Propensity to use public transport: Who uses it and what that tells us about Auckland




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With thanks from our clients at Auckland Transport, Travel Demand Team

Executive Summary

Big retailers know their market and they target them with bespoke campaigns and even open stores where they know they can attract the greatest number of customers. Can we learn from this approach as transport planners when undertaking network planning for public transport or undertaking behaviour change programmes?

Transport planning often focusses on spatial, design or service level aspects of the transport network. This study looks at the *users* of public transport instead. It is a market analysis of public transport users in Auckland - used as a tool to understanding who is most likely to use public transport and inversely who is unlikely to use public transport. It is argued that such an approach has application in more efficient network planning and service provision by focussing on areas which are most likely to achieve a mode shift toward public transport use.

The method involves Spatial Regression Analysis, a statistical process for estimating the relationships between variables. Census data from 2013 was used to do the regression analysis with the number of current public transport users as dependent variable.

Six variables were shown to have a strong relationship to public transport use. In Auckland, these are people who:

- Do not have children
- Have an education level of degree or higher
- Are unmarried
- Are in the age group from 20 years to 39 years
- Are currently studying
- Work 20 – 40 hours per week

The area which has the greatest density of people with propensity to use public transport is generally clustered around the inner southwest of Auckland (Kingsland, Sandringham, Mount Eden and surrounds).

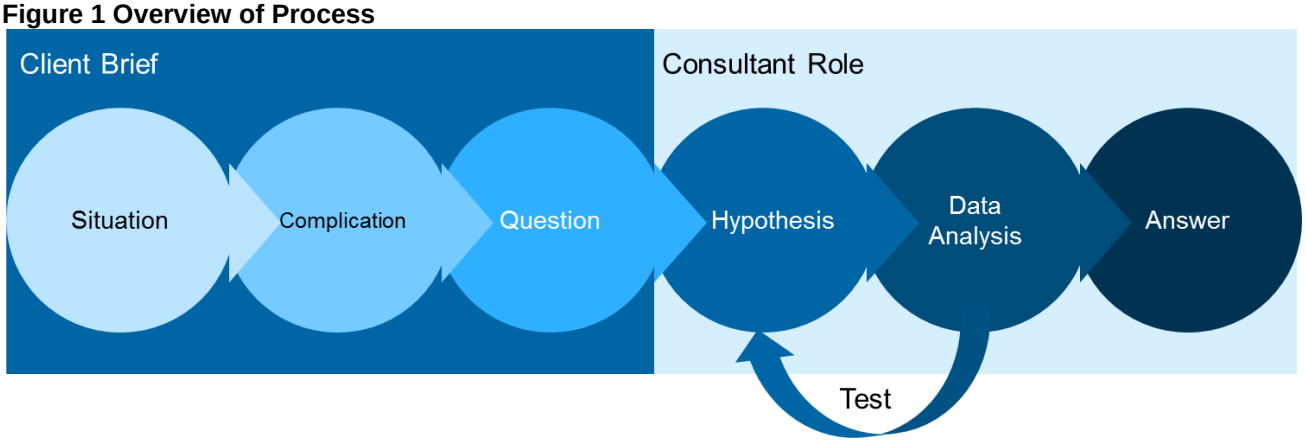
This research was undertaken to help Auckland Transport's Travel Demand Team focus their behaviour change programmes. However, this approach has broader applications in network planning for various modes- including active modes. With public transport and active transport budgets often being limited, this type of approach can be used to identify areas which are likely to get the best ‘bang for buck’ (measured by ridership or use) from public transport or active transport investment. Similarly it can be used by economists when developing cost and benefit ratio models as different modes are likely to attract different types of users.

Good planning is based on data

Our client for this project wanted to know which areas they were likely to get the greatest response to their travel behaviour change programmes. This project which we developed to help them with this problem took a methodical approach to identify a target market for behaviour change programmes in Auckland. An overview of the process is shown in Figure 1.

The hypothesis was: There is a certain type of person which is likely to use public transport.
The key research question was: Are there particular geographic or demographic variables which have a strong correlation with public transport use?
Which led to a subsequent question: And if so, are there concentrations of people which have a strong propensity to use public transport in Auckland, who are currently not using it?

Figure 1 Overview of Process



The method was based on literature review and GIS Spatial Regression Analysis

The literature review has focussed on studies which identify the common factors in communities which have scope for reduced car use. That is, communities in which it is most feasible to undertake an AM Peak journey by a mode other than the car. Four study were sourced which used robust statistical methods to determine the factors which contributed to car use/public transport use. The titles and their case study locations are as follows:

- **Melbourne, Australia:** Paez D. and Currie G. (2010), *Key Factors Affecting Journey to Work in Melbourne using Geographically Weighted Regression Analysis*, Australian Transport Research Forum
- **Christchurch, New Zealand:** Buchanan et al, (2006), *The effect of urban growth on commuting patterns in Christchurch, New Zealand*, Journal of Transport Geography 14, pp 342-454
- **Sydney, Australia:** Longworth T. and Wilson C., (2006) *An Exploration of Mode Choice in Sydney Using Journey to Work Data*, Masson Wilson Twiney Pty Ltd, Sydney, NSW, Australia
- **The Netherlands:** Schwanen T., Dieleman FM. and Dijst M. (2004) *The Impact of Metropolitan Structure on Commute Behavior in the Netherlands: A Multilevel Approach*, Growth and Change, Vol 35 No. 3 (Summer 2004), pp.304-333

The literature review informed the list (shown in Table 1) of compositional and city structure variables which were then tested through spatial regression analysis:

Table 1 Variables Tested

Item No.	Variables tested	Compositional Variables	City Structure Variables
1.	No Child/ren	✔	
2.	Has Child/ren	✔	
3.	Ethnicity: European	✔	
4.	Ethnicity: Asian	✔	
5.	Ethnicity: Maori and Pacifica	✔	
6.	NZ Born	✔	
7.	Overseas Born	✔	
8.	Unmarried	✔	

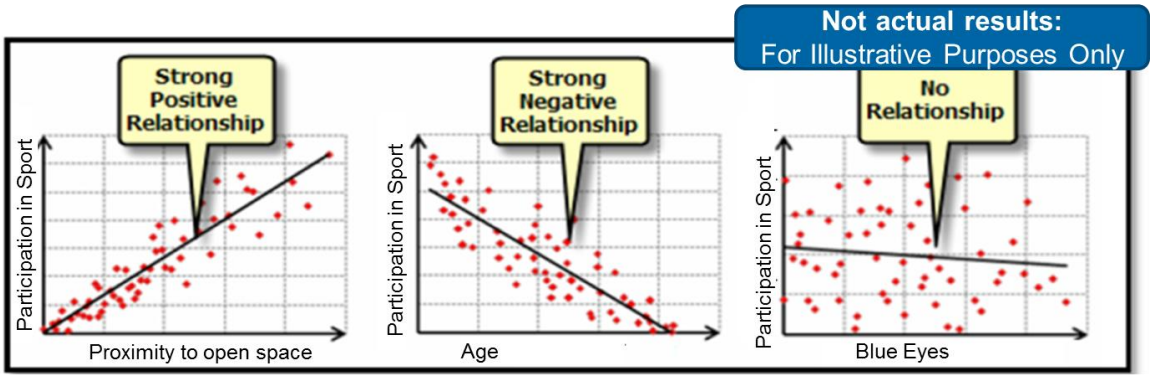
Item No.	Variables tested	Compositional Variables	City Structure Variables
9.	Married	✔	
10.	Income: >$50k	✔	
11.	Studying	✔	
12.	Not Studying	✔	
13.	Gender: Female	✔	
14.	Gender: Male	✔	
15.	Working Hours: < 20 hours	✔	
16.	Working Hours: 20 – 40 hours	✔	
17.	Working Hours: > 40 hours	✔	
18.	Distance to CBD		✔
19.	Distance to Town Centre		✔
20.	Proximity to Bus Stop, train stations and ferry terminal		✔
21.	Education: Degree	✔	
22.	Education: Certificate course	✔	
23.	Education: No higher education	✔	
24.	Age group: 20-29	✔	
25.	Age group: 30-39	✔	
26.	Age group: 40-49	✔	
27.	Age group: 50-59	✔	

Regression analysis is a statistical process for estimating the relationships between variables. Spatial Regression analysis is used in this job to better understand what the main factors influencing on people to take public transport and to identify the locations where there is potential to encourage people taking Public Transport.

Census data from 2013 has been used to do the regression analysis with the number of current public transport users as dependent variable (Y), and many other variables (X1,….., Xn) from the census database as explanatory variables: age ranges, marriage status, gender, family structure (has children or no children), work status (hours, occupations), education status, countries of birth, distance to facilities such as CBD and Town Centers etc. The census database includes responses to the question of how an individual travelled to work/study on the day of census and this has been used to determine if a person is a ‘public transport user’ or not for the purpose of this analysis. Regression analysis describes the strength and the sign of the explanatory variable's relationship to the dependent variable (Public transport use). by using Geographically Regression Analysis in GIS. Through the process, R-squared values have been checked to select those explanatory variables which have high correlations with public transport use to work/study, also examined p value to make sure that coefficients are statistically significant at high confidence level. Identifying candidate explanatory variables also involves in consulting theory and common sense. It is an iterative process that involves finding effective independent variables to explain the dependent variable well.

A high level overview of the concept of regression analysis is shown in Figure 2. The study sought to identify variables which had a strong relationship with our independent variable of public transport use (either strong positive or strong negative correlation).

Figure 2 Example of Regression Analysis (illustrative only)



What is the market for public transport use in Auckland?

This market analytics process showed that there are seven variables which have a strong relationship to public transport use. These variables are people who:

- Do not have children
- Have an education level of degree or higher
- Are unmarried
- Are in the age group from 20 years to 39 years
- Are currently studying
- Work 20 – 40 hours per week

Table 2 summarises the relationship of variables tested which had a strongly significant correlation. Variables which had a correlation greater than R^2=0.55 were considered to have a strong enough relationship to be significant.

Table 2 Significant Variables: Adjusted R2 Value >0.55

Significant.	Variables tested	Adjusted R-Squared Value
Significant	No Children	0.777720
	Unmarried	0.668424
	Study	0.600942
	Working Hours: 20 – 40 hours	0.566122
	Education: Degree	0.679366
	Age group: 20-29	0.625646
	Age group: 30-39	0.579748

The study shows that compositional variables have the greatest relationship with public transport use. It is beyond the scope of this study to identify 'why' these compositional variables are significant, however it is hypothesised that the variables are significant for the following reasons:

No Children: This finding correlates with the findings outlined by Buchanan et al (2006) in the Christchurch study which found that couples *with* children are more likely to commute by car. The factors which are considered to influence this group to have stronger public transport dependence may include,

- Flexibility with working hours,

- Comfort of travel (i.e. no fixed time travel to include school pick-up and drop-off),
- Geographical location of the home in close proximity to public transport infrastructure, and
- Greater likelihood of having a trip which involves one single destination (rather than a multi-destination trip such as to school/daycare and then onto work).

Unmarried: The factors which are considered to influence this group to have stronger public transport dependence may include

- Younger age group;
- Single people have fewer options for carpooling with a partner to work;

Study: The factors which are considered to influence this group to have stronger public transport dependence may include,

- Financial constraint (cost of owning a vehicle and maintenance whilst studying),
- No driver licence (younger age groups)
- Attractive public transport student discounts,
- Traveling with classmates and friends, and
- Physically active age group

Working Hours: 20 - 40 hours: The factors which are considered to influence this group to have stronger public transport dependence may include,

- Less reliance on private car due to flexible working hours,
- Off-peak travel are reliable and faster with public transport, and
- Cost of owning a vehicle and maintenance.

Education: Degree: This finding correlates with the findings outlined by Schwanen et al (2004) in the Netherlands study which found that more highly educated workers are less likely to commute by car. The factors which are considered to influence this group to have stronger PT dependence may include:

- Greater likelihood of Central City or inner suburban work destination – resulting in increased density of public transport options.
- Social responsibility,
- Awareness of sustainable travel options (ATs Journey Planner etc),
- Opportunities to use alternative travel mode (office vehicle, carpooling etc.),
- Lack of parking available at work place (if office is located in CBD location),
- Job role that demand less work related traveling.

Age Group: 20 -29 years and 30 – 39 years: The factors which are considered to influence this group to have stronger public transport dependence may include,

- Financial constraints to own a private vehicle (student loan, home loan saving, etc.),
- Geographical location of the home in close proximity to public transport infrastructure,
- Lack of parking available at work place (if office is located in CBD location),
- Socially and physically active age group.

Where does the 'public transport' market live?

The results of the regression analysis of census data to produce the seven significant variables can be mapped by CAU (Census Area Unit) using GIS. Mapping the people who have propensity to use public transport is a two-step process:

- First mapping the locations with the greatest density of population for propensity for public transport use (map in Figure 3); and
- Second removing those who currently catch public transport as indicated by census data for method of travel to work (map in Figure 4).

The resulting map (shown in both Figure 5 and Figure 6) shows the areas which are most likely to have a the most positive mode shift outcomes.

Figure 3 Density of population with propensity for public transport use

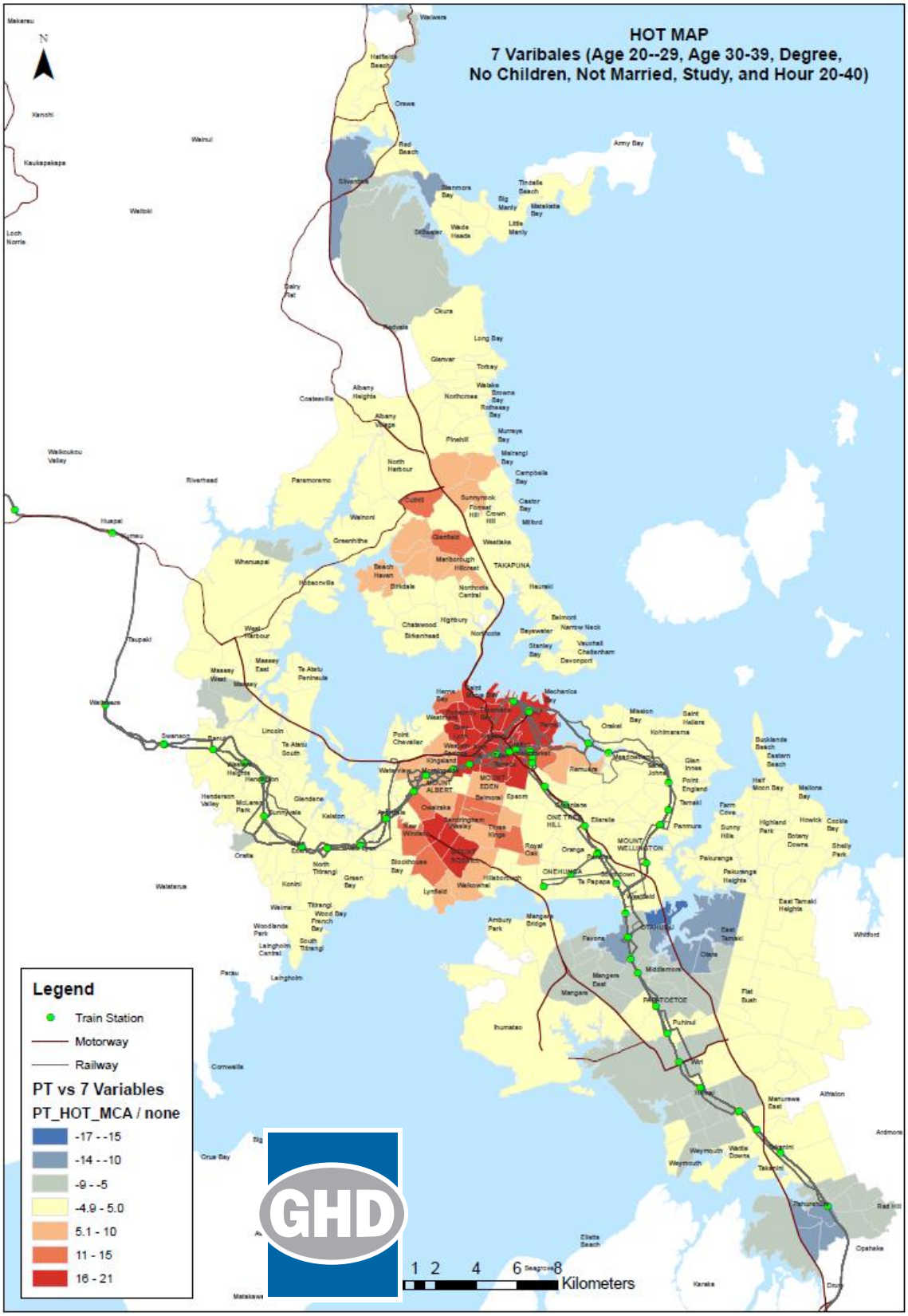


Figure 4 Density of population who currently catch public transport

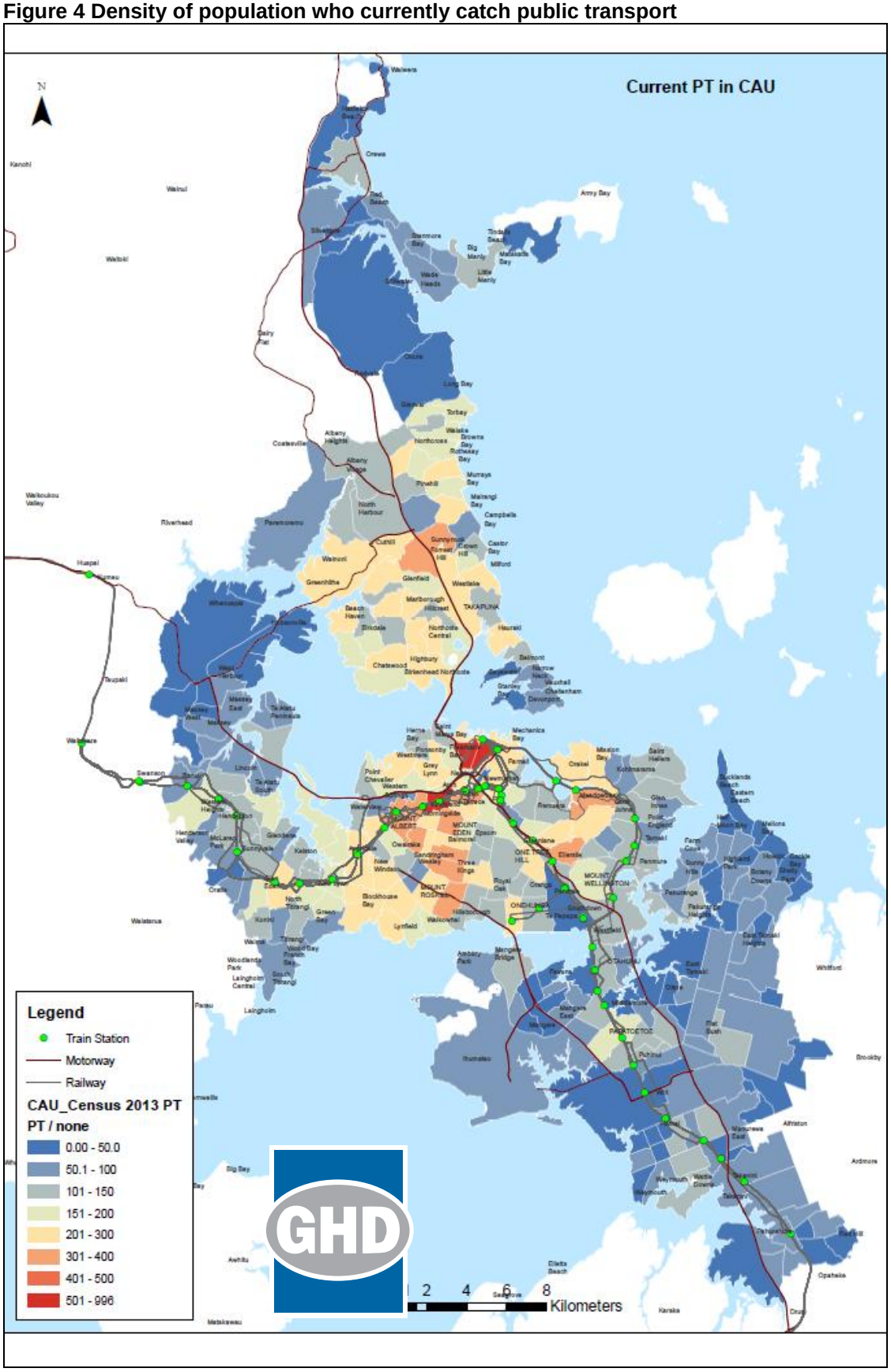


Figure 5 Greatest potential of mode shift to public transport (1/2)

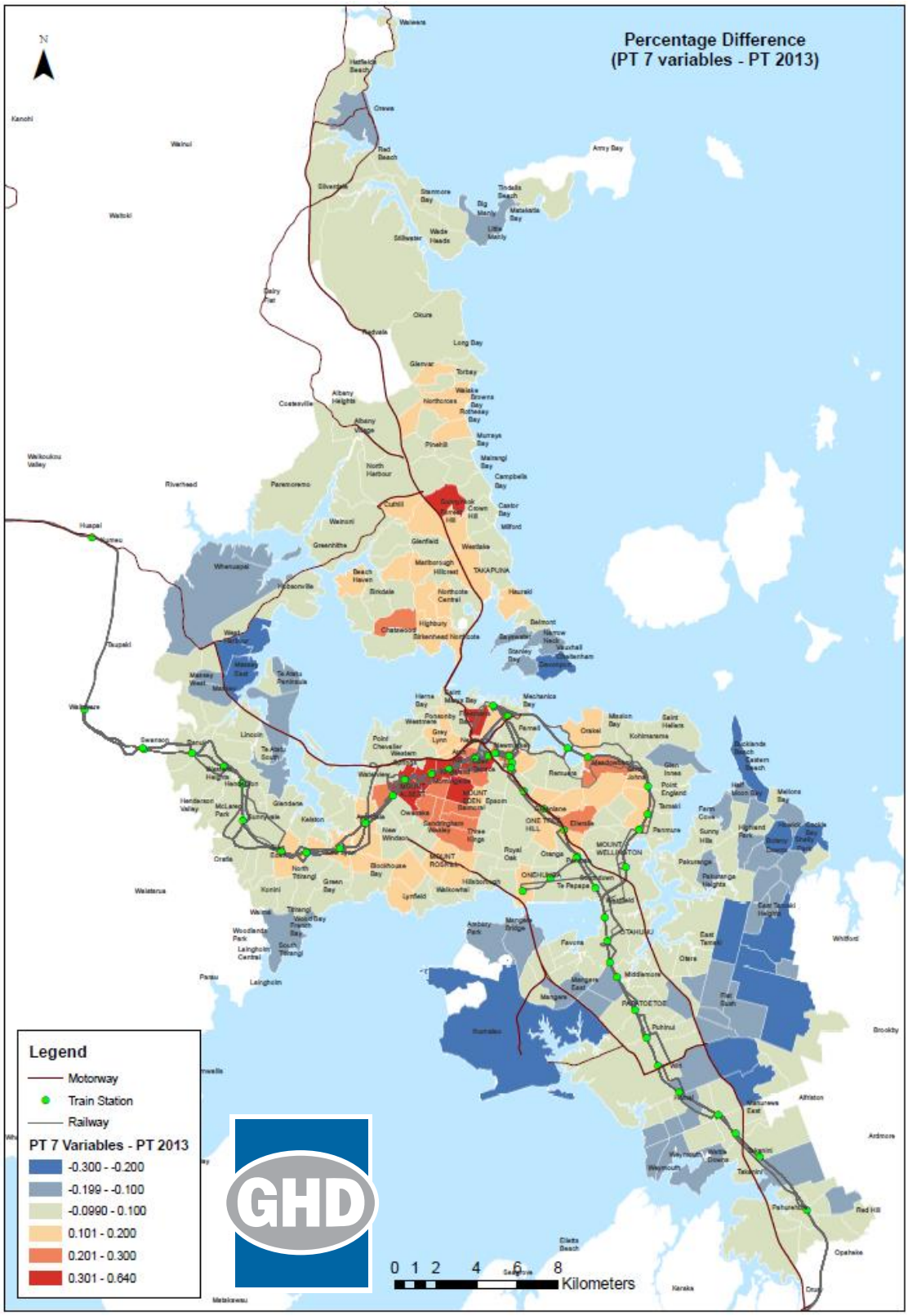
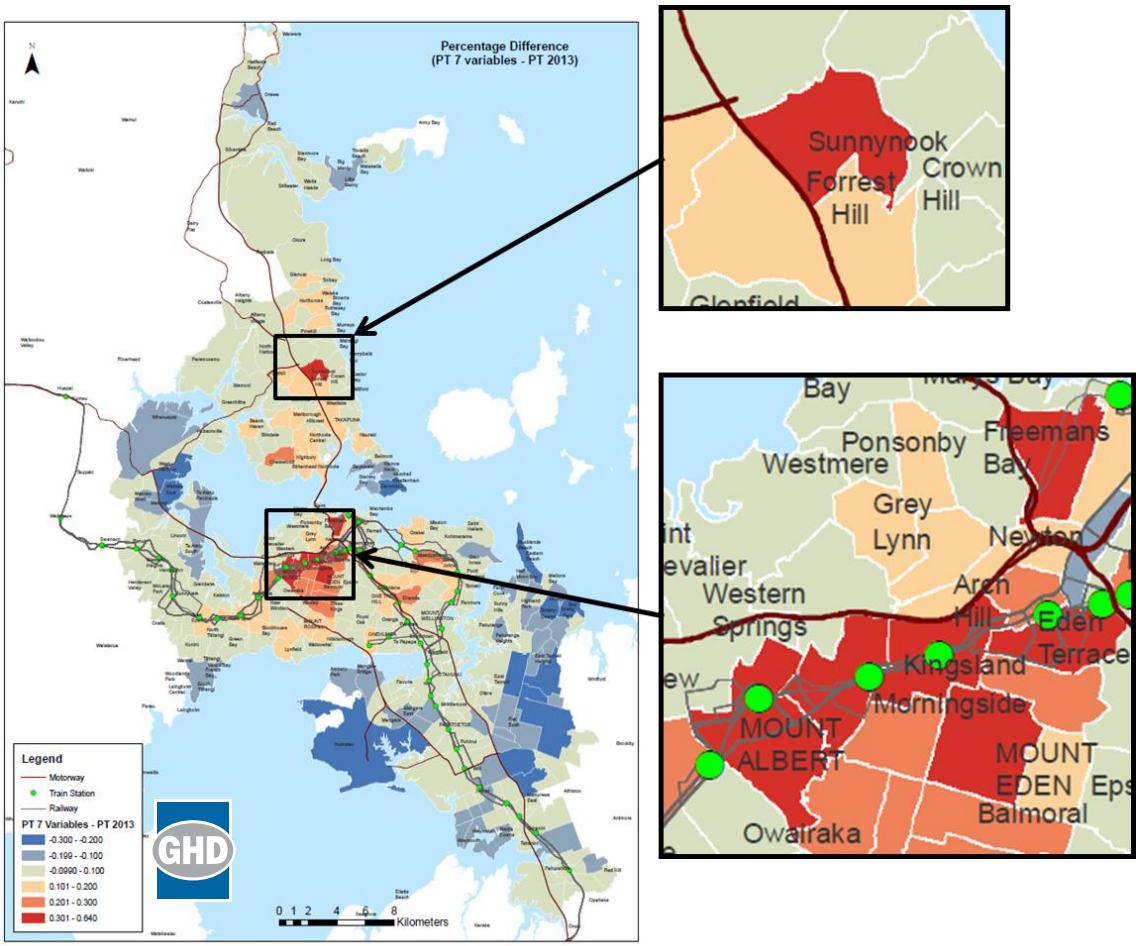


Figure 6 Greatest potential of mode shift to public transport (2/2)



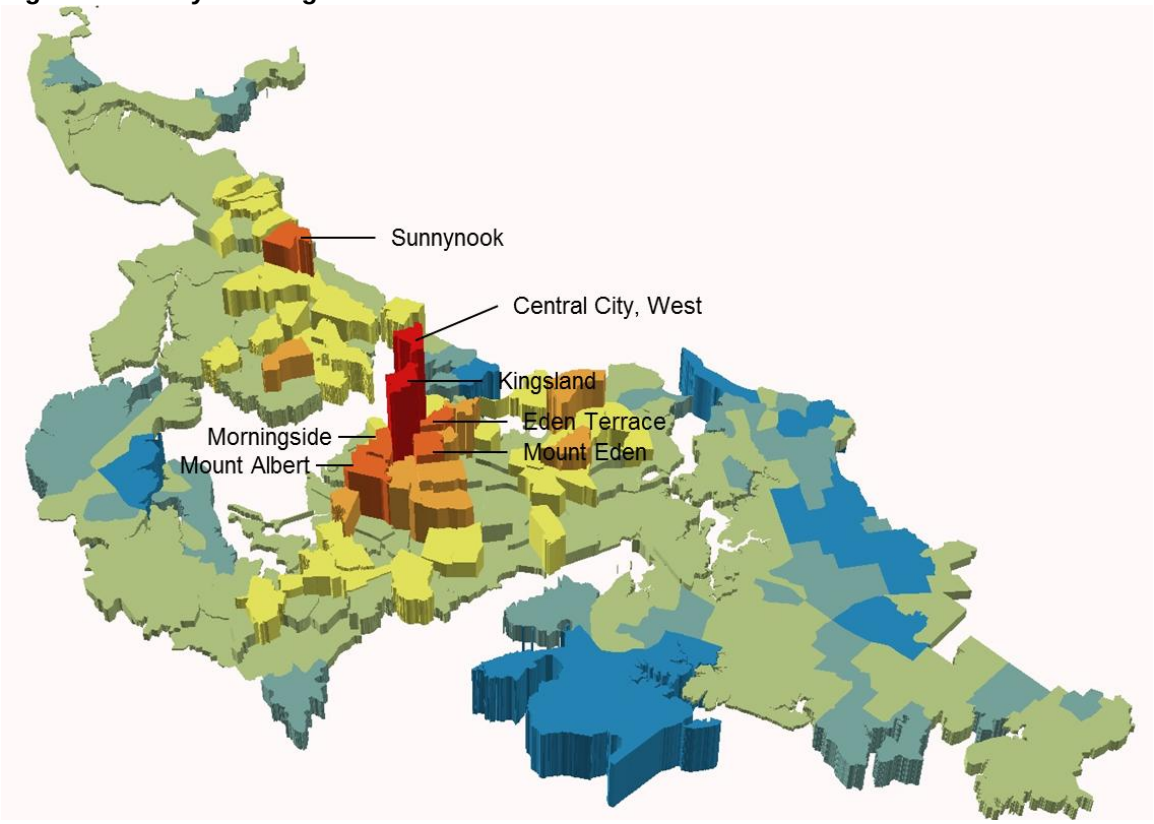
What next?

There are seven locations which have the greatest density of population with propensity for public transport use who are currently not using public transport. These are shown in priority order in Table 3 and Figure 7.

Table 3 Priority Ranking

Priority Ranking	Location	Total Population of CAU
1	Kingsland	4,632
2	Central City, West	11,700
3	Morningside	4,683
4	Mount Eden	5,445
5	Eden Terrace	3,225
6	Mount Albert	5,673
7	Sunnynook	6,711

Figure 7 Priority Ranking



The conclusion on the seven locations that are likely to have the greatest potential for mode shift toward public transport is based on analysis using 2013 Census data. It does not take into account compositional or city structure variables which may have changed since that time. For example, one notable change since 2013 has been the steep increase in housing prices in real terms but also in relation to income in Auckland which has changed the affordability landscape across the city. Such a change may well impact upon factors which have a relationship with public transport variables. However these types of changes have not been captured in this analysis. It may be prudent to repeat the study when 2016 census data is available.