

THE EFFECTS OF THE NORTHERN BUSWAY ON SURROUNDING LAND USE AND TRAVEL BEHAVIOUR

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ABSTRACT

As a remedy to the ongoing issue of congestion over the Harbour Bridge between North Shore City Centre and Auckland City Centre, and to encourage the city's use of public transport, the Northern Busway was implemented in 2008. As Auckland's first Bus Rapid Transit (BRT), the Northern Busway caused the travel behaviour of North Shore residents to be unique in New Zealand. This research focuses on this public transport infrastructure and assesses the impacts it has had on the North Shore in terms of land use; population, land value and employment, switch from car to bus and multimodal integration of bike and bus.

Analysis was carried out through raw data supplied by Auckland Transport and Auckland Council. A survey was completed at each of the Northern Busway stations to determine the multimodal integration of bike and bus. Results found an increase in population, residential and business land value and an increase in employment. It was also seen that traffic counts decreased and bus patronage increased. Findings from the survey showed that participants found the combination of bike and bus as a fast and enjoyable travel choice. Overall it was concluded that the Northern Busway has had a positive effect on both land use and travel behaviour.

1.0 INTRODUCTION

Congestion is a prominent issue in Auckland, and with a high level of car dependency and growing population, this will only worsen. Like many other major cities around the world, Auckland is moving towards public transport as a remedy to this issue, with the ulterior motive of promoting more sustainable travel modes (Doris and Yan 2008).

In an attempt to reduce congestion on Auckland's State Highway 1 (SH1) between the North Shore and Auckland Central Business District (CBD), the Northern Busway was implemented. Officially opening in 2008 (NZ Transport Agency 2008), this became Auckland's first Bus Rapid Transit (BRT), causing the travel behaviour of North Shore residents to be unique (Doris and Yan 2008).

1.1 Research objectives

This research aims to assess the impacts the Northern Busway has had on Auckland's North Shore in terms of land use and travel behaviour. In order to achieve this, the effects of the Northern Busway on land use were assessed through population, land value and employment, the shift in travel mode from car to bus was determined, and multimodal integration of bike and bus was assessed.

2.0 LITERATURE REVIEW

This literature review provides an overview of the two main concepts behind this research; the relationship between land use and travel behaviour, and the effect BRT has on land use and travel behaviour.

2.1 Land use and travel behaviour

2.1.1 Relationship between land use and travel behaviour

The relationship between land use and travel behaviour is the centre of interest of many planners, urban policy makers and transport researchers worldwide. A majority of studies undertaken in this area are based on data from Europe and the USA (Antipova et al. 2011; Levinson 1998; van Acker and Witlox 2011). A lot of this interest is focussed on the influence of land use on travel behaviour (Antipova et al. 2011; Levinson 1998; van Acker and Witlox 2011). Central to this is the issue of increasing congestion and increasing commuting times, and the use of policy to influence land use

patterns and therefore alter travel behaviour to alleviate these issues (Antipova et al. 2011; Levinson 1998; van Acker and Witlox 2011).

Although most literature focusses on the influence of land use on travel behaviour, the relationship between land use and travel behaviour is a two-way relationship; they both influence each other. It has been found that land use patterns determine the need to travel, while travel patterns also influence urban development (Wegener 2004). This research is directed at this two-way relationship, rather than the influence one component has on the other individually. A large amount of conflict still remains on this relationship between land use and travel behaviour (Antipova et al. 2011; van Acker & Witlox 2011), and therefore the need for more research in this area is very evident, especially in countries such as New Zealand where there is a large gap in the literature in this topic area.

2.1.2 Land use and commuting

Commuting to work and education is a common occurrence for most people as working and living are generally two spatially separated activities (van Acker and Witlox 2011). Levinson (1998) reports that 17-38% of the variability in commuting times can be explained by attributes of urban structure such as accessibility to jobs and housing (Levinson 1998). It is therefore understood that urban design also influences commuting times.

In the field of land use and travel behaviour, commuting is generally considered by only assessing a single aspect of commuting, such as density or accessibility. This is shown in previous studies (Chen et al. 2008; Schimek 1996; Simma and Axhausen 2003). This research follows a concept similar to that seen in such studies of (Schwanen et al. 2002; Susilo and Maat 2007; van Acker and Witlox 2011), where travel behaviour is influenced by several commuting aspects, i.e. "modal choice is influenced by commuting distance and commuting time is influenced by both commuting distance and modal choice" (van Acker and Witlox 2011).

In their 2011 study, Van Acker and Witlox found that "More diversity results in lower car use but lower car use does not result in shorter commuting times indicating that commuters travel by slower modes such as public transport and bike." They further identified the complex relationship between commuting and land use and the need for more research in this area to better understand this relationship.

Another important aspect of the relationship between commuting and land use is the distance between the place of residence and the nearest public transport (PT) station or stop (van Acker and Witlox 2011). It is found that the shorter the distance to the nearest PT station or stop, the more inclined people are to use public transport as opposed to car (van Acker & Witlox 2011). This relates directly to this research; the assumption being that the Northern Busway facilitated improved public transport that was available only a short distance from various suburbs on the North Shore. The availability of the Northern Busway therefore encouraged more people to use it as the commuting time became less during peak periods, than the commuting time via car.

2.2 BUS RAPID TRANSIT INFRASTRUCTURE

2.2.1 Effects of BRT on land use

Although it is generally accepted that transport infrastructure improvements have a positive effect on land use the effects of BRT systems on this remains in question and requires further research.

A study in Seoul, Korea estimated an increase of 10% and 25% of land price premiums for residences within 300m of BRT stops and non-residential uses within 150m of BRT stops respectively (Cervero and Kang 2011). While some studies agree with this relationship, not all studies found the same effect.

Levinson et al. (2002) and Vuchic (2002) believe that rail has larger benefits than those seen by BRT, while a study in Los Angeles by Cervero (2004) found BRT to have negative impacts on property values. In contrast studies in Columbia found appreciable land value benefits from the effect of BRT (Rodriquez and Targa, 2004) as cited by (Cervero and Kang 2011)

These contrasting opinions on the impacts of BRT on land use indicate a need for further research on this topic. In particular, research can be done in New Zealand, with the Northern Busway being New Zealand's first BRT.

2.2.2 Effects of BRT on travel behaviour

A year after the introduction of the exclusive median bus lane in Seoul, Korea, bus patronage increased by 10% and in 2009 100,000 more passengers were using the BRT service than rail (Cervero and Kang 2011). BRT infrastructure is therefore believed to have a positive effect on travel behaviour, i.e. the use of BRT has shown increases above that of other modes, however, comparative data outcomes are required to further support this conclusion.

Both the studies of McDonnell and Zellner (2011) and Vuchic (2005) concludes that exclusive BRT lanes are only effective at high levels of population and that modal choice is dependent on previous experience. The study of McDonnell and Zellner (2011) further concludes that "The addition of the exclusive bus lane and the subsequent removal of buses from general traffic results in a much improved performance for all indicators" and "Although the bus mode remains the quickest, the removal of buses from general traffic has significant positive benefits for the remaining car users."

This leads to the assumption that BRT systems may impact positively on road congestion while at the same time improving the performance of public transport. This research will seek to verify the assumption by analysing traffic counts and bus patronage levels as indicators of travel behaviour and mode change.

3.0 RESEARCH METHOD

This research focussed on three main variables; land use, travel mode switch from car to bus, and multimodal integration of bike and bus. The methods used to analyse each of these variables follow.

3.1 Land use

To evaluate the effect the Northern Busway has had on land use, three factors were assessed; population, land value and employment. Once assessed separately, the trends of each of these factors were evaluated collectively to identify the overall land use impact.

3.1.1 Population

Population data was sourced through Statistics New Zealand. Using the New Zealand Census results collected every 5 years, Statistics New Zealand found the estimated resident population for every year from 1996 – 2014. This data is provided for Territorial Authority Areas, Regional Council Areas and Urban Areas.

Specific years of interest were determined to be for a 10-year time frame, 2004 – 2014, showing data before the Northern Busway and after the Northern Busway to determine the long term effects. The population percentage change in the Northern Auckland Urban Zone close to the Northern Busway was analysed to determine any effect. This was compared to the Land Value data, discussed in the next section.

3.1.2 Land value

Land Value data was obtained from Auckland Council showing the land use type, the location and the most current valuation. Due to the commercial value of this data, only the most recent land

values were available. The data received was analysed and sorted into Census Area Units (CAU's) for suburbs within district areas. Only those area units in the North Shore district were further analysed finding the average land value for residential and business land use types. Particular interest was paid to those CAU's within close proximity to the Northern Busway Bus Stations. These were displayed on a map to show the differences in land values for each land use type and how the Northern Busway effected these. The conclusion was drawn based on the traditional relationship between land use and transport. It was understood that the Northern Busway increased accessibility to the affected areas and thereby encouraged development.

3.1.3 Employment

Employment was analysed by looking at the number of employment and business units in the CAU's surrounding the Albany bus station due to the high level of commercialism around here. This data was supplied by Auckland Transport and displayed a diverse range of business types including manufacturing, forestry, farming, services, hospitality and retail. Particular interest was paid to the years 2005, with the opening of the Albany Park and Ride late in this year, and 2008, the year the Northern Busway was officially opened. The conclusion was again drawn based on the traditional relationship between land use and transport. We acknowledge that other factors would also have an effect, however, to control for it was a difficult task given the data constraints.

3.1.4 Land use overview

By looking at each of these factors at different area levels, the effect the Northern Busway had on the Northern Auckland Urban Zone, the North Shore district and specific Census Area Units was able to be seen for an overall assessment of the land use impacts.

3.2 Travel mode switch (car to bus)

In order to analyse the shift in travel mode from car to bus, two factors were assessed; traffic counts and bus patronage. Once assessed separately, the trends of both factors were evaluated together to identify the overall travel behaviour impact.

3.2.1 Traffic counts

Traffic Counts were obtained from Auckland Transport for specific roads around each of the Northern Busway Bus Stations, while SH1 traffic count data was sourced from the New Zealand Transport Agency. For each, Annual Average Daily Traffic (AADT) Counts were determined for relevant years before the Northern Busway and after the Northern Busway to evaluate the trend over time due to its implementation. Northbound and Southbound traffic directions were compared for each road of interest to further analyse the traffic flow.

3.2.2 Bus patronage

Bus Patronage data was sourced from Auckland Transport for the Northern Express Service and all other buses serving the North Shore. Each of these were analysed separately, paying particular attention to the Northern Express service, the bus service dedicated to the Northern Busway. Trends were analysed over time and ratios between the Northern Express and all other North Shore bus services were determined.

3.2.3 Travel mode switch overview

Individually these factors provided trends of how each of these travel modes were impacted by the implementation of the Northern Busway. Together, the traffic counts and bus patronage data gave a global view of the overall impact the Northern Busway has had on travel behaviour over an 8-year time period.

3.3 Multimodal integration (bike and bus)

To assess multimodal integration of bike and bus, a survey was performed at each of the 5 Northern Busway Bus Stations; Albany, Constellation, Sunnynook, Smales Farm and Akoranga.

This was completed over 2 working weeks, Monday – Friday, in the peak morning period, 6:30am – 9:30am. The questions asked included reasons for combining bike and bus, as well as travel modes used before the Northern Busway and for recreational activities. Characteristics of a typical cyclist were also determined asking such things as the bus station used, their destination, travel purpose, cycle journey time and time of arrival. This data was entered into excel and analysed through percentages and trend analysis, enhancing our understanding of the Northern Busway.

4.0 RESULTS

4.1 Land use

4.1.1 Population

The Northern Auckland Urban Zone has a greater population percentage change than the Auckland Region over all years except for 2013-2014. 2004 – 2006 saw the largest population increase for Northern Auckland corresponding with the Albany Park and Ride Station opening in late 2005. It is believed this bus station provided improved accessibility to the Auckland CBD from the Northern Auckland Urban Zone, in particular the suburbs near the Albany Park and Ride Station, and therefore played a part in encouraging an increase in population in this area. The low population change for both the Northern Auckland Urban Zone and Auckland Region between 2007 and 2009 corresponds directly with the Global Financial Crisis (GFC) occurring in 2007 – 2008 which effected all of New Zealand. The greater increase in population percentage in the Northern Auckland Urban Zone from 2009 - 2010 corresponds with the opening of the Northern Busway in late 2008. Again, the opening of the Northern Busway is believed to have improved accessibility for those suburb close to the Northern Busway Stations.

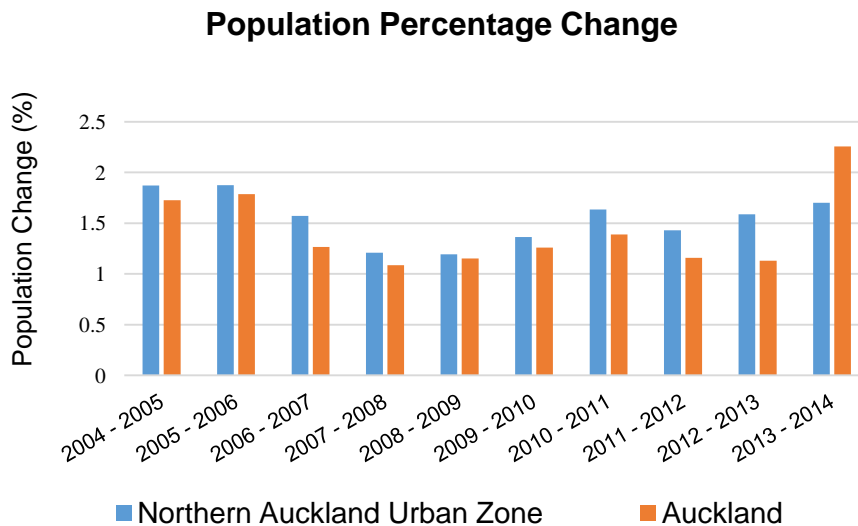


Figure 1: Population Percentage Change (Northern Auckland Urban Zone and Auckland Region)

4.1.2 Land value

Overall, those CAU's within close proximity to the Northern Busway Bus Stations have higher business land values than residential land values. Land values for both business and residential land use types are required before the implementation of the Northern Busway to accurately draw a conclusion from these results.

Residential Land Values

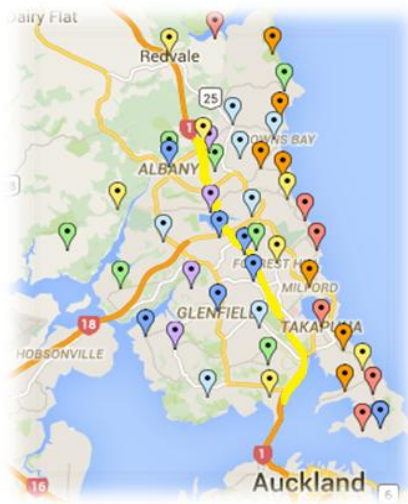


Figure 2: Residential Land Values Map

Business Land Values

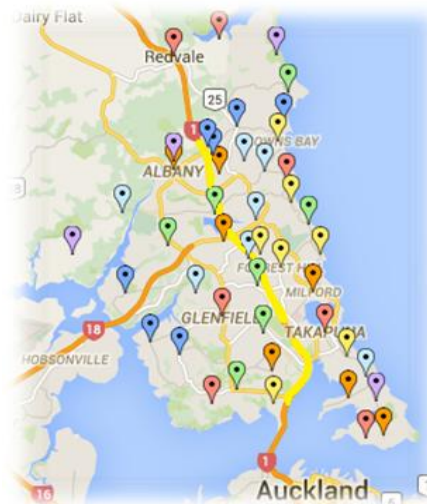


Figure 3: Business Land Values Map

Key:



Figure 4: Land Value Map Key

4.1.3 Employment

Both the number of employment and business units show an overall increasing trend from 2000 until 2014 in the Albany CAU. In 2008 there was a greater increase in both employment and businesses for this area corresponding with the official opening of the Northern Busway. The Northern Busway is therefore believed to have had agglomeration impacts in that it shortened travel times between the centres of employment and the labour force. The conclusion was drawn based on the traditional relationship between land use and transport. It was understood that the Northern Busway increased accessibility to the affected areas and thereby encouraged development. We acknowledge that other factors would also have an effect, such as other Business areas which may have led to specialisation and/or densification. To control for these additional factors, however, was a difficult task given the data constraints.

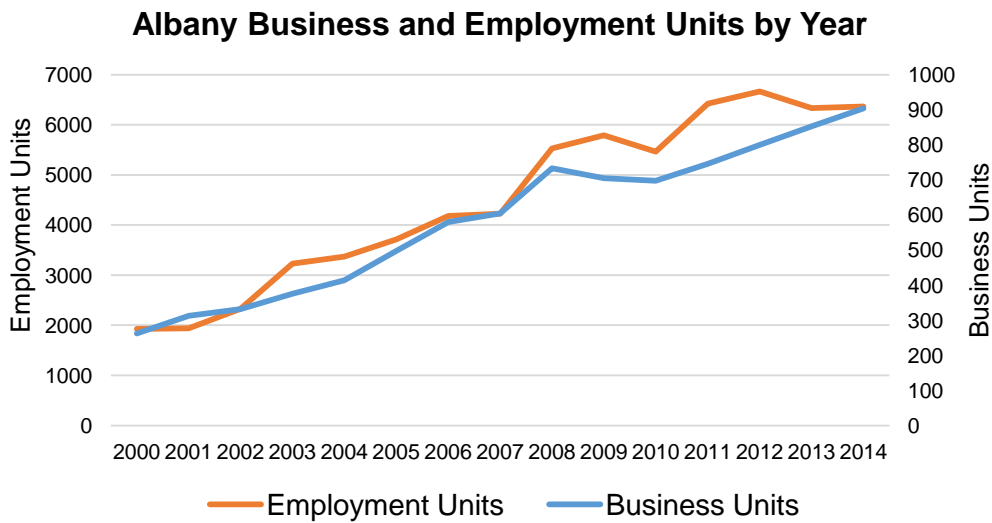


Figure 2: Albany Employment and Business Units by Year

4.2 Travel mode switch (car to bus)

4.2.1 Traffic Counts

Constellation Drive and Tristram Avenue are both high traffic volume roads on Auckland’s North Shore. A steep decrease in traffic volumes can be seen in the year 2008 for both of these roads in both the southbound and northbound directions corresponding directly with the opening of the Northern Busway. We acknowledge that other factors would also have had an effect, such as the increase in fuel prices due to the Global Financial Crisis to encourage public transport use. 2008 – 2009 sees an increase in traffic volumes for both roads in both directions when they plateau until 2014. The growth of traffic after 2009 is marginal and this may be attributed to the population growth.

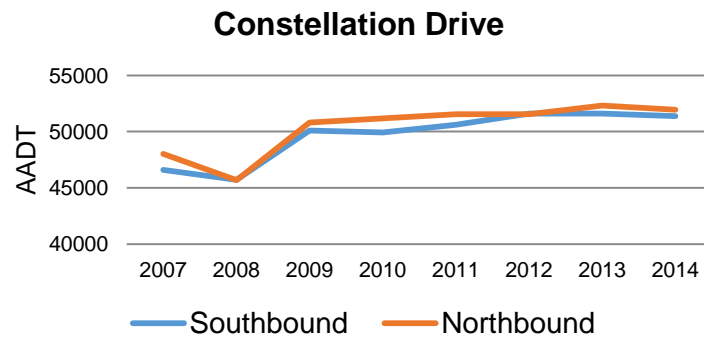


Figure 3: Constellation Drive AADT (Southbound and Northbound)

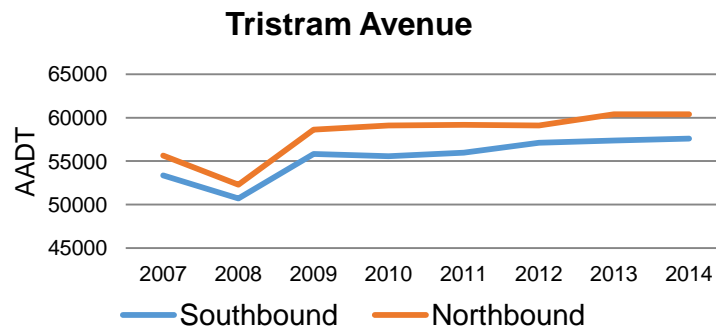


Figure 4: Tristram Avenue AADT (Southbound and Northbound)

Following the opening of the Northern Busway in 2008, AADT counts on SH1, north of the Harbour Bridge, showed a significant drop. With respect to the Harbour Bridge data, AADT counts shown only apply to the clip-ons. This is because traffic data for the central lanes cannot be accurately broken down into Northbound and Southbound traffic as lane directions can be altered. The graph below shows a steep decrease in traffic on the Northbound Clip-On of the Auckland Harbour Bridge, similar to the other roads of interest.

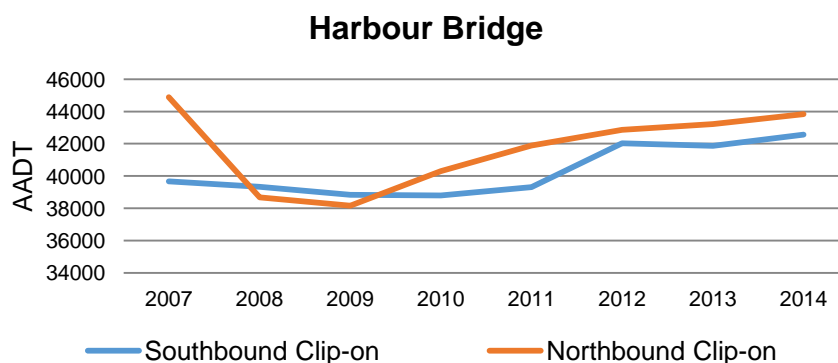


Figure 5: Harbour Bridge AADT

4.2.2 Bus patronage

The amount of people utilising the Northern Express Bus service has been increasing at a relatively constant rate ever since it began operation in late 2005. By looking at the ratio of change in patronage, we can see that when compared to other bus services, the amount of people using the Northern Express has been increasing at an impressive rate. In recent years however, patronage on both the Northern Express and other bus services have been increasing at very similar rates.

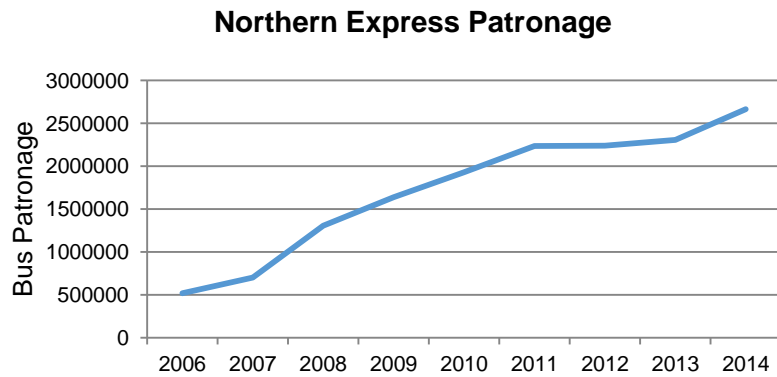


Figure 6: Northern Express Annual Bus Patronage

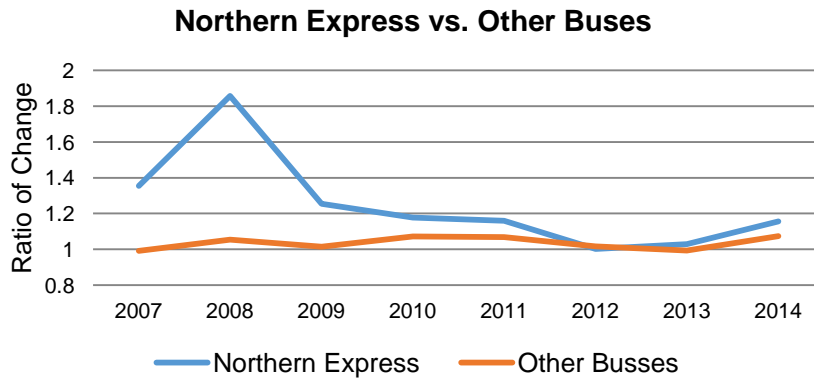


Figure 7: Bus Patronage Ratio of Change (Northern Express vs. Other Buses)

4.3 Multimodal integration (bike and bus)

Participants of the Northern Busway bike mode share survey indicated that the main reasons behind combining bike and public transport were that it was the fastest and most enjoyable travel mode while also incorporating fitness into their travel routine. Before the Northern Busway was implemented, the most popular mode of transport was Public Transport, with 44% of the survey participants using this travel mode. The provisions for bike at the stations in the Northern Busway facilitated the integration of biking and PT use. To keep the questionnaire short, the survey did not ask participants to elaborate on why they did not bike then use Public Transport before Northern Busway. Car was found to be the most popular travel mode for other activities such as social or recreational with 42% of participants choosing this. 33%, however used either car or bike for these activities.

Why Combine Bike and Public Transport?

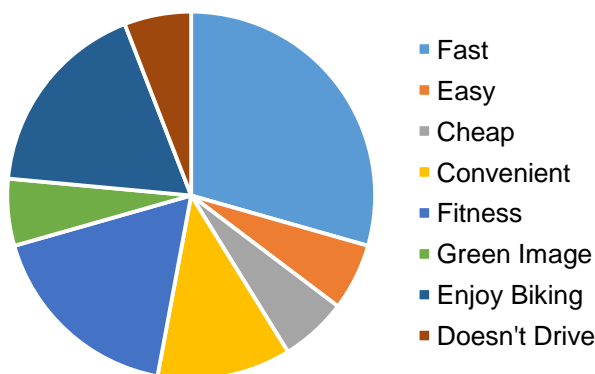


Figure 8: Bike Survey Results (Why Combine Bike and Public Transport)

Travel Mode Before The Northern Busway

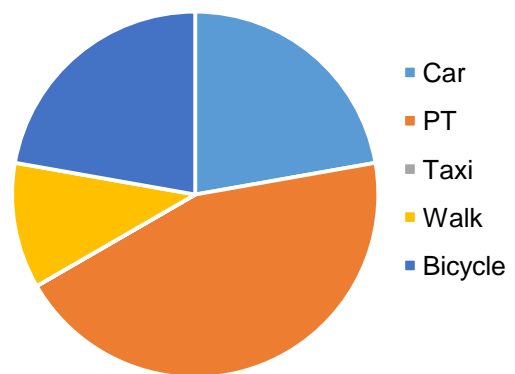


Figure 9: Bike Survey Results (Travel Mode before the Northern Busway)

Travel Mode For Other Activities

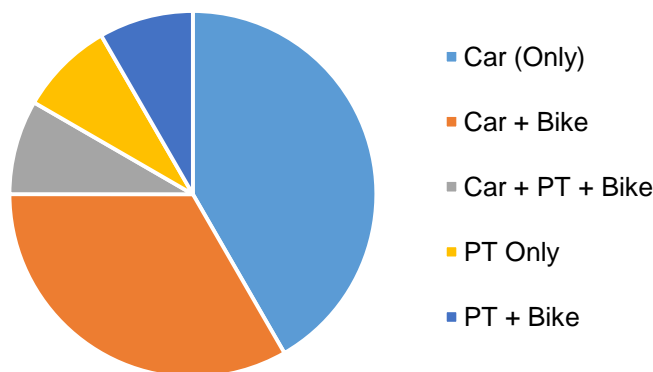


Figure 10: Bike Survey Results (Travel Mode for Other Activities)

4.3.1 Typical cyclist characteristics

- Busway Station: Smales Farm (38%) or Akoranga (35%)
- Destination: Auckland CBD (75%)
- Travel Purpose: Work (83%)
- Bike Journey Time: Under 20 minutes (75%)
- Time of Arrival: 6:30am – 8:00am (71%)

5.0 Discussion

The impact of the Northern Busway on the surrounding land use can be seen through the consistently growing population in the Northern Auckland Urban Zone. This population growth is also evident in the increase in traffic volumes from 2008 to 2009; while the bus patronage is consistently increasing since 2005, the increasing population is growing at a greater rate and therefore the excess population moves towards private vehicle, as the Northern Busway reaches capacity during the peak hours. Although the Northern Busway was provided as a more sustainable travel mode choice, it was also used to increase the overall transport capacity between the North Shore and Auckland CBD; a senior Auckland Transport official provided the detail that it was determined that the number of people moved by one lane of busway is equivalent to widening the motorway by 2 lanes. Through this research, it can be seen this has been achieved, while also having a positive effect in encouraging more people to live on Auckland's North Shore.

It is also evident that the impact of the Northern Busway was very sudden, as seen in the sharp increase in bus patronage following the implementation of the Northern Express in 2005, and the sharp decrease in AADT's in 2008. These impacts, however, both plateau from 2009 until 2014. Similarly, employment and business units in the Albany CAU show a greater increase in 2008 but again follow the original trend line from 2009 until 2014. This shows the greatest impact of the Northern Busway was in the short term. With petrol prices reaching a high of \$2.18 in July 2008 (Taylor 2008), this may have encouraged those habitual car users to transfer to bus for their daily commute, even if just for the rest of the year, while, occurring in 2007 – 2008, the Global Financial Crisis (GFC) may have also played a part in the plateauing of the land use and travel behaviour factors.

It can also be assumed other external factors such as natural growth, the economy and planned development may have also influenced the trends we can see from this research. These external influences, however, are very difficult to identify and by focussing on a wide range of factors over a large time period and over various area scales, it can be seen the Northern Busway has had some influence on both the surrounding land use and travel behaviour by increasing accessibility and transport capacity for the North Shore residents to the Auckland CBD.

6.0 Conclusions

Following the introduction of the Northern Busway, the surrounding land use has developed positively. This can be seen through the increasing population of the Northern Auckland Urban Zone at a greater rate than the rest of the Auckland region, the high business land values, and the increase in employment and businesses in the Albany business district. It

The travel behaviour of North Shore residents is unique with New Zealand's first Bus Rapid Transit. High volume local roads and State Highway 1 saw a sharp decrease in AADT's in 2008 following the opening of the Northern Busway, while the number of people using the Northern Express, the most frequent bus service along the Northern Busway, has shown a steady increase since its implementation in late 2005. Integration of bike and bus is also a popular travel choice since the opening of the Northern Busway, being a fast and enjoyable travel mode that incorporates fitness into the commuter's travel routine.

Overall it can be concluded the Northern Busway has had a positive effect on both land use by improving accessibility and encouraging development, and travel behaviour by increasing transport capacity between the North Shore and the Auckland CBD.

7.0 References

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