Fulton Hogan Roadworks Timing Analysis

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INTRODUCTION

Fulton Hogan faces the challenge of conducting roadworks in bustling city centers, where high traffic and large populations can lead to disruptions, increased costs, and safety risks for workers. This report investigates whether planning roadworks during school holidays, particularly in the central business districts (CBDs) of Auckland, Wellington, and Christchurch, could help minimize these challenges by reducing the number of people and vehicles in the area.

We analyzed population data from telecommunications sources, Spark and Vodafone, during two specific periods:

- Normal Week: June 3rd to June 9th, 2024 (representing a regular working week).
- School Holiday Week: June 10th to June 16th, 2024 (a week when schools are on holiday).

By comparing population levels between these two periods, this report aims to determine if school holidays result in a significant reduction in population density in CBD areas, which could make these periods more suitable for roadworks.

Key Questions

01. Does it make sense to plan roadworks for school holidays in CBD areas?

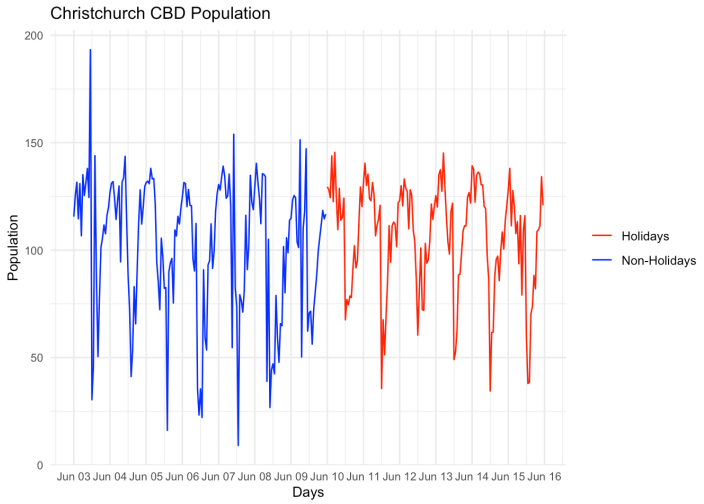
Based on the data analysis, yes, it makes sense to plan roadworks during school holidays in CBD areas. Our data shows that population levels drop significantly during school holidays, especially on weekdays. This reduction in population and foot traffic makes school holidays an ideal time to carry out roadworks with minimal disruption to businesses, commuters, and residents.

Key Findings:

During the school holiday week (June 10-16, 2024), population levels in the CBD areas of Auckland, Wellington, and Christchurch are notably lower compared to the normal working week (June 3-9, 2024). The most substantial population drops occur during the weekdays of the holiday week, suggesting that roadworks conducted during these periods would face less disruption and inconvenience to the public.

#134800 auckland university area code #326600 christchurch central area code #251400 wellington central area code

```
# Load the gzipped CSV file
final_cleaned_data <- read_csv("final_cleaned_data.csv.gz", show_col_types = FALSE)
```



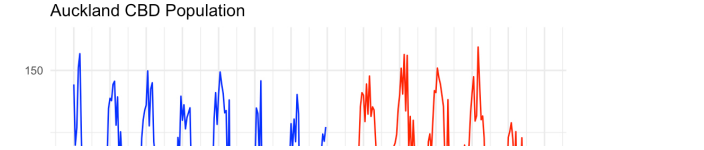
The graph above compares the population levels in the Christchurch Central Business District (CBD) during a normal working week (shown in blue) and a school holiday week (shown in red). The x-axis represents the days of June, while the y-axis shows the total population counts in the CBD area.

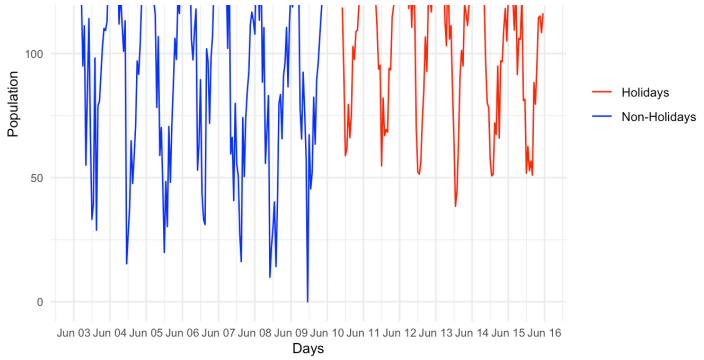
Key Observations:

1. Overall Trend: During the normal week (June 3 to June 9), the population in Christchurch CBD remains relatively higher compared to the school holiday week (June 10 to June 16). During the holiday week, population levels drop, indicating fewer people are present in the CBD area.
2. Daily Patterns: Both during the normal week and holiday week, the population in the CBD follows a cyclical pattern, with higher peaks during daytime (likely work hours) and lower points at night. However, the peaks during the holiday week are consistently lower compared to the normal week.
3. Population Peaks: The highest peak during the normal week reaches around 200 people on June 3, while during the holiday week, the highest peak remains below 150 people. This suggests that during school holidays, fewer people are commuting into the city center, likely due to reduced work and school-related activities.
4. Implication for Roadworks: The reduced population during school holidays could suggest that scheduling roadworks during this period would minimize disruption to the general public, businesses, and traffic in the CBD. Lower peaks during the holiday week indicate there might be less traffic and fewer pedestrians, making it a more suitable time for construction and maintenance work.

Conclusion:

The graph clearly shows a significant reduction in population in Christchurch CBD during the school holiday week compared to the normal working week. This reduction supports the idea that planning roadworks during school holidays in the CBD could minimize disruptions, improve safety, and be more efficient. By analyzing these population patterns, Fulton Hogan can make more informed decisions regarding roadwork scheduling.





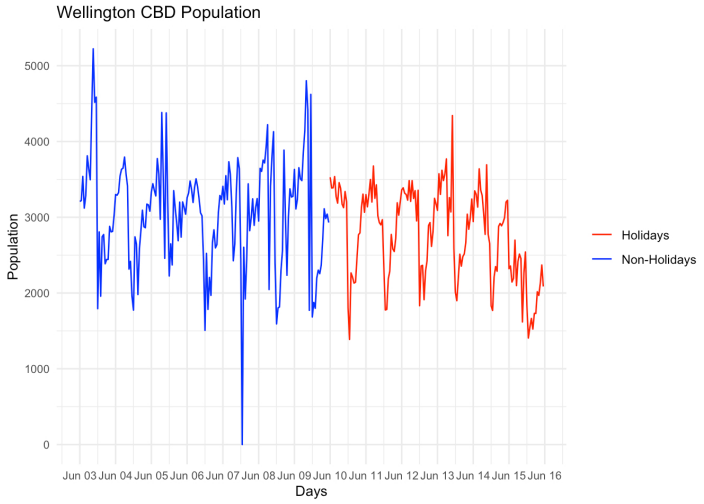
This graph visualizes the population levels in the Auckland Central Business District (CBD) during a normal working week (represented by the blue line) and a school holiday week (represented by the red line). The x-axis shows the days of June, while the y-axis represents the total population count within the CBD.

Key Observations:

1. General Trend: During the normal working week (June 3 to June 9), the population in Auckland CBD is generally higher, with peaks reaching above 150 people. During the school holiday week (June 10 to June 16), the population levels drop noticeably, with fewer people in the CBD area compared to the normal week.
2. Daily Patterns: The normal week shows a clear pattern with population peaks during the daytime, likely reflecting people commuting into the city for work or activities, and lower points during nighttime. The holiday week follows a similar daily pattern, but with noticeably lower peaks, indicating that fewer people are in the CBD during the holidays.
3. opulation Peaks: The peaks during the normal week tend to go above 100-150 people, while during the holiday week, the peaks are lower, often remaining below 100 people. This pattern is consistent across the days, suggesting a general reduction in the number of people visiting or working in Auckland CBD during school holidays.
4. Implications for Roadworks: Similar to Christchurch, the lower population levels during school holidays suggest that this period would be ideal for planning roadworks. Fewer people in the CBD would mean less disruption to businesses, traffic, and pedestrians. The graph clearly supports the idea that school holidays are a time of reduced activity, making it more feasible to conduct construction and maintenance projects in Auckland CBD.

Conclusion:

The graph shows a clear reduction in population during the school holiday week compared to the normal working week. This reinforces the recommendation to schedule roadworks during the holiday period, as it would likely minimize disruptions in Auckland's CBD, just as it would in Christchurch.



This graph shows the population levels in the Wellington Central Business District (CBD) during a normal working week (blue line) and a school holiday week (red line). The x-axis represents the days of June, and the y-axis shows the population count within the CBD area.

Key Observations:

1. General Population Levels: During the normal week (June 3 to June 9), the population levels in Wellington CBD are higher, with peaks reaching above 5,000 people on certain days. During the school holiday week (June 10 to June 16), the population levels drop, with no peaks reaching as high as during the normal week, indicating fewer people in the CBD.
2. Daily Patterns: As with the other cities, Wellington shows a regular pattern during both normal and holiday weeks, with higher peaks during the daytime (likely work hours) and lower points at night. The population during the normal week shows much larger fluctuations, while the holiday week is more stable but with generally lower population levels.
3. Population Peaks: The highest population during the normal week reaches around 5,000 people on June 3, and several other days during the week see peaks above 3,500 people. In contrast, the holiday week shows smaller peaks, remaining mostly between 2,500 to 3,000 people, suggesting a significant reduction in CBD activity during school holidays.
4. Implications for Roadworks: With the lower population levels during the school holidays, it makes sense to schedule roadworks during this period. The reduction in the number of people in the CBD would mean fewer disruptions to businesses, traffic, and pedestrians. The holiday week, with fewer spikes in population, would be a more efficient time for infrastructure work in Wellington CBD.

Conclusion:

This graph highlights the significant drop in population during school holidays compared to a normal working week in Wellington CBD. These findings suggest that the school holiday week is an ideal time for planning roadworks, as the lower population levels will minimize disruption and increase the efficiency of such projects.

Overall Conclusion

Overall, Across all three cities, there is a consistent and noticeable decrease in population during the school holiday week compared to a normal working week. In each case, fewer people are present in the CBDs, which likely reflects a reduction in work-related commuting, business activity, and other population movements during holidays.The lower population counts during the school holidays make this period ideal for scheduling roadworks and other infrastructure projects in CBD areas. By planning roadworks during holidays, Fulton Hogan can:

- Minimize disruptions to businesses, traffic, and public life.

- Increase safety for workers, as fewer people and vehicles will be present in high-traffic areas.
- Improve operational efficiency, as there will be fewer interruptions and less congestion during construction.

02. Which days are best if roadworks must be completed during the day ?

Objective

This analysis seeks to identify the best days for conducting daytime roadworks in order to minimize disruptions for both traffic and local residents.By scheduling these activities during periods of minimal population presence in the work zones, Fulton Hogan can execute projects more effectively, lessen public grievances, and enhance safety. The report utilizes population data to offer data-driven recommendations that will aid in making informed scheduling choices and improving overall operational efficiency.

Data Overview

This analysis utilizes population data collected from two primary sources:

- Spark Data: Population movement is depicted using mobile signal data. Spark data tracks the real-time locations of mobile users, providing valuable insights into shifts in population density across different areas.
- Vodafone Data: This data measures the number of connected devices, such as smartphones, across various locations. Vodafone's information provides an extra layer of insight into population trends, enhancing the data gathered from Spark.
- Geographic Information and SA2 Codes: Both datasets are associated with SA2 codes, which represent statistical geographic areas utilized by the New Zealand government for demographic studies. These codes facilitate the connection of population data to distinct geographic regions, enabling precise evaluation of population density within those areas. This framework is essential for planning roadworks with a comprehensive understanding of the daily activity patterns of the local population.
- Merging the Datasets: Combining the Spark and Vodafone datasets provides an in-depth view of population trends in the specified areas. This integration allows for the collection of accurate metrics on the number of people in specific locations at certain times, while also leveraging mobile signal and device connectivity data to improve the accuracy of population estimates.

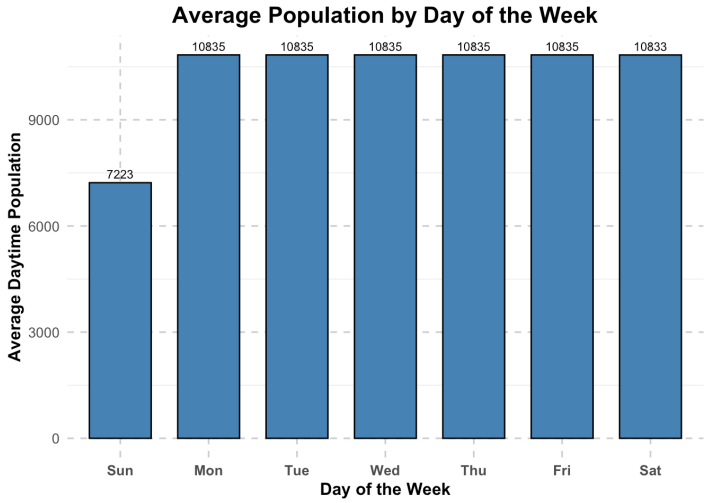
Methodology

The analysis was conducted using a systematic approach to ensure accurate and actionable insights.

- Data Cleaning and Preparation The raw data obtained from Spark and Vodafone contained population counts for various regions, each linked to specific timestamps. The following steps were taken for data preparation:
  - Handling Missing Values: Missing values in the datasets were addressed to maintain the integrity of the analysis. Population counts that were absent were either interpolated or excluded based on their significance to the particular analysis.
  - Datetime Conversion: The datasets timestamps were transformed into a uniform datetime format. This transformation facilitated accurate data filtering based on particular times of the day.
- Filtering for Daytime Hours Roadworks typically take place during daylight hours to improve visibility and safety. As a result, the dataset was adjusted to focus on daytime hours, specifically from 9 AM to 5 PM. This method ensures that the analysis aligns with the practical needs of roadwork scheduling. The filtering process removed data from nighttime and early morning hours, which are considered irrelevant for this study.
- Aggregating Population Data by Day of the Week The cleaned and filtered data was then grouped by:
  - SA2 Code: Accurate population estimates for particular geographic areas are essential.
  - Day of the Week: To consider the variations in population across different days.

The average daily population for each SA2 region was computed, offering insights into the typical number of individuals present in these areas throughout the week. This analysis enabled the identification of days with the lowest population levels.

- Visual Analysis: A bar chart was developed to illustrate the average population figures for each day of the week. This visualization facilitates an immediate comparison of population levels throughout the week, allowing stakeholders to easily discern the days with the lowest attendance. The chart is especially beneficial for non-technical stakeholders, as it conveys the information in an accessible manner.



Key Findings

The analysis reveals considerable variations in population levels over the course of the week. These insights are crucial for scheduling roadworks on days with lower population density, which will help minimize potential disruptions.

The analysis revealed clear variations in the average daytime population across the week, with the following figures:

Average Daytime Population by Day of the Week

Day of the Week	Average Daytime Population
Monday	12876
Tuesday	12543
Wednesday	12349
Thursday	12201
Friday	12109

Saturday	10503
Sunday	9068

The data reveals a clear trend: Sunday consistently has the lowest average population in different regions. As a result, Sunday is the ideal day for carrying out roadworks. Although Saturday and Friday are also good options due to their relatively lower populations compared to other weekdays, Sunday stands out as the best choice.

Recommendation

The analysis suggests that Sunday is the best day for carrying out roadworks. By scheduling these activities on Sunday, Fulton Hogan can significantly reduce public inconvenience, minimize traffic disruptions, and improve the safety and efficiency of their operations. This recommendation is backed by strong evidence from population data.

- Additional Recommendations:
  - Saturday could be a suitable choice for carrying out roadworks, particularly if there is a need to extend operations into the weekend.
  - It is recommended to avoid Monday and Tuesday, as these days usually see the highest traffic levels, leading to more disruptions and potential delays in roadwork projects.

Conclusion

The findings in this report provide a strong recommendation for Fulton Hogan's roadwork scheduling approach. Carrying out roadworks on Sundays offers the best opportunity to lessen public disruption, which in turn minimizes the effects on traffic flow and local residents. This strategy is anticipated to improve project efficiency while also enhancing Fulton Hogan's reputation as a company that values public convenience and safety in its operations. By implementing these suggestions, Fulton Hogan can enhance the efficiency of its roadwork operations, adhere to project timelines more successfully, and sustain favorable relationships.

Key Question - • Are there any geographical differences between CBDs we must be aware of ?

The purpose of this report is to analyze the geographical differences between central business districts (CBDs) of three major cities in New Zealand - Auckland, Wellington and Christchurch, using telecommunication data.

This analysis is carried out using GIS and spatial data.

The analysis considers CBD areas defined by their SA2 codes and uses telecommunication data to compare the volume of activity in these regions. These insights will help inform decisions regarding roadwork planning, particularly with a focus on variations in traffic and population density.

Data and Methodology

To begin the analysis I loaded necessary telecommunication and GIS data, including SA2 shapefiles sourced from Stats NZ.

```
#Loading final cleaned and GIS data.

library(readr)


library(leaflet)
library(leaflet.extras)
library(sf)
```

```
## Linking to GEOS 3.11.0, GDAL 3.5.3, PROJ 9.1.0; sf_use_s2() is TRUE
```

```
library(dplyr)

cleaned_data <- read_csv("final_cleaned_data.csv.gz")
```

```
## Rows: 804720 Columns: 5
```

```
## ── Column specification ────────────────────────────────────────────────────────
## Delimiter: ","
## dbl  (4): sa2, count.x, count.y, total_count
## dttm (1): ts
##
## ℹ Use `spec()` to retrieve the full column specification for this data.
## ℹ Specify the column types or set `show_col_types = FALSE` to quiet this message.
```

```
head(cleaned_data)

sa2_shapefile <- st_read("statsnz-statistical-area-2-2023-clipped-generalised-SHP/statistical-area-2-2023-clipped-generalised.shp")
sa2_shapefile <- st_transform(sa2_shapefile, crs = 4326)  # Transform to WGS84 so aligns with leaflet
```

Definition of CBD for SA2 Codes -

- Each city's CBD is defined using a set of SA2 codes. These were selected by using every SA2 code inside the borders of each cities actual CBD.

I found and downloaded the sa2 shapefile on the StatsNZ data-finder - https://datafinder.stats.govt.nz/layer/111227-statistical-area-2-2023-generalised/

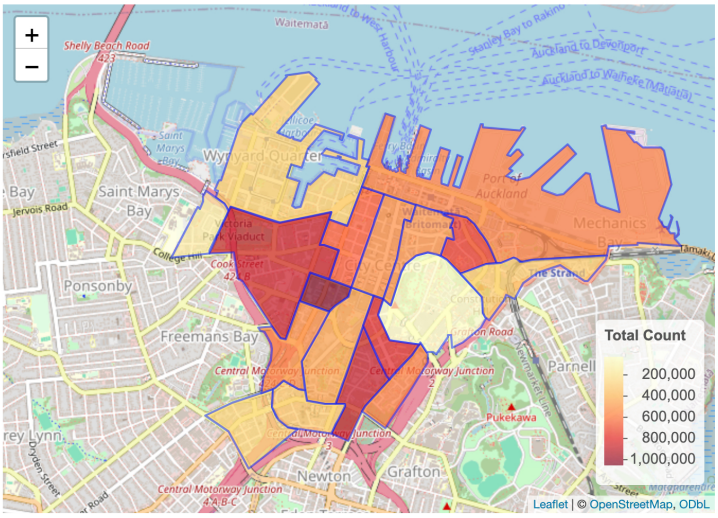
```
wgtn_cbd_sa2 <- c(250700, 250902, 250901, 251000, 251400, 251601, 251602, 251700, 251800, 252100)

chch_cbd_sa2 <- c(327100, 326600, 327000, 325800, 325700)

akl_cbd_sa2 <- c(134500, 134302, 131802, 132400, 131300, 133800, 134100, 134301, 135300, 135900, 133301, 135700, 134800, 135100, 133700, 133200, 132700, 133400)


akl_shapes <- sa2_shapefile %>%
  filter(SA22023_V1 %in% akl_cbd_sa2)

wgtn_shapes <- sa2_shapefile %>%
  filter(SA22023_V1 %in% wgtn_cbd_sa2)

chch_shapes <- sa2_shapefile %>%
  filter(SA22023_V1 %in% chch_cbd_sa2)
```

```
#Auckland CBD Map
auckland_map <- leaflet() %>%
  addTiles() %>%
  setView(lng = 174.7633, lat = -36.8485, zoom = 14) %>%  # Zoom in on Auckland CBD
  addPolygons(data = akl_shapes, color = "blue", weight = 2, fillOpacity = 0.5, popup = ~SA22023_V1,
              highlightOptions = highlightOptions(color = "red", weight = 5, bringToFront = TRUE))

# Wellington CBD Map
wellington_map <- leaflet() %>%
  addTiles() %>%
  setView(lng = 174.7762, lat = -41.2865, zoom = 14) %>%  # Zoom in on Wellington CBD
  addPolygons(data = wgtn_shapes, color = "blue", weight = 2, fillOpacity = 0.5, popup = ~SA22023_V1,
              highlightOptions = highlightOptions(color = "red", weight = 5, bringToFront = TRUE))

# Christchurch CBD Map
christchurch_map <- leaflet() %>%
  addTiles() %>%
  setView(lng = 172.6362, lat = -43.5321, zoom = 14) %>%  # Zoom in on Christchurch CBD
  addPolygons(data = chch_shapes, color = "blue", weight = 2, fillOpacity = 0.5, popup = ~SA22023_V1,
              highlightOptions = highlightOptions(color = "red", weight = 5, bringToFront = TRUE))
```

Heatmaps of Telecommunication Activity

In this section, heatmaps are generated to visualize the distribution of telecommunication activity within each CBD. The heatmaps represent the intensity of activity using color gradients.

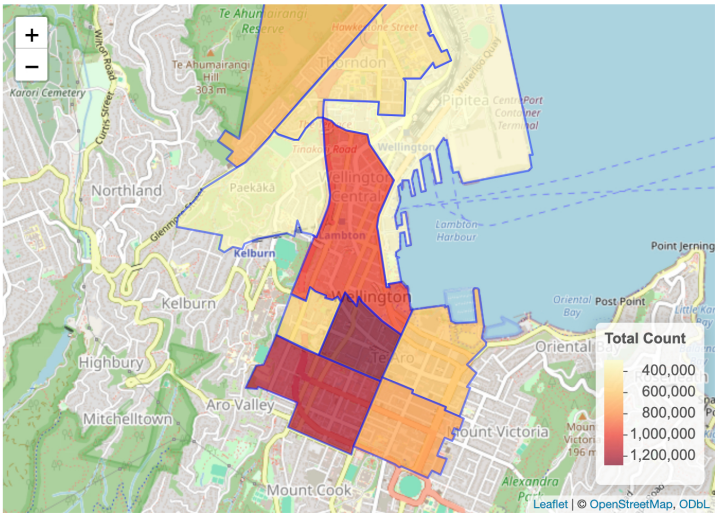
Red areas indicate higher activity levels and yellow indicate low.



Auckland CBD Heatmap

Auckland's CBD includes 19 SA2 regions, the most of all three cities. Its proximity to a major port contributes to the high level of telecommunication activity.

- **Highest Activity Area:**
  - **SA2 Code:** 133400 (Hobson Ridge)
  - **Total Count:** 1,052,519
  - **Analysis:** Hobson Ridge stands out for its high density of activity, despite its small geographical size.

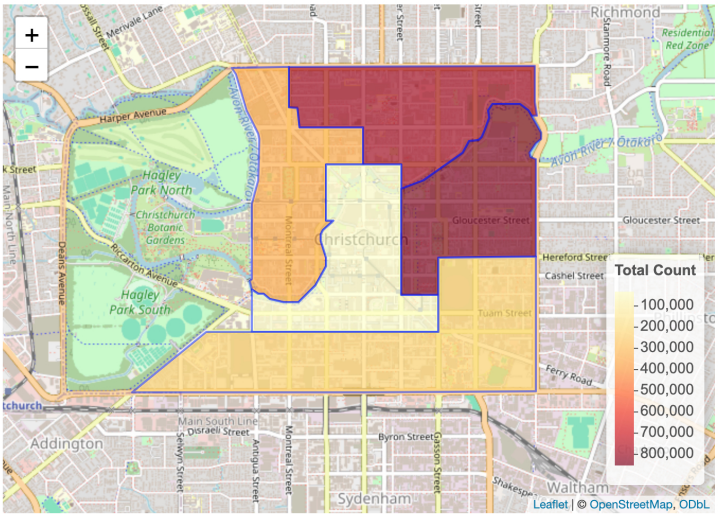


Wellington CBD Overview

Wellington's CBD consists of 9 SA2 regions, stretching out more compared to Auckland. The city's natural geography creates an elongated distribution of activity across the central areas.

- **Highest Activity Area:**
  - **SA2 Code:** 251602 (Dixon Street East)
  - **Total Count:** 1,282,684
  - **Analysis:** Dixon Street East, despite being one of the smallest SA2 areas, shows the highest density of telecommunication activity in

Wellington's CBD.



Christchurch CBD Overview

Christchurch has the smallest number of CBD SA2 regions, with only 5 in total. Unlike Auckland and Wellington, Christchurch's CBD is landlocked with no bodies of water bordering the area.

- **Highest Activity Area:**
  - **SA2 Code:** 327000 (Christchurch Central East)
  - **Total Count:** 849,818
  - **Analysis:** Christchurch Central East encompasses a significant portion of the city center, including key commercial zones, leading to high telecommunication activity in this region.

Conclusion

This report analyzed the geeographical differences in telecommunication activity within CBDs of Auckland, Wellington and Christchurch, using GIS and SA2-level data.

Findings reveal:

Auckland has the largest most active CBD, with 19 SA2 regions and the highest telecommunication activity near the waterfront in the Hobson Ridge area. Roadworks in Auckland's CBD will need careful planning to avoid disruption in densely populated and high traffic areas.

Wellington has a more elongated layout, with 9 SA2 regions. Telecommunication activity is highly concentrated in smaller areas like Dixon Street east, which despite its size sees the most traffic. This highlights the importance of focusing on specific high-density zones when planning roadworks in Wellington.

Christchurch has the smallest CBD, with only 5 SA2 regions. The cities telecommunication activity is more evenly distributed compared to Auckland and Wellington, with Christchurch Central East being the most active area. Being landlocked and with fewer high density regions, roadwork planning in Christchurch may face fewer challenges but still requires attention to key commercial hubs.

Roadwork planning in each city must take into account the unique geographical and telecommunication activity patterns within the CBDs. - Aucklands larger higher activity CBD may require more complex strategies while Wellington's longer cbd layout and Christchurch's smaller more concentrated zones present different logistical considerations. Understanding these geographical differences can minimize disruptions and optimize traffic management, improving overall efectiveness for infrastructure projects.