Network modelling

The Melbourne network is a routable street network with modelled exposure covariates for evaluating the behavioural and health impacts of infrastructure and policy scenarios for the Greater Melbourne region in 2018, produced as part of the JIBE project.

Figure 1 displays an outline of the principal data inputs and processes used to create the Melbourne network. Data inputs are summarised in Table 1. Subsequent sections of this document explain the processes. The network outputs (AToM Network, Adjusted Network, Network .gpkg, MATSim Network and MATSim Network with Traffic Volumes) are available athttps://osf.io/wh3td.

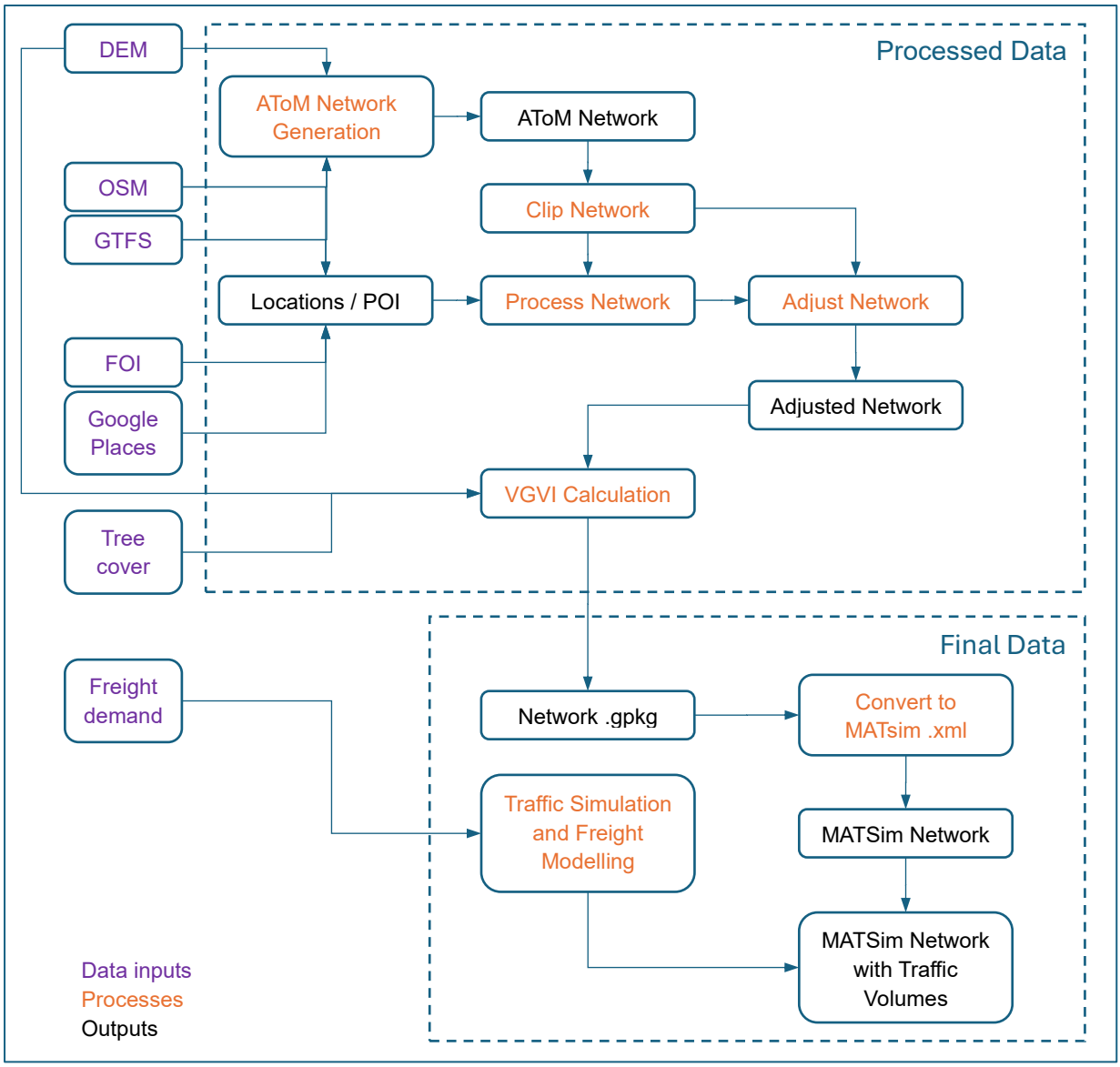

Figure 1: Diagram of network modelling processes

Table 1: Data sources for the network modelling processes

Data input	Title	Content	Author/source	Publication year	URL
OSM	OpenStreetMap	OpenStreetMap extract for Australia	OpenStreetMap contributors	2019	https://download.geofabrik.de/australia-oceania/australia-190101.osm.pbf
GTFS	PTV GTFS	General Transit Feed Specification for Public Transport Victoria	Public Transport Victoria	2019	https://transitfeeds.com/p/ptv/497
DEM	Vicmap Elevation	Digital Elevation Model – 10m resolution	State Government of Victoria	2018	https://www.land.vic.gov.au/maps-and-spatial/spatial-data/vicmap-catalogue/vicmap-elevation
FOI	Vicmap Features of Interest	Features of Interest for Victoria	State Government of Victoria	2023	https://discover.data.vic.gov.au/dataset/vicmap-features-of-interest
Google Places	Google Places	Location data for places	Google	2023	https://developers.google.com/maps/documentation/places/web-service
Tree cover	Tree Cover	Tree cover (woody vegetation greater than 2m in height and with crown cover greater than 10%) for Victoria	State Government of Victoria	2018	https://discover.data.vic.gov.au/dataset/tree-cover
Freight demand	Vehicle demand	Victorian Integrated Transport Model (VITM) vehicle demand	State Government of Victoria	2018	Supplied by Department of Transport and Planning, State Government of Victoria (not publicly available)

AToM network

The AToM Network is generated using processes based on those described in Jafari et al. (2022). These processes use OpenStreetMap (OSM) road (including pedestrian path) data, General Transit Feed Specification (GTFS) public transport data, and a digital elevation model (DEM) to generate a network of links and nodes representing the road network, including public transport infrastructure. Links are attributed with values such as speed limits and lane numbers drawn from OSM, and slope calculated from the DEM. Where required values (for example, speed limits) are missing from OSM, default values based on typical values for the relevant road types are used.

The code for generating the AToM network is at https://github.com/jibeproject/networkMelbourne and https://github.com/matsim-melbourne/network (dev branch).

Locations/POIs

Points of interest are the locations of a variety of destination types (such as shopping, education, community facilities and services, and public transport stops). Their locations are sources from OpenStreetMap (OSM), Google Places, the Vicmap Features of Interest (FOI) dataset and General Transit Feed Specification (GTFS) for public transport stops.

In addition to spatial coordinates, associated files generated in relation to the POIs include information on high street classifications, positive and negative POI codes and weights, and a quietness score derived from road and cycleway types. POIs with positive codes represent destinations that enhance the walking and cycling environment (e.g. small shops, museums, churches), while those with negative codes indicate destinations that make streets unattractive for active travel (e.g. large shopping centres, parking lots, industrial facilities).

Weights were assigned to POIs based on number of employees and building size for most destinations, service frequency for public transport stops, and catchment population and park size for parks. Quietness scores were calculated as a function of road type, with off-road cycling infrastructure receiving the highest score.

The code for generating the POI locations and associated details is at https://github.com/jibeproject/networkMelbourne/tree/main/scripts.

Clipped, processed and adjusted network

The AToM Network, which covers the whole of Victoria, is filtered so that it comprises all roads (together with public transport infrastructure) in Greater Melbourne, plus major roads (tertiary and above) in the rest of Victoria. The major road network for the rest of Victoria is retained as it is used for the freight model.

The POI locations and related codes, weights and values are used with the clipped network to calculate attribute values for network links in respect of quietness, positive and negative POIs, whether a link is part of a highstreet, and Shannon diversity.

The clipped network and POI attribute values are then combined, and other adjustments are made to attribute values derived from OSM to produce a network in the form and structure consistent with subsequent modelling in the JIBE project. The resulting Adjusted Network comprises *edgesMelbourne.gpkg* and *nodesMelbourne.gpkg*.

The code for clipping, processing and adjusting the network is at https://github.com/jibeproject/networkMelbourne.

VGVI

Viewshed Greenness Visibility Index (VGVI) values are calculated for each link, using processes based on those described in Labib et al. (2021) and code at https://github.com/Spatial-Data-Science-and-GEO-AI-Lab/GreenExp_R/.

The calculation requires a digital elevation model (DEM) and tree cover data, which were obtained from the sources described in Table 1 and merged into a single file covering the study region.

The resulting layer of links with the VGVI attributes, *edgesMelbourne_VGVI.gpkg*, together with the node layer from the Adjusted Network, *nodesMelbourne.gpkg*, comprise the Network .gpkg.

Conversion to MATSim network

After preparing the undirected network graph and adding VGVI, the Network .gpkg graph was converted to a MATSim directed network graph using the methods described in Staves et al. (2025) to produce the MATSim Network. The conversion code for Melbourne is at https://github.com/jibeproject/matsim-jibe/blob/master/src/main/java/network/CreateMatsimNetworkMelbourne.java. This network is used for all subsequent simulation and modelling work.

For visualisation of the MATSim Network, it can be converted into geopackage format using the code in https://github.com/jibeproject/matsim-jibe/blob/master/src/main/java/network/WriteNetworkGpkg.java. This output can be customised to include relevant attributes for visualisation in the output (e.g., stress)..

Simulated vehicle traffic

To estimate vehicle traffic flow on the network, a traffic simulation was prepared using demand data from the Activity-based and agent-based transport model of Melbourne (ATOM) (Jafari et al., 2024). A 10% sample of ATOM's travel demand, which include trips

made by car, public transport, walking and cycling was used for the simulation. This was combined with a 10% sample of freight demand data (see below) and routed on the MATSim network. The simulation outputs are available at melbourne/preprocessing/network/traffic flow.

The vehicle traffic simulation outputs were used to estimate traffic volumes throughout the network. These estimates were used to compute indicators of traffic stress for pedestrians and cyclists following the methodology in Staves et al. (2025).

Freight modelling

Modelled freight volumes were combined with the simulated vehicle traffic described above. The freight model allocates volumes of freight traffic (numbers of truck trips) to network links. The model has two components:

- Using matrices of vehicle demand supplied by the Victorian Department of Transport and Planning (DTP) to allocate departure times and origin and destination addresses for freight trips.
- Using Matsim to route the vehicle trips along the road network.

The freight demand data supplied by DTP consist of a series of matrices specifying demand (numbers of freight trips) between pairs of traffic zones. For this purpose, Victoria is divided into 2959 freight zones of varying size. The demand is specified for each of 4 time periods: AM peak (7am to 9am: 2 hours), inter-peak (9am to 3pm: 6 hours), PM peak (3pm to 6pm: 3 hours) and off-peak (6pm to 7am the following day: 13 hours).

This freight demand data was converted to a set of trips with specified departure times and origin and destination addresses as follows.

1. Each trip within the demand data was randomly allocated to an hour within its applicable time period. This is treated as the departure time for the trip.
2. The road network, created as set above, was filtered to include only tertiary secondary, primary, trunk and motorway roads. This reflected the fact that freight origin and destination locations are generally situated on or near main roads, and avoided freight trips being modelled as routed along residential or other minor roads.
3. Potential origin and destination locations for freight trips were identified, using Geocoded National Address File (GNAF) points and 2016 census mesh blocks. Each GNAF address point located within a mesh block classified as 'Commercial', 'Industrial' or 'Primary Production' and within a traffic zone was treated as a potential origin and destination location for that traffic zone. For

traffic zones that did not contain any such addresses, the centroid of the zone was treated as the origin and destination location for the zone.

4. Each trip within the demand data was randomly allocated an origin and destination from the potential origin and destination locations for its origin and destination zones respectively.

The result was a set of freight trips, each with a departure hour, an origin location, and a destination location.

Using MATSim, this set of freight trips was then routed on the Victorian road network (confined, as described above, to roads classified as 'tertiary' or above), to identify the most efficient route for each trip, minimising travel time based on road distance and congestion. The output specified the volume of freight trips for each link of the network.

The code for generating the set of freight trips with departure hour, origin location and destination location is at https://github.com/jibeproject/freightMelbourne.*]*

MATSim network output

The output directed network incorporating the simulated traffic flow, the MATSim Network with Traffic Volumes, is in MATSim xml fornat.

References

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