The prospects for improving public transport in Auckland

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Abstract

In many cities of the World, transport systems continue to focus on private vehicle travel, to the detriment of public transport use. This inclination towards providing for private vehicle travel then makes it difficult to effectively improve public transport systems. This thesis has sought to investigate this transport trend further, exploring the factors integral to public transport success. In working towards this, focus has been placed on addressing the public transport system itself by investigating the service provision elements of public transport. In working towards this, network planning was used to examine how the public transport system itself holds the key to its own success. By undertaking an in-depth analysis into the Auckland public transport network, it was shown that when applied, network planning has the potential to improve the existing public transport system.

Preface

Since 2008, over half the World's population were living in urban areas, with this figure only set to increase into the future (Population Reference Bureau, 2010). This continued increase in urban population makes it integral to provide a quality transport system to meet the needs of citizens. In most instances though, this transport system has been provided by focusing on road transport. As such, private vehicles have become the primary travel mode used by citizens (Ewing, 1997; Kokaz, 2001). Cities favouring private vehicles however, have resulted in segmented, decentralised and sprawling cities (Barton, 1992). This works to make private vehicle travel a necessity, with this occurring at the expense of public transport (Laird, Newman, Bachels, & Kenworthy, 2001). The inclination to favour private vehicle travel has made reversing this travel trend a formidable task for transport planners.

The poor performance of public transport in many World cities continues to be justified using the characteristics of a city. Common arguments validating public transport failure include 'the population is too spread out' (Huxley, 1995) or 'people prefer to travel using private vehicles' (Tertoolen, Van Kreveld, & Verstraten, 1998). These factors though are outside the control of the public transport system itself and require a long-term planning approach to change. This makes it expensive, time-consuming and difficult to change these factors to improve public transport. As a result, the poor performance of public transport continues to be tolerated in many cities that lack the necessary characteristics.

Auckland, New Zealand is a city that has provided a transport system focusing on road transport. As a direct result, this city of 1.3 million people (Statistics New Zealand, 2006a) is dominated by private vehicle travel. For instance, over eighty-seven percent of journeys to work are made using private vehicles. This is occurring to the detriment of public transport, which caters for only seven percent of all journey to work trips (Statistics New Zealand, 2006b). Auckland too validates the poor performance of public transport by using its city characteristics. As a result, this poor public transport performance continues to be tolerated.

This thesis seeks to practically address this dominant transport trend. As such, the principle aim of this thesis is:

- To investigate policy approaches which will improve the existing public transport system in Auckland.

The central idea behind this thesis is that the public transport system itself holds the key to its own success. This is regardless of the city characteristics present. In exploring this idea,

network planning – an approach focusing on the public transport system itself will be investigated. This investigation will focus on Auckland, asking the question as to whether network planning has the potential to improve public transport in the city.

To achieve this, the thesis has been organised into seven chapters. Chapter one introduces the need of successful urban public transport, working to uncover the key influencers to its success in a city. Chapter two reviews existing literature relating to the network planning approach, seeking to better understand network planning while discussing in detail the key elements needed for its success. Chapter three will set out the thesis methodology that will be adopted to achieve the aim, objective and research questions of this thesis. Chapter four will investigate the institutional history of Auckland's public transport network. Chapter five will investigate in detail the current state of Auckland's public transport system. Chapter six will discuss the findings of chapters four and five, while working to compare this against the findings of the literature and analysis. Chapter seven will make conclusions and key recommendations for the thesis.

Acknowledgements

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Furthermore, this project has been evaluated by peer review and judged to be low risk. As such, it has been granted approval for a low-risk ethics notification to undertake the required fieldwork.

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1. The need for public transport

1.1. Introduction

Efficient public transport systems are integral for improving the overall quality of a transport system in any city. Cities that focus on providing an efficient public transport system will in turn provide a better quality of life for its citizens. This chapter aims to explore the predominant transport system that exists in many cities, which focuses on private vehicle travel. To achieve the aim, private vehicle dominance will be examined, detailing the impact that this has had on transport systems in cities. The consequences of providing transport systems that focus on private vehicles will then be examined. This chapter also aims to discuss the key factors that influence public transport success. In working towards this, both long-term and short-term factors have been identified as influencing the success of public transport. Next, network planning will be introduced, working to set the scene for the remainder of the thesis.

1.2. Aim

The aim of this research is to investigate policy approaches which will improve the existing public transport system in Auckland.

1.3. The dominance of private vehicles in urban transport systems

Currently, over fifty percent of the World's population are living in urban areas with this figure predicted to increase to seventy percent by 2050 (Population Reference Bureau, 2010). This continual growth in urban population places heavy pressure on a city's transport system (United Nations, 2008). Compounding on this pressure is the dominance of private vehicle travel in many cities of the World (Ewing, 1997; Kokaz, 2001). For example, Australia's population increased fifty percent between 1976 and 1996. Private vehicle use though tripled during this same period (Laird, et al., 2001). This combination of increasing population and private vehicle demand traditionally results in the construction of new roads aimed at relieving the heavy pressure (Organisation for Economic Co-operation and Development, 1996). However, this increased capacity gained from road construction is refilled soon after its completion (Laird, et al., 2001). This means that capacity is never enough to meet private vehicle travel demands in urban areas (Goodwin, 1996; Noland, 2001; Standing advisory committee on trunk road assessment, 1994).

This private vehicle dominance was initiated with Henry Ford's introduction of the 'Model T' car in 1908, which worked to make car ownership an affordable and practical way to travel

(Mees, 2000, 2010; Wolf, 1996). This then made it possible to develop cities in any direction desired (Newman & Kenworthy, 1999). The result of this new trend however was for cities to decentralise, densities to decrease and for land-use to become segmented (Barton, 1992). This then worked to make private vehicles a necessity of life as public transport could no longer provide the transportation linkages necessary in this new environment (Newman, 1996). Consequently, public transport patronage dropped, with this being replaced with increases in private vehicle use (Economic and Social Commission for Asia, 1993; Kenworthy, Barter, Newman, & Poboon, 1994; Laird, et al., 2001). Poor public transport patronage levels in turn meant that public transport had now become unprofitable. In response to this, many authorities either reduced or removed public transport services. Britain is one example of this, where both bus and rail services experienced service cuts (Pooley, Turnbull, & Adams, 2005).

1.4. The consequences of current urban transport systems

Peaking at the 1992 Rio Earth Summit, the consequences of private vehicle travel was now clear and well recognised (Whitelegg, 1993). For decades, private vehicles had been shaping the development and land use patterns of cities (Low & Gleeson, 2003). Many cities no longer retained their once compact, mixed-use and pedestrian focused centres. Instead, cities were faced with decentralised, segmented and automobile focused development (Barton, 1992). Such significant changes however did not occur without consequences.

1.1.1. Economic Consequences

The maintenance of private vehicle travel requires the development of an extensive roading network (Pooley, et al., 2005). Providing such a network however is expensive and places extreme financial pressures on authorities. For example, the provision of an extensive roading network in the United States requires more than fifty-eight percent of all transport funding to be committed just to its maintenance. After a further thirty-three percent is committed to the construction of new roads, under two percent of transport funds are being used to improve public transport (Smart Growth America, 2011). The congestion of private vehicles also imposes economic costs onto cities (Banister & Button, 1993; Carlson, Wormser, & Ulberg, 1995; Pooley, et al., 2005). For example, congestion in Australia during 2006 cost the country $93 billion in lost business, leisure time, pollution and vehicle operating costs (Australian Government, 2007). These congestion costs though can be significantly reduced through the improvement of public transport.

1.1.2. Social consequences

Transport systems focusing on private vehicle travel are a major cause of road accidents (Banister & Button, 1993; Mees, 2000). Every year, 1.2 million people die in road accidents throughout the World (Peden, et al., 2004). Such accidents however would be avoidable if an alternative transport system to the private vehicle could be provided. Furthermore, infrastructural developments that provide for private vehicles physically divide communities, creating social fragmentation (Banister & Button, 1993; Carlson, et al., 1995; Mees, 2000; Wolf, 1996). This in turn creates inequitable cities. This is because individuals without access to a private vehicle will be limited in their ability to travel around the city

1.1.3. Environmental consequences

The increasing use of private vehicles impacts on both the local and global environment. At the local scale, private vehicles consume energy, pollute air and use valuable resources (Banister, 1998; Banister & Button, 1993; Carlson, et al., 1995; Mees, 2000, 2010; Pooley, et al., 2005). For example, road transport accounts for over eighty percent of transport energy consumption in OECD counties (Organisation for Economic Co-operation and Development, 2006). Additionally, United Kingdom road transport accounts for twenty-five percent of total carbon dioxide emissions (Department for Transport, 2003). Furthermore, nearly half of all land within urban areas is required for private vehicle related infrastructure (Carlson, et al., 1995). This impacts on people's wellbeing while also contributing towards urban smog and acid rain. At the global level, increasing carbon dioxide emissions from private vehicle usage is contributing towards global warming (Banister, 1998; Banister & Button, 1993; Carlson, et al., 1995; Mees, 2000, 2010; Pooley, et al., 2005). Over the last thirty years, carbon dioxide emissions from road transport have grown 95% within the United States and 156% within Europe (Organisation for Economic Co-operation and Development, 2006). Such increases in greenhouse gases however have been to the detriment the global environment.

1.2. Addressing the consequences with public transport

Sustainable transport systems have the potential to address the negative consequences of private vehicle travel in urban areas. Truly sustainable transport systems will focus on walking and cycling as these modes produce no harmful consequences (Mees, 2000). Walking and cycling alone however are not realistic travel options to fulfil all travel needs. The reason for this is that people want to travel quickly and for longer distances. Additionally, not all people are able-bodied enough to travel using only these modes. This makes it necessary to provide an alternative travel option to fulfil these needs. Within a sustainable city, this alternative travel option will be the provision of public transport. Public transport will in turn provide a

better urban environment as it produces far fewer consequences than private vehicles (Mees, 2000, 2010).

1.3. Long-term factors for the improvement of public transport

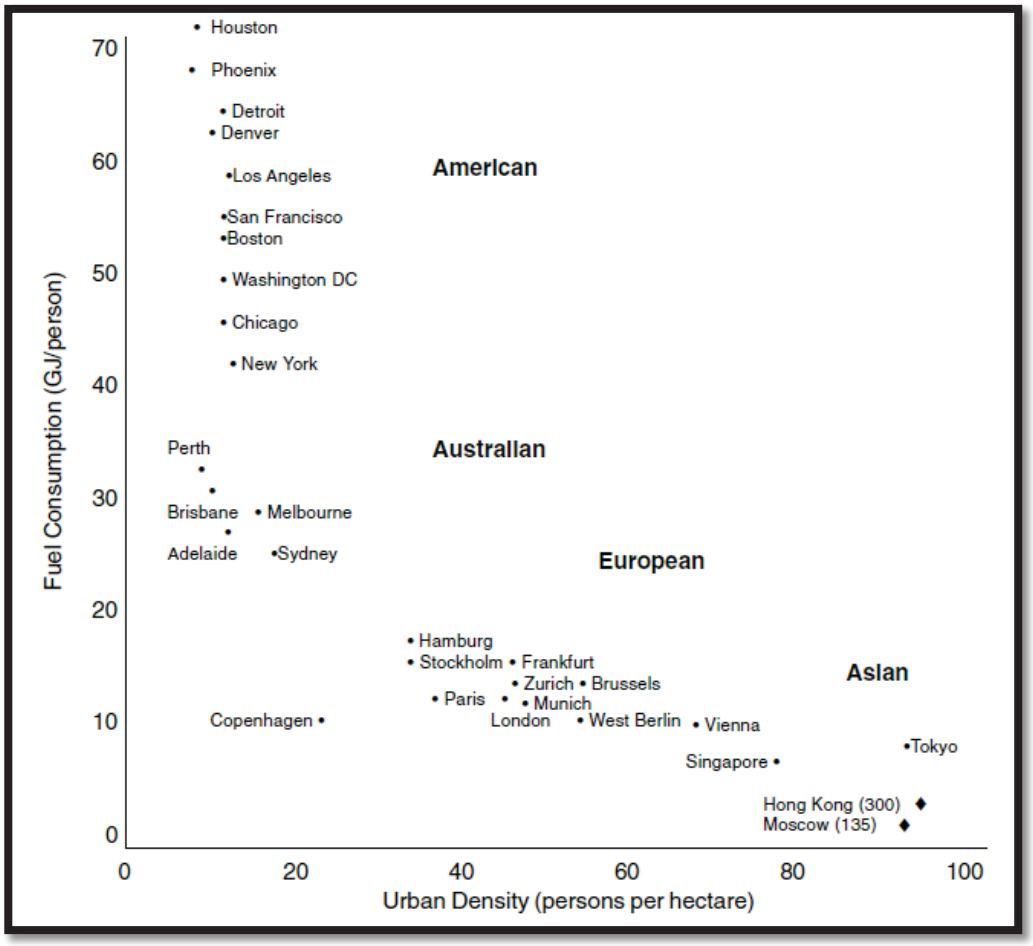
The characteristics of a city have often been used to validate the success or failure of public transport systems. These characteristics include the urban composition of a city, its social-economic situation, psychological status and political influences. Each of these factors has an influence on the success of public transport in a city. Consequently, methods do need to be developed to overcome the barriers that each of these factors can potentially impose. However, it needs to be recognised that these factors do not solely determine the success or failure of a public transport system operating in a city. Therefore, present discourses need to be overcome so that they do not continue to hinder efforts made to improve public transport.

1.3.1. Urban composition

Urban composition focuses on the features that make up a city and how this influences public transport. Originating through terms like 'compact city' (see Chicago Area Transportation Study, 1959, 1960, 1962) and 'new urbanism' (see Chesterton, 1929), these features incorporate a city's urban design, structure and form, land-use patterns and population density.

Influential authors Newman & Kenworthy (1989) strongly proposed that if a city is more compact in form, densely populated, in addition to having mixed land-use patterns, then it is more likely to experience successful public transport. Evidence of this can be seen in cities like Hong Kong or Tokyo, Japan. For instance, Hong Kong has a population density of 6,480 persons per square kilometre (Hong Kong Government, 2009). Tokyo also has a high population density of 5,751 persons per square kilometre (Ministry of Internal Affairs and Communications, 2010). Consequently, public transport use in the two cities is high, with over thirty percent of all trips made being done using public transport (Australian Bureau of Statistics, 2009). On the other hand, cities that have low population densities in urban areas will consequently experience low public transport use. This includes cities within the United States, Australia and New Zealand for example (Laird, et al., 2001). This relationship between urban composition and private vehicle use is portrayed through figure 1.1. In the figure, urban density is compared against fuel consumption. As high levels of fuel consumption are associated with high private vehicle usage, it is clear from the figure that a strong relationship does exist between high private vehicle use and low urban density.

Figure 1.1: Urban density as correlated against fuel consumption



Source: (Newman & Kenworthy, 1989).

Figure 1.1 suggests that if a city is to be redesigned with population densities increasing, then public transport will be more successful as a result. Most literature (see for example Cevero, 2002; Dieleman & wegener, 2004; Frank & Pivo, 1994) works to support this finding. For instance, Huxley (1995) concluded that outward and dispersed developments "appear to rule out the comprehensive public transport provided by densely patronised systems like the Paris metro" (Huxley, 1995, p. 1). The key point such literature is making, is that once cities lose their compact form and density in favour of outward and dispersed developments such as new low-density suburbs, then public transport can no longer be successful. This then makes private vehicles a necessity of life. The United States and Australia provide an excellent example of this concept. In these countries, there is a strong suburban culture present in addition to businesses relocating outside of town centres onto larger outlying land blocks. The result of this is for public transport patronage to drop (Banister, 1998; Carlson, et al., 1995). This is in contrast to most European cities, which can be up to three times denser, and as such

experience higher patronage levels on their public transport systems (Dieleman & wegener, 2004; Kenworthy, et al., 1999; Stretton, 1996).

Although literature on urban composition is highly one-sided, the concept that a city's urban composition contributes to successful public transportation has not gone unchallenged. Both Bagley & Mokhtarian (2002) and Cao, et al., (2007) argued that while there is an association between urban composition and public transport success, there has been no evidence from research to show that urban composition independently influences travel behaviour – and therefore public transport success. Instead, the key idea here is that the success of public transport is the result of the transportation systems provided and not a direct result of the urban composition present; "land-use configurations must, to a great extent, conform to the nature of the transportation systems that serve them" (T. Stone, 1971, p. 45). In other words, in cities where private vehicle travel dominates, urban form and land-use patterns are going to change to reflect this in the same way cities in the past developed around rail, tram and bus systems.

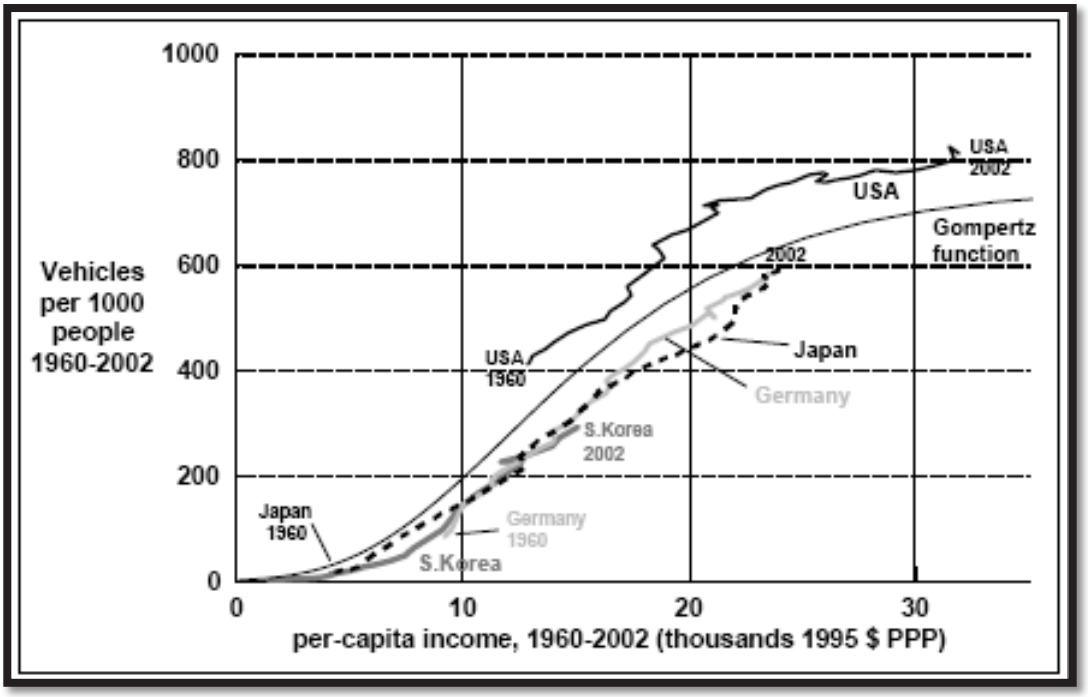
When focusing on population densities, there is literature that works to unravel common perceptions, showing that low density cities can have public transport success. For example, Breheny (1996) demonstrated that attempts made to change the urban composition of Paris during World War Two through a series of high-rise housing estates to be unsuccessful. The area has now gained a reputation for its poor quality public transport and high private vehicle usage. This shows that population densities are not necessarily the determining factor in public transport success. Additionally, Mees (2000) showed that in most Italian cities (which epitomise the urban composition ideals), public transport patronage is dropping. These cities are experiencing rising private vehicle use and unsuccessful public transport. Later, Mees (2010) used Sternenberg (a rural suburb of Zurich, Switzerland) to show that even when the urban composition ideals are not present, a city can still experience an integrated and well-networked public transport system that people will choose to use. The fundamental idea behind this opposing literature is that urban composition elements do not necessarily dictate the success of public transport.

1.3.2. Social-economic matters

Income levels are said to influence public transport success, with lower incomes corresponding with higher public transport usage. The key idea behind this argument is that lower income groups cannot gain access to private vehicles. Therefore, they are forced into using public transport. Dargay, et al., (2007) correlated a graph to prove this trend. Figure 1.2 correlates

income levels for Japan, Germany, South Korea and the United States against vehicle ownership over time. It can be seen from the figure that a positive correlation exists between the two variables. Most literature (see for instance Cheek, 2008; Dargay & Gately, 1999; Jara-Diaz & Videla, 1989) works to make this same conclusion.

Figure 1.2: Vehicle ownership and per-capita income for Japan, Germany, South Korea and the United States from 1960-2002



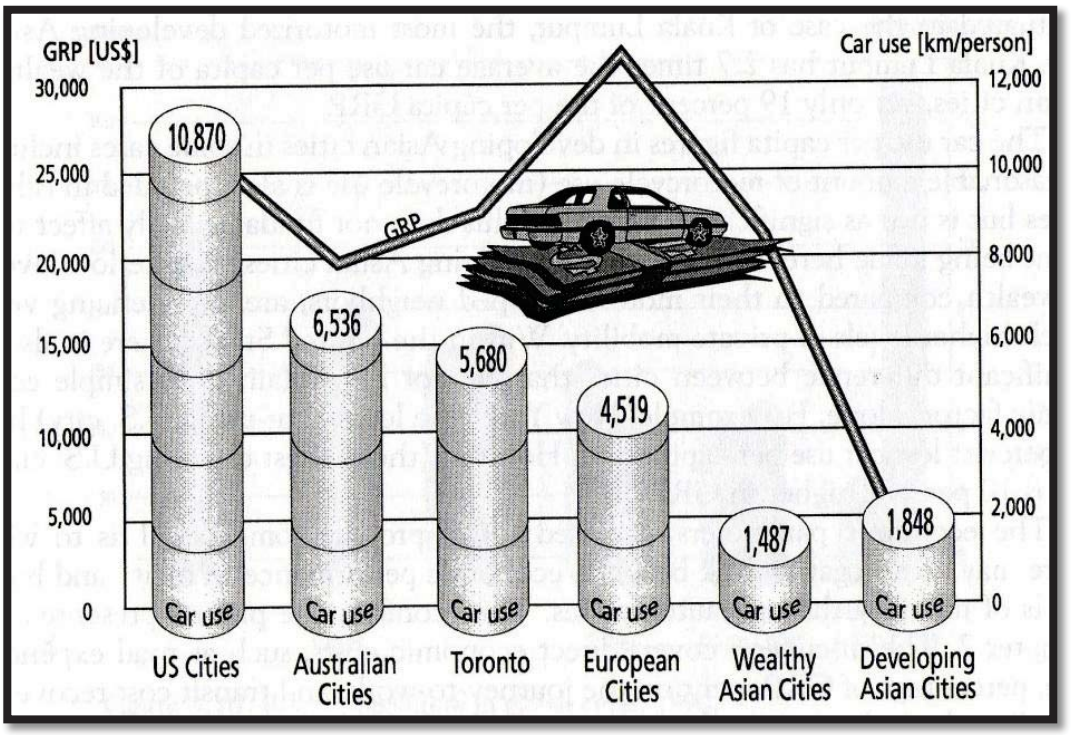
Source: (Dargay, et al., 2007).

When examining why this trend is present, both Carlson, et al., (1995), and Murakami & Young (1997) concluded that it was because when people have higher incomes, a lower proportion of total income is needed to cover necessities. Therefore, they can afford to drive and generally will. When focusing on the rising incomes of some developing countries, the same trends were also observed (Dargay, et al., 2007; Mees, 2000). In these countries, public transport is becoming less successful as incomes are rising. As a result, countries like China, India, Brazil and Mexico are expected to experience substantial increases in private vehicle numbers; "By 2030, the six countries with the largest number of vehicles will be China, USA, India, Japan, Brazil, and Mexico" (Dargay, et al., 2007, p. 19).

Although the relationship between public transport success and income levels is a widely accepted concept, it does face some opposition. Newman and Kenworthy (in 1989) sought to correlate wealth against private vehicle use. In this world study, it was found that social-

economic factors did not account for variations seen in public transport use between cities. This finding is portrayed through the figure 1.3 which shows city incomes correlated against private vehicle use. In the figure, American, Canadian and Australian cities showed to have high private vehicle use. On the other hand, wealthier European and Asian cities had comparably lower private vehicle use (Newman & Kenworthy, 1989). In essence, no obvious trend was found to exist between the data.

Figure 1.3: Income correlated against private vehicle use



Source: (Newman & Kenworthy, 1989).

Later, Mees (2000) concluded that although a relationship does exist at times, there is evidence that the quality of public transport has more of an influence over private vehicle ownership and use. For example, Zurich, Switzerland is one of the richest cities in the World, yet it also has one of the lowest car ownership levels in the developed world; "Zurich has achieved an enviable reputation for providing high quality public transport that an affluent population actually chooses to use" (Mees, 2000, p. 121). Additionally, in Sydney, Australia, people with higher incomes are choosing to locate where quality public transport is provided. The result of this has been declining private vehicle ownership levels and increased patronage on public transport (Mees, 2000).

When focusing on the locational element of social-economic matters, Srinivasan & Rogers (2005) found the same locational observation to be present in Chennai, India as is being seen in Sydney. Here, higher income groups are also choosing to locate in the central city where the best quality public transport is provided. In contrast to the locational finding of Sydney and Chennai, the research of both Murakami & Young (1997), and Dieleman & Wegener (2004) concluded that low income groups will locate in city centres where the best public transport is provided. On the other hand, high income groups will locate in suburbs on the city's periphery. As a result, high income groups need to use a private vehicle whereas low income groups can rely on public transport, walking and cycling to meet their mobility needs. These findings suggest that there is no definitive relationship between the locations of different income groups and public transport. As such, this locational factor will vary from city to city and should not be relied on in planning for public transport.

1.3.3. Psychological factors

Psychological factors play a role in public transport success. From literature, three distinct psychological factors have emerged, offering explanations for why people may choose to use particular transport modes. These are *attitudinal factors*, *public transport perceptions* and *public transport experiences*.

Attitudinal factors focus on how individuals approach situations and view the World. The key idea here is how a person's values will influence the decisions they make. Vugt, et al., (2006) determined that individuals make decisions in two distinct ways. Firstly, the private vehicle versus public transport decision can be interpreted as a "choice between the pursuit of a person's own immediate outcomes (i.e., personal convenience) versus a concern with the collective well-being in the long run (i.e., our environment)" (Vugt, et al., 2006, p. 260). Depending on where a person's attitudes towards these issues are will directly determine the decision they will make. Secondly, the car versus public transport debate can be interpreted as a situation where individuals think of their short-term consequences. Here, people are more likely to consider factors such as travel time, ride continuity and accessibility when making their decisions. Decisions made here do not focus on long-term societal consequences but instead the immediate costs and benefits for an individual (Liebrand, 1983, 1986).

Public transport perceptions focus on individual attitudes towards different travel modes. Here, feelings of sensation, power, freedom, status and superiority that the different transport modes offer are expected to influence travel choice. Private vehicles are considered to positively correlate with these feelings whereas public transport does not. This is often

considered to be a key reason why people choose to use private vehicles instead of public transport (Steg, 2005; Steg, Vlek, & Slotegraaf, 2001; Tertoolen, et al., 1998).

Public transport experiences consider personal experience as being a significant element of mode choice. Here, if viable public transport is not available or if customers have negative experiences, then these users will choose to use private vehicles (Schiefelbusch & Dienel, 2009). As public transport is usually publically provided and experiences no competition, "the incentive for the provider to orientate its services to the user's needs is missing. The only 'exit' is to choose another mode" (Schiefelbusch & Dienel, 2009, p. 6). This choice has been demonstrated by reduced passenger numbers and increased private vehicle use. This not only places the users of public transport at a real disadvantage but also the public transport service itself, as customers who have negative experiences are likely to stop using public transport altogether. Each of these three psychological factors has the potential to influence public transport use. As a result, they do need to be considered when planning for public transport. The reason for this is so that strategies can be developed that can work towards overcoming these psychological barriers.

1.3.4. Political influencers

Political policies have the potential to directly influence the success of public transport. For this reason, transport systems play a significant role during election campaigns when trying to gain voters. For example, Mayor Samuel Moreno in Bogota, Colombia actively pursued improvements to public transport during his campaign. This won him the campaign where work is now being undertaken to integrate the existing bus system with the Transmilnio, and for construction of a Metro to start in 2011 (Alvarez, 2010). Furthermore, Mayor Len Brown from Auckland, New Zealand also pursued public transport improvements during his campaign. This promise for a change in political direction won him the campaign. Among the plans to improve public transport are preparations to implement integrated ticketing, electric trains and the construction of a Central Business District rail link (Auckland Council, 2011).

For such campaigns to be successful however, policies implemented then need to focus on promoting public transport patronage while discouraging private vehicle use. Policies that can contribute towards this have been well researched (see Ferguson, 1998; Litman, 2003; Louw, Maat, & Mathers, 1998; M. Meyer, 1999), with these policies normally being categorised onto pricing or non-pricing policies. Such policies work to address parking protocols, car technologies, ridesharing and carpooling, along with additional charges and penalties for private vehicle use.

Originating with the Smeed Committee's (1964) report to the United Kingdom Department of Transport, pricing mechanisms were expected to better allocate scarce roading resources (Roth, 1966). One pricing mechanism, the congestion charge zone has showed to be a successful political policy as seen in London (Homme & Bocarejo, 2005; Jansson, 2008; Mohammad, Bell, Schmocker, & Fonzone, 2007). These researchers showed the 21km² zone in central London (which charges £5 to enter) to improve public transport patronage while also reducing private vehicle travel. The effect of implementing this approach in 2003 was dramatic. Traffic congestion dropped thirty percent in central London with average traffic speeds increasing from 4km/h to 13-17km/h. In addition, the number of private vehicles entering the congestion charge zone fell by 150,000 vehicles a day, of which 50-70% of the passengers moved onto public transportation (Mohammad, et al., 2007; Transport for London, 2003).

Another pricing policy, the Area Licensing Scheme (first introduced in Singapore in 1975) requires private vehicle users to purchase a special licence that must be displayed on car windscreens before driving a private vehicle. This policy was introduced with accompanying schemes such as central city parking charges, high taxes on motor vehicle ownership, along with the improvement of public transport. These policies introduced by the Singapore Government worked to reduce traffic levels and promote public transport use (Clarke & Wong, 1998; Mees, 2000, 2010; Stretton, 1994). However, despite these policies, car ownership levels are increasing each year along with the number of kilometres travelled (Clarke & Wong, 1998). Furthermore, the poor are being priced out of vehicles through this policy as only the wealthy can afford to drive private vehicles (Mees, 2000, 2010; Stretton, 1994).

A non-pricing policy applied to Vancouver has worked to shift people from private vehicles to public transport. As part of their Livable Region Strategic Plan, the Greater Vancouver Regional District stated:

> "Congestion is usually considered an evil; however, allowing congestion to deteriorate for single-occupant vehicles is a practical method of promoting transit and carpools…For instance, buses/carpools in HOV [high occupancy vehicle] lanes will gain an edge since the relative time saved by escaping lineups will be greater" (Greater Vancouver Regional District, 1993, p. 26).

As a result of this policy, average journey to work trip time decreased from 70 minutes in 1992 to 67 minutes in 2005. At first glance, a 3 minute trip time decrease over the span of 13 years

would be considered a negligible result. However, when it is considered that in the rest of the World, trip times have largely deteriorated during this same time, this policy has shown to be effective (Mees, 2010). This shows the importance of implementing a range of policies aimed at reducing private vehicle use while also promoting public transport usage.

Addressing the long-term factors of public transport

Each of the four factors discussed, urban composition, social-economic matters, psychological factors and political influencers play a role in the success of public transport on some level. They do not however solely determine public transport success. Addressing any of these factors though is not easy as they cannot be readily changed. This makes any necessary changes time consuming and expensive, which will require a long-term planning approach to address. Additionally, transport planners will have limited or no control over these factors. Therefore, their focus needs to be on the public transport system itself. Changes to the public transport system can be achieved in the short-term at a lower financial cost. This means that transport planners have the ability to directly improve the public transport system so that it can become integrated, well networked, user friendly and accessible. When such a quality public transport system is in place, this in turn has the potential to create the urban composition and political elements needed to improve public transport. This will also work towards overcoming in time the psychological and social-economic barriers to successful public transport.

1.4. Short-term factors for improvement of public transport

Addressing public transport services can be achieved in the short-term at relatively little cost. Changes to service provision elements will have an immediate impact on the quality of the public transport system offered. Therefore, addressing the service itself will have the potential to improve public transport. With regards to service provision, there are a number of different elements that need consideration.

Reliability

The reliability of public transport refers to how dependable the services offered are for the users of the system. Originating with the work of Welding (1957), reliability of public transport has focused on maintaining and calculating realistic timetabling. The key concept behind this focus is that a five minute delay can make a passenger late or miss a transfer. Reliability is particularly emphasised in travel and arrival times, with research (see Howes & Rye, 2005;

Turnquist, 1980) maintaining that this factor will significantly influence whether or not people will use public transport services:

> "When making a trip, a traveller expects a certain travel time, based on his knowledge of the route and on past experience. Slight variations in actual travel time are natural to the system and completely acceptable to users of the system. The system is considered to be reliable if expected and actually experienced travel times closely agree. If a traveller frequently faces unexpected delays, the system is regarded as unreliable" (Giaoutzi & Nijkamp, 2008, p. 38).

If public transport does not meet minimum reliability expectations, then passengers will perceive the service as unreliable. Once the service is considered unreliable, passengers will start to use alternative travel modes where possible.

Frequency

Frequency of public transport refers to how often a public transport unit travels along a particular path. Frequency research focuses on the designing of optimal frequency intervals using mathematical models, with this originating with the work of Szpigel (1973). By adopting these models in public transport planning, frequency is determined by patronage levels. As a result, if public transport patronage falls, then frequency levels will be reduced and if patronage increases, then services will be increased. This approach creates a demand responsive system which will typically see the off peak times like evenings or weekends experience irregular, infrequent or no services at all because of low demand. When such a service is provided though, people will choose not to use public transport where possible. In the later study of Howes & Rye (2005) it was determined that optimal frequency levels for public transport needs to be at ten minutely intervals during the daytime. Furthermore, regular services need to be offered at all times and not just restricted to peak periods. This is because the frequency of services offered impacts on people's decisions when choosing a mode to travel by (Zhou & Zhong, 2007).

Accessibility

Accessibility refers to the ease at which public transport can be used by passengers. Starting with the work of Vuchic (1966), accessibility research has focused on the location and separation distance of bus stops. Through the influential work of Byrne & Vuchic (in 1972), the

focus of these formulations has been on calculating an acceptable balance in travel time. This balance focuses on the fact that bus travel time decreases as stops are separated further apart. However, the distance travelled on foot will increase as bus stops are further separated. In later studies, Nielson (2005) and Mees (2010) stated that ideal stop separation will be no more than 800 metres. This is because the upmost distance that people are willing to walk to access a bus stop is 400 meters. When bus stops are poorly located, public transport trips will be frustrating for users. This will discourage the use of public transport (Smart, Miller, & Taylor, 2009). Accessibility though involves more than bus stop location. Accessibility needs to focus on the connectivity of the public transport network as a whole and include factors such as service coverage, travel time, connectivity, and the transfer quality of interchange points (Brons, Givoni, & Reitveld, 2009).

Fare structures

Fare structures refer to the manner in which passengers are charged to use public transport services. Through the influential work on pricing strategies for public transport markets by Mohring (1972), mathematical formulations have commonly been used to try and determine the best fare strategies to be applied to public transport. Applying ideal fare strategies is important as fare prices are usually the first point of unrest and dissatisfaction among passengers. Therefore, they must be affordable and reflect the quality of the service being offered (Mees, 2000). With regards to fare structures, there are two types that are most commonly implemented. First are flat fares, which involve passengers paying the same price for a public transport ticket regardless of distance travelled. Second are zonal fares where passengers pay for the distance they travel (Leutze & Ugolik, 1979; Rock, 1975).

Transferring

Transferring in public transport is the need to shift from one public transport line to another in order to reach an end destination. The focus of transferring research has been on the need to avoid the necessity of transfers in a public transport network. For instance, Horowitz & Zlosel (1981) consider that the necessity to change bus services produces a large penalty for public transport systems. This is because transfers are considered a negative element of public transport travel; “riders may perceive it to be more acceptable to take modified routes that eliminate transfers, even if initial waits and riding consume more time” (Horowitz & Zlosel, 1981, p. 282). As a direct result of this thinking, many public transport systems around the World have been designed to accommodate for this. Both Lo, Tip, & Wan (2003) and Guo &

Wilson (2011) however, emphasise the importance of transfers, particularly in the utilisation of timed-transfers. For instance, in Hong Kong, travellers often need to transfer three or four times to reach their end destination (Lo, et al., 2003). Furthermore, 70% of all Munich and 40% of all Paris public transport trips will require at least one transfer to reach an end destination (Guo & Wilson, 2011). Therefore, when transfers are necessary, how they are timed and structured will play the greatest role in their success.

Information technologies

Information technologies are the utilisation and development of computer-based systems used to improve the ease of use and efficiency of a public transport system. There are a number of information technologies that can work to improve public transport service provision by making travel simpler and easier for users. Moore & Guiliano (1998) look at Smart Cards and Radio Frequency Cards and how they have impacted on public transport development. Dessouky, Hall, Zhang, & Singh (2003) consider global positioning systems, wireless communications and passenger sensors as being integral, as these technologies can potentially control and coordinate vehicle movements. Eriksson, Friman, & Norman (2007) focused on the importance of website design. Websites are considered a common source of travel information where passengers can view travel-related information to plan their trips with. Sollohub & Tharanathan (2006) emphasised the importance of printed schedules. Their research concluded that this is particularly important for users who are on lower incomes and do not have access to digital materials. Originating with Forsyth & Silcock (1985), real time information was studied, focusing on how this can reduce passenger uncertainties about travel times. The combination of all these information technologies is important in the design of successful public transport systems.

Comfort

Comfort of public transport refers to the levels of amenities offered both on a journey and at stop and interchange points, which work to make the experience more pleasant. Although very little research has been done on the comfort of public transport, it is an important factor in public transport usage. To summarise, Stone (1971) provides an excellent analysis of people's comfort expectations for public transport services. He identified that people expect different service levels based on trip time. For instance, on a two hour high-speed train trip, people would expect "bars, lounges, restrooms, reading lights, enroute meals…for our low-speed transit devices we need ask for little more than shelter from the weather, temperature control, smooth and silent operation, and reasonable seating accommodations due to the short travel-

times involved" (T. Stone, 1971, p. 103). Therefore, comfort needs to be considered and designed to reflect the level and length of service offered.

Security

Security of public transport refers to the level of safety both experienced and perceived by passengers using the services. The safety and security of public transport will impact on patronage levels. Early research conducted by Mellon University found that passenger perceptions of crime directly impact on their daily ridership patterns. In fact, factors such as the unfamiliarity of environments, along with the fear of being a crime victim will directly influence public transport use (Pearlstein & Wachs, 1982). In a later study focusing on rail users in Britain, these points were reiterated. This study found that negative perceptions of passengers toward crime levels resulted in reduced patronage levels. The findings of the study focused on design elements and how traditional designs with impaired visibility led to feelings of fear and insecurity. In addition, the negative portrayal of stations as being unsafe places by media also influenced user decisions to use public transport (Cozens, Neale, Hillier, & Whitaker, 2004). For people to choose to use public transport, they must first feel it safe to do so.

Marketing

Marketing refers to the promotion and advertisement of public transport services to its users. The marketing of public transport services is an important yet underemphasised element of public transport service provision. By marketing services, an identity or brand can be established that will help sell and best portray public transport. This type of marketing can be traced back to the 1910-20's in London where the bus and rail systems established a 'transit identity' centred on the novelty of new technological innovations of mechanised transport. This included posters to convey this message using carefully designed lettering (Vanier & Wotruba, 1976). The marketing of public transport became popular from the 1970's through an increased awareness of the environmental consequences of private vehicle use (Vanier & Wotruba, 1976). This need for change focused on conserving resources and protecting the environment. Today, Cronin & Hightower (2004) see marketing as being most influential when improvements have just been made to the public transport service. However, marketing should also be adopted to create awareness of bus services, to improve the image of public transportation, to eliminate any misconceptions, and to advise passengers of any changes or special promotions (Morris, Ison, & Enoch, 2005).

Line structures

Line structures are the routes that public transport systems travel along. Most research (for instance Lampkin & Saalmans, 1967) has focused on network design problems, which centres on the development of public transport routes and schedules. From such research, public transport line structures have been designed with peak period commuters in mind. As a result, this has developed public transport lines that move from outer suburbs into the central city (G. Thompson, 1977). This in turn creates a radial public transport pattern, which is the predominant form of public transport line structures present today. Originating with Holroyd (1965), an opposing line structure to the traditional one has been proposed. This line structure, which was generated with optimal route design in mind, involves creating a grid-type pattern of public transport lines. Under this design, trip origins and destinations are considered to be evenly distributed, with this design expected to better cater for more types of travel purposes than the traditional radial pattern does.

Addressing the short-term factors of public transport

Public transport planners have the capabilities to address each of the highlighted service provision factors. Changes to these factors will result in an immediate impact on the quality of the public transport service provided. This will in turn have a direct impact on public transport patronage levels. However, the type of changes that need to occur to these service provision elements is unclear. Little direction has been placed on how public transport service provision can be redesigned and developed on so that it can provide for an improved public transport system. Therefore, this is an area that needs further focus and research. This thesis seeks to focus on this research gap, working to show how changes in policies that address service provision elements can result in an improved public transport network.

1.4.1. Research question

How can public transport service provision be improved in Auckland?

1.5. Improving public transport service provision through network planning

Public transport service planning has traditionally provided networks that only cater for specific groups in society. This is often the peak period commuter, and in some cases the travel disadvantaged such as the poor, young or elderly (Hensher, 1994; Mees, 2000, 2010). As a direct consequence of this approach, public transport has not been successful in attracting users outside of these targeted groups. This is because other users require a more diverse and dynamic type of travel, which narrowly designed public transport networks cannot effectively

cater for. These other groups require a public transport system that can easily access all parts of the city, at all times (Beirão & Cabral, 2007; Hensher, 1994; Mees, 2000, 2010). Understanding this key dynamic is integral if public transport service provision is to be addressed in a way to improve the wider system.

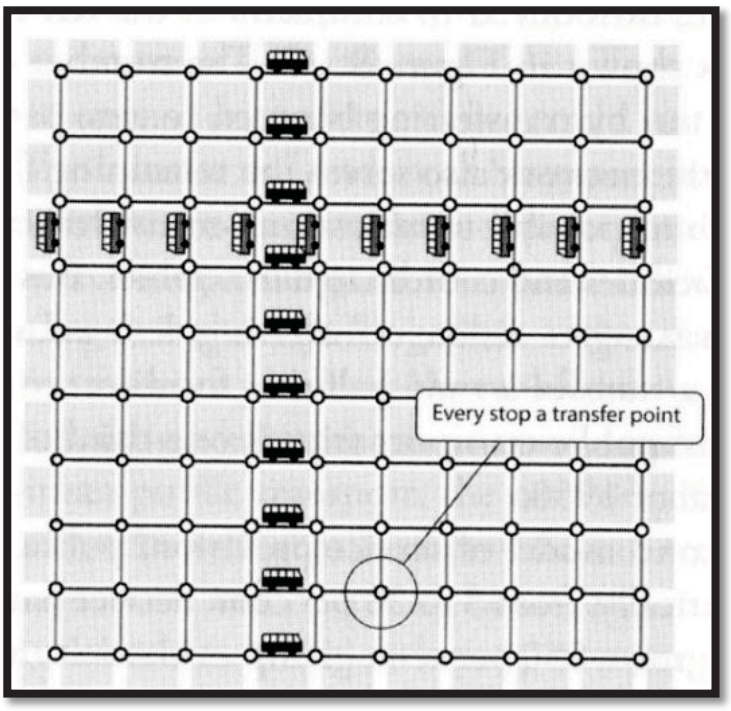
The result of traditional public transport approaches has been to create a network where public transport lines move from the suburbs into the central city, where the city is the final stop. Although travel patterns of users once followed this path, today, this is not the principal travel pattern that most cities are experiencing (Beirão & Cabral, 2007; Mees, 2000; J. Thompson, 1977). Instead, trips into the central city are declining. This is because trip origins and destinations have become less concentrated and are now more dispersed throughout the city (El-Hifnawi, 2002; Gregory & Matoff, 2003). For instance, most United States central city areas contain less than 10% of city jobs (Gregory & Matoff, 2003). Furthermore, in Toronto, Canada, over 70% of public transport trips do not cross the central city (Mees, 2000). What this is suggesting is that passengers want to move in cross-city patterns. Despite this growing trend, public transport systems are still focusing on passengers wanting to enter the central city area from the suburbs. Continuing to approach public transport in this way however will ensure its continued ineffectiveness in drawing passengers away from using their private vehicles.

One approach to public transport that focuses on service provision elements while also catering for today's changing travel patterns is the network planning approach. Although relatively little research has been conducted on this approach and its application (please refer to Mees, 1996, 2000, 2010; Mees, Stone, Imran, & Nielson, 2010; Nielson, 2005; J. Thompson, 1977), it is the approach that cities such as Zurich, Toronto and Vancouver who have successful public transport use. By using this approach, quality public transport that has previously only been found in dense urban areas is now being successfully extended into lower-density cities, suburbs and rural areas. In achieving this, the network approach is working to provide a viable alternative to the private vehicle. What this shows is that it is possible to improve public transport by addressing its service provision elements. Furthermore, this approach is also showing that public transport can be successful in a city regardless of the city characteristics present.

The primary concept behind the network planning approach is to be able to provide a public transport system that can cater for a 'go anywhere, anytime' type of passenger movement. In other words, to provide a public transport system that offers "high service levels for travel in

all directions" (Mees, 2000, p. 134). To better highlight the primary concept behind this approach, the example of 'Squaresville' will be used to explain its main features where a rectangular street pattern is present. 'Squaresville' uses a public transport network where routes run both north-south and east-west as shown in figure 1.4.

Figure 1.4: The network approach using 'Squaresville'



Source: Adapted from (Mees, 2000, p. 140; 2010, p. 149; Nielson, 2005, p. 86).

In the ideal 'squaresville', public transport stops are located 800 metres apart, making the maximum walking distance between stops 400 metres for passengers. Each two crossing lines represent a street intersection in real terms. Passengers choose their own travel path which can move from any point in the city grid to any other point within the city. The primary requirement for this approach to work is for passengers to transfer at least once between public transport lines in order to reach their final destination. An advantage of the network planning approach is that it eliminates the need to plan and predict where passengers want to travel, as the comprehensive grid network caters for all travel purposes. In fact, with the network approach, the more complex and diverse travel needs are, the more successful public transport will be (Mees, 2000, 2010; Mees, Stone, Imran, & Nielson, 2009). 'Squaresville' however is not restricted to a square city, with these principles being able to be modified to fit most street patterns.

Although network planning is a relatively new concept, a similar approach has been adopted in other fields. For instance, Mees (2000, 2010) refers to the airline industry as operating a network planning approach. Using the United States as an example, he shows how airlines rely on 'hubbing' to reduce costs and increase densities of passengers. This is an approach that is required due to the dispersed and low density demand of the airline industry. These airlines operate a worldwide network where few could survive without being a part of the total network. For example, from Australia, it is not possible to fly directly to Europe. To reach cities such as Paris, Berlin or Rome, passengers need to transfer planes at another airport such as London, Singapore or Dubai. Network planning applied to the airline industry has allowed for airlines to connect to a larger range of destinations, while increasing patronage and decreasing fares. Berechman (1993) reported that the bus company, American Greyhound also employs a similar strategy in the country to cope with the low density, multi-directional travel that is required of them. It is this necessity of 'hubbing' or in the case of public transport, 'transferring' that is the key to the success of network planning.

With regards to the network planning approach, five key elements of service provision have been identified as being particularly essential in its success (Mees, et al., 2010; Nielson, 2005). Firstly, appropriate **institutions** need to be in place. Network planning works best where one organisation owns and operates the system. Secondly, a simple **line structure** must exist where routes are well defined and are stable. Thirdly, public transport must be reliable and **frequent** so that a consistent, high-quality service can be provided during both peak and off peak times, and also on nights and weekends. Fourth, convenient **transfers** must be provided at every interchange point that is either 'timed' or frequent. Finally, due to the requirement of transfers, the system needs transfer-friendly **fare systems** where patrons pay for distance travelled instead of being charged for the number of modes used. In order to best understand the key ideas behind network planning, each of these key elements will need to be analysed in detail and will be discussed in chapter two of this thesis.

2. Public transport network planning – Key components

2.1. Introduction

Public transport services can be improved by adopting the network planning approach. This is because any change made to service provision by network planning has a direct and immediate impact on the quality of the existing network. The aim of this chapter is to investigate in detail the key components needed for the network planning approach to work. To achieve the aim, this chapter will examine five key components essential for network planning. These components are institutional structures, line structures, frequency levels, transferring and fare structures. Each of these key components will firstly be discussed in general, focusing on the different approaches that have been applied to each of these components. Next, the key elements needed for each of these components for network planning success will be discussed.

2.2. Institutional structures essential for network planning

Over time, there have been three distinct types of institutional structures applied to public transport planning. These have been publically run systems, privately run systems and public-private partnerships. Each of these institutional structures has their own distinct characteristics, in addition to their own strengths and challenges when applied to public transport planning.

Public institutional structures

Publically provided institutional structures is a situation where something is provided by the state or government rather than an independent, private and commercial company (Soanes & Hawker, 2005). In essence, it is a situation where public transport is provided by a government department. In this situation, public transport infrastructure and operation is organised and led by a team of professionals (Leland & Smirnova, 2008). In addition, the Government would be responsible for regulating the public transport industry. The principle aim behind this type of institutional structure is to protect collective interests through government-imposed regulations. These regulations seek to protect customers, employees, and benefit the wider public through quality and safety standards, price controls, along with regulating the entry of new transport providers (Sohail, Maunder, & Cavill, 2006). As public transport is viewed as a public good under this type of institutional structure, providing a stable, full and reliable public transport service is the priority (Rothengatter, 1991).

Publically provided transport systems were most common in the World from the 1950's to 1980's. While this structure had the benefit of maintaining a full public transport network and providing equal access opportunities for all, this was achieved by maintaining unprofitable public transport lines. The result of this was for the public companies to experience large financial burdens. In fact, studies of the time (see for instance the work by DeAlessi, 1973; Hamermesh, 1975; Lurie, 1960; Niskanen, 1971, 1975; Peltzman, 1971, 1975) showed there to be a positive correlation between publically provided public transport and high levels of debt. The result of this was for Government operated public transport to be perceived of as inefficient and excessive through their mismanagement and misallocation of key resources. In Japan, focus was placed on providing a full and comprehensive public transport network, particularly with regard to the nationwide rail system. To achieve this however required maintaining unprofitable routes through cross-subsidisation. The result of this was for the Government to run large fiscal deficits and by 1986, the Japan railway had reached a deficit of 25.4 trillion yen (Saito, 1989). Moreover, a similar situation in Bangkok, Thailand meant that by 1979, the publically provided system was in debt by $25 million US dollars (Roschlau, 1989). While the majority of research draws this same conclusion, it is important to note that there is opposition to this argument with both Foster (1973) and Nelson (1972) finding public ownership to be associated with lower costs in their studies.

The mismanagement of and poor decision making towards resources is the predominant thinking behind the large deficits experienced by public companies. As a result, the Government's in control of public transport have been described as "self-interested utility-maximiser[s] motivated by such factors as salary, power and patronage and as such represents only pro-regulatory political interests when making decisions" (Sohail, et al., 2006, p. 178). In other words, publically provided companies work to protect their interests through their ability to regulate the industry while also being the provider and operator of that same industry. This results in poor and unwise decisions being made and as such, they cannot effectively manage a public transport network. These decisions centre around poor cost controls, unwise (uneconomical, inefficient) service expansions, and a reluctance to increase fare levels (Savage, 2004). The result of this is for the need of large subsidies to be paid out to these companies.

When considering these poor management decisions, public transport fares have gained much focus. For instance, in the former Soviet Union, regulations concerning concessionary fares meant that in some cities, 80% of the population was entitled to either free or reduced fares. This high level of concessionary fares public transport operators were obliged to allow for worked to undermine the profitability of the public transport industry (Gwilliam, 2008). A

similar concessionary fare situation was also seen in Africa (Teurnier & Adolehourne, 1994). Furthermore, in the Dominican Republic in the Caribbean, regulations imposed meant that public operators could only charge flat fares. However, the private operators which were still allowed to run then worked to undercut the public providers who were in turn unable to remain competitive (Gwilliam, 2008). The result of these decisions on fares was for the public sector to experience financial failures and deficits.

Poor management decisions in publically provided structures can also occur as a result of corruption. Corruption works to undermine the system's efficiency and profitability. In corrupt situations, driver licences can be brought, police paid to turn a blind eye, in addition to vehicle inspections and maintenance becoming fraudulent (Gwilliam, 2008). This is at the expense of providing an efficient and effective public transport system. For example, in Paris, 1993, there were a series of scandals where local government officials used their power to become wealthier and gain advantages such as free travel and expensive gifts (Duthion, Vincent, & Ziv, 1999). As officials managed their operations to suit themselves or the requests of bribers, this worked to undermine the public transport system.

Private Institutional structures

A privately operated institutional structure is a situation where a business or industry in control of an asset is not operated or influenced by the Government. The key concept behind a privately operated entity is to allow for increased competition through a free market system. It is expected that this will result in a situation of increased economic efficiency and productivity (Soanes & Hawker, 2005). A privately provided system was expected to enhance the success of public transport and stop the large financial deficits that resulted from public institutional structures through reduced subsidies and better resource allocation. Under this system, the management of public transport was influenced by the perceptions of economists, and their prevailing economic thinking of the time. These economic understandings, which gained momentum through the work of Roth & Wynne (1982) focused on economic rationalisation and the idea that publically provided public transport was highly inefficient. Privatisation and consequential increased competition was considered to be the solution to the previous inefficiencies of publically provided systems.

Privately provided public transport systems were most commonly seen during the 1980's and 1990's. These new institutional structures were not restricted to the developed World through. In developing countries such as Sri Lanka, Pakistan and Tanzania (Sohail, et al., 2006), these Western ideas were forced upon through Structural Adjustment Packages (Armstrong-

Wright & Thiriez, 1987; Estache & De Rus, 2000; World Bank, 1986). As a result of these changing institutional structures, only minimal regulations were then left in place. Regulations remaining were only those needed to ensure that a basic service level was maintained. For example, in the United Kingdom, the only regulations left ensured that private companies could not neglect maintenance or safety requirements (Vickerman, 2008). All other regulations were subsequently removed.

It was expected that privatisation would result in transport providers becoming very innovative and providing a high-quality demand responsive service (J. Meyer, Kain, & Wohl, 1965; Ogden, 1995; Roschlau, 1989). By achieving this, public transport was then expected to become more efficient and profitable. In many instances, increased profitability and efficiency was achieved through privately provided public transport. For example, this was shown to be the case in Singapore (Roschlau, 1989). Additionally, this increased efficiency and profitability then meant taxes from revenues could be paid to government (Williams & Abdulaal, 1993).

The success of private institutional structures was not achieved without consequences. For instance, by focusing on efficiency and profitability, many private companies decreased service levels, neglected maintenance requirements, while also increasing fares. The result of this was for the quality of public transport services offered to drop. A reduced service level in turn caused patronage levels to fall. For example, in Dakar, Senegal, the private company, Daker Dam Dik reduced bus services to less than 40 by 2004 (from 60 buses operating in 2002). This resulted in poor service frequencies and long waits, in addition to frequent breakdowns from substandard maintenance levels (Gwilliam, 2008). Furthermore, in the United States, private companies ‘gave up’ all unprofitable lines. This then required a public company (AMTRAK) to step in and provide for these services (Rothengatter, 1991).

Private institutional structures can also pose problems in terms of service coordination, especially where multiple private transport operators are allowed to set up. Multiple transport providers will often result in piecemeal and fragmented services. This is because each operator will have their own routes, timetables and fare systems. This in essence means that they are in competition with each other. This was an issue experienced within the United Kingdom before the 1930’s (Gwilliam, 2008). In the United Kingdom, multiple private operators resulted in a lack of coordination between the different operators. Using another example, in Melbourne, Australia, bus operators worked to strategically design services in a way that worked to compete with, rather than complement existing rail and tram services (Mees, 2000). This resulted in a poor quality public transport system being offered to users. Moreover, public

transport service coordination also becomes a problem where regional or institutional boundaries are present. London is an example of this where coordination issues emerged between the city and its neighbouring metropolitan regions (Vickerman, 2008).

Public-private partnerships

Public-private partnerships are institutional structures which incorporate both the Government and private companies. In this situation, the Government is the controlling authority, which regulates and directs the public transport system. The Government will then invite tenders from private companies for the right to operate the public transport network. The key idea behind this institutional arrangement is to utilise the beneficial elements of both public and private structures, while also overcoming their individual weaknesses. This structure recognises that public transport cannot be effectively managed using economic principles. For quality public transport to emerge, a full and comprehensive service needs to be offered that only a publically provided structure can offer. On the other hand, public institutions do not place efficiency and profitability as top priorities as a private company would. Therefore, tendering out the right to run the public transport network ensures that a full and comprehensive service can be provided at the lowest possible cost.

Public-private partnerships have been most commonly seen since the new millennium, with the principle benefit of this institutional structure being to provide an improved public transport system. For instance, in the Dominican Republic in the Caribbean, the government has worked to establish a strong and stable government-led institutional structure. This has in turn worked to ensure that bus services are stable, reliable and better connected (Gwilliam, 2008). Furthermore, in Africa, this new institutional structure is becoming more commonplace. For example, the Government has worked to establish partnership arrangements in the cities of Accra, Lagos and Dakar. In Dakar, this new partnership has meant that the public transport fleet has been able to expand its network, with bus numbers increasing to 400 through government funding and assistance (Kumar & Barret, 2007). Moreover, in Toronto, Canada, their public transport success has been attributed to a strong government-led approach, which has resulted in a well planned and integrated public transport system (Sohail, et al., 2006). In essence, a strong government-led institutional structure has the potential to improve public transport.

On the other hand, this institutional structure can also experience the same disadvantages seen in public structures. As a result of this institutional structure, public transport subsidies in some cases have been steadily increasing, reminiscent of the large debts incurred by public

institutional structures. For example, in the United States, subsidies at all levels for the country totalled $32.3 billion in 2003. This is a 5.4% increase since 1990 (Taylor, Miller, Iseki, & Fink, 2009). Despite these subsidies being paid to improve public transport, patronage levels have barely increased. In China, public-private structures for public transport were implemented in 2001. Since this arrangement, the Government has only worked to incur large debts (Huang & Chang, 2008; Jong, Rui, Stead, Yongchi, & Bao, 2010). While having the potential to provide an improved public transport system, without careful management, this institutional approach can also result in large debts through the inefficient use of resources.

Institutional structures essential for network planning

For network planning to work, there needs to be a strong publically-led institutional structure present. This strong government-led structure will be in the form of a public-private partnership. This will then allow the government to regulate and control the industry for the entire urban area while a private company is contracted out to run the network (Mees, et al., 2010). In this situation, focus will need to be placed on improving both the public transport operation and infrastructure, in addition to developing policies that will work towards improving the public transport network. These policies will focus on measures to reduce private vehicle travel while also addressing existing land use patterns (Nielson, 2005). Such an approach is necessary as private arrangements cannot successfully provide the dense and comprehensive public transport networks needed for its success (Mees, et al., 2010; Nielson, 2005). This is because private structures often focus their services on the strongest routes which will provide the highest returns. This type of planning however leads to poor service coverage, while making public transport complicated for passengers to use. When a public-private partnership is adopted, public transport can then be designed so that it is full and complete, in addition to being simple for users to understand.

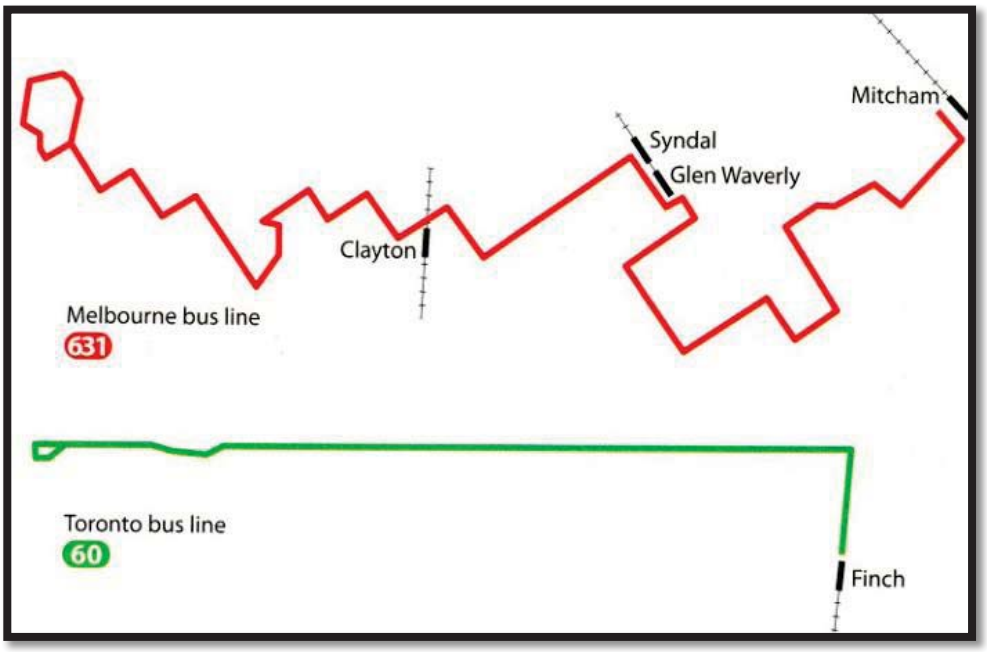
2.2.1. Research question one

Investigating the types of institutional structures that have been present in a city over time will provide insight on the current public transport system. This is because decisions made by both previous and current institutional structures have guided and shaped the development of today's public transport. For this reason, the thesis will ask the question, what types of public transport institutions have been present throughout Auckland's public transport history to shape the current public transport policies and services in the city?

2.3. Line Structures

Public transport line structures are the routes that buses, trains and trams move along. They "have a defined and unchanging physical route with a fixed stopping pattern, a specific timetable, and a unique name and number" (Mees, et al., 2010, p. 20). There are two key elements that work to define the pattern of line structures in a city. The first element looks at whether public transport line structures follow a meandering or straight line pattern. A meandering public transport line is where public transport winds its way around a series of local streets before coming to its final destination. On the other hand, a straight line structure will move from origin to destination using the most direct path possible given the surrounding land uses and topography. Straight line structures, as seen in cities like Zurich and Toronto have shown to minimise travel time as passengers are provided with the most direct travel path (Holroyd, 1965; Mees, 1996, 2000, 2010; Mees, et al., 2010; Nielson, 2005; G. Thompson, 1977). Figure 2.1 works to show the key difference between meandering and straight line structures. In the diagram, a Melbourne, Australia bus line is used to show characteristics of a meandering public transport line, while a Toronto, Canada bus line demonstrates what a straight line structure will look like.

Figure 2.1: The difference between meandering and straight line structures

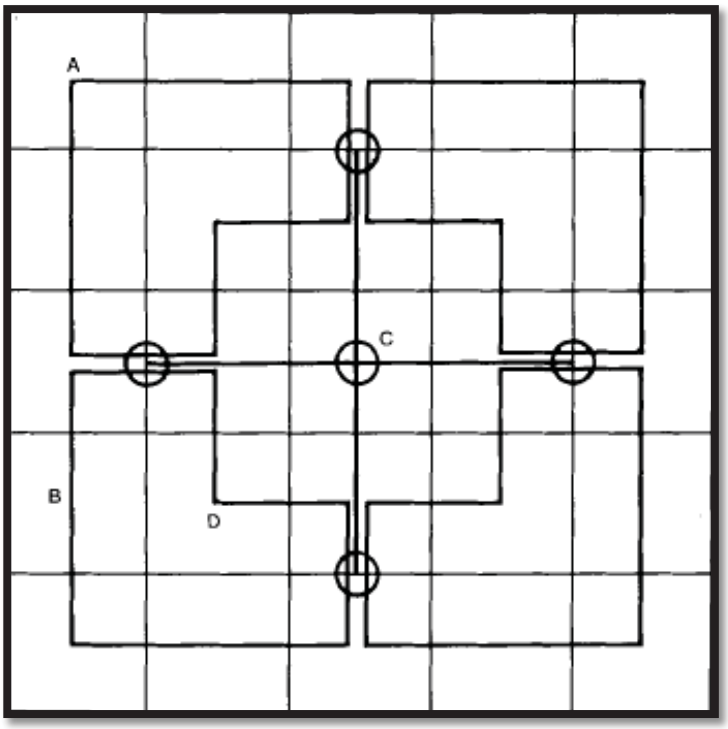


Source: (Nielson, 2005, p. 133: Orginally from Mees, 2000).

The second line structure element looks at whether public transport moves from the outer suburbs into the central city or moves in a cross-city pattern. Traditionally, public transport line

structures have moved from the outer suburbs into the central city, working to create a radial public transport pattern. This pattern was designed focusing on the peak period commuter and was created at a time when the main travel destination was the central city (Gregory & Matoff, 2003; Mees, 1996, 2000, 2010; G. Thompson, 1977; White, 2002). When this pattern of line structure is present however, passengers wanting to travel between outer suburbs will need to first travel into the central city. From here, they will be required to transfer onto another public transport line that will take them back out of the city to their end destination. This radial public transport pattern is shown through figure 2.2.

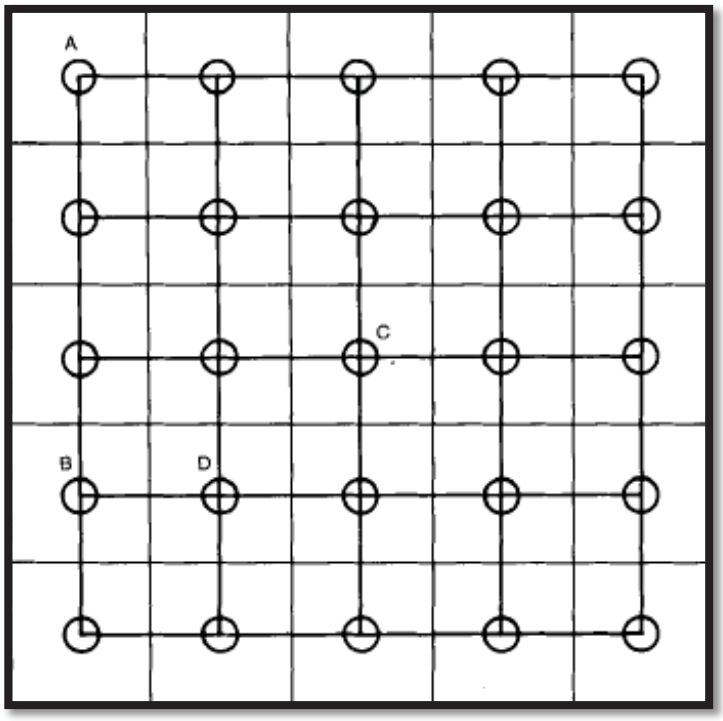
Figure 2.2: A traditional radial public transport system



Source: (G. Thompson, 1977, p. 161).

On the other hand, cross-city public transport lines do not have the outer suburbs and central city as their start and end destinations. Instead, public transport lines will move on past or around the central city. Public transport travelling this way will create a grid pattern as shown through figure 2.3. In this cross-city system, there are two sets of routes. The first run parallel in a north-south direction and the second run parallel in an east-west direction, with every north-south route intersecting with the east-west route.

Figure 2.3: A grid patterned public transport route design



Source: (G. Thompson, 1977, p. 161).

Under this pattern, passengers can travel to any square they wish using the most direct path possible. As a result, this line structure works to create a very comprehensive public transport service as all parts of the city can be accessed from any other part of the city. The only requirement is for passengers to normally transfer at least once to reach their final destination. This in essence creates a 'go-anywhere, anytime' public transport network (Mees, 2000; G. Thompson, 1977). This is an approach that is adopted by cities such as Zurich and Toronto, who both experience successful public transport networks (Mees, 2000).

Travel patterns today are now dispersed in nature as activities become more and more decentralised. This has meant that the traditional radial public transport patterns have increasingly become ineffective in catering for passenger demands (El-Hifnawi, 2002); "the physical and operational layout of public transit systems in most US [United State] urban regions bears little relationship to the structure of the regions they serve" (Gregory & Matoff, 2003, p. 296). In fact, in most United State cities, the central area contains less than 10% of regional jobs. This means that travel demand is outside of the city. However, public transport has not changed to reflect this, meaning that it has become increasingly ineffective. While this changing travel pattern has been used to justify private vehicle usage (Huxley, 1995), efforts are being made to address this growing travel trend. To overcome this, some cities have

worked to compliment these traditional line structures with the addition of cross-town public transport lines. For example, in the 1980's, San Diego, Portland and Sacramento in the United States recognised the need to restructure public transport lines in order to accommodate for changing travel patterns. This change resulted in their public transport systems becoming more effective when compared to other United State cities (Gregory & Matoff, 2003). Furthermore, in Monterry, Mexico, sixteen new cross-town routes were introduced in 1993 to complement the existing radial network, with this being met with increased patronage levels (El-Hifnawi, 2002).

Line structures essential for network planning

For the network planning approach to work, line structures need to firstly follow a straight line pattern and secondly adopt a grid-type network (Nielson, 2005). The primary reason for this is that straight line patterns offer direct travel paths for passengers. Furthermore, a grid network will provide the most comprehensive service. This comprehensive service will be achieved using fewer resources as no overlapping of services will occur. This is because all lines will be coordinated to work together and not compete against each other. Together, a straight-line and grid-type line structure pattern can work towards providing an improved public transport network. The reason for this is that when this pattern is present, it works to create a sense of permanence and simplicity to its users. This also makes all public transport modes comparable to each other. What is meant by this is that tram and rail lines already compliment this straight line pattern as their line structures are permanent and unchanging. Therefore, when bus routes are designed using these same principles, this then works to create a single integrated and coordinated public transport network (Mees, et al., 2010). This in turn makes public transport very easy for passengers to use and understand. On the other hand, when buses operate differently to the rest of the network, the line concept is lost (Nielson, 2005).

2.3.1. Research question two

Public transport line structures directly impact on the quality of a public transport network. They therefore need to be carefully designed so that they provide for the travel patterns present within individual cities. This thesis will explore this concept and ask the question, what types of public transport line structures are present in Auckland?

2.4. Frequency

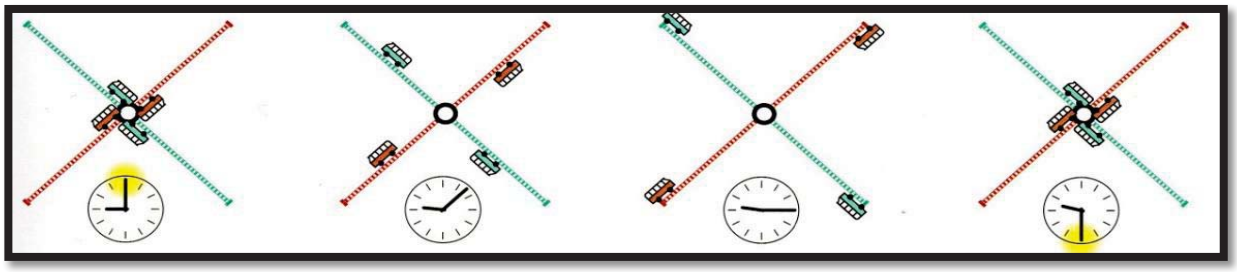
The frequency of public transport refers to the number of occurrences of bus, tram or rail units passing along a single line structure within a given period. In practice, deciding on and then allocating frequency levels for individual public transport lines has been determined using one

of two different approaches. The first and most common approach to frequency allocation involves using a mathematical formulation that will calculate optimal frequency for a line structure based on a number of key variables. In most instances, these models (see for instance Carey & Crawford, 2007 [trains]; Ceder, 1986 [buses]) will focus on patronage levels as the key variable in these calculations. What this means is that when patronage falls, then the frequency of a public transport line will be reassessed, resulting in lowered frequency levels of that public transport line. On the other hand, if patronage figures increase, then more services will be added to the line, working to increase frequency levels. Public transport systems operating using this approach will most commonly experience increased services running in the morning and evening to cater for the peak period commuters. On the other hand, daytime services will experience reduced frequencies, with the quiet and off peak times like at night or on the weekends experiencing irregular or no services at all.

An alternative approach to the traditional method of frequency allocation entails shaping frequency based on the kind and form of public transport system desired. This approach involves looking at the entire public transport network and then allocating individual frequencies so that individual lines become integrated with each other. This will in turn ensure that they operate as a singular network and not individual entities. The idea behind this approach is that when a public transport system is designed based on what users want then people will be more likely to use public transport. The result of this will be for patronage levels to increase. As the ideal frequency for a public transport line is one unit every ten minutes or less (Howes & Rye, 2005; Mees, 2000; Mees, et al., 2010; Nielson, 2005), this approach will require implementing these frequency levels where possible. When it is not realistic to supply this level of service on a public transport line, then the frequency of that line will need to be coordinated to ensure that the lower frequency will not inconvenience users. A method used to achieve this is the pulse-timetable technique.

The pulse-timetable technique involves timing different public transport lines so that they will arrive and depart at an interchange point at the same time. This works to address long waits involved with low frequency services and allows passengers to transfer onto another line without missing the next bus, tram or train (Mees, 2000, 2010; Mees, et al., 2010; Nielson, 2005). Figure 2.4 helps to show how the pulse-timetable technique works. In the figure, it can be seen that there is one interchange point where all public transport lines come together. These lines are all timed so that they arrive and depart together, which allows passengers to transfer and continue on their journey with minimal wait times. This further works to create a reliable public transport system.

Figure 2.4: The pulse-timetable technique.



Source: (Nielson, 2005, p. 117).

Frequency levels essential for network planning

Frequency levels essential for network planning require a supply-led approach to be adopted. What this means is that frequency must be determined based on the kind and form of public transport desired and not on the number of passengers using the service. This will involve providing a consistently high-quality service that will operate using a twenty-four hour schedule. Where possible, high frequency corridors need to be offered with services running at least once every ten minutes. When this is not practical, services must then be coordinated using a method such as the pulse-timetable technique (Mees, 2000, 2010; Mees, et al., 2010; Nielson, 2005). The reason this is necessary is because network planning requires a full and comprehensive public transport service in order to be successful. When frequencies are determined based on individual line performances, they lose their ability to be coordinated and integrated into a singular network. This will undermine efforts made to provide the comprehensive public transport network system, as there will be weak points within the network.

2.4.1. Research question three

Frequencies of public transport lines significantly influence public transport use. Low or poorly designed frequencies increase the inconvenience of using public transport for users. This results in people not using public transport as it does not meet minimum service expectations. This thesis seeks to explore this influence of public transport frequencies, asking the question, what are the frequency levels of public transport services in Auckland?

2.5. Transferring

Transferring in public transport refers to changing between public transport lines in order to reach a final destination. Traditionally, in public transport planning, networks have been designed to avoid the need to transfer where possible. The reason for this is that transferring is often considered a major deterrent for people in using public transport (Guo & Wilson, 2011;

Horowitz & Zlosel, 1981). This is because transferring is considered to be inconvenient, invoking large penalties in terms of total travel time. As a result, public transport networks have been planned for based on the concept that "riders [will] perceive it to be more acceptable to take modified routes that eliminate transfers, even if initial waits and riding consume more time" (Horowitz & Zlosel, 1981, p. 282). When this is the key idea driving public transport design, line structures will travel using long and meandering paths. The purpose of this is to allow passengers to access as much of the city as possible without the need to transfer onto another public transport line to finish their journey.

Although poorly designed transfer points do create long and frustrating delays for passengers, public transport systems designed so that transfers are coordinated can work to overcome this inconvenience (Guo & Wilson, 2011; Shrivastava, Patel, & O'Mahony, 2007). Therefore, the way in which transfers are coordinated and structured may play the greatest role in whether passengers will be willing to transfer or not. For instance, in London, 70% of all underground and 30% of all bus trips will require at least one transfer. Additionally, in New York, 30% of subway trips and 80% of commuter rail trips will require at least one transfer to reach an end destination (Guo & Wilson, 2011). Despite this necessity to transfer in these cities, patronage levels remain high. What this shows is that how transfers are structured and designed will play a greater role in whether people will transfer or not (Lo, et al., 2003; Mees, 1996, 2000, 2010; Mees, et al., 2010; Nielson, 2005). This shows that transferring is not necessarily a major deterrent to passengers. Rather, it is the quality of the transfer will determine whether people will use the service or not.

Transfer elements essential for network planning

The fundamental element to the success of network planning is in its ability to provide quality transfer points for passengers. To achieve this, transfer points will need to offer either high frequency interchange points or timed transfers for lower frequency interchange points. On high frequency interchange points, wait times for passengers will be very low. As a result, there will be little inconvenience for these passengers. This means that they will be willing to transfer between lines. At infrequent interchange points though, transfers will need to be coordinated using the pulse-timetabling technique in order to avoid long delays between transfers. To achieve this, public transport lines will need to operate using the same frequency levels and the same hours of operation (Mees, 1996, 2000, 2010; Mees, et al., 2010; Nielson, 2005). Timing transfers on the low frequency lines is necessary to ensure the overall quality of the public transport network can be maintained.

2.5.1. Research question four

The quality of transfers between public transport lines will determine whether people will be willing to transfer or not. For an integrated and coordinated public transport system to be provided, users need to be able to transfer between lines. Therefore, the provision of quality interchange points needs to be a priority in transport planning. This thesis looks to examine the influence of quality interchange points for transferring, asking the question, does public transport in Auckland facilitate transfers between different lines and modes?

2.6. Fare Structures

Public transport fares are charges paid by passengers to travel on a bus, tram or rail service. Traditionally, the determination of fare levels along a public transport service has been achieved by using mathematical formulations. These formulations, (see for example Acworth, 1905; Curtin, 1968; Mohring, 1972) focus on creating ideal pricing strategies for public transport using economic market conditions as a guide. In these formulations, the most widely applied model is that public transport usage will decline by one-third of one percent for every one percent increase in fares. This creates a price elasticity for public transport of -0.33% (Curtin, 1968). By applying this model, transport planners then determine a suitable fare level for their system by finding the right balance in fare elasticity. The importance of finding the right balance is further stressed through the recognition that the price of fares is usually the first point of unrest for passengers. As a result, fares must reflect the quality of public transport offered (Mees, 2000).

Once an appropriate fare level has been calculated for a public transport system, there are two key ways that this can then be implemented. The first method is to adopt flat fares. Flat fares require passengers to pay the same charge for a public transport trip regardless of the distance travelled. Flat fares however can be considered inequitable, with those travelling the longest distance receiving greater cost benefits than those who travel shorter distances (Leutze & Ugolik, 1979; Rock, 1975). The second method is to use zonal fares. Zonal fares require passengers to pay a charge for how many ‘zones’ they travel through. This in essence works to make passengers pay an increased change the longer distance they travel (Leutze & Ugolik, 1979; Rock, 1975).

In addition to the price and method of fare structures, the transferability of public transport fares is also an important fare structure consideration. Traditionally, passengers will be charged for each single public transport line they travel along. In this case, to change between three public transport lines will mean paying three individual fares. This in essence imposes a

surcharge on passengers wanting to transfer between different lines and modes (Mees, 1996, 2000, 2010; Mees, et al., 2010; Nielson, 2005). However, this works to discourage transferring as it will be cheaper to travel using as few different public transport lines as possible. If passengers are charged extra to transfer in order to make one journey, then they are likely to either not change lines or to not use the service altogether. Therefore, when looking at the fare systems in place, it is important to consider the need of transfer-friendly fares. A transfer-friendly fare is a situation where passengers pay for how far they travel and not the number of different modes they use or the amount of times that they transfer between lines (Mees, 1996, 2000, 2010; Mees, et al., 2010; Nielson, 2005). In this situation, only one ticket will be purchased to make a single trip.

Fare structures essential for network planning

To ensure the success of network planning, it is necessary to adopt fare structures that operate using a zonal fare system. In addition, fares need to allow for transferring between services without it imposing an additional financial cost to passengers. This will then result in a system where passengers pay an increased fare the further they travel, with this occurring regardless of how many times they need to transfer between services. By coupling a zonal system with transferable fares, then passengers will pay an appropriate price for their total length of travel. The reason such an approach is necessary is that public transport needs to be looked upon as a single entity and not a series of individual components. This then makes it necessary to provide a fare structure that will remove the barrier of expense to transfer between public transport lines. Once this barrier is removed, then passengers will be free to design a public transport trip which will best suit their needs.

2.6.1. Research question five

How fares are structured impacts on how people will choose to use public transport. Fare structures that result in additional financial costs to passengers will result in decreased passenger numbers. Fares therefore need to be structured so that they help create a single and integrated public transport network. This thesis seeks to investigate fare structures, asking the question, do fare structures in Auckland encourage the use of public transport?

2.7. Conclusion

The service provision elements of public transport are a key component for making improvements to public transport in the short-term. This is because changes made to a service provision element will have an immediate impact on the quality of the existing public transport network. Traditional approaches to public transport planning are not focusing on the key

service provision elements so that public transport can be improved. Network planning however focuses on the essential service provision elements in a way that works to improve public transport in a city. For network planning to work though, it requires a strong government-led institutional structure. Once this is achieved, this structure will then be able to create a public transport system that will adopt straight line and grid-type line structures, high or timed frequency corridors, the provision of quality transfer interchange points, in addition to the provision of transferable friendly fares. By implementing the right kind and form of institutional structures, line structures, frequency levels, transfer points and fare structures, network planning has the potential to work towards reshaping and improving the existing public transport network.

3. Research Methodology

3.1. Introduction

The principle aim of this thesis is to investigate policy approaches which will work towards improving public transport in Auckland. To achieve this aim, one policy approach, network planning has been chosen to be investigated in detail. This thesis will seek to explore how this approach can work towards improving public transport service provision in Auckland. To answer this primary research question, five subsidiary questions have been developed from the literature review on network planning. These five subsidiary research questions are:

1. What types of public transport institutions have been present throughout Auckland's public transport history to shape the current public transport policies and services in the city?
2. What types of public transport line structures are present in Auckland?
3. What are the frequency levels of public transport services in Auckland?
4. Does public transport in Auckland facilitate transfers between different lines and modes?
5. Do fare structures in Auckland encourage the use of public transport?

The proposed methodology of this thesis will be designed to specifically answer these five subsidiary research questions. Answering these five research questions will in turn provide an answer to the initial research question of how to improve public transport service provision by adopting the network planning approach in Auckland. To address these five subsidiary research questions, a variety of data collection and research analysis techniques were chosen.

3.2. Literature review

The development of the aim and research questions of this thesis was the result of an extensive literature review. This was the chosen data gathering and analysis technique applied to chapters one and two of this thesis. Gathering the literature review data was achieved by undertaking desk-based research. From this desk-based study, a general search was first conducted looking for relevant information from key websites, the Massey University Library database, and from journal article databases. Literature gathered was in the form of books, web articles, journal articles, along with government and institutional documents. Next, references used from key articles found were looked up with the goal of backtracking and discovering where key ideas discussed in this thesis originated. Additionally, a specific search of key journal articles was undertaken by looking through the contents pages of past issues. The purpose of this was to find original sources of key ideas and concepts used.

Analysing the information gathered involved compiling and categorising the literature found. As the key aim of using a literature review was to gain an understanding of what is already known on public transport planning, grouping literature resulted in the ability to identify both well researched and poorly researched areas. This theoretical background was then used to shape and identify a gap in knowledge that this thesis has proposed to fill.

3.3. Case study and data collection

Chapters four and five of this thesis focus on answering the five subsidiary research questions. The principle data collection and analysis technique chosen for these chapters were case study investigations. Data collection for these case studies involved both desk-based and field-based components. Initially, desk-based research was undertaken. Desk-based research involved looking through New Zealand newspaper article databases, New Zealand library and archival databases, the Massey University Library database, key websites, and journal article databases. Information gathered from these sources was in the form of website articles, newspaper articles, press releases, books, journal articles, and photographs, along with government and institutional documents. The purpose of this was to gather as much information as possible on the Auckland public transport network before undertaking the field-work component. The field-work component was first used to verify findings on particular case-studies that were found through desk-based research. Secondly, it was used to gather information not able to be found through desk-based research. Thirdly, it was used to make observations and to collect the detailed data needed to undertake analysis of particular case study examples.

3.3.1. Selection and justification

The selection of case studies chosen from the Auckland public transport system were selected based on information found through desk-based research. For this, there were two ways in which a case study was selected. The first method of selection was to choose individual public transport lines that were well publicised or mentioned for particular features within the information gathered. If the features mentioned coincided with one of the five subsidiary research questions, then the case study could be used as a best or worst practice example of network planning elements in Auckland. The second method of selection involved the generation of an excel spreadsheet detailing the characteristics of each public transport bus line in the city. The characteristics focused on answering questions for each of the five subsidiary research questions. These characteristics were then used to select case studies that epitomised both best case and worst case examples for each of the five research elements. A best case example was one that embodied much of the network planning principles, with a

worst case example being one that used many of the traditional methods of public transport planning. By providing a comparison of the two examples for each research question, it was then able to be seen whether the best case example was more efficient or performing better. If this was the case, then it could be looked upon that when network planning principles are present, the performance of a public transport line will improve. On the other hand, if the best case examples did not perform better, then it could be looked upon that network planning is not a policy approach that could be adopted to improve public transport.

The Northern Express

The Northern Express in addition to its surrounding network is the principle case study example used in this thesis. The reason for this is that the Northern express embodies many of the elements needed for network planning in each of the five categories. No other public transport line in Auckland contained the necessary characteristics as found through the spreadsheet analysis. As a result, this case study was chosen to be investigated in detail for the purpose of further analysis. On the other hand, the surrounding bus network possesses nearly none of the elements needed for network planning success. As a result, this surrounding network was also chosen to be investigated in detail alongside the Northern Express line. The reason this North Shore network was chosen instead of other network areas with similar characteristics was because of its connection with the Northern Express. As both case studies serve the same part of Auckland, they both possess the same urban composition, social-economic, psychological, and political influences. Therefore, it can be better assessed as to whether there are clear performance differences between the two services.

680, 681 Bus Line

The 680 and 681 Howick-Botany Downs bus lines are used to assess public transport line structures. From the information gathered on Auckland, these lines were well publicised as having undergone measures to simplify their routes. These modifications involved changing their routes so that they no longer meander around local streets before reaching their end destination. As a result, the response from passengers on these changes can be assessed to determine whether straight line structures in Auckland can improve public transport. As changes have been made to an existing public transport line, the surrounding characteristics are identical. This will therefore provide a better assessment of the effect that changes to line structures have on public transport success. This is opposed to comparing two individual public transport lines with different characteristics.

The 680 bus line was also chosen as an example of an unreliable bus line in Auckland. From the information gathered on Auckland, this bus line was publicised as being unreliable for users. This example was chosen to be used as it is a finding of relatively recent research conducted on public transport in Auckland. Therefore, the information is already available to be used.

660, 661 Bus line

The 660 and 661 Howick-Botany Downs bus lines in addition to their surrounding suburb area are used as straight line case studies. From the information gathered on Auckland, these lines were well publicised as having undergone measures to simplify their routes. These modifications included removing the previously complex bus system operating in the area. The response from passengers on these changes can then be used to assess the effectiveness of straight line structures. As the surrounding characteristics will be identical, this will provide a better assessment of the effect that changes to line structures will have on public transport success.

750, 755, 756, 757 Bus Line

This bus line was chosen to assess line structures in Auckland and provides the best example of a meandering bus line operating in the city. The reason this bus line was chosen as a case study was because it was recorded as travelling using the most indirect route from origin to destination given road layouts and topography within the spreadsheet analysis.

008 and 009 Bus Lines

These bus lines were chosen to assess line structures in Auckland, providing examples of cross-town bus travel in the city. From the information gathered on Auckland, these bus lines were publicised as having been adjusted for the purpose of achieving cross-town travel. Because changes have been made to these routes, any resulting changes in patronage levels can be used to assess the impact that the implementation of more cross town bus lines will have in the city. Assessing changes to these lines will provide a better analysis than if two separate bus lines were to be compared. This is because the surrounding characteristics in terms of urban composition, social-economic, psychological, and political influencers will be identical whereas two separate lines will not. Additionally, no other bus routes were found to be re-routed with cross town travel in mind.

446, 447 Bus Line

The 446 and 447 bus line was chosen to assess line structures in Auckland, providing an example of a radial bus line. This bus line was recorded as travelling the longest distance from an outer suburb area into the central city, resulting in its selection as a case-study. Although there were many examples of radial bus lines, the longest line was expected to depict the concept of radial line structures in the city most clearly.

007 Bus Line

This bus line was chosen for the purpose of assessing its level of transferability. The reason this line was chosen was because of its line structure pattern. This bus line moves in a cross-town pattern, intersecting with many other bus lines heading into downtown. This creates a grid pattern along this line, which is the pattern recommended for successful transfers in network planning. The reason this line was chosen for the analysis over others was because it had the highest number of intersecting bus lines as determined through the spreadsheet analysis. This meant that it has the most potential to provide the best transfer opportunities for passengers.

886 Bus Line

The 886 was chosen to assess the transferability of a public transport line. This bus line is designed in a way which means that it provides for no transfer opportunities along its travel path. Despite travelling alongside other public transport lines at times, it does not intersect with any of these other bus lines in a manner that promotes transfer opportunities according to network planning principles. Although there are many examples in Auckland of bus lines whose design does not promote transferring, this bus line was chosen over the rest because it was recorded as having the highest number of other bus lines travelling along the same route for part of its journey in the spreadsheet analysis. This means that despite the presence of a high number of other bus lines, there is still no potential for transfers.

B.line Buses

The 'b.line' bus lines were chosen to assess frequency levels. The reason these lines were chosen was because they showed to be the only high frequency corridors operating in Auckland aside from the Northern Express as shown through the spreadsheet analysis.

3.4. Institutional analysis

For the purpose of answering the first subsidiary research question, an institutional analysis was used. This analysis first required gathering information on Auckland's public transport

history from 1840 to 2010. This information was gathered from Museums, New Zealand archive collections, key websites and policy documents, New Zealand newspaper and journal archives, along with registry and census archives. From the information gathered, a timeline was created, detailing the key events that have occurred over time with regards to the public transport system. This timeline was then used to determine what forms of institutional structures have been present in Auckland during different periods in history. Once this was determined, analysis was undertaken using the information gathered.

The institutional analysis first critically examined the different institutional structures and approaches that have been used towards public transport in Auckland. This involved investigating the performance of each structure used by focusing on its strengths and weaknesses. The purpose of doing this was to determine whether any institutional structure and its consequential policies and decisions resulted in successful public transport. Secondly, the findings from the institutional analysis were compared against literature findings. The purpose of this was to determine whether the characteristics of institutional structures used in Auckland correspond with those identified through the literature review. This cross-examination seeks to verify whether government-led structures will contribute towards improved public transport networks or not.

3.5. Line structure, frequency and fare structure analysis

Answering the second, third and fifth subsidiary research questions centred on the utilisation of case study investigations. Case studies were adopted to provide examples of both best and worst case scenarios occurring in Auckland for each of the three components. Analysis looked at the performance of these case studies, focusing on any strengths and weaknesses that emerged. The purpose of this was to determine whether a traditional or networked approach for these three components would result in improved public transport. The findings of the case study analysis were then cross examined against the findings from the literature review. This was done to determine how well these findings correlated with each other. This correlation was then used to draw conclusions as to whether network planning can lead to improved public transport systems or not.

3.6. Transfer analysis

For the purpose of answering the fourth subsidiary research question, an investigation into the transferability of Auckland public transport lines was undertaken. This was achieved by investigating two public transport lines in detail by conducting a transfer analysis on the two lines. These two lines are the Northern Express and the 007 bus line. This transfer analysis

involved gathering detailed information from the field-work component so that the level of transferability could be measured. The Northern Express was chosen for this analysis as it possesses the infrastructural requirements needed to promote transferring between public transport lines. The 007 bus line was chosen because it was shown to have the highest number of intersecting buses along its path through the spreadsheet analysis. This works to create the grid-pattern required for transferring using network planning principles.

In the transfer analysis, data was collected for six elements that contribute towards the transferability of a public transport line. These six elements are wait times, ticket prices, walking distance between transfers, fare structures, and the frequency of the transferring line. These key elements were chosen based on literature findings as each of these elements work to influence whether people will be willing to transfer or not. The data collected on these elements was then graded based on performance and awarded a score from zero to five, with five being the best possible score. The determination of the scores awarded was compiled using best practice recommendations as a guide. Once a score had been awarded for each of the five categories, an average grade was calculated to gain an overall score for the public transport line. The best score in this analysis is thirty. The next step in this analysis was to compare the results against the findings of the literature review. This cross-examination was used to verify whether the way in which transfers are structured can work to improve public transport networks.

3.7. Content analysis

For the purpose of further cross-examining the findings of the literature and case studies, a content analysis was undertaken. A content analysis is “the process of organising written, audio, or visual information into categories and themes related to the central questions of the study” (Instructional Assessment Resources, 2010). This content analysis was used to identify how Auckland is currently approaching public transport planning. For this, it was judged that the content of public transport planning documents would indicate what current priorities are. By identifying priorities, it can then be established how current transport planners are approaching public transport planning in the city. These findings were then cross-examined against the case study findings and literature to verify whether the network planning approach can improve public transport service provision. The result of doing this will be to verify whether current planning approaches, network observations, and literature findings are all corresponding with each other or not. The intention of triangulating these elements is to strengthen the key arguments that are made through this thesis.

To undertake the content analysis, fifteen current and recent transport planning documents were analysed. In order to gain an impression of the current transport planning system, documents selected were no older than six years. This time limit was chosen so that currently operative plans, which were produced five years ago, could be included. In addition to current plans, past annual reports from 2005 to 2009 were selected along with the last three monthly business reports for the 2010 year at the time this content analysis was conducted. The number of additional reports selected corresponds with the six year time limit and also on the availability and accessibility of these past documents. The reason the monthly and annual reports were included was to balance the content analysis. This is because these documents are specific, mentioning current initiatives and the latest developments for Auckland's public transport whereas the formal transport documents are vague and generalised. The selected transport documents are listed in table 3.1. The documents shaded in red are current major transport planning documents relating to Auckland. The documents shaded in green are past transport documents also included in this analysis.

Table 3.1: Transport planning documents for Auckland examined through the content analysis.

Transport planning document	Year
Auckland Regional Public Transport Plan	2010
Auckland Regional Land Transport Programme	2009/10-2011/12
Auckland Passenger Transport Network Plan	2006-2016
Rail Development Plan	2006
Sustainable Transport plan	2006-2016
Auckland Transport plan	2009
Auckland Transport plan	2007
Auckland Regional Transport Authority Annual Report	2004/05
Auckland Regional Transport Authority Annual Report	2005/06
Auckland Regional Transport Authority Annual Report	2006/07
Auckland Regional Transport Authority Annual Report	2007/08
Auckland Regional Transport Authority Annual Report	2008/09
Auckland Regional Transport Authority Monthly Business Report	May 2010
Auckland Regional Transport Authority Monthly Business Report	June 2010
Auckland Regional Transport Authority Monthly Business Report	July 2010

Source: (Table by Author, 2010).

In conducting the content analysis, each of the selected transport planning documents was examined against a set of key words and phrases that relate to each of the subsidiary research questions. Each time one of these key phrases or words was used in a document, it was recorded. For this analysis, only those words and phrases used in the right context were recorded. Those key words and phrases that received the highest total counts were judged as being priorities for current transport planners and vice versa. This identification of priorities worked to provide an overall perspective on current public transport approaches utilised in the city.

4. Auckland's public transport institutions – A historical analysis

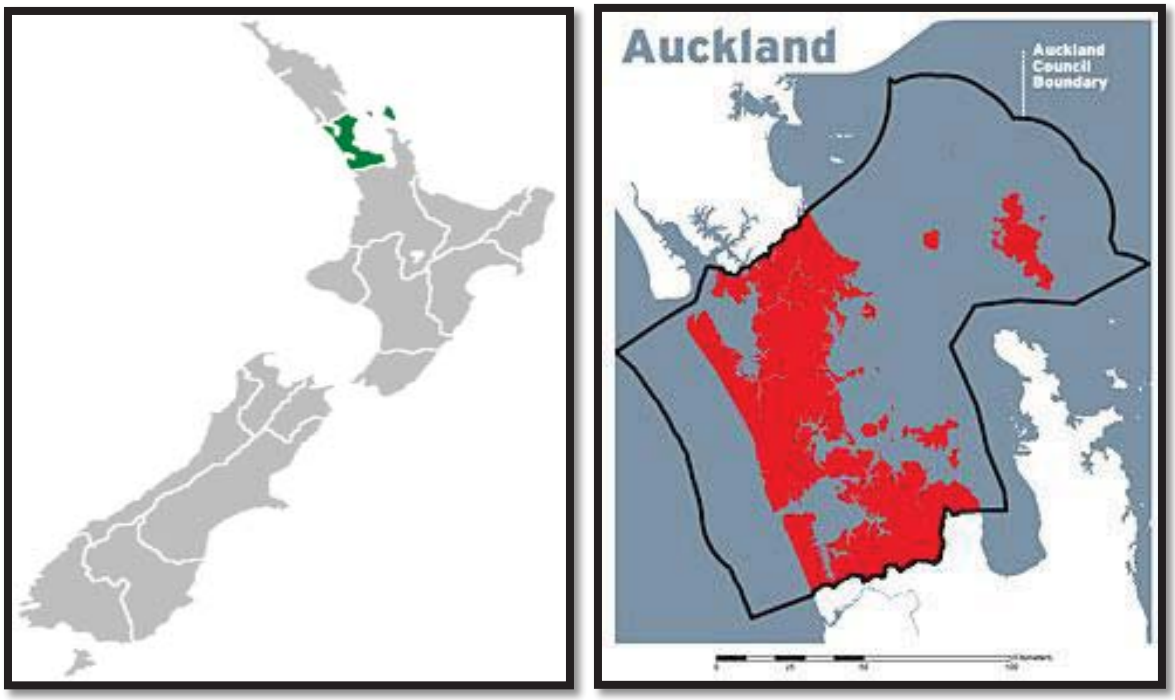
4.1. Introduction

Auckland's public transport network can be traced back to before the city's official declaration in 1840. Since 1840, a variety of different institutional structures have been used to plan for public transport in the city. A detailed timeline showing this history is provided in Appendix One of this thesis. With the adoption of a regional scope, the aim of this chapter is to cover the history of Auckland's public transport institutional structures from 1840 to 2010. The chapter seeks to explore the rationale behind the different institutional structures used, examining in detail the impact that they had on the public transport network. Additionally, their individual strengths and weaknesses will be investigated. The purpose of this is to identify those institutional structures that worked best in Auckland along with those that did not.

4.2. Auckland context

Auckland is the largest city in New Zealand with a population of approximately 1.3 million people (Statistics New Zealand, 2006a). It is one of sixteen regions in the country as depicted in figure 4.1, which represents the boundary and jurisdiction of the Auckland Council. Within the region's land area of 5,600 km², there are 326 km of State Highways, and 7,700 km of local urban and rural roads (Land Transport New Zealand, 2006). Auckland faces severe road congestion and is said to have the worst public transport levels of any western city in the developed world (Laird, et al., 2001). With regards to public transport, the region has approximately 46.5 million bus boarding's, 7.6 million rail boarding's, and 4.3 million ferry boarding's each year (Auckland Regional Transport Authority, 2010b).

Figure 4.1: Auckland Region of New Zealand



Source: (Auckland Regional Council, 2009; Field, 2010).

Until October 2010, transport planning in Auckland had been provided by numerous institutions at the central, regional and local government levels. At the central level, these institutions are the Ministry of Transport and the New Zealand Transport Agency. At the regional level, they were the Auckland Regional Council and its subsidiary, the Auckland Regional Transport Authority. At the local level, there were seven territorial authorities present, the Waitakere, Papakura, Manukau, North Shore, Franklin, Rodney and Auckland City Councils. In 2009, a report was released by the Royal Commission on Auckland Governance which recommended the establishment of one council, the Auckland Council. This council would merge the seven district councils and also the regional council into a single unitary authority (Salmon, Bazley, & Shand, 2009). The principle reason for this merger was to increase the effectiveness of local government. By merging the regional and local authorities, it was expected that the institutional barriers to improving public transport would be removed.

4.3. Auckland's institutional history

From 1840 to 2010, four distinct institutional structures have been used to manage Auckland's public transport network. These four distinct structures, which were identified through the detailed timeline provided in Appendix One of this thesis, all adopt unique approaches for the management of public transport. Their characteristics will now be analysed in more detail,

showing how their different management approaches have impacted on the performance of the public transport network.

4.3.1. Mixed institutional structures for public transport - 1840-1950's

Initial transport development in Auckland can be traced back to its colonial influences, with development paralleling other British colonies such as Australia (Australian Encyclopedia, 1958). Using early British transport systems as a model (Bloomfield, 1975; Dahms, 1980; Valentine, 1926), the desired outcome was to colonise the country by opening it up to immigration and settlement (Australian Encyclopedia, 1958). By adopting the latest technologies in mechanised transport, early transport systems quickly became symbols of municipal pride, superiority, economic growth and progress (Bloomfield, 1975; Watson, 1996). Institutional structures during this period were primarily privately planned with these earliest public transport systems focusing on innovative, localised, and opportunistic developments. They worked to fill Auckland's growing transport need and quickly became the backbone of the city (Armstrong, 1959). The only exception was the publically provided rail system.

The key reason why the rail network was publically provided was due to the Government's attitudes towards rail at the time. Developing a nationwide rail system was looked upon as a key factor in colonising the country. Consequently, the Vogel government of the 1870's developed two principle aims; the first being to increase European settlement and the second being to increase economic development. It was proposed that developing road, rail and telegraph networks would fulfil the two aims (Harris, 2006; Sinclair, 1999; Turnbull, 1966; Watson, 1996). In addition to providing a rail network, the Government also intended to be the primary rail operator. This was to stop wasteful and uncoordinated spending, in addition to bringing the country together economically and socially. To achieve this though, the Government set out to double the level of public debts (Sinclair, 1999). Consequently, by 1891, 37.5% of all public debt had been incurred through railway developments (Watson, 1996).

Early horse bus services were privately operated and can be traced back to the 1850's (Stewart, 1973). They worked to fill the newly forming demand for transport services in the city. The first horse-bus service travelled between Auckland city and Onehunga. This service soon flourished, resulting in the establishment of other public transport lines whose operators sought to take advantage of this transport success. The bus network however was very informal and fragmented, with it only being concentrated on high demand areas (Stewart, 1973).

Privately run ferry services can be traced back to the 1840's. Early settlers would provide an informal service for travellers in return for a small fee (Humphris, 2010; Titchener, 1977). The first official and regular ferry service however was provided by Mr J Reed in 1854. This service travelled across the Waitemata Harbour from Stokes point, Northcote, Shoal Bay, Devonport, and Auckland City (Sandi, 1998). Like the horse buses, these ferry services were very informal and fragmented, concentrating services on high demand areas.

The first tram system in Auckland was privately provided and can be traced back to mining in the province during the 1860's. Due to the isolated nature of the mine, the coal company believed that a tramway would reduce costs and make coal deliveries to Auckland cheaper (Ball, 2009). The development of an urban tram network extended off this mining tramline, officially being allowed for through the 1872 Tramways Act, and later the 1894 Tramways Act. These Acts invited tenders to be made by private (or public) enterprises to build a tram network in the city:

> "Tramways may be constructed in any borough, town, district, or county when authorised…a local authority may, from time to time, on the application of any person in that behalf, grant a licence to such person to lay down, construct, and maintain a private tramway" s4(1), 7(1) ("The Tramways Act," 1894).

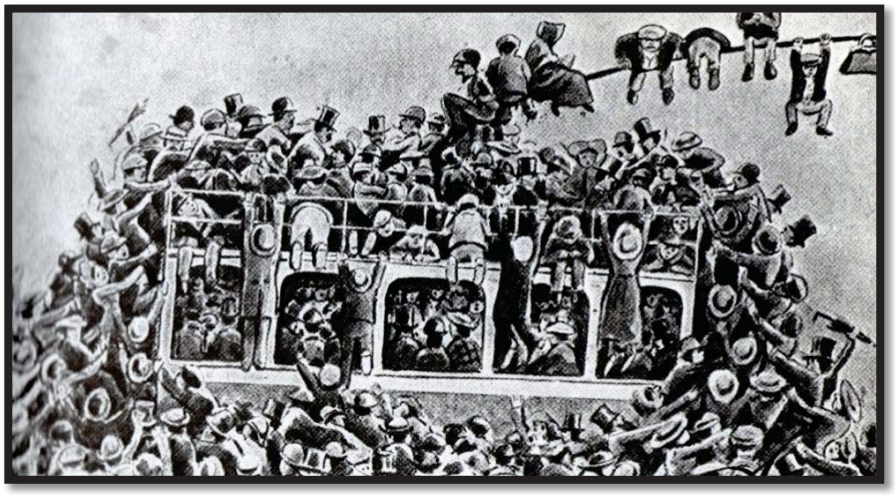
The Auckland City Council was the local authority in Auckland, making them the regulator of the tram network. Through their tendering process, the Council placed strict terms and conditions in terms of the operation of the network - frequency, hours of operation, and fares. As a result, the council saw only two tenders made, both of which were ruled ineligible and were subsequently rejected (Bush, 1971). In time (and after relaxing the strict terms and conditions), another tender was made, which came from the St Helier-Northcote Land Company in 1882. The council accepted this tender and granted the company with a 21 year concession to run a horse tramway over specified routes (Bush, 1971; Stewart, 1973). When this tram network opened in 1884, nearly 500 passengers used its service on the first day. The new public transport network quickly became popular as it allowed for fast, efficient and relatively cheap movement around the city. What was particularly appealing was its smooth ride – Auckland city was notoriously known for its poor quality road network at this time, which made road travel unpleasant (Bush, 1971). This new popularity however resulted in the problem of overcrowding, suggesting that there were not frequent enough services being supplied to meet the demands of the public.

To make room for the tramway, the Council ordered horse bus operators to move off the centre of roads where they had traditionally operated from. Initially, they refused to move and later in retaliation, pursued to compete against the trams. This initiated the bus versus tram wars of 1884 (Stewart, 1973). Most passengers however were prepared to wait longer for a tram instead of taking the bus – in part perhaps because of the smoother ride it offered and its popularity. This popularity continued into the early 1900's, with media placing much focus on the newly developing morning and evening rush hours. Figure's 4.2 and 4.3 show two images which appeared in the early 1900's showcasing the popularity of the Auckland tram network. Figure 4.2 is a cartoon from the Auckland Weekly News. This cartoon depicts the newly occurring 'five o'clock rush'. In it, working-class passengers are pushing and shoving to catch the tram. The left of the picture shows a dishevelled businessman and two battered-looking women who have missed out. The right side of the figure shows a thief who has stolen a ladies purse in the commotion, and a man trying to jump through the window in a desperate attempt to get onboard. Figure 4.3 is a postcard entitled 'The last car for Parnell' where an overwhelming number of passengers are clamouring to get onboard the last tram for the day. This figure was used to depict to tourists and visitors the extreme popularity and novelty of Auckland trams.

Figure 4.2: Newspaper cartoon depicting the new popularity of the tram network.

Source: (Stewart, 1973, p. 60). Figure originally from Auckland Weekly News, 1910.

Figure 4.3: Postcard depicting the popularity of the Auckland trams, entitled 'the last car for Parnell'.



Source: (Stewart, 1973, p. 75). Figure originally from Alexander Turnbull Library collection, National Library of New Zealand.

The trams were designed to carry thirty-eight people – twenty-four seated and fourteen standing. However, it was common to see as many as seventy passengers boarding one tram. This meant that trams were sometimes carrying nearly twice the number of passengers they were designed to carry safely (Stewart, 1973). The Auckland Weekly News commentated on the effect of this new transport trend. They stated that the trams have brought with them disorderly behaviour and have created for the first time a 'rush hour' where passengers push and shove to cram onto morning trams to get to work in the city only to repeat the process in the evening to get back home to the suburbs (Stewart, 1973).

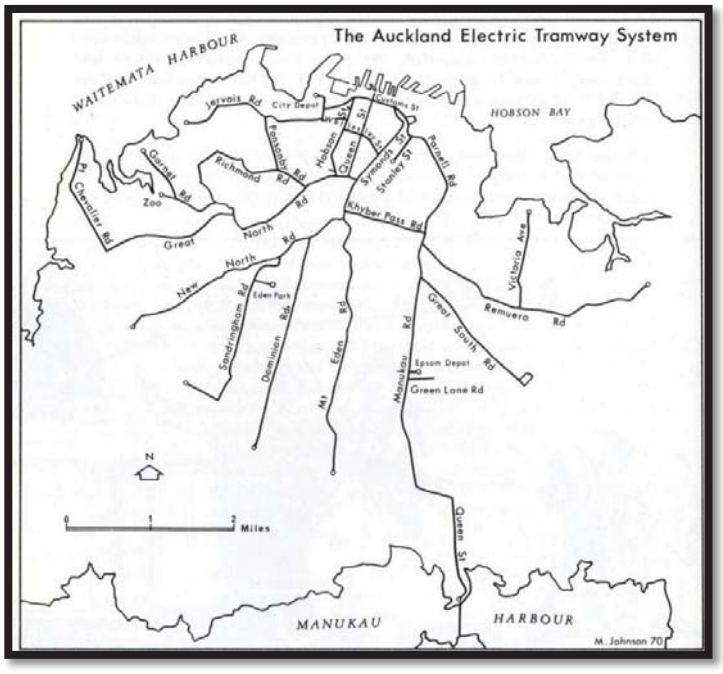
This new travel trend was the result of outward suburban expansion occurring along the tramway corridors (Stewart, 1973). Despite this outward expansion, development patterns remained concentrated. This worked to retain the compactness of the city, albeit in a different form than previously witnessed. Previously, development had been restricted to the central city. The nature of this new development is portrayed in figure 4.4. The figure is a photo showing Auckland's Queen Street taken in the 1880's. In the photo, activities are centred along tramway corridors. Shops are oriented towards the tram (and bus) networks with there being plenty of sidewalk space for the pedestrians they carry. This photo also shows horse-buses to be running along the tram corridors where they effectively competed with tram services for passengers.

Figure 4.4: Photo looking down Queen Street to Customs Street, taken in the 1880's.

Source: (Stewart, 1997, p. 31). Figure originally from E. A Wildy, Auckland Institute and Museum collection.

Upgrades to the tram network came through its electrification in 1902. Over 70,000 people came on opening day to see this new technology with the New Zealand Herald considering the improved tram system to be one of the finest rapid transit networks in Australasia (Stewart, 1973). By the time of electrification, the tram network was extensive, stretching from coast to coast as portrayed through figure 4.5.

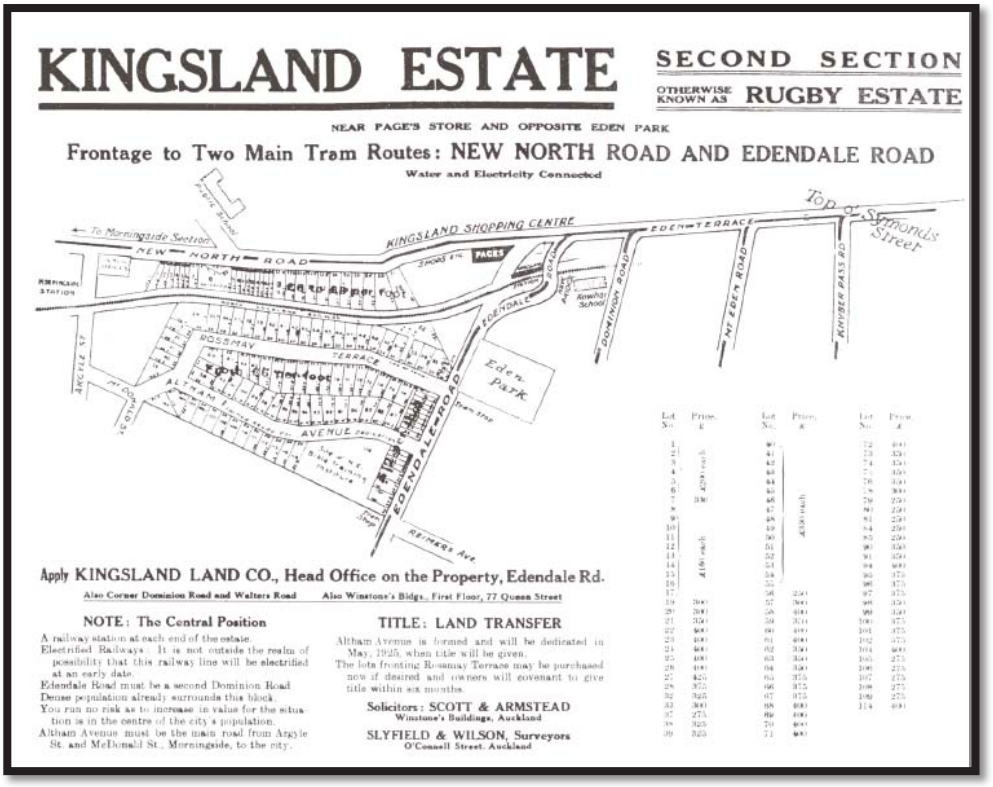
Figure 4.5: The Auckland tramway network



Source: (Bush, 1971, p. 240). Original source unknown.

The increased speed and reliability of the electric network worked to further encourage the outward expansion of the city along tram corridors (Stewart, 1973). This trend however was not restricted to New Zealand with it being a common phenomenon occurring overseas. For example, in the United States and Britain, tram and rail developments increased accessibility and consequently also increased surrounding land values. New Zealand real-estate entrepreneurs were aware of this overseas trend and as a result, took full advantage of the suburban expansion that tramways here initiated (Bloomfield, 1975; R. Stone, 1973). Subsequently, the development of urban tramways in Auckland was driven through the desire to raise land values and make a profit (Dahms, 1980; Hickman, 2003; Humphris, 2010; Stewart, 1973; Watson, 1996). This trend started with the first horse tramways where entrepreneurs would advertise residential subdivisions along new tram lines (Bloomfield, 1975). Figure 4.6 shows one advertisement from the mid-1880's that was used to promote a new residential subdivision along two tram corridors. From the figure, it can be seen that the main selling point to people is that the subdivision has 'frontage to two main tram routes' that travelled along New North and Edendale Roads.

Figure 4.6: Advertisement for a new tramway subdivision



Source: (Bloomfield, 1975, p. 116). Figure originally from the Vaile Collection, Auckland Institute and Museum.

During this period of transport and real estate investment, the Auckland tramway company also set aside land for sporting attractions which included the development of a racecourse and football grounds with complementary grandstands and facilities. By developing the surrounding tramway land in this way, trams would experience increased patronage levels in addition to further increasing surrounding land values (Stewart, 1973). The tram company also built accommodation to specifically provide a place for visitors and tourists to stay, with newly arriving visitors to Auckland via incoming paddle steamers being the focus for this accommodation (Stewart, 1973). Although to a lesser extent, the Government also worked to profit from the increase in land values surrounding newly laid rail corridors (Sinclair, 1999).

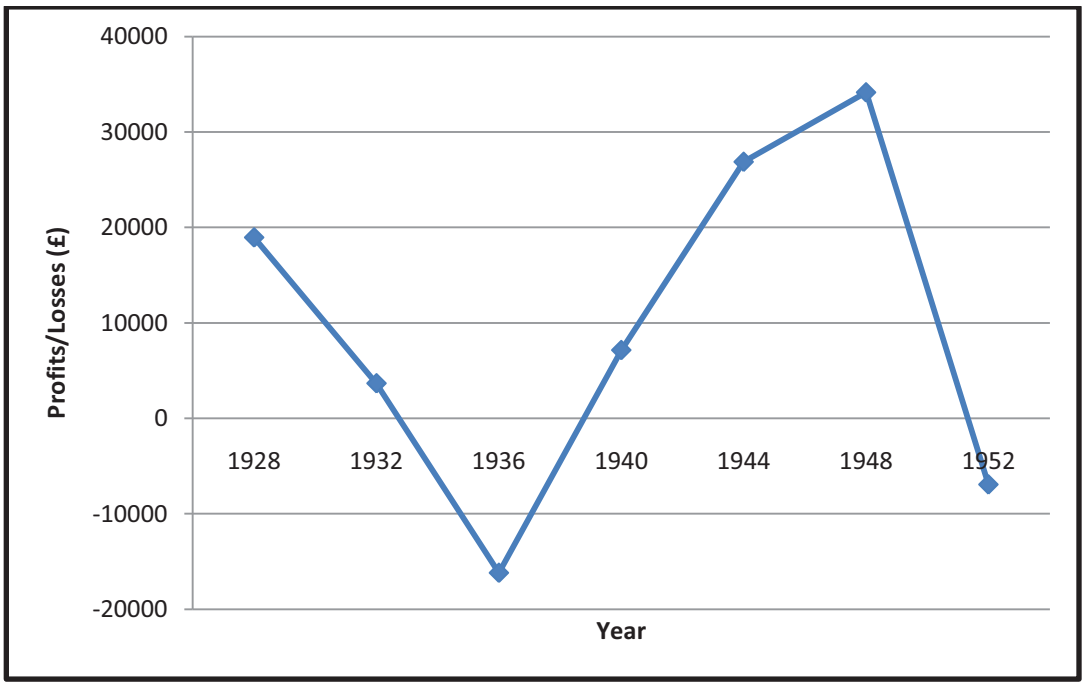
Despite profits gained through land developments, both tram and rail revenues struggled from the 1880's with the Auckland tramway company becoming bankrupt by 1890. This was attributed to low capitalisation levels, low fares being charged to passengers, in addition to the 1880's economic recession (Bloomfield, 1975; Bush, 1971; R. Stone, 1973). Moreover, the Auckland City Council was requiring that the tram company improve entire roadways where tram lines had been laid (Bloomfield, 1975). This worked to further add to operation costs. Additionally, continued competition from bus operators had resulted in decreased profit levels (Stewart, 1973). Trams had become increasingly ineffective in competing with buses because of the continued operational requirements imposed by the Auckland City Council. Buses were not required to maintain minimum service levels, meaning that they were effective in competing with trams. The buses competed by racing trams stop to stop for their passengers. Buses also worked to undercut tram fares (Bloomfield, 1975). Rail was also affected in much the same way as trams were, with their patronage and profitability being affected by bus competition, the recession, and private vehicle travel (Bush, 1971; Dahms, 1980; McDonald, 1974; Stewart, 1973).

After the tram company declared bankruptcy, its assets were acquired by the Bank of New Zealand Estates Company (Bloomfield, 1975; Bush, 1971; Stewart, 1973, 1997; R. Stone, 1973). The bank then proceeded to lease the network out to private operators. This new institutional structure proved highly ineffective however, and by the 1910's the network was deemed to be grossly mismanaged. This was because the lease holders, the British Electric Traction Company were not honouring their obligations under the Deed of Declaration. In response to this, the Auckland City Council decided it vital to purchase the tram company (Bush, 1971). In a newspaper pole, ratepayers showed to support this council decision through a four to one majority vote. 1,672 votes were received - this was however less than 20% of the population (Bush, 1971; New Zealand Herald, 1919). As a result, the tram network moved into public

ownership for the first time in 1919 when the Auckland City Council officially purchased the network from the bank for £1,143,750 (Bloomfield, 1975; Bush, 1971).

Once in public ownership, the tramways began to make a profit, with profits only dropping through the economic recession of the 1930's. The Second World War though saw an increase in profit levels once again (Bush, 1971). These increased profits during the War are attributed to high private vehicle restrictions such as petrol rationing and rubber tyre shortages, which made private vehicle travel expensive and difficult. Shortly after the War however, profit levels plummeted. This has largely been attributed to an upsurge in private vehicle numbers and their popularity. Bush (1971) reported that car registrations in Auckland were less than 1000 in 1913, increasing to 12,000 by 1923, and further increasing to 25,000 by 1929. Figure 4.7 works to portray these changes in profit levels from 1928 to 1952.

Figure 4.7: Auckland tram profits from 1928 to 1952

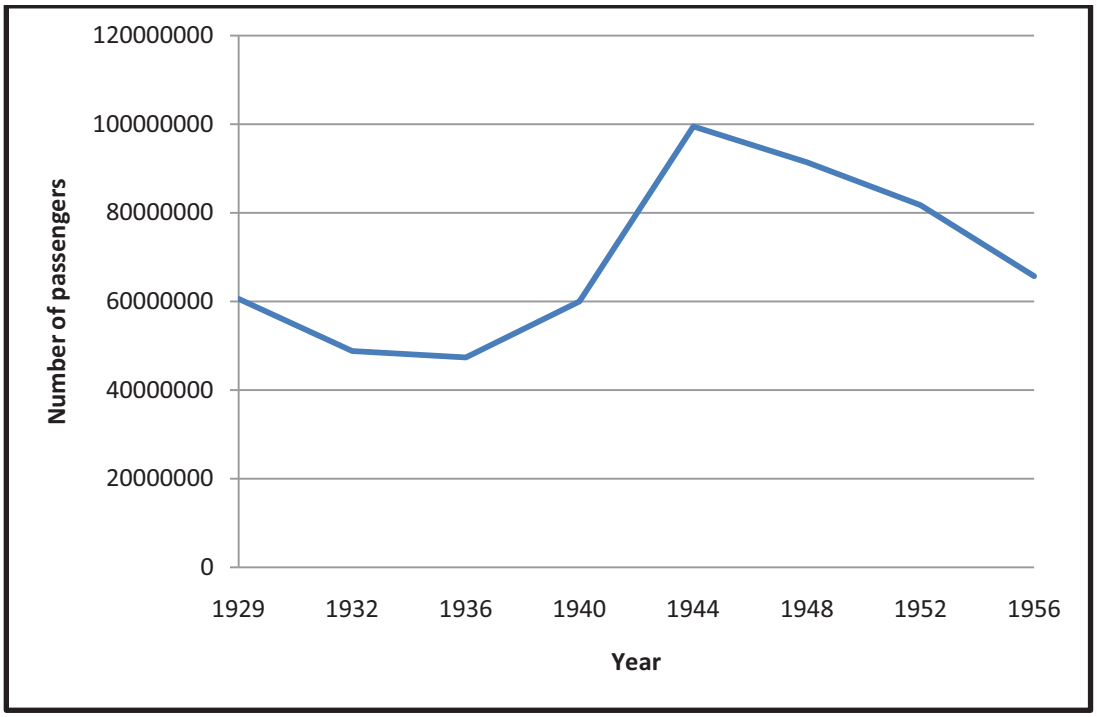


Source: (Figure by Author. Data compiled from Registrar General, 1928-1956).

Tram revenue patterns closely corresponded with patronage levels, showing passenger numbers to have the largest influence over profit levels. The changes in patronage levels from 1929 to 1956 are shown in figure 4.8. In the figure, decreased passenger numbers from the 1920's was the result of extensive motor bus competition. The bus versus tram wars was re-ignited in 1919 with the public purchase of the tram company. Once in public ownership, the council required buses to move from their stations, which were in front of the post office. The

post office attracted a lot of tourists and sightseers, whereas the side street they were delegated to had poor custom levels in comparison (Stewart, 1973). As a result, the bus companies were angered and actively worked to pursue tram passengers once again by racing trams stop to stop and by undercutting fares (Bush, 1971; Dahms, 1980; McDonald, 1974; Stewart, 1973). As a result, the number of buses serving Auckland increased, with them becoming well patronised at the expense of tram and rail networks (Stewart, 1973). Increased passenger numbers seen during the Second World War followed heavy private vehicle restrictions, with the decrease in passengers after the War following a large upsurge in private vehicle travel (Bush, 1971).

Figure 4.8: Auckland tram passengers from 1929 to 1956



Source: (Figure by Author. Data compiled from Registrar General, 1928-1956).

Competition relief for trams and rail networks eventually came through the Motor Omnibus Traffic Act 1926. This Act created a system for the Government licensing of transport with the aim being to reduce wasteful competition and to maintain minimum safety levels. This Act allowed a bus operator to operate granted they follow conditions relating to safety, timetables, and fares for passengers (McLeod, 1966). This Act specifically contained provisions prohibiting bus competition with trams except where they charged fares which were two dimes more than tram fares per section (Registrar General, 1928-1956). In other words, for the first time, buses were now legally prohibited from competing with tram and rail services

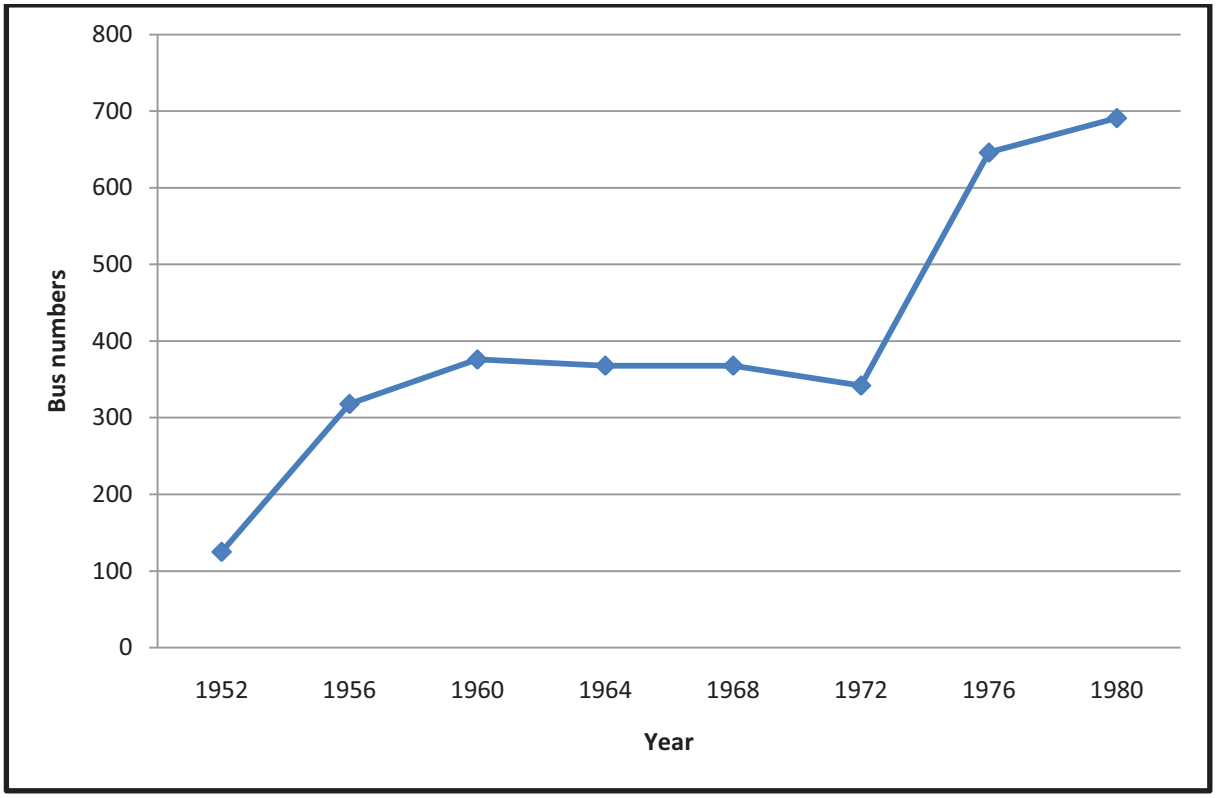
(McDonald, 1974). This Act however also meant that private bus operators would receive subsidies from local bodies to run their services, which then worked to the advantage of private bus operators (McLeod, 1966).

The Omnibus Act was later followed with the introduction of the 1928 Auckland Transport Board Act. This Act allowed the Auckland Transport Board to strictly control passenger transport in the city (Bloomfield, 1975). It was at this time that the emergence of new private bus operators stopped, with public operators becoming more dominant over the following decades. The effect of these Acts was quickly seen with regards to profits. For instance, in the 1927/28 financial year, the tramways carried 63,000,000 passengers and made a profit of £18,500, whereas the private buses made a £60,000 loss (Bush, 1971).

4.3.2. Publically provided public transport - 1950's-1990's

By the 1950's, institutional structures in Auckland had shifted from a predominantly privately provided public transport, to a largely publically provided industry. Rail and tram networks were already publically provided by this time, with public bus networks greatly expanding from the 1950's. The only exception was the still privately provided commuter ferry services. The growing dominance of the public bus network in Auckland is portrayed through figure 4.9 which shows the number of public buses operating in the city from 1952 to 1980. In 1952, public bus numbers were relatively small, with there being 125 in operation. This had risen to 368 by the 1960's; with bus numbers sharply increasing again in the 1970's to reach 691 by 1980. By 1954, public buses made up sixty percent of services, compared to forty-five percent in 1945 (McDonald, 1974). Such increases in public bus numbers came through the acquisition of private companies. Furthermore, New Zealand Rail provided their own bus fleet to act as feeder services to and from the rail network during the 1950's (McDonald, 1974).

Figure 4.9: Number of local authority trolley buses and buses from 1952 to 1980



Source: (Figure by Author. Data compiled from Registrar General, 1952-1980).

The implementation of rail feeder bus services was in response to falling patronage levels. These feeder buses worked by transporting passengers to and from rail stops in an attempt further retain and attract passengers (McDonald, 1974). This New Zealand rail feeder service was initially effective, with the company making an $18,000 profit in 1952. Despite these efforts however, profits started to fall, and by 1972, the rail made a loss of $89,000. This trend was partly the result of decreased passenger numbers, which continued through to the 1980's (McDonald, 1974). Similar patronage and profit losses were also being experienced by the local authority bus networks. For instance, passenger numbers fell from 93,076 in 1951 to 39,356 in 1971. This resulted in falling profits, which the council responded to by continually increasing fares. In 1951, a single fare was $2.56. This had increased to $9.40 by 1971 (McDonald, 1974). Increasing fares however worked to further detract passengers from using the services.

Bus and rail profits were also affected through the offering of concession tickets, with rail services in particular being obligated to offer numerous concession fares (McLeod, 1966; Stewart, 1973). In 1920, over half of all rail passengers paid full fares. This had dropped to less than one third by 1960 (Humphris, 2010). The reason for this was that concessions tickets were now being offered to a greater proportion of the population than before. However,

despite these falling patronage and profit levels during this time period, public transport use in Auckland was still very favourable. In fact, during the 1950's, patronage levels were comparable to many other World cities of the time with patronage averaging over 100,000,000 passenger trips per annum (Lee, 2010). This number is over twice the passenger numbers seen today despite there now being a much larger population (Lee, 2010). From the 1960's however, this favourable public transport use significantly changed. From this point, patronage levels declined with this drop being the largest and sharpest in Auckland's public transport history.

This decline was largely influenced by a change in transport planning direction. Initially, through the 1946 Auckland Rail Plan, the Ministry of Works had planned to expand and electrify the rail network (Lee, 2010). This would have been the next logical step in Auckland's rail development. These plans however were abandoned in 1954 (Lee, 2010). These plan changes coincided with the introduction of the first master transportation plan for Auckland, which changed the city's transport focus from public transport to private vehicle travel. This plan recommended that an inner ring road to be constructed around the central business district, linked by express urban motorways. The plan also proposed that extensive parking facilities be provided in the inner city. Through the further recommendation to discontinue the previous rail upgrade, this plan almost exclusively favoured private transport above and instead of public transport and active travel alternatives (Harris, 2005; Mees & Dodson, 2001). This meant that the Auckland rail system failed to be electrified and expanded in the 1950's. These decisions also coincided with the withdrawal of the electric tram network – a particularly popular and well patronised public transport system. It was since this change in transport planning direction that patronage levels started dropping in spite of continually increasing population levels (Mees & Dodson, 2001).

Subsequent planning approaches and decisions have worked to reiterate this new transport planning direction, engraining it into everyday life. For instance, Auckland's second attempt at electrifying and expanding the rail network was disallowed through key decisions made. This rapid rail scheme had been developed in response to rising congestion concerns. The Mayor of Auckland City Council, Sir Dove-Myer Robinson believed this plan to be the only way to reverse the extreme decline in public transport usage that had been experienced since the 1950's. Consequently, the labour government of 1972-75 committed to the scheme. However, the rail scheme failed to gain approval with the successive national government in 1976 who negated

on the financial commitment made by the labour government (Auckland City Council, 1998). This meant that this rail upgrade could no longer go ahead.

This change in transport direction coincided with the decentralisation of Auckland, with land-use patterns then becoming segmented and dispersed (Macdonald, 2006; Mees & Dodson, 2001; Statistics New Zealand, 2006c). Public transport however did not adjust or adapt to these changing development patterns. Auckland's public transport was still servicing the traditional 'suburb to city' commuter movements in the 1970's. However, by this time, business and travel needs were already scattered throughout the city and people were no longer travelling as they had done in the past. As a result, public transport had quickly become ineffective and was struggling (Badcock, 1970; Fitzsimons, 1981; William, 1975). It is not surprising then that by the 1970's private vehicles were being used over and above public transport in Auckland (Badcock, 1970; Boileau, 1970), with there being 1,500,000 trips made in cars compared to 200,000 trips made on buses in 1970 (William, 1975).

4.3.3. Privately provided public transport - 1990's-2000

The 1990's brought about changes in institutional structures so that all public transport services in Auckland became privately provided. This was a forced change by Government which saw all publically provided bus and commuter rail services (ferry services had remained privately provided throughout) forced into privatisation (Humphris, 2010). This change was spurred from international thinking of the time which focused on economic rationalisation and free market ideology. Publically provided transport was perceived as being costly and inefficient. Auckland's public transport system was showing to be no exception to this international trend. For example, throughout the 1980's, publically provided bus and commuter rail services continued to have decreasing patronage levels while also experiencing large annual deficits. In 1991, public transport revenues were $45,127,602 while expenses almost doubled this figure at $88,461,296 (Backels, Newman, & Kenworthy, 1999). Public transport had continued to struggle, showing to be incapable of successfully catering for the low density and segmented land-use patterns of Auckland. As a result, private vehicles had become a necessity of life with it being widely perceived as impossible by transport planners to change this trend so that public transport would become a desirable travel option (Grieve, 1992; Peterson, 1990).

This change of institutional structure was initiated by the Muldoon Government of the late 1980's. To allow for the privatisation of public transport services, the Government passed three significant pieces of legislation. Firstly, the Local Government Reform Act 1989 worked

to corporatize local authority public transport systems. This Act required public authorities to make any transport companies they had under their control separate entities or to sell them completely. Regional Council's were to become regulating authorities of the industry, deciding on minimum service requirements and tendering out operations to private operators.

Secondly, the Transport Services Licensing Act 1989 removed the ability to licence specific routes to individual providers. This effectively removed protection for buses by introducing competition to the market (Ashmore & Mellor, 2010). This meant that no public transport operator could control a specific route in a city. In essence, this worked to stop multiple operators from running fragmented and disjointed routes. The idea behind this was that public transport should operate as one efficient system instead of several piecemeal and overlapping services. Routes would now be decided upon by the Auckland Regional Council (Humphris, 2010). The introduction of this Act however meant that regional councils had little influence in implementing the form of public transport they desired. The reason for this was that if a public transport operator did not require a subsidy, then they were not obligated to cater for regional council directions (Gibson, 2010). This also meant that these operators were not required to allow council access to commercially sensitive data such as revenue and cost figures, along with patronage data (Ashmore & Mellor, 2010). This meant that regional councils now had little knowledge or control over the whole of the transport network operating in their cities. For Auckland, this accounted to just under thirty percent of the public transport network (Ashmore & Mellor, 2010).

Thirdly, the Tranzit New Zealand Act 1989 required public transport operators to be subject to competitive pricing in order to receive subsidies from local authorities (Humphris, 2010). The result of this was for the new private operators to require subsidies to remain profitable just as public operators required public subsidies to cover losses. Less than thirty percent of services operated without subsidies in Auckland (Ashmore & Mellor, 2010). The difference now was that Auckland authorities had limited control over the public transport system that operated within their city.

After the corporatisation of the public transport entities, they proceeded to be sold off to private buyers. In Auckland, the rail service was sold to an American firm, Wisconsin central while the local authority Yellow Bus Company was sold to Stagecoach (Ashmore & Mellor, 2010). The revenues gained from selling these entities were then used to partly cover previous debts incurred by the public companies. As a direct result of privatising public companies

throughout New Zealand, the countries public debt was reduced from sixty-seven percent of Gross Domestic Product in 1984 to sixty percent in 1995 (Sinclair, 1999).

However, once in private ownership, the primary objective had shifted from providing a quality public transport network to focusing on making a profit. As a result, the inefficient and uneconomic public transport lines then proceeded to be either reduced or removed (Humphris, 2010; Watson, 1996). Although privatisation did result in efficiency through decreased labour costs and lowered subsidy costs in real terms, this was achieved at the expense of passengers who continued to stop using the service provided (Ashmore & Mellor, 2010). From 1991 to 1996 passenger numbers had dropped fifteen percent (Backels, et al., 1999). This drop in public transport patronage was in turn being replaced with private vehicle travel. For example, in 1991, 7.6% of people in Auckland travelled to work by public transport, with 84.9% using private vehicles. By 1996 though, public transport travel had decreased to 7.3%, with these people moving onto private vehicles, which has increased to 86.7% (Backels, et al., 1999).

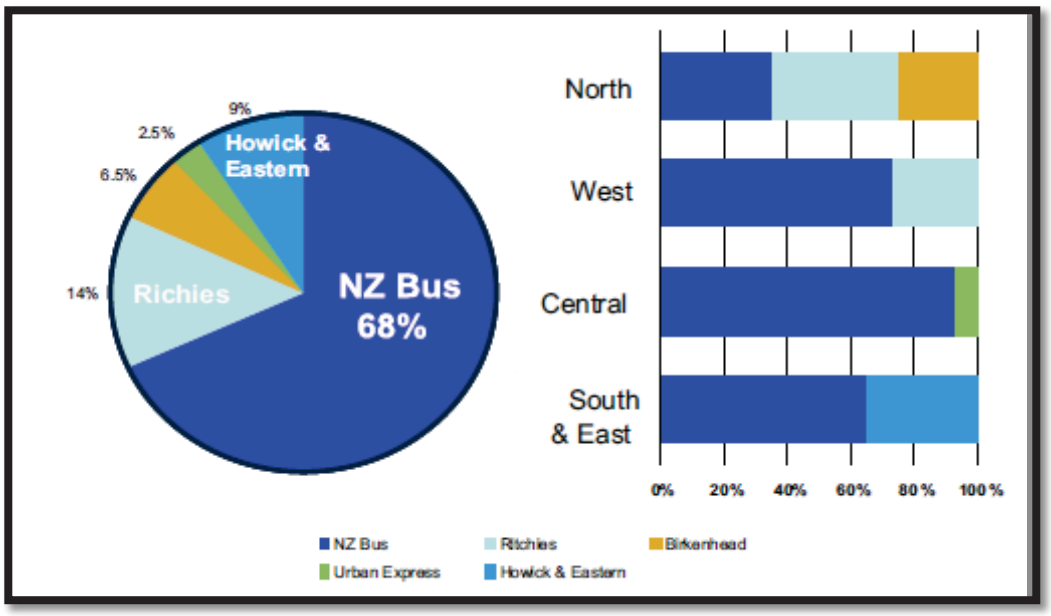
4.3.4. Public-private partnerships – 2000 – now

The start of the new millennium again saw changes to the institutional structures of public transport. From 2000, public transport institutional structures have resembled a form of public-private partnerships. In this situation, the Auckland Regional Transport Authority (ARTA) has been the regulating body, with private firms placing tenders to ARTA to operate the bus and commuter rail networks. Despite this restructure, changes in the management approach to public transport remained the same. Focus remained on promoting the innovation of the private sector by increasing efficiency through competition and reducing costs through a tendering process (Gibson, 2010). The introduction of the 2008 Public Transport Management Act set to address this. This Act requires operators to meet minimum service standards along with sharing information such as patronage data that was previously deemed commercially sensitive. Such legislation has meant that public transport operators can now be forced to integrate services, ticketing and fares if instructed to by the regulating authority (Gibson, 2010).

Since 2000, many restructures have occurred at the central government level. For instance, the 2003 Transport Management Act saw the formation of the New Zealand Transport Agency. In 2005, Transfund New Zealand and Land Transport Safety Authority merged to become the New Zealand Transport Agency. In addition, 2005 also saw Stagecoach sell their bus company to Infratil who in turn rebranded the company New Zealand Bus. Currently, New Zealand Bus

caters for sixty-eight percent of total urban travel (over ninety percent in central Auckland) (Ashmore & Mellor, 2010). Other private companies still operate in Auckland, including Howick and Eastern, Urban Express, Birkenhead, and Ritchies. The market share of each of these providers is shown through figure 4.10, which shows the current bus market for Auckland.

Figure 4.10: The market share of bus operators in Auckland



Source: (Ashmore & Mellor, 2010, p. 166).

The presence of multiple bus operators however has the effect of undermining attempts made to provide a quality public transport bus network. This is because the different bus companies present are effectively competing with each other (Mees, et al., 2010). In addition to this competition, there is no coordination between rail (provided by Veolia), bus or ferry networks. Bus lines are not acting as feeder services to rail stations. Instead, they offer public transport lines that run parallel to rail lines. This effectively competes with rail services through the offering of parallel routes (Mees, et al., 2010). Such competition between different bus operators, along with competition between bus and rail operators has worked to create a public transport service in Auckland which is very dense and complex (Mees, et al., 2010). This complexity however has not translated into a comprehensive and full service being offered. In fact, public transport coverage remains poor despite this complexity, in addition making it difficult for users to understand.

In an attempt to overcome the lack of coordination occurring within the public transport industry, ARTA (now Auckland Council) set about creating a system where information for each

individual provider operating in Auckland would be brought together under one brand, known as MAXX. Starting in 2009, this brand has sought to make travelling using public transport easier for users to understand. The purpose of this was to attract and retain public transport users. Although the brand has helped to make planning public transport journeys simpler for users, it has not addressed any of the coordination issues present in the city. Each individual provider uses their own fare system, with there being little provision of transferrable tickets between providers. This works to undermine efforts made to bring the network together under one brand because the system cannot be used as a single network. Individual pricing strategies mean that users will use as few public transport lines as possible to avoid the need to change between providers.

It might not be much of a surprise then that public transport usage rates for Auckland are among the lowest in the World (Mees & Dodson, 2005). In fact, today, "Auckland's per capital public transport patronage is the worst of any major city in Australasia and Canada" (Lee, 2010, p. 10). Although Auckland has a motorway network that rivals many overseas cities, this has been at the expense of public transport (Mees & Dodson, 2001). Table 4.1 uses results of the last three census's to show this low level of public transport use in comparison to private vehicle travel. Through the table, it can be seen that public transport journey to work trips average about 7% of total trips. This is in comparison to about 87% of journeys being made by private vehicles.

Table 4.1: Modal split of commuters travelling to work in the Auckland region.

	Auckland Region		
	1996	**2001**	**2006**
Car	87.0	87.9	87.4
Public transport	6.8	7.0	7.0

Source: (Table by Author. Data compiled from New Zealand Government, 1996-2006).

A partial explanation for continually low patronage levels is that the current public transport network is not effectively catering for the travel demands of the people it serves. For instance, the current public transport system almost exclusively caters for passengers who travel from an outer suburb into the central city. The Northern Express is one example of this as it specifically targets North Shore commuters travelling to and from the central city (Raea, 2007). Providing such a system however means that cross city travel is still not being catered for. Although there will always be a demand for public transport travel into the central city, it is not

the primary travel destination in Auckland as it once was (William, 1975). Therefore, for public transport to be successful and attract passengers, it needs to better serve their needs. Although the public transport network has not been redesigned to cater for complex travel patterns, investments are being made towards improving public transport in Auckland. Such investments include the expansion and electrification of the rail network. As a direct result of this investment, rail patronage has increased from 2.5 million trips per annum in 2003 to 9 million trips in 2010 (Lee, 2010). Such patronage increases work to show that improvements to the public transport network will result in increased patronage levels.

4.4. Conclusion

Examining Auckland's history has revealed four distinct institutional structures to have been present from 1840 to 2010. The mixed institutional structures of the 1840's to 1950's focused on providing for an emerging transport demand in the city in addition to allowing for colonisation and immigration. This institutional structure saw the establishment of the first public transport networks in the city. Competition between buses and trams however worked to undermine this network development. The public institutional structure present during the 1950's to 1980's coincided with the most successful period of public transport in Auckland's history. This was when transport planning focused on providing access opportunities for all through the provision of a full and comprehensive public transport network. At this time, the railway provided feeder buses to the network. Additionally, buses were coordinated with incoming ferry services. This helped to create a connected and integrated public transport network. The privately provided transport of the 1990's saw limited success through their focus on profits and economic efficiency. Today, the priority of the public-private partnerships is on increasing patronage levels and reducing private vehicle travel. To date however, this structure has seen limited success. Competition between different modes remains with buses running parallel routes to rail lines. This contributes to a disjointed and poor quality service. In summary, each of these four institutional structures has worked to shape, influence and create the public transport network seen today. Therefore, their success and failures need to be learnt from and considered when making future decisions regarding public transport in Auckland.

5. Auckland public transport service provision analysis

5.1. Introduction

Public transport line structures, frequency, ease of transferring and fare structures all play an integral role in its success. As a result, the way in which these elements are designed and managed by public transport planners will significantly contribute towards public transport usage. This chapter aims to critically assess the current state of public transport services in Auckland. The purpose of this is to identify the type of line structures, frequency, transferring and fare structures currently present in Auckland in order to answer four of the subsidiary research questions. In working towards this, a regional scope of Auckland's public transport will be used. Localised case studies from within the wider regional system will be utilised to demonstrate key points made throughout the chapter. Figure 5.1 shows the location of these case studies.

- The 680, 681 Howick and Eastern bus line in East Auckland will be used as a straight line case study. These lines have undergone simplification measures so that they move more directly from Botany to Downtown.
- The 660, 661 Howick and Eastern bus line in East Auckland in addition to its surrounding area is used as a straight line case study. These lines have undergone simplification measures to remove the complex bus system previously operating in the area. The 660 bus line is also used as a case study of reliability.
- The 750, 755, 756, 757 Metrolink or Waka Pacific provided bus line is used as a meandering line case study. This line travels from Otahuhu in South Auckland to central Auckland.
- The 008, 009 Urban Express bus lines are used as case studies for cross-town bus travel. These bus lines have undergone changes to accommodate for this, moving across suburbs from New Lynn to Sylvia Park.
- The 446, 447 Waka Pacific bus line is used as a case study of a radial bus line. This line moves from Manukau City in South Auckland to central Auckland.
- The 007 Metrolink bus is used as a case study to test transfers. This bus line moves from St. Heliers to Pt. Chevalier in central Auckland.
- The 886 Ritchies bus line is used as an example of transferability in Auckland. This North Auckland bus line moves from Long Bay to Constellation Station.
- The b.line buses have been used as frequency case studies. These Central Auckland buses run along Dominian and Mt Eden roads to downtown Auckland.

- The Northern Express bus line is used as a best practice example in Auckland for all four elements. It travels from Albany in the North Shore to downtown Auckland. The surrounding feeder network will be used as a case study example also.

Figure 5.1: The location of case studies used

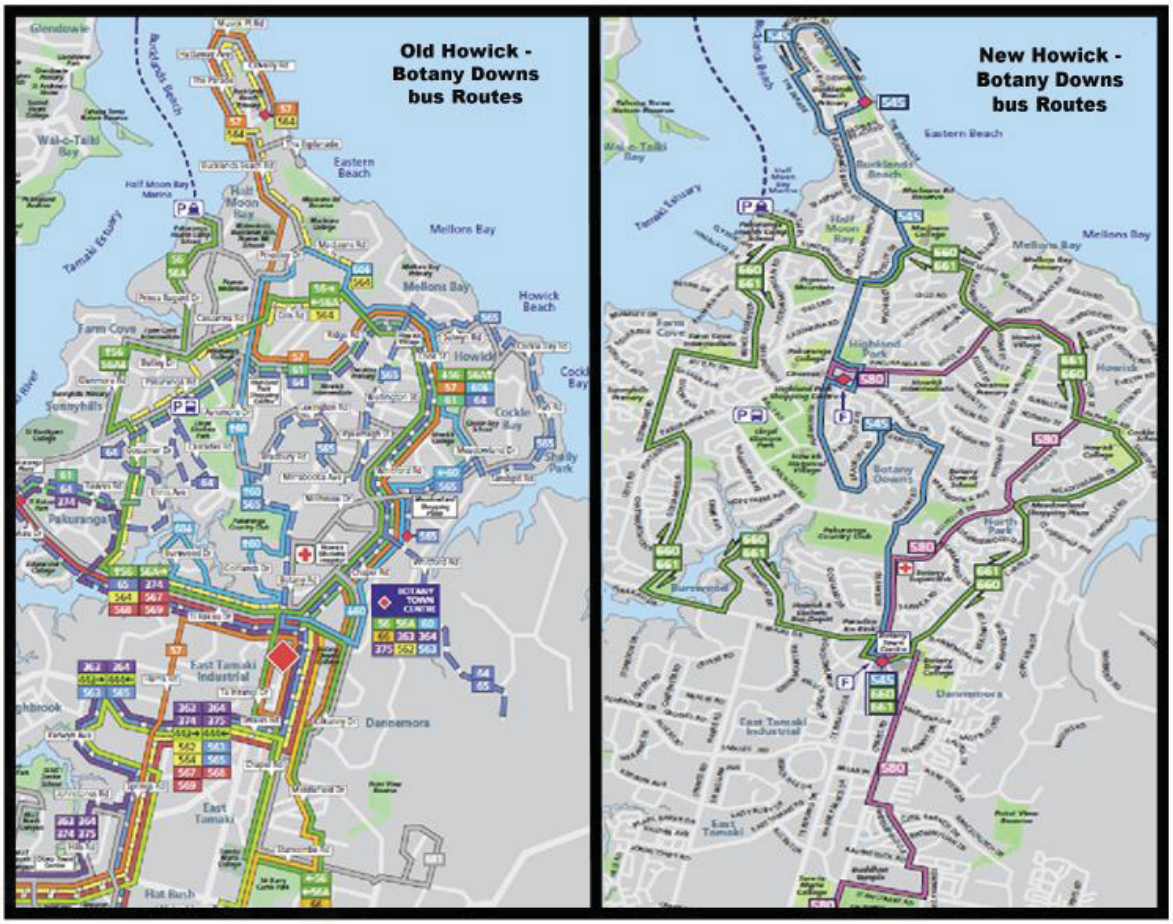
Source: (Figure by Author, 2010. Background adapted from Google Maps, 2010).

5.2. Line structure analysis

For public transport line structures to contribute towards successful public transport in a city, they need to be simple. A simple bus line is one that is easy for passengers to use, is clear to operate and moves in a logical and direct path from origin to destination. Auckland however, is notoriously known for its overly complex bus network with public transport users stressing this as a major barrier towards increasing public transport usage (Auckland Regional Transport Authority, 2010f).

As a result of this complexity, transport planners have been working towards simplifying the most complex bus lines. The simplification of bus routes, so that bus lines move in a relatively direct path from origin to destination (given road layouts and topography), is expected to have a positive impact on public transport patronage. For instance, the Manukau area in particular has been the centre of simplification, with planners focusing on simplifying the overly complex bus lines. This first stage of simplification involved replacing the number 68 bus line with two new lines, the 680 and 681 bus lines that move from Botany Town Centre to downtown Auckland. After the first stage of the simplification initiative, patronage had increased by 47% only one month later (Auckland Regional Transport Authority, 2008b). Once all simplification measures within Manukau were completed in February 2009, patronage levels increased a further 60% (Auckland Regional Transport Authority, 2009b). These final simplification changes were applied to the Howick – Botany Downs suburb. These changes are shown in figure 5.2 which shows the routes these bus lines travelled both before and after their simplification. The left map shows the multiple bus lines that once operated whereas the right map shows the bus lines provided today.

Figure 5.2: Location of the Howick – Botany Downs both before (left) and after (right) their simplification.



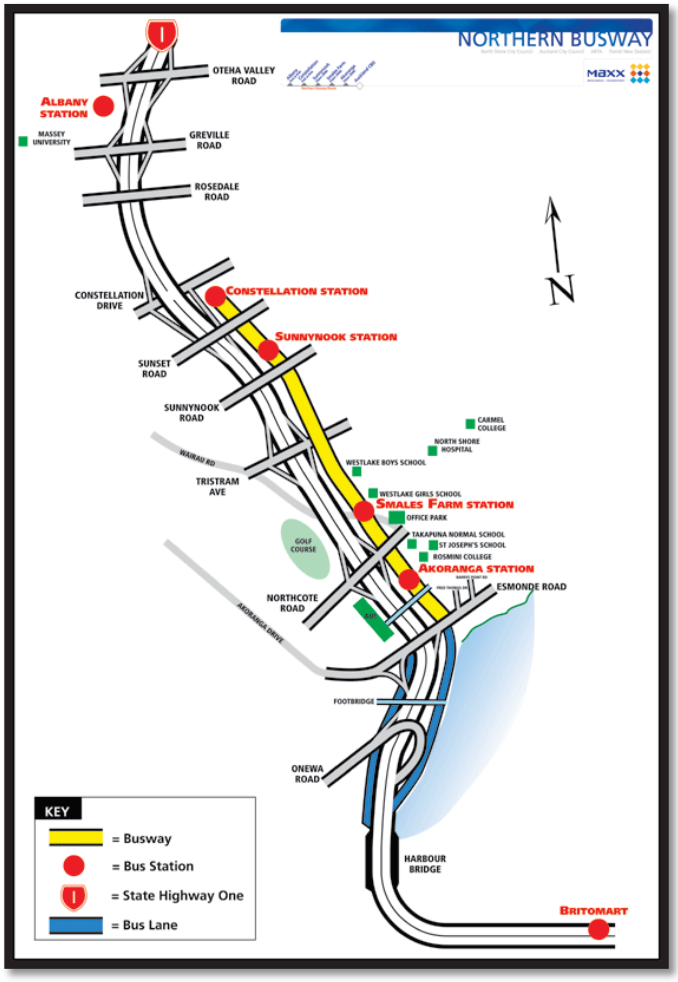
Source: (Maps adapted from Auckland Regional Transport Authority, 2008c, 2010g).

In response to the positive impact of simplifying these bus lines, other simplification measures are said to have also been implemented in north and south Auckland, with these changes being met with increases in patronage levels (Auckland Regional Transport Authority, 2010n). These examples work to emphasise the importance of providing bus lines that are simple to use and understand in a city, and how such changes do make a key difference in the success of public transport.

Within Auckland, the Northern Express provides a good example of a simple bus line as it travels straight to downtown Auckland from Albany by using the most direct route possible. This bus line travels along the first bus right of way to be built in New Zealand, which cost $300 million. Formally opened in February 2008, there are five stations along the corridor – Albany, Constellation, Sunnynook, Smales Farm and Akoranga as portrayed in figure 5.3. The bus right

of way is shaded in yellow and runs a length of 6.2 kilometres (Auckland Regional Transport Authority, 2010m).

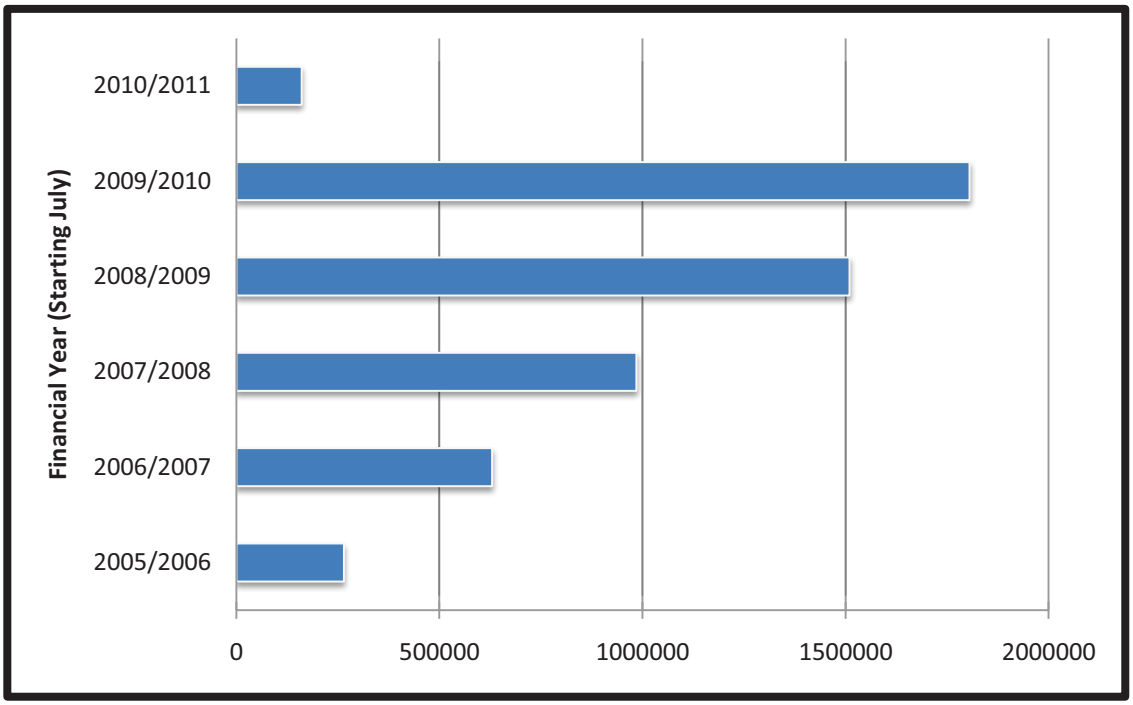
Figure 5.3: The location of the Northern Busway.



Source: (Auckland Regional Transport Authority, 2010m).

The Northern express is proving to be very successful, with patronage levels continually increasing (Auckland Regional Transport Authority, 2010i) as shown in figure 5.4. It should be noted that the 2005/2006 and 2010/2011 years do not show patronage statistics for a full year period.

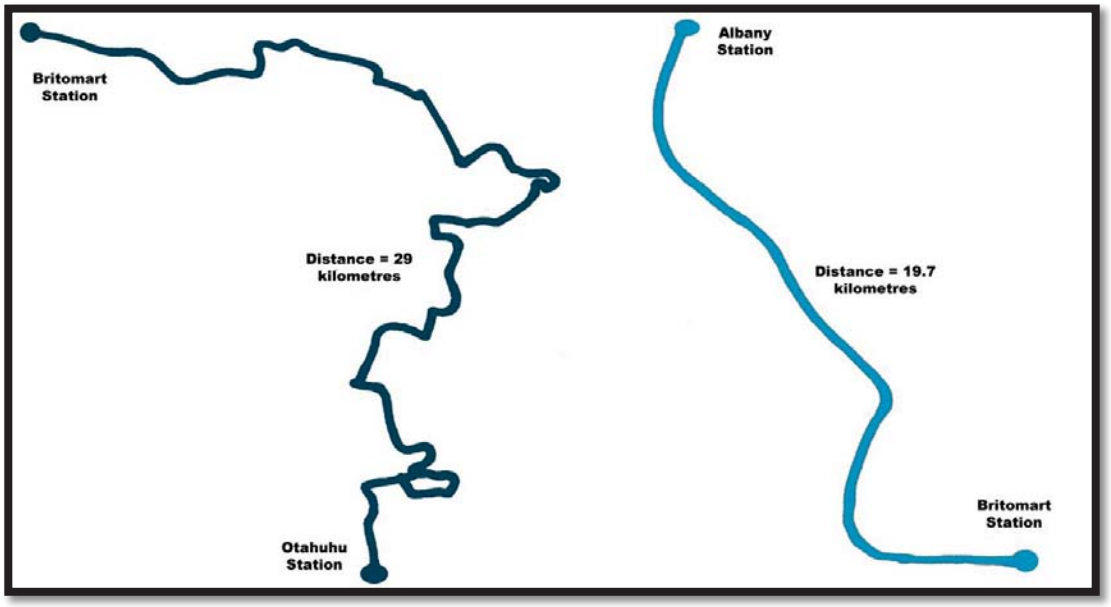
Figure 5.4: Northern Express patronage levels from November 2005 to July 2010.



Source: (Figure by Author. Data compiled from Auckland Regional Transport Authority, 2010l).

Most other bus lines however take indirect routes from origin to destination and meander around many local streets before reaching their destination. One example of this is the 750, 755, 756, 757 Metrolink or Waka Pacific bus line. This bus line travels from Otahuhu into downtown Auckland by travelling through suburbs in Karaka Bay. This difference in line structure design between the two bus lines is shown through figure 5.5. It can be seen that the Otahuhu bus line travels using an indirect path to reach its destination, travelling a total distance of 29 kilometres. This is compared to 18.7 kilometres for the Northern Express. However, if this bus line travelled directly from origin to destination given natural road layouts and topography, the distance travelled would be less than that travelled by the Northern Express.

Figure 5.5: A bus with an indirect route (left) compared to one that takes the most direct path (right)



Source: (Figure by Author, 2010).

Movement type is also important when designing simple public transport line structures. Public transport movements that create a grid pattern are likely to be more successful than public transport networks that create a radial line pattern. Auckland though provides a radial public transport network. This is because the majority of Auckland's public transport lines end in downtown Auckland or at an outer transport centre. Within Auckland, there is one public transport line that does not follow this predominant line structure pattern. This line is the 007 bus which moves from Pt Chevalier to St Heliers Bay as shown in figure 5.6. This bus line travels across town, starting and ending with the natural topography. The figure shows that although main public transport centres like Glen Innes, Greenlane and Mt Albert are destinations for this bus line, they are not the end destination as this bus continues on through past these centres.

Figure 5.6: The location of the 007 bus line.

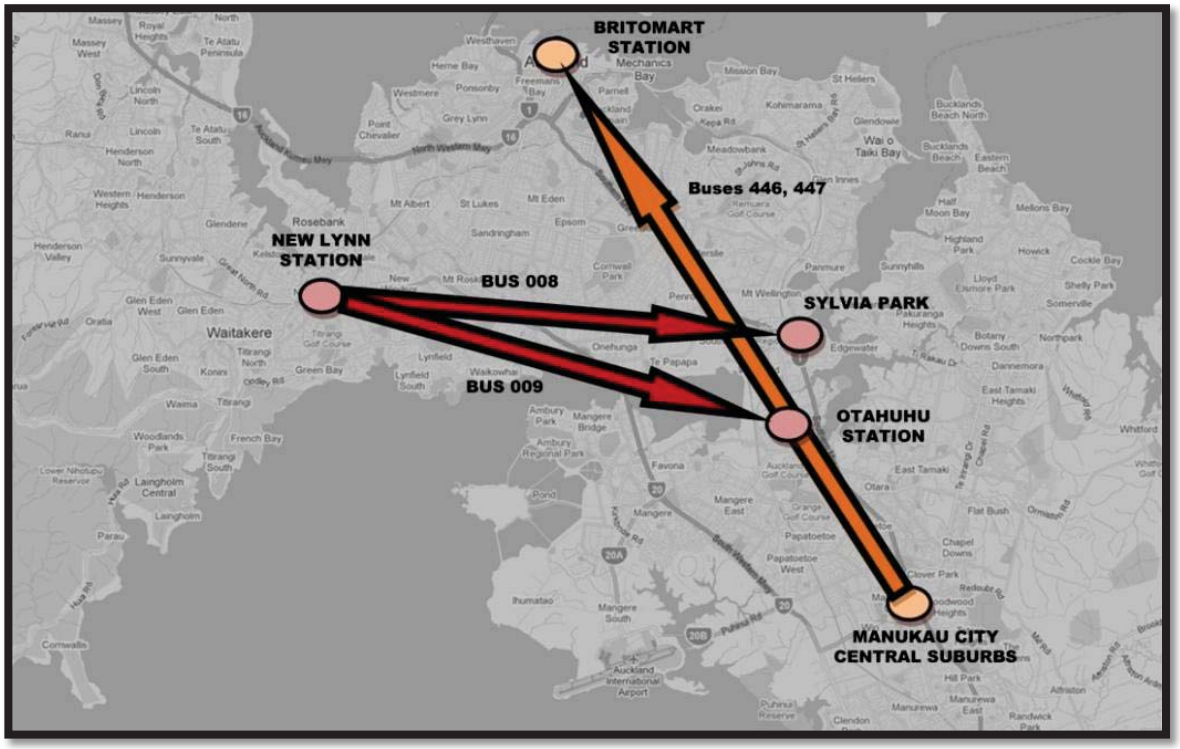
Source: (Auckland Regional Transport Authority, 2010j).

Public transport lines structured like the 007 work to cater for users outside of the traditional peak period commuter. Therefore, if more cross-town lines were provided, then this would work to link the already dominant radial bus lines, creating a number of transfer points. This in essence works to create the network effect where passengers can transfer between public transport lines in order to travel as directly as possible to their end destination. Auckland Regional Transport Authority has emphasised that they are aware of the trend away from peak period commuter movements into the central city, which would require the implementation of more cross town bus lines; “our customers don’t just want services that take them to and from work, they also want to be able to use public transport for leisure activities” (Auckland Regional Transport Authority, 2010o, p. 1). To cater for this changing trend, two cross town routes, the 008 and 009 have been redesigned to focus on shoppers. This however, provides for a demand responsive transport system as it works to change bus lines so that they accommodate for specific users in much the same way that the radial bus lines target peak period commuters. It is more a coincidence that these bus lines move in a cross town pattern rather than designing lines like this to create a grid network.

Despite the reasons behind the implementation of the cross town lines, the 008, 009 Urban Express redesign has resulted in increased patronage growth - particularly in the weekends, with Saturday patronage increasing by 56% on the two lines (Auckland Regional Transport Authority, 2010o). Patronage further increased 31% on the 008 and 009 bus lines in the 2008/2009 financial year (Auckland Regional Transport Authority, 2009b). This has meant that

the Regional Authority has been successful in attracting more weekend shoppers (the users targeted in the redesign of this bus line) to use this bus service. This however can also inadvertently work to demonstrate the importance of providing cross town lines in addition to the traditional radial bus lines already present in Auckland. The success of these bus lines shows that people are demanding travel options outside of the traditional suburb to central city movements and outside of peak travel times. Figure 5.7 works to emphasise the difference in movement of the 008 and 009 cross town routes. They are compared against a traditional suburb to central city radial bus line – the 446 and 447 Waka Pacific line. This bus line travels from the Goodwood Heights suburb in South Auckland, into the central city, with this being a particularly long commute.

Figure 5.7: The difference in movement between the 'cross town' and 'suburb to central city' bus lines.



Source: (Figure by Author, 2010. Background adapted from Google Maps, 2010).

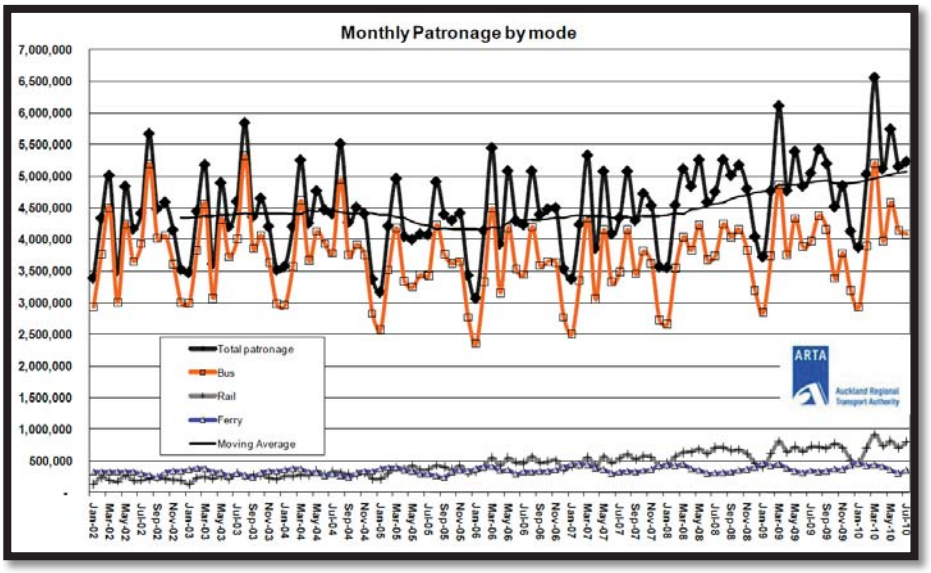
5.3. Frequency analysis

For public transport to be successful, it must also be frequent in addition to offering a simple and reliable service. To achieve this, services must either operate a high frequency 'forget the timetable' system or operate a coordinated 'pulse timetable' system. As the simplicity and reliability of a public transport line has a direct impact on the frequency of the line, these

aspects must also be considered when looking at frequency. Increasing frequency on a bus line that is constantly being made late by local traffic will not work to make public transport more successful unless the reliability of the bus line is first addressed. A reliable bus line is one that can be trusted to arrive at its destination on time, with bus reliability not being determined through the amount of other traffic on the roading network. In fact, many of Auckland's buses are being caught up in the congestion of private vehicle travel. This has a direct impact on the effectiveness that a highly frequent or pulse timetable system would have in the city. McCracken (2009) found that city buses were on average taking longer to commute from Botany Downs to the central city than it does for government ministers to fly home from Wellington to Auckland. This 680 bus line is taking 66 minutes to travel 21 kilometres at an average speed of 19 kilometres an hour. This interestingly is one of the bus lines that have been simplified in the Howick – Botany Downs area. Although the bus line is now much simpler, it is still not reliable. This will in turn hinder any attempts made to address the frequency levels of the bus line in the future.

To try and address the issue of unreliability and infrequency, the Auckland Regional Transport Authority with rail operator Veolia has been focusing on making trains more frequent, reliable and punctual. Increasing frequency is easy on a dedicated right of way such as train lines or busways due to the reliability that can be offered from the corridor. Together, they introduced a new timetable in September 2010 which provided a 25% increase in services, with 400 new trips being provided for (Auckland Regional Transport Authority, 2010a). This however does coincide with the opening of the new Onehunga rail line, meaning that this new increase in services is unlikely to fully apply to the current three train lines. However, as shown in figure 5.8, rail patronage represents only a minority of total public transport trips in the Auckland region. A key factor in this is the low coverage of rail corridors in Auckland city. As a result, focusing on increasing rail frequency, reliability and punctuality will only have a limited impact on the overall public transport network.

Figure 5.8: Monthly patronage levels by mode in Auckland from January 2002 to July 2010.



Source: (Auckland Regional Transport Authority, 2010k).

Addressing the reliability of the bus network can be readily achieved by providing bus lanes and bus right of ways. Through the development of the bus right of way for the Northern Express, buses are taking around 24 minutes to travel from Albany Station to Britomart. This is compared to a 45 minute journey when travelling by car (Auckland Regional Transport Authority, 2010i). The reason the Northern Express has a lower travel time than the car is because the busway has been effective in increasing reliability levels for buses travelling along this corridor. However, outside of the bus right of way, the buses are subject to local traffic conditions. This becomes a problem, particularly during rush hour periods. With the motorway becoming full by 7a.m. during the morning peak period, it makes the ride between Albany to Constellation, and again soon after Akoranga to Britomart very slow. With the only road access to downtown Auckland being to go over the Harbour Bridge, a bottle-neck of traffic emerges at this point. This makes bus travel unreliable and slow from this point. Nevertheless, travelling along this bus corridor is still faster than car travel because of the presence of the busway.

When focusing on the bus network, Auckland provides three good examples of a 'forget the timetable' high frequency corridor. They are the Northern Express, along with the two new 'b.line' corridors. The Northern Express offers frequency levels of one bus every 4 minutes during morning peak periods, 10 minutes during the daytime, and 15 minutes late nights, weekends and public holidays. In addition to the Northern Express, the new 'b.line' branded buses are providing highly frequent services in areas outside of a dedicated busway. Currently, there are two 'b.line' corridors which are located along Mt Eden and Dominion roads heading

into the central city. These two bus lines have been specifically designed to target passengers who stopped using public transport due to its unreliability and infrequency (Auckland Regional Transport Authority, 2010n). These buses are operating a minimum of one bus every fifteen minutes from 7a.m. to 7p.m. Monday to Friday. It is important to note however, that this frequency is not offered along the entire corridor for these two bus lines. Additionally, outside of peak period times, the buses are largely subject to general traffic conditions. This is because the bus lanes that these buses travel along to provide increased reliability and frequency are only available during peak period times. During the rest of the day, the buses must travel along the same road space as private motorists. Furthermore, bus lanes during peak times are not offered throughout the entire bus line. Despite this however, these highly frequent corridors are said to be very successful within the Auckland public transport system. Figure 5.9 shows where these two 'b.line' corridors are operating. The highlighted yellow segment is the part of the lines that offer frequent services.

Figure 5.9: The location of the two 'b.line' bus lines running in Auckland

Source: (Auckland Regional Transport Authority, 2010e).

The Dominion road line has proved so successful as a result of this high frequency that in February 2010 purposely provided buses were added to the line, working to cater for an additional 62 passenger trips Monday to Friday – a further 15,500 trips each year. This has worked to further increase the frequency of this particular line to one bus every 5 minutes, with this bus line carrying 43,000 passengers every week in 2009 (NZ Bus, 2010). Moreover, the Mt Eden bus line experienced a 56% patronage increase during the 2008/2009 financial year (Auckland Regional Transport Authority, 2009b). As a result of the success of these corridors, the Auckland Regional Transport Authority has identified over twenty more bus lines as being potential future high frequency b.line corridors (Auckland Regional Transport Authority, 2010f). The success of these bus lines can also be attributed to its extensive marketing to users in addition to its design simplicity. All b.line buses along with bus stops, signs and shelters are marked with a distinctive bright yellow branding marker. This works to make the service simple to use for passengers and easy to identify. Figure 5.10 provides an example of a flyer used in the marketing of this bus service.

Figure 5.10: Brochure advertising the B.line bus brand

Source: (Auckland Regional Transport Authority, 2010d).

5.4. Transfer analysis

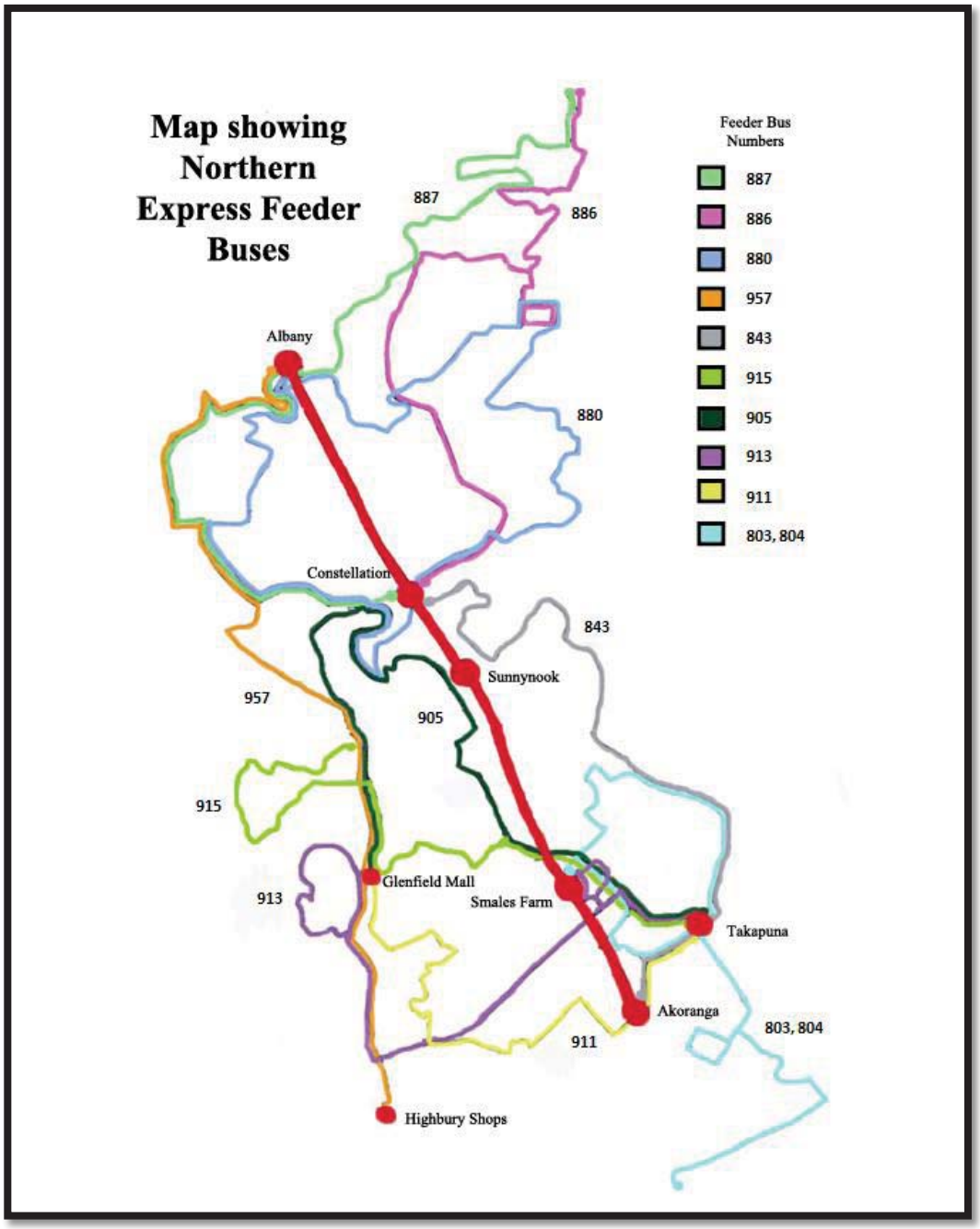
Transferring between different bus lines and different public transport modes is an important element for public transport in a city. Currently, services in Auckland work to minimise the necessity of transferring as shown through the highly complex, indirect and radial bus routes. Few public transport bus lines cross in a manner that could allow for transferring between public transport lines, with cross town bus lines (which are providing the best transfer

opportunities in the city) being uncommon. In fact, the majority of bus lines that do cross paths are travelling to and from nearby points. Consequently, such lines do not realistically provide for transfer opportunities between bus lines. One such line is the 886 Ritchies bus line which provides for no transfer opportunities along its line despite its long and winding bus route. Instead, it crosses only with other bus lines that have the same or similar destination and origin.

In order to best analyse the transferability of the wider Auckland public transport network, a transfer analysis was undertaken. In conducting the analysis, two separate bus lines were chosen to compare. The first was the Northern Express and its surrounding feeder bus network. The Northern Express was chosen as it provides the best infrastructural set up in the city to potentially foster transfer opportunities between services. The second bus line chosen for the transfer analysis was the 007 bus line from Point Chevalier to St Heliers Bay. This second bus line was chosen as it has the highest number of other bus lines crossing its path and has the potential to attract passengers to transfer. This therefore creates the grid pattern line structure needed for transferring as emphasised by network planning.

For the Northern express analysis, the five stations along the line were used as transfer points, with data being collected from ten local feeder buses arriving at these stations. Figure 5.11 shows a map of the Northern Express and the feeder bus routes tested.

Figure 5.11: The Northern Express Feeder buses analysed in the transfer analysis.



Source: (Figure by Author, 2010).

For the 007 bus line, twelve potential transfer points were tested, with data being collected from the intersecting buses heading into the downtown area. Figure 5.12 shows the transfer points tested for the 007 bus line.

Figure 5.12: The transfer points assessed along the 007 corridor

Source: (Figure by Author, 2010).

The 007 test was recorded with the 007 moving left to right from Point Chevalier and then transferring onto an incoming bus that was headed into the downtown area. For the Northern Express, the bus line was tested with the feeder buses arriving into the transfer points and then transferring onto a Northern Express bus heading to downtown Auckland.

Each of these bus lines were tested based on six key elements, with each key element being awarded a score based on performance. Scores were on a 0 to 5 scale, with 5 being the best possible score. Table 5.1 shows how the scores were allocated for each of the six elements. After allocating scores to buses at each of the transfer points, an overall score was then awarded for each of the elements by calculating the average. As five is the best score possible score for each element, the highest score possible in this analysis is thirty. The determination of the scores awarded was compiled using best practice recommendations as a guide. For instance, key literature on the application of network planning (for example, see Nielson, 2005) provided a base for minimum service requirements.

Table 5.1: The scoring of each of the six categories in the transfer analysis

Frequency interval of transferring bus		Single transferrable ticket	
5	Under 5 minutes	5	Offered
4	5-10 minutes	4	n/a
3	10-15 minutes	3	n/a
2	15-20 minutes	2	n/a
1	20+ minutes	1	n/a
0	No transfer available	0	Not Offered
Ticket price for return journey		**Distance between stops**	
5	Under $7.50	5	0-10 metres
4	$7.50-$10.00	4	10-20 metres
3	$10.00-$12.50	3	30-40 metres
2	$12.50-$15.00	2	40-50 metres
1	$15+	1	50+ metres
0	No transfer available	0	No transfer available
Number of passengers transferring		**Average wait times**	
5	20+	5	Under 5 minutes
4	15-20	4	5-10 minutes
3	10-15	3	10-15 minutes
2	5-10	2	15-20 minutes
1	1-5	1	20+ minutes
0	0	0	No transfer available

Source: (Table by Author, 2010).

Table 5.2 provides the total scores for each of the two bus lines tested, along with the individual scores for each element tested. For detailed results for each transfer analysis please refer to Appendices Two and Three. The transfer analysis showed the Northern Express to be performing well in most criteria, with a total score of 22.62. This is largely due to the Northern Express being designed to take into account the measured elements. On the other hand, the 007 bus did not score very highly, with a score of 7.56. Although the line structures are present in a way that transfers could be offered, the surrounding network is not designed in a way that encourages transferring.

Table 5.2: The overall results of the transfer analysis of the two bus lines

Overall Score	Single transferable fare	Fare price for return journey	Distance between stops	Average wait time	Frequency interval of transferring bus	Number of passengers transferring	Total score
007 bus	0	1.11	1.92	2.73	1.79	0	**7.56**
Northern Express	5	3.05	5	4.5	3.67	1.4	**22.62**

Source: (Table by author, 2010).

Figure 5.13 shows two photos comparing the design of each of the two bus lines. The left photo is from a transfer point outside the UNITEC for the 007 bus line. It can be seen that infrastructure is simple, offering a shaded bus shelter. On the other hand, the photo to the right shows a transfer point for the Northern Express. This photo is of Albany Station and shows the significant infrastructural set up of these bus services. This is quite a contrast to the 007 transfer points.

Figure 5.13: A typical 007 bus transfer point (left) compared to a Northern Express transfer point (right).

Source: (Figure by Author, 2010).

The Northern Express transfer points offer design elements such as complete shelter from the weather, real time information, bike stands and lockers, ticketing machines, help and

emergency points, along with food, drink and newspaper kiosks - the 007 does not. Although the 007 does have a handful of real time information systems, it does not offer any other features. Figure 5.14 shows two photos that portray a selection of design elements offered at the Northern Express transfer points. The left photo shows bike stands, with the bike lockers being seen in the background. The right photo shows a real time information display that is situated in many spots at each of the transfer stations. Both of these photos were taken from Albany Station.

Figure 5.14: Bike stands and lockers (left) and a real time information display (right).

Source: (Figure by Author, 2010).

Although the 007 bus line does cross in a manner which could allow for transferring between bus lines, field work found that no passengers were using the bus line to transfer. Although there is potential for transfer opportunities, the infrastructure is not set up to encourage transferring. In addition, as this is an inner city bus, there are many buses that would be travelling along intersecting streets to head into town. With so many bus lines ending in downtown Auckland, passengers wanting to travel downtown are more likely to walk to an intersecting bus line than to transfer between two public transport lines. Another key reason why people are not transferring on the 007 is because the wider grid network is not there. For people to determine their own journeys and transfer between buses, the entire network needs to be designed in this way.

Even though the Northern Express scored well in this analysis, the scores would have been much lower if the analysis recorded data for a return journey from downtown Auckland. In this instance, the score for wait time and the score for the frequency of transferring line would have dropped significantly. This is because the feeder buses do not operate at the same frequency as the Northern Express, nor do they operate using a pulse timetabling system. Furthermore, the actual design of the feeder system hinders its attempts to be used as a

feeder bus service. This is because it has not been designed in a manner to easily connect people from the suburbs to the Northern Express. Feeder bus routes are indirect, uncoordinated and haphazard. As a result, people are not using these bus services as feeder services, with there being very few people transferring as seen through field work investigations. Such a complex network does not work to foster patronage growth and will not create the 'network effect' needed for a public transport system to be successful.

Furthermore, it is also important to note that all day park and ride facilities are provided at Albany and Constellation stations – 514 at Albany and 273 at Constellation. These park and ride facilities become full very early on in the morning (just after 7a.m. on weekdays) as shown in figure 5.15, which shows the park and ride facilities at Albany and Constellation Stations. It is likely that once full, drivers will continue to drive themselves to their destination. This however, will make the Northern Express service seem unreliable to these passengers, with their ability to use the bus service being determined through their unlikely ability to access a car park. What this further shows is that the feeder services provided are not effective in attracting passengers.

Figure 5.15: The park and ride facilities offered at Albany Station (left) and Constellation Station (right).

Source: (Auckland Regional Transport Authority, 2010m).

5.5. Critical review on fare structures

Simple fare structures are essential for making public transport understandable for users. In Auckland, a zonal-based fare system operates. Under this system, passengers are required to pay more for a fare the longer distance that they travel. This system however is highly complicated in Auckland. As there are nine separate public transport providers in the city, this means that there are nine different sets of fares to choose from (Auckland Regional Transport

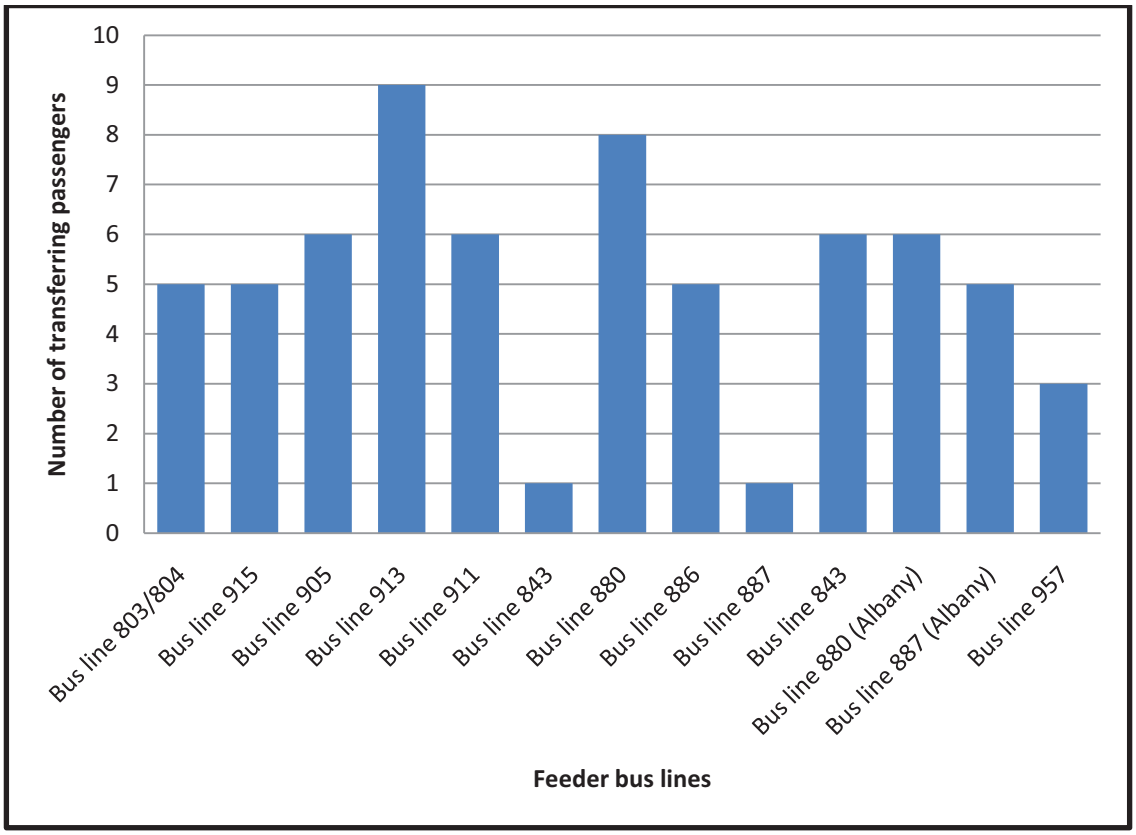
Authority, 2010h). Although the Auckland Council works to try and simplify this by bringing all the information together, it still remains a highly complex fare system for the user. To further add to this complexity, there is one exception to this trend. For example, in the North Shore, the Northern Express and its surrounding network offer a time-based ticketing system, where passengers pay for the time they travel and not the distance. Despite this however, a zonal-based fare system can still be used and requested on these services (Auckland Regional Transport Authority, 2010h).

In terms of concession tickets available in Auckland, pensioners can travel for free while approved tertiary students can receive a 40% discount on fares (Auckland Transport, 2010). When looking at transferrable tickets though, Auckland generally does not offer transferrable fares. What instead occurs is a situation where users pay for each provider and/or mode of transport used. In saying this though, transferrable tickets can at times be offered between the same transport operators. Other transport operators however, will not accept another operators ticket (Auckland Regional Transport Authority, 2010h). This works to undermine the MAXX brand and attempt at providing a coordinated public transport system.

The North Shore however, does offer transferrable fares. In the North Shore, it is possible to travel between public transport lines in order to travel around the region and to downtown Auckland. It also allows for travel past the central city to Newmarket along selected bus and rail lines. This ticket though is not available to use throughout the rest of the Auckland network. The cost of a return journey ticket is $9.00 in most instances or $11.30 if travelling from the Albany area during the peak period. However, it is important to note that not all buses will accept this ticket. From Albany, the Birkenhead feeder buses will require passengers to pay an additional fare if transferring.

Despite this transferrable fare being in place, the North Shore feeder bus network is not being used for this purpose. Figure 5.16 shows the number of passengers recorded as using the Northern feeder buses to transfer onto the Northern Express during the morning peak period from 7a.m.-9a.m. During this two hour period, most of these buses have four arrival times. The figure has recorded the total number of passengers from all bus arrivals for the two hour period.

Figure 5.16: The total number of transferring passengers for each feeder bus line during a morning peak period from 7a.m. to 9a.m.



Source: (Figure by Author, 2010).

The figure shows that very few passengers are using the buses for transfer purposes. Instead, these buses are only attracting passengers of their own accord, meaning that they are not being used as a feeder bus service at all. Despite this, the Northern express buses are consistently full meaning that this bus line is not attracting passengers because there is a quality public transport network offered but because of the quality of the bus line in and of itself.

Additionally, for network planning to be successful, the cross subsidisation of bus routes needs to occur. For this, the least used routes will need to be subsidised by the highly used routes. However, this is not occurring in Auckland. Instead, the least used routes are being cut. This is being ensured by Auckland Regional Transport Authority through a programme which evaluates the performance of bus routes twice a year. This programme aims to rationalise poorly patronised bus lines instead of maintaining a full comprehensive public transport network through cross subsidisation. Under this programme, bus lines with patronage levels below a set minimum level will be cut completely or have their services severely reduced. This

is done to save money and avoid subsidising bus services that are costing too much to run. Currently, (for the 2008/2009 financial year) subsidies paid out by the Transport Authority to its public transport operators are $4.46 for each rail passenger, $2.00 for each bus passenger and $1.13 for each ferry passenger (Auckland Regional Transport Authority, 2009b).

5.6. Content analysis

As a part of the investigation into Auckland's public transport system, a content analysis was undertaken. This was done to determine where transport planners are placing their focus in managing public transport in the city. In undertaking the analysis, key words and phrases were looked for within each of the four categories, line structures, frequency, transferring, and fares. In the analysis, all variations of key words and phrases used where looked for. For example, when looking for the word simple, other variations of the same word such as simplify, simplification, and simplified were looked for also. Table 5.3 lists the words and phrases chosen within each category along with the final word count after the analysis was completed.

From the content analysis, line structures in Auckland gain little attention by transport planners. Although the Northern Express bus line and the busway it travels along was highly discussed with a word count of 320, this was at the expense of the rest of the network. For instance, Auckland's wider bus network is overly complex, with public transport lines meandering and creating a radial public transport network. However, these points are not focused on as needing to be addressed. Additionally, the need to implement cross town bus routes was missing, with it only being mentioned 22 times. Commuter travel in contrast was discussed nearly twice as much with 42 counts. Focusing on this however will result in maintaining the current radial line structure patterns that cater almost exclusively for commuter travellers. Frequency on the other hand was highly mentioned with 246 counts despite there being only three bus lines in Auckland operating relatively frequent lines. This means that for the wider public transport network, improving frequency was found to be the focus of planning documents. This improved frequency however has not considered the implementation of pulse-timetables. In comparison however, much less focus is being placed on reliability (75 counts) and punctuality (60 counts). The problem with this however is that reliability and punctuality are first needed if addressing frequency levels are to be effective.

Table 5.3: The words and phrases chosen for the content analysis.

WORD/ PHRASE	WORD COUNT	KEY PHRASE/ EXAMPLE
LINE STRUCTURES		
SIMPLE	42	With reference to the Botany, Manukau, and Howick services - "**Simplified** routes within these areas and to the CBD [central business district] have resulted in a 60% increase in patronage - for just a 1.4% increased investment" (Auckland Regional Transport Authority, 2008a, p. 2).
BUSWAY/ BUS RIGHT OF WAY	76	With reference to the Hisbiscus Coast - "Patronage of other services using the **busway** also grew. Travel on the Hisbiscus Coast Express was up 27%" (Auckland Regional Transport Authority, 2008a, p. 15).
BUS LANE	23	With reference to the Auckland Manukau Eastern Transport Initiative – The first stage of the project will include…improving roads, **bus lanes**, walking and cycling" (Auckland Regional Transport Authority, 2009a, p. 6).
NORTHERN BUSWAY/ EXPRESS	244	"The success of the **Northern Busway** proves that Aucklanders will get out of their cars when a fast, frequent and reliable alternative is available" (Auckland Regional Transport Authority, 2007, p. 3)
CROSS TOWN	18	"To meet the future need for **cross-town** travel…ARTA [Auckland Regional Transport Authority] will develop a Quality Transit Network (QTN) that provides fast, high frequency and high quality passenger transport services between key centres" (Auckland Regional Transport Authority, 2006a, p. 5).
COMMUTER	40	"There are currently nine **commuter** ferry services" (Auckland Regional Transport Authority, 2006a, p. 21).
COMPLEX	0	n/a
MEANDER	0	n/a
STRAIGHT	0	n/a
RADIAL	2	"…travel in Auckland is increasingly becoming more dispersed…This trend has not, to date, been well matched by the passenger transport system which is primarily **radial**, with the majority of routes focused on Auckland's CBD [central business district]" (Auckland Regional Transport Authority, 2006a, p. 3).

FREQUENCY		
FREQUENT	246	"The Northern Express has proved so popular that additional peak capacity was added in both October 2008 and March 2009, taking the **frequency** to every three minutes, with 88 buses using the busway in the morning peak" (Auckland Regional Transport Authority, 2008a, p. 15).
HIGH FREQUENCY/ FORGET THE TIMETABLE	55	"A Rapid Transit Network (RTN) involves a passenger transport system with a **high frequency**, high quality service operating on 'transport spines' that does not get held up by road traffic congestion" (Auckland Regional Transport Authority, 2006a, p. 4).
PULSE TIMETABLE	0	n/a
RELIABLE	75	"The ferries continued to provide the most **reliable** and punctual service of all modes of passenger transport service" (Auckland Regional Transport Authority, 2005, p. 19).
PUNCTUAL	60	With regard to the Western Rail Line – "On completion of this double tracking work, service **punctuality** has improved, with 80% of services running within five minutes of their scheduled time in 2007/08, compared to 72% in 2006/07" (Auckland Regional Transport Authority, 2008a, p. 16).
B.LINE	8	"Real-time bus tracking information is available at 580 bus stops where there is an on-street electronic information display and on all Mt Eden and Dominion Road corridors as part of the **b-line** launch" (Auckland Regional Transport Authority, 2010l, p. 11).
UNRELIABLE	10	"The bus network is at times **unreliable**, with its efficient operation further hampered by commuter traffic" (Auckland Regional Transport Authority, 2006a, p. 12).
INFREQUENT	1	"While the physical coverage of the bus network in the urban areas is very good, most bus routes operate **infrequently**, with around 75 per cent operating fewer than three buses per hour" (Auckland Regional Transport Authority, 2006a, p. 21).
TRANSFER		
TRANSFER	61	"…the easier it is to **transfer** between services, the more journey destinations that are possible" (Auckland Regional Transport Authority, 2010c, p. 11).
TIMED TRANSFER	0	n/a
FEEDER	26	"Improvements to **feeder** services have also helped to increase patronage" (Auckland Regional Transport Authority, 2008a, p. 15).

PARK AND RIDE	75	"The location of **park and ride** facilities should enable a seamless interchange from car to passenger transport" (Auckland Regional Transport Authority, 2006b, p. 56).
COORDINATE	1	With reference to b.line corridors – "The customer promise is a scheduled bus service every 1 to 15 minutes with improved bus standards (**coordination** of newer bus fleet on to these corridors)" (Auckland Regional Transport Authority, 2010k, p. 10).
CONNECT	20	"…a passenger transport network that **connects** key employment and population centres, including centres outside the CBD [central business district]" (Auckland Regional Transport Authority, 2006a, p. 28).
INTEGRATE	180	"There is strong support from Auckland passenger transport users for an **integrated** ticket allowing travel on rail, bus and ferry, regardless of the service provider" (Auckland Regional Transport Authority, 2005, p. 19).
FARES		
FARE/TICKET	301	"…a **fare** structure that is simple and easy for existing and potential users to understand, and that will provide the framework for integrated **ticketing**, should be implemented" (Auckland Regional Transport Authority, 2006a, p. 30).
SINGLE TRANSFERRABLE FARE/INTEGRATED TICKET	118	"Travel by public transport will be made easier and simpler with the introduction of the new **Integrated Ticketing** System for Auckland, which will be based on smartcard technology" (Auckland Regional Transport Authority, 2009a, p. 6).
FREE TRANSFER	0	n/a
SUBSIDY	40	"The role of regional government is to **subsidise** those services which cannot be operated profitably" (Auckland Regional Transport Authority, 2007, p. 9).
RATIONALISE	4	"Additional case-by-case service value for money reviews have been undertaken and services **rationalised** or redesigned" (Auckland Regional Transport Authority, 2007, p. 20).

Source: (Table by Author, 2010).

Although providing an integrated transport network was highly mentioned (180 counts), there was little focus placed on how this would be achieved. With regard to integrated transfers, most focus was placed on providing park and ride facilities (75 counts) as opposed to designing a wider feeder bus network (26 counts). Although both gained relatively few mentions, this does show a preference being shown to providing for park and ride facilities as opposed to strengthening the surrounding bus network. In Auckland, the need to transfer is often avoided, with bus lines making elaborate journeys to cater for as many different users as possible. What results however is an overly complex and indirect transport network. When looking at fares, it was found that public transport fares and tickets were highly discussed in transport planning documents, with there being a total word count of 301. From this, about one third of this count focused on the implementation of a single transferrable fare or ticket (118 counts). Although Auckland does not currently offer transferrable tickets, this does show that transport planners are working towards their implementation.

5.7. Conclusion

This chapter has examined the current state of Auckland's public transport focusing on line structures, frequency levels, transferability, and fare structures. Additionally, the chapter also provided the results of the content analysis undertaken. Auckland was found to provide a traditional public transport system. As such, line structures are designed so that they move from the suburb to central city, creating radial line patterns. Public transport also works to meander around local streets, effectively avoiding the need to transfer. Furthermore, Auckland offers a demand-responsive frequency system where public transport frequencies are increased when demand increases and vice versa. Moreover, fares are only designed for single line trips and are not designed to allow for travel between different public transport lines and/or modes. The content analysis largely worked to verify these findings on the current Auckland public transport network. Each of these four factors is integral to public transport success. Therefore, the way in which they are planned for will have a direct impact on patronage levels.

6. Discussion

6.1. Introduction

This chapter aims to discuss the primary research question of this thesis which is how can public transport service provision be improved in Auckland? To work towards this, each of the key network planning elements - institutional structures, line structures, frequency, transferring and fare structures, will be discussed. The chapter will discuss these elements by comparing the Auckland research findings against the literature review findings. The purpose of this is to determine whether research findings correspond with what literature is saying. Next, the Auckland research and literature findings will be compared against the results of the content analysis. This will be done to determine whether current planning approaches correspond with the current Auckland situation and literature. The purpose of doing this is to strengthen and validate the findings on Auckland's transport system by triangulating the data.

6.2. Institutional structures

Different institutional structures have varying priorities and management approaches towards public transport planning. Therefore, the type of institutional structure present in a city will directly impact on public transport (Mees, et al., 2010; Nielson, 2005). Investigating the types of institutional structures present in Auckland over time provided insight on the current public transport system. Research showed how decisions made by both previous and current public transport institutional structures have guided and shaped the development of today's public transport. Auckland research sought to investigate the first subsidiary research question, what types of public transport institutions have been present throughout Auckland's public transport history to shape current policies and services in the city? From Auckland's institutional analysis, four types of institutional structures were found to be present throughout Auckland's history that have influenced and shaped the present public transport network. Initially, mixed institutional structures were present from 1840 to the 1950's as public transport was provided by both private and public institutions. This period saw the creation of a public transport network for the city to cater for a growing demand in transport services. Tram and rail developments saw the outward expansion of the city along transport corridors in addition to the emergence of morning and evening rush hour periods.

The 1950's to 1990's saw the emergence of Auckland's second institutional structure with this period being the most successful time for public transport in Auckland's history. At this time, public transport services were primarily publically provided, meaning that an extensive and comprehensive service was being offered. Passengers were being attracted by the large

number of concession tickets offered. More importantly though, the public transport network was highly coordinated with feeder buses being implemented by the rail network, in addition to tram services coordinating their timetables to meet incoming ferry services. The result of such coordination was for public transport to be well integrated and successful.

After 1955 however, patronage levels plummeted. This was in direct response to the implementation of the 1955 Master Transportation Plan, the failure to electrify and expand the rail network, in addition to the closure of the popular tram network. This drop in public transport patronage was met with increases in private vehicle usage. This new trend though worked to decentralise the city. This in turn changed the travel patterns of citizens, making the public transport network designed to service traditional travel patterns ineffective. The 1970's though saw an increase in patronage levels, with this coinciding with the 1970's oil crises. This made private vehicle travel particularly expensive, which forced more people into public transport. This was short lived however, with the 1980's seeing patronage levels drop again. This period corresponded with Auckland's second failed attempt at electrifying and expanding the rail network.

The 1990's saw the emergence of Auckland's third change in institutional structure when public transport came into private ownership. These privatisation measures started through the corporatisation of publically owned public transport in the late 1980's. This was followed by their eventual privatisation in the early 1990's. These corporatisation and privatisation measures resulted in decreased patronage levels.

The new millennium saw the emergence of Auckland's fourth institutional structure. This structure is a public-private partnership and is the institutional structure presently operating in the city. Since the introduction of this institutional structure, patronage has slowly been increasing. This increase though is occurring at a similar rate to population increases, effectively meaning that patronage levels have remained stagnated since the introduction of the present institutional structure.

From the literature, three distinct institutional structures were found to have been used to manage public transport during different periods. These structures were public, private and public-private partnerships. These literature findings largely corresponded with the findings on Auckland's institutional history, with all three of these institutional structures having existed at some stage in Auckland's history. Public structures focused on providing a full and comprehensive public transport network as found in the literature review (Rothengatter, 1991). This structure however also coincided with large budget deficits from poor cost controls

and high concessionary fares (DeAlessi, 1973; Hamermesh, 1975; Lurie, 1960; McCracken, 2009; Niskanen, 1971, 1975; Peltzman, 1971, 1975). Auckland's public institutional structure from the 1950's to 1980's focused on providing a full, comprehensive public transport network, just as the literature found. This involved maintaining uneconomic routes to maintain this service. Furthermore, Auckland's public structures experienced large financial deficits and also showed a reluctance to increase fares with this being shown through the large amount of concession tickets offered.

Within the literature review, private structures were found to have focused on providing for economic efficiency and rationalisation (Soanes & Hawker, 2005). This efficiency however was achieved by increasing fares and removing uneconomic services (Gwilliam, 2008). These literature findings correspond with the Auckland privatisation era of the 1990's. Both the literature and Auckland's institutional history reported the same benefits as a result of the privatisation of services in terms of increased efficiency from a market driven system and lowered debt levels. However, literature and Auckland history also reported the same shortcomings. As a result of privatisation, patronage levels decreased, services deemed inefficient were removed, and fares were continually increased.

Public-private partnerships were identified through literature as being the predominant structure today in managing public transport networks. This structure focuses on utilising the best elements of both public and private structures while overcoming the weaknesses from each system. However, if poorly managed, the deficiencies of the public and private structures will have the potential to emerge as found through literature (Taylor, et al., 2009). Since 2000, Auckland has managed public transport through a public-private partnership structure, which corresponds with the literature. Despite the presence of a public-private partnership, Auckland is not experiencing all the benefits it should be as suggested by literature. For instance, this structure is supposed to provide a comprehensive service through the presence of a public regulator. The Auckland Regional Transport Authority however did not provide such a service. Instead, it followed a management approach similar in nature to the private institutional era where economic efficiency and rationalisation were priorities. Additionally, by tendering out the operation of rail and bus networks, competition between tenders is supposed to ensure the best value for money. Auckland however did not attract multiple tenders meaning that this intention of increased efficiency through competition is missing. What results is a highly inefficient network which requires large subsidies. This is what has been occurring in Auckland. In short, the Auckland research on public-private partnerships did not correspond with literature findings. However, literature did state that if this structure is poorly managed, then

the shortcomings experienced with public and private institutional structures can emerge. It is likely that this is the reason recent Auckland institutional approaches have not been working as they should under this structure.

What was not covered in the literature however, was the form of institutional structures present before the 1950's. Even though it is known that Auckland's public transport was either publically or privately managed, it is not known how this compares internationally. Although it is likely that many international networks developed in a similar manner, Auckland's colonial influences potentially influenced transport development in a way that differed to other international examples. This is due to the focus being placed on the immigration and settlement of the country.

Under the public-private structure currently present in Auckland, the Auckland Regional Transport Authority was the regulating body up until October 2010. Despite this institutional structure, their management remained focused on promoting the innovation of the private sector by increasing efficiency through competition and reducing costs through a tendering process (Gibson, 2010). This undermined efforts made to improve public transport services. Their effective management under this approach was also impacted on by the presence of multiple local councils. The presence of multiple governing bodies created conflict and disputes over public transport planning for the region. Additionally, the presence of multiple bus operators worked to further undermine efforts made to improve the quality of the public transport network provided. This is because the different operators effectively competed with each other.

Since October 2010, the Auckland Council has been responsible for regulating public transport in the region. This restructure involved the merger of the multiple governing bodies present. As a direct result, Auckland now has the institutional structure necessary to effectively plan for a successful public transport network. This is because the Auckland Council has the potential to plan the network for the entire region. At this time however, it is too early to comment on the effectiveness of this new council structure. Despite this, barriers are still present which can potentially undermine efforts made to improve public transport. For instance, the relationship needed between the Auckland Council and the private operators is presently missing. Under current legislation, bus companies operating without government assistance through subsidies are not obligated to follow Auckland Council's planning directives. This undermines the Council's ability to plan for the entire network. To overcome this, both the Council and private operators need to reassess their relationship, understanding that a planned network will result

in increased patronage, which would be mutually beneficial (Mees, et al., 2010). The current competition between services only works to detract passengers. Once this is understood, the Council and private operators can then cooperate and work together towards achieving a singular, integrated public transport network that both parties can benefit from.

With regards to the success of network planning, the institutional structure needed is mostly there. As mentioned, there are some barriers that will still need to be overcome. Network planning requires a strong government-led intervention to public transport service planning and coordination. Although present in theory, literature and research is suggesting that the strong approach needed is not eventuating. The Auckland Council needs to take up the role of the regulator and coordinate and direct the entire network. As this strong direction is currently missing, this is undermining attempts made to improve the public transport network. Furthermore, the presence of private bus operators exempt from council direction only works to further undermine any efforts made to improve public transport by the Council. Unless these issues are first addressed, efforts made to improve public transport will continue to be ineffective.

6.3. Line structures

The line structures present in a city will directly impact on the quality of a public transport network. Therefore, their design needs to carefully consider the travel patterns present in a city (El-Hifnawi, 2002). Auckland research sought to evaluate the second subsidiary research question, what types of public transport line structures are present in Auckland? From the literature, it had been determined that there are two key design elements that public transport line structures comprise of. The first element looks at whether public transport lines travel using a meandering or straight line pattern (Mees, 2010). Meandering public transport lines are the traditional form of line structures, which focus on providing access to as many key points as possible in a single journey. Straight line structures on the other hand work to provide the most direct travel path for passengers. The second element looks at whether public transport lines create a radial or grid pattern (Mees, 2010). Radial public transport lines provide for commuter travel from the suburb to city and are the traditional type of pattern seen in cities. Grid public transport lines travel on past or around the central city, overlapping to create a grid pattern, with these networks providing best for dispersed travel patterns.

The research found that Auckland lines are primarily meandering line structures in addition to them forming a radial public transport pattern into the central city. This corresponds with the literature detailing the form of line structures present in the traditional public transport

situation. By providing this form of public transport line structures, Auckland caters best for commuter travellers heading into the city. On the other hand though, Auckland cannot fully provide for dispersed travel patterns as the type of line structures present are ineffective in catering for these types of journeys. The content analysis worked to verify the findings from both the literature and research. From the content analysis, it became evident that transport planners do focus on providing a traditional public transport system. Peak period commuters are the focus of many planning documents, with this being emphasised through the attention placed on the Northern Express – a public transport line designed to specifically target peak period travellers from the North Shore heading into the central city.

The form of line structures present in Auckland will be successful when the central city is the primary destination for travellers. This was particularly evident in the 1950's, when public transport was most successful. At this time, the central city was in essence the primary travel destination for users. As such, public transport had been designed to specifically cater for this travel need. Today however, Auckland public transport is not successful, suggesting that the central city is no longer the primary travel destination for people. In fact, research did find this to be the case as far back as 1970 (Badcock, 1970; Fitzsimons, 1981; William, 1975). Despite this knowledge, Auckland's public transport has still not been redesigned to cater for the dispersed travel needs of its users over forty years later. The result of this is for the design of public transport lines to be simply ineffective in providing for passenger needs.

Literature argued straight and grid pattern line structures to be the most effective in catering for dispersed travel needs (Nielson, 2005). Therefore, when these line structure elements are present in Auckland, the response from users should be positive. In fact, Auckland research did suggest this to be the case. For instance, the Northern Express epitomises the definition of a straight line structure. The direct travel path offered plays a key role in its success, with the line being one of the most highly patronised public transport lines in the city. Furthermore, the 680 and 681 Howick-Botany Downs lines were redesigned so that they embody more of the characteristics of straight line structures. Previously, they were very complex and meandering line structures. The move away from a meandering pattern was met with a positive response from users, as seen through increased patronage levels. This shows that there is a demand for simple and direct public transport trips. Additionally, the redesign of the 008 and 009 cross town bus lines to target shoppers as opposed to the traditional commuter was met with increased patronage levels. This works to show that people are demanding for travel opportunities outside of the traditional commuter travel trips. When public transport lines are

redesigned to cater for this, then people will respond by using the service as has been found through the research.

When comparing these line structures to the network planning principles, it is evident that Auckland does not provide line structure patterns that can foster successful network planning. Network planning requires straight line structures and grid patterned public transport. Although research findings suggest that when these elements are present in Auckland, patronage levels can increase, this is not the typical form of public transport line structures present in the city. For network planning to work in Auckland, line structures will need to be simplified so that they are designed adopting straight line structure principles while also being designed as part of a wider, connected and integrated grid network. Currently in Auckland, public transport lines are treated as single entities and are not planned for nor looked upon as a part of a single network. This is because Auckland line structures simply do not work together. Each public transport line has been designed for its own purpose, with there being very few links in the network. This however creates a situation where there are large service gaps in parts of the city while other parts of the city experience an overload of public transport services. This results in a very sparse yet dense network at the same time. This complexity however has eventuated in a poor quality public transport network. When public transport line structures are so poorly designed, people will avoid using the service when possible. This is what is occurring in Auckland.

Addressing this problem however will not be easy as it will require extensive changes to be made. Creating an integrated straight line and grid patterned network would require the complete restructure of many public transport lines. This would not be an easy task. Despite this though, buses do need to be redesigned so that they act as feeder services to the key arterial lines. These arterial lines are the rail network and key busway corridors such as the Northern Express. There needs to be a focus placed on meaningful integration, which will mean the removal of competing and overlapping services. What will result though is a simple, multi-modal and integrated public transport network. Only once this is achieved will public transport start to operate as a single network.

6.4. Frequency

Public transport frequencies significantly influence public transport use. This is because low or poorly designed frequencies increase the inconvenience of using public transport for users (Mees, 2000, 2010; Mees, et al., 2010; Nielson, 2005). Such poor frequencies will mean that public transport cannot meet minimum service levels, which will result in decreased patronage

levels. Auckland research sought to investigate the third subsidiary research question, what are the frequency levels of public transport services in Auckland? From the literature, it had been found that the most common approach in addressing frequency levels was to utilise mathematical formulations to calculate ideal time intervals between public transport units (Carey & Crawford, 2007; Ceder, 1986). These calculations focus on patronage levels meaning that frequencies will be higher when patronage is high and vice versa. This creates what is known as a demand responsive service. The alternative to this is to provide service frequencies based on creating the kind and form of public transport system desired. To achieve this involves providing high frequency public transport lines where possible. Under this system, when it is neither realistic nor practical to implement such a high frequency corridor, then a pulse-timetabling system needs to be implemented. In this situation, public transport lines will be timed so that they will arrive and depart at a destination at the same time (Mees, 2000, 2010; Mees, et al., 2010; Nielson, 2005). The purpose of designing frequency intervals in this way is to provide a public transport network that people will choose to use.

From research on Auckland, it was found that public transport frequencies are generally very poor. Within the entire network, only three high frequency lines were found to be operating, with no pulse-timetabling occurring throughout the rest of the network. When comparing these findings against the literature, it can be seen that Auckland is operating a demand-responsive model to frequency planning. Under this demand responsive model, the frequency of public transport lines is dependent on the number of people using the service. By using this system though, poorly patronised times such as evenings or weekends will experience either irregular or no public transport services at all. This finding corresponds with what is occurring in Auckland.

The results of the content analysis however did not correspond so closely with the literature or Auckland research findings. This was because frequency was a highly discussed and focused on aspect of transport planning documents. This suggests that public transport planners have placed improving the frequency levels of public transport lines a priority. Despite this however, such focus has not eventuated into the emergence of a high frequency public transport network. On the other hand, pulse-timetabling is not a focus for planners as seen through the content analysis. This though does correspond with literature and research findings.

Literature found that providing a public transport network designed utilising high frequency and pulse-timetabling to be the most effective system in attracting passengers (Nielson, 2005). Although Auckland provides no examples of pulse-timetabling, there are three high frequency

lines that help showcase this point. The two b.line corridors along with the Northern Express offer reliable and frequent all day services to passengers during the week. These three public transport lines are highly patronised. In fact, the b.line corridors have had their timetables specifically redesigned so that they offer forget the timetable travel for passengers. It was only after this redesign that patronage significantly increased for these two public transport lines. This demonstrates that people will utilise high frequency public transport lines when they are offered. On the other hand, the wider public transport network does not offer such high frequency travel. As a result, this lower frequency of public transport lines often eventuates into long and inconvenient waits. The fact that the wider Auckland public transport network is poorly patronised shows that there is something vital missing in the timetabling design. This missing component is the utilisation of pulse-timetabling. Pulse-timetabling will significantly eliminate and reduce the long waits experienced by passengers. Therefore, its implementation will work towards adding an element of reliability and convenience to the user which is presently missing.

When looking at the network planning ideals, Auckland is not providing a network of frequencies that contribute towards successful network planning. The level of frequency needed in addition to its coordination within the network is simply missing. Even the three existing high frequency lines do not epitomise the ideals of high frequency corridors. This is because for the b.line corridors, services on weekends and evenings are of a much lower quality. Although frequencies can be reduced during off-peak times, they need to remain regular and consistent in order to be effective. When examining the wider public transport network, the lower frequency lines are not operating an integrated and coordinated service. For instance, when transferring between lines, current timetables mean that if the bus runs late, then the connecting bus will not wait. This means that the passenger will miss their connecting bus and have to wait for the next one. As buses run relatively infrequently, this eventuates into a long wait. Furthermore, few Auckland public transport arrival times can be relied upon. Aside from the initial leaving time, arrival times are always estimates. This creates uncertainty for passengers who can then be unsure of arrival times. When so many public transport lines in Auckland are long and winding, this is a crucial weakness in the usability of the public transport network. If public transport frequencies cannot be relied upon, then passengers will not use the service.

When such poorly managed frequencies are provided then the network does not operate as a single entity. Instead, public transport lines operate individually, attracting customers based on the quality of individual line performance. A key example of this is the Northern Express. This

highly frequent bus line is a highly patronised and popular one. Yet the surrounding feeder bus network is poorly patronised. What this shows is that the Northern Express is attracting passengers in and of itself. However, there is no reason why these same passengers in addition to new passengers would not also utilise a local feeder bus network, if only such a quality system was to be provided. It is clearly not the public transport system that people are unwilling to use but the current state of the system provided.

For network planning to work in Auckland, the management approach to frequency planning must change. Focus cannot be on providing frequency intervals based on the number of passengers using the service. Instead, what needs to occur is for the main arterial public transport lines to operate using high frequency corridors. From this point, the feeder services need to be timed so that they arrive to pick up and drop off passengers at key transfer points together. Achieving this will mean providing a public transport network that is operating as a single integrated network.

6.5. Transferring

The quality of transfer points will influence whether people will be willing to transfer between services or not (Lo, et al., 2003; Mees, 1996, 2000, 2010; Mees, et al., 2010; Nielson, 2005). Therefore, the provision of quality interchange points needs to become a priority in transport planning. Auckland research looked into answering the forth subsidiary research question, does public transport in Auckland facilitate transfers between different lines and modes? Literature found that traditional public transport networks avoid the need to transfer wherever possible (Guo & Wilson, 2011; Horowitz & Zlosel, 1981). In this situation, public transport lines meander around local streets, taking elaborate journeys before reaching their final destination. However, literature also found that within successful public transport networks, transferring is a required element. In these instances, transfers are designed so that they are integrated, offering either highly frequent interchange points or timed transfers (Guo & Wilson, 2011; Shrivastava, et al., 2007).

From the Auckland research, it was found that public transport is designed so that it avoids the need to transfer where possible. When comparing this finding against the literature, it can be seen that Auckland operates a traditional public transport system with regards to its facilitation of transfers between different lines and modes. Under this traditional approach, public transport users will often not be required to transfer to reach their end destination. However, by removing this necessity of transferring, public transport trips become long and elaborate to compensate for this. This is because a single public transport line will attempt to

access as many key destinations as possible within a single route. The purpose of this is to eliminate the inconvenience of transferring and to cater for as many different journeys as possible.

The content analysis results verify the findings of both the literature and Auckland research. This is because very little attention is being given to facilitating for transfers by transport planners. Instead, focus is being placed on the development and expansion of park and ride facilities to be used as transfer points. This however does not work to encourage people to use public transport. This is because the private vehicle remains a necessity even when making a public transport trip. The central city areas may experience reduced congestion but this is met with increased traffic congestion around the park and ride facility. The congestion has just been shifted to another location. Furthermore, this approach does not promote the utilisation of the wider public transport network. Instead of travelling using public transport by utilising local feeder services and by transferring between lines, users select individual lines to drive their private vehicles to in order to use. This trend away from the utilisation of the wider network was emphasised through its lack of attention by planners in the content analysis. Such an approach however means that each public transport line will be used based on its own strengths and not based on the accumulated strength that is gained by being a part of a wider integrated network.

Literature found that a public transport network that is designed to facilitate transfers to be most successful (Nielson, 2005). The Auckland public transport network however has simply not been designed for the need to transfer. In fact, the network has been planned specifically to avoid the need to transfer where possible. This is evident through the design of public transport lines. For instance, the 886 bus line was found to travel using a long, complex and winding bus route. There are multiple other bus lines travelling around the same area, with the same or similar start and end points. Despite this, none of these bus lines are designed to facilitate transfers between lines. Even so, as the overlapping lines are so similar, there would be no point in transferring between these lines. Further, the 007 was found to be designed to potentially allow for the best transfer opportunities. This was because it crossed paths with many other bus lines to create the grid pattern promoted by network planning. However, fieldwork showed there to be no passengers transferring between lines. This is largely due to the fact that these intersecting lines are not designed to facilitate transfers. Additionally, the wider grid network needed to promote transferring is missing. For transferring to be successful in a city, it needs to be supported as part of a wider network. Instead, different transport modes operate separately from each other – even competing in many instances. In some parts

of Auckland, there are multiple individual bus lines running along the same road. In several instances, bus lines also carry along the same path as rail corridors. This works to undermine the wider public transport system.

For network planning to work, transfers need to be facilitated for by adopting either highly frequent interchange points or timed transfers. The reason for this is that the high frequency interchange points will pose little inconvenience for passengers, meaning that they will be willing to transfer between lines. For timed-transfers, the coordination between different lines is necessary to avoid long delays between transfers. This is to ensure transferring does not become a burden for passengers with regards to travel time and inconvenience. This will require the rescheduling of timetables so that buses become coordinated with rail and ferry and other bus timetables in such a way that they pick up and drop off passengers at key transfer points.

If transfers are not facilitated for in this way, then passengers will not be willing to transfer. This is seen with the Northern Express and its surrounding feeder bus network. Although the Northern Express offers little inconvenience for passengers due to the high frequency of its interchange points, its surrounding network does not meet this standard. The feeder buses are infrequent and untimed. This means that passengers using this service as a transfer point will find transferring time consuming and inconvenient – particularly when transferring onto a feeder bus from the Northern Express. The result of this however is for passengers to not use this network to transfer, which is exactly what was discovered during fieldwork.

6.6. Fare structures

The way fares are structured impacts on whether people will choose to use public transport or not (Mees, 1996, 2000, 2010; Mees, et al., 2010; Nielson, 2005). For instance, fares that result in additional financial costs to users will result in reduced passenger numbers. Auckland research looked into answering the fifth subsidiary research question, do fare structures in Auckland encourage the use of public transport? Literature found that fare structures have traditionally been determined by using ideal pricing strategies (Curtin, 1968). Under this approach, an ideal fare is calculated so that an appropriate fare can be applied based on the quality of the network provided. The calculated fare is then implemented using either a flat or zonal based fare system. Additionally, fares can offer either transferrable tickets or charge a fare for each mode used. Within a traditional public transport system, fares charged have tended to be charged based on each individual public transport trip made. Additionally, the best public transport systems operate a system where the weak public transport lines are cross

subsidised with the strong public transport lines. This works to ensure a full and comprehensive public transport network can be maintained. Traditional public transport systems however do not operate this way. Instead, the weak lines are either cut or removed due to their unprofitability. This however, leaves gaps in the network.

From the Auckland research, it was found that Auckland primarily operates using a zonal fare system in addition to charging passengers for each individual trip made. Furthermore, funding of public transport lines is not implemented using a cross subsidisation system. When comparing this against the literature, it can be seen that Auckland uses a traditional approach to fare structures. Under this traditional approach, transferrable fares are not readily offered. Instead, passengers pay for each public trip made in addition to paying more the longer distance travelled. Furthermore, Auckland operates a rationalisation system, where public transport lines are reviewed based on their patronage history. Public transport lines that are poor performers will be reviewed and as a result can have their services cut, adjusted or removed from the network.

The results of the content analysis however do not closely correspond with the findings of the Auckland research and literature review. This was because the implementation of a single transferrable fare gained much attention by transport planners. Despite this though, they have not been successful in providing a single integrated ticketing system in the city. On the other hand, the content analysis found evidence of the rationalisation approach being applied to public transport lines. Although subsidies were mentioned within plans, this was not in the form of the cross subsidisation of public transport.

Zonal fare systems which offer a transferrable fare and allow for cross subsidising are recommended for improving public transport systems. However, the design of fare structures in Auckland does not provide for this. As a result, the fares do not encourage people to use public transport. Although the zonal system is in place, the lack of a transferrable fare across the network is missing. When a transferrable fare is offered, users will not be penalised for using the network as a single entity. Instead, passengers will pay for the distance travelled and not the number of different public transport lines and modes used. Such a system will in turn encourage people to use the network to plan for journeys by maximising the entire public transport network. Although a transferrable ticket is not offered throughout Auckland, the North Shore area does offer a transferrable ticket using a time-based ticketing system. In addition to this though, users can still request a zonal based single fare if desired. This system however does not work to connect this service to the wider public transport network in

Auckland. These differences within the wider network make fare structures complicated and difficult to understand for users. The result of this though will be for people to avoid using the service.

Moreover, Auckland is lacking a form of cross-subsidisation that is needed to ensure a comprehensive public transport network is provided. This is in part because the Auckland Council has not placed itself in a position of being the controlling authority over public transport. It is not pooling and then redistributing all public transport revenues and subsidies. Currently, subsidies are paid based primarily on patronage levels and not based on performance standards. Managing subsidies in this manner however encourages operators to provide long and elaborate routes that access as many key destinations as possible. These routes often travel similar paths, access the same key points and cluster on high-demand corridors. Routes therefore are purposefully designed to attract as many passengers as possible. This however does not result in successful public transport. On the other hand, when operators are paid subsidies based purely on performance targets such as the punctuality and reliability of arrival and departure times, there will be an incentive to provide a high quality public transport network. This will encourage operators to provide a coordinated and integrated public transport network as the focus is no longer on increasing patronage and competing against other transport operators. By pooling and redistributing revenues and subsidies in this way, Auckland Council will be paying operators in Auckland based on the quality of the service they offer and not on the number of passengers using their services. Achieving this however is undermined through the Council's inability to direct the private operators in Auckland. Without first addressing this, an overlapping and restrictive fare structure will continue to operate.

For network planning to be successful, public transport networks must operate using an integrated and transfer-friendly ticketing system (Nielson, 2005). This means the adoption of a zonal fare system where passengers pay for the total distance travelled and not the number of lines or modes of transport used. This is because public transport needs to be looked upon as a single entity and not a series of individual components. This then makes it necessary to provide a fare structure that will remove the barrier of expense to transfer between public transport lines. Once this barrier is removed, then passengers will be free to design a public transport trip which will best suit their needs. Only then will the fare systems in place encourage people to use public transport in Auckland.

6.7. Conclusion

After discussing the Auckland public transport system, it is evident that the network provided has continued to be developed using traditional approaches to service provision. This is despite the changing and evolving needs of users. Although there are some good examples present in amongst the network, the key service provision elements needed for network planning are largely absent. Auckland has not designed line structures that work to create a straight line and grid network. As such, the system does not provide for transferring. Furthermore, the fare structures and frequency levels needed to contribute towards improving public transport are absent. As these key service provision elements have a direct impact on the success of public transport, the result has been a poor quality public transport network. This in turn results in a poorly patronised and largely unsuccessful public transport system for the city. In saying this however, the new institutional structure present does have the potential to address these service provision elements for the future.

7. Conclusion and recommendations

7.1. Conclusion

The aim of this thesis was to investigate policy approaches which will improve the existing public transport system in Auckland. To narrow down the scope of this aim, key factors limiting the future progress of public transport were addressed. These factors focused on both the long-term and short-term influencers of public transport. The long-term influencers included urban composition, social-economic matters, psychological factors and political influencers. Traditionally, these long-term factors have been used to validate the level of public transport success in a city. As such, they are commonly used as justifications for why a poor performing public transport system cannot be improved on. This research however worked to demonstrate that these factors do not solely determine public transport success. Doing this worked to show that the right policy approaches can have the potential to improve public transport in a city, regardless of the long-term factors present.

When investigating where policies need to focus to improve public transport, the short-term influencers were examined. The short-term influencers to public transport success focus on the public transport system itself. These short-term influencers included public transport service provision elements - reliability, frequency, accessibility, fare structures, transferring, information technologies, comfort, security, marketing, and line structures. Each of these service provision elements are directly linked to the public transport system itself. Therefore, any changes to these service provision elements will have an immediate impact on the quality of the public transport system provided. This means that policy approaches focusing on these service provision elements will have the most potential to improve public transport. Literature however provided little insight into how these short-term factors should be addressed so that public transport can be improved on. As a result, the primary research question set to work towards investigating this research gap. As such, the primary research question of this thesis was how can public transport service provision be improved in Auckland? Investigation into potential policy approaches found there to be one approach that focuses on addressing the short-term service provision factors of public transport. This approach is the network planning approach. As a result, this approach was chosen to be investigated in detail to determine whether it is a policy approach that could be implemented to improve public transport service provision in Auckland.

The success of network planning is partly determined through the institutional structures governing public transport in a city. Additionally, the service provision elements, line

structures, frequency, transferring, and fare structures are integral towards its success. For network planning to work, a public-private institutional structure needs to be present. Under this structure, the public body will be the regulator for the entire city, with the operation of the network being contracted out to private bodies. With regards to the service provision elements, line structures need to create a straight and grid patterned network. Frequencies need to operate using either a high frequency or pulse timetabling system. Transfers need to be facilitated for and be timed on low frequency corridors. Finally, fare structures should provide transferrable fares which are implemented using a zonal fare structure. This thesis then focused on these five network planning elements in order to investigate the potential of network planning. This led to the development of the five subsidiary research questions. These subsidiary research questions sought to analyse how the Auckland public transport system compared to the network planning ideals. The key concept behind doing this was that if Auckland did not possess these network elements then this could be used as a partial explanation for the poor performance of public transport in the city. The following points provide the answers as found through the Auckland analysis for each of the five subsidiary research questions asked.

1. What types of public transport institutions have been present throughout Auckland's public transport history to shape the current public transport policies and services in the city?
    - Auckland was found to have adopted four types of institutional structures from 1840 to today which have shaped the present public transport system through key decisions made. These institutional structures were mixed institutional structures (1840 - 1950's), public institutional structures (1950's - 1980's), private institutional structures (1980's - 1990's), and public-private institutional structures (2000 - today).
2. What types of public transport line structures are present in Auckland?
    - Research found traditional line structures to be present which provide a meandering and radial line structure pattern.
3. What are the frequency levels of public transport services in Auckland?
    - Frequencies are based on the number of passengers using the service. As such, only three high frequency corridors operate. Additionally, no pulse-timetabling occurs between public transport lines in the rest of the network.

4. Does public transport in Auckland facilitate transfers between different lines and modes?
    - Research found Auckland public transport lines to be specifically designed to avoid the need to transfer. Auckland therefore does not facilitate for transfers between different lines and modes.
5. Do fare structures in Auckland encourage the use of public transport?
    - Transferrable fares are not offered throughout the network, with there being an array of different fare structures used by the different operators present. Although fares are implemented using a zonal system, fare structures in Auckland are not encouraging the use of public transport.

In summary, Auckland was found to not possess the ideal elements needed for network planning success. Under this approach, the absence of these key elements means that public transport will not be successful. This correlates with the current Auckland situation as the city is known for its poor quality public transport network and low patronage levels. This limited success can be attributed to the traditional approaches being adopted towards public transport planning in the city. The maintenance of traditional public transport planning approaches in Auckland has meant that the city has not been able to adapt its services to account for changes in travel patterns. However, it should be noted that as of October 2010, the institutional approach needed for network planning success has been present. This means that there is potential to address this traditional approach in the future to improve the public transport service provision elements.

When examining the potential for network planning to improve public transport in Auckland, it is necessary to examine case study examples that possess some key network planning elements. The purpose of this is to determine whether performance variations within the public transport network can be attributed to network planning ideals. The Northern Express bus line adopts many network planning service provision ideals. This line structure is simple and straight, high in frequency in addition to offering a transferrable fare to connect to the wider North Shore bus network. When compared to the rest of the Auckland network, this bus line is experiencing high patronage levels. This is despite the wider Auckland network being poorly patronised in comparison. This example helps showcase the potential of network planning for improving public transport in a city.

Additionally, the potential for network planning in Auckland was seen through the institutional analysis. The 1940’s and 50’s for Auckland was the most successful time for public transport in

the city's history. This was a time where the rail system was providing a feeder bus network to compliment its rail service. In addition, buses would schedule their timetables to meet with incoming and outbound ferry services. This meant that many network planning ideals such as networked line structures, pulse-timetabling and timed-transfers were present. This meant that Auckland's public transport was relatively integrated, coordinated and connected. Despite the fact that only a selection of network planning ideals was present during this time, there was enough in place so that the transport network had begun to operate as a whole. The result of this was for the public transport system to start to create the network effect. The result of this was for public transport to experience high patronage levels. What this suggests is that network planning does have the potential to improve public transport in a city.

This in turn works to provide an answer for the aim and primary research question of this thesis. The primary research question was how can public transport service provision be improved in Auckland? Research found that the implementation of the network planning service provision ideals - line structures, fare structures, transferring and fare structures, will result in increased patronage levels. This means that public transport service provision in Auckland can be improved by addressing these service provision elements through the application of network planning. This answer then works to provide an explanation for the aim of this thesis, which was to investigate policy approaches which will improve the existing public transport system in Auckland. As the application of network planning has the potential to improve public transport service provision, it will then contribute towards improving public transport. This means that network planning can then be adopted as a policy approach aimed at improving the existing public transport system in Auckland.

7.2. Key recommendations

The main recommendation of this research project is to redesign Auckland's public transport using the network planning ideals as a guide. To work towards this, the following key recommendations have been made:

1. For Auckland Council and its subsidiary, Auckland Transport to become the planning entity for all public transport network planning in the city.
2. To redesign public transport lines to create a simple and straight line network.
3. To provide more high frequency corridors and utilise the pulse-timetabling technique for low frequency corridors.
4. Design public transport with transferring in mind. This involves making transfers possible and providing adequate infrastructure.

5. To provide transferrable tickets that can be used on any operator in the city.

7.3. Limitations of research

Despite best efforts to minimise the limitations of this research, there are some key limitations that need to be addressed. In conducting the research, a key limitation has been the inaccessibility and unavailability of information and resources. Sensitive information such as patronage data for individual public transport lines was unable to be accessed. To obtain access to data such as patronage numbers would have worked to further verify and clarify research findings. Additionally, access to resources such as key transport planning stakeholders was not possible for this research due to limited time and resources. To gain access to key personal within the transport planning field to conduct interviews with would have worked to further strengthen and validate research findings.

Another key limitation of this research was the utilisation of case studies in the analysis of the Auckland public transport network. The reason for this is that by drawing general conclusions from case studies and then trying to apply these findings to the entire Auckland network has the potential to be inaccurate. Conclusions made from one public transport case study might not be applicable to another public transport line in Auckland.

In addition to these limitations, the research must comply with university requirements and guidelines. This has meant that there is a limited period of time in which to complete and hand in this thesis. This means that the project has needed to be managed in a way to ensure its completion by the due date. This has meant compromising on the scope of the project so that it can be finished. This time limit has also resulted in a necessity of limited sample size and collection period being used for field work. Furthermore, the word limitations of this research have meant that not all information and findings were able to be presented within the final thesis.

7.4. Scope for further research

In terms of future research, two areas have been identified. Firstly, is to undertake a comparative study. In a comparative study, a relatively similar city to Auckland would be chosen that has designed its public transport in a way that compliments the network planning ideals. As no two cities are alike, a ‘similar’ city would need to have comparable characteristics in terms of its long-term factors. What this research would achieve is to better determine whether the presence of network planning does in fact contribute towards improving public transport or not. This would therefore work to examine how the quality of a public transport network provided to users impacts on the success of the system. The purpose of undertaking a

comparative study would be to minimise the limitations of a single focus study. By comparing comparable cities, the long term characteristics can no longer be used to validate why a public transport system is successful or not. Instead, the impact of the quality of the public transport system itself will be made the focus. Secondly, there is scope to extend on this research by re-applying the findings of this thesis on Auckland. This would involve looking into how a network city would look, work and operate within Auckland. The purpose of this would be to practically apply the findings of this research and to analyse how such an approach can be applied to an existing public transport system. In essence, such a study would examine the feasibility and practicability of implementing the network planning approach in Auckland.

8. Appendix One

Table 8.1: Key events in Auckland relating to the public transport system from 1940-2010 as compiled from literature.

Date	Key events
1840	Auckland formed.
1840's	Sailing cutters operated by local seamen. Rowing boats used to transport passengers.
1854	First official Waitemata harbour service operated by Mr J Reed.
1856	Auckland provincial government formed.
1860	First paddle steamer ferries. The Railways Act passed.
1862	Mining in the Auckland province lead to the construction of the Waihoihoi Tramway. First regular ferry service operating.
1863	Auckland to Drury Railway Act passed. Rail construction begins by provincial government.
1865	Auckland to Drury rail line completed.
1872	The Tramways Act passed.
1877	The District Railways Act passed.
1880-1981/82	Rail controlled by New Zealand Railways Department (central government).
1881	The Railways Construction and Land Act passed. Devonport Bus Co. Ltd formed.
1884	First horse trams. The St. Heliers and Northcote Land Company inaugurated the Auckland tramway system.
1886	The St. Heliers and Northcote Land Company changed their name to City of Auckland Tramways and Suburban Land Company.
1887	Commuter rail passenger services start.
1890	Auckland Tramway Company went bankrupt.
1891	37.5% public debt incurred through the railways.
1892	Patterson and Co. operates the horse tramway.
1894	Tramways Act passed.
Early 1900's	Passenger Transport Company ran a bus fleet.
1902	The New Zealand Electric Tramways and Lighting Company of London electrified the tram network for Auckland. Electric tramway begins under the Electric Tramways Co. Ltd. Andrew, Son and Co. bus company closed.
1910	Two steam tramway lines operated.
1917	Auckland City Council took over the operation of the tramway system.
1919	Auckland City Council purchased trams from the Electric Tramways Co Limited. Auckland City Council ran their first bus fleet.
1921	Auckland has 190 buses operating.
1924	Saw the emergence of the first regular motor bus networks. Tram and bus wars occurring.

	Private bus operators - Alf Smith and The United Service Motor – Omnibus Co. Limited formed through Auckland Transport Holdings Limited:
1925	Auckland Transport Board assumed responsibility of the tramways. The Government Railways Act enacted.
1926	Many private bus operators formed; Northern Automobiles Limited. Royal Motor Bus Company Limited. Reliance Bus Service. Peat and Mulligan. Mt Eden Motor Bus Company Limited (Mt Eden section). Gallagher and Sterling. GH Gustafen.
1927	The two steam tramway lines (Takapuna and North Shore) closed. Many private bus operators formed; My Eden Motor Bus Company Limited (General omnibus company section). RH Heatt (Trading as progressive bus services). North Shore Transport Limited (Formed from Auckland Transport Holdings Limited, amalgamating the two 1924 companies Alf Smith and The United Service Motor – Omnibus Co. Limited).
1929	Auckland City Council assumed responsibility of bus operations. Auckland Bus company formed. Auckland Transport Holdings Started suburban bus operations. Gubbs Motors Ltd formed.
1933	Transport Bus Services (A subsidiary of the Auckland Transport Board) formed. Birkenhead transport formed.
1939	Eastern buses formed
1946	Auckland Transport Board absorbed their subsidiary Transport Bus Services. Hospital Bus Company formed. Whenuapai Bus Company formed. Abbots Motors Ltd formed
1949	WJ Wheeler and Sons (Auckland-Penrose area) formed.
1950	LJ Keys Bus Company formed.
1952/3	Commercial Buses Ltd formed and acquired Transport Bus Services.
1956	The tramway system was closed, to be replaced with bus services. Johnstons Blue Motors Ltd formed.
1959	North Shore Ferries start commuter services.
1960's	Abbots Motors Ltd sold to Brice Motors of Clevedon
1960	Greenline buses formed. Bus Travel Ltd formed and acquired Huia Passenger Services.
1962	Eastern buses took over Howick buses
1963	Auckland Regional Authority formed and provided bus lines.
1964	Auckland Transport Board expanded their fleet. Auckland Regional Authority takes over Auckland Transport Board Buses.
1966	Papakura Bus Services Ltd formed.
1967	Trolley buses stopped and were replaced with conventional buses. Fourways Coachlines Ltd formed acquiring Shears Coachlines Ltd and Green Line Bus Service.
1969	Te Atatu Buses formed by the Auckland Bus Company and Whenuapai Bus Company.

1970's	Shears Coachlines Limited Formed
1971	Te Atatu Buses run by Whenuapai Bus Company.
1972	Passenger transport company expanded fleet. Auckland Transport Holdings Limited Formed: North Shore Transport Limited (first formed 1927). Cheltenham Bus Company. Stanley Bay Bus Company. Tates Motors. Waitemata Bus and Transport Company.
1974	Auckland bus company expanded their fleet, acquiring North Shore Transport, Suburban Buses, The Passenger Transport Company, and the Auckland Bus Company. Auckland Regional Authority acquire Devonport Bus Co. Ltd
1976	Greenhalgh Coachlines brought Whenuapai Bus Company. East Coast Bays Transport Ltd formed. Hanhams Buses Ltd formed.
1977	Papakura Bus Services Ltd acquired Morrison Motors.
1976-1880	Rail controlled by central government through the Public Works Department.
1979	Fourways Couchlines formed. Waitemata City Council brought Whenuapai Bus Company. Whenuapai Bus Company still remained the bus operators, forming a public-private partnership. Bayes Coachlines formed after acquiring George Roberts. Ranby Motors Ltd formed.
1981/82	Rail corporatized. Renamed the New Zealand Railways Corporation. The Auckland services were run under the brand Cityline. Removal of Government subsidies. Bayes coachlines acquired John Kennedy. Bus Travel Ltd acquired Commercial Buses Ltd. Greenhalgh Coachlines Ltd service acquires by Ritchies Transport Holdings. Johnstons Blue Motors Ltd sold to Midland Coachlines. Mainline Coachways Ltd formed acquiring Midland Coachlines. Owera Transport formed.
1986	Papakura Bus Services Ltd acquired Manurewa Transport.
1987	Wooden ferry fleet turned into modern fleet.
1988	Ferry commuter service provided by South Pacific Travel Holdings Limited (Trading as Fullers Coorporation Limited). Went into receivership shortly afterwards and was brought by Fullers Group Limited
1989	The Local Government Reform Act 1989 enacted. The Transport Services Licensing Act 1989 enacted. Transit New Zealand Act 1989 enacted.
1989-1996	Government restructuring forced the privatisation of publically owned bus companies such as the Yellow Bus Company (Auckland Regional Council Fleet – formally the early Auckland City Council bus fleet).
1990's	State Owned Enterprises sold to recover Government debts.
1990-91	Core rail operations transferred to New Zealand Rail Limited (A State Owned Enterprise). The Auckland services were run under the Cityrail brand.

	The rest of the rail operation remained with the New Zealand Railways Corporation.
1993	New Zealand Rail Limited was privatised. New Zealand Railways Limited sold to Wisconsin Central.
1995	The rail network was renamed TranzRail.
1996	Whenuapai Bus Travel Limited sold to Stagecoach.
1998	Stagecoach sold to Ritchies Transport Holdings Limited. Yellow Bus Company (Auckland Regional Council) sold to Stagecoach. Fullers Auckland had controlling interest in Waiheke Bus Company. Stagecoach New Zealand Limited became the majority shareholder of the ferry service.
2002	Crown brought back the Auckland railway network. Auckland Regional Council won the tender to run rail services. They did so under the TranzMetro brand. Territorial Authority rail stations were transferred to Auckland Regional Transport Network Limited.
2004	Veolia is the new rail operator for Auckland. The New Zealand Railways Corporation rail operations are renamed ONTRACK. ONTRACK work to maintain the rail.
2005	Auckland Regional Transport Authority was formed and has the rail stations and other assets under the Auckland Regional Transport Network Limited transferred to them. Stagecoach brought by Infratil (To be renamed New Zealand Bus).
2006	New Zealand Bus starts North Shore bus line (Blue and Yellow buses).
2007	New Zealand Bus starts GO WEST bus line (Green buses). New Zealand Bus starts METROLINK bus line (Blue and Silver Buses).
2008	ONTRACK becomes Kiwirail (Legal name is still the New Zealand Railways Corporation). Howick and Eastern bus company sold to Souter Holdings Ltd.
2009	New Zealand Bus starts Waka Pacific bus line (Silver buses).
2010	The seven territorial authorities and one regional council are merged, creating the Auckland Council. Auckland Regional Transport Authority is now called Auckland Transport and is still a subsidiary of the Auckland Council.

Source: (Table by Author, 2010).

9. Appendix Two

Table 9.1: Detailed results of the Northern Express Transfer analysis

Feeder Bus Number	Northern Express Station	Feeder Bus Company	Single Transferrable Fare	Distance Between Stops	Peak Morning Feeder Arrive At Station	Northern Express Leave	Wait Time (Mins)	Frequency Interval Of Northern Express	Number of transferring Passengers Morning Peak 7am-9am	Daytime Feeder Arrive At Station
880	Albany	Ritchies	YES	Under 10 Metres	7:25	7:27	2	4	6	13:50
	Constellation				7:50	7:54	4	4	8	14:20
886	Constellation	Ritchies	YES	Under 10 Metres	7:25	7:27	2	4	5	13:55
887	Albany	Ritchies	YES	Under 10 Metres	7:35	7:39	4	4	5	14:05
	Constellation				7:55	7:58	3	4	1	14:25
957	Albany	Birkenhead Transport	YES	Under 10 Metres	7:20	7:23	3	4	3	13:50
803/804	Smales Farm	Ritchies	YES	Under 10 Metres	7:22	7:27	5	4	5	14:07
913	Smales Farm	North Star	YES	Under 10 Metres	7:40	7:43	3	4	9	13:40
915	Smales Farm	Birkenhead Transport	YES	Under 10 Metres	7:40	7:43	3	4	5	14:05
843	Constellation	North Star	YES	Under 10 Metres	7:30	7:34	4	4	6	14:00
	Akoranga				8:00	8:03	3	4	1	14:30
905	Smales Farm	Ritchies	YES	Under 10 Metres	7:38	7:39	1	4	6	14:08
911	Akoranga	Ritchies	YES	Under 10 Metres	7:40	7:43	3	4	6	14:08

Feeder Bus Number	Northern Express Leave	Wait Time (Mins)	Frequency Interval Of Northern Express	Number Of Transferring Passengers Daytime 1pm-3pm	Peak Evening Feeder Arrive At Station	Northern Express Leave	Wait time (Mins)	Frequency Interval Of Northern Express	Number Of Transferring Passengers Peak Evening 4:30pm -6:30pm
880	14:00	10	10	2	17:20	17:30	10	10	3
	14:25	5	10	5	17:50	17:55	5	10	5
886	14:00	5	10	2	17:25	17:30	5	10	3
887	14:10	5	10	3	17:35	17:40	5	10	5
	14:35	10	10	3	17:55	18:05	10	10	2
957	14:00	10	10	N/A	17:26	17:30	4	10	1
803/804	14:09	2	10	2	17:33	17:39	6	10	2
913	13:49	9	10	4	17:45	17:49	4	10	3
915	15:09	4	10	3	17:30	17:39	9	10	3
843	14:05	5	10	2	17:00	17:05	5	10	4
	14:32	2	10	3	17:30	17:32	2	10	2
905	14:09	1	10	4	17:38	17:45	7	10	2
911	14:12	4	10	3	17:38	17:42	4	10	2

Feeder Bus Number	Evening Feeder Arrive At Station	Northern Express Leave	Wait Time (Mins)	Frequency Interval Of Northern Express	Number Of Transferring Passengers Evening 7pm-9pm	Saturday Feeder Arrive At Station	Northern Express Leave	Wait Time (Mins)	Frequency Interval Of Northern Express	Sunday Feeder Arrive At Station
880	19:20	19:30	10	15	0	12:20	12:30	10	15	15:20
	19:50	20:00	10	15	1	12:50	13:05	15	15	15:50
886	19:25	19:30	5	15	0	12:25	12:35	10	15	15:25
887	19:35	19:45	10	15	0	12:35	12:45	10	15	15:35
	19:55	20:05	10	15	0	12:55	13:05	10	15	15:55
957	18:56	19:00	4	15	0	12:20	12:30	10	15	15:40
803/804	19:07	19:09	2	15	0	12:35	12:45	10	15	15:35
913	19:30	19:39	9	15	0	12:20	12:24	4	15	15:39
915	19:35	19:39	4	15	0	12:20	12:24	4	15	15:20
843	19:30	19:35	5	15	0	12:30	12:35	5	15	15:30
	20:00	20:10	10	15	0	13:00	13:12	12	15	16:00
905	19:05	19:09	4	15	0	12:08	12:09	1	15	15:08
911	19:38	19:42	4	15	0	12:38	12:42	4	15	15:38

Feeder Bus Number	Northern Express Leave	Wait Time (Mins)	Frequency Interval Of Northern Express	Number Of Transferring Passengers Weekend During Two Hour Interval	Average Wait Time Scores Weekday Morning Peak	Weekday Daytime	Weekday Evening Peak	Weekday Late Evening	Saturday	Sunday And Public Holidays
880	15:30	10	15	0	5	4	4	4	3	3
	16:05	15	15	2						
886	15:30	5	15	1	5	5	5	5	3	5
887	15:45	10	15	6	5	4	4	4	4	4
	16:05	10	15	5						
957	15:45	5	15	0	5	4	5	5	4	5
803/804	15:45	10	15	N/A	5	5	4	5	4	4
913	15:54	5	15	N/A	5	4	5	4	5	5
915	15:24	4	15	N/A	5	5	4	5	5	5
843	15:35	5	15	4	5	5	5	4	4	4
	16:12	12	15	N/A						
905	15:09	1	15	N/A	5	5	4	5	3	5
911	15:42	4	15	N/A	5	5	5	5	3	5

Feeder Bus Number	Frequency Interval Of Northern Express Average Score Weekday Morning Peak	Weekday Daytime	Weekday Evening Peak	Weekday Late Evening	Saturday	Sunday And Public Holidays	Total Fare Price For Return Journey ($)	Average Number Of Passengers Transferring for all periods tested
880	5	4	4	3	3	3	10.15	3.20
886	5	4	4	3	3	3	9.00	3.00
887	5	4	4	3	3	3	11.30 9.00	4.20
957	5	4	4	3	3	3	14.70	3.80
803/804	5	4	4	3	3	3	9.00	4.80
913	5	4	4	3	3	3	9.00	6.20
915	5	4	4	3	3	3	9.00	5.20
843	5	4	4	3	3	3	9.00	2.20
905	5	4	4	3	3	3	9.00	5.40
911	5	4	4	3	3	3	9.00	5.20

Feeder Bus Number	Single Transferrable Fare Score	Distance Between Stops Score	Average Wait Time Score	Frequency Interval Of Northern Express Score	Number Of Passengers Transferring Score	Fare Price For Return Journey Score	Total Score For Each Bus Line
880	5	5	3.83	3.67	1.00	3.00	**21.50**
886	5	5	4.67	3.67	1.00	4.00	**23.33**
887	5	5	4.17	3.67	1.00	3.50	**22.34**
957	5	5	4.67	3.67	1.00	2.00	**21.33**
803/804	5	5	4.50	3.67	1.00	3.00	**22.17**
913	5	5	4.67	3.67	2.00	3.00	**23.33**
915	5	5	4.83	3.67	2.00	3.00	**23.50**
843	5	5	4.50	3.67	1.00	3.00	**0.00** **22.17**
905	5	5	4.50	3.67	2.00	3.00	**23.17**
911	5	5	4.67	3.67	2.00	3.00	**23.33**

Source: (Table by Author, 2010).

* Transfer times tested were 7:20 am, 1:55 pm, 5:25 pm, 7:15 pm Monday-Friday, 12:30 pm Saturday and 3:30pm Sunday. Times used reflect the closest feeder bus time to those above arriving at the transfer destination. Transfers tested were from a feeder bus onto the Northern Express, heading into Britomart.

* Transferring passenger numbers data collection times: 803/804, 915, 913 and 905 Smales Station tested Wednesday 20th October 2010. 911, 843 Akoranga Station tested Monday 18th October 2010. 880, 886, 887, 843 Constellation Station tested Tuesday 2nd November and Saturday 23rd October. 880, 887, 957 Albany Station tested Monday 1st November and Saturday 23rd October.

*Please refer back to table 5.1 for scoring criteria for each element tested.

10. Appendix Three

Table 10.1: Detailed results of the 007 transfer analysis.

Reference	Transfer Area	Bus Number(s)	Transfer Bus Company	Single Transferrable Ticket	Distance Between Stops	007 Bus Stop	Transfer Bus Stop
Point A	Carrington Road	006	Metrolink	NO	33 Metres	Carrington Rd	Carrington Rd
Point B	Mt Albert Rd / New North Rd	210, 211, 212, 223, 224	Metrolink or Go West	NO	50+ (Average 100 Metres)	Mt Albert Rd - Uncovered	Mt Albert Rd - Covered
Point B	Mt Albert Rd / New North Rd	Mt Albert Train Station	Veolia	NO	50+ (Average 200 Metres)	Mt Albert Rd - Uncovered	Covered Train Station
Point C	Balmoral Rd / Sandringham Rd	233, 241, 243, 248, 249	Metrolink or Go West	NO	50+ (Average 150 - 200 Metres)	Balmoral Rd - Covered	Sandringham Rd - Covered
Point D	Dominion Rd / Balmoral Rd	011	Metrolink	NO	50+ (Average 200 - 250 Metres)	Balmoral Rd - Covered	Dominion Rd - Covered
Point D	Dominion Rd / Balmoral Rd	256, 258. 267	Metrolink	NO	50+ (Average 250 Metres)	Balmoral Rd - Covered	Dominion Rd - Covered
Point E	Balmoral Rd/ Mt Eden Rd	274, 275, 277	Metrolink	NO	50+ (Average 300-350 Metres)	Balmoral Rd - Uncovered	Mt Eden Rd - Uncovered
Point F	Balmoral Rd / St Andrews Rd	288, 297, 298	Metrolink	NO	50+ (Average 350-400 Metres)	Balmoral Rd - Uncovered	St Andrews Rd - Uncovered
Point G	Manukau Rd / Green Lane West	324-354	Metrolink or Waka Pacific	NO	50+ (Average 100-200 Metres)	Green Lane West - Uncovered	Manukau Rd - Uncovered
Point G	Manukau Rd / Green Lane West	302, 304, 305, 312, 315	Metrolink or Waka Pacific	NO	50+ (Average 150-200 Metres)	Green Lane West - Uncovered	Manukau Rd - Uncovered
Point H	Green Lane West / Wheturangi Rd	392	Metrolink or Waka Pacific	NO	50+ (Average 250-300 Metres)	Green Lane West - Uncovered	Wheturangi Rd - Uncovered
Point I	Great South Rd / Green Lane West	428-497	Waka Pacific	NO	50+ (Average 200-250 Metres)	Green Lane West - Uncovered	Great South Rd - Covered
Point I	Great South Rd / Green Lane West	502, 511, 512, 522, 532	Metrolink or Waka Pacific	NO	50+ (Average 200-250 Metres)	Green Lane West - Uncovered	Great South Rd - Covered
Point I	Great South Rd / Green Lane West	595	Metrolink or Waka Pacific	NO	50+ (Average 200-250 Metres)	Green Lane West - Uncovered	Great South Rd - Covered
Point I	Great South Rd / Green Lane West	50, 51	Howick and Eastern	NO	50+ (Average 200-250 Metres)	Green Lane West - Uncovered	Great South Rd - Covered
Point I	Great South Rd / Green Lane West	52	Howick and Eastern	NO	50+ (Average 200-250 Metres)	Green Lane West - Uncovered	Great South Rd - Covered
Point I	Great South Rd / Green Lane West	55, 680, 681	Howick and Eastern	NO	50+ (Average 200-250 Metres)	Green Lane West - Uncovered	Great South Rd - Covered
Point I	Great South Rd / Green Lane West	Green Lane Train Station	Veolia	NO	50+ (Average 450-500 Metres)	Green Lane West - Uncovered	Green Lane Train Station
Point J	Remuera Rd / Upland Rd	606	Metrolink or North Star	NO	50+ (Average 350-400 Metres)	Remuera Rd – Uncovered	Upland Rd - Covered
Point K	Glen Innes Bus / Train Terminal	Glen Innes Train Station	Veolia	NO	10 - 20 Metres	Bus / Train Terminal	Covered Station
Point K	Glen Innes Bus / Train Terminal	625	Metrolink or Waka Pacific	NO	Under 10 Metres	Bus / Train Terminal	Covered Station
Point K	Glen Innes Bus / Train Terminal	655	Metrolink or Waka Pacific	NO	Under 10 Metres	Bus / Train Terminal	Covered Station
Point K	Glen Innes Bus / Train Terminal	715	Metrolink or Waka Pacific	NO	Under 10 Metres	Bus / Train Terminal	Covered Station
Point K	Glen Innes Bus / Train Terminal	745	Metrolink or Waka Pacific	NO	Under 10 Metres	Bus / Train Terminal	Covered Station
Point K	Glen Innes Bus / Train Terminal	750, 755, 756, 757	Metrolink or Waka Pacific	NO	Under 10 Metres	Bus / Train Terminal	Covered Station
Point L	Tamaki Drive / St Heliers Bay Rd	767, 769	Metrolink	NO	50+ (Average 200-250 Metres)	St Heliers Bay Rd – Uncovered	Tamaki Drive – Uncovered
Point L	Tamaki Drive / St Heliers Bay Rd	770, 771	Metrolink	NO	50+ (Average 200-250 Metres)	St Heliers Bay Rd – Uncovered	Tamaki Drive – Uncovered

Reference	Peak Morning 007 Arrive	Transfer Arrive	Wait Time (Mins)	Frequency Interval Of Transferring Bus	Day Time 007 Arrive	Transfer Arrive	Wait Time (Mins)	Frequency Interval Of Transferring Bus	Peak Evening 007 Arrive	Transfer Arrive	Wait Time (Mins)	Frequency Interval Of Transferring Bus	Evening 007 Arrive	Transfer Arrive	Wait Time (Mins)	Frequency Interval Of Transferring Bus
Point A	7:27	7:48	21	30	14:03	14:18	18	30	17:31	5:35	4	30	19:20	N/A	N/A	60
Point B	7:29	7:34	5	10	14:05	14:15	10	15	17:33	17:40	7	10	19:22	19:28	14	30
Point B	7:29	11:05	214	15	14:05	16:21	146	30	17:33	17:35	2	15	19:22	20:35	73	60
Point C	7:40	7:46	6	10	14:15	14:19	4	15	17:43	17:57	14	10	19:28	19:32	4	20
Point D	N/A	N/A	N/A	N/A	14:18	14:18	0	60	17:47	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Point D	7:44	7:47	3	5	14:18	14:22	4	10	17:47	17:50	3	5	19:30	19:42	12	10
Point E	7:45	7:46	1	10	14:19	14:23	4	10	17:51	17:58	7	10	19:31	19:45	14	30
Point F	7:45	7:46	1	20	14:19	14:23	4	30	17:55	18:11	16	20	19:31	19:45	14	60
Point G	7:52	8:00	8	20	14:25	14:30	5	30	17:58	17:10	12	20	19:36	20:05	29	30
Point G	7:52	7:57	5	15	14:25	14:39	14	20	17:58	18:05	7	15	19:36	19:50	14	30
Point H	7:57	8:15	18	15	14:30	15:15	45	60	18:02	18:05	3	30	19:40	20:55	75	60
Point I	7:58	8:10	12	20	14:30	14:35	5	30	18:04	18:40	36	20	19:41	19:50	9	30
Point I	7:58	8:08	10	10	14:30	14:33	3	30	18:04	18:12	8	10	19:41	19:43	2	60
Point I	7:58	8:18	20	30	14:30	15:13	43	60	18:04	18:12	8	30	19:41	20:18	37	60
Point I	7:58	8:05	7	10	14:30	14:45	15	20	18:04	18:10	6	10	19:41	19:50	9	30
Point I	7:58	8:05	7	30	14:30	14:45	15	60	18:04	18:10	6	30	19:41	19:45	4	60
Point I	7:58	8:04	3	15	14:30	14:43	3	60	18:04	18:25	19	30	19:41	20:04	23	60
Point I	7:58	8:08	10	30	14:30	14:43	12	30	18:04	18:22	18	30	19:41	20:18	37	30
Point J	8:11	9:00	49	20	14:39	15:00	21	30	18:10	18:13	3	30	N/A	N/A	N/A	N/A
Point K	8:20	8:39	19	10	14:48	14:58	10	20	18:18	18:36	28	10	19:53	20:48	53	30
Point K	8:20	8:35	15	5	14:48	14:50	2	15	18:18	18:20	2	5	19:53	20:05	12	30
Point K	8:20	8:50	30	5	14:48	15:15	27	15	18:18	18:20	2	5	19:53	20:20	27	30
Point K	8:20	8:35	15	30	14:48	3:05	17	30	18:18	18:35	17	30	19:53	21:10	77	60
Point K	8:20	8:35	15	20	14:48	15:35	47	60	18:18	18:35	17	20	19:53	20:05	12	60
Point K	8:20	8:55	35	15	14:48	15:00	12	30	18:18	18:50	32	15	19:53	20:35	42	60
Point L	8:42	9:00	18	10	15:00	15:15	15	15	18:30	18:40	10	10	20:10	20:15	5	60
Point L	8:42	8:55	13	20	15:00	15:45	45	40	18:30	19:15	45	20	21:10	21:10	0	60

Reference	Saturday 007 Arrive	Transfer Arrive	Wait Time (Mins)	Frequency Interval Of Transferring Bus	Sunday 007 Arrive	Transfer Arrive	Wait Time (Mins)	Frequency Interval Of Transferring Bus	Average Wait Time Scores Weekday Morning Peak	Weekday Daytime	Weekday Evening Peak	Weekday Late Evening	Saturday	Sunday And Public Holidays
Point A	12:08	N/A	N/A	60	13:38	N/A	N/A	60	1	2	5	0	0	0
Point B	12:10	12:15	5	30	15:40	15:46	6	30	5	4	4	3	5	4
Point B	12:10	13:14	64	60	12:10	20:14	294	60	1	1	5	1	1	1
Point C	12:20	12:39	19	20	15:50	15:57	7	60	4	5	3	5	2	4
Point D	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0	5	0	0	0	0
Point D	12:22	12:29	7	10	15:52	15:54	2	10	5	5	5	3	4	5
Point E	12:23	12:35	12	10	15:53	16:05	12	30	5	5	4	3	3	3
Point F	12:23	12:35	14	40	15:53	16:05	12	80	5	5	2	3	3	3
Point G	12:30	12:55	25	40	16:00	16:20	20	40	4	5	3	1	1	2
Point G	12:30	12:40	10	20	16:00	16:06	6	20	5	3	4	3	4	4
Point H	12:35	13:30	65	60	16:05	N/A	N/A	120	2	1	5	1	1	0
Point I	12:36	12:43	7	40	16:06	16:16	10	40	3	5	1	4	4	4
Point I	12:36	13:23	73	60	16:06	16:23	17	60	4	5	4	5	1	2
Point I	12:36	13:13	39	60	16:06	16:13	7	60	2	1	4	1	1	4
Point I	12:36	12:50	14	30	16:06	16:45	39	60	4	3	4	4	3	1
Point I	12:36	12:45	9	30	16:06	16:45	39	60	4	3	4	5	4	1
Point I	12:36	12:49	13	60	16:06	16:49	43	90	5	5	2	1	3	1
Point I	12:36	12:48	12	30	16:06	16:48	42	30	4	4	2	1	3	1
Point J	12:43	13:20	37	30	N/A	N/A	N/A	N/A	1	1	5	0	1	0
Point K	12:50	13:16	26	30	16:20	17:16	56	30	2	4	1	1	1	1
Point K	12:50	13:05	15	15	16:20	17:05	45	30	3	5	5	3	3	1
Point K	12:50	13:15	25	15	16:20	16:30	10	30	1	1	5	1	1	4
Point K	12:50	13:05	15	60	16:20	17:05	45	60	3	2	2	1	3	1
Point K	12:50	13:35	45	60	16:20	16:35	15	30	3	1	2	3	1	3
Point K	12:50	13:00	10	30	16:20	16:30	10	30	1	1	1	1	4	4
Point L	13:05	13:15	10	30	16:35	16:45	10	45	2	3	4	5	4	4
Point L	13:05	13:45	40	60	16:35	16:45	10	60	3	1	1	5	1	4

Reference	Frequency Interval Of Transferring Bus Scores Weekday morning peak	Weekday Daytime	Weekday Evening Peak	Weekday Late Evening	Saturday	Sunday And Public Holidays	Total Fare Price For Return Journey ($)	Single Transferrable Ticket Score	Distance Between Stops Score	Average Wait Time Overall Score	Frequency Interval Of Transferring Bus Score	Number Of Passengers Transferring Score	Fare Price For Return Journey Score	Total Score For Each Bus Line
Point A	1	1	1	1	1	1	15.80	0	3	1.33	1.00	0	1	**5.33**
Point B	4	3	4	1	1	1	15.80	0	1	4.17	2.33	0	1	**7.50**
Point B	3	1	3	1	1	1	13.00	0	1	1.67	1.67	0	2	**4.33**
Point C	4	3	4	2	2	1	15.80	0	1	3.83	2.67	0	1	**7.50**
Point D	0	1	0	0	0	0	13.60	0	1	0.83	0.17	0	2	**2.00**
Point D	5	4	5	4	4	4	13.60	0	1	4.50	4.33	0	2	**9.83**
Point E	4	4	4	1	4	1	15.80	0	1	3.83	3.00	0	1	**7.83**
Point F	2	1	2	1	1	1	15.80	0	1	3.50	1.33	0	1	**5.83**
Point G	2	1	2	1	1	1	15.80	0	1	2.67	1.33	0	1	**5.00**
Point G	3	2	3	1	2	2	15.80	0	1	3.83	2.17	0	1	**7.00**
Point H	3	1	1	1	1	1	15.80	0	1	1.67	1.33	0	1	**4.00**
Point I	2	1	2	1	1	1	18.00	0	1	3.50	1.33	0	1	**5.83**
Point I	4	1	4	1	1	1	18.00	0	1	3.50	2.00	0	1	**6.50**
Point I	1	1	1	1	1	1	18.00	0	1	2.17	1.00	0	1	**4.17**
Point I	4	2	4	1	1	1	18.00	0	1	3.17	2.17	0	1	**6.33**
Point I	1	1	1	1	1	1	18.00	0	1	3.50	1.00	0	1	**5.50**
Point I	3	1	1	1	1	1	18.00	0	1	2.83	1.33	0	1	**5.17**
Point I	1	1	1	1	1	1	18.00	0	1	2.50	1.00	0	1	**4.50**
Point J	2	1	1	0	1	0	18.00	0	1	1.33	0.83	0	1	**3.17**
Point K	4	2	4	1	4	1	20.00	0	4	1.67	2.67	0	1	**8.33**
Point K	5	3	5	1	3	1	22.60	0	5	3.33	3.00	0	1	**11.33**
Point K	5	3	5	1	3	1	22.60	0	5	2.17	3.00	0	1	**10.17**
Point K	1	1	1	1	1	1	22.60	0	5	2.00	1.00	0	1	**8.00**
Point K	2	1	2	1	1	1	22.60	0	5	2.17	1.33	0	1	**8.50**
Point K	3	1	3	1	1	1	22.60	0	5	2.00	1.67	0	1	**8.67**
Point L	4	3	4	1	1	1	24.80	0	1	3.67	2.33	0	1	**7.00**
Point L	2	1	2	1	1	1	24.80	0	1	2.50	1.33	0	1	**4.83**

Source: (Table by Author, 2010).

* Transfer times tested were 7:20 am, 1:55 pm, 5:25 pm, 7:15 pm Monday-Friday, 12:00 pm Saturday and 3:30pm Sunday for the 007 bus line. Times reflect the 007 moving from Pt Chevalier to St Heliers Bay from the times stated. Transfers tested are from the 007 onto a bus or train line heading into Britomart.

*Please refer back to table 5.1 for scoring criteria for each element tested.

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