## Abstract

This paper examines if residential self-selection can be observed in the population of the Greater Dublin Area and analyses the interactions that occur between travel choices and household location decisions. The research is based on data collected through a postal survey issued in April 2014.

The paper outlines the differences observed in travel behaviour across contrasting land-use areas; with the findings showing higher use of sustainable modes for residents of denser, mixed-use urban areas with greater public transport options. Travel-based residential self-selection is a contributory factor to modal split characteristics but not to an extent that would invalidate the positive role of land-use measures in promoting sustainable travel. The study found that while transport is an important factor in choosing where to live, it is not the primary factor for all residents and its role is dependent on the characteristics of the respondent involved.

The key conclusion is that residential self-selection does not occur to such an extent that it is more important than land-use factors in determining modal-split characteristics. However, it remains a significant contributory factor for certain populations when sustainable modes are considered. The paper highlights the importance of taking self-selection tendencies and housing characteristics into account when creating land-use-transport policies to reduce car dependency and discusses the role of the urban region in producing self-selection behaviour.

**Is Travel Based Residential Self-Selection a Significant Influence in Modal Choice and Household Location Decisions?**

**Key Words**: *Residential self-selection, land-use, urban development, modal choice, housing location.*

## Abstract

This paper examines if residential self-selection can be observed in the population of the Greater Dublin Area and analyses the interactions that occur between travel choices and household location decisions. The research is based on data collected through a postal survey issued in April 2014.

The paper outlines the differences observed in travel behaviour across contrasting land-use areas; with the findings showing higher use of sustainable modes for residents of denser, mixed-use urban areas with greater public transport options. Travel-based residential self-selection is a contributory factor to modal split characteristics but not to an extent that would invalidate the positive role of land-use measures in promoting sustainable travel. The study also found that while transport is an important factor in choosing where to live, it is not the primary factor for all residents and its role is dependent on the characteristics of the respondent involved.

The key conclusion is that residential self-selection does not occur to such an extent that it is more important than land-use factors in determining modal-split characteristics. However, it remains a significant contributory factor for certain populations when sustainable modes are considered. The paper highlights the importance of taking self-selection tendencies and housing characteristics into account when creating land-use-transport policies to reduce car dependency and discusses the role of the urban region in producing self-selection behaviour.

### **1. Introduction**

A number of studies have observed a link between denser, mixed-use areas and lower levels of driving while less dense, single-use residential areas produce the opposite effect (Cao et al., 2008; Loo and Chow, 2011; Schwanen and Mokhtarian, 2003; Handy et al., 2005). On this basis, transport planning policy has focused on the creation of new developments, or retrofitting existing areas, to use urban form measures to promote greater levels of sustainable travel (Bento et al., 2005; Bertaud et al., 2009; Bhat and Guo, 2006). However, some researchers ask whether observed patterns of travel behaviour can be attributed to residential location and the built-environment or to prior self-selection by residents who intentionally chose areas that allowed them to travel in this way (Cao et al., 2008). This concept is known as residential self-selection (RSS); people choosing their residential location on the basis of their travel abilities, needs and preferences (Mokhtarian and Cao, 2008).

The issue of RSS is viewed as important because failing to account for RSS could lead to overestimation of the modal shift capabilities attributed to land-use-transport interventions (Van Wee, 2009; Silva, 2014). Van Wee and Boarnet (2014) state that this overestimation is less likely to be a policy issue for newly developed sustainable neighbourhoods as people with suitable modal preferences and a tendency to self-select would locate there. Problems emerge if the results from such developments are taken as a standard outcome, without accounting for the role of RSS, and are used to predict the benefits of constructing public transport options in a neighbourhood where sustainable travel preferences are less pronounced (Van Wee and Boarnet, 2014). In response to this problem, studies have either sought to clarify whether RSS exists in study populations or to ‘control’ for it and create more accurate estimations of the built environment’s effect on travel (Chatman, 2014; Silva, 2014). Mokhtarian and Cao (2008) and Cao et al. (2009) describe the often contrary results that emerge in this field. For example, Silva (2014) describes the overall conclusions reached on RSS as ‘mixed’ with earlier studies tending to conclude that RSS is more influential than land-use factors (Kitamura et al. 1997) while more recent studies suggest that the opposite is the case (Bhat and Guo 2007). Based on the extensive review of empirical results by Cao et al. (2009), it appears that while RSS is found to contribute to the influence of the built environment on travel, much research has found an independent effect of the built environment on travel behaviour beyond self-selection (Cao and Ettema, 2014; Silva, 2014).

The aim of this paper is to examine, within a European context, the relative impact of residential self-selection on modal choice characteristics when compared to land-use factors.The case study is the Greater Dublin Area (GDA). The GDA includes Dublin City, South Dublin, Fingal, Dun Laoghaire-Rathdown as well as Kildare, Meath and Wicklow. There are two objectives to this research:

1. To establish if modal choice differs between areas of contrasting urban form
2. To establish if residential self-selection for modal preferences is exhibited in the population of the Greater Dublin Area and to explore the relative impact of residential self-selection and urban form on modal choice in the survey population

Section 2 describes the theoretical contribution of the study. Section 3 sets out the methodology, including: the study area, the survey and the sample. Section 4 outlines the results according to each research objective. Section 5 discusses the implications of the results for research and policy. Section 6 concludes on the contribution of the study and the need for further research.

#### 2. Literature Review

While a number of studies have investigated RSS within the context of land-use and transport, much of this research has taken place in North America (Van Wee and Boarnet, 2014; Wang and Lin, 2014; Cao, 2014). Wang and Lin (2014) state that this is problematic because travel-related attitudes amongst populations from different countries may vary significantly, depending on differences in socio-economic development, lifestyle factors, social norms and the level of residential choice provided by the housing system. The issue of urban context is also raised by Naess (2014), who views attempts to produce exact predictions of the influence of land-use on transport as impossible due to varying spatial and social situations across urban areas. For this reason, different urban situations may cause self-selection to be irrelevant or take place in a dissimilar form than expected when investigated outside the North American context (Wang and Lin, 2014). Cao (2014) notes five contributions to RSS research from European studies, including:

* Van Acker et al. (2011) investigated the role of RSS in Belgian leisure travel and found that the built environment influenced travel, independent of self-selection but that ignoring RSS could lead to inaccurate estimation. Contrary to most American studies (Cao et al., 2009); this involved underestimating the impact of land-use factors. This result echoed some other studies outlined by the authors (Chatman, 2009; Ewing and Cervero, 2010; Lund et al., 2006).
* Aditjandra et al. (2012) concluded that the built environment has an independent effect on travel behaviour after accounting for self-selection in a British context.
* De Vos et al. (2012) investigated whether respondents in Belgium lived in areas which suited their travel preferences and found that less than half resided in such areas.

In Ireland, the closest previous research examined employment sub-centres and modal choice in the Dublin area (Vega and Reynolds, 2007; 2008). This study makes specific mention of self-selection but concludes that ‘further statistical analyses that includes… characteristics of alternative modes of transport and the socio-economic attributes of travellers would be needed to give insight into the nature of this relationship in a Dublin context’ (Vega and Reynolds, 2007, p.8).

Beyond context-specific issues, Naess (2009, 2014) outlines that RSS does not question the impact of the built environment on travel and instead validates the role of land-use factors, as people are aware of the limitations of different urban structures and select those most suitable to them for travel. Under this argument, urban form enables households to self-select and this process can be used to achieve modal shift (Aditjandra et al., 2012). It is important to note that the travel preferences that led to self-selection may themselves be based on experiences of residency in particular land-use areas and so even if it was the case that travel behaviour could be completely attributed to prior self-selection, the contribution of the built environment would still be present in some form (Van Wee, 2009; Van Wee and Boarnet, 2014). Based on these views, combined with the conclusions reached by Cao et al. (2008), it would appear that entirely discounting the impact of the built environment on travel due to RSS processes is not a justifiable argument and that the importance of land-use factors for planning policy is not in doubt (Naess, 2014).

The contrasting views presented in self-selection literature, along with the limited range of geographic locations of the previous studies, suggest that further research is required to achieve greater understanding of RSS but whether research should continue in the same vein of quantifying RSS influences to ‘control’ for its influence in land-use modelling is debatable. Chatman (2014) raises the prospect that this approach may be missing the point and throwing away vital information about residential choices. Chatman (2014) views the understanding of residential decisions as key to providing successful alternative housing as the influx of population attracted by its construction will not be a random group, as proved by the need to control for self-selection, and so understanding the populations which act in this way will be vital to successful outcomes. Essentially, this requires research into the particular populations which will most likely base their residential location decisions on the basis of transport preferences. Consideration of the role of travel preferences in residential choices differs with Naess (2009; 2014); and Van Wee and Boarnet (2014) asserting that travel preferences are not the dominant criteria in household preferences as these are often in conflict with other factors in location decisions. This suggestion is similar to research by Pinjari et al. (2007), which found that households and individuals make residential location and modal decisions jointly in a process that involves compromise to achieve a suitable choice for their life stage e.g. locating into areas which suit their socio-demographic background, attitudes and travel preferences.

This presents the argument that at least for certain populations, travel preferences may take priority in household location but that socio-economic circumstances can constrain both the choice of residence and the mode involved (Cao and Mokhtarian, 2008; Bhat and Guo, 2006; Pinjari et al., 2011; Silva, 2014) while restrictions are also imposed by the limited availability of locations (Naess, 2009). It could be viewed that establishing when such preferences take priority involves further exploration of the time-order of modal decisions in respect to residency during the transition between past and current locations. Studies that consider this aspect are rare with many focused on the outcome of RSS for travel behaviour rather than the conditions that lead to a tendency to self-select. One exception outlined by Cao et al. (2008) is a qualitative study by Hammond (2005) which identified that 18% of respondents selected their commuting mode prior to deciding on a residential location, with 39% making this decision simultaneously. Such results suggest that in certain circumstances modal preferences can dictate housing decisions, but it remains unclear which populations are associated with this behaviour emerging, or indeed, whether it continues throughout life.

This paper centres on the exploration of the extent that travel preferences, in the form of specific modal preferences, can shape the resulting choice of residential location. It was hypothesised prior to the study that residential self-selection would be observed but only in certain population types, the suggestion that RSS may vary among different individuals is also put forward by Chatman (2014). Identifying when RSS occurs and the specific populations associated with it will have critical implications for both housing and transport policies. This is particularly relevant to the Irish context as there is a severe housing shortage, particularly in Dublin, and an urgent need to return to large scale housing construction. It is vital that past mistakes are not repeated and that housing and transport policy are examined more closely before this occurs.

### **3. Research Design**

#### *3.1. Study Location*

The city of Dublin was once compact with a strong urban core and served by radial travel patterns (National Transport Authority, 2011). Throughout the 20th Century, this urban structure was weakened by the creation of several car-orientated ‘new towns’ in the surrounds of city during the 1960s which were designed to facilitate car-use (NTA, 2011; Vega and Reynolds-Feighan, 2008). Yet, employment remained heavily centralised until the 1990s and 2000s when significant decentralisation of jobs and services occurred along with rapid residential expansion across the urban region (Vega and Reynolds-Feighan, 2008; Murphy, 2012). During this transition, radial travel reduced while inter-suburban, cross-city and reverse commuting became more common, which promoted increasing reliance on the private car (Browne et al., 2011; Murphy, 2012). In the 21st century, the private car is the primary mode for the majority of GDA residents and this reflects national trends (Caulfield, 2012).

Rapid urban expansion effectively ceased during the economic crisis of 2008-2015 but development previous to this period reshaped the city into a mono-polycentric urban spatial structure (that is a polycentric city with a strong core). The GDA retains a relatively strong CBD surrounded by a number of employment sub-centres located between large swathes of single-use, low density suburban housing (Vega and Reynolds-Feighan, 2008). Residential construction has returned to growth since 2013 but remains significantly lower than the previous decade (Central Statistics Office, 2014). In relation to transport infrastructure, there is an extensive road network and a bus network which is primarily radial and acts as the main car alternative in most suburban areas. Heavy rail services are restricted to the coast and several westerly lines while light-rail consists of two radial lines with some suburban spurs (*Figure 1*). In terms of housing composition, the city centre and suburbs show very different types of households: in the centre housing is more likely to be rented, with fewer children, lower car ownership and more apartments than the suburbs.

|  |  |
| --- | --- |
| *Figure 1*: Public Transport in the GDA *(Mapping:* JH, 2015; *Data:* NTA GTFS, 2013*)* | |
| GDA Rail Network  *(Heavy and Light Rail)* | Dublin Bus Network  *(Primary Urban Bus Operator)* |
| C:\Users\John UCD\Desktop\Stats Data - November 2016\Paper1_Corrections.jpg  C:\Users\John UCD\Desktop\Stats Data - November 2016\Paper1_Corrections.jpg |  |

In summary, the GDA represents an example of recent rapid urban growth and decentralisation across a metropolitan area which has a diversity of land-use characteristics, leading to contrasting use of sustainable modes or motor vehicles depending on the local area (Caulfield and Ahern, 2014).

#### *3.2. Study Area Identification*

A survey collected primary data from contrasting land-use areas across the GDA as existing data sources such as the Census (last collected in 2011) do not provide information on issues such as travel preferences, modal choices and residential location decisions (Ahern et al., 2013). The postal survey questioned respondents on topics linked to self-selection and incorporated land-use factors through a tailored distribution. The study area identification process did not treat the GDA as a homogenous region and instead incorporated differences in land-use composition and travel opportunities so that the effect of the built environment could be considered. GIS analysis of Central Statistics Office (CSO) ‘small areas’[[1]](#footnote-1) allowed for categorisation of the GDA according to different levels of public transport access, jobs/housing balance[[2]](#footnote-2) and housing density:

* Public transport access defined according to the frequency of each mode using buffers[[3]](#footnote-3) around stops plotted from GTFS data. This included Luas (light-rail), DART (heavy-rail rapid transit), Irish Rail (heavy-rail commuter services) and Dublin Bus services.
* Jobs/housing balance estimated using employment trip destinations from the Place of Work, School or College Census of Anonymised Records data (POWSCAR, 2011).
* Housing density calculated from the Census (2011) using units per hectare (UPH).

Two[[4]](#footnote-4) types of urban development were categorised to represent contrasting areas of urban form; one study area where sustainable travel options were a viable option and one study area where sustainable travel options were available but the land-use characteristics reflected typical sprawl areas (*Table 1)*.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | *Table 1:* Study Area Urban Form Characteristics | | |  |
| *Study Area* | *Public Transport Access* | *Development*  *Density* | *Jobs/Housing*  *Balance* | *References* |
| Sustainable Travel Areas | 1-20 minute frequency (bus) or  1-30 minute frequency (rail) | >35 residential  UPH | >1.2 jobs per household | Housing density definitions (Dept. of Environment, 2009) and  jobs/housing balance definitions (Peng, 1997) |
| Unsustainable  Travel Areas | 20-30 minute frequency (bus) or  30-60 minute frequency (rail) | <30 residential  UPH | <1.2 jobs per household |

There are 6,661 CSO small areas in the GDA. The identification of small areas which matched the characteristics of Table 1 resulted in locations related to CBD proximity but not exclusively:

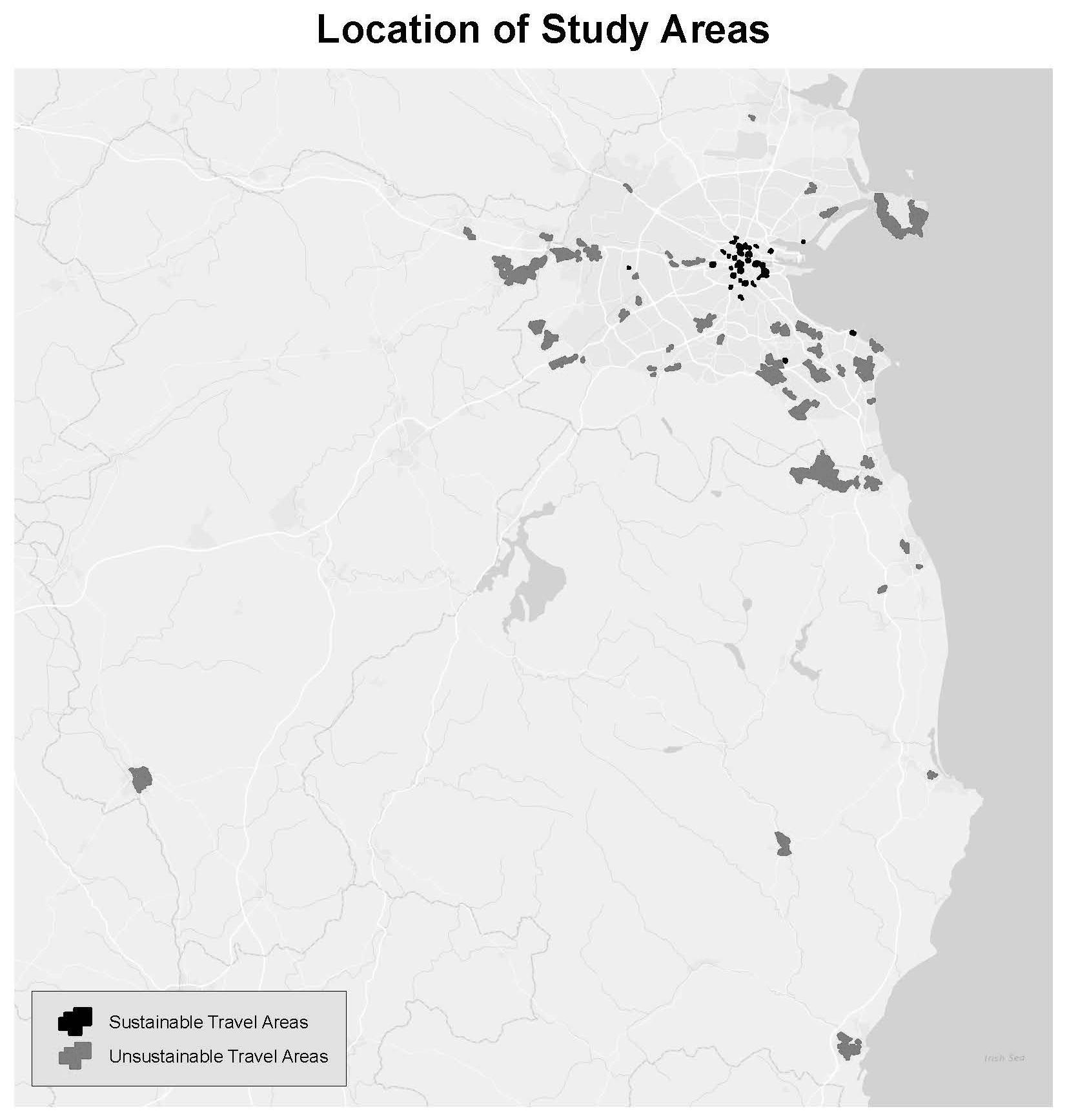
1. Sustainable travel areas were primarily located in the CBD or in locations near major heavy or light rail stations (*Total CSO small areas identified: 47*)*.*
2. Unsustainable travel areas were located outside the city centre and spread across historic Dublin suburbs, ‘post-2001’ developments and rural towns (*Total CSO small areas identified: 260*).

The locations of these can be viewed spatially in *Figure 2*.

*Figure*

*2*

. Location of Study Areas



#### *3.3. Survey Design*

The survey collected data on both the current circumstances of the respondent as well as their past experiences and contained six sections:

### Section A: Travel Behaviour

Investigated modal choices for commuting, shopping, social and school trips as well as other variables to do with commuting distance, fuel expenditure and destinations.

### Section B: Residential History and Preferences

Investigated prior residential experiences covering issues such as occupancy type, duration of residency, local area characteristics and past means of travel. In order to make some attempt to avoid recall bias, respondents were only asked about their residence immediately prior to their current residence. However, the authors acknowledge that this could not eliminated recall bias fully: for some respondents the last house move may have been quite some time ago, and so recall bias is still a risk. Preference data focused on important factors in residential relocation decisions and choice restrictions.

### Section C: Travel Preferences

Investigated the respondent’s preferred modal choices for commuting, social and shopping trips if their choices were not restricted. Preferences regarding modal decisions were also queried.

### Section D: Housing and Travel Decisions

Investigated whether respondents had chosen a preferred mode of travel before choosing their home and if so, which mode that was. It also determined whether being able to use this mode was a necessary condition of choosing the residence. The consistency of these decisions over time was also explored as well as variations for renting or owning a home.

### Section E: Respondent Characteristics Section F: Household Characteristics

These sections provided important demographic details on the respondent and their household.

The study acknowledges that collecting data on past events can lead to possible unreliability in the accuracy of recalling previous actions (Cao et al., 2008) and that the preferred solution is a longitudinal study. However, the timeframe of this project (3 years) did not allow for this and efforts were made to limit inaccurate recall by intentionally not questioning respondents on past variables which would be particularly imprecise (e.g. attitudes to transport several years ago).

#### *3.4. Sample Composition*

Target respondents were individuals aged 18+ living in a household within either study area. Respondents completed the survey in respect to themselves and on behalf of all other occupants of the home. In order to identify an appropriate sample size which would be representative of the population, Cochran’s (1977) sample size formula was used to calculate the required responses for each area:

Values:

(t): Value for selected alpha level of 0.025 in each tail = 1.96

(p) & (q): Estimate of variance = 0.25

(d): Margin of error accepted by the researcher for the proportion being estimated = 0.05 or 5%

(Bartlett et al, 2001, p. 47)

Using this formula, it was determined that the minimum number of responses required was 384 from the larger unsustainable travel areas. However, as the total population was known and 384 responses consisted of more than 5% of all households in the less numerous sustainable travel areas, Cochran’s (1977) correction formula was applied and this stated that a minimum of 349 responses was required from this study area*[[5]](#footnote-5)* (Bartlett et al, 2001).

The survey of Cao et al (2006) achieved a 23% response rate and outlined that postal surveys distributed to the general population can achieve a response rate as low as 10% and up to 40%. On this basis, a figure of 20% was taken as the guide for the estimate of how many surveys should be distributed and the Cochran (1977) formula figures were multiplied by five. In total, 4794[[6]](#footnote-6) surveys were distributed in April 2014 to a random sample of addresses in each study area extracted from the national database, GeoDirectory. Surveys sent to addresses in each study area had identifying codes so that they could be categorised according to land-use typology when returned.

In total, 367 responses were received from sustainable travel areas and 471 from unsustainable travel areas. This achieved the requirements for the results to be considered as representative of the population that lives in either sustainable or unsustainable land-use areas of the GDA. The response rate was 17.2% and the calculation for this figure is shown in *Table 2*.

|  |  |  |  |
| --- | --- | --- | --- |
| Table 2. Response Rate Calculation | | | |
| Surveys Distributed | Failed Delivery | Completed Surveys | Response Rate |
| 4974 | -96 | 838 | (838 / 4878) x 100  = 17.2% Response Rate |

There were fewer responses than expected and this was attributed to the long and detailed nature of the survey, the lack of financial incentive and the possibility that respondents did not fully understand the objectives of the research. A non-normal distribution limited statistical tests to non-parametric methods. There is some acknowledged bias when the sample composition is compared with the Census (2011), this is shown in *Table 3*.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Table 3. Comparison of Sample Population with Census Results(% of each area) | | | | |
|  | Sustainable Area *(Survey)* | Sustainable Area *(Census)* | Unsustainable Area *(Survey)* | Unsustainable Area *(Census)* |
| **Age Bracket** |  |  |  |  |
| 18-34 | 42 | 63.7 | 9.2 | 30.6 |
| 35-54 | 36.5 | 23.2 | 39 | 36.5 |
| 55-64 | 11.4 | 6.3 | 21.5 | 15.9 |
| 65+ | 10 | 6.8 | 30.2 | 17.1 |
| **Level of Education** |  |  |  |  |
| <=Irish Leaving Cert | 18.3 | 27.3 | 35.6 | 45.4 |
| Apprenticeship | 5.8 | 13.1 | 12.2 | 17.5 |
| 3rd Level Education | 75.9 | 47.6 | 52.3 | 33.6 |
| Not Stated | - | 11.7 | - | 3.1 |
| **Household Occupancy** |  |  |  |  |
| Owned (mortgage) | 15.6 | 9.9 | 49 | 39.9 |
| Owned | 19.2 | 6.1 | 37.1 | 37.5 |
| Rented | 65.2 | 80.7 | 13.9 | 21.3 |
| Other | - | 3.1 | - | 1.1 |
| **Household Unit** |  |  |  |  |
| House | 24.2 | 18.5 | 90.4 | 88.9 |
| Apartment/Flat | 75.8 | 77.3 | 9.6 | 9.9 |
| Other | - | 4.3 | - | 1.2 |

**4. Results**

##### 4.1. Objective 1 Results

The first objective seeks to identify whether contrasting urban form characteristics are associated with significant differences in the modal choices of residents. The comparison of household access to motor vehicles between the two study areas gives an indication that in accordance with the literature, greater public transport accessibility and ‘sustainable’ land-use configurations can be associated with lower levels of car-use (*Figure 3,* Cramer’s V; .554, P.0.00).

No Motor

Vehicles

Motor

1

Vehicle

2

Motor

Vehicles

Motor

3+

Vehicles

% Responses from

Sustainable Travel Areas

50.4

%

%

37.3

%

10.9

%

1.4

% Responses from

Unsustainable Travel Areas

%

6.6

39.1

%

42.7

%

11.7

%

%

0.0

%

10.0

20.0

%

%

30.0

%

40.0

%

50.0

60.0

%

*Figure 3*

Household Access to Motor Vehicles (N: 838)

:

In considering the modal split for different trip types[[7]](#footnote-7) in sustainable travel areas, statistically significant results emerge9 (*Figure 4*).

Walk

Cycle

Public

Transport

Motor Vehicle

Commuting Mode

51.4

%

%

9.3

%

19.9

%

17.7

Mode for Shopping Trips

%

62.0

%

7.4

%

7.7

22.9

%

Mode for Social Trips

%

51.9

%

4.4

21.4

%

22.3

%

%

0.0

%

10.0

20.0

%

30.0

%

%

40.0

%

50.0

%

60.0

70.0

%

**% of Total Responses**

*Figure 4:*

Modal Split of Sustainable Travel Areas

*Figure 5* outlines the modal split characteristics of respondents from unsustainable travel areas.

Walk

Cycle

Public

Transport

Motor Vehicle

Commuting Mode

%

5.8

5.2

%

%

14.1

71.8

%

Mode for Shopping Trips

12.6

%

%

1.1

3.2

%

%

83.1

Mode for Social Trips

%

5.8

%

.2

%

14.0

80.0

%

0.0

%

10.0

%

%

20.0

30.0

%

40.0

%

50.0

%

%

60.0

%

70.0

%

80.0

%

90.0

**% of Total Responses**

*Figure 5*

Modal Split of Unsustainable Travel Areas

:

Overall, these results demonstrate that different types of urban form are associated with significant variances in modal split characteristics. Private motor vehicle use and car dependency is generally very high across the GDA (Caulfield, 2012) and so the results for sustainable travel study areas represent an important variation from normal trends. However, a note of caution must be mentioned regarding data in relation to household mobility as respondents in sustainable areas indicated that they were unlikely to remain living in their current homes for the long-term, while those in unsustainable areas intended to be almost permanent residents (*Table 4*).

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| *Table 4.* Intended Length of Future Residency | | | | | |
|  | <1 Year | 1-5 Years | 6-10 Years | >10 Years | No Intention to Move |
| Sustainable Travel Study Area | 20.8% | 48.7% | 7.3% | 5.1% | 18.0% |
| Unsustainable Travel Study Area | 3.4% | 16.2% | 9.1% | 14.4% | 56.9% |
| Cramer’s V; .518, P0.00 | | | | | |

##### 4.2. Objective 2 Results

The second objective seeks to establish whether self-selection for a particular modal preference can be identified in the population of the GDA and then to identify the relative impact of this variable. The first stage in achieving this aim requires investigation of the time-order of modal and residential location decisions, under the assumption that self-selection could not occur if people had not made modal decisions prior to moving into their current home. The study sought to ascertain whether respondents who had moved at least once in their lifetime (N: 739) had ‘intended to use a particular mode of transport’ for the majority of their trips prior to moving into their current residence. The results showed that 68-70%[[8]](#footnote-8) of respondents had prior modal intentions and no statistically significant associations were identified between this result and the type of study area or respondent characteristics. This would suggest that modal choices are at least part of household location decisions regardless of the circumstances of the individual involved. Whether this result simply represents prudent assessment of transport options by respondents prior to moving or travel-based self-selection requires further analysis. The suggestion that the latter may have taken place is strengthened by considering the specific modal intentions involved. In this regard, strong associations emerge (Cramer’s V; .617, P0.00) between those who intended to use active modes or public transport prior to moving into sustainable travel areas (83% of intentions) and those who moved into unsustainable travel areas intending to use motor vehicles (73%).

It was demonstrated that the stated modal intention prior to moving was a continuation of the mode used previously at the respondents’ last residence in many cases[[9]](#footnote-9) (Cramer’s V; .556, P0.00). Further statistically significant associations were observed between this prior choice of mode and the respondent’s circumstances at their last address regarding housing type, occupancy type, vehicle ownership, parking access, parking price and duration of occupancy. Those less inclined to choose a motor vehicle prior to moving tended to come from past residences associated with rented apartments, shorter occupancy, zero car ownership and more restricted parking access. This was also observed regarding the land-use characteristics of previous neighbourhoods where there was a suggestion that those who had previous lived in areas of urban form more suitable to car-use, intended to use a motor vehicle when a mode was chosen prior to moving. The study sought to ascertain the role of these related past variables11 at the time when the modal decision prior to residency was made. A binominal logistic regression test was performed (*Table 5*) to explore what the likelihood was that a sustainable or unsustainable mode would have been chosen by the respondent. The independent variables were characteristics of previous travel and household characteristics shown to have an autonomous and statistically significant effect on the dependent variable.

The logistic regression model was statistically significant (N; 495[[10]](#footnote-10), χ2(15) =239.5, P<.000) and explained 51.1% (Nagelkerke *R2*) of the variance. Three independent variables emerged as significant at the 95% level and these were the mode used at the previous residence, the level of motor vehicle ownership at the last home and the duration of occupancy at the last address. The results showed that past car users were 10.5 times more likely to intend to use a motor vehicle at their next residence than those who had used an active mode previously. Public transport did not emerge as a statistically significant influence. Duration of residency at the last address was shown to be influential with those who had lived longer at their last address being 1.9 times (3-5 years), 2.7 times (6-10 years) or 2.1 times (10+ years) more likely to intend to use a motor vehicle than those who lived at their last address for less than 2 years. Furthermore, those who previously owned at least one motor vehicle at their last residence were at least 2 times more likely to intend to continue to use a motor vehicle at their next home when compared to previously zero car households (90% confidence level, *Figure 5*).

*Table 5*: Logistic Regression Model; Prior Modal Intentions on the Basis of Past Variables

|  |
| --- |
| **Dependent Variable Encoding** |
| Intended Sustainable Mode = 0 |
| Intended Unsustainable Mode = 1 |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| *Variable* | **B** | **S.E.** | **Wald** | **Sig.** | **Exp(B)** |
| **Constant** | -3.053 | .649 | 22.114 | .000 | .047 |
| **Previous Household: Housing Type**  (Base = House) |  |  |  |  |  |
| Apartment/Flat | -.241 | .309 | .609 | .050 | 1.945 |
| **Previous Household: Duration of Stay**  (Base = Less than 2 years) |  |  | 9.030 | .029 |  |
| 3-5 years | .665 | .340 | 3.839 | .050 | 1.945 |
| 6-10 years | .988 | .344 | 8.245 | .004 | 2.685 |
| 11+ years | .751 | .354 | 4.496 | .034 | 2.120 |
| **Main Mode Used at Previous Residence**  (Base = Active Modes) |  |  | 64.292 | .000 |  |
| Public Transport | .252 | .370 | .463 | .496 | 1.287 |
| Motor Vehicle | 2.361 | .328 | 51.732 | .000 | 10.597 |
| **Previous Household: Motor Vehicle Ownership**  (Base = No Motor Vehicles) |  |  | 6.866 | .076 |  |
| 1 Motor Vehicle | .903 | .381 | 5.616 | .018 | 2.468 |
| 2 Motor Vehicles | 1.043 | .427 | 5.981 | .014 | 2.839 |
| 3+ Motor Vehicles | 1.088 | .562 | 3.744 | .053 | 2.969 |
| **Previous Local Area: Public Transport Access**  (Base = No Public Transport Access) |  |  | 3.010 | .390 |  |
| Poor Public Transport Services | .752 | .532 | 1.996 | .158 | 2.122 |
| Good Public Transport Services | .384 | .527 | .531 | .466 | 1.468 |
| Excellent Public Transport Services | .277 | .587 | .222 | .637 | 1.319 |
| **Previous Local Area: Single Use or Mixed Use**  (Base = Mainly Houses, Few Local Businesses) |  |  | 1.301 | .729 |  |
| Mixture of Housing and Local Businesses | .013 | .295 | .002 | .966 | 1.013 |
| Businesses or Shops with some Housing | -.776 | .867 | .800 | .371 | .460 |
| No Businesses or Shops Locally | .302 | .469 | .414 | .520 | 1.352 |
| Number of Cases | 495 |  |  |  |  |
| Nagelkerke *R2* | 51.1% |
| Hosmer & Lemeshow test | P = 0.082 |
| Classification accuracy | 81.2% |

The results presented in this section suggest that when modal choices are made prior to residency, these transport intentions are significantly influenced by the modes being used at the time when the decision is made, except for public transport. In the case of public transport, the difference between the reference group and public transport is not statistically significant. The role of past occupancy duration and motor vehicle ownership are also highlighted as a lesser, but still influential, factors. With respect to the influence of prior intentions on the travel characteristics of areas; it was found that the intended mode continued to be used at the time of survey for 84% of active modal intentions, 89% of motor vehicle intentions and 54% for public transport intentions. The survey queried whether respondents had ‘intended to use a particular mode of transport’ for ‘the majority of their trips’ prior to residency and 68-70% (68% in sustainable and 70% in unsustainable travels areas) indicated that they had. This is a little higher than the figure of Hammond (2005), who, in a qualitative study, found that 57% of people chose modes prior to residency. Specific detail on the time-order of decisions from other studies is not available for further comparison but it does raise the suggestion that modal choice is not necessarily caused by the conditions present in the current area of residence.

The results presented thus far have established that modal choices are a consideration in household location decisions with the choice of mode often taking place prior to residency. This observation combined with the evidence of a strong link between current and past travel behaviour gives the impression that travel-based RSS may have been exhibited in the sample population. Determining if this was the case requires assessment of whether modal choices took priority in the housing location decision process. A question in the survey broached this issue directly with specific mention of the time-order of decisions where respondents stated their agreement to the following statement[[11]](#footnote-11):

*'When deciding to move to a new location, I would consider areas that would suit my preferred mode of transportation for the majority of my trips before considering the types of neighbourhood available'*

Just over half (51%) of respondents agreed with prioritising preferred modes over neighbourhood characteristics but nearly half were either opposed or neutral to the idea (*Figure 6*):

Strongly

Disagree

Disagree

Neutral

Agree

Strongly

Agree

% of Responses

9.3

19.1

20.6

30.7

20.2

0.0

5.0

10.0

15.0

20.0

25.0

30.0

35.0

*Figure 6*

:

Prioritising Modes over Neighbourhoods

The relationship between these responses and the level of importance respondents attached to other issues in household location decisions added context to these results. Statistically significant relationships outlined that those who responded favourably to this statement also put greater importance on access to quality public transport locally and shorter commutes when choosing a home. Those who disagreed were more likely to put greater emphasis on living in a particular housing type, having sufficient parking space, living in attractive neighbourhoods and having good car access. This outlined that modal preference prioritisation was just one aspect in a set of transport-focused household preferences. Those who disagreed with the concept were more likely to favour housing preferences removed from transportation issues or those focused on motor-vehicle use. This highlighted a possible mode-specific divide in the responses and further statistical tests outlined that:

* Agreement reduced as car ownership increased (Gamma; -.295, P0.00)
* Agreement was greater from those who ‘intended’ to use a sustainable mode (*Figure 7*)
* Disagreement was greater from those who intended to use a motor vehicle (*Figure 7*)

%

0.0

5.0

%

10.0

%

15.0

%

20.0

%

25.0

%

30.0

%

35.0

%

Strongly

Disagree

Disagree

Neutral

Agree

Strongly

Agree

*Figure 7*

:

Responses to the Statement by 'Intended Mode'

% of Responses from those

who intended to use a motor

vehicle

% of Responses from those

who Intended to use a

Sustainable Mode

Few clear divides emerged according to the background of the respondent with no statistically significant links between these responses and gender, educational level or the type of occupants. Slight (.1-.2) associations were observed between a higher level of agreement and those who were non-Irish, renting apartments, single, younger or intended to move again in the short term. These demographic groups reflected the respondent characteristics found in sustainable travel study areas*.* Residency in sustainable study areas was shown to be statistically linked with higher levels of agreement (62% vs 42%) and lower levels of disagreement (21% vs 33%) when compared with residents of unsustainable areas (Cramer’s V; .204, P0.00). The results provided an opportunity to investigate whether contrasting modal split characteristics could be attributed to self-selection tendencies in the sample population. New variables were created which combined prior modal intentions with attitudes towards prioritising particular modes in household location decisions. This excluded respondents who had never moved house in their lifetime but included those who had never ‘intended to use a particular mode’ as a control group for comparison. Four attitudinal group variables were created to capture varying RSS tendencies, divided by the mode specific nature of their preferences when self-selection appeared likely (*Table 6*).

|  |  |  |
| --- | --- | --- |
| Table 6. RSS Tendencies by Attitudinal Group | | |
| *Attitudinal Group* | *Modal Choices Made Prior to Residency?* | *Opinion towards prioritisation of modal preferences over neighbourhood factors statement* |
| ***Group A*** | ✓ | Expressed ***disagreement*** with the statement |
| ***Group B*** | ✓ | Expressed ***a neutral opinion*** towards the statement |
| ***Group C*** | ✓ | Expressed ***agreement*** with the statement and intended to use **a sustainable mode** |
| ***Group D*** | ✓ | Expressed ***agreement*** with the statement and intended to use **an unsustainable mode** |

*Table 7* demonstrates the proportions of the sample population which sat within each grouping.

*Table 7*: Proportional Presence of RSS Attitudinal Groups in the Sample Population

|  |  |  |
| --- | --- | --- |
|  | *% of Sample Population* | *N* |
| *Group A* | 15.73 | 131 |
| *Group B* | 12.24 | 102 |
| *Group C* - Sustainable RSS | 20.41 | 170 |
| *Group D* - Unsustainable RSS | 12.85 | 107 |
| No Prior Modal Intentions | 27.49 | 229 |
| Never Moved Residence | 11.28 | 94 |

The important conclusions to be reached from *Table 7* are threefold. Firstly, the largest segment of the sample (38.77%) is not involved in self-selection according to modal preferences. Secondly, the presence of RSS tendencies in the sample population constitutes just over a third of the total population (33.26%; *Groups C-D*). Lastly, just under a third of the sample did not prioritise modal factors when choosing a home but did choose their mode prior to residency (27.97%; *Groups A-B*).

RSS would appear to be a contributory factor, but not the sole explanatory factor, for the modal split characteristics observed in areas of contrasting urban form. For this to be the case, RSS tendencies would have had to have been acted upon in practice and resulted in residency in an area which would facilitate a particular mode. A simple frequency comparison of the current areas of residence for each RSS tendency from *Table 7 i*s shown in *Table 8.* This observation shows that *Group C* respondents did locate in areas suitable for sustainable modes in 79% of cases. In sustainable travel areas, RSS tendencies accounted for 40% of residents with a lower 22% proportion for unsustainable travel areas.

|  |  |  |  |
| --- | --- | --- | --- |
| *Table 8:* Study Area of Residence for RSS Groups *(Cramer’s V; .417, P0.00)* | | |  |
|  | *Residents of Sustainable Areas* | *Residents of Unsustainable Areas* | *N* |
| No Prior Modal Intentions | 108 | 121 | 229 |
| Group A | 42 | 89 | 131 |
| Group B | 33 | 69 | 102 |
| Group C - *Sustainable RSS* | 134 | 36 | 170 |
| Group D - *Unsustainable RSS* | 18 | 89 | 107 |
| Proportion of Residents Associated with RSS Behaviour | **40%** | **22%** |  |

A binominal logistic regression test was performed to confirm these results and ascertain the degree of likelihood that current areas of residence could be predicted from RSS tendencies when such preferences were present[[12]](#footnote-12). This model does not control for socio-economic factors.

The logistic regression model (*Table 9*) was statistically significant (N; 510, χ2(3)=135.579, P0.00) and the model explained 31% of the variance (Nagelkerke *R*2). The dependent variable was residency (Dependent variable encoding: Residency in a Sustainable Travel Area=0, Residency in an Unsustainable Travel Area =1). No statistically significant differences were observed between *Group A* and *Group B* respondents. Respondents with an unsustainable RSS tendency were x2.33 times more likely to live in unsustainable transport areas than *Group A* respondents. Sustainable RSS tendency respondents were 87% less likely to live in unsustainable travel areas than *Group A* respondents. The model would confirm that RSS tendencies appear to have a strong influence on the residential location chosen by the respondent. Yet such attitudes are not the only explanatory factor in residential choices and a majority of the population do not agree that they would act in this manner.

*Table 9.* Logistic Regression Model Results; Current Residency Prediction by RSS Tendencies

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| *Variable* | **B** | **S.E.** | **Wald** | **Sig.** | **Exp(B)** |
| **Constant** | .751 | .187 | 16.092 | .000 | 2.119 |
| **RSS Tendency Type**  (Base = Group A) |  |  | 109.115 | .000 |  |
| Group B | -.013 | .283 | .002 | .962 | .987 |
| Group C - *Sustainable RSS* | -2.065 | .265 | 60.687 | .000 | .127 |
| Group D - *Unsustainable RSS* | .847 | .319 | 7.050 | .008 | 2.333 |
| Number of Cases | 510 |  |  |  |  |
| Nagelkerke *R2* | 31.3% |
| Hosmer & Lemeshow test | P = 1 |
| Classification accuracy | 74.4% |

#### 5. Discussion of Results

The paper contributes to the debate regarding the relative influence of urban form and residential self-selection on modal choice. The paper clarifies that the travel characteristics of more densely populated areas with more local jobs and public transport options are in significant variation to the motor vehicle dependency observed in areas with low housing density and limited local employment. The study identifies that self-selection behaviour can be observed in the sample population of the GDA but not to an extent that the modal characteristics of contrasting urban form areas can be considered to be the sole result of prior self-selection. It would appear that while some members of the population do exhibit elements of residential selection behaviour and choose to live in locations that suit their modal preferences; these are in a minority of when the whole sample population is considered.

The findings of this research support the approach of building denser, mixed-use developments with alternative transport options to promote sustainable travel behaviour. This seconds the assertion of Naess (2014) and Van Wee and Boarnet (2014) that the presence of RSS does not invalidate the importance of land-use measures in transport planning policy. Furthermore, modal use was often shown to be a continuation of previous travel experiences and so the creation of areas not reliant on the private car would encourage this behaviour in future moves. However, travel-based RSS does appear to be a contributing factor to the transport characteristics of contrasting urban form areas with this occurring to a greater extent (40%) in sustainable travel areas. Due to the weak performance of public transport preferences, when self-selection occurs in the Greater Dublin Area, it is mainly for active modes or car preferences with the latter accounting for 22% of residents in sprawl areas.

The comparison of sustainable or unsustainable travel areas outlined that residents of the former are transient while residents of more car-dependent areas are less residentially mobile. For land-use policy to affect permanent modal shift, this situation may need to be reversed. Regarding the cause of self-selection activity and short term occupancy, the respondent characteristics associated with *Group C,* sustainable RSS, are linked to younger, renters, without families or access to a car. While those in *Groups A-B-D* are generally older owner-occupiers with families and access to motor vehicles. This suggests that at a particular life stage other factors take priority over sustainable travel preferences and residents have to ‘graduate’ to car and household ownership in sprawl areas.

The study area selection process highlighted that sustainable travel areas are limited across the GDA and rarely provide for people who want to own their properties or live in houses, aspects which would increase the occupancy length (*Figure 8*). This presents the following issues:

* The small number of sustainable travel areas located in the GDA means a certain amount of self-selection to pursue a preference, or requirement, to use active modes is inevitable in order to avoid the majority of areas where such means of travel could not be realised.
* The lack of supply of family-sized houses for sale, in sustainable travel areas immediately eliminates this type of residency for many population groups even if price is not considered e.g. the low proportion of families in central areas (*Figure 8*).

|  |  |  |  |
| --- | --- | --- | --- |
| *Figure 8. GDA Housing Characteristics* (Census, 2011) | | | |
| *% of Rented Accomodation* | *% of Non-Apartment/Flat Accomodation* | *% of Households With Children (<18 Years)* |  |
|  |  |  |  |

In the GDA, the amount of areas where sustainable travel can be realised are very limited with the housing unit and occupancy types available within them unsuited to long term residency. On this basis, it would appear that the urban context and housing supply characteristics of the GDA have contributed to the presence of self-selection in the sample population and also threatened the permanency of the modal shift achieved by land-use measures.

#### 6. Conclusion

Travel-based residential self-selection is a contributory factor to modal split characteristics but not to an extent that would invalidate the positive role of land-use measures in promoting sustainable travel. This paper indicates that some segments of the population do self-select into residential locations to use particular modes but these actions take place in a city with restricted travel options and a polarised housing market. These conditions put greater emphasis on the need for non-car modal preferences to be achieved by residents who, out of necessity or inclination, do not wish to live in the majority of residential areas suited to private vehicle use. The lack of similar studies from Europe limits the opportunity for cross-comparison and so it is challenging to identify whether this trend represents common behaviour in urban areas outside North America, or characterises a localised situation.

This paper demonstrates the importance of studying RSS to increase confidence in, and inform the development of, policies which co-locate dense housing near jobs and public transport services. However, the study also highlights the need to consider the wider role of travel preferences in housing location decisions as it was shown that the majority of modal choices are actually made prior to residency and that modal choices often remain consistent during residential relocation. These two issues have critical implications for how researchers and policy makers interpret the modal shift attributed to urban form in the current area of residency. Furthermore, the study highlights the need to consider the role of housing unit type when measuring the success of land-use interventions in sustainable development as it was shown that areas strongly associated with non-car use are also linked to temporary residency. In the short term, future research should seek to further understand how sustainable RSS tendencies can be encouraged in housing policies while the long-term challenge regards the need to create sustainable developments which allow people to live and work without need of the private car for a lasting duration, rather than for just a short period of their lives.

## Acknowledgements

This paper was completed as part of the Earth and Natural Sciences Doctoral Studies Programme which is funded under the Programme for Research in Third-Level Institutions and co-funded under the European Regional Development Fund. The assistance provided by the Central Statistics Office (CSO) in the provision of the POWSCAR (2006-2011) dataset and the National Transport Authority (NTA) for assistance in procuring GTFS data is much appreciated. Many thanks to UCD colleagues who assisted with this project at different stages, the contributions of Dr. Enda Murphy, Dr. Brendan Williams, Sheila Convery and Dr. Sarah Rock are particularly appreciated.

## Glossary

CBD - Central Business District

CSO - Central Statistics Office, Ireland

DART – Dublin Area Rapid Transit

GDA - Greater Dublin Area

GIS - Geographic Information Systems

GTFS - General Transit Feed Specification

NTA - National Transport Authority, Ireland

OSI - Ordinance Survey Ireland

POWSCAR - Place of Work and School Census of Anonymised Records

RSS - Residential Self-Selection

UPH - Units per Hectare

## Bibliography

Aditjandra, P. Cao, X. Mulley, C. 2012. Understanding Neighbourhood Design Impact on Travel Behaviour: An Application of Structural Equation Models to British Metropolitan Data. *Transportation Research Part A: Policy and Practice.* **46** (1), 22-32.

Ahern, A, Weyman, G. Redelbach, M. Schulz, A. Akkermans, L. Vannacci, L. Anoyrkati, E. Von Grinsven, A. 2013. *Analysis of National Travel Statistics in Europe Optimism WP2*, Publications Office of the European Union, Brussels.

Akkermans, L. Maerivoet, S. Schulz, A. Redelbach, M, Ahern, A. Vannacci, L. 2013. Harmonisation of National Travel Statistics in Europe Optimism WP2. Office of the European Union, Brussels.

Bartlett, J. Kotrlik, J. Higgins, C. 2001. Organizational Research: Determining Appropriate Sample Size in Survey Research. *Information Technology, Learning and Performance*, **19**(1), 43-50.

Bento, A. Cropper, M. Mobarack, A. Vinha, K. 2005. The Effects of Urban Spatial Structure on Travel Demand in the United States. *The Review of Economics and Statistics*, **87**(3), 466-478.

Bertaud, A. Lefevre, B. Yuen, B. 2009, June. *GHG Emissions, Urban Mobility and Efficiency of Urban Morphology: A Hypothesis.* Proceedings of the Urban Research Symposium. France:

Marseille. Retrieved from:

[http://siteresources.worldbank.org/INTURBANDEVELOPMENT/Resources/3363871256566800920/6505269-1268260567624/Bertaud.pdf](http://siteresources.worldbank.org/INTURBANDEVELOPMENT/Resources/336387-1256566800920/6505269-1268260567624/Bertaud.pdf) (Accessed: April, 2015).

Bhat, C. Guo, J. 2006. *A Comprehensive Analysis of Built Environment Characteristics on Household Residential Choice and Auto Ownership Levels*. [Research Report]. University of Texas. Retrieved from: <http://www.caee.utexas.edu/prof/bhat/REPORTS/Report_SWUTC167860_Bhat_Guo.pdf>(Accessed: April, 2015).

Bhat, C. Guo, J. 2007. A Comprehensive Analysis of Built Environment Characteristics on Household Residential Choice and Auto Ownership Levels. *Transportation Research Part B.* **41**, 506–526.

Browne, D. Caulfield, B. O’Mahony, M. 2011. *Assessing the Barriers to Sustainable Transport in Ireland*. Environmental Protection Agency. Retrieved from:

[http://www.epa.ie/pubs/reports/research/climate/CCRP%20Report%20Series%20No.%207%20%20Barriers%20to%20Sustainable%20Transport%20in%20Ireland.pdf](http://www.epa.ie/pubs/reports/research/climate/CCRP%20Report%20Series%20No.%207%20-%20Barriers%20to%20Sustainable%20Transport%20in%20Ireland.pdf) (Accessed: April, 2015).

Cao, X. Handy. S. Mokhtarian, P. 2006. The Influences of the Built Environment and Residential Self-Selection on Pedestrian Behaviour: Evidence from Austin, TX. *Transportation*. **33**(1), 1-20.

Cao, X. 2008. Is Alternative Development Undersupplied? Examination of Residential Preferences and Choices of Northern California Movers. *Transportation Research Record*. **2077**, 97-105.

Cao, X. Mokhtarian, P. Handy, S. 2008. *Examining the Impacts of Residential Self-Selection on Travel Behaviour: Methodologies and Empirical Finding*s. [Research Report] University of Minnesota Centre for Transportation Studies. Retrieved from: <http://conservancy.umn.edu/handle/11299/96713>(Accessed: April, 2015).

Cao, X. Mokhtarian, P. Handy, S. 2009. Examining the Impacts of Residential Self-Selection on Travel Behaviour: A Focus on Empirical Findings. *Transport Reviews.* **29**(3), 359–395.

Cao, X. 2014. Residential Self-Selection in the Relationships between the Built Environment and Travel Behaviour: Introduction to the Special Issue. *Journal of Transport and Land-Use.* **7**(3), 1-3.

Cao, X. Ettema, D. 2014. Satisfaction with Travel and Residential Self-Selection: How do Preferences Moderate the Impact of the Hiawatha Light Rail Transit Line? *Journal of Transport and Land-Use*. **7**(3), 93-108.

Caulfield, B. 2012. An Examination of the Factors that Impact upon Multiple Vehicle Ownership: The Case of Dublin, Ireland. *Transport Policy*, **19**, 132-138.

Caulfield, B. Ahern, A. 2014. The Green Fields of Ireland: The Legacy of Dublin’s Housing Boom and the Impact on Commuting. *Case Studies on Transport Policy*, **2**(1), 20-27.

Central Statistics Office. 2011. *Irish Census*.

Central Statistics Office. 2011. *Place of Work, School or College - Census of Anonymised Records*.

Central Statistics Office. 2014. Production in Building and Construction Index. [Online Report].

Retrieved from: [http://www.cso.ie/en/releasesandpublications/er/pbci/productioninbuildingandconstructionindexquarte r42014/#.VT-T2JPmkbA](http://www.cso.ie/en/releasesandpublications/er/pbci/productioninbuildingandconstructionindexquarter42014/#.VT-T2JPmkbA) (Accessed: April, 2015).

Chatman, D. 2009. Residential Self-Selection, the Built Environment and Non-Work Travel: Evidence Using New Data and Methods. *Environment and Planning A.* **41**(5), 1072–1089.

Chatman, D. 2014. Estimating the Effect of Land-Use and Transportation Planning on Travel Patterns: Three Problems in Controlling for Residential Self-Selection. *Journal of Transport and Land-Use*. **7**(3), 47-56.

Cochran, W. 1977. *Sampling techniques* (3rd ed.). New York: John Wiley & Sons.

Dept. of Environment, Heritage and Local Government, Ireland. 2009. *Sustainable Residential Development in Urban Areas.* Retrieved from:

[http://www.environ.ie/en/Publications/DevelopmentandHousing/Planning/FileDownLoad,19164,en.p df](http://www.environ.ie/en/Publications/DevelopmentandHousing/Planning/FileDownLoad,19164,en.pdf) (Accessed: April, 2015).

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 Behaviour. *Journal of Transport Geography*.**22**, 1-9.

Ewing, R. Cervero, R. 2010. Travel and the Built Environment: A Meta-Analysis. *Journal of the American Planning Association*. **76**(3), 265-294.

Handy, S. Cao, X. Mokhtarian, P. 2005. Correlation or Causality between the Built Environment and Travel Behaviour? Evidence from Northern California. *Transportation Research Part D*. **10**(6), 427444.

Hammond, D. 2005. *Residential Location and Commute Mode Choice*. Dissertation submitted in fulfilment of the MSc in Transport and Planning, University of Wales, Cardiff. IN: Cao, X. Mokhtarian, P. Handy, S. 2008. *Examining the Impacts of Residential Self-Selection on Travel Behaviour: Methodologies and Empirical Finding*s. [Research Report] University of Minnesota Centre for Transportation Studies. Retrieved from: <http://conservancy.umn.edu/handle/11299/96713>(Accessed: April, 2015).

Kitamura, R. Mokhtarian, P. Laidet, L. 1997. A Micro-Analysis of Land-Use and Travel in Five Neighbourhoods in the San Francisco Bay Area. *Transportation.* **24**(2), 125–158.

Levine, J. 1998. Rethinking Accessibility and Jobs-Housing Balance. *Journal of the American Planning Association.* **64**(2), 133-150.

Loo, B. Chow, A. 2011. Jobs-Housing Balance in an Era of Population Decentralisation: An Analytical Framework and a Case Study. *Journal of Transport Geography*, **19**(4), 552-562.

Lund, H. Wilson, R. Cervero, R. 2006. A Re-Evaluation of Travel Behaviour in California TODs. *Journal of Architectural and Planning Research*. **23**(3), 247–263.

Mokhtarian, P. Cao, X. 2008. Examining the Impacts of Residential Self-Selection on Travel Behaviour: A Focus on Methodologies. *Transportation Research B*. **42**(3), 204-228.

Murphy, E. 2012. Urban Spatial Location Advantage: The Dual of the Transportation Problem and its Implications for Land-Use and Transport Planning. *Transportation Research Part A*, **46**(1), 91-101.

National Transport Authority. 2011. *Greater Dublin Area Draft Transport Strategy 2011-2030*. Retrieved from: [*http://www.nationaltransport.ie/downloads/GDA\_Draft\_Transport\_Strategy\_20112030.pdf*](http://www.nationaltransport.ie/downloads/GDA_Draft_Transport_Strategy_2011-2030.pdf) (Accessed: April, 2015).

Naess, P. 2009. Residential Self-Selection and Appropriate Control Variables in Land-Use: Travel Studies. *Transport Reviews*. **29**(3), 293-324.

Naess, P. 2014. Tempest in a Teapot: The Exaggerated Problem of Transport-Related Residential Self-Selection as a Source of Error in Empirical Studies. *Journal of Transport and Land-Use*. **7**(3), 57-79.

Peng, Z. 1997. The Jobs-Housing Balance and Urban Commuting. *Urban Studies*, **34**(8), 1215-1235.

Pinjari, A. Pendyala, R. Bhat, C. Waddell, P. 2007. Modelling Residential Sorting Effects to Understand the Impact of the Built Environment on Commute Mode Choice. *Transportation.* **34**(5), 557-573.

Pinjari, A. Pendyala, R. Bhat, C. Waddell, P. 2011. Modelling the Choice Continuum: An Integrated Model of Residential Location, Auto-Ownership, Bicycle Ownership and Commute Tour Mode Choice Decisions. *Transportation*, **38**(6), 933-958.

Schwanen, T. Mokhtarian, P. 2003, October. *Does Dissonance Between Desired and Current Residential Neighbourhood Type Affect Individual Travel Behaviour? An Empirical Assessment from the San Francisco Bay Area.* Proceedings of the European Transport Conference*.* Strasbourg, France. Retrieved from: <http://trid.trb.org/view.aspx?id=770466>(Accessed: April, 2015).

Silva, J. 2014. Spatial Self-Selection in Land-Use–Travel Behaviour Interactions: Accounting Simultaneously for Attitudes and Socio-Economic Characteristics. *Journal of Transport and LandUse*. **7**(2), 63-84.

Van Acker, V. Mokhtarian, P. Witlox, F. 2011. Going Soft: On How Subjective Variables Explain

Modal Choices for Leisure Travel. *European Journal of Transport and Infrastructure Research.* **11**(2), 115-146.

Van Wee, B. Holwerda, H. Van Baren, R. 2002. Preferences for Modes, Residential location and Travel Behaviour: The Relevance for Land-Use Impacts on Mobility. *European Journal of Transport and Infrastructure Research.* **2**(3-4), 305-316.

Van Wee, B. 2009. Self-selection: A Key to a Better Understanding of Location Choices, Travel Behaviour and Transport Externalities? *Transport Review.* **29**(3), 279-292.

Van Wee, B. Boarnet, M. 2014. Reaction to the Paper; Tempest in a Teapot: The Exaggerated Problem of Transport-Related Residential Self-Selection as a Source of Error in Empirical Studies. *Journal of Transport and Land Use.* **7**(3), 81-86.

Vega, A. Reynolds-Feighan, A. 2007. *Employment sub-centres and the choice of mode of travel to work in the Dublin region*. University College Dublin, Centre for Economic Research. [Working Paper]. Retrieved from: <http://core.ac.uk/download/pdf/7109003.pdf>(Accessed: April, 2015).

Vega, A. Reynolds-Feighan, A. 2008. Employment Sub-Centres and Travel-to-Work Mode Choice in the Dublin Region. *Urban Studies*. **45**(9), 1747-1768.

Wang, D. Lin, T. 2014. Residential Self-Selection, Built Environment, and Travel Behaviour in the Chinese Context. *Journal of Transport and Land-Use.* **7**(3), 5-14.

1. CSO small areas are the most detailed spatial data for census (2011) data, representing between 50-200 households. [↑](#footnote-ref-1)
2. Jobs/housing balance was used as a proxy for defining single-use or a mixed-use area as other data was not available. [↑](#footnote-ref-2)
3. Public transport buffers were measured as a 400m radius for bus stops and a 800m radius for rail stops. [↑](#footnote-ref-3)
4. Three land-use types were originally used which separated sustainable travel areas into monocentric (more jobs than housing) and balanced jobs/housing areas. After a smaller than expected response rate, these two study areas were merged.

   The Peng (1997) definition was used to define the difference between ‘balanced’ and ‘jobs centric’ areas. [↑](#footnote-ref-4)
5. Cochran’s (1977) correction formula is used when the population is known and the sample exceeds 5% of the population (384 would represent 10.1% of the known population of 3,807 households): (Bartlett et al, 2001)  [↑](#footnote-ref-5)
6. There were three study area types at this time and the higher distribution figure reflects this context – Due to the lower than expected response rate, the two types of sustainable travel area were merged. See Footnote 4. [↑](#footnote-ref-6)
7. Results for commuting mode are lower than the full sample (588) as they do not include retired respondents (236) or those who work from home (14) in both of the study areas. 9 Statistically significant associations observed between study areas and commuting mode (Cramer’s V; .597, P0.00, N: 602), shopping mode (Cramer’s V; .607, P0.00, N: 831) and the mode used for social trips (Cramer’s V; .616, P0.00, N: 828). Varying sample size reflects a small number of blank responses. [↑](#footnote-ref-7)
8. 68% in sustainable and 70% in unsustainable travels areas. [↑](#footnote-ref-8)
9. Continuations of past modes for 80% of car users, but less so for walkers (67%) and public transport users (60%). 11 Socio-economic information was excluded as only present-day data was available for comparison which would not necessarily reflect the individual or household at the time of moving. As a result, these models do not control for SE factors. [↑](#footnote-ref-9)
10. There were 515 respondents who had prior modal intentions, the smaller N: 495 figure reflects the omission of a small number of cases were the data was not fully completed for all the survey variables included in the model. [↑](#footnote-ref-10)
11. It could be queried whether this statement captures all of the facets involved in RSS as it excludes other aspects of household location choices. This statement was the result of extensive discussion with testers and its deficiencies reflect the challenge of creating layman terminology for what is essentially an academic concept. Attempts to use a ‘modal preferences over all other aspects’ or other similar statements provoked an unnecessary level of misunderstanding and feedback suggested the choice was between transport and what the testers considered to be ‘neighbourhood types’ e.g. housing estates or denser areas, attractiveness of the local area, crime rates, etc. This ‘residential self-selection statement’ should be viewed as a functional compromise which captures whether residents prioritised modal preferences in household location decisions. [↑](#footnote-ref-11)
12. Those who ‘had never intended to use a particular mode’ were excluded from this test as their almost random residential distribution would reduce the effectiveness of the model and they had shown no traits of being involved in self-selection. 14 The respondent characteristics associated with unsustainable RSS tendencies were almost identical in composition to *Group A-B* respondents. Those uninvolved in self-selection had a much more balanced distribution across all occupancy types, housing types, ages, residency areas and car ownership level variables. [↑](#footnote-ref-12)