IMPROVING PUBLIC TRANSPORT IN AUCKLAND, NEW ZEALAND

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ABSTRACT

The aim of this paper is to investigate policy approaches which will improve the existing public transport system in Auckland, New Zealand. The four principles of public transport network planning: line structure, frequency, transfers and fare systems, have been investigated by selecting the Northern Express (the only Bus Rapid Transit (BRT) in New Zealand) in Auckland. The data of the Northern Express and its associated network were collected from policy and planning documents, timetables and websites. The data was further verified by conducting a detailed field-work on the selected network. The result shows that the Northern Express exhibits some network planning principles such as the simple and straight line, high frequency and transferrable fare. However, the Northern Express is poorly designed with feeder buses and could be improved to gain higher patronage levels. The analysis indicates the poor performance of public transport in Auckland can be addressed by fixing public transport services in the short-term at relatively little cost.

Keywords: Public transport, straight line structure, frequency, transferring, fares, Auckland

1. INTRODUCTION

Efficient public transport systems are integral to improving the economic, social and environmental sustainability of a transport system in any city (Vuchic 1999, Cervero 1998, Low & Glesson 2002, Banister 2002). However, there are a range of factors that influence the development of an efficient public transport system, especially in dispersed cities. The poor performance of public transport in Auckland, New Zealand has been justified by the spatial characteristic of the city, people's socio-economic characteristics, and the policies adopted overtime (Imran & Matthews 2011). Certainly, these sorts of factors have influenced the successes and failures of city public transportation, but a public transport services has of itself the potential to make a system successful, in the short-term, at relatively little cost (Mees *et al* 2010; Stone *et al.* 2012). The aim of this paper is to investigate the policy approaches that are capable of improving the existing public transport services in Auckland.

This paper first reviews the long, medium and short-terms factors capable of making a public transport system successful. Next the research design and the reasons for selecting the Northern Express (the only BRT line) in Auckland as a case study for data collection and detail investigations are discussed. The following sections contain an in-depth analysis of the Northern Express followed by a discussion and conclusion.

2. HOW TO IMPROVE PUBLIC TRANSPORT? – A LITERATURE REVIEW

Public transport has the potential to mitigate the social, economic and environmental consequences of private vehicle travel in urban areas (Vuchic 1999, Cervero 1998, Low & Glesson 2002). However, better quality and improved forms of public transport are a prerequisite for this role and so the question is how to achieve better quality public transport? The discussion in the literature can be divided into long, medium and short-term factors.

2.1 Long-term factors

The physical, social and economic characteristics of a city, its people, and the political system are factors that need to be considered in making public transport successful in the long run. These are factors include:

a) Urban structure: Urban structure focuses on city physical composition; the land use patterns, population and employment density which makes a city compact and dispersed. Ewing (1997), Cevero (1998), Newman & Kenworthy (1999) and Naess (2006) advocate that compact cities, with high population densities and mixed land use, are more likely to develop successful public transport systems. They provide examples of Hong Kong, Singapore and Tokyo in Asia, and Zurich, Freiburg and Paris in Europe to justify their arguments. However, Cao *et al.* (2007) argue that urban composition cannot independently influence public transport success. Instead, the success of public transport is the result of the quality of the transportation system provided. For example, a series of high-rise housing estates built in Paris after the Second World War did not make public transport successful (Breheny 1996). These arguments show that urban structure matters to some extent but is not the only factor in making public transport successful.

b) Social-economic and psychological factors: The relationship between public transport and income and status levels of people is widely accepted (Dargay *et al.* 2007). Low income people are more likely to use public transport as they do not have access to private vehicles. Similarly, it is argued that high social status keeps people away from public transport as is happening in China, and India where per capita income is less and people are status conscious (Dargay *et al.* 2007). However, Newman and Kenworthy (1999) argue that social-economic factors do not account for the variations seen in public transport use in many other cities around the world. They provide examples of wealthier European and Asian cities with successful public transport systems. Mees (2000) finds that although a relationship does exist between income and public transport, the quality of the public transport system has a greater influence over private vehicle ownership and usage. For example, 'Zurich has achieved an enviable reputation for providing high quality public transport that an affluent population actually chooses to use'(p. 121). This phenomenon has been observed in Sydney and Melbourne where people with higher incomes are choosing to locate to where quality public transport is provided (ibid). Moreover, people's public transport perceptions and experiences also influence the use of public transport. These perceptions and experiences are built mainly upon the immediate costs and benefits for the individual (Liebrand 1986) such as personal convenience, power, freedom, status and superiority, travel time, ride continuity and accessibility (Vugt *et al.* 2006; Tertoolen *et al.* 1998).

c) Political factors: Political parties, their leadership and agendas have the potential to directly influence the success of public transport. Therefore, public transport systems play a significant role during election campaigns. For example, Mayor Samuel Moreno in Bogota, Colombia actively pursued the integration of the existing bus system with the Transmilnio (BRT local name), and the construction of a Metro during his campaign (Alvarez 2010). Similarly, Mayor Len Brown from Auckland, New Zealand also focused on public transport improvements and promised integrated ticketing, electric trains and the construction of a Central Business District rail link (Auckland Council 2012).

In summary, urban structure, social-economic and psychological factors and politics play a role in the success of public transport. However, making any changes in these factors requires long-term policies and investment which is sometimes beyond the control of transport planners.

2.2 Medium-term factors

The medium-term factors mainly encompass institutional structures that support public transport policy and planning. These are:

a) Institutional structures: Over time, there have been three distinct types of institutional structures deployed in public transport planning. These have been publically provided systems, privately run systems and public-private partnerships.

In a publically provided system, public transport infrastructure and operation is managed by public sector agencies (Leland & Smirnova 2008). The government is responsible for regulating the public transport industry to protect customers, and employees, and benefits the wider public through the setting of quality and safety standards and price controls, as well as regulating the entry of new transport providers (Sohail *et al.* 2006). Public transport is viewed as a public good under this type of institutional structure where 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 1950s to 1980s. While this structure had the benefit of maintaining a full public transport network and providing equal access opportunities for all, the public companies experienced large financial burdens due to inefficiencies caused by poor and unwise decision making (Lurie 1960; Savage 2004). This resulted in the need for large subsidies to be paid to these companies.

Privatisation and consequential increased competition was considered to be the solution to the inefficiencies of publically provided systems. Governments allowed private companies to run public transport in a free market system to increase economic efficiency and productivity. Only minimal, mainly safety regulations, were placed on private companies (Vickerman 2008). The privately provided public transport systems were most commonly seen following the 1980s and were widely applied in developed and developing countries (Sohail *et al.* 2006). Singapore and Hong Kong achieved the highest level of efficiency by adopting private institutional structures. However, in many cities, private companies neglected accessibility requirements, increased fares, decreased service levels and even gave up all the unprofitable lines, and ultimately patronage dropped (Mees 2005; Gwilliam 2008; Rothengatter 1991). Moreover, multiple transport provided often resulted in competition, provided piecemeal and fragmented services and posed coordination problems (Gwilliam 2008).

In the last two decades, the new structure of public-private partnerships has emerged, where government regulates and directs the public transport system by inviting tenders from private companies. The selected private company gets the right to operate all or part of the public transport network. In this way, the public sector ensures that full and comprehensive services can be provided by employing the private sector at the lowest possible cost (Gwilliam 2008). The public transport franchising schemes in the UK and many other countries are examples of this structure (Preston 2008). In summary, the successful public transport system demands a strong publically-planned and privately-run institutional structure. This will allow the government to regulate and control the network for the entire urban area while a private company is contracted to run the network (Mees *et al.* 2010). Moreover, the government formulates policies to improve public transport infrastructure while the private sector focuses on the efficiency of operation (Nielson 2005).

2.3 Short-term factors

The short-term factors include fixing public transport services at relatively little cost. These fixes may include improvements in frequency, reliability, transferring and fares by adopting simple and grid-based line structures adopted as a network.

a) Line or route structures: The network planning approach to public transport demands the adoption of a straight line principle, moving from origin to destination using the most direct path possible given the surrounding land uses and topography (Mees 2000; Nielson 2005). The primary reason for this is that straight line patterns offer the most direct and quickest travel paths for passengers. Mees *et al*. (2010) argue that public transport lines should be a 'defined and unchanging physical route with a fixed stopping pattern, a specific timetable, and a unique name and number' (p.20). The straight line structure is adopted in cities like Zurich and Toronto to minimise travel time and make the public transport network more efficient (Mees 2000, 2010; Stone *et al.* 2012; Nielson 2005; Thompson 1977).

By adopting a straight line principle, public transport line structure moves in a cross-city pattern instead of to the central city. The cross-city public transport lines do not have the outer suburbs and central city as their start and end destinations. Instead, public transport lines run in north-south and east-west directions, creating a grid pattern. Under the grid pattern, passengers can 'go anywhere, anytime' using the most direct path possible (Mees 2000; Thompson 1977). As a result, this line structure works to create a very comprehensive public transport service network as all parts of the city can be accessed from any other part of the city. The only requirement is normally for passengers to transfer at least once to reach their final destination. This is an approach that is adopted by cities such as Zurich and Toronto, which both have successful public transport networks (Mees 2000). This pattern is also suitable for todays' travel patterns which are dispersed in nature as activities become more and more decentralised. For example, the CBDs in United States cities contain less than 10 per cent of city jobs (Gregory & Matoff 2003). These facts demand a city wide public transport network. In line with this principle, this research explores the types of public transport line structures present in Auckland.

b) Transferring: Transferring means to shift from one public transport mode to another to reach an end destination. It is a key concept in the grid-based network planning approach as discussed above. The coordinated transfers and quality of transport play the greatest role in improving passenger experience (Lo *et al.* 2003; Mees 2010; Stone *et al.* 2012; Nielson, 2005). In Hong Kong, travellers often need to transfer three or four times to reach their end destination (Lo *et al.* 2003). Similarly, 70 per cent of all Munich and London underground trips, 40 per cent of all Paris public transport trips and 30 per cent of New York subway trips require at least one transfer to reach an end destination (Guo & Wilson 2011). Due to well-designed transfers, patronage levels remain high in these cities. However, if timely and quality transfers were not provided, transfer would become a negative element in public transport travel as '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). Therefore, the provision of quality interchange points and a connected network needs to be a priority in public transport service design. This research seeks to investigate whether public transport in Auckland facilitates transfers between different lines and modes.

c) Frequency: Frequency of public transport refers to how often a bus or train travels along a particular route. Currently, frequency is determined by patronage levels at particular times; if public transport patronage falls, then frequency levels will be reduced and vice versa (Carey & Crawford 2007; Ceder 2007). This approach creates a demand responsive system in which evening and weekend services are irregular, infrequent and even non-existent because of low demand.

Network planning requires a supply-led approach based on desired levels public transport (Mees 2000; Nielson 2005). 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 in turn ensures that they operate as a singular network and not as individual entities. This supply-led approach involves 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; Stone *et al.* 2012; Nielson 2005) to ensure that the lower frequency will not inconvenience users. 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 (ibid). This research explores the frequency levels of public transport services in Auckland.

d) Fare structures: Fare structures refer to the manner in which passengers are charged to use public transport services. The most common fare structures are; 1) flat fares that involve passengers paying the same price for public transport tickets regardless of distance travelled 2) zonal fares where passengers pay for the distance they travel (Leutze & Ugolik 1979; Rock, 1975; Nielson 2005). Network planning requires a zonal fare system which allows for transfer between services without imposing additional financial cost to passengers. By coupling a zonal system with transferable fares, passengers 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. If passengers are charged extra to transfer in order to make one journey, they are likely to either not change lines or to not use the service at all. Therefore, when looking at fare systems, it is important to consider the need for transfer-friendly fares and integrated ticketing. This research asks the question, do fare structures in Auckland encourage the use of public transport?

In summary, public transport service provision principles include: straight line and grid-type line structures, high or timed frequency corridors, the provision of quality transfer interchange points and the provision of transferable friendly fares', these are all key components in making improvements to public transport in the short-term.

3. RESEARCH DESIGN

The research has been conducted in Auckland, the largest city in New Zealand with a population of approximately 1.5 million people (Statistics New Zealand 2012). It is one of sixteen regions in the country (see Figure 3.1). Eighty seven per cent of journeys to work in Auckland are made using private vehicles (Statistics New Zealand 2006). As a result, Auckland is renowned for its congestion and the worst levels of public transport provision in a western city in the developed world (Laird *et al.* 2001) catering for only seven per cent of all journey to work trips. Auckland 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, 2010a).

There are several agencies at multiple levels of government responsible for transport planning in Auckland. At the central government level, the New Zealand Transport Agency (NZTA) manages the State Highways and motorways while Kiwi Rail is responsible for managing the rail network in Auckland. At the local or metropolitan level, the newly created

Auckland Council[1] and its subsidiary Auckland Transport are responsible for formulating transport strategies and planning.

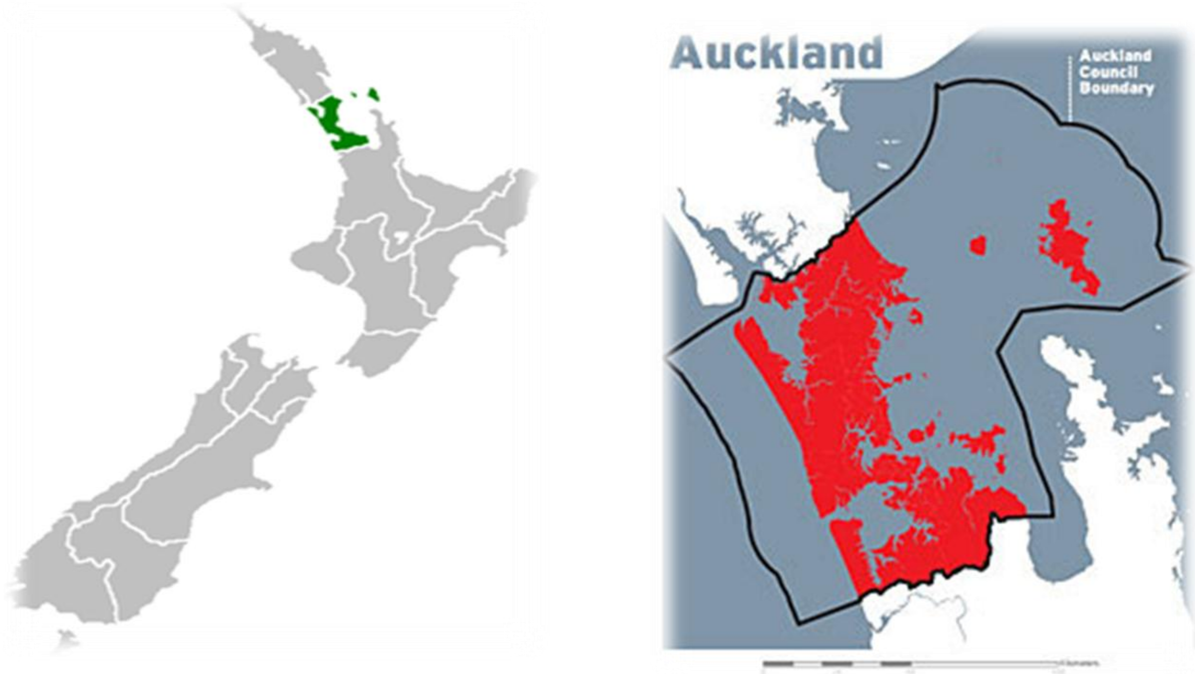

Figure 3.1: Map of Auckland, New Zealand (Source: Auckland Council website)

The main aim of the data collection and analysis is to answer four subsidiary questions: What types of public transport line structure are present in Auckland? What are the frequencies of public transport services in Auckland? Does public transport in Auckland facilitate transfers between lines and modes? And do fare structures in Auckland encourage the use of public transport? The Northern Express (BRT in Auckland) and its surrounding network are used as a case study to answer these questions.

The data collected includes both desk-top and fieldwork components. The desk top data covers government and non-government policy and planning documents, timetables and other information available publically on websites. Detailed fieldwork has been conducted to confirm waiting times, ticket prices, walking distance between transfers, fare structures, and the frequencies on transferring lines. The elements of the data collected was graded, based on performance and awarded a score from 0 to 5, with 5 being the best possible score. Once

[1] The Auckland Council were created in 2010 after merging seven territorial authorities and one regional council in Auckland after the recommendation of the Royal Commission on Auckland Governance. The principle reason for this merger was to increase the effectiveness of local government in providing different metropolitan level services including public transport.

a score had been awarded for each category an average grade was calculated to generate an overall score for the public transport line.

For cross-examining, 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). Fifteen transport planning documents which are no older than six years were analysed. This time limit was chosen so that currently operative plans, which were produced five years ago, could be included. In addition to current plans, annual reports and monthly business reports up to 2010 are included.

The selected transport documents include: 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 (2007, 2009), Auckland Regional Transport Authority Annual Report (2004/05, 2005/06, 2006/07, 2007/08, 2008/09) and Auckland Regional Transport Authority Monthly Business Report (May 2010, June 2010 and July 2010). These reports include the latest developments in Auckland's public transport and verify Auckland's approach to public transport planning.

To conduct 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 appropriate 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 the current public transport approaches utilised in the city.

There are some limitations of the research design. This research did not gain access to commercially sensitive information such as patronage data for individual public transport lines, which would have enabled a more in-depth analysis. Moreover, conducting interviews to ascertain stakeholders' perspectives would have further strengthened and validated the research findings.

4. THE NORTHERN EXPRESS - PUBLIC TRANSPORT SERVICE PROVISION ANALYSIS

This section aims to critically assess the current state of public transport services in Northern Auckland (locally called the North Shore) by identifying the type of line structures, frequency, transferring and fare structures of the Northern Express and surrounding network.

a) Line structure analysis: Auckland is notoriously known for its overly complex bus line network (Auckland Regional Transport Authority, 2010b). However, the Northern Express provides a good example of a simple bus line as it travels straight from the north Auckland (Albany station) to the CBD 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 shown in Figure 4.1. The bus right of way is shaded in yellow and runs a length of 6.2 kilometres (Auckland Regional Transport Authority, 2010m).

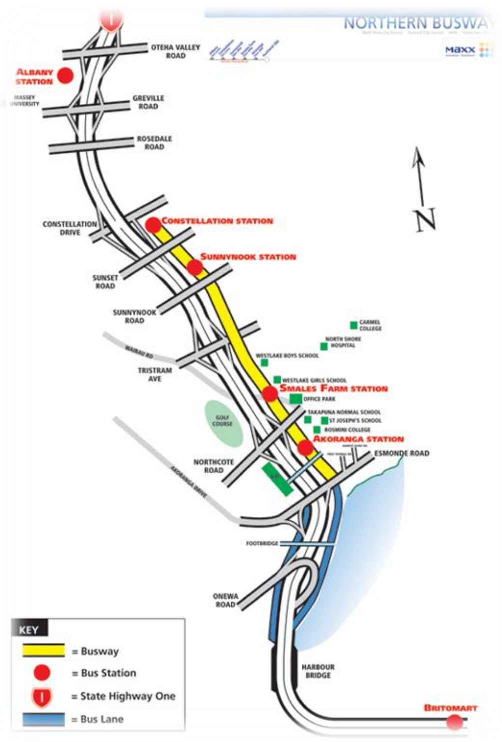

Figure 4.1 The location of the Northern Busway
Source: (Auckland Regional Transport Authority, 2010d)

The Northern Express is proving to be very successful, with patronage levels continually increasing from 0.8 million passengers in 2008 to 1.8 million passengers in 2010

(Auckland Regional Transport Authority, 2010c). In short, the Northern Express simple and direct line structure contributes to the success of public transport in northern part of Auckland.

b) Frequency analysis: The Northern Express provides a good example of a ‘forget the timetable’ high frequency corridor. 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 at nights, and at weekends and public holidays.

The reliability of the Northern Express has been achieved by providing bus lanes and bus rights of way. Therefore, buses are taking around 24 minutes to travel from the origin (Albany Station) to destination (Britomart Station in the CBD). This is compared to a 45 minute journey when travelling by car (Auckland Regional Transport Authority, 2010c). However, outside of the bus right of way, the buses are subject to local traffic conditions. This becomes a problem, particularly during peak hour periods. With the motorway becoming full by 7am during the morning peak period, it makes the ride in some sections very slow (such as between Albany and Constellation, and again soon after Akoranga to Britomart). With the only road access to downtown Auckland being 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. In short, the Northern Express offers frequent and relatively reliable services in Auckland.

c) Transfer analysis: The public transport services in Auckland discourage transferring due to the provision of highly complex, indirect and radial bus routes. Few public transport bus lines cross in a manner that could allow for transfer between public transport lines, with cross town bus lines (which provide 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.

In order to analyse the transferability, a transfer analysis was undertaken for 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. 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 4.2 shows a map of the Northern Express and the feeder bus routes studied. 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.

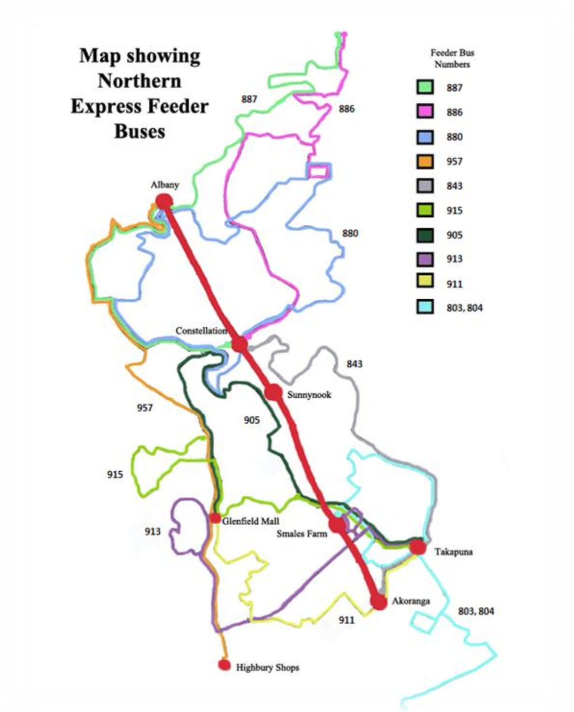

Figure 4.2 The Northern Express Feeder buses analysed in the transfer analysis. (Source: Authors)

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 4.1 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 4.1: 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: Authors

Table 4.2 provides the total scores of the bus lines tested, along with the individual scores for each element tested. For detailed results for each transfer analysis please refer to Appendix one. 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. 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 transfer.

Table 4.2: The overall results of the transfer analysis of the two bus lines

Transfer factors considered	Overall score
Single transferable fare	5
Fare price for return journey	3.05
Distance between stops	5
Average wait time	4.5
Frequency interval of transferring bus	3.67
Number of passengers transferring	1.4
Total score	22.62

Source: Authors

Figure 4.3 shows photos of a transfer point for the Northern Express. This photo is of Albany Station and shows the significant infrastructural set-up of these bus services.

Figure 4.3 Northern Express Bus Station (Photos taken by Authors)

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.

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 to easily connect people from the suburbs to the Northern Express. Feeder bus routes are indirect, uncoordinated and haphazard (see Figure 4.2). As a result, people are not using these bus services as feeder services, with their 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 in Northern Auckland 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). 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 constrained by their inability to access a car park. What this further shows is that the feeder services provided are not effective in attracting passengers. In short, the Northern Express does not offer good transfer to and from different feeder services despite the building of high quality bus stations.

d) Fare structures: A zonal-based fare system operates in Auckland. Under this system, passengers are required to pay more for a fare the longer distance that they travel. This system however is highly complicated. 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, 2010e). 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. In Northern Auckland, 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, 2010e).

In terms of concession tickets available in Auckland, pensioners can travel for free while approved tertiary students can receive a 40 per cent 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. However, transferrable tickets can at times be offered between the same transport operators, but competing operators do not accept each other's tickets (Auckland Regional Transport Authority, 2010e). This works to undermine the MAXX brand and attempts to provide a coordinated public transport system.

Northern Auckland does offer transferrable fares. In this part of the city, it is possible to travel on different public transport lines to travel around the region and to downtown Auckland, but this ticket is not usable throughout the rest of the Auckland network. In 2010, the cost of a return journey ticket is NZ$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 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. The survey recorded between one and nine passengers using the 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 data has recorded the total number of passengers from all bus arrivals for the two hour period.

The figure shows that very few passengers are using the buses for transfer purposes. Instead, these buses are only directly attracting passengers, meaning that they are not being used as a feeder bus service. 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. In short, a simple and integrated fare structure is in place on the Northern Express and its surrounding network.

e) Content analysis

As a part of the investigation into Auckland’s public transport system, a content analysis was undertaken. Key words and phrases were looked for within each of the four categories, line structures, frequency, transferring, and fares. In the analysis, all the variations in the use of the key words and phrases were looked for. For example, when looking for the word simple, other variations of the same word such as simplify, simplification, and simplified were also looked for.

From the content analysis, line structures in Auckland gain little attention from transport planners. Although the Northern Express bus line and the busway it travels along was frequently 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 often mentioned with 246 occurrences despite there being only three bus lines in Auckland operating on a relatively frequent basis. This means that for the wider public transport network, improving frequency was found to be the focus of planning documents.

> *"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)*

> *"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, 2008, p. 15).*

This improved frequency however did not consider the implementation of pulse-timetables. By comparison, much less focus is placed on reliability (75 counts) and punctuality (60 counts). The problem with this is that reliability and punctuality are first needed to address frequency levels effectively. Although providing an integrated transport network was frequently mentioned (180 counts), there was little focus placed on how this could 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).

> *"The location of park and ride facilities should enable a seamless interchange from car to passenger transport" (Auckland Regional Transport Authority, 2006, p. 56).*

Although both gained relatively few mentions, this does show a preference for providing park and ride facilities as opposed to strengthening the surrounding bus network. When looking at fares, it was found that public transport fares and tickets were often discussed in transport planning documents, with a total word count of 301. Of these, about one third focused on the implementation of a single transferrable fare or ticket (118 counts).

> *“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, 2009, p. 6).*

Although Auckland does not currently offer transferrable tickets, this does show that transport planners are working towards their implementation.

5. DISCUSSION AND CONCLUSION

The research aims to investigate the prospects of public transport in Auckland in the short term by analysing four key principles of network planning: straight line structure, frequency, transfers and fares.

The straight line structures of public transport directly impact on the quality and reliability of public transport (El-Hifnawi 2002; Mees 2010). This is because straight line structures provide the most direct travel path for passengers and create a grid pattern which is best for dispersed travel patterns (Neilson 2005; Mees 2010). Auckland lines are primarily meandering line structures which form a radial public transport pattern into the central city to serve commuters. Peak period commuters are the focus of many planning documents, with this being emphasised through the attention placed on the Northern Express – a straight line public transport service designed to specifically target peak period travellers from Northern Auckland heading into the central city. The content analysis also confirms this. 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. However, the Northern Express lines are treated as single entities and are not planned for nor looked upon as a part of a single network. Therefore, local buses are not designed well to serve as feeder services to the Northern Express. There needs to be a focus placed on meaningful integration, which will mean the removal of competing and overlapping local bus services.

Public transport frequencies significantly influence public transport use and must therefore be planned to meet customer's needs (Mees 2000, 2010; Stone *et al.* 2012; Nielson 2005). Generally, customers demand high frequency public transport lines and a pulse-timetabling system so public transport lines will be timed in a way that main line and feeder services will arrive and depart at a destination at the same time (ibid). However, the public transport frequencies in Auckland are generally very poor. Within the entire network, only three high frequency lines were found, including the Northern Express, with no pulse-timetabling occurring throughout the rest of the network. The Northern Express offers reliable and frequent all day services to passengers during the week and is therefore highly patronised. However, the Northern Express services on weekends and evenings are of a much lower frequency. Although frequencies can be reduced during off-peak times, they need to remain regular and consistent with the wider network in order to be effective. This is not the case because of absence of pulse-timetabling which can significantly eliminate or reduce the long waits experienced by passengers. When a pulse timetable is not provided the network does not operate as a single entity. Instead, the Northern Express operates individually, attracting customers based on the quality of individual line performance and the availability of Park & Ride facilities. Yet the surrounding feeder bus network is poorly patronised. However, there is no reason why the Northern Express passengers along with new passengers would not also utilise a local feeder bus network, if such a quality system was provided. It is clearly not the public transport system that people are unwilling to use but the current state of the system provided. The results of the content analysis show that frequency is often discussed in planning documents. This suggests that public transport planners have placed priority on improving the frequency levels of public transport. Despite this however, such focus has not eventuated in the emergence of a high frequency public transport network, and pulse-timetabling is not a focus for planners as seen through the content analysis.

Transfer is a key element in the provision of a successful public transport network (Guo & Wilson 2011; Shrivastava, et al., 2007). The quality of transfer points and timely transfer will influence people's willingness to transfer between services (Lo *et al.* 2003; Mees 2000, 2010; Mees *et al.* 2010; Stone *et al.* 2012; Nielson, 2005). The Auckland public transport network however has not been designed to accommodate transfer. This is evident in the design of the public transport lines. The Northern Express offers high frequency and world class stations as transfer points but the surrounding bus network does not meet the frequency standard and straight line principles. 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 fieldwork shows there are few passengers transferring between lines. This is largely due to different buses operating separately from each other – even competing in many instances. The content analysis shows that little attention is being given to facilitating transfers between different modes of public transport. The focus is on the development and expansion of park and ride facilities to be used as a transfer point. This shows that public transport trips remain dependent on the private vehicle and availability of their parking. This strategy might reduce the CBD congestion but shifts congestion to the park and ride facilities in the suburbs. Clearly, this approach does not promote the utilisation of the wider public transport network. Such an approach 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.

Public transport networks should operate using an integrated and transfer-friendly ticketing system (Mees 2000, 2010; Mees *et al.*, 2010; 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 (ibid). The research shows that Auckland has primarily adopted a zonal fare system and passengers pay for the distance they travel. However, Auckland public transport system is charging passengers for each individual trip they make and transferrable fares are not readily offered. There is an exception in the Northern Auckland area, including the Northern Express which offers transferrable ticketing using a time-based ticketing system. These differences within the wider network make fare structures complicated and difficult to understand for users. The results of the content analysis show that the implementation of a single transferrable fare gained significant attention from transport planners. Despite this though, they have not been successful in providing a single integrated ticketing system in the city.

Auckland public transport is operated by several private companies and is therefore lacking a form of cross-subsidisation. Auckland Council and Auckland Transport do not pool and then redistribute 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 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 but this 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 is an incentive to provide a high quality public transport network. This encourages 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.

The discussion shows that the Northern Express is relatively a good example of network planning present in Auckland public transport network. However, the key service provision elements needed for network planning are largely absent in the wider network. Auckland has not designed line structures that work to create a straight line and grid network that encourage transferring. Furthermore, the fare structures and frequency levels needed to contribute towards improving public transport are lacking.

The aim of this research is to investigate short term policy approaches to improve the existing public transport system in Auckland. The short-term approaches include line structure, frequency, transfer and fare structures to address public transport service provision. The research finds that a meandering and radial line pattern is present in Auckland, except the straight line route of the Northern Express. The Northern Express line structure is simple and straight, high in frequency, has world class bus stations and offers a transferrable fare to connect to the wider Northern Auckland bus network. When compared to the rest of the Auckland network, the Northern Express is experiencing high patronage levels. This example shows the potential for short term network planning factors to improve public transport in a city.

The main recommendation of this research project is to redesign Auckland's public transport using the network planning principles: 1) to redesign public transport lines to create a simple and straight line network 2) to provide more high frequency corridors and utilise the pulse-timetabling technique for low frequency corridors 3) design public transport with transferring in mind. This involves making transfers possible and providing adequate infrastructure, and 4) to provide transferrable tickets that can be used on any service in the city.

Acknowledgement

This paper is based on Lee Matthews's unpublished Master thesis in the Resource and Environmental Planning at Massey University supervised by Dr Muhammad Imran.

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APPENDIX ONE (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: (Authors).

* 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 2010.
*Please refer back to table 4.1 for scoring criteria for each element tested.