Reshaping Christchurch’s public transport system: The potential of transit orientated development and rail

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Christchurch, New Zealand, is a city with a seemingly forgotten rail history. The city once had an intricate tram system that served much of the city which was removed and sealed over in the 1950s, and a heavy rail system that serviced much of the surrounding Canterbury townships and the South Island which has served only tourists since 1970. This abandoning of the rail network that once shaped the region was due to the rapid uptake of private vehicle usage which was more convenient and cheaper than rail. In recent years studies into the feasibility of reinstating public rail transport have received significant interest from local government and public due to growing concerns about climate change and the city's urban sprawl. This research will investigate the potential of a public rail network in the Greater Christchurch region of New Zealand and will provide further analysis Rapid Mass Transit options in the region.

Literature was reviewed on the current and previous rail proposals for the Greater Christchurch region as well as reviewing successful rail projects internationally. Key informant semi-structured interviews were conducted with members of the Christchurch City Council/Greater Christchurch Partnership, Environment Canterbury and The Ministry of Transport to ascertain the key barriers and enablers of implementing a rail system in Christchurch. A quantitative analysis calculated the possible ridership numbers of an comprehensive Greater Christchurch region was also conducted using ArcGis, Census Commuter Data with Excel-based equations. This helped create a key research finding of an upper limit of 376,063 daily trips or 137,262,995 yearly trips that could be moved by rail between the catchments as defined within ArcGis.

Other key findings highlight the importance of transit orientated development (TOD) in the success of rail whilst highlighting the success of new rail is at the expense of other transportation modes such as private vehicles. This suggests restricting cars in densified zones such as the central city being key to influencing a mode shift. Additionally, a change in mindset is also needed from the public to adopt public transport and from planners to find better ways of examining the potential success of rail through Cost-benefit analysis.

Keywords: Rail, Heavy Rail, Light Rail, Tram, Greater Christchurch, Transit Orientated Development, Density, Catchments, Mixed-use

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Chapter 1 Introduction

1.1 Introduction

Rapid Mass Transit (RMT) in the form of buses, light and heavey rail has seen a greater uptake globally through the late 20th century and into the 2000's. Cities such as Portland, Sydney, Aarhus, Copenhagen, Nantes and Strasbourg all made significant investments into making rail – in the forms of heavy rail, light rail and trams – a priority of their public transport systems. This is motivated by RMTs ability to reduce "*emissions, congestion, road deaths and injuries, delivers wider social benefits, and provides resilience and connection between communities*" (MoT, 2020).

In many cities throughout the world, public transport (usually in the form of rail or tram) was commonplace in the early 20th century but was replaced by roads and private motor vehicles. This was common, particularly throughout Europe and New Zealand. French cities Nantes, Strasbourg and Grenoble in particular had sizeable tram networks running within the cities but removed them in favour of road transport in the form of cars and buses in the mid-20th century (Boquet, 2017). This modal shift is similar to what occurred throughout New Zealand cities in the same time period where trams were once operated widely in New Zealand in cities such as Auckland, Dunedin, Wellington, Christchurch, Whanganui, Invercargill, Napier, Gisborne and New Plymouth in the 1910s but were phased out between 1928 and 1964 (Humphris, 2010). Unlike New Zealand however, many cities in Europe turned back to trams and new light rail technology in the late 20th century.

Within New Zealand, expansion of rail has been occurring in Auckland throughout the greater city region but also to the surrounding districts of the Waikato and Manukau (significantly since the early 2000s, and more recently involving the electrification of the rail). Wellington similarly has five Metlink-operated lines between the central city and surrounding suburbs and satellite towns that link the city with the Wairarapa, Hutt Valley and the Kapiti Coast. However, in the city of Christchurch, there has not been a form of rail public transportation since the passenger operations on the Lyttleton line ceased in 1976 in the form of heavy rail and no public tram service has been operated since 1954, with the current inner city tram loop being tourist orientated.

In Christchurch there have been numerous proposals to reintroduce rail/rapid mass transit, particularly in the last decade as part of the Christchurch rebuild post-earthquake. Currently, a significant business case is being produced under the overarching strategic direction of the Canterbury Regional Land Transport Plan (CRLTP) 2015-2025 and the Canterbury Public Transport Plan (CPTP) 2018-2028. This raises some questions as to why a rail system has not been reimplemented for Christchurch, what may have been missed, and what other urban form, transport, behavioural and policy/institutional changes may need to occur before RMT can be implemented.

The aim of this dissertation is to further add to the debate about what conditions are needed for the successful implementation of RMT in the Greater Christchurch region by reviewing international literature and conducting a GIS and interview-backed research case study on if and how rail transport could be suitable. The remainder of this chapter will contain background information pertaining to the specific case study of Christchurch, and the policy context. Chapter 2 is comprised of a literature review of past and current studies of international cities of relevance and of Christchurch. Chapter 3 contains the research question, methodology and research analysis. This chapter aims to explain the mode of the research conducted in the dissertation and support the analysis and further discussion, as well as containing GIS (Geographical Information System) software-produced maps. Chapter 4 contains interview summaries and analysis with New Zealand planning professionals on public transport and local government officials. The key findings from these interviews inform the discussion and bring to light important points regarding the implementation potential of RMT in the Greater Christchurch region. Chapter 5 and 6 contains the research discussion and Recomendations. Chapter 7 contains conclusions and suggestions for further research.

1.2 Background

1.2.1. New Zealand

New Zealand has a strong history of dependency on private vehicles for transport. As a result, studies such as car insurance company 'confused.com' ranked countries on the following factors related to transport:

- Size of railway network
- Efficiency of trains
- Quality of rail infrastructure
- Efficiency of public transport services
- Adequate access to public transport
- Transport cost
- Taxi price
- Rail usage

This confused.com study found that New Zealand was the most dependent country in the world for the use of private vehicles. 2018 Census figures show that 73 percent of people in New Zealand drive or are passengers in private or work vehicles and 50.2 percent of students drive or are driven to school in private vehicles. This is the result of substantial urban sprawl with all New Zealand towns, and cities such as Christchurch, struggling to stop the expansion and engulfing of satellite towns into their boundaries, meaning people must travel further each day to work. Within this system, cars are the easiest and most convenient way to complete their travel needs.

Car dependency has also been compounded due to much of New Zealand's rail being removed, mothballed, or primarily used for freight. Maps of New Zealand's current and past rail network can be seen in Figure 1 and Figure 2. The only viable source of public transport in cities such as Christchurch being buses which over the years have been found to be unreliable and inconsistent in their timings. In February 2023 it was reported that 15,000 bus trips had been cancelled throughout Greater Christchurch in the four months prior, an average of 127 a day and 28,674 trips in the year prior (Law, 2023). A 2020 University of Canterbury study on the youth perception of public transport had found that timing and scheduling was a barrier with one 16-year-old participant stating, "*There's just so much uncertainty with buses as well, like they can be really late or really early, and just not on time whatsoever*" (Coultas et al., 2020).

Figure 1: Map of New Zealand's North Island's rail network (D'Arrigo, 2006).

Figure 2: Map of New Zealand's South Island's rail network (D'Arrigo, 2006).

1.2.2. Christchurch

With an estimated population of 390,000, Christchurch is the largest city in the South Island of New Zealand. The Greater Christchurch region which encompasses the Waimakariri and Selwyn Districts had a population count of 489,069 in 2018 which is projected to increase to 621,600 by 2038, with the Selwyn District projected to have the most growth (Canterbury Wellbeing Index, n.d). A WSP interim report into the feasability of RMT also outlines the Greater Christchurch region is expected to have a population of 641,000 in 2048. Due to the region's recent and expected growth, there is now more traffic congestion into and around the city. The city has been dominated by cars since the 1950s when the historic tramways and heavy rail networks become unprofitable and were removed or paved over. It was during this age of rail, however, that Christchurch showed its first sign of Transit Orientated

Development (TOD) around tram terminai in suburbs such as Woolsten, Sydenham, Riccarton and St Albans (CCC, 2005) which is barely seen today around the current bus routes (Gyles et al., n.d).

The current public transport system in Christchurch consists solely of buses with other major forms of transport including cycling and a strong reliance on private vehicle usage. Figure 3 and Figure 4, show Christchurch is significantly above the national average in private vehicle usage for both work and education. The same patterns emerge when looking at both the Selwyn and Waimakariri districts, with bus and cycle usage in both these regions is significantly lower compared with Christchurch city figures. Interestingly when focused on Christchurch, the city is above average in cycling, which shows that the people of the city are willing to use active transport modes when the infrastructure is in place. This reliance on private vehicles for transit is similar to what has been seen in many cities around the world.

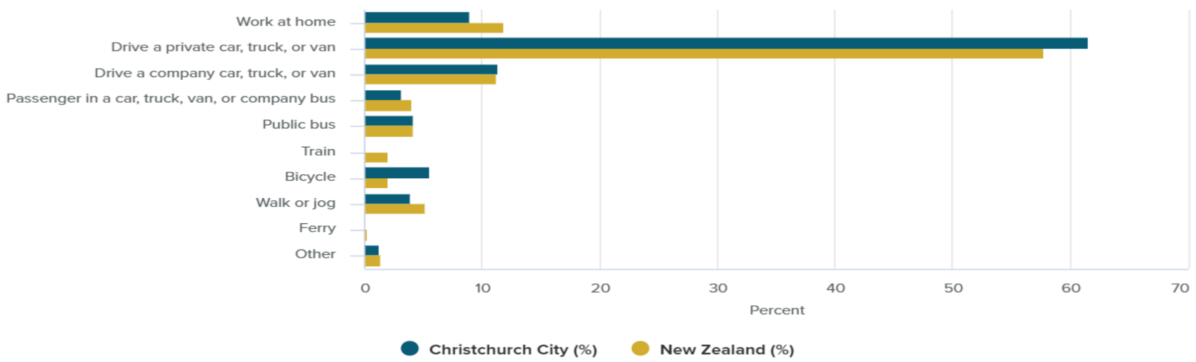

Figure 3: Main means of travel to work for people in Christchurch City and New Zealand, 2018 Census (StatsNZ, 2018).

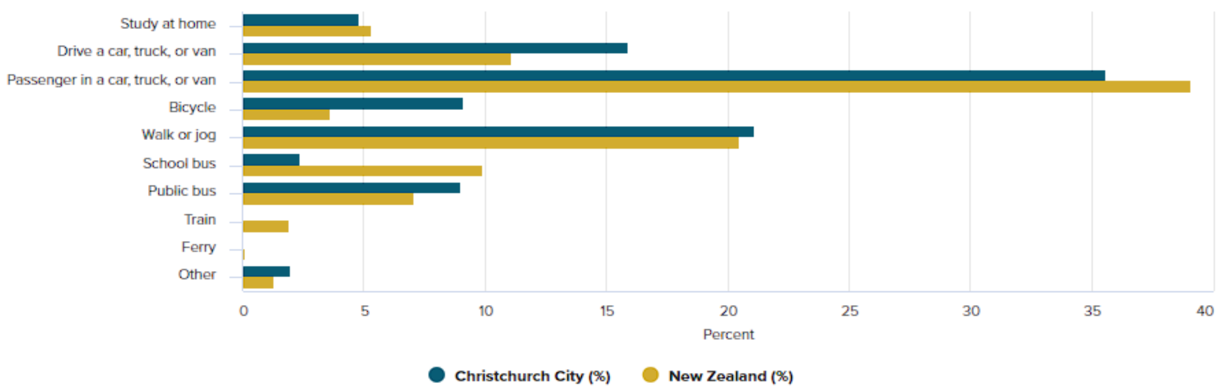

Figure 4: Main means of travel to education for people in Christchurch City and New Zealand, 2018 Census (StatsNZ, 2018).

Up until the 1950s Christchurch had an extensive tram and heavy rail passenger transport network. This tram and heavy rail system can be seen below in Figure 5 and Figure 6. These maps show that before cars and buses were widespread, the Greater Christchurch region was linked together with a comprehensive network.

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https://thespinoff.co.nz/society/22-03-2021/changing-the-future-before-its-too-late-the-case-for-rail-in-christchurch.

Figure 5: The Christchurch tram network at its greatest extent (Lewis, 2021).

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https://www.stuff.co.nz/the-press/news/117875372/a-trip-back-to-the-future-for-christchurch-public-transport.

Figure 6: Christchurch regional passenger railway network as of 1890 (McCrone, 2020).

1.3 Policy Context

Rail in the policy context of New Zealand government has seen limited funding and development Since the 1970's. In a recent development, the New Zealand Rail Plan of 2021 has no plans for any passenger transport in Christchurch with the city's only mention in the document regarding the upgrade and renewal of mechanical depots and maintenance hubs. The New Zealand 2021- 2024 National Land Transport Programme for Canterbury will be targeted at the vital main freight and long-distance passenger lines that connect Canterbury to ports and other regions. This appears to focus on the tourist trains of the Transalpine, the Coastal Pacific, and the possible reintroduction of the Southerner from Christchurch to Dunedin. Instead of focussing on Greater Christchurch as a growing city and investing in its public transport infrastructure, the focus continues to be on the North Island cities.

The Government Policy Statement (GPS) on land transport also supports the implementation of the New Zealand Rail Plan, which includes improving the safety of the rail network and how mode shift will make the overall land transport system safer. Increasing the use of freight and passenger rail will therefore support the Government's Road to Zero strategy by providing safer transport options and reducing traffic volumes on roads over time, which will improve road safety. The GPS aims to increase access to safer travel modes (e.g., public transport), with initial priority in Auckland, Tauranga, Hamilton, Wellington, Christchurch, and Queenstown. Both of these allude to offering some sort of rail transport to Christchurch in the near future. Nevertheless, the document does not specify rail coming to Christchurch, with the focus being on Greater Auckland and Wellington.

The Government Policy Statement (GPS) on Land Transport does require KiwiRail to deliver a three-year investment programme for the rail network and means that KiwiRail could be a potential partner in the public interest for rail in and around Greater Christchurch. The Rail Network Investment Programme (RNIP) will also include an indication of significant rail network activities expected in the next RNIP and a 10-year forecast and states that GPS 2021 implements the findings of the Future of Rail review. The premise of this activity class is to implement the New Zealand Rail Plan by funding approved activities from the Programme (RNIP (prepared by KiwiRail), and the priority is to ensure a reliable and resilient national rail network. It provides funding to KiwiRail to maintain and renew the national rail freight network. This is a significant development as in the past KiwiRail has been left to fund any maintenance and increases in infrastructure from the entity's own income. This government funding from the Land Transport Management Fund over the next three years, and increased acknowledgment of the benefits of climate change that rail can provide may finally see an opportunity for commuter rail in Christchurch to become a reality (Ministry of Transport, 2021). From these key documents however, it becomes clear that Christchurch is not seen as a priority for any rail development in New Zealand.

Another key piece of legislation is the National Policy Statement on Urban Development (NPS-UD). Objectives 3 and 8 are of most importance (NPS-UD, 2020):

Objective 3 states "*Regional policy statements and district plans enable more people to live in, and more businesses and community services to be located in, areas of an urban environment in which one or more of the following apply":*

a) *The area is in or near a centre zone or other area with many employment opportunities.*
b) *The area is well-serviced by existing or planned public transport.*
c) *There is high demand for housing or for business land in the area, relative to other areas within the urban environment.*

Whilst Objective 8 states "*New Zealand's urban environments":*

a) *Support reductions in greenhouse gas emissions.*
b) *Are resilient to the current and future effects of climate change.*

Objective 3 is important as its implementation is key to allowing for higher density zones and thus facilitating Transit Orientated Development (TOD). In the 2018 Christchurch City Council District Plan Belfast/Northwood, Eastgate/Linwood, Hornby, North Halswell, Barrington, Papanui/Northlands, Riccarton, Shirley/Palms and New Brighton were outlined as key areas for densification. These new zones are defined as key activity centres listed for more intensive mixed-use development. Also of note is the inclusion of Christchurch Central as a medium to high-density development zone.

The definition of key activity centres is "*key existing and proposed commercial centres identified as focal points for employment, community activities and the transport network, and which are suitable for more intensive mixed-use development"* (CCC, 2018). Whilst mixed-use is defined as a development that combines residential, commercial and/or community facilities. These additions are key and will help develop possible rail routes as these areas are seen as possible densification zones. The intensive mixed-use development along the transport network is also key for developing a sustainable transit-orientated city.

The NPS-UD is also important as it requires all Tier 1 urban environments, which includes the Christchurch City Council, the Selwyn District Council, and the Waimakariri District Council to implement plan changes with intensification policies. For the context of the NPS-UD, an urban environment is defined as "*any area of land (regardless of size, and irrespective of local authority or statistical boundaries) that* (Ministry of Housing and Urban Development, 2020)*:*

(a) is, or is intended to be, predominantly urban in character; and

(b) is, or is intended to be, part of a housing and labour market of at least 10,000 people".

This is important for this study as Christchurch, Rolleston, Kaiapoi and Rangiora are now all required to intensify their urban areas through the introduction of medium and high-density zones. It is also worth noting that the Hurunui District Council, which falls below a Tier 3 District Council, has included density objectives that are not required of them. One such policy is Policy 4.11 *"To provide for high-density residential developments in close proximity to the town centres of Hanmer Springs and Amberley, provided such developments are designed to maintain a sense of spaciousness and greenery, and are undertaken in accordance with an approved concept plan"* (HDC, 2023). Due to this, Amberley will be included in further research due to its proximity to the Main North Lines rail infrastructure. Due to the NPS-UD's objectives on increasing density and lowering greenhouse emissions, mixed-use density housing surrounding new transport hubs would be best suited to enable councils to fulfil these requirements.

1.4 Transit Orientated Development

Transit-oriented development (TOD) is an urban planning strategy that prioritizes the development of dense, mixed-use communities around public transportation hubs. The aim of TOD is to create walkable, liveable neighbourhoods that reduce car dependency, promote sustainable transportation, and improve access to jobs, services, and amenities. TOD is considered a vital element for the creation of sustainable, equitable, prosperous, peaceful modern cities (ITDP, 2019). This type of development is becoming increasingly popular in cities around the world, particularly in Europe where cities have a long history of transit-oriented design. Cities such as Copenhagen have implemented spatial plans such as the 5-finger strategy to help shape development along railways and stations.

A city of similar size to Greater Christchurch that has implemented TOD is Portland in the United States of America (USA). Portland is described as the USA's most aggressive city for TOD. By 2040, Portland plans for 40% of households and nearly 70% of jobs to be located in or near centres or corridors served by public transport. A TOD on Portland's waterfront, served by aerial tramway and light electric rail, aimed to support 10,000 jobs and 3,000 housing units, with the city's highest densities by 2015 (Thomas, 2012).

There are numerous benefits of transit orientated development with the transit orientated development institute outlines that the strategy can (TODI, n.d):

- Reduce traffic congestion.
- Allows residents to learn, work, live and play in the same areas.
- Improve air quality by lowering the areas carbon footprint.
- Promote sustainable modes of transportation.
- Spur economic development.
- Create jobs.
- Improve the overall quality of life in a community.

These benefits would be a positive way of promoting the change in development in Christchurch and the addition of a rail system would help create a pathway to transition as currently it would be difficult to create this type of development around the bus routes.

Chapter 2 Primary Literature Review

Many cities worldwide with a similar population and car dependency, and urban sprawl issues have transitioned to rail as a way forward, and in some cases, this transition has been 'backwards' to tram networks that previously existed in the cities before cars. Key examples of this are seen throughout Europe and cities such as Nantes and Strasbourg, France are key research locations. This 'backwards' transition is not too dissimilar from what Christchurch and similar small to medium-sized cities worldwide will need to look at doing to reduce the reliance on private vehicles. It is important when analyzing the literature for this research that there is a clear focus on cities of a similar geographical and population size to Christchurch as nothing will be gained from comparing a city like Christchurch to megacities with existing and flourishing rail networks such as London or Tokyo.

This literature review will critically analyze how rail has been successful or unsuccessful in similar-sized cities to Christchurch, what plans or studies have been made in Christchurch for the implementation of rail, and how transit-orientated development could help progress the city towards a potential successful public rail system.

2.1. International Studies

The Greater Auckland Partnership quoting Alon Levy, a Fellow in the Transportation and Land Use program of the NYU Marron Institute, states that "*one way [that] cities can fail is by adopting transit features from cities of the wrong size class*" (Levy, 26/06/ 2018). A second design feature Levy mentions concerns Transit Orientated Development and ensuring the city is shaped to be denser around the transport options. Density around transport hubs and adopting the relevant transportation modes are therefore critical to Transit Orientated Development in any city globally. There is little to nothing to be gained from comparing a smaller city to a mega-city within these two factors. There will be little over-lap in successes if a comparison was to take place, or similar incentives or modes implemented.

A European study by Fageda (2021) examined the impact of light rail on congestion, travel time, and pollution in medium-sized cities, and found that light rail systems have been successful on average in reducing the negative externalities associated with car traffic. However, the study had several limitations with one being rail systems may not be so helpful in reducing the negative externalities associated with car traffic if they are not designed to maximize annual ridership (Fageda, 2021). This infers that if light rail were to be adopted in small to medium sized cities it would have to be designed to maximize ridership and not be conservative for lower numbers. This includes purchasing new and well-maintained rolling stock, as implementing a new system with old trains may deter any potential riders. Making sure there is enough capacity for initial patronage numbers is also important as too many people standing initially may draw people away. Standing riders are expected but it would be best to not go small in an effort to reduce costs.

Boquet (2017) examined the renaissance of tramways in France and provided background information on how many cities in France turned away from trams in the mid-20th century much like Christchurch but have since redeveloped the tramways to reduce car usage. Particular interest is placed on cities such as Nantes which constructed a network in spite of the local political opposition and public scepticism. In 1985, Nantes became the first city in France to implement new modern tramways paving the way for any future developments.

Other cities, including Grenoble and Strasbourg, began coupling new tramways with urban development and renewal. The Bouquet (2017), pg 14, goes on to describe the relationship of trams with politics whilst outlining that "*Trams are a tool to regulate the role of the automobile in the city, by reducing the road space assigned to it in urban centres, and encouraging the reconstruction of public spaces, giving more room for pedestrians and bicycles."* Studies in Strasbourg since the tramway's development have found that public transport ridership has increased, however car traffic has not declined this is largely due to the increased population and travelling between suburbs not serviced by the trams. Car usage and access has decreased in the city centre of Strasbourg however as per the requirements of the tramways and its reach and has become significantly efficient in transporting the public to the city's centre . In the case of Strasbourg, public transport in the form of, at least for now, trams and trains, cannot solve the traffic problem of reaching further away suburbs and so car usage is the preferred mode of transportation for this purpose (Boquet, 2017). Strasbourg as of 2019 saw 127 million trips from its population of 473,000 over its 6 tramways lines totalling 40 miles that were reinstated in 1994 (Krebs, 4th August 2022). Strasbourg's journey to reinstating the trams began in 1973 when the city established a pedestrian sector surrounding the Cathedral in the city old-town with the mayor of the time Pierre Pfilmant stating *"What we hope for is that the pedestrian can walk in total freedom without fear of being hit or grazed by a car and wander at his leisure in the wonder that is Old Strasbourg"* (Krebs, 4th August 2022). The city then decided in the late 1980s, after removing a pro-car mayor from office, to adopt a tram system over an underground metro system. This was described by transport planner Dejan Petkov as *"Trams are compatible with different environments — in confined street spaces, pedestrian areas, and in mixed traffic, but also underground, on their own rights of way, in urban, suburban and rural areas"* (Krebs, 4th August 2022).

Within an Eric Krebs 2022 article "*Europe's new trams are reviving a golden age of transit",* it is outlined that since the beginning of the 21st century, trams have experienced a small form renaissance in the USA with mixed results with the example of Tempe, Arizona being of key mention. In May of 2022, Tempe unveiled a new free tram service for the city of 180,000 but the streetcar only averaged 767 weekday riders in its first month. This apparent failure of the tram system is due to cars still remaining the more convenient mode of transport with Petkov explaining "*The optimal operation of tram services comes often at the expense of other traffic modes, especially cars.*" (Krebs, 4th August 2022). Where Strasbourg found success and Tempe did not is largely due to Strasbourg's decision to pedestrianize its city centre making car travel impossible. This is an important finding as it may suggest for Christchurch removing cars and making car travel inconvenient is a key requirement to ensure the success of a rail system.

Nantes, France is another medium-sized city that has found success from its reinstated tramway in 1983 when the population was recorded at 470,000 (Macrotrends, 2023). As of 2020 the population was 678,000 and the tram network was the preferred mode of transport for 300,000 people, just under half of the city's population. The rail network also includes 21 park & ride facilities with 6000 parks between them showing the potential successes of integrated public transport. It is also well documented by both Boquet and TER4RAIL in a European Union sanctioned study that the trams were not always expected to be successful as in 1983 only 50% of the population in Nantes supported the tramway this, however, grew to 93% support by 1995 (TER4RAIL, 2020). Nantes is an extremely important city for this research and will be discussed in greater detail within the Discussion section.

2.1.1. Green tracking

An interesting concept that can be adopted with light rail is green tracking. Green tracking is an opportunity provided by rail in which the tracks lined with real or artificial grass that demonstrate environmental responsibility and retains amenity value that is lost through large grey roads. Green Roof Technology who are described as "*the leader in integrating living green solutions into any given architectural design for over 40 years*" (Breuning, 2023) state the following benefits can be achieved through adopting green tracks such as those seen in the over 500 miles present in Europe:

- *Improves natural water balance.*
- *Beautifies urban areas, nice, green, and beautiful.*
- *Reduces stormwater loads in sewer systems.*
- *Lowers blowing up of dust and pollutants.*
- *Significantly improves urban microclimate.*
- *Additionally lowers noise levels.*
- *Considered and recommended as compensatory measures.*
- *Step stone bio habitat for flora and fauna.*
- *Of course, reduction of heat island effect.*
- *Naturally, increase of property value near Green Rail Tracks.*
- *Cooling of track system."*

(Breuning, 2023).

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https://www.researchgate.net/figure/Green-tram-tracks-in-Nantes_fig27_312588628

Figure 7: Green tracks in Nantes (Pospieszny, 2015)

2.2. Domestic Studies

A University of Canterbury research project (Gyles et al., n.d) found that density is an important factor in the success of designs that take TOD into account. This is because density is a vital factor in ensuring there is a supply of residents and workers in an area to use the transport system. The supply of residents and workers then ensures there can be an ongoing demand for the use of that transit option, thereby ensuring that the transit system has ongoing economic viability (Gyles et al., n.d). Stadiums, universities and airports are key locations within a city that have large amounts of people moving (Boquet, 2017). This knowledge is important for making sure these locations are served by a proposed rail network. However, as the current WSP business case study leaves the airport and university off the proposed route. Boquet also outlines that trams are an opportunity for cities to rehabilitate and restructure the urban fabric of cities, reorganise space, reconquer urban areas and revitalise commercial centres (Boquet, 2017). This is important in Christchurch as there are urban areas on the decline that could be revitalized by better planning and the introduction of rail. One of these is New Brighton, which has suffered what the Christchurch City Council describes as a period of sustained decline since the 1970's when trading laws were liberalised (CCC, 2017). This decline and potential revitalization will be focused on in the discussion.

A 2017 proposal for rapid regional rail in Auckland by the Greater Auckland Partnership suggests that Christchurch would be an obvious candidate for rapid regional rail linking the city to Dunedin, via Oamaru and Timaru, which could be implemented on an upgraded South Island Main Trunk line or simply from Ashburton into the city if it is more feasible (Greater Auckland, 2017). In New Zealand, the KiwiRail value for rail report (2021b) also provides insights into the benefits of rail throughout New Zealand with the air quality benefits of rail currently estimated to save 70 lives throughout New Zealand each year whilst also helping reduce 288 injuries and car fatalities each year by reducing the number of people driving (KiwiRail, 2021b). This is important as this is currently country-wide, but these benefits will be seen in Christchurch with fewer deaths and health issues being caused by private vehicles. Other key benefits KiwiRail listed are:

- Reduced congestion
- Reduced greenhouse gases
- Improved road safety
- Lower road maintenance costs
- Fuel savings

2.3. Past and Current Studies in Christchurch

As previously mentioned, the estimated population of Christchurch is 390,000 while the Greater Christchurch region which encompasses the Waimakariri and Selwyn Districts has an estimated population of 516,800 in 2019 which is projected to increase to 621,600 by 2038.
As of 2018 census results (CCC, 2022):

- 75% of Christchurch residents drive or are driven to work.
- 96% of non-Christchurch residents working in Christchurch drive or are driven to work.
- In Christchurch, approximately half of the commuter trips taken by private vehicles are less than 7km.

This indicates a possibility for improvement or change in the Greater Christchurch region as the current public transport option of buses is either not sufficient to meet public needs or is not preferred by the public.

Commuter rail was proposed in the Christchurch Draft Central City Recovery Plan for Christchurch after the 2011 earthquakes and can be seen in Figure 9 shown on page 20 with all other proposed Christchurch rail maps. The 2011 CCC Draft Recovery Plan aimed to investigate the possibilities of a "commuter rail network" to support the planned growth of the city and its wider areas, both long term and short term, through strategic goals. This involved considerations into how the commuter rail network would incorporate connections with Lyttleton, Rolleston, and Rangiora into the Central City. The systems would include access to car parking facilities.

The draft plan considered studying the potential benefits of both heavy rail and light rail to be of high importance as rail "*systems have often had a transformational effect on a city's image, helping to generate business growth and confidence as a consequence, while improving the quality of life, city vitality and community health and wellbeing."pg 109.* This is similar to Boquet's report which outlined the ability of trams to revitalise a city. However, it also notes that many people have said that the city may be too small, and most people favoured looking at optimising the current rail system and not building new light rail. The plan goes on to state "*international comparisons of longstanding and recently introduced light rail systems in cities of a range of sizes has shown that such a system could assist economic growth when viewed as part of a comprehensive network of public transport routes and services for Greater Christchurch."*pg 109. The council's eagerness to pursue commuter rail at the time raises the question why the city moved forward at such a time without it but continues to fund studies such as that by WSP If the 2011 rebuild was not the right time to implement new systems in the city what do the Ministry of Transport, current and former councils see as different and more beneficial now?

In a study titled 'Greater Christchurch Northern Rail – Rapid Assessment for Environment Canterbury' (Aurecon New Zealand Limited, 2014) the objectives was a *"rapid assessment of the feasibility and indicative costs of providing a passenger rail service between Christchurch and Rangiora as a short-term option to help ease the immediate peak congestion issues on the northern corridor.*" pg 3. This study looked at using the existing rail and upgrading former stations to be suitable for passengers between Addington and Rangiora to ease congestion along the northern road corridor. The rapid assessment concluded that for a short-term option of 6 months, passenger rail was not a feasible as the cost was estimated at 8.2 million to purchase and 900,000 to lease, with operating costs *"for 6 months of 1.54 million. Based on Project 241996 File Rapid Assessment Report-Final.docx 17 July 2014 Revision 3 Page 3 a six-month period and a 50% cost recovery, this would result in a funding requirement in the region of 770k*.". However, the assessment did note that a long-term service would ensure greater benefits and could be better planned through strategic land use and transport planning.

A 2021 report prepared by WSP New Zealand Limited ('WSP') exclusively for Waka Kotahi explored three scenarios that connected Rolleston through the city to Kaiapoi and Rangiora:

- A heavy rail scenario – with limited stop opportunities but very competitive travel times.

- A street running scenario (buses) with limited stops that focuses on competitive travel times and generally follow the motorway corridors; and

- A street running scenario with more frequent stops that focuses on more households within the walk-up catchment (light rail), at the expense of travel time competitiveness (especially for the communities at the edges of the line). This scenario generally follows the urban arterials of Riccarton Road and Papanui Road.

The report found that heavy rail was unsuitable, this may be the reason why it has not been further considered by the Christchurch partnership transport for the future discussion, which has discarded the heavy rail option for a number of reasons including: rail not going through the central city, limited infrastructure capabilities, and the freight trains that already use the lines regularly. This has left the partnership looking at light rail and metro buses both of which have exceedingly high costs ranging between $1.8 and 4.4 billion while reducing the vehicle kilometres travelled on the network by 4% (~590,000 vehicle km per day) for buses and by %3.5 (~470,000 vehicle km per day) for light rail (Morahan et al., 2021).

For this report the methodology assumes population forecast and distribution as contained in Christchurch Transport Model (CTM 2018). This projects the population in the Greater Christchurch Region to reach 641,000 by 2048; employment to reach 307,000 and a student roll of 100,000. Phase C of the method estimated that MRT would redistribute the forecast population growth towards the station catchment areas. The magnitude of this redistribution varies by between 5,000 and 9,000 (for population) and between 2,000 and 7,000 (for employment) depending on the MRT scenario tested. This shows Transit Orientated Development was implemented in these studies forecast.

The Huihui Mai survey conducted in 2023 by the Greater Christchurch Partnership produced a number of important results for this study particularly in relation to opinions on density and also the proposed line between Hornby and Belfast. In relation to density survey results found that 39% of people would live in high density housing, 17% might and 44% said no with younger people being more likely to say yes. This is important as it provides data on the people of Christchurch's willingness to move into any future transit orientated regions. (Greater Christchurch Partnership, 2023a).

In terms of the turn up and go proposed route between Belfast and Hornby 53% agreed with the route, 23% didn't know if they agreed and 24% said no, they did not agree. Of the people that said no the following alternatives were identified:

- *Rolleston (18%)*
- *Eastern Christchurch (15%)*
- *Greater Christchurch generally (15%)*
- *Rangiora (11%)*
- *South Christchurch (9%)*

This was followed by north and west Christchurch (both at 6%), the airport and central Christchurch (both at 5%), south-east Christchurch, University, North Canterbury and Lyttelton. 3.2% of people wanted heavy rail corridors to be used."

(Greater Christchurch Partnership, 2023a).

This data was found to correlate with where the people answering the survey lived. This is important as it shows there is a significant population wanting to see the rail elsewhere in Christchurch rather than just along the proposed route that can be seen below in Figure 10.

However, due to the way the Huihui Mai survey has been conducted, the results may not be entirely truthful as questionnaires open up the possibility of social desirability response bias (SDR). SDR is the tendency of people to present a favourable image of themselves (van de Mortel, 2008). As the Huihui Mai survey does ask a lot of questions that relate to active transport and how the city could tackle potential climate change issues responders may have felt inclined to act is if they were more climate friendly than they really or would act more climate friendly if there were greater opportunities to do so. One example of this may be seen in the survey for the question *"Currently, how often do you use public transport, cycling and walking to get around?"* This question received the unlikely response of 18% saying all the time, 20 % A lot of the time, 25% sometimes and 37% saying rarely. This is unlikely as statistics show that the majority of trips in Christchurch are by car. One plausible explanation may be that the responders of this survey were all the bus riders of Christchurch but more likely it is that since the options were vague people subconsciously made themselves seem more eco-friendly than they truly are. A possibly better way of asking this question would have been to have options of everyday, 3-5 times a week, 1-2 times a week, a few times a month, never. This could have led to some more realistic results as defining the difference between sometimes and rarely will lead to most people saying they're better than they are, but the bias may still have remained.

2.3.1 Previously Proposed Routes from a Range of Sources

These are some of the illustrations of the proposed rail networks mentioned throughout the Literature review.

Image Removed for Copyright Compliance

https://www.greaterchristchurch.org.nz/assets/Documents/greaterchristchurch/Mass-Rapid-Transit/Greater-Christchurch-Mass-Rapid-Transit-Interim-Report-June-2021.pdf.

Figure 8: Proposed MRT lines by WSP interim report. Heavy rail, bus lanes and light rail options all considered (Morahan et al., 2021).

Image Removed for Copyright Compliance

https://www.stuff.co.nz/the-press/news/christchurch-earthquake-2011/5433078/Christchurch-light-rail-network-proposed.

Figure 9: Post-earthquake light rail proposal estimated at $4 billion as part of the Christchurch city draft plan. Bob Parker the mayor at the time wanted to link the University with the central city by 2015 and then move to further options (Sachdeva, 2011).

Image Removed for Copyright Compliance

https://greaterchristchurch.org.nz/urbangrowthprogramme/transport

Figure 10: Revised Greater Christchurch turn up & go route (Greater Christchurch Partnership, 2023b).

2.4 Summary of Literature Review

In the international studies reviewed which focused largely on medium sized cities, it was found that overall, European reports and cities had great success with the reintroduction of urban rail as a mode of public transportation, and placed great value on the benefits rail has on its cities, citizens, and wider environment. Strasbourg, France, spoke of its old town being revitalised, and the public feeling safe walking the streets freely without cars.

Studies by Levy (2018) stressed the significance of tailoring transit features to the city's population size, while Fageda's (2021) study highlighted the positive impact of light rail on congestion and pollution in medium-sized cities. Boquet (2017) explored the renaissance of tramways in France, specifically in cities such as Nantes and Strasbourg emphasizing the role of trams in reducing private vehicle usage in the city centres however, found that within the suburbs private vehicles still were commonplace. Strasbourg's success in implementing trams is attributed to its decision to pedestrianize the city centre with trams being attributed to reshaping and revitalising urban spaces.

It is also important to note that the literature also found that trams have not always be successful, particularly when private cars are still more convenient as was seen in the case of Tempe, USA. The studies of Strasbourg, France, also showed that, as explained by (Krebs, 2022), light rail has been successful when applied in context to the city, and has received adequate funding, plus has support from the political spheres. All in all, Strasbourg, France is an example of a medium sized city's successful return to rail a major form of public transportation, and places emphasis on rails seamless inclusion in the urban environment. This was highlighted through the concept of green tracking exemplified by Nantes' use of grass-lined tracks, which provided environmental benefits whilst reducing amenity loss within the urban environments.

Both international and domestic literature places significance on Transit Orientated Development in the success of rail with research from the University of Canterbury (Gyles et al) emphasized the importance of density in the success of transit systems incorporating Transit Orientated Development. Boquet outlined key locations stadiums, universities, and airports, which attract large populations, should be considered in rail network planning something that has not always been seen in Christchurch proposals.
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Examining past and current studies in Christchurch, the city's 2011 Draft Central City Recovery Plan proposed a commuter rail network through to the University and airport to link to the city and to support growth, but subsequent studies have explored alternatives such as the 2014 temporary Northern Corridor Line or the Greater Christchurch Business Case study that was initially looking at a Rolleston to Rangiora line but was reduced to Hornby to Belfast. This left a clear gap in the literature that no study had proposed an extensive city-wide rail system. The environmental and societal benefits of rail are also well documented in the New Zealand context with KiwiRail detailing the benefits in the value of rail report of 2021. This report is in a country wide context, but the benefits would all relate to what Christchurch might see if rail is adopted.

The Greater Christchurch Partnership's 2023 Huihui Mai survey indicates public opinions on proposed rail routes and density preferences suggesting a majority wanted some form of MRT system which could be rail or buses, but many wanted it to be considered in more areas than the proposed line. The study also suggested opinion was split on whether people would be happy living in densified areas. However, when examining the results of the study due to potential social desirability response bias in survey responses some results must be acknowledged with caution.

Case studies of Nantes, France and the suburb of New Brighton in Christchurch are also further built upon in the discussion chapter below and provide details into the specific impacts of public transport on urban environments and how they could benefit the Greater Christchurch region.

2.5 Research Objectives and Questions

Through the examination of the literature it has provided some key areas for this research to investigate, which created the following main research question and two sub questions. These questions are based off what is missing from current and previous studies so therefore the answering of these questions will contribute to the overall rail debate in the Greater Christchurch Region.

Research Questions:

- To what extent could Transit Orientated Development minimise private vehicle usage in Greater Christchurch through the creation of a comprehensive public rail network?

- What have been the barriers in the past for the progression of rail in Christchurch?
- What are the key benefits that Christchurch could expect from a public rail system?

Chapter 3 Methodology

3.1 Research approach

The study used a mixed-methods approach, namely.

- Key informant interviews
- High-level quantitative model to examine the mode shift possible.

These are further explained below.

3.1.1. Key informant interviews

The research involved interviewing members of the Ministry of Transport, Environment Canterbury, and the Christchurch City Council/ Greater Christchurch Partnership to gain insight into the current transportation landscape and potential challenges and opportunities for introducing rail systems in the region. The objective of this part of the research is further understand the barriers to reintroducing rail, and what features of a proposed rail system would need to be present to overcome these barriers in the future. The interviews are set out to be conducted in the semi-structured format which is a qualitative research method with a predetermined set of thematic questions which are intended as talking points that can lead to a conversational form of interview (George, 2023).

The interviews were undertaken with planners in their professional capacity, eliciting their professional rather than personal opinions. Whilst a human ethics application is not strictly needed, the interviews (and data) were dealt with in the same manner (i.e., maintaining anonymity and option to withdraw at any time).

3.1.2. Interviewees and Rationale

The interviewees were planning members of Christchurch City Council (Greater Chrustchurch Partnership), Environment Canterbury and the Ministry of Transport because these are the three main parties that would be heavily involved in any future rail network in the Greater Christchurch Region.

A number of different questions were asked across the three different intervieews based on their differing knowledge and expertise. As the interviews also occurred across June and July of 2023 this led to new information on the growing rail topic in the region coming to light so that also framed differing questions for different interviewees.

The interviews along side literature will be key to answering the research questions:

- What have been the barriers in the past for the progression of rail in Christchurch?
- What are the key benefits that Christchurch could expect from a public rail system?

3.3 Quantitative transport analysis

To address the main research question of to what extent could Transit Orientated Development minimise private vehicle usage in Greater Christchurch through the creation of a comprehensive public rail network?, a transport analysis was done to quantify the mode shift possible under a comprehensive rail system scenario. Given the scope of the dissertation, a full transport analysis using the same transport modelling software as the CCC's was not possible. Therefore, a high level analysis using ArcGIS-Pro was used for this research to help answer whether an extensive rail connection would be successful in obtaining ridership and whether Transit Orientated Development can also create a successful operation.

The three main data sources/software's used for this research are;

1. ArcGIS - For mapping out the locations of railway lines and stations.
2. Census Commuter Data with excel based calculations.
3. WSP results – for projections.

3.3.1 ArcGIS

Within ArcGIS 41 stations were chosen by first plotting Greater Christchurch Partnerships proposed MRT route. Following this further routes were created to major suburbs, satellite towns, high employment centres such as malls and the airport, and education centres. The proposed routes have followed routes that could be optimised for MRT as they are wide or double laned arterial roads. The stations within the CCC jurisdiction are also based largely on the Key Development Zones listed within the CCC District Plan.

Using the pairwise buffer tool an 800m or 1500m buffer ring was placed around each station these are seen in Figure 11 and 12. 800m was chosen as "*800m, or approximately half a mile, is generally considered a standard walkable distance as it typically takes approximately 10 minutes to walk*" (Streb, 2022). It is also the same distance used by the WSP report as the distance people were willing to walk to the stations so as to keep in line with that study 800m was the preferred buffer zone for stations located within the city. 1500m was chosen as the last mile to provide bike-share opportunities and park and ride facilities to help decrease the impact of the last mile on residents in the outer reaches of Christchurch and other towns added to the network. These include Lyttleton, Halswell, Rolleston, Templeton, Rangiora, Kaiapoi, Amberley and the Airport (the airports radius was increased as the positioning of the Census results had placed the airports point on the runway far from any potential station so therefore the buffer had to be increased to cover this area).

From this the routes were created to provide a visual aid of how these stations might conect and can be seen on Figures 13 and 14. The routes aimed to follow wide roads that could adopt rail and there is a key station in the central city on Manchester street that all lines will go through except the Lyttleton brown line which will be explained shortly. Importantly the colours are not necessarily different lines but are showing the key destination routes as one line could be from Halswell to New Brighton for example and they will all go through the key exchange hub in the central city. The proposed routes also utilise both the current heavy rail network for its infrastructure along with potential new light rail or tram services. This is due to there being no logical need to create another form of rail to Lyttleton but also heading north of Christchurch between Belfast and Amberley it may be beneficial to have an exchange from the city's light rail to the heavy rail network to avoid extra costs of creating a whole new line where the Main North Line presently already runs.

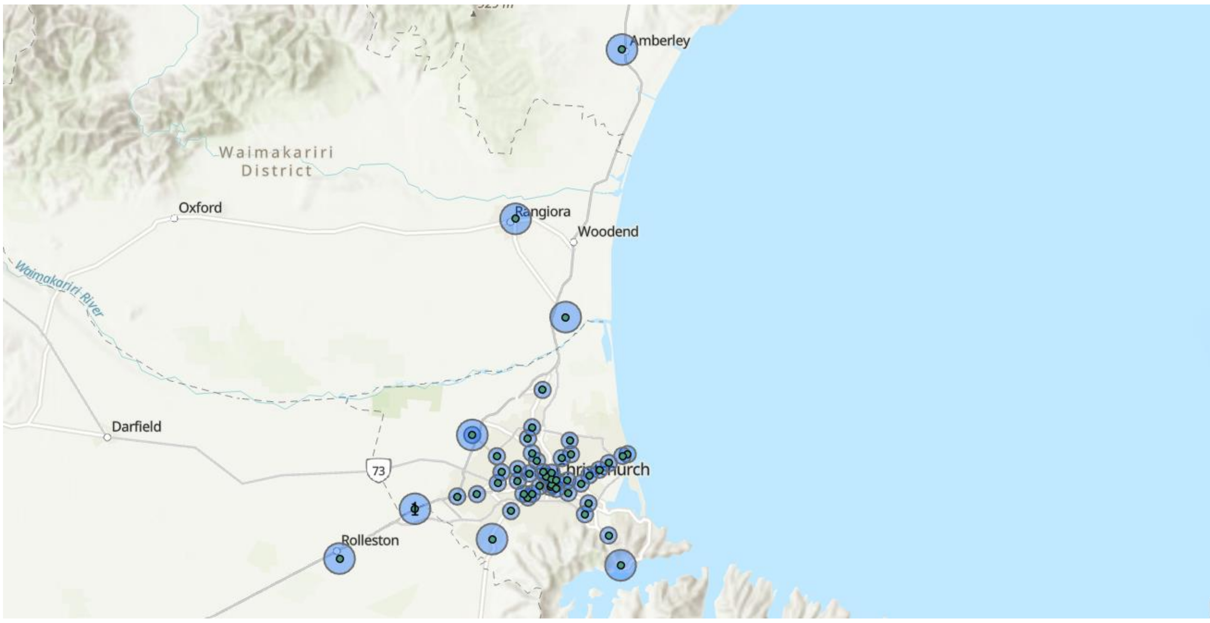

Figure 11: Proposed stations of Greater Christchurch 800m and 1500m buffers are visible.

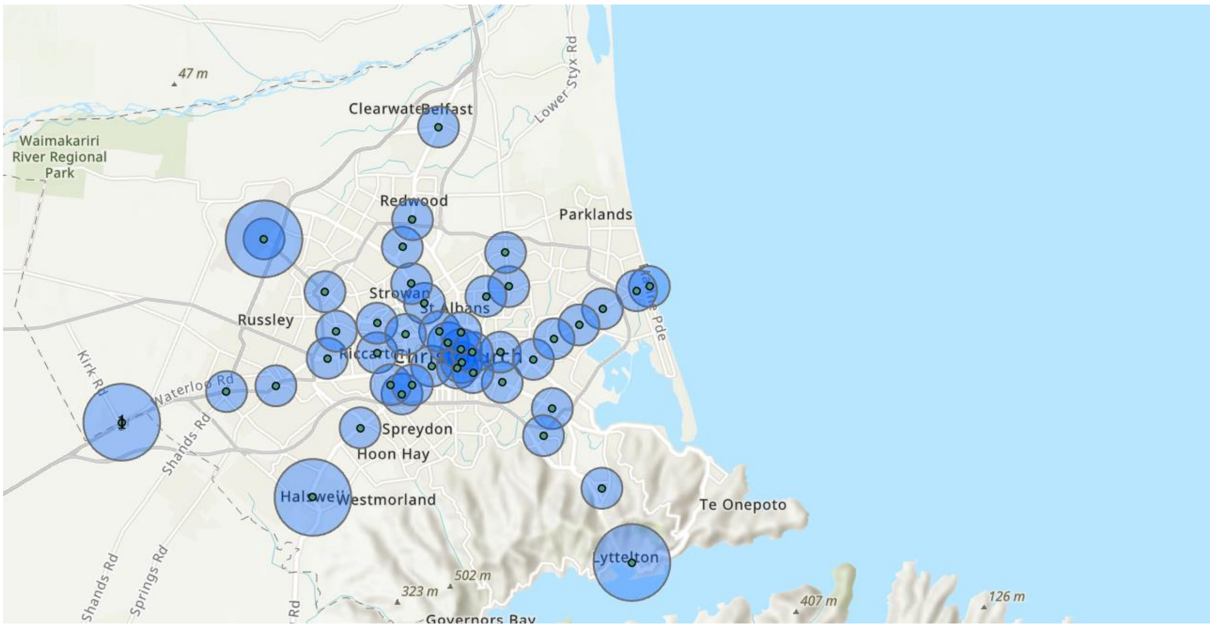

Figure 12: Proposed stations of the city of Christchurch 800m and 1500m buffers are visible.

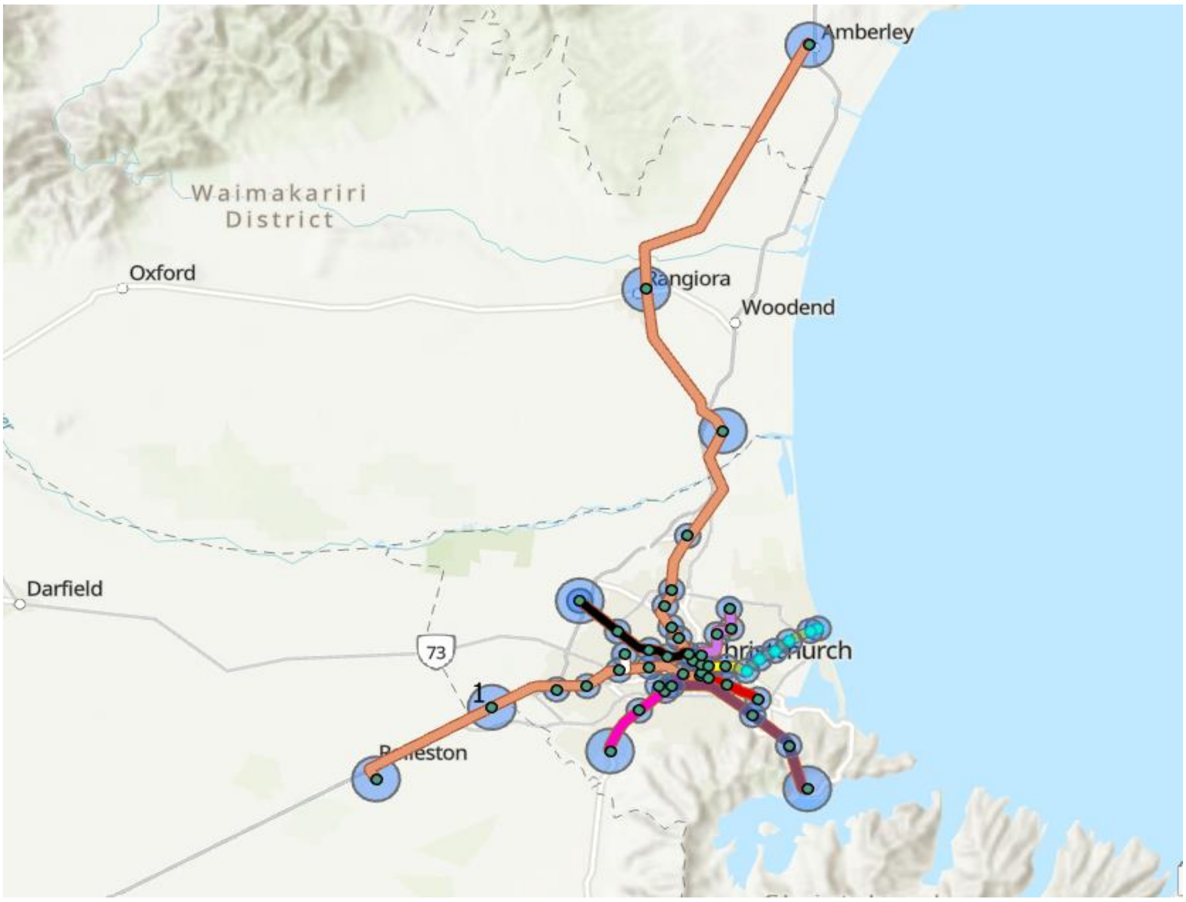

Figure 13: Proposed rail lines of Greater Christchurch.

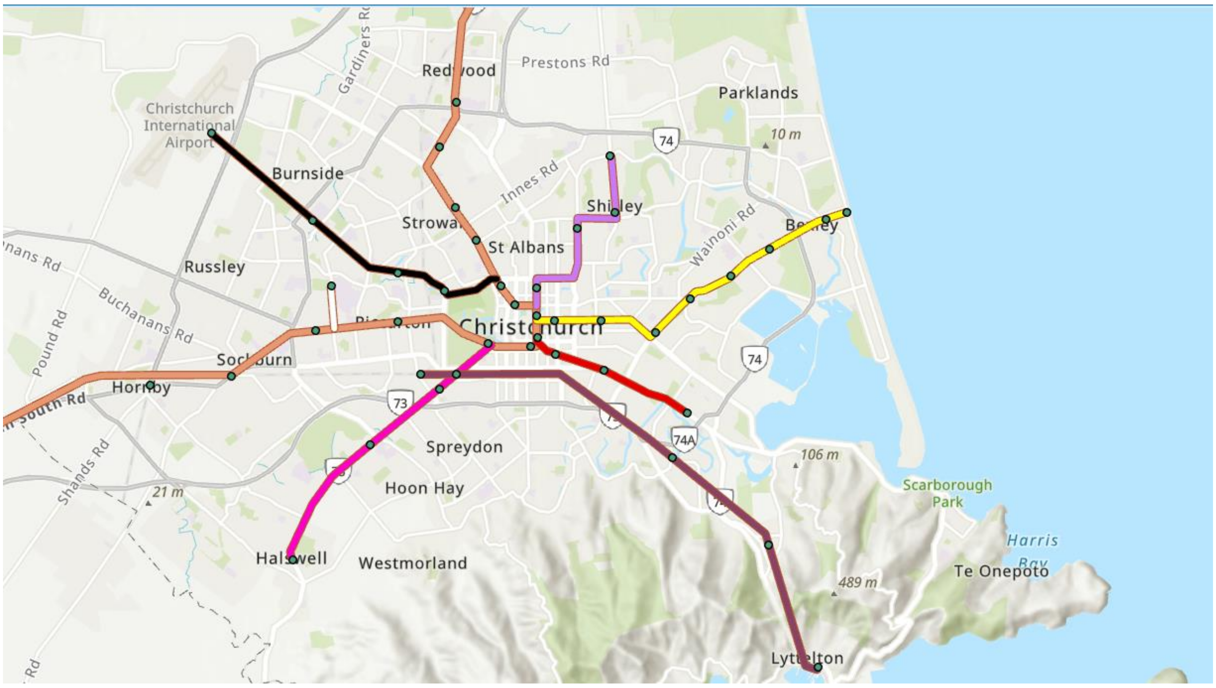

Figure 14: Proposed City of Christchurch lines with all lines bar the heavy rail route from Lyttleton going through the central station on Manchester Street.

3.3.2 Census Commuter Data and Excel Calculations

An analysis of the StatsNZ census commuter data was also undertaken using data from https://commuter.waka.app/ which provides the coordinates of suburbs where people start and end their journeys to employment and education. From this results were found that will help shape possible rail routes. This analysis looked at the results of the 2018 census to find how many people's travel patterns to work and education in 2018 fall within the buffer zones of the proposed stations on ArcGIS. This was done by taking the co-ordinates of the stations placed on ArcGis, placing them in the Microsoft Excel spreadsheet with the census data, and finding which journeys fell within both the start and end buffer zones of 800m for the central stations and 1500m for the satellite towns stations.

The original dataset which included all of New Zealand was also first filtered to range from no further than Amberley in the North and Rolleston in the South whilst including all Christchurch suburbs but not extending East along State Highway 73 to towns such as Darfield. The northern towns that were not located along the Main North Line such as Woodend were also removed. This ensured a realistic set of results of how many people could be moved by rail to education and work against the amount of people travelling by alternative modes in the region as the numbers would ultimately be skewed if townships not considered for the rail were left in the dataset. This allowed for the main research question to be answered.

The major limitation for this part of the research is that the 2023 census results are not publicly available as of the time of this research so results may vary from the present travel patterns in the region. An airport station will also not provide sufficient data on how many people arriving both domestically and internationally would use a rail connection at the airport, so the numbers would be assumed to be far lower than what the probable uptake would be.

3.3.3 WSP Comparison

WSP's interim report was also used to compare this research's results to this is important to see the difference between the possible ridership on one route compared to a comprehensive system of multiple routes. WSPs report also provided the walkable catchment range of 800m and provided a Denisty increase range of 10% based on a rounded middle ground between their ranges of 12.3% for heavy rail and 9.3% for light rail.

Chapter 4 Results: Interviews and Analysis

The three interviews were recorded on an app named 'Otter' which provided rough transricpts of the interviews alongside the audio recordings. From these the answers for the indicitive questions were summarised below. From the summary an analysis of the findings was conducted and provided in Section 4.2.

4.1 Interview Summaries

4.1.1. ECAN Interview

Q1: **There have been a number of rail proposals for Christchurch in the past, why did they not progress**?

The first thing the decision maker looks for is the cost benefit analysis or the BCR, benefit cost ratio; is it going to deliver more benefits in terms of quantifiable benefits than it will cost to deliver. The other thing I look for is patronage estimates. Can we leverage existing infrastructure? How much can we leverage existing infrastructure?

Q2: What key indicators or metrics are required before rail or RMT will be implemented?

Do we have a population to support rail on this corridor? And what's the mode share of trips along that corridor? And is there no equivalent, like a bus service? How many people would you expect to shift based on this proposition? You want to know where they are traveling to, and why they are traveling? Is it work, education, recreational? My thinking is if you can shift the trips that people make most commonly like work and education that they are more likely to continue.

Those direct bus services are the closest existing service proposition (to current rail proposals) and there's not many people currently using those.

Q3: Are there any key barriers for the Cost Benefit Analysis, how might they be overcome?

Having confidence in investment decision making is a big one. Having the right information in front of elected members. But it's the confidence to investors, and knowing that you are going to deliver, that there are going to be these benefits and people are going to use it. Rail is competing with private vehicle. In many instances, driving is very convenient for people, they can go point to point, it's fast, it doesn't stop like a bus, or a train does. The value of rail is in moving large numbers of people from one point to another.

we need to get better at measuring those other (environmental and societal) benefits . The more we can get better at that we found a better investment in rail generally tends to stack up.

Q4: **Why have past studies focused on a single or limited rail/RMT line rather than a comprehensive network?**

We haven't only looked at one route there are around 13 different combinations route-wise. And because understanding which employment and population catchments each of those corridors serve, leading into the project, knowing that its transit-oriented growth planning essentially rather than so much serving existing (populations), as it would serve an existing population as well, but it's more around supporting planned growth. We knew most of the growth is happening to the north or the southwest. The general corridors or directions that needed to go in, and the areas that are less subject to natural hazard constraints and airport noise contours etc.

Q5: **What are the key factors for enhancing or maximising the mode shift from car to public transport in the Greater Christchurch area?**

I think frequency and the quality of the service. People that are traveling into the city typically prefer direct service. having good Park and Ride hubs, or last mile facility, whether it be secure bike storage etc. For people to walk or scooter etc., for maybe they get preferential parking; how you can kind of get more out of it, having that last mile integration is really critical.

In terms of Transit Orientated Development and densification it can be really important to have a good level of service from the get go as the academic theory with peoples travel preferences is that habits form early on so if you get in there when people first move in and there's really good transport choice then it's more likely to be successful

Q6: **How important is the integration of other modes of transport into a future rail network plan?**

Absolutely critical. If we're talking heavy rail, whether it ends in Riccarton or the city, where and how do you get about from that point? What does it connect with? How well integrated is it and does it have connected bus services.
if it's not running all the way into the city that connection on to some form of light rail or mass rapid transit in Riccarton becomes important. There is a real aversion toward transferring in Christchurch. More so than many other cities.

Q7: **From your professional point-of-view, what does the ideal public transport system look like in Christchurch?**

The broader benefits of public transport; managing peak time demand, environmental benefits, benefits to individuals, mental and physical wellbeing by involving a walk or cycle trip. Perfect, quick and effective, it's easy to use, and well-integrated across different modes of transport. If money isn't a constraint, then light rail has advantages for its capacity to move people at peak times, plus integrate well into the existing urban environment.

4.1.2. Ministry of Transport Interview

Q1: **What have been the barriers to Christchurch and the South Island not being developed with a passenger rail system in the 21st century?**

If you look at policy over the last 20 to 30 years, it has been car centric.
GPS 2018 (Government Policy Statement on Land Transport) is where you saw a substantive shift towards mode shift and have moved towards investing in public transport. There has always been a certain level of investment in public transport, but it's been more about sustaining existing services with a level of increase. It was not until GPS 2018 that you saw a mode shift, partly in response to climate change and to realities around urban form, particularly the larger cities like Auckland where we cannot sustain the current transport network in urban form.

It also comes down to need and cost. An issue already identified in Christchurch is the loss of some of the rail links they used to have but they are hard to put back in, not having that link to the CBD has a major impact.

Q2: What would a successful integration of rail to Christchurch look like?

You look at any successful public transport schemes, they must operate as an integrated network. It is not just integrating into other Public Transport services. It is also integrating into active transport, walking, cycling paths. Then it's trying to carefully plan the stations or the hubs so that you have got a primary PT spine, let's say it's light rail or rail, at each of the stations there's the interconnecting services which could be bus services or walking, cycling paths or any successful scheme leverages off those linkages, and trying to maximize benefits to communities.

Q3. Has transit-orientated development been successful around rail systems in Wellington and Auckland, and if so, could this success be replicated in Christchurch?

Transit oriented development happened in Wellington with the establishment of the rail network and the ongoing public transport network.
In some ways Wellington's transport network and Wellington came about through transit-oriented development. The links through to Johnsonville and around there, were developed with the idea that the railing would provide the linkage between the suburb and the CBD. I say absolutely it has been successful in Wellington and can be related to Christchurch. We keep trying to look at the future without going back to the past.

We have got 50 or 60 years where the face of urban form has been orientated around the private vehicle. In transport we need to get away from a dichotomy where public transport is good, and cars are bad; it is about users. Are users going to move on to public transport if it is not offering the same level of amenity, convenience and if it is more expensive than driving the car?

Q4: Why did New Zealand follow the more American car-centric way of shaping transport and urban form rather than Europe's higher public transport in the 80s-90s?

New Zealand is not a European style, city, form and densities, those European cities that you were talking about, when people live in dense apartments, car parking becomes a major issue and cost, and reality starts to bite around urban form and congestion and parking cars. In New Zealand where up to the 1950s or 60s we did have extensive tram networks, but it is demand as much as anything else. People wanted cars, car ownership went up, and the far more convenient urban form, reoriented towards the use of the car again because of urban form and densities.

Cars were a better form or was felt at that time, a better offer in terms of people being able to move from A to B. The funding was reallocated away from those (rail) services into better roads or more roads and the car opened other areas of land.

4.1.3. Christchurch City Council / Greater Christchurch Partnership Interview

Q1: Will the Huihui Mai survey results lead to greater support from the council and/or government funding towards rail?

I would say the public support was high. Or at least for some sort of MRT scheme. The general principle of growing the city around transport, not sprawling out into the mountains. That doesn't necessarily translate to support by elected members of staff. But it also said it's not necessarily rail. The proposal was something along the street corridor, so it could be on for example light rail, or it could be a bus like Metro buses.

Q2: **Why was the Rolleston -> Rangiora changed to Hornby-> Belfast line within the MRT proposal?**

It was through the business case process; it wasn't across the city. It was decided at the greater Christchurch level. Selwyn and Waimakariri they were involved in the conversations and agreed to that. It was just around cost effectiveness. The Hornby to Belfast sections were the parts that had the greatest patronage. The business case did an analysis of the additional cost of extending it out to Rolleston to Rangiora, compared to the additional patronage did by going out there. It showed that it did cost a lot more to go out there because it is quite long, it increases the distance a lot. And the additional patronage that you get isn't high.

Q3 **Are there plans for the proposed route to gain branch lines if patronage is high and there appears to be a need for it (airport and eastern suburbs for example)?**

That alone is quite a big project and will cost a lot of money. There's a lot of uncertainty. I think we'll be doing quite well to get that built. We are focusing on data now just for the sake of scale and trying to bite off something we can practically do. One option they looked at was a route to the airport. They did some analysis on that in different groups. Basically, that airport noise contours are why that didn't go here. One option is to just use the same approach for this area, which is don't let any more densifications happen. Another option would be to not do that and just let the development happen anyway, knowing that there will be noise.

Q4: **Do you think an opportunity was missed in the development of the Christchurch central city blueprint post-earthquake? Or do you think maybe the earthquakes happened 5-10 years too early for this new mindset?**

It was a missed opportunity, but that is where the public mood was. In the last 12 years, a lot has changed in terms of the public mood around for example climate change, we needed to do something 12 years ago. Then certainly the legislative environment. Things such as in NPS-UD and Medium Density Requirements, which upzone swathes of cities. The removal of minimum parking requirements as part of their bigger focus on getting cities growing upwards, not growing outwards. Then plugging your transport systems around there. Building good public transport is important.

4.2 Interview Results and Analysis

The interviews conducted for this research aided by drawing conclusions and discovering themes directly related to the research. The interviewees discussed their experiences and expertise in their answers and opinions. Visible themes brought up by the interviewees help inform the research and provide a view into the thoughts of professionals from Christchurch and wider New Zealand. The first theme is cost and effectivness. The cost-benefit analysis and ratio are heavily discussed by the professionals and is seen to be a barrier to the execution of rail infrastructure in Greater Christchurch. The interviewees discussed how the decision-makers look at how the benefits outweigh the cost of the rail. The construction and upkeep of the rail infrastructure will require significant costs. The demand and resulting ridership must be sufficient to justify this investment.. Interviewee 2 discussed how Christchurch has significant missing rail links which are costly to reestablish, however, that it is clear that people do desire a mode of transportation including rail. Another point which was brought up by the Interviewee 3 is the correlation between patronage and cost. This is specifically in regard to the MRT proposal for Christchurch, where there is a lot of weight on "good value for money", and the cost-benefit ratio. This is also said about whether a route to the airport would be proposed; that it would be a high-cost project for insufficient marginal return. This brought up other issues of noise (and noise contours) in that area. Interviewee 1 did point out there is a major need to get better at measuring the wider environmental and societal benefits that rail can provide in the cost-benefit analyis, as rail tends to be the best investment as measuring these benefits improves

Another theme is (planned) growth and development in Christchurch. This is mostly seen in the north and south-west. There are questions about light-rail corridors in these areas, heavy-rail, or other options for transportation such as buses. The most discussed options are buses, as they are already an established mode of public transportation. The quality of these services is also discussed by the Interviewee 1 and Interviewee 2, as they point out that people are more likely to use the available services if they are high quality, efficient and reliable. Integrating active transport such as cycling, walking or other modes of transport being effectively integrated into the rail network's stations, as a 'last mile' distance for patrons, through cycle paths, sidewalks and more. This point was raised by the interviewees as a significant drawcard and condition for the rail initiative.

Interviewee 2 pointed out that New Zealand is not Europe, and Christchurch is not a European styled city. It is important to remember in this research that New Zealand has a different view and history of public transport to Europe, having been car centric for a number of decades, and that for 50-60 years planning was around the private vehicle.

Interviewee 2 highlighted the success of Tranit Orientated Devleopment within Wellington outlining that this development happened with the establishment of the rail and emphasised it could be related to Christchurch. However, in saying this the interviewee pointed out that urban form has been orientated by the private vehcile for 50-60 years and pepole are unlikely to move onto public trasnport if it does not offer the same amenity level and convenience. In terms of Trasnit Orientated Devleopment interviewee also outlined the importance if the rail is to occur it must be built and having a good level of service in time with any density developments as to prevent new residents of the devleopment areas creating habits of driving to work or education two types of trip that outlined would most likely cause modal shift for further recreational trips.

Intergration between different modes of transport was also identified as absolutly critical between any rail network and buses but also active modes of transport with bike storage and cycleways being outlined by interviees as key, whilst also providing the necessary accessability for people to walk and scooter also being labelled as important. Park and Ride hubs were also outlined as ways to increase public transport use and for this research are essential for satilite towns in the Greter Christchurch region.

In a Christchurch context both Interviewee 1 and 2 outlined the airport noise contours as potential barriers to transit orientated development, and the reason an airport line was not considered for the WSp buissness case study. It was outlined that the current proposed route within the buissness case study was not the only route considered but due to cost factors the Hornby to Belfast line has the best value for money. The presence of the air contour lines lead to two solutions; allowing development to occur and accepting the noise, or, only allowing an express line and thus, not TOD along the route.

The changing landscape for rail was also seen throughout the interviews with interviewee acknowledging that the last decade has seen major shift in the public’s view, with climate change being a major cause.
Policy context was also stated by Interviewee 2 and 3 to be key to any new developments with the NPS-UD and the GPS 2018 enabling a substantive mode shift and development potential.

Chapter 5 Results : Modelling and Analysis

5.1 Modelling Results and Analysis:

The number of trips to work and within the parameters set for the Greater Christchurch region (Rolleston, Templeton, City of Christchurch, Kaiapoi, Rangiora and Amberley) was a total number of 126,774 people travelling to work or education via private or company vehicle, being a passenger in private or company car, Public and school buses that were leaving from within these locations in the greater Christchurch region. The 126,774 travellers were split as follows:

Table 1: Journeys to work and education for the area studied.

Drive a Private Vehicle	Drive a Company Vehicle	Passenger in vehicle	Public Bus	School Bus	Total
89,643 70.7%	8,673 6.8%	21,447 16.9%	5,577 4.4%	1,434 1.1%	126,774

However, due to how the 2018 Census data was collected these trips also included start and end points within the same suburb e.g., a person in Lyttleton who drives to work within Lyttleton is also included. As these types of trips are not able to be moved by rail, they needed to be filtered out of the results. The results shown in from Table 2 were then used to find the percentage of journeys within the Greater Christchurch catchment which could be moved by rail.

Table 2: Results of people's journeys to work and education with intra-suburb trips removed.

Drive a Private Vehicle	Drive a Company Vehicle	Passenger in vehicle	Public Bus	School Bus	Total
87,921 72.8%	7,980 6.6%	17,862 14.8%	5,583 4.6%	1,422 1.2%	120,768

The co-ordinates of suburbs provided by the 2018 Census Approximately correspond to the middle of the suburb. The coordinates of proposed stations extracted from the GIS rail map and the 800m and 1500m buffers surrounding Station locations seen in Figures 11 and 12 were used to create results and it was then possible to find what journeys start and finish within the 800 or 1500m radius of a station.

This provided the number of journeys that are currently undertaken that could be replaced by rail. The results are Displayed in Table 3.

Table 3: Journeys to work and Education that started and ended within the buffer zones shown on Figure 11 and **Error! Reference source not found.**.

Drive a Private Vehicle	Drive a Company Vehicle	Passenger in vehicle	Public Bus	School Bus	Total
26,217 77.9%	1,107 3.3%	3,654 10.8%	2,538 7.5%	135 0.4%	33,651

These results show that within the catchment 27.86% of all 2018 school and work trips by car or bus could have potentially been moved by rail.

5.2 Extreme Upper limit for Ridership

Using these results it is possible to formulate an upper limit of possible ridership within this catchment. The first step is to double the Table 3 results as they are only one way trips to work and education, and this creates a new number of 67,302. For the next part the WSP expected population of 2048 of 641,000 is divided by the 2018 Greater Christchurch population of 489,069 to give an answer of 1.31. This number is showing that the 2048 population is 1.31x the 2018 population. It can be inferred that the catchment for the created rail corridors would then also increase by this 1.31 factor and therefore all trips will be scaled up accordingly. This led to the next equation of 67,302 x 1.31 = 88,165 trips that would be taken to and from emplyment and education in 2048 assuming the same population distribution and travel patterns as in 2018. Next, using Ministry of Transport data it can be found that only 28% of all trips taken are for employment and education purposes (MoT, n.d). Therefore, if we assume that all travel can be shifted to the rail network in the same proportion as work and education,to find an upper limit of all trips that could be moved by rail the 88,165 employment and education trips is dividied by the 0.28 giving a number of 341,875 possible daily trips for all travel puposes from within the station catchments provided. The final step is to increase this total by 10% to adjust for densification around these stations in relation to Transit Orientated Devleopment. This number is chosen as a rounded number of the WSP interim reports 9.3% increase in resident growth along their proposed route. This created the final total of 376,063 daily trips when rounded or 137,262,995 yearly trips that could be moved from within the station catchments by rail. This addresses the main question of this research seen in Section

3.1 of 'To what extent could transit-orientated development minimise private vehicle usage in Greater Christchurch through the creation of a comprehensive public rail network?'

This compared to the WSP interim reports results from between Rolleston and Rangiora which expected the singular light rail line to carry 12 million trips a year or 32,876 a day or the heavy rail line which would be expected to carry 11 million or 30,137 per day. This is not an upper limit but is their expected ridership which differs from my anaylsis. However, it does show that a comprehensive system has the potential to move over 10 times as many trips per annum a key finidng that will be expanded on in the discussion.

Chapter 6 Discussion

6.1 Positives and Negatives of a Christchurch Rail Network

If a public rail network alongside Transit Orientated Development was to go ahead within Greater Christchurch, the region would see many positives both environmentally, socially and politically. A first key point is the policy alignment the network would provide as the NPS-UD and the CCC District Plan calls for greater densification within the region. A well implemented transit orientated rail network would sufficiently provide for this densification, whilst helping ensure the success of the rail network due to the walkability of the zones reducing the need for cars, and rail providing intra-suburb journeys. The densification of cities and the use of rail as pointed out within the KiwiRail Value of Rail report will also see lower congestion, greenhouse gas emissions (another key policy objective of the NPS-UD), pollution related illnesses and injuries and fatalities on the roads. These key benefits should not be overlooked for the city of Christchurch as limiting all of these negatives of road use will in turn save the city money.

The concept of green tracking is also a key amenity positive of a potential rail network as it will reduce visual aesthetic loss that occurs with roads and could be implemented along new corridors that could see carless streets within the city centre and the new densified suburbs allowing for 'the garden city' to live up to its name. An added side effect of the green tracking is that sound pollution will also be minimised, and property value will not be impacted which may be seen as a potential negative of a rail network as the area will remain green and relatively quiet. Rail also has the potential to move far more people than the buses, which as outlined in the WSP interim Report are not currently an attractive mode of transport within the city. Rail would provide a new clean, fast, and efficient option for public transport within the city.

From the interviews, the key negative of rail for Greater Christchurch is the extreme costs (in order of billions) of implementing the system, and how it would take many years and for the system to be created. The costs would grow exponentially as current rail infrastructure only includes the heavy rail line and stations at Addington and Rangoira, thus, the system would have to be largley bult from scratch. There would also be extra costs in creating the new light rail/tram corridors, as houses and businesses will need to be removed for the creation of new corridors. There would also be major disruptions for commuters during the creation of the network, as roads would be blocked off which could cause initial biases to form against the system if it initially causes issues for communities. The other main issue is with public opinion, as although the Huihui Mai survey shows that 53% of people agree with the potential route, once their rates increase to help pay for the rail system this opinion may change. This will be particularly an issue for people in regions not served by the proposed route and therefore why it is important that more lines are planned to ensure the rail benefits the majority of the region, otherwise the public opinion on rail may turn sour before the project gets off of the ground.

6.2 Interview findings in context

From the interviews it became clear that a key reason for the car dominance within Greater Christchurch is due to the lack of any better convienient point-to-point options. Providing for point-to-point options is very difficult in sprawling cities, and this is where densification and transit orientated development can help. Providing all key amenities within a walkable mixed-use neighbourhood will lead to many people not needing to drive to their point in the first instance, but a comprehensive rail system with many transit orientated developed hubs will lead to people be able to use active modes of transport to access both points of their journies with the rail being the linking piece.

This is also where in the satellite town park and ride options will become helpful and successful. For example, creating a car park at the Rolleston station seen on the created maps will mean a greater population can now access the trains from distances further away than what is considered by many to be walkable. This is important because it means people will view the rail as money saved due to not having to pay for fuel to get all the way into Christchurch but just for their trip from home to the station. This in turn has the benefit for park and ride patrons that once they are in the city it becomes walkable due to the transit orientated suburbs.

Another important theme expressed through the interviews is the integration of other transport modes which is essential to the success of any possible rail system. This could be through bus routes to areas not serviced by the proposed rail networks in Figures 13 and 14 such as Cashmere, Sumner and other satellite towns such as Darfield and Lincoln. These bus routes would need to seamlessly connect with the rail network. This is why it is important that the key rail hub created is on Manchester Street within a short 300m walk from the current bus exchange located on Lichfield Street. Other important integrations are between the rail and cycling providing integrated bike sheds at stations but also allowing bikes on the trains and trams will allow for a possible wider catchment not accounted for in the proposed routes as people are more likely to cycle further than they are to walk. Cycleways at stations will also provide for greater integration between the two modes of transport. Allowing for this integration of transport modes including park and ride stations for private vehicles will provide a larger likelihood of active and public transport methods being utilised within the Greater Christchurch Region.

A further major point determined within the interview with the Ministry of Transport Planner is that New Zealand is not a European styled country in terms of how many of its cities including Christchurch are laid out and continue to sprawl. This has led to the population becoming used to and reliant on cars as the convenient mode of transport and the relatively low-density suburbs have become the staple of how the city continues to grow. Even with new density standards many people may be unwilling to move into high density living as seen through the Huihui Mai survey results in which 44% of people said they would not consider it. This in turn could suggest European examples such as Nantes may not be directly translatable in a Christchurch context. With this it is worth considering Dejan Petkov's statement that "*the optimal operation of tram services comes often at the expense of other traffic modes, especially cars."* In a Christchruch context, this could be done by removing the ability to drive in certain areas of the central city, making them on serviced by rail or by bus lanes. This would cause people to have to take public transport or active modes of transport to reach certain areas.

6.3 Literature Findings in context

An effective transit network should include stops at key city locations such as stadiums, airports, and universities (Boquet, 2017). However, there are some known issues that may impact rail and transit orientated development with these routes in Christchurch. Firstly, the stadium has no major issues it is in the central city being close to transit stops as it is in close proximity to a number of stations but most importantly the key main Manchester Street Station. Universities and the airports in Christchurch are where issues start to occur. Firstly, Greater Christchurch has two universities Canterbury University in Ilam and Lincoln University in Lincoln. Figure 12 shows that the University of Canterbury is located on a spur off of the orange line it is important to note from the figures the key takeaway is the catchment circle and the lines are just providing possible routes so in reality the black airport line could loop around the university before continuing to the airport from the city but they are there as a visible illustration of potential routes but the catchment is the important part of the study. It is also of note that Lincoln University is not included on the route despite being a key location with many students driving to the campus from Christchurch city. Rail to Lincoln is currently very unrealistic due to the new Southern Motorway that has cut off any potential rail corridor from reaching both the townships of Prebbleton and Lincoln. There still remains a short spur of rail between the southern eastern side of the motorway to Prebbleton but any rail network to the towns and campus would require major redevelopment of the highway to pass over the current heavy rail corridor and then the new subdivisions in the towns would have to be reshaped. This makes it seem that the townships would be better served by reliable and frequent buses.

Finally, the airport presents an issue due to its noise contours that are in the process of being reviewed and possibly expanded. From the interviews the area within these noise contours (shown in Figure 15) limit densification, which is why an airport route has been initially overlooked in the current buissness case study. This can impact results from this research as the densification has been included within the catchments that fall within these noise contours. This leaves two options. The first is to remove any restrictions surrounding densification of these areas or in certain parts such as Riccarton which has been outlined as a key development zone and Ilam which is a key housing area for students attending the University of Canterbury. This is relevant as the Hui hui Mai survey results show that younger people are more likely to live in high density areas. These contours would remove a possible area where this type of development could occur but as pointed out in the CCC interview is *"just let the development happen anyway, knowing that there will be noise"*. The second more realistic option is to still view the airport route as a good investment but optimise it as an express transport option to the central city with limited stops at key locations within the central city and other key locations such as the spitfire shopping centre or the hotels on Memorial Avenue. Having an expressway that quickly links to the city centre benefits both tourists (whose numbers are not accounted for in the ridership results) but also the rest of the city who can then link up with the rest of the rail network from other stations such as the Manchester Street station. This would allow Christchurch residents to easily use the rail instead of Ubers, taxis, private motor vehicles or the current bus system which is seen as unattractive by much of the population to access the airport.

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https://www.christchurchairport.co.nz/globalassets/about-us/sustainability/noise/christchurch-airport-noise-contour-map.pdf

Figure 15: Christchurch International Airport noise contours shown reaching into Ilam and Riccarton to the East and Kaiapoi in the north (Christchurch Airport, 2017).

Bouquet (2017) also raised a key point, specifically regarding Strasbourg, where the city centre rail infrastructure does not reach outer lying suburbs and therefore, car usage remains the preferred mode of transport to reach wider areas of the city. This may be an issue for Christchurch as the city is sprawling so although numbers could reduce in terms of city-bound traffic private vehicle usage will still be high in the suburbs and satielite towns. This may call for more drastic measures to lower car usage in these areas such as restricting car usage in the city centre and key development areas that are designed in a transit orientated manner.

6.3.1 Nantes Case Study

Nantes as previously mentioned is a key city in the research process for Christchurch rail for a number of reasons backed by literature. As of 2020 the Nantes metropole area was home to 677,766 inhabitants not to dissimilar from Christchurch's expected population of 641,000 by 2048. Nantes as like the majority of the world had a tram network of 110km that was removed in 1958 before what is described in a European Union sanctioned report (TER4RAIL, 2020) as a 'forward looking decision' to scrap a proposed idea to build a high capacity motorway to the city's centre and instead build a ring road surrounding the city which would be complemented by an efficient public transport network in the 1970's to avoid all the negative consequences within the city centre (pollution, noise, accidents, emissions and congestion) the first tram line was then opened in 1985 (TER4RAIL, 2020). Currently the city has 3 lines intersecting the city centre reaching 43km of tram lines that were chosen due to the limited capacity of buses and were also chosen for aesthetic reasons as "*they allow the user to discover the city in a different way and they constitute themselves integral part of the city landscape, contributing to the creation of a dynamic urban environment"* (TER4RAIL, 2020). As of 2020 the tram network was the preferred mode of transport for 300,000 people, just under half of the city's population which includes 21 park & ride facilities with 6000 parks between them. The trams were not always expected to be a success however as in 1983 only 50% of the population in Nantes supporting the tramway which grew to 93% support by 1995 and in 2020 is described as the 'pride of the city' (TER4RAIL, 2020). It is also of note that in 1983 the Nantes population is recorded at 470,000 (Macrotrends, 2023). This is again very similar to the Greater Christchurch population of 489,069 in 2018.

If Christchurch is ever wanting to grow as a sustainable city Nantes is the key city to base any future development off. The city "*has been at the forefront of sustainable transportation for more than a decade – indeed Time magazine described it as 'the most liveable city in Europe' in 2004 and it has been chosen to be European Green Capital in 2013"* (Allen, 2013). But examining the success of Nantes' tram system is important to the success of rail in Christchurch for a number of reasons. Firstly, the city's population is very similar to the expected Christchurch population in 2048. Secondly, the success of park and ride stations is something of note as any successful rail network in Greater Christchurch will need park and ride options implemented in satellite towns such as Rolleston and Rangiora. But finally, the success and ridership numbers despite the initial public scepticism is increasingly important, particularly in light of the Huihui Mai survey results that show similar amounts of support to the 1983 support numbers seen in Nantes.

6.3.2 Potential revitilisation

In a Christchurch context as pointed out in the Boquet report is the ability of trams as an urban planning tool that can help rehabilitate and revitalise areas. In a Christchurch context, this would be an incredibly important tool in helping declining urban centres in Greater Christchurch such as New Brighton which has seen a 'gradual decline' since the 1980s (Kenny, 2021). Dr Greg Clydesdale, an economist and retired Lincoln University lecturer believes that the world has moved on from the former New Brighton mall days and that it needs to become a boutique shopping area and states that "*the shopping area needs to be drastically reduced in size, with the 1970s mall area cleared to make way for new apartments and "beautified" public spaces"* (Kenny, 2021). The area has seen some recent revitalisation through the He Puna Taimoana hot pols opened in 2020 but Clysdedale has described this as *"a black hole in which millions of dollars have been thrown with little effect"* (Kenny, 2021). As Boquet has said one way to better link and revitalise the New Brighton region is through implementing a tram network to the suburb. A tram system would allow movement for people throughout the greater Christchurch region to and from New Brighton and implementing ideas such as green tracking would follow Dr Clydesdale's belief that the suburb needs beautified public spaces as a green tracked tram system would flow seamlessly into new public spaces and a walkable densified mixed-use neighbourhood.

Another important finding from Fageda (2021) was that it is important that the design needs to maximise ridership and not cut corners to incur lower numbers or costs overall. Implementing a new system that benefits the riders will benefit the city overall.

6.4 Model Findings in Context

From the model findings and analysis, it was hoped to show that a larger series of catchments could provide evidence to suggest rail could be a viable option in the Greater Christchurch region. From the models, it can be seen that an comprehensive system coupled with Transit Orientated Development would have a significant catchment size with 376,063 daily trips or 137,262,995 yearly trips having the possibility of being moved away from private vehicles. This was found to be 10 times the WSP studies ridership which was based on the expected ridership compared to this research which found an extreme upper limit. The models also showed the importance of increasing the catchments for park and ride locations, which increased the possible numbers of potential riders. This is important as this feature has been successful overseas as seen in Nantes, France and has been something not necessarily covered within many of the other reports (listed in the literature review above) on Christchurch rail. For example, it was only mentioned once within the WSP interim report relating to the potential street running bus option.

From the models it would be unrealistic to expect all the potential riders to take up the trains as people may already live in the cathcments prior to any densification and therefore will contiune with their driving if its convienient. However, there are ways as outlined thorughout this research paper that could lead to a higher uptake the key one being pedestrianising key centres as they are desnified will lead to new residents finding private vehicles to be inconvienent to use so will look to other active modes.

6.5 Limitations

The key limitation of this research is that the Census data used is from the 2018 Census as the 2023 Census results had not been publicised as of the writing of this research. This is an issue due to population shifts within this time period such as in the Central city and Rolleston. These population changes could impact results as there may be increased growth both within the created catchments but also in other areas throughout the region that may affect results of a future study. Another limitation of the created maps is that the catchments show an 800m buffer for walkability however, this 800m is not based on 800m walking on current footpaths but as a radius from the station. This would suggest that the catchments for a real 800m catchment of walkability would be smaller than what the created maps suggest. However, with the methods used for the research analysis it is expected that once the 2023 Census data become public the data can be used again in a similar fashion to produce more up to date results. From the absolute upper limit found of 376,063 daily trips when rounded or 137,262,995 yearly trips that could be moved from within the station catchments by rail. It must be noted that the actual percentage will most likely be lower as people will already have habits of driving in these regions and any new residents may not move to these zones along with many other variables. It is an important number however it does show the potential success of the proposed networks.

6.4 Summary

Through this research the below questions have been answered through modelling analysis, key informant interviews and knowledge provided through the literature.

To what extent could Transit Orientated Development minimise private vehicle usage in Greater Christchurch through the creation of a comprehensive public rail network?

The answer to this question was found through the modalling analysis which concluded that by 2048 there is a possible upper limit ridership of 376,063 daily trips or 137,262,995 yearly trips. Therefore there is the abaility to remove a significnat number of private vehicles trips each day if a comprehensive rail network was adopted alongside Tranist Orientated development within Key Development Zones.

What have been the barriers in the past for the progression of rail in Christchurch?

This sub question was answered through the key informant interviews which outlined the significant cost barrier in the implementation, the current lack of suffcient ways of comprehensivley measuring the possible societal and environmental benefits within Cost-Benefit Analysis and also that new viewpoints on growing issues such as climate change becoming significantly apparent in recent years have helped spark the debate but were not present throughout previous studies.

What are the key benefits that Christchurch could expect from a public rail system?

This sub question was answered through the key informant interviews and the literature which outlined the key main benefits being reduced congestion and emissions which thereby improves air quality and reduces health issues and road deaths. The revitalisation of urban centres is also a key finding and Tranist Orientated Devleopment further increases the ability for active modes of trsanport which in turn improves physical and mental wellbeing of then population.

Chapter 7 Recommendations

If Christchurch is to ever sufficiently adopt an comprehensive public rail system, there is a number of key recommendations that could ensure its potential success. Firstly, Transit Orientated Development is essential for the successes of rail, therefore it will become important that densification occurs around potential stations' sites but not before the rail is ready to run. This is critical to its success as the interviewee 1 made it clear that it is important that new residents do not form habits of driving to their day-to-day activities as they will be more unlikely to move to rail if they have already found convenience in driving. It is therefore essential that new densified developments enabled by the NPS-UD are built alongside the building of any potential rail network.

Secondly, it would be recommended that looking at the successes of similar sized cities is noted and examined in great detail. Nantes, specifically its past, is very important to the current Greater Christchurch rail debate due to its similar population size in 1983 when only 50% of people agreed with the proposals and carrying out of the rail, which is very similar to the 53% seen in Christchurch now. This similarity should not be overlooked as positive public opinion quickly jumped to 93% 10 years after the implementation of the rail as the whole city was seeing environmental and societal benefits. Nantes also shows the success of park and ride facilities, an important feature that will be prominent in any Greater Christchurch rail system. Nantes is an extremely successful sustainable medium sized city that Christchurch should aspire to be like. Green tracks like those seen in Figure 7 in Nantes is also an opportunity for Christchurch, which could see rail blend effortlessly with the Christchurch 'garden city' aestheitc. This would culminate in reducing any visual amenity loss that could possibly occur from the rail which can not be done with roads.

Thirdly, there is a clear need for a change in mindset from both the public but also planners and the councils in Canterbury. For the public as stated within the interviews if a larger mode of public transport is needed or wanted riding the bus is key to showing that, however, as noted by an interviewee, *"there are currently not many people using (the buses)."* This is where issues begin to arise however as outlined in the WSP interim report "*The public transport system is not sufficiently attractive (in terms of travel time, reliability, convenience, comfort and cost) to encourage its use in preference to private vehicles"* (Morahan et al., 2021). The problem in the Greater Christchurch regions public transport system as current is that buses are rarely faster than a car as they get stopped in the same traffic as private vehicles as bus lanes are rarely utilised throughout the region. As pointed out as a key theme within the interviews, people want easy, quick point to point transport and currently the best option for this is private vehicles. This is why it would be recommended that planners and councils do not attempt to bottleneck both the current bus system and potential new modes of transport together in the same bracket, as rail and buses are not the same and will have very different benefits and ridership numbers when coupled with transit orientated development.

It is also important when assessing new public transport options, the current method of using a cost-benefit analysis may not be the best fit. This is pointed out by interviewee 3; "*we need to get better at measuring those other benefits. The more we can get better at that we found a better investment in rail generally tends to stack up.*" It would be recommended that when assessing something like rail a change in mindset is also needed as it is more important to weigh the environmental and social benefits over the monetary cost as it is currently unclear if the rail could become profitable through ridership as there has not been such a system in place for nearly 70 years. However, there are other benefits guaranteed for the city both environmentally and socially that are looked at within the KiwiRail Value of Rail Report with an emphasis on lower CO2 and lower health issues and fatalities that occur due to widespread public vehicle usage.

Another key recommendation from the findings from this research is that an extensive rail network should be investigated in the Greater Christchurch region as the madalling results show that by 2048 there will be a large catchment of people that could be moved more efficiently and environementally friednly by rail instead of by private vehicle. This shows clear potential in the trasnport mode in the region if the correct steps are taken and the right benefits from international systems are evaluated and adapted into any potential Greater Christchurch system.

Finally, it is very important that up to date census data is used in any future studies into the concept as this report has utilised the 2018 census as the 2023 census is yet to become publicly available. The recent 2023 census will most likely show population shifts and growth particularly in the Central City, Rolleston and Amberley which have all seen new developments that will changes the models created for this research in one way or another. Understanding the current population is important to keep up to date with any future population predictions, whilst understanding where people are moving to in the present to best serve their needs with public transport.

Chapter 8 Conclusions

The purpose of this study was to further add to the debate about what conditions are needed for the successful reimplementation of a public transport rail network in the Greater Christchurch region. The study has found that Transit Orientated Development is the best potential urban planning method for implementing rail whilst also aligning with key policy documents.

The further major finding was that within the created catchments there is an upper limit of 376,063 daily trips when rounded or 137,262,995 yearly trips. These numbers suggest that a Greater Christchurch rail network could be potentially successful in the region as long as the system is prioritised over private vehicles. The case study of Nantes and brief overviews of other cities such as Strasbourg in France provide global context for a rail network to be implemented in Christchurch as those cities have similar backgrounds, populations and social contexts to Christchurch. Learning from these cities with successful rail is useful for the Greater Christchurch scenario in order to implement the best possible features whilst also looking at the unsucessful cities such as Tempe, USA, which outine key opportunnites missed.

This planned execution of rail in Christchurch has long been put down to being too costly. However, as stated throughout the dissertation, basing the re-implementation of rail in Christchurch only on cost is not an effective outlook, and other factors such as the both the city and the residents health and wellbeing, density, and active transport must be weighed and balanced more rigoursly as interviewee 1 suggested current Cost-Benefit Analysis methods do not measure these benefits adequetley. The role of climate change in public transport cannot be underestimated, and is a big driver in planning for the future and mitigating changes in Greater Christchurch, by for example calling attention to reducing greenhouse gas emmissions.

Finally, a number of important limitations need to be considered. Firstly, the Census data used is from the 2018 Census as the 2023 Census results had not been publicised. It would be recommended that any future study uses the 2023 data when it becomes available. A further limitation as it is currently impossible to tell the exact number of people that will adopt rail as their preferred mode of transport, however, the results show a large catchment that will have the ability to be influenced into a possible mode shift.

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Appendix I – Interview Questions

For Interviewee 1: Environment Canterbury

Q1: There have been a number of rail proposals for Christchurch in the past, why did they not progress?

Q2: What key indicators or metrics are required before rail or RMT will be implemented?

Q3: If a key successess indicators or metrics are lacking, how might this be overcome?

Q4: Why have past studies focused on a single or limited rail/RMT line rather than a comprehensive network?

Q5: What are the key factors for enhancing or maximising the mode shift from car to public transport in the Greater Christchurch area?

Q6: How important is the integration of other modes of transport into a future rail network plan?

Q7: From your professional point-of-view, what does the ideal public transport system look like in Christchurch?

For Interviewee 2: Ministry of Transport

Q1: What have been the barriers to Christchurch and the South Island not being developed with a passenger rail system in the 21st century?

Q2: What would a successful integration of rail to Christchurch look like?

Q3. Has transit-orientated development been successful around rail systems in Wellington and Auckland, and if so, could this success be replicated in Christchurch?

Q4: Why did New Zealand follow the more American car-centric way of shaping transport and urban form rather than Europe's higher publuc transport in the 80s-90s?

For Interviewee 3: Christchurch City Council / Greater Christchurch Partnership

Q1: Will the Huihui Mai survey results lead to greater support from the council and/or government funding towards rail?

Q2: Why was the Rolleston -> Rangiora to Hornby-> Belfast line removed from the MRT proposal?

Q3 Are there plans for the proposed route to gain branch lines if patronage is high and there appears to be a need for it (airport and eastern suburbs for example)?

Q4: Do you think an opportunity was missed in the development of the Christchurch central city blueprint post-earthquake? Or do you think maybe the earthquakes happened 5-10 years too early for this new mindset?