Expanding Bike-Share in Christchurch

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Expanding Bike-share in Christchurch

Abstract

Bike-share programmes can be defined as short-term bicycle hire schemes that allow bicycles to be rented and transported from station to station (Fishman, 2015). In recent years, bike-share programmes have expanded rapidly across much of the World. In Christchurch, New Zealand, there is a pilot programme known as “Spark Bikes” which is run by Nextbike. There is currently a plan in place to transition the pilot programme into a permanent programme. In order to ensure the long term success of the programme, information is needed to identify the best locations for new bike-share stations, this research aims to identify this research gap. Successful characteristics of bike-share are first obtained from international literature. This includes factors such as population densities, job densities, pedestrian areas, tourist attractions and cycleways all being correlated with bike-share usage. Areas that may support bike-share stations are then located in Christchurch based on this information. This research helps to provide a New Zealand context for bike-share programmes specifically addressing where stations may go. However, a number of limitations included old census data, some of the landmarks not yet being completed, a potential lack of cycling infrastructure compared to international research and a lack of understanding of how the pilot programme is currently being used. Future research may identify the most common demographic and address areas of high or low demand to ensure the long term sustainability of the bike-share programme.

Introduction

Bike-share programmes are short-term bicycle hire schemes that allow bicycles to be rented and transferred from one station to another (Midgely, 2011). There have been a number of different generations for bike-share programmes which are explained by Shaheen, Guzman and Zhang (2010). The first generation were known as white bikes which did not lock, were free and contained no docking stations. The second generation system consisted of coin deposit systems that were connected to docking stations and the third generation saw the introduction of information technology based systems that introduced smart card technology for checking in or out. Recent fourth generation programmes consist of demand responsive multimodal systems. Some of these programmes include solar-powered docking stations and can be linked with public transport payment systems. In the last decade there has been a rapid uptake in bike-share programmes across much of the world. In 2009, bike-share programmes were operational in over 70 cities globally, compared with 125 cities in 2010 (Mateo-Babiano et al., 2016). As of 2016, over 1000 bike-share programmes operate in 60 countries worldwide (Mateo-Babiano et al., 2016).

Bike-share programmes are relatively popular across much of Europe, North America, China and South America. However, there have recently been attempts to establish bike-share programmes in New Zealand. “Spark-Bikes” is a pilot programme that operates in Christchurch, New Zealand. It was launched in August, 2015 and currently has six temporary stations located within the Central Business District in Christchurch (Nextbike, n.d). The programme requires a user to sign up and download an application to their phone. After sign up, users are required to verify their payment method and an initial $4 is charged to the user’s credit card, although this offsets future costs. Following this, the first 30 minutes of bike-share are free, hourly charges are $4 and the daily maximum $20. The pilot programme is due to end in late 2017 and plans are underway to transition it into a permanent programme. In order for this to occur, information is needed to determine where the best locations for new bike-share stations could be placed. Therefore, the purpose of this research is to determine what factors influence the use of bike-share and then identify how this information can be used to determine new stations in Christchurch.

Literature Review

Past research has identified useful information of the relationship between the built environment and use of bike-share programmes. For instance, Mateo-Babiano et al. (2016) sought to understand how both the built and natural environment can influence the use of bike-share programmes in Brisbane, Australia. Brisbane is a city with a population of just over one million with a relatively low population density of 845 people per square kilometre (Mateo-Babiano et al., 2016). It is also home to Australia’s largest bike-share programme known as ‘CityCycle’ which launched in 2010. The authors investigated the relationship between the use of the bike-share and a number of built environment characteristics such as cycling infrastructure, pedestrianised streets and land-use patterns. In their research they used two key data sets, CityCycle usage data, and land-use data and also transport infrastructure data. Their results found significant correlations between the both presence of cycleways and high population densities with bike-share usage. Moreover, stations that were located in either pedestrian areas or areas with an absence of vehicles were found to be more active. These findings suggest that bike-share stations located in areas of high population densities, near cycleways or in pedestrian areas may lead to successful bike-share stations. Given that Christchurch also has a relatively low population density, these findings could be very relevant to the current research.

Chen et al. (2015) studied bike-share programmes in Washington D.C in the United States of America (USA) and Hangzhou in China. Their research sought to identify alternative forms of data that could be used to assess bike trip demand. The authors argue that heterogeneous urban open data is both more effective and efficient than traditional methods which generally involve sending surveyors to areas to assess the viability of bike-share. Instead the authors argue that the most important factors in bike trip demand in an area is the area function, human activity and demographic information. Area function suggests that high bike trip demand areas largely occur near residential areas, transition hubs or tourist attractions but much less in industrial areas. Human activity suggests that people generally rent a bike for certain activities such as commuting, shopping, entertainment or personal errands. Lastly, demographic information suggests that the most common users of the system tend to be considerably younger, highly educated and relatively less affluent. In their research, they used information such as point of interest datasets, which were used to indicate area functions, check in data sets which were used to serve as an indicator of human activities and demographic data sets that included median household incomes, median age and education level. This research suggests that such data could be used to understand bike trip demand which may be relevant to the current research when making a variety of choropleth maps. This may help in locating ideal sites for new bike-share stations.

Further research has sought to use GIS to understand potential demand for trips while using location-allocation models to determine certain characteristics of demand for stations (García-Palomares, Gutiérrez & Latorre, 2012). This study highlights the importance of locating stations in close proximity to either public transport networks, pedestrianised areas or population activities. They argue that this allows usage to spike due to the constant source of movement and activities occurring in the area. The authors further state that when suggesting new sites for stations the distance between them should be taken into consideration. Bike-Share programmes in both Paris and Montreal use 250-300 metre buffer zones around each station to ensure bike users are able to efficiently access bikes and return them after use. Moreover, it also helps to identify the walkable catchment around each station. This research may be relevant to the current project as it identifies the importance of finding the right use for buffer zones. Further research also argues that bike-share could support public transport and may suggest that stations could be viable at workplaces and education campuses. The National Association of City Transportation Officials report of 2016 suggested that bike-share was used primarily to commute to work. In fact, from the data, collected 65% Capital bike-share users in Greater Washington DC and 50% of Citi Bike members in New York reported that it was their primary choice to workplaces.

Study Area

Christchurch is the largest city in the South Island of New Zealand with a population of over 340,000. The urbanised area is around 16,000 hectares with an average population density of 241 people per square kilometre (Statistics New Zealand, 2013). According to data from the 2013 census, Christchurch had the second highest proportion of people cycling to work in New Zealand which was around 7% of the total population. Car transport was the most popular mode of transport, with two-thirds of the population travelling by either private vehicle, van or truck to work. Christchurch also has a relatively low proportion of people using public transport to get to work, which indicated 3.7% of the total population travelled by bus. The topography of the land is moderately flat, making it ideal for cycling as this has been recognised as a barrier in preceding research.

Method

Rational

The main aim of this research was to determine suitable locations for new bike-share stations in Christchurch's Central Business District (CBD) and surrounding inner city Suburbs. The methods that were used in this research were based off international literature that identified successful characteristics of bike-share programmes. Mateo-Babiano et al. (2016) identified successful stations in Brisbane in Australia as those being located close to cycleways, pedestrian areas or around high population density areas. This study was particularly useful due to the location in Australasia. Moreover, Brisbane and Christchurch both having a relatively low population densities (Mateo-Babiano et al., 2016). Further research also suggests that areas with tourist attractions or shopping areas could lead to successful outcomes for bike-share (Chen et al., 2015). There is also research that identifies the link between high job density areas and bike-share use (Zhang et al., 2016). These concepts from international research have been used in helping to determine new stations in expanding Christchurch's pilot programme.

Sources of data

The sources of data that were used in this research project include the Canterbury Earthquake Recovery Authority (CERA) blueprint, Jobs per hectare data, Cycleway data, population data and the data collected from the field investigation. Jobs per hectare data was sourced from the Christchurch City Council (CCC) but had to be dissolved into meshblocks. This was because a jobs per hectare map could not be sourced. Instead, a meshblock map for Christchurch was used as this was the next smallest geographical units. This was then changed to represent job density rather than jobs per hectare. Cycleways data was also sourced from the CCC but is not their official data. Cycleways data is originally sourced from Boffa Miskell and Vistrada who provide consultancy work for the Council. Population density data was collected from Koordinates, an open source GIS database website.

Procedure

Field Investigation

The first part of the research project was a field investigation into Christchurch's CBD and inner city suburbs which included Addington, Riccarton, Sydenham and Merivale. The purpose of this investigation was to identify potential tourist attractions, cycling infrastructure such as cycleways or separated cycleways and also high activity or pedestrian areas that may support the use of bike-share. It is hypothesised that there will be an influx of visitors surrounding tourist attractions and bike-share stations can provide adequate transport for tourists to travel around and commute to their next destination. In the context of this research, pedestrianised streets or areas that are mostly prioritised for pedestrian use rather than vehicle use are defined as pedestrian priority areas. Pedestrian priority areas were also identified during the field investigation and subsequently mapped using GIS.

Data Analysis

Once all the data was collected it was imported into ArcGIS software for analysis. Population density data was imported and displayed into a Christchurch Base Map. Irrelevant information, such as population density information from the entirety of New Zealand or suburbs too far from the Christchurch's CBD were removed. This data was then classified into areas of high and low density with colour schemes. Jobs per hectare data was not compatible with ArcGIS software and had to be edited on Microsoft Excel. In its original form, the data displayed multiple values per meshblock. This data had to be calculated so that it had the total number of jobs per hectare for a given meshblock. For both job density and population density data suburbs of interest had to be added as the base map did not contain this information. The coordinates for suburbs were obtained from google maps and then exported into the Base Map as point data. Tourist attractions were mapped and labelled as landmarks and blueprint projects or landmarks were also included. This data was first input into a Microsoft excel spreadsheet and the coordinates for each was found using google maps. It was then imported onto a Christchurch base map in ArcGIS. Cycleway data was simply imported into ArcGIS and required little editing. All maps required us to add additional information such as a legend to explain the colour scheme, north arrow to show direction and scale to show distance.

After these results were obtained it was then used to assess viable locations for bike-share in Christchurch. This required a Christchurch base map and finding coordinates for each specific location. All stations were based off a combination of factors of the results sections. Two maps were then produced. The first a map of the stations plotted around the inner city suburbs and CBD. These were then colour coded, with each colour relating to a specific characteristic about the area based off international literature. The colour red was chosen to represent education campuses, blue to represent blueprint projects, yellow to represent landmarks and green to represent both job and population density. However, some areas fell into multiple categories but only one colour criteria was used. The second map was the same but included buffer zones of 250 metres around each of the station. This represented both its proximity to other stations and its walkable catchment.

Results

Job Density

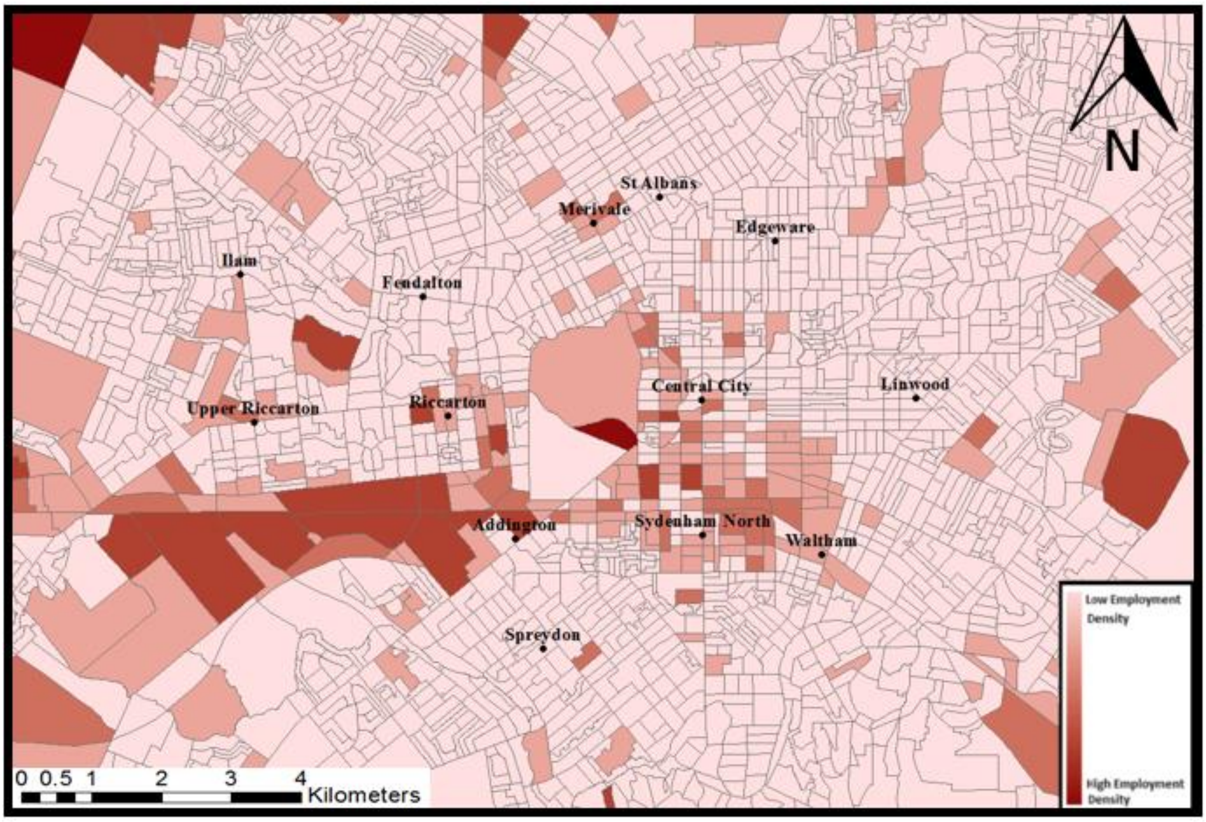

Figure 1: Job Density for Christchurch (Christchurch City Council, 2013)

Figure 1 displays job density within Christchurch's Inner City Suburbs and Central Business District (CBD). The areas with lighter colours indicate meshblocks with lower job densities whereas the areas with darker colours indicate meshblocks with higher job densities. The lowest value was 0 while the highest value was 5882. The map highlights high job density areas to the south of the CBD and toward the northern area of Sydenham. Moreover, there appears to be a significant density in Addington stretching toward the west of the city toward Hornby. The Northern area of Addington and Riccarton also contains a relatively high job density as does Upper Riccarton. Furthermore, Merivale is also shown to have a high population density.

Population Density

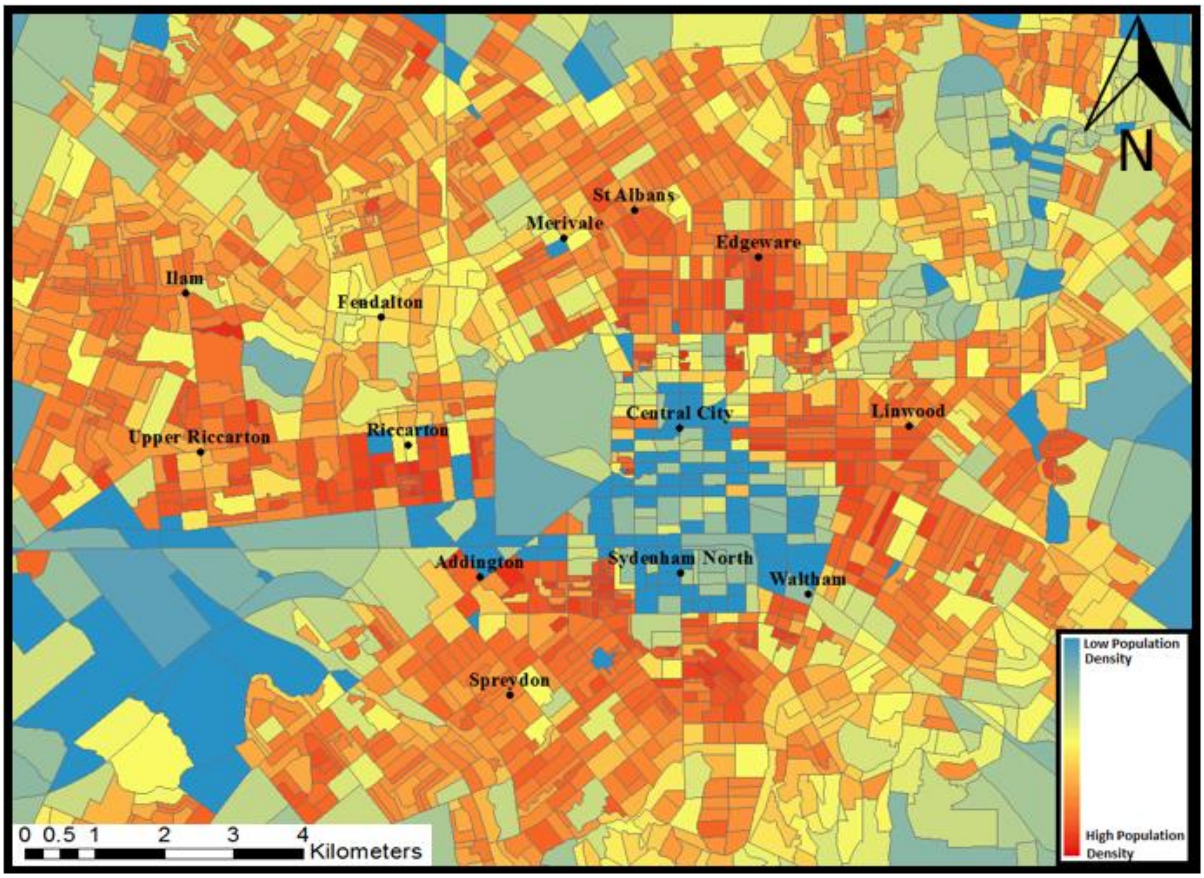

Figure 2: Population Density in Christchurch (Koordinates, 2017)

Figure 2 displays a GIS map of population density in the inner city suburbs and CBD of Christchurch. It can be seen that the CBD has a very low density except toward the east, where the density is relatively high. South of Saint Albans, Merivale and Edgeware appears to have a high population density. Sydenham North and Addington North both have relatively low population densities. However, there is a relatively high population density to the immediate east of Addington and the immediate west of Sydenham North. Moreover, between Upper Riccarton and Ilam appears to have a relatively high density while south of Riccarton is shown to have a much higher density than most of the surrounding areas.

Pedestrian Streets and Landmarks

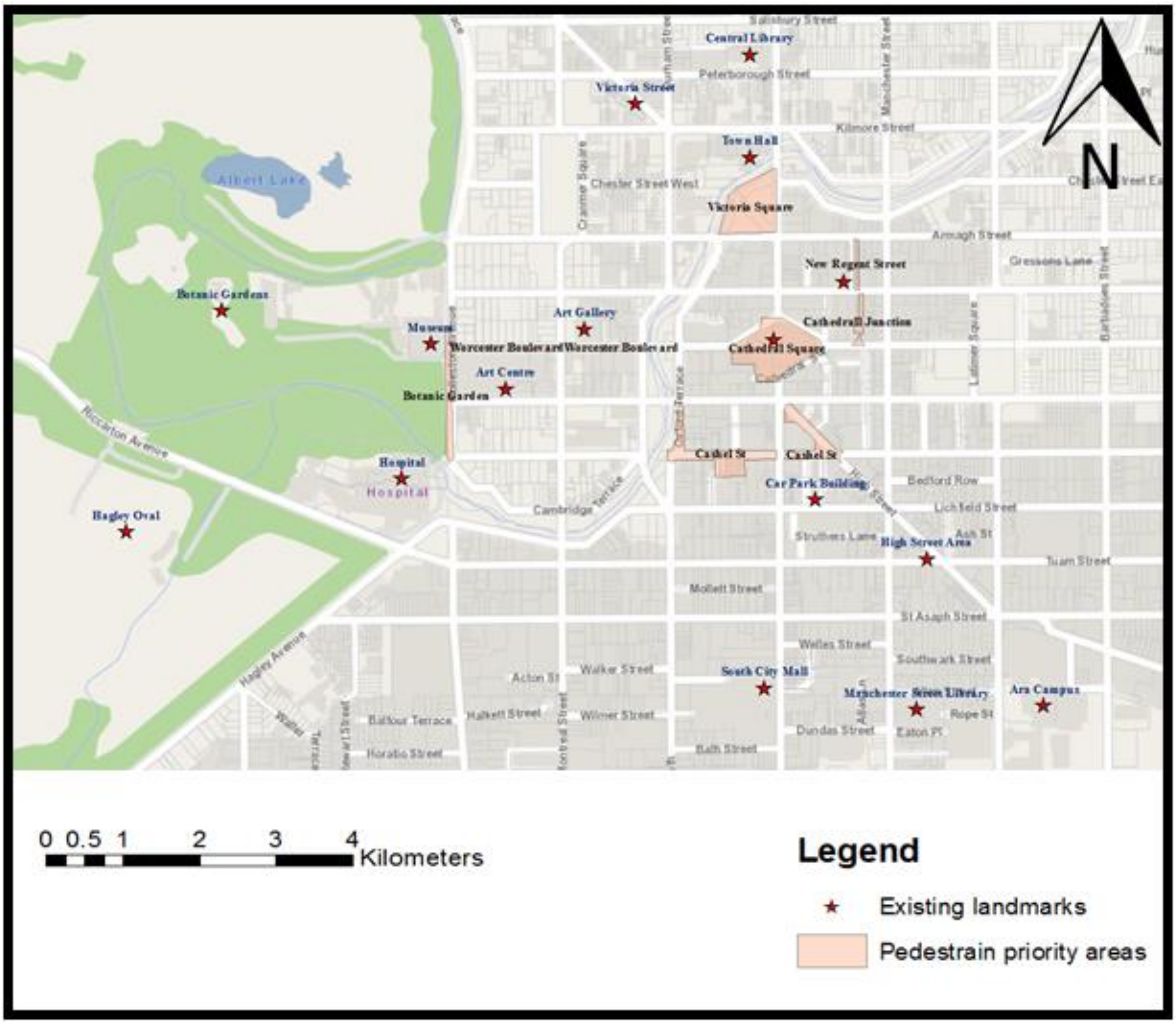

Figure 3: Pedestrian Streets and Landmarks (Chapagain, Cox & Mukherjee, 2017).

Figure 3 displays a GIS map of both pedestrian priority areas and landmarks within the central city of Christchurch. Pedestrian priority areas were identified around the Museum and Botanic Gardens and across Worcester Boulevard with a large pedestrianised area in Cathedral Square. Further pedestrian priority areas were identified in Oxford Terrace in close proximity to the Avon River Terraces and Bridge of Remembrance, Christchurch's pedestrian mall Cashel Street, High Street, Cathedral Junction, New Regent Street and Victoria Square. Landmarks that were identified in the West of the CBD include the Hagley Oval, Botanic Gardens, Museum, Art Centre and Art Gallery located in the west of the central City. Landmarks located in the North area of the CBD include the Central Library and Town Hall. Landmarks that were identified in the Southern area of the CBD include the car park building opposite the bus interchange, South City Mall, the Manchester Street Library and Ara education Campus.

Landmarks outside CBD and Blueprint Projects Central city

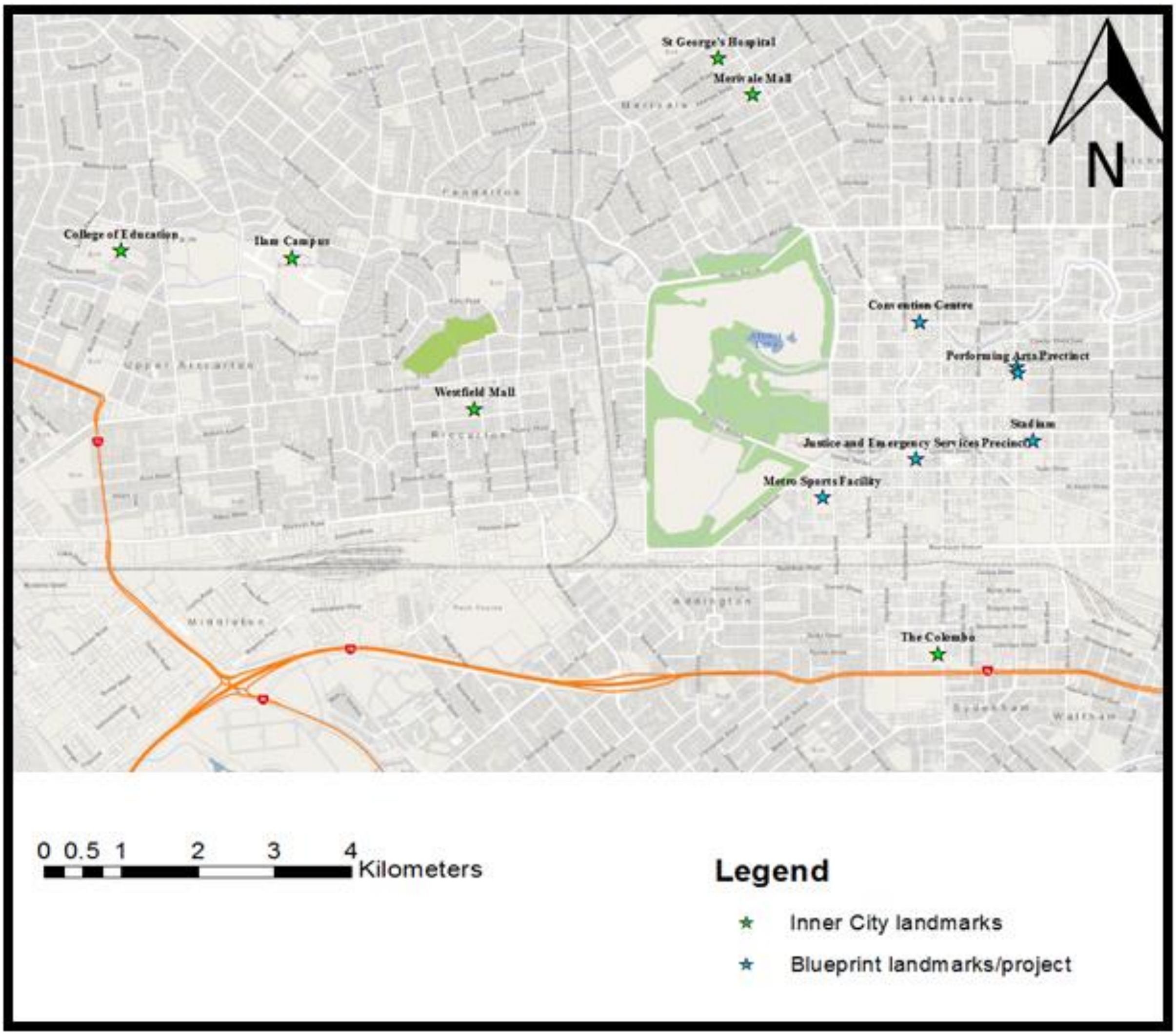

Figure 4: Inner City Suburb Landmarks and CERA Blueprint Landmarks (CERA, 2012; Chapagain, Cox & Mukherjee, 2017)

Figure 4 displays a map of both landmarks located outside of the CBD and Blue Print Projects within the CBD. Landmarks identified in the west include, the University of Canterbury's College of education and Ilam campuses and the Westfield Mall. Landmarks identified to the North include Saint Georges Hospital and Merivale Mall and landmarks in the South included the Colombo. The Blueprint projects within the CBD include the Metro Sports Facility, Justice and Emergency Services Prescient, Stadium, Convention Centre, Stadium and the East and South Frames.

Cycleways

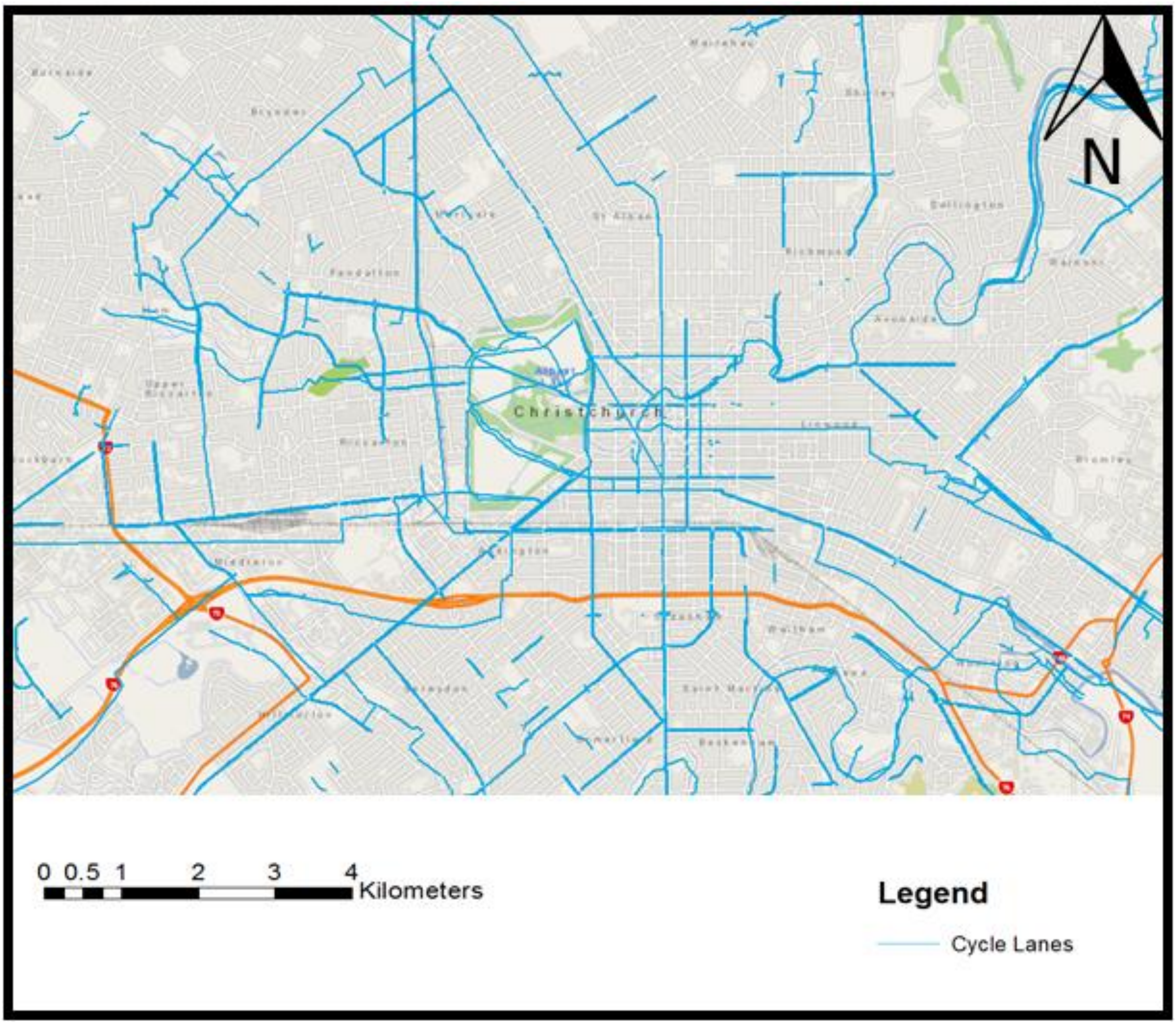

Figure 5: Cycleways in Christchurch (Boffa and Miskell, Vistrada, n.d.)

Figure 5 displays a GIS map of cycleways within Christchurch's CBD. No stations were based on cycleways alone but instead were used to determine transport links between landmarks, pedestrian priority areas or residential areas. It can be seen that cycleways extend from North to South through the CBD with a vast number of cycleways also providing a link from east to west.

Proposed Stations

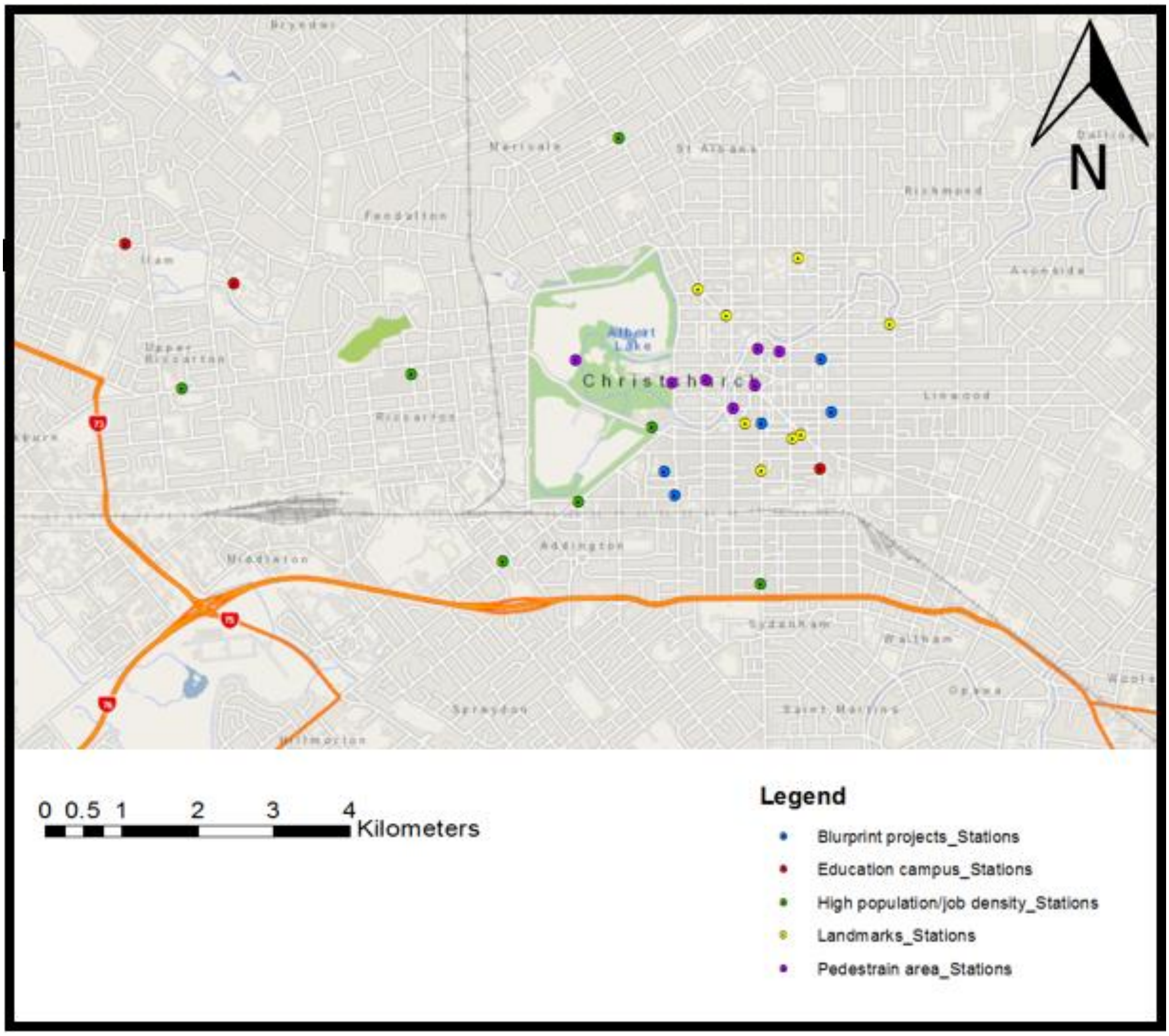

Figure 6: Proposed sites for new stations in Christchurch (Chapagain, Cox & Mukherjee, 2017)

Figure 6 is a GIS map of the proposed sites for new bike-share stations for the inner city suburbs and CBD of Christchurch. The stations are colour coded according to the specific characteristic that may make it viable for a bike-share station. For instance, red colours were given to stations based on education campuses, yellow for landmarks, blue were given to blueprint projects, purple to pedestrian priority areas and green to areas of high job density and high population density. Inevitably, some areas had multiple characteristics for a successful bike-share station. This is because some areas or suburbs had a catchment of high population densities, job densities and landmarks simultaneously.

Proposed Stations with Buffer Zones

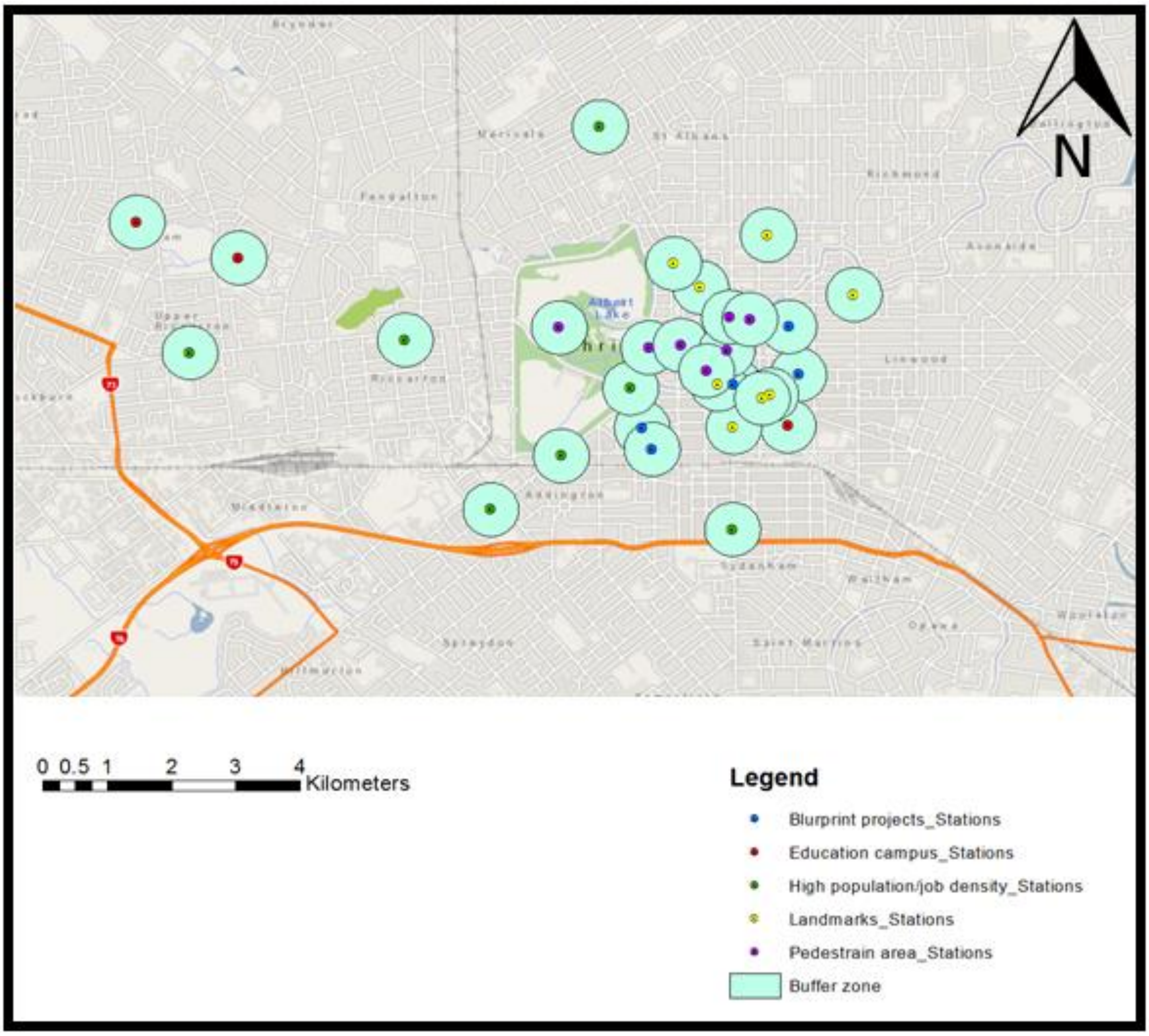

Figure 7: New stations with buffer zones (Chapagain, Cox & Mukherjee, 2017)

Figure 7 is a GIS map of proposed sites for new bike-share stations with a 250 metre buffer zone.

Discussion

In total, 30 new bike-share stations have been proposed, an increase of 24 stations from the pilot programmes 6 stations. Each station has been colour coded according to international research. For example, blueprint projects and landmarks have been mapped as blue and yellow respectively. This was based on evidence from Chen et al. (2015) who argues that tourist attractions or areas of activity are correlated with high bike-share usage. Therefore, these areas may provide a viable location for bike-share stations. Education campuses, as shown in red are based on international research which suggests that the most common demographic that uses bike-share are those who are younger, less affluent but highly educated (Chen et al., 2015). Furthermore, Shaheen, Guzman and Zhang (2010) describe the expansion of bike-share programmes across university campuses in North America. As of 2010, a total of 65 bike-share programmes were operational at different universities with another 10 planned. This provides further evidence that stations across education campuses may lead to successful outcomes for bike-share. Job Density and Population Density, are indicated by green stations. Population density information is based off Mateo-Babiano et al., (2016), who found significant correlations between high population density and bike-share usage. The east of the CBD also shows a relatively high population density as indicated by figure 2 but has been mapped according to blueprint projects and landmarks. This is because the CBD is full of attractions, landmarks and different densities making mapping difficult. However, outside of the CBD these activities and landmarks diminish leading to less of these characteristics needing to be mapped. Therefore, potential sites for new bike-share stations according to population density include Addington, west of Sydenham North and Riccarton.

It can be seen from figure 1 that high job densities were identified in Riccarton, Upper Riccarton, Merivale, Addington and the Central City. Moreover, there is a significant job density located at the hospital. While significant job densities were found to the west of Addington, no stations were located in this area due to the high vehicle traffic and volume of heavy duty vehicles. Job density stations were based off research from Zhang et al. (2016) who suggests that high density areas and transit areas are correlated with bike-share usage. Further research from Hampshire and Marla (2012) found that high bike-share usage was correlated with morning commute to work. This also supports 'the last mile' hypothesis that bike-share users often use the programme to cover the last mile of urban transport when commuting to work (Shaheen, Guzman & Zhang, 2010). This may suggest that the areas of high job density in Christchurch in conjunction with transport stations could provide sufficient sites for successful bike-share stations. Pedestrian priority areas have been coloured as purple with seven stations based in these areas. This is based off research from Mateo-Babiano et al. (2016) who found correlations between bike-share usage, off-road cycling infrastructure and an absence of motor vehicles. Therefore, viable sites for bike-share stations could be identified in these areas. Figure 7 is a map that displays all this information with an additional buffer zone. This highlights a walkable 250 metre catchment around each of the stations. It also emphasises the proximity of one station to another. This research may help to provide a New Zealand context to successful bike-share stations. There are currently very few programmes operating in New Zealand and the programmes that are in operation have a limited amount of bikes or stations. For instance, the Auckland programme only has two bike-share stations with a total of eight bicycles (Nextbike, n.d.).

Although viable sites for bike-share stations have been identified, there were a number of limitations to the research. Firstly, the datasets that were used may not reflect present-day Christchurch. The data used for population data was based on the 2013 census. This may not provide a true reflection of Christchurch as the city is ever changing, with the redevelopment of the CBD and subsequent movement of the population. A second limitation is that Christchurch may lack the cycling infrastructure compared to overseas cities that have the cycling infrastructure to support bike-share programmes. Moreover, only 7% of the total population indicated that they cycled to work, suggesting that cycling could be unpopular in Christchurch. A third limitation is that some of the Christchurch Blueprint projects are either nearing completion or yet to start. The problem for this research is that some of the dates of completion for projects are unknown, such as the stadium or convention centre. Allocating stations to these areas then becomes difficult. The final limitation is that it is unknown how the current pilot programme is being used. The destinations or locations that people travel to were not known or used in this research and stations could not be allocated according to this factor. Moreover, with a limited number of stations it may not be used in the same way post-expansion. In addition to this, the most popular demographic for bike-share in Christchurch is unknown. Finally, the basis of the research was from international literature and their built environments may be vastly different to that of Christchurch's. It is unknown whether or not these concepts or research findings will be successful in Christchurch.

In future, it could be suggested that research investigates station usage, such as assessing the areas of high or low demand for certain stations following the expansion of the programme. This is based on research from Zhang et al. (2016) who examined a bike-share programme in China post-expansion. It was noticed that previous areas of high demand became underutilised, which the authors argue was due to the programmes expansion. Furthermore, older stations saw a decrease in demand which was attributed to either the negative performance of the programme or the competition from new stations. Although, the authors note that there was not a substantial difference over the years and areas of high or low demand continued to emerge. Nevertheless, it could be important for monitoring of the system to ensure that the programme can be sustainable. This could involve shifting stations of low demand into new areas which would ensure that the programme was able to address demand sufficiently. Secondly, research could identify the most common demographic that would be using the programme following the expansion. This is based on Chen et al. (2015) who identified users who were younger, less affluent but highly educated as the most common users of bike-share. It is currently unknown what the most common demographic will be following the expansion of the Christchurch programme. However, if research identifies this, future stations could be targeted toward areas that contain a higher proportion of common users, which may lead to a more successful programme. Despite limitations, this research provides new and potentially valuable information on what could provide a viable bike-share programme in New Zealand.

References

Chen, L., Zhang, D., Pan, G., Ma, X., Yang, D., Kushlev, K., Li, S. (2015). Bike sharing station placement leveraging heterogeneous urban open data. Paper presented at the 571-575. doi:10.1145/2750858.2804291

Fishman, E. (2015). Bikeshare: A Review of Recent Literature. Transport Reviews, 36(1), 92-113. http://dx.doi.org/10.1080/01441647.2015.1033036

Hampshire, R., & Marla, L. (2012). An Analysis of Bike Sharing Usage: Explaining Trip Generation and Attraction from Observed Demand (pp. 1-17). Washington, DC: Transportation Research Board.

Mateo-Babiano, I., Bean, R.,Corcoran, J., & Pojani, D. (2016). How does our natural and built environment affect the use of bicycle sharing? *Transportation Research Part a-Policy and Practice, 94*, 295-307. doi:10.1016/j.tra.2016.09.015

Next Bike.(n.d.). Home - nextbike Christchurch. Retrieved May 26, 2017, from http://www.nextbike.co.nz/en/christchurch/

Shaheen, S., Guzman, S., & Zhang, H. (2010). Bikesharing in Europe, the Americas, and Asia past, present, and future. *Transportation Research Record, 2143*(2143),159-167. doi:10.3141/2143-20

The National Association of City Transportation (NACTO). (2016). New York. Retrieved from https://nacto.org/bike-share-statistics-2016/

United Nations Department of Economic and Social Affairs. (2011). *Bicycle-Sharing Schemes: Enhancing Sustainable Mobility in Urban Areas* (8). Retrieved from United Nations website: http://www.un.org/esa/dsd/resources/res_pdfs/csd-19/Background-Paper8-P.Midgley-Bicycle.pdf

Zhang, Y., Thomas, T., Brussel, M., & van Maarseveen, M. (2016). Expanding bicycle-sharing systems: Lessons learnt from an analysis of usage. *Plos One, 11*(12), e0168604. doi:10.1371/journal.pone.0168604

GIS Data Sources

Boffa and Miskell (n.d.) *Cycleways Christchurch* dataset Sourced from: Dataset supplied by Christchurch City Council Staff. Retrieved: 30th March 2017

Chapagain, Cox & Mukherjee (2017) *Landmarks and Pedestrian Priority Areas.* Retrieved: 20th April 2017

Christchurch City Council (2017) *Jobs per Hectare dataset. S*ourced from: Christchurch City Council. Retrieved: 9th May 2017

Statistics New Zealand, (2017). *New Zealand meshblock 2013 census data.* Retrieved from: https://koordinates.com/layer/8578-nz-meshblocks-2013-census/ 30th March 2017.

Vistrada (n.d.) *Cycleways Christchurch dataset.* Sourced from: Dataset supplied by Christchurch City Council. Retrieved: 30th March 2017