental relationship (Handy et al., 2006; Mokhtarian and Cao, 2008; Singleton and Straits, 1999). Residential self-selection has commonly been identified as a spurious factor in the literature (Handy and Clifton, 2001). It refers to individuals' inclination to choose a particular neighbourhood according to their travel abilities, needs, and preferences (Guo and Chen, 2007; Litman, 2012; Pinjari et al., 2007). In the context of a TOD this means, for example, that individuals who prefer transit services intentionally choose to live in TODs. Therefore, the observed relationship between urban form and mode choice behaviour is largely due to differences in travel attitudes and preferences, not urban form differences – although the effect will be captured by urban form variables in a model in the absence of variables related to travel attitudes and preferences. No matter whether it's because of urban form or self-selection, they both act in favour of public transit usage for a TOD. However, a clear understanding of the relationship is important from policy perspective – i.e. whether barriers should be removed for self-selection to occur or whether urban form should be changed (e.g. increase diversity) or both.

Barriers to self-selection must be removed in order to reduce the level of residential dissonance in TODs (Kamruzzaman et al., 2013). Residential dissonance refers to the mismatch in land use patterns between individuals' preferred neighbourhood type (e.g. non-TOD) and the type of neighbourhood where they actually reside (e.g. TOD) (Schwanen and Mokhtarian, 2004). It remains a relatively unexplored theme in the literature, yet, has been identified as a significant

behavioural element in the development of sustainable transport and land use policy options. For example, urban dissonants are more likely to use the car and less likely to use the bus and active transport compared to their urban consonants counterpart (De Vos et al., 2012; Schwanen and Mokhtarian, 2005b). Urban dissonants also make longer distance car trips (Schwanen and Mokhtarian, 2005a). Therefore, it is indispensable to reduce the level of dissonance in TODs in order to enhance their effectiveness.

Hypothetically, the level of dissonance can be reduced (or the self-selection process can be enhanced) in two ways in a TOD (Schwanen and Mokhtarian, 2005a). First, TOD residents can relocate to non-TOD areas whereas non-TOD residents can relocate to TOD areas in order to match their preferences. However, a recent study has not found stronger evidence to verify that such process occurs in the context of a TOD over short-mid term periods (Kamruzzaman et al., 2013). Rather the study reported that the rate of residential mobility from TODs was not significantly higher for those who did not prefer TOD than those who preferred TOD. On the other hand, despite having the preferences to live in TODs, individuals from non-TOD areas were less likely to move into TODs due to costs and other associated factors. As a result, they either stayed or moved into another non-TOD area resulting in a mix of dissonants and consonants in both TOD and non-TOD areas.

The second process is more internal to individuals and is related to their attitudinal adjustments. For example, despite being TOD dissonants now, individuals can change their travel attitudes and living preferences over time and become TOD consonants. If such attitudinal adjustment exists and is rapid, then public policies need only focus on the built environment and not on attitude change. However, empirical evidence is lacking to support this second proposition. Kamruzzaman et al. (in press) analysed mode shift behaviour of TOD/non-TOD dissonants between 2009 and 2011 in Brisbane and found little behavioural evidence to support this adjustment process. The study used chosen ‘main mode in a week’ to generate the mode shift variable. A reported limitation of this study is that the main mode (among five options) used 26% of the time or 100% of the time would be coded exactly the same by a respondent. The given five options (public transport, car or motorcycle, walk, bicycle, and other) were also not a complete set of alternative modes available in Brisbane. Another limitation of this study was that the chosen mode can be used for any purposes (e.g. work for employed individuals, shopping/recreation for non-working individuals). The chosen main mode for a working individual will have a different impact on the environment and road network than the chosen main mode of a non-working individual. For example, traffic congestion levels are higher during the morning and afternoon commuting periods which means that work-related journeys are the greatest challenge for transportation planners to manage. In contrast, policies can be targeted more effectively due to routine and repetitive nature of the commuting journeys (Commins and Nolan, 2011). Therefore, a more refined analysis by examining the empirical burden of proof is required either to accept or reject the hypothesis. This research aims to contribute to this gap in the literature.

The first objective of this is to identify commuting mode choice behaviour of dissonants/consonants living in TOD and non-TOD areas using a more refined dataset. Second, if there are differences in the patterns, then to investigate whether dissonants adjust

their behaviour over time. The data and methods used to conduct the above evaluations are discussed in Section 2. Section 3 outlines the findings of the research, and Section 4 concludes this research providing policy implications.

2. DATA AND METHOD

2.1 Data

This research used the HABITAT (**H**ow **A**reas in **B**risbane **I**nfluence Heal**T**h and **A**c**T**ivity) panel survey data collected from 2675 commuters in Brisbane (Burton et al., 2009). The 2009 and 2011 versions of the survey were used in this research. Respondents were the common participants in both periods. They were also employed in both phases and did not change home between the periods. As a sampling strategy, first, a stratified random sampling technique was used to select 200 CCDs from Brisbane; and then from each CCD, a simple random sample was drawn. The participants were all mid-aged adults (aged between 40 and 70 years) and were intentionally chosen to study health and related behaviour of a 'baby boomer' cohort. The participants are representative to the wider population in Brisbane for this age group.

2.2 Dependent variables

Respondents were asked to choose the type of transport they used to travel to and from work based on a given complete set of transport mode available in Brisbane including bus, train, ferry, car, walk, motorcycle, bicycle, taxi, and other. Respondents were also instructed to choose multiple options if they used more than one type of transport. Therefore, respondents selected whether a particular mode they used or not (multiple binary outcomes). Bus, train, and ferry were combined and referred to as public transport (PT). If respondent chose any of these as their travel mode, they were coded as 1 otherwise 0. Walk and cycle were also combined and referred to as active transport (AT). A similar coding system was also used for AT. In contrast, car, taxi, and motorcycle were combined to indicate unsustainable mode of transport (UT) and a similar coding system was used for this. This coding system, therefore, allows to investigate whether a particular group (e.g. TOD consonant) is more/less likely to use a more sustainable (e.g. PT, AT) or unsustainable mode of transport.

2.3 Generation of 'TOD dissonants/consonants' variable as an independent factor

A four category 'TOD dissonants/consonants' factor was generated in this research in order to examine both the commuting mode choice and mode adjustment behaviour of dissonants including: TOD consonants, TOD dissonants, non-TOD consonants, and non-TOD dissonants. A similar method to that Schwanen and Mokhtarian (2004) was used for the generation of this factor. First, individuals' actual neighbourhoods (where they were actually living) were classified into either a TOD or non-TOD types based on four indicators related to urban form: residential density, land use diversity, street connectivity, and public transport accessibility (Kamruzzaman et al., 2013). Second, individuals preferred neighbourhood (where they would like to live) were also categorised into TOD and non-TOD types based on a factor analysis of 14 statements

representing their travel preferences (Handy et al., 2005). The combination of these preferences with the actual residential neighbourhood of the respondents results in the four categories of the 'TOD dissonants/consonants' factor. This factor, therefore, captures both built environmental characteristics and travel preferences together.

Residential density, land use diversity, and network connectivity indicators were calculated based on a 1km circular buffer from respondent's home location (Frank et al., 2005). The average size (m^2) of residential zoned lands within the buffer was used to represent residential density – i.e. the higher the value, the lower the density (Wilson et al., 2012). Land use diversity was generated using an entropy equation as described by Leslie et al. (2007) that ranged from 0 (complete homogeneity) to 1 (even distribution) based on five land use classes located with the buffer: residential, commercial, industrial, recreational, and other. Network connectivity was measured using an intersection density indicator based on the number of 4 or more way intersections located with the buffer. The three indicators were aggregated into a composite measure of 'urban compactness' and classified into compact and incompact areas following Kamruzzaman et al (2013). The accessibility of public transport services was then combined as an ultimate criterion. If PT services (e.g. bus/train/ferry) are located within a 600 metre (or 10 minutes) walking distance from home, then these are considered as accessible (Queensland Government, 2009). Based on these accessibility and compact development criteria, respondents' actual home locations were then classified as either TOD type (when both compact and PT access criteria met) or non-TOD type.

Table 1 – Pattern matrix showing variable loadings on travel attitude factors in 2009

Statements	Factors			
	Anti-PT	Env. con	Pro-car	Car safer
Public transport is inconvenient and unreliable	.851	.026	-.020	-.052
Using public transport takes too much time	.650	.031	.168	-.030
Travelling by public transport is not very pleasant	.619	-.007	-.021	.079
Public transport can sometimes be difficult than driving	.453	-.116	.077	.093
Public transport is expensive	.407	-.005	-.055	.011
People need to walk and cycle more to improve the environment	-.022	.910	-.032	.111
People need to walk and cycle more to reduce global warming	-.014	.794	-.037	.100
People need to walk and cycle more to reduce traffic congestion	-.006	.744	.021	.025
People need to use public transport more often to reduce traffic congestion	-.066	.529	.017	-.102
Driving a car is expensive	.043	.295	.010	-.108
I need a car to do many of the things that I do	.010	.020	.746	.006
I could not manage pretty well without a car	-.001	-.022	.698	.027
Travelling by car is safer overall than taking public transport	.167	.063	-.002	.751
Travelling by car is safer overall than walking	-.018	-.048	.052	.552
% of variance explained	23.092	13.558	6.119	3.849
Total variance explained (%)				46.618
Kaiser-Meyer-Olkin Measure of Sampling Adequacy				0.796
Extraction method: Principle Axis Factoring				
Rotation method: Oblimin with Kaiser Normalisation				
N				2675

The factor analysis resulted in a four factor solution and can respectively be interpreted as reflecting anti PT attitudes, environmental concerns attitudes, pro-car attitudes, and safety concerns attitudes while travelling (Table 1). The first factor was used to classify respondents

into either preferring a TOD type of living environment or not. This is due to the fact that public transit services are key elements in facilitating travel in TODs and respondents with anti PT attitudes are less likely to choose TOD as a place to live (De Vos et al., 2012). As a result, respondents with a positive score in the first factor were classified as preferring non-TOD type of neighbourhood whereas respondents with a negative score in this factor were classified as preferring TOD type of neighbourhood.

Table 2 – Socio-economic characteristics of the respondents participated in the surveys

Socio-demographics	2009		2011	
	Frequency	%	Frequency	%
Travel time				
0-15 minutes	719	26.9	697	26.1
15-30 minutes	1175	43.9	1174	43.9
30-60 minutes	702	26.2	708	26.5
More than 60 minutes	79	2.9	96	3.5
Gender				
Male	1263	47.2	1263	47.2
Female	1412	52.8	1412	52.8
Mean age	52.17 (SD 6.2)		54.17 (SD 6.2)	
Car availability				
Yes, always	2456	91.8	2474	92.5
Yes, sometimes	156	5.8	125	4.7
No	29	1.1	40	1.5
Do not drive	34	1.3	36	1.3
Employment status				
Working full time	1903	71.1	1872	70.0
Working part time	772	28.9	803	30.0
Level of education				
Upto year 12	799	29.9	799	29.9
Diploma/certificate	794	29.7	794	29.7
Bachelor or above	1082	40.4	1082	40.4
Current living arrangement				
Living alone with no children	360	13.5	389	14.5
Single parent with >=1 children	192	7.2	172	6.4
Single and living with friends/relatives	103	3.9	108	4.0
Couple living with no children	656	24.5	755	28.2
Couple living with >=1 children	1309	48.9	1223	45.7
Other	55	2.1	28	1.0
Average household size	2.96 (SD 1.4)		2.87 (SD 1.3)	
Income percentile				
First (lower)	453	16.9	398	14.9
Second	808	30.2	762	28.5
Third	483	18.1	456	17.0
Fourth	664	24.8	750	28.0
Missing	267	10.0	309	11.6
Average heath status	3.4 (SD 0.9)		3.5 (SD 0.9)	
Country of birth				
Australia	2051	76.7	2051	76.7
Other	624	23.3	624	23.3
N				2675

2.4 Controlling factors

Commuting mode choice behaviour not only dependent on the environmental and attitudinal factors as described above but individuals' socio-demographics and trip characteristics (e.g.

travel time) also significantly affect the choice. Based on findings reported in previous studies, ten socio-demographic variables and one trip characteristics variable were selected and were used as controlling factors in this research in order to understand the true impact of the 'TOD dissonants/consonants' factor. These variables have been identified as significant predictors of commuting mode choice behaviour and include gender, age, availability of car, income, employment status, household size, health status, education, living arrangement and country of birth (Table 2) (Cervero, 1996; Commins and Nolan, 2011). Due to the changeable nature of some of the socio-demographic characteristics over time (e.g. income, availability of car) at the individual level, separate sets of socio- demographic variables were taken into account for 2009 and 2011(Meurs and Haaijer, 2001). Table 2 provides an overview of the minor changes in the socio-demographic status that occurred between the periods.

2.4 Data analysis

In this research a binary logistic regression model was used to model a binary 'travel to work mode' response variable given that the form of the questionnaire regarding travel mode yielded a binary outcome. This binary form has been used in similar research contexts (Emond and Handy, 2012; Hine et al., 2012; Rose and Marfurt, 2007). The binary outcome variables across travel modes were then regressed using the 'consonant/dissonant' variable while controlling for other socio-demographic variables, trip characteristics, and neighbourhood characteristics. Binary logistic regression was applied to identify the impact of residential dissonance on travel behaviour. In total, six logistic regressions were estimated, one for each of the modes (PT, AT, UT) and one for each of the 2009 and 2011 waves. All models were estimated using Stata. To account for the clustering effect within each CCD, the **vce(cluster *clustvar*)** option was used to obtain a robust variance estimate that adjusted for within-cluster correlation (Greenwald, 2006). The CCD code was used as the clustering variable in the model. The binary logistic regression model computed the odds ratios (ORs) for each explanatory variable that indicated a measure of how much more likely one group (e.g. TOD dissonant) used a certain mode (e.g. PT) when compared to its counterpart (e.g. TOD consonant), controlling for other variables in the model. Only the statistically significant explanatory factors were retained in the models upon refinement of an initial starter specification that included all variables. Only statistically significant factors ($p<0.05$) were retained in the final models upon refinement of initial models that included all explanatory factors.

3. RESULTS

Analysis shows that overall 80.26% respondents used the car as their mode of travel to work in 2009, which slightly increased to 81.87% in 2011 (Table 3). In contrast, 23.89% respondents mentioned that they used public transport for their travel to work in 2009, which reduced substantially to 17% in 2011. Only 12.1% respondents used active transport for travelling to work in 2009, which remained almost same in 2011. As mentioned previously, respondents' travel behaviour was analysed using a binary mode choice indicator in this research. Table 4 shows the results obtained from the binary logistic regression models for the three modes analysed in this research for both periods. Table 3 also shows descriptive statistics related to

travel to work mode choice behaviour of the different dissonant and consonant groups considered in this research in both time periods.

Table 3 – Descriptive statistics showing the choice of travel mode to work[a]

	Respondents		Transport mode use (%)					
			2009			2011		
	Frequency	%	PT	AT	UT	PT	AT	UT
TOD consonants	656	24.5	34.2	35.5	21.4	33.9	34.5	22.0
TOD dissonants	577	21.6	15.7	21.6	22.3	18.2	21.8	22.2
Non-TOD consonants	718	26.8	15.3	17.6	29.7	16.0	20.9	28.8
Non-TOD dissonants	724	27.1	34.9	25.3	26.6	31.9	22.7	27.0
N	2675		639 (23.89%)	324 (12.11%)	2147 (80.26%)	457 (17.08%)	330 (12.34%)	2190 (81.87%)

[a] The sum of the percentages may not equal to 100 due to multiple response set.

3.1 Public transport

TOD dissonants were 2.8 times less likely to use public transport than TOD consonants in 2009. This difference reduced slightly in 2011. Like the TOD dissonants, non-TOD consonants were also found to be 4 times less likely to use public transport compared to TOD consonants in 2009. This gap also slightly increased in 2011. The findings suggest that both attitudes and the built environment played a significant role in influencing this behaviour. Note that both TOD dissonants and non-TOD consonants possess similar travel attitudes but lived in different types of built environments. If built environment had no impact, then it was expected that both group would use public transport equally given they possess identical attitudes. On the other hand, if attitudes had no impact, then TOD dissonants and consonants were expected to use public transport equally. However, the odds ratios indicate that attitudes played a stronger role here than the built environment. In contrast, non-TOD dissonants used public transport equally compared to TOD consonants in 2009, again suggesting the important role of attitudes in choosing public transport services. These two groups lived in distinct neighbourhood types but possess similar travel attitudes. However, the likelihoods of using public transport services were reduced for non-TOD dissonants in 2011 suggesting that they adjusted their attitudes towards the surrounding land uses. This means that a lack of public transport services forced this group to use alternative mode of transports over the time period. Similar adjustment behaviour was also evident in TOD areas where TOD dissonants slightly shifted their behaviour from 2.8 times less likely to use public transport service in 2009 to 2.4 times less likely in 2011. Therefore, availability of public transport services in TODs influenced this group to change their attitudes in favour of public transport services.

3.2 Car (unsustainable transport)

TOD dissonants were 2.2 times as likely to use the car compared to TOD consonants in 2009 and this gap reduced slightly to 2 times in 2011. Non-TOD consonants were 3.4 times more likely to use the car in 2009 compared to TOD consonants. This gap also reduced to 2.9 times in 2011. Whilst it might be expected that both TOD dissonant and non-TOD consonant groups

would use the car equally given similar travel attitudes, it is apparent that either car use struggles with physical constraints in TOD areas, such as congestion and parking problems (De Vos et al., 2012), access to PT in TOD decreases car use, or both. The differences in car use between TOD consonants and non-TOD dissonants were marginal in both periods. Non-TOD dissonants were 1.7 times more likely to use the car compared to TOD consonants, which remained almost equal in 2011. The above findings suggest that travel attitudes are still the most dominant factor in choosing the car, but the built environment had marginally less influential roles in shaping commuting mode choice behaviour.

Table 4 – Binary logistic regression analysis results showing the ORs associated with mode choice behaviour in 2009 and 2011 (Std. Err. adjusted for 200 clusters in CCDs)

Explanatory factors	Dependent variable: mode of transport to work (1 = yes, 0 = no)					
	PT		UT		AT	
	2009	2011	2009	2011	2009	2011
Dissonants/consonants in 2009						
TOD dissonants (ref: TOD consonants)	0.361	0.416	2.218	2.090	0.762	-
Non-TOD consonants (ref: TOD consonants)	0.280	0.243	3.421	2.878	0.714	-
Non-TOD dissonants (ref: TOD consonants)	-	0.673	1.688	1.834	-	-
Urban form characteristics in 2009						
Residential density (continuous - higher value, less dense)	0.999	0.999	-	-	1.001	-
Network connectivity (continuous)	-	-	-	-	1.016	1.017
Trip characteristics (‘09, ‘11)						
Travel time: 15-30 minutes (ref: 0-15 minutes)	10.239	6.724	1.518	1.599	0.315	0.438
Travel time: 30-60 minutes (ref: 0-15 minutes)	43.695	26.338	0.584	0.564	0.545	-
Travel time: more than 60 minutes (ref: 0-15 minutes)	50.347	33.759	0.494	0.490	-	-
Socio-demographics						
Gender: female (ref: male)	1.476	1.389	1.384	1.421	0.679	0.701
Age (continuous) (‘09, ‘11)	-	0.972	-	-	-	-
Car availability: yes, sometimes (ref: yes, always) (‘09, ‘11)	5.812	6.588	0.166	0.171	3.560	4.966
Car availability: no (ref: yes, always) (‘09, ‘11)	14.770	4.738	0.042	0.086	5.322	6.229
Car availability: do not drive (ref: yes, always) (‘09, ‘11)	16.264	11.490	0.037	0.051	7.649	5.897
Education: diploma/certificate (ref: upto year 12)	-	-	-	1.298	-	-
Education: bachelor or above (ref: upto year 12)	-	-	-	-	1.470	-
Household size (continuous) (‘09, ‘11)	-	0.796	-	-	-	-
Country of birth: other (ref: Australia)	-	-	-	-	0.727	-
Income percentile: third (ref: first) (‘09, ‘11)	-	-	0.726	-	-	-
Income percentile: missing (ref: first) (‘09, ‘11)	-	-	-	0.732	-	-
Health status (continuous) (‘09, ‘11)	-	-	0.847	0.797	1.164	1.279
Log pseudolikelihood	-884.573	-933.127	-1137.005	-1088.478	-887.787	-908.296
Wald Chi^2	343.90[a]	357.10	329.10	317.69	202.08	213.80
Pseudo R^2	0.2567	0.2324	0.1383	0.1291	0.0946	0.0876
N						2675

[a] Coefficients are significant at the 0.05.

3.3 Active transport

TOD dissonants were less likely to walk and cycle in 2009 for their travel to work compared to TOD consonants. Both of these groups live in the same neighbourhood (TOD) but possess different attitudes. This attitudinal difference, therefore, impacted significantly in choosing this travel mode. They, however, used active transport equally to TOD consonants in 2011 suggesting their attitudinal shift towards surrounding land uses. A stronger attitudinal influence was evident for non-TOD dissonants group in 2009. Despite living in distinct environment, this group used active transport equally to those TOD consonants in 2011.

4. DISCUSSION AND CONCLUSION

The findings from the cross-sectional analyses for both time periods (2009, 2011) are consistent with previous cross-sectional studies. Most of the literature provides a static analysis within one time period. The primary contribution of this research has been to provide a longitudinal evaluation of travel behaviour of TOD and non-TOD dissonants and consonants. Given the validity of the cross-sectional analyses – the observations from this study confirm the literature findings on behaviour change – that it is a rather slow process. Minor behavioural differences were observed in the two year period amongst different groups. The evidence examined here suggests that travel preferences are more important in choosing transport mode than the built environmental factors; however, the built environment has some influence on commuting travel mode, with the largest effect on public transport and car. Attitudes and preferences seem to dominate commuting mode choice over the two years surveyed, with minor changes occurring between survey periods. The correlation of attitudes among the consonants and dissonants living in dissimilar living environments provides valuable insight into the importance of individual's ingrained preferences on travel behaviour.

Critical to the study is group-specific attitudes regarding the built environment. In the case of both 2009 and 2011 data, TOD dissonant groups and non-TOD consonant groups were 2.8 times and 4 times less likely to use public transport. These gaps reduced slightly in 2011 for both groups. In addition, the built environment may contribute to the reduction of car usage and increase of public transport usage over a time, albeit slowly. The results reported in this paper clearly indicate that the built environment alone is not enough to change behaviour of residentially dissonant mode choosers, at least over the short-term. TOD–dissonant groups living in TOD areas tended to change attitudes and behaviour very slowly. Major policies with the potential to influence mode choice in Brisbane have remained relatively static, including parking availability, parking pricing, tolling, relative travel times, etc. Building TODs to encourage the use of public transit is often recognized as a critical first step in reducing automobile dependence; however, the attitudes of individual's will remain a strong factor to influence mode choice. Well designed policies to support TODs with positive and negative reinforcement may increase their effectiveness substantially.

This paper adopted a conservative approach in the longitudinal analysis. Mode choice behaviours of an individual were analysed in two different time periods in order to examine whether a shift occurred or not indirectly. A more direct measure of mode choice such as the

distance travelled by mode would allow monitoring marginal changes which was not possible to capture here. In addition, the behaviour shift was investigated between 2009 and 2011. This two year time span might not be long enough for an attitudinal adjustment. Future studies should seek to investigate this issue using a longer time span and also based on other travel behaviours such as number of trips, or vehicle kilometres of travel by mode which might provide a more in depth analysis and offer additional insights not provided here.

5. REFERENCES

Bertolini, L., Curtis, C., Renne, J.L., 2009. Introduction, In: Curtis, C., Renne, J.L., Bertolini, L. (Eds.), Transit Oriented Development: Making it Happen. Ashgate Publishing Limited, Surrey.

Burton, N.W., Haynes, M., Wilson, L.-A.M., Giles-Corti, B., Oldenburg, B.F., Brown, W.J., Giskes, K., Turrell, G., 2009. HABITAT: A longitudinal multilevel study of physical activity change in mid-aged adults. BMC Public Health 9, 76.

Cervero, R., 1996. Mixed land-uses and commuting: Evidence from the American Housing Survey. Transportation Research Part A: Policy and Practice 30, 361-377.

Cervero, R., Kockelman, K., 1997. Travel demand and the 3Ds: density, diversity, and design. Transportation Research Part D: Transport and Environment 2, 199–219.

Commins, N., Nolan, A., 2011. The determinants of mode of transport to work in the Greater Dublin Area. Transport Policy 18, 259-268.

De Vos, J., Derudder, B., Van Acker, V., Witlox, F., 2012. Reducing car use: changing attitudes or relocating? The influence of residential dissonance on travel behavior. Journal of Transport Geography 22, 1-9.

Emond, C.R., Handy, S.L., 2012. Factors associated with bicycling to high school: insights from Davis, CA. Journal of Transport Geography 20, 71–79.

Frank, L.D., Schmid, T.L., Sallis, J.F., Chapman, J., Saelens, B.E., 2005. Linking objectively measured physical activity with objectively measured urban form: Findings from SMARTRAQ. American Journal of Preventive Medicine 28, 117-125.

Greenwald, M.J., 2006. The relationship between land use and intrazonal trip making behaviors: Evidence and implications. Transportation Research Part D: Transport and Environment 11, 432-446.

Guo, J.Y., Chen, C., 2007. The built environment and travel behavior: making the connection. Transportation 34, 529-533.

Handy, S., Cao, X., Mokhtarian, P., 2005. Correlation or causality between the built environment and travel behavior? Evidence from Northern California. Transportation Research Part D: Transport and Environment 10, 427-444.

Handy, S., Cao, X., Mokhtarian, P.L., 2006. Self-Selection in the Relationship between the Built Environment and Walking. American Planning Association. Journal of the American Planning Association 72, 55-74.

Handy, S.L., Clifton, K.J., 2001. Local shopping as a strategy for reducing automobile travel. Transportation 28, 317-346.

Hine, J., Kamruzzaman, M., Blair, N., 2012. Weekly activity-travel behaviour in rural Northern Ireland: differences by context and socio-demographic. Transportation 39, 175-195.

Kamruzzaman, M., Baker, D., Washington, S., Turrell, G., in press. Residential dissonance and mode choice. Journal of Transport Geography.

Kamruzzaman, M., Washington, S., Baker, D., Turrell, G., 2013. Does residential dissonance impact residential mobility? Transportation Research Board 92nd Annual Meeting Compendium of Papers. Washington, D. C.

Leslie, E., Coffee, N., Frank, L., Owen, N., Bauman, A., Hugo, G., 2007. Walkability of local communities: using geographical information systems to objectively assess relevant environmental attributes. Health and Place 13, 111-122.

Lin, J.J., Gau, C.C., 2006. A TOD planning model to review the regulation of allowable development densities around subway stations. Land Use Policy 23, 353-360.

Litman, T., 2012. Land Use Impacts on Transport: How Land Use Factors Affect Travel Behavior. Victoria Transport Policy Institute.

Meurs, H., Haaijer, R., 2001. Spatial structure and mobility. Transportation Research Part D: Transport and Environment 6, 429–446.

Mokhtarian, P.L., Cao, X., 2008. Examining the impacts of residential self-selection on travel behavior: A focus on methodologies. Transportation Research Part B: Methodological 42, 204-228.

Pinjari, A., Pendyala, R., Bhat, C., Waddell, P., 2007. Modeling residential sorting effects to understand the impact of the built environment on commute mode choice. Transportation 34, 557-573.

Rose, G., Marfurt, H., 2007. Travel behaviour change impacts of a major ride to work day event. Transportation Research Part A 41, 351-364.

Schwanen, T., Mokhtarian, P., 2005a. What if you live in the wrong neighborhood? The impact of residential neighborhood type dissonance on distance traveled. Transportation Research Part D: Transport and Environment 10, 127–151.

Schwanen, T., Mokhtarian, P.L., 2004. The extent and determinants of dissonance between actual and preferred residential neighborhood type. Environment and Planning B: Planning and Design 31, 759-784.

Schwanen, T., Mokhtarian, P.L., 2005b. What affects commute mode choice: neighbourhood physical structure or preferences toward neighborhoods? Journal of Transport Geography 13 83–99.

Singleton, R.A., Straits, B.C., 1999. Approaches to Social Research. Oxford University Pres, New York and Oxford.

The City of Calgary, 2004. Transit Oriented Development: Best Practices Handbook. Land Use Planning and Policy, Calgary.

Transportation Research Board, 2001. Making transit work: insight from Western Europe, Canada, and the United States. Transportation Research Board Special Report 257.

Wilson, L.-A., Giles-Corti, B., Turrell, G., 2012. The association between objectively measured neighbourhood features and walking for transport in mid-aged adults. Local Environment 17, 131-146.