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The impacts of connected vehicle data for local area traffic management

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Abstract

The availability of Connected Vehicle (CV) data has sparked a paradigm shift in the approaches to defining, implementing, and evaluating Local Area Traffic Management (LATM) schemes and projects. This research investigates the potential of CV data to enhance LATM by addressing challenges such as limited data granularity and delayed response times. In this study, CV data is used to analyse driver behaviour, such as speed compliance, braking, acceleration, and swerving. Furthermore, the data is used to identify congestion hotspots through real-time traffic pattern analysis. Interactive dashboards are developed to visualise these insights, supporting more targeted LATM design and proactive traffic interventions.

This paper also explores the role of CV data in the implementation and ongoing evaluation of LATM schemes, through a case study assessment of the Belvedere Precinct in Victoria, Australia. By enabling better resource allocation, optimised infrastructure planning, and enhanced performance monitoring, CV data supports more adaptive and effective traffic management strategies. The case study demonstrated that CV data allows traffic engineers to prioritise high-risk corridors, refine LATM scheme designs based on actual driver behaviour, and guide the precise deployment of targeted interventions such as speed humps, roundabouts, and lane narrowing. Real-time and historical CV data facilitated dynamic traffic signal adjustments, improving traffic flow, reducing congestion, and enhancing travel time reliability. Furthermore, by enabling pre- and post-implementation comparisons, CV dashboards provided critical insights into the effectiveness of interventions, ensuring continuous improvement of road safety initiatives. Through these practical examples and analytical applications, this research highlights the transformative potential of CV data in shaping safer, more efficient, and evidence-based local transport networks.

1 Introduction

Local area traffic management (LATM) schemes and projects are crucial components in the planning and functionality of the road network and the overall transport system. LATM refers to the planning and control of road space within a local traffic area, aimed at adapting streets and networks originally designed in outdated ways (Austroads, 2020). It serves as a method of traffic calming (TC) at a local scale i.e. reducing speeds and volume of traffic including non-local traffic, commonly referred to as ‘rat-running’ in such local streets (Brisbane City Council, 2024). As documented in the primary guidance for the implementation of LATM strategies, the Austroads Guide to Traffic Management Part 8: Local Streets, these interventions leverage physical infrastructure, like roundabouts and traffic islands, along with streetscape enhancements. Moreover, various measures, including regulations, shortening sightlines, introducing traffic deflections, and directing local traffic onto suitable routes can help achieve these objectives (Austroads, 2020). Additionally, considerations such as land-use planning, and intersection design are essential for optimising traffic flow and enhancing safety within local road networks. By implementing these guidelines, LATM initiatives can effectively

address traffic challenges and create safer, more liveable neighbourhoods for drivers, pedestrians, and cyclists (Austroads, 2020; Brisbane City Council, 2024).

However, as the dynamics of urban mobility evolve, traditional approaches to LATM may require changes to effectively address modern challenges (Hadi et al., 2018). Specific data challenges include, but are not limited to, laborious and expensive data collection methods such as those using tube counts and manual surveys and inability to quantify impacts of LATM schemes for evaluation purposes due to the inaccessibility of data (Disefano and Leonardi, 2022). On the other hand, vehicle driver-assist technologies like anti-lock braking systems (ABS) and adaptive cruise control (ACC) are widespread, with more innovations like lane centring and full automation on the horizon (Austroads, 2020). As vehicles become more automated and connected, LATM must evolve to ensure relevance for continued community safety. This entails adjusting strategies and devices to align with emerging safety standards and changing community needs. With advancements in technology, CV data has become an abundant resource in modern transport systems. This data is continuously collected from vehicles equipped with sensors and GPS systems, including commercial cars, freight trucks, and public buses. Known as vehicle probe data, it provides real-time insights into vehicle movements and behaviours (ITS Australia, 2023).

In response to this evolving context, this study examines the impact of CV data on the processes of defining, implementing, and evaluating Local Area Traffic Management (LATM) schemes. A real-world case study, the Belvedere Precinct in Frankston, Victoria, Australia was used to demonstrate the potential of the data source across the stages of the LATM process. The research investigates how CV data could inform project definition by identifying traffic patterns and driver behaviours, support implementation through improved decision-making and resource allocation, and enhance evaluation via data-driven performance monitoring. CV data was provided by Compass IoT, a software company specialising in transportation solutions. The overarching goal was to demonstrate how CV data could influence traffic management decisions, strengthen monitoring capabilities, and inform policy development within the context of LATM. The remainder of the paper includes some further background information regarding the use of CV data in the context of LATM applications. This is followed by the case study analysis methodology, results and discussion of future applications.

2 Background

The automotive industry is witnessing an increasing demand for "always connected" vehicles, driving automakers to innovate in software and electronics design to meet connectivity requirements. McKinsey & Company estimates that by 2030, 95% of worldwide vehicle sales will be CVs (Abdelkader et al., 2021). CVs enhance safety by enabling 'vehicle-to-everything' communication, alerting drivers to nearby hazards, and reducing accidents, addressing the alarming statistics of road traffic fatalities and injuries (Xiao et al., 2021). The rise of smart cities and the Internet of Things (IoT) has also helped create an environment conducive to utilising CV data in urban planning and ‘smart’ traffic management (Ullah et al., 2024). Urban environments like cities are investing in infrastructure to support CVs, further driving the availability and relevance of CV data (Alfalahi, 2021).

Moreover, the demand for connectivity is surging among consumers, with many willing to switch car brands for better connectivity options, e.g., reflecting a desire for a more luxurious driving experience with entertainment apps accessible from the vehicle (Kanthavel, Sangeetha, & Keerthana, 2021). CVs also help offer environmental benefits by managing traffic congestion and optimising fuel economy through ‘vehicle-to-infrastructure’ (V2I) communication. For example, V2I technology can detect heavy traffic congestion ahead due to an accident or road closure. The system communicates this information to approaching vehicles, allowing them to adjust their routes or speeds in advance, thereby reducing the

likelihood of stop-and-go traffic and idling engines. In turn, this proactive approach helps minimise fuel consumption and emissions (Pan et al., 2024),

Additionally, CVs present automakers with new revenue streams beyond just the point of sale, allowing for long-term customer connections through features like remote diagnostics and predictive maintenance alerts (Alfalahi, 2021). Hence, CVs are designed and engineered not only for passenger transport, but to function as fully connected hubs.

Therefore, the emergence of CVs presents advantages for various stakeholders such as government authorities and policy makers leading road safety and traffic optimisation, as well as automakers and consumers. CV data is an expanding resource in this landscape, offering real-time insights into traffic behaviour (Kandiboina et al., 2024), road conditions (Dennis et al., 2014), and road safety (Al-Yarimi, 2024). Leveraging this data holds immense potential for enhancing LATM strategies and broader traffic and transport engineering solutions.

To integrate CV data effectively into LATM processes, understanding the six stages of the LATM process outlined by Austroads (2020) is crucial as summarised in Table 1.

Table 1: Integration of CV data in the LATM process

LATM Stage	Integration of CV Data
1. Preparing for an LATM Study	CV data supports rapid assessment of traffic patterns, congestion hotspots, and safety issues. It strengthens community consultation by providing a secondary source of truth and guiding focused discussions.
2. Defining the Study Scope and Objectives	CV data offers granular insights into traffic behaviour, vehicle types, and routing changes. It provides a cost-effective alternative to traditional surveys, simplifying the definition of scope and objectives.
3. Developing Plans	Real-time CV data enables evidence-based selection of LATM strategies, optimal spacing of devices, and design considerations aligned with actual traffic conditions.
4. Scheme Design	CV data refines scheme designs to better match real-world needs, including comparative analysis with global projects. It enhances infrastructure and traffic control device planning under time constraints.
5. Implementation	Live CV data enables dynamic adjustments during implementation stages, optimising the timing, staging, and resource deployment for LATM schemes.
6. Monitoring and Review	CV data enables continuous monitoring with real-time and historical analytics, supporting timely performance reviews, before-and-after comparisons, and necessary scheme revisions.

Therefore, by integrating CV data into each stage of the LATM process, local authorities can make more informed decisions, improve the effectiveness of traffic management measures, and create safer and more efficient transportation networks for their communities.

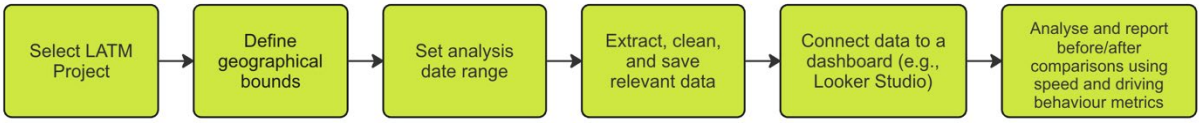
3 Methodology

A case study approach was adopted to enable an in-depth examination of a specific LATM implementation, offering rich, context-specific insights into how CV data can influence local traffic management. By focusing on a concrete example, the study aimed to illustrate the

potential of CV data to enhance the definition, implementation, and evaluation of LATM practices.

Figure 1 described the steps taken to conduct the case study analysis. The process began with selecting the LATM project and defining its geographical boundaries. Next, the date range for analysis was set based on the project's timeline. Relevant traffic data was then extracted, cleansed, and stored in a table. The prepared dataset was connected to a reporting tool, such as Looker Studio, where dashboards were created to visualise key metrics. Finally, the analysis involved comparing before and after conditions, focusing on speed patterns and harsh driving behaviours.

Figure 1: Methodology flowchart



3.1 Case study selection

The LATM project selection for this study prioritised three key criteria: implementation status (Stage 5 of Austroads guidelines or staged delivery with preliminary CV data evidence), data availability (clearly defined geographical boundaries, key roads, treatment plans, and implementation timelines), and analytical feasibility (sufficient CV data for robust before/after comparisons). Based on these requirements, the Belvedere Precinct in Frankston, Victoria emerged as the ideal case study, offering complete project documentation and suitable CV data for comprehensive spatial and temporal analysis of LATM interventions.

3.1.1 Belvedere Precinct background

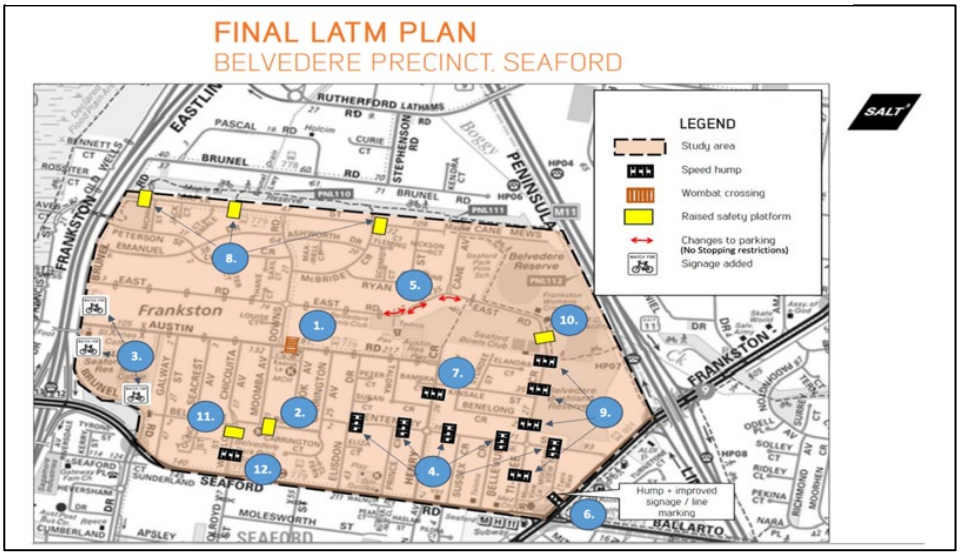
Frankston City Council (FCC) is a local government area (LGA) in the southern suburbs of Melbourne, Victoria with a population of approximately 139,281 people (Australian Bureau of Statistics, 2021). In October 2022, the council finalised an LATM project plan for Belvedere Precinct within the Seaford statistical area 2 (SA2) in response to identified key issues. The plan outlined a series of traffic treatments to be implemented over two financial years (FCC, 2023). These selected treatments were developed based on community consultation, including questionnaire surveys, meetings, Engage Frankston! feedback, site observations, and analysis of existing conditions using tube count surveys and traffic data provided by the Council.

The key issues guiding the plan included:

- Speeding and dangerous driver behaviour on streets like Centenary Street, Maple Street, Ti-Tree Crescent, and Wicklow Street.
- Parking issues causing access problems for through vehicles.
- Lack of pedestrian crossings and bicycle facilities.
- Intersection safety concerns, notably at the intersection of the Frankston-Dandenong Road service road and Mountain View Crescent.

Engineering investigations confirmed these issues, leading to proposed objectives aimed at speed calming on local streets, enhancing pedestrian and cycling facilities, addressing parking and access issues, prioritising locations with higher community concerns, and maximising available funding (FCC, 2023).

Figure 2: Belvedere Precinct final LATM project map (FCC, 2023)



Works for the LATM project, depicted in Figure 2, was scheduled to commence in late May 2023 and conclude by the end of the financial year 2023-24 (FY23-24). The project aims to examine the region bounded by Maple Street to the north, Peninsula Link and Frankston-Dandenong Road to the east, Seaford Road to the south, and Brunel Road to the west (FCC, n.d.).

3.2 Data collection

An aggregated dataset of CV data was sourced from Compass IoT. The dataset is hosted on Google Cloud Platform (GCP) and contains anonymised CV data collected from a combination of data providers consisting of telematics service providers (TSPs) and original equipment manufacturers (OEMs), capturing the raw vehicle data packets or points which are projected by individual vehicles at certain intervals of time i.e. every 2-60 seconds depending on the data provider. Common across all data packets (also referred to as vehicle points) is the anonymised vehicle ID, trip ID, vehicle type, latitude and longitude of the packet, vehicle speed and timestamp of the packet. Fields for accelerations and gyroscope can also be available depending on the data provider. Moreover, with coverage ranging from 1-5% across the Australian road network, Compass' total database receives over 50 billion individual data packets from vehicles and around 300,000 new vehicle trips daily, providing a robust source for analysis.

Data collection is automated, with TSPs and OEMs gathering data directly from vehicles equipped with telematics systems, performing their own filtering of the data. As a result, the data collection process does not involve human participants. Compass has also developed a continuously updating data processing pipeline that seamlessly transforms data packets from vehicles into structured tables and datasets within BigQuery, GCP's data warehouse. The pipeline also filters out invalid data points such as duplicates, those that cannot be correctly mapped to a valid vehicle ID, or those that have out-of-range latitude and longitude GPS coordinates.

3.3 Data validation

Data validation is crucial when using and apply CV data to analyse g-forces and speeding behaviour in a road network. To ensure the accuracy and reliability of the data, iterative

filtering, cleansing, and analysis of outliers were conducted. This process helps to eliminate any anomalies and ensure that the data accurately represents real-life traffic scenarios.

Speed validation is conducted by comparing vehicle speeds with posted speed limits obtained from OpenStreetMap (OSM). This ensures that the results are reliable and accurate, as any discrepancies between observed speeds and legal speed limits are identified and addressed.

3.4 Data analysis approach

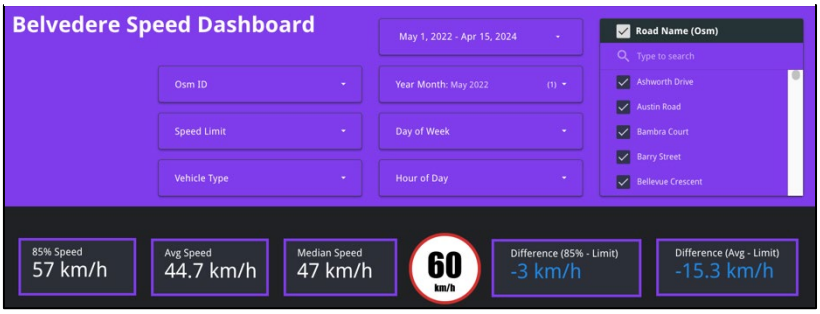
Findings were reported using visualisations, tables, and descriptive summaries in two different dashboards on Looker Studio to communicate key insights derived from the analysis. This approach ensures transparency and readability of results, facilitating informed decision-making in the development, implementation, and evaluation of LATM schemes and projects.

3.4.1 Speed compliance analysis

Speed compliance refers to the extent to which drivers adhere to posted speed limits on roads and is essential for maintaining safety on the roads. When drivers exceed speed limits, the risk of accidents increases, as it reduces the time available to react to unexpected events and increases the severity of collisions.

A speed dashboard was developed in Looker Studio using the original CV dataset. It encompasses various charts, including two maps, a time series graph, a table, and a column graph, all sourced from a BigQuery connection to the final dataset. The dashboard-style report presents aggregate speed measures for the LATM case study, starting with KPIs at the top, followed by maps, tables, and graphs. It includes filters for date range (May 2022–mid-April 2024), month, day(s) of the week, hour(s), road name/Osm link, and vehicle types. Figure 3 shows the dashboard layout: filters first, then KPIs, followed by charts (unpictured).

Figure 3: Speed dashboard



Some new calculated fields were created in the dashboard on Looker Studio mostly to obtain speed differentials between the posted speed limit and either the 85th percentile speed or average speed, either over the LATM network (across many roads) or just one road (or Osm link). The 85th percentile speed is widely used in traffic engineering as an indicator of prevailing driving behaviour and speed compliance. Table 2 provides a summary of these two new metrics used in the dashboard.

Table 2: Speed difference metrics definitions

Field	Definition
Difference/Speed Diff (85% - Limit)	Refers to the difference between the 85th percentile speed and the posted speed limit. If the result is a positive value, it means that the 85th percentile speed is higher than the speed limit.
Difference/Speed Diff (Avg - Limit)	Refers to the difference between the average speed and the posted speed limit. If the result is a positive value, it means that the average speed is higher than the speed limit.

With posted speed limit being one of the key variables for the analyses, the 'OsmSpeedLimit' variable was used as the source for this data, which is the posted speed limit for the Osm link. If this value wasn't available, the Belvedere Precinct Survey Questionnaire was used to deduce the posted speed limits imposed on key roads analysed in section 4 (e.g. the 50-speed limit value denoted for Centenary Street, Maple Street and Ti-Tree Crescent). The survey questionnaire also mentioned that there are speed compliance issues on Wicklow Street during school zone periods so it was assigned a 40km/hr speed limit value for the purposes of the analysis, noting that only the school zone period would be considered for this street when comparing speeds with the speed limit on the dashboard.

Hence, the compilation of these charts in the speed dashboard facilitates the visualisation of different aspects of the CV data, emphasising speed and speed compliance. This demonstrates the diverse analytical possibilities and the extensive capabilities of the data, topics that will be explored in section 5 of this report, including where its applications for informing LATM project definition, implementation and evaluation will be discussed. For the purposes of this research, an example road with one of the LATM project plan treatments was analysed (Centenary Street) before looking at the speed data at a network level for the overall precinct area.

3.4.2 Harsh braking and swerving driving behaviour analysis

In traffic engineering, harsh braking and swerving driving behaviours signify potential risks on the road. Traffic engineers study these behaviours to discern underlying causes and enhance road safety and efficiency. Harsh braking instances, tracked via traffic cameras or sensors, highlight areas susceptible to congestion or inadequate road infrastructure. Swerving actions, often indicative of sudden lane changes or evasive manoeuvres, prompt assessments of road geometry, visibility, and driver behaviour.

A G-forces-focused dashboard was developed in Looker Studio using the original CV dataset (screen captures seen throughout section 4.2). This dashboard illustrates how CV data can pinpoint harsh braking, accelerating, and swerving hotspots geospatially, while also comparing these hotspots or vehicle points to the experienced speeds. Serving as a complementary layer to the speed dashboard utilised for the initial speed compliance analysis (see section 3.5.1), this dashboard enhances the understanding of vehicle dynamics and safety metrics.

1Analysing speed and G-forces in a 'side-by-side' manner enables an enriched representation of driving behaviour. While speeds indicate how fast or slow vehicles are travelling, g-force data offers insights into the underlying reasons, particularly when analysing and comparing multiple vehicle trajectories within the CV dataset. This approach allows for the identification of both typical and atypical behaviours in specific routes or areas of interest. For example, while high speeds on a straight road may be typical, the presence of unusually high g-forces during braking or cornering could indicate potential safety concerns such as aggressive driving or hazardous road conditions. Conversely, moderate speeds coupled with elevated g-forces in certain curves may suggest cautious driving behaviour in response to sharp bends or adverse weather conditions.

3.5 Data collection and preparation for Belvedere Precinct

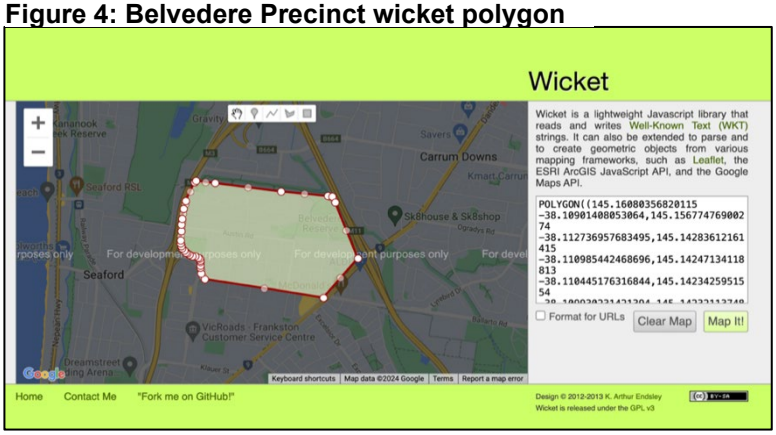
The data extraction and analysis process for the Belvedere Precinct LATM project involved several key steps, including geographical and time-based selection, data cleansing, and the use of advanced query and analysis tools.

Geographical and time selection: Wicket, a web application, was used to manually draw the geofenced area for the Belvedere Precinct LATM project by mapping WKT strings, as illustrated in Figure 4. The resulting polygon was used to query vehicle point data within the defined boundaries from BigQuery. While most data points were accurately captured, some

external Osm links, such as Berry Street and Boston Avenue, were included due to minor inaccuracies in the drawn polygon. For time selection, vehicle data points were collected over a two-year period from 1 May 2022 to 15 April 2024. This timeframe was chosen to cover the LATM project's planning, implementation, and evaluation phases, aligning with the project's completion date of 30 June 2024.

Data cleansing and filtering: The dataset underwent extensive cleansing and filtering to ensure accuracy and usability. Timestamps were converted from UTC to the 'Australia/Victoria' time zone to align with local standards. Vehicle types were corrected and streamlined into four categories: 'car', 'BUS', 'LCV', or 'HCV'. Invalid acceleration values were flagged and replaced with null values to prevent skewing analyses. Additionally, new fields were created to categorise vehicle points into time buckets (e.g., AM Peak, PM Peak, School Peak, Weekend Peak, and Night) and to distinguish braking, accelerating, and swerving g-force values. After cleansing, the dataset comprised 2,575,626 unique vehicle points from 23,929 vehicles across the two-year period.

Figure 4: Belvedere Precinct wicket polygon



Data query and analysis tools: BigQuery was used to query the data using SQL, with constraints applied for time periods and geospatial location. Looker Studio was employed to analyse and visualise the data through dashboards, graphs, and maps. BigQuery Geo Viz was used to geospatially represent vehicle points, as shown in Figure 5, highlighting their distribution across the precinct. The analysis focused on descriptive analytics to uncover patterns in traffic volume, speed, and vehicle behaviour. Nearmap's high-quality aerial imagery was also utilised to align the timing of LATM implementation strategies with the dataset's date ranges, ensuring accurate before-and-after analyses.

Figure 5: Belvedere Precinct CV data points (normal map and satellite)

4 Case study evaluation results

This analysis illustrates the value of connected vehicle data in the evaluation of an LATM project. While it does not offer a comprehensive appraisal of the entire road segment examined in the case study, it provides a practical example of how traffic-related issues can be quantified and how traffic management plans can be effectively monitored and evaluated using this supporting dataset.

4.1 Speed compliance

Centenary Street is used as an example road segment to illustrate a speed compliance evaluation leveraging connected vehicle data. Tube count surveys from the LATM draft plan identified speeding concerns, with an 85th percentile speed of 50.4 km/h on a road with a posted limit of 50 km/h (Goodliffe, 2022). In response, five speed humps were installed by June 2023 in accordance with the Belvedere Precinct's traffic treatment schedule, as shown at Treatment ID 4 in Figure 2 (FCC, 2023).

Analysis of Centenary Street using the speed dashboard revealed excessive speeding prior to speed hump installation (Figure 6). Key instances include June 13, 2022, and February 6, 2023, where 85th percentile speeds exceeded limits by 28 km/h and 23 km/h respectively, reaching over 70 km/h. These pre-intervention findings (all prior to June 2023 measures) highlight the need for traffic calming and demonstrate how such analysis supports LATM by pinpointing issues, validating treatments, and assessing intervention effectiveness.

Figure 3: Centenary Street May 2022 speed table

Overview

Date	Osm Road Name	85% Speed	Avg Speed	Speed Limit	Speed Diff (85% - Limit)	Speed Diff (Avg - Limit)	Trip Count
Jun 13, 2022	Centenary Street	78	47	50	28	-3.42	5
Feb 6, 2023	Centenary Street	73	44	50	23	-5.79	7
Jul 4, 2022	Centenary Street	57	37	50	7	-13.37	5
Dec 9, 2022	Centenary Street	55	39	50	5	-10.51	6
Jun 19, 2022	Centenary Street	54	39	50	4	-10.8	4
Feb 15, 2023	Centenary Street	54	36	50	4	-13.81	4
Feb 19, 2023	Centenary Street	54	43	50	4	-6.72	9
Oct 14, 2022	Centenary Street	54	38	50	4	-11.61	7
Apr 19, 2023	Centenary Street	53	36	50	3	-14.23	7
Aug 25, 2022	Centenary Street	53	40	50	3	-9.91	10
Dec 27, 2022	Centenary Street	53	45	50	3	-4.77	5

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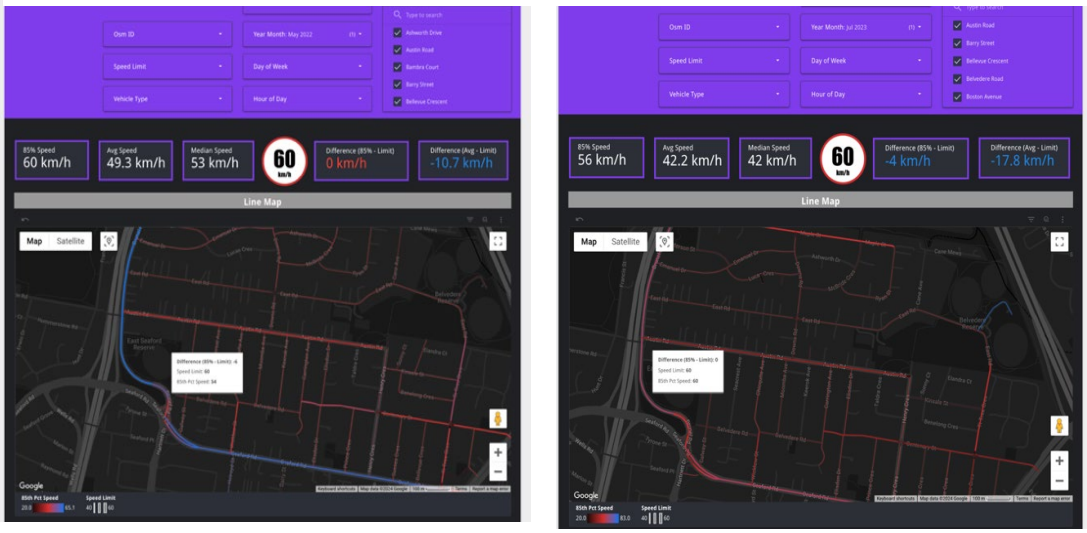
Figure 7 presents the temporal variation in speed that can be obtained from the dashboard. The LATM treatment of 5 vertical deflection devices was applied between April and June 2023, and this is clearly reflected in the time series line graph and the time bucket categorisations comparing 2022 and 2023 data. 85th percentile speeds have declined by 21.7% following the treatment, indicating that the speed reduction objective has been achieved. These dashboards and data analysis outputs are beneficial for the monitoring of LATM applications and reduce the need to collect further post-implementation field data.

Figure 7: Centenary Street speed metrics against temporal breakdowns

4

Figure 8 compares network-wide speed data from May 2022 and July 2023, illustrating changes following LATM interventions in the Belvedere Precinct. In May 2022, the 85th percentile speed across the network averaged 60 km/h, with a differential of 0 km/h despite many roads having a 50 km/h limit- indicating widespread non-compliance.

Figure 8: Belvedere Precinct network speeds before during May 2022 (left) vs after during July 2023 (right)



High-speed segments were concentrated along major boundary roads such as Seaford and Brunel Roads, the latter showing a differential of -6 km/h. By July 2023, post-implementation data showed improved speed compliance, with the network-wide 85th percentile speed differential dropping to -4 km/h. The reduced prevalence of higher-speed segments (previously shown in purple and blue) further supports the effectiveness of LATM measures. Notably, Brunel Road's differential increased to 0, suggesting localised variation in treatment

impact. This comparative analysis underscores the value of connected vehicle data in monitoring LATM performance across both spatial and temporal dimensions.

Figure 9 presents the lowest-performing roads in terms of speed compliance within the Belvedere Precinct, comparing data from May 2022 (first two columns) and July 2023 (last two columns). Centenary Street showed an improvement in 85th percentile speed differential from -8 to -12. Ti-Tree Crescent, where two speed humps and one raised safety platform were implemented (FCC, 2023), also demonstrated enhanced compliance, with the 85th percentile speed differential improving from -2 to -5 and the average speed differential decreasing from -12.15 to -14.14.

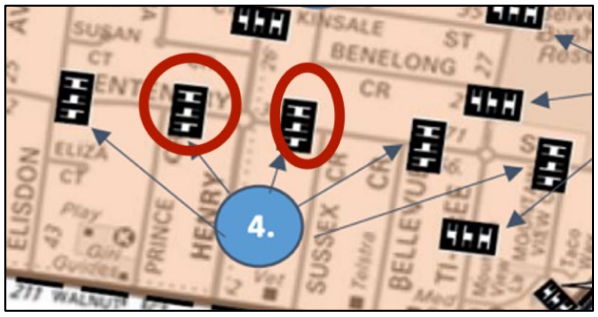
Figure 9: Belvedere Precinct all roads speed table comparison

	May 2022		July 2023	
Osm Road Name	Speed Diff (85% - Limit)	Speed Diff (Avg - Limit)	Speed Diff (85% - Limit)	Speed Diff (Avg - Limit)
Brunel Road	3	-4.37	2	-4.99
Wicklow Street	2	-6.11	1	-6.66
Seaford Road	-1	-8.52	0	-8.42
Ti-Tree Crescent	-2	-12.15	-2	-10.48
Maple Street	-2	-11.12	-5	-14.14
Centenary Street	-8	-16.61	-12	-18.64
			-21	-28.75

4.2 Harsh braking and swerving

As per the key issues shaping the original LATM plan (see section 4.1), the roundabout at Centenary Street and Henry Crescent was noted to have safety concerns. This segment is at the roundabout between the two circled proposed speed humps in figure 10 as per the final LATM plan (taken from figure 2).

Figure 10: Centenary Street and Henry Crescent roundabout proposed speed humps



The FCC survey (2023) highlighted pedestrian safety concerns at the roundabout, recommending speed reduction. To analyse this, the harsh driving behaviour dashboard focused on Henry Crescent and Centenary Street (May–Dec 2022), excluding unrelated OSM IDs to isolate roundabout-adjacent sections for targeted assessment.

Figure 11 compares braking/accelerating g forces at the roundabout between 2022 (top) and 2023–2024 (bottom) while figure 12 compares swerving g forces for the same. Higher/lower-than-0.3 g forces (green/red dots) are common due to turning manoeuvres, with no significant change over time which is consistent with the LATM goal of speed reduction. Figure 11 reveals braking/accelerating behaviour shifts post-speed hump installation. Maximum accelerating g force rose from 0.31 to 0.52, likely on Henry Crescent, while braking events dominated Centenary St (speed hump location).

Figure 11: Braking/accelerating g force map at Centenary St and Henry Crescent Roundabout

Figure 52: Swerving g force map at Centenary St and Henry Crescent Roundabout

Figure 13 analyses Centenary Street's OSM links near the roundabout, showing reduced average/median speeds post-speed hump implementation (2022 vs. 2023–2024). The % of harsh acceleration events (|X Acc| > 0.4) also dropped from 0.51% to 0.28%, confirming the humps' effectiveness in curbing aggressive driving.

Figure 13: Table metrics comparison for Centenary St near the Henry Crescent Roundabout

	Road Name	Avg Speed	Median Speed	% |X Acc| > 0.4	% |Y Acc| > 0.3	% Total G Force > 0.3g	% Points Overspeeding	% Trips Overspeeding	Avg Accelerating G Force (X)	% Accelerating G Force > 0.4	Avg Braking G Force (X)	% Braking G Force < -0.4	Trip Count
1.	Centenary Street	33.8	36.41	0.51%	1.88%	3.81%	5%	15%	0.09	0.00%	-0.12	0.98%	892

	Road Name	Avg Speed	Median Speed	% |X Acc| > 0.4	% |Y Acc| > 0.3	% Total G Force > 0.3g	% Points Overspeeding	% Trips Overspeeding	Avg Accelerating G Force (X)	% Accelerating G Force > 0.4	Avg Braking G Force (X)	% Braking G Force < -0.4	Trip Count
1.	Centenary Street	25.42	29	0.28%	0.58%	3.92%	0%	2%	0.1	0.09%	-0.12	0.49%	695

Figure 14 presents a heatmap of accelerating g-forces across the entire Belvedere Precinct (May–July 2022). Centenary Street stands out with persistent red hotspots, justifying FCC's focus, while Austin Road (west) and Chicquita Avenue (excluded from LATM plans) also show high acceleration zones.

Figure 15 highlights left-swerving g-forces, with a notable hotspot on the Frankston-Dandenong Service Road's sharp turns. FCC's planned improvements (e.g., signage, speed

humps) aim to address this, though March 2024 Nearmap imagery shows no devices have been constructed —suggesting advisory signage may be the interim measure.

Figure 14: Avg accelerating g force heatmap for the network

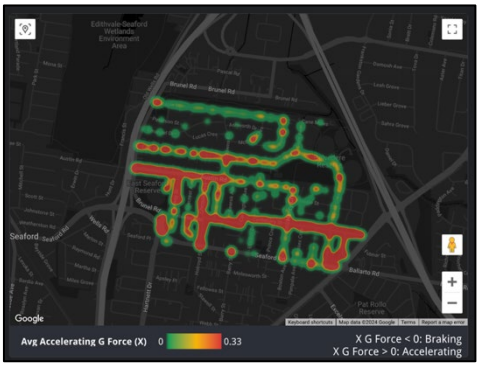


Figure 6: Avg left swerve g force heatmap for the network

5 Discussion

The use of connected vehicle (CV) data dashboards offers a powerful toolset for the planning, implementation, and evaluation of Local Area Traffic Management (LATM) projects. The Belvedere Precinct case study demonstrated how these dashboards can generate actionable insights that support data-driven decision-making throughout the LATM process.

During the planning stage, CV-derived speed data can be used to identify locations with frequent speeding and elevated 85th percentile speeds, highlighting the need for interventions such as speed limit enforcement or geometric redesign. In the case study, roads with consistent non-compliance—such as Centenary Street and Ti-Tree Crescent—were identified prior to intervention. Likewise, dashboards tracking harsh driving behaviour (e.g., hard braking or sharp acceleration) can reveal areas prone to aggressive manoeuvres, which inform the placement of traffic calming measures like speed humps or roundabouts.

During implementation, CV dashboards support the targeted deployment of these treatments. In the Belvedere Precinct, for example, speed and behaviour data helped justify the installation of raised devices on specific streets. Such data can guide where to locate interventions such as raised pedestrian crossings, narrowed lanes, or modified curves to address observed behaviours. This targeted approach improves the precision and efficiency of LATM treatments.

CV data also enables robust evaluation of LATM interventions. By comparing pre- and post-intervention data, practitioners can assess changes in speed compliance and driving behaviour. In the case study, a post-implementation reduction in both average and 85th percentile speeds on several streets indicated improved compliance. Evaluating these changes helps identify which measures were most effective and where further refinement may be needed, contributing to the iterative improvement of LATM strategies.

In response to considerations around sample size and statistical significance, the analysis was underpinned by a large dataset of over 2.5 million unique vehicle points, representing almost 24,000 unique vehicles across the study period. While certain individual metrics such as a 3 km/h improvement in the 85th percentile speed may appear modest, the volume of data points per road segment and consistency of directional trends lend robustness to the findings. Where applicable, confidence intervals and standard deviations were reviewed to ensure the observed changes were unlikely to be due to random variation or sampling bias. That said, we acknowledge that CV data remains a sample of the driving population and that further work is needed to establish standard thresholds for statistical sufficiency in LATM contexts.

The use of CV data in LATM applications requires careful consideration of limitations. In the Belvedere Precinct, a lack of precise intervention dates limited the ability to define clear before-and-after periods. In other cases, restricted data coverage or variability in external conditions (e.g., weather, construction) may affect analysis. These factors underscore the need for contextual understanding and cautious interpretation.

In the future, CV data has the potential to play a broader role in urban traffic management. Real-time speed data can support adaptive signal control, targeted enforcement, and proactive infrastructure planning. Behavioural data can inform public education campaigns and help shape safety policy. Integration of CV data into broader multimodal transport and safety frameworks will enable more responsive, coordinated approaches to improving urban mobility. The Belvedere Precinct case study illustrates how such integration can begin at the local level, offering a foundation for scalable, data-informed LATM practice.

6 Conclusion

The analysis of CV data has provided critical insights into defining, implementing, and evaluating LATM schemes. By examining speed compliance, driver behaviour indicators (e.g., harsh braking, accelerating, and swerving), and traffic patterns, the study identified hotspots for speeding and aggressive driving, underscoring the need for targeted interventions like traffic calming measures and enhanced enforcement to improve road safety. The integration of CV data also demonstrated its potential to optimise traffic flow, reduce congestion, and enhance travel time reliability through real-time speed data and dynamic traffic signal adjustments. These findings highlight the transformative role of CV data in enabling evidence-based decision-making and fostering safer, more efficient urban mobility. Future research should focus on improving the scalability and coverage of CV data to better reflect real traffic volumes, paving the way for cost-efficient, automated, and sustainable transportation systems.

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