Network Analysis for Urban Planning and Beyond

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Design & Planning Lab

Urban Redevelopment Authority

Agenda

- About URA
- Network Analysis Applications
- Summary

URBAN REDEVELOPMENT AUTHORITY

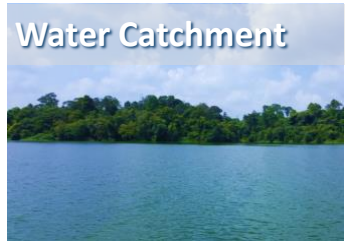
Singapore's National Land Use Planning Authority

***Mission:** To make Singapore a Great City to Live, Work & Play*

Artist's impression of Jurong Lake District

Land Area: 721.5 km²
Population: 5.6 million
Density: 7,800 persons/km²

LAND NEEDS



SEA NEEDS

Planning Objectives

ECONOMIC

Sustain a robust and vibrant economy

SOCIAL

Provide a good quality of living and a sense of well-being for all

ENVIRONMENT

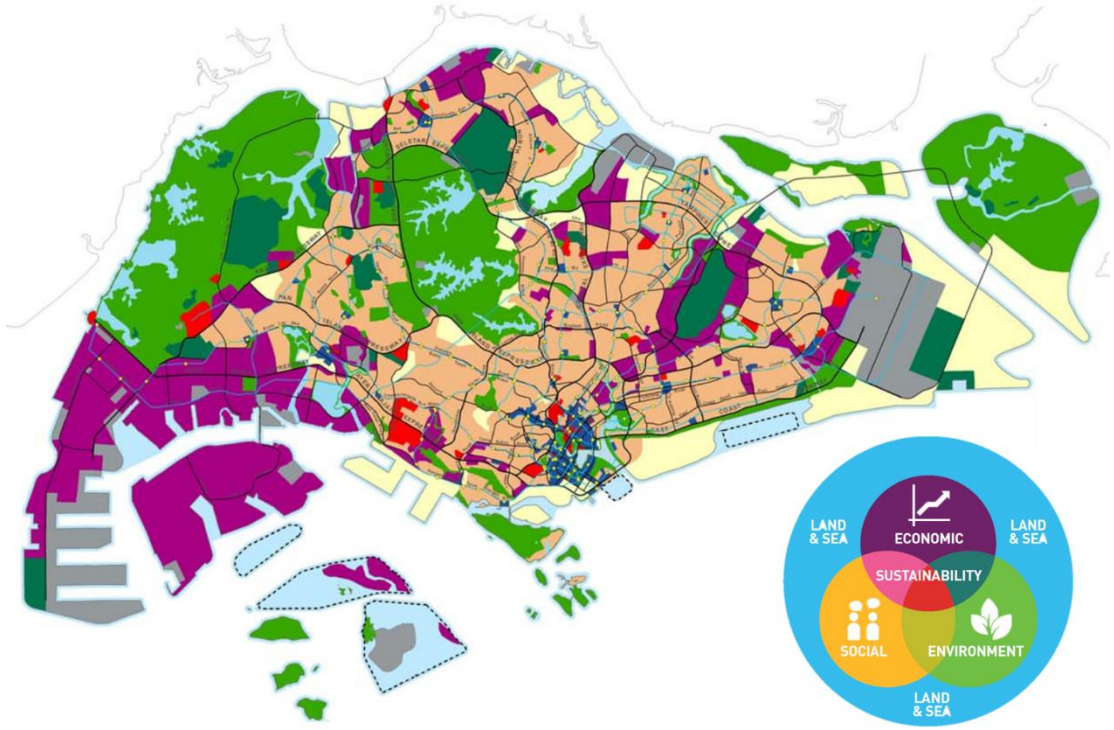
Develop in an environmentally responsible manner

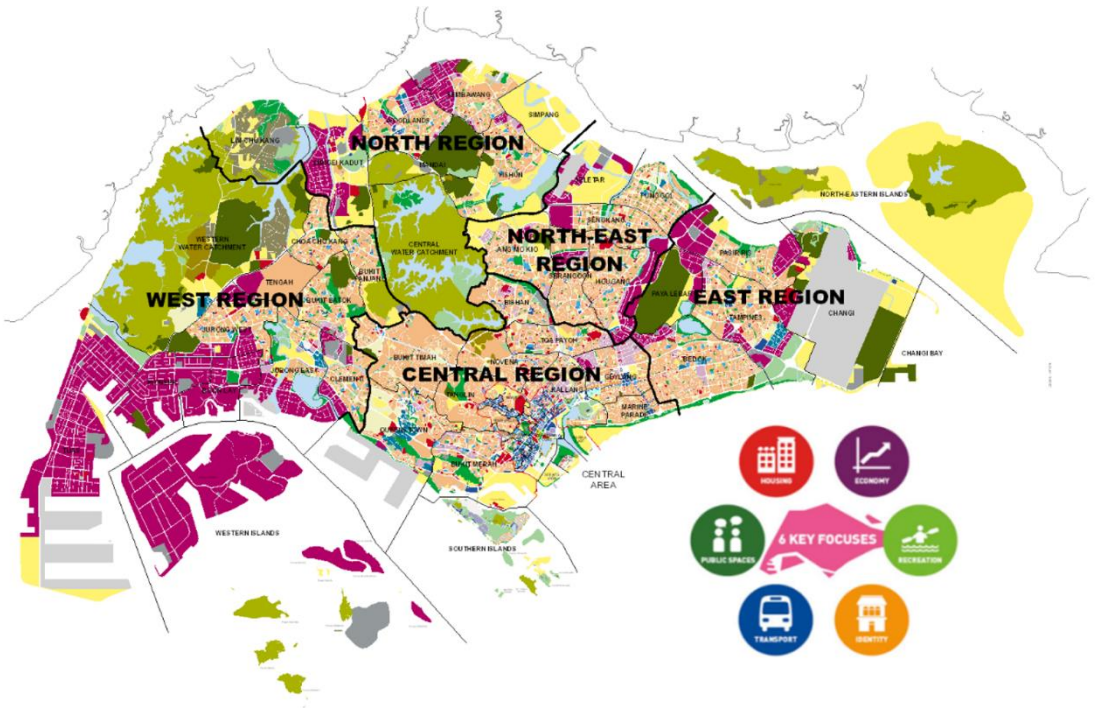
LAND & SEA

Optimise our limited land and sea space

+ FLEXIBILITY RESILIENCE

Need to also plan for greater flexibility and resilience given the rise of disruptive technology, unanticipated uncertainties, and the effects of climate change





Concept Plan

Strategic land use and transportation plan guiding development over the next 40-50 years

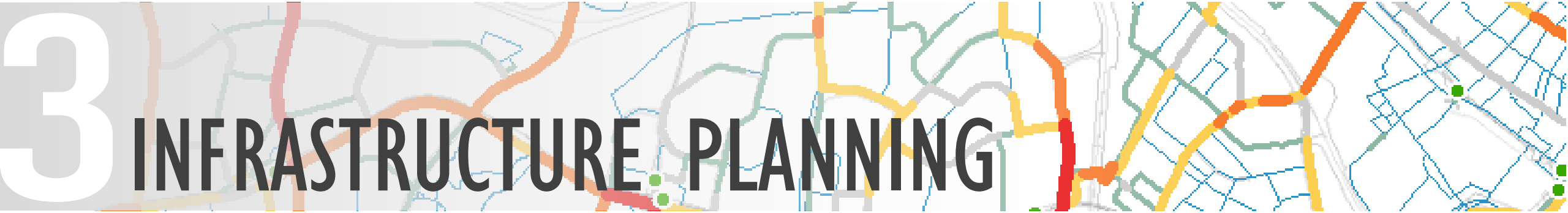
Master Plan

Translate Concept Plan into detailed plans for near term implementation over 10-15 years

Applications

1 COVERAGE AND GAP ANALYSIS

2 AMENITIES PLANNING

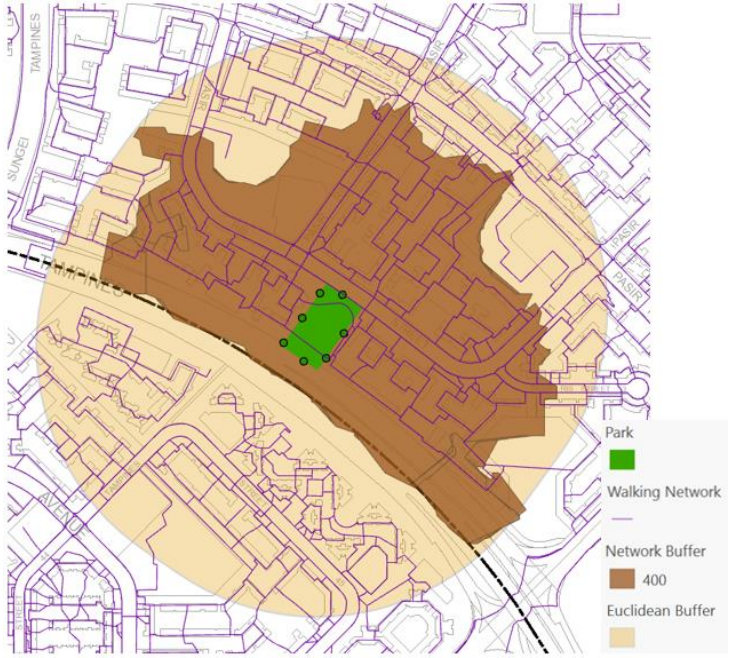


3 INFRASTRUCTURE PLANNING

1 COVERAGE AND GAP ANALYSIS

Increasing Granularity

Euclidean Buffer

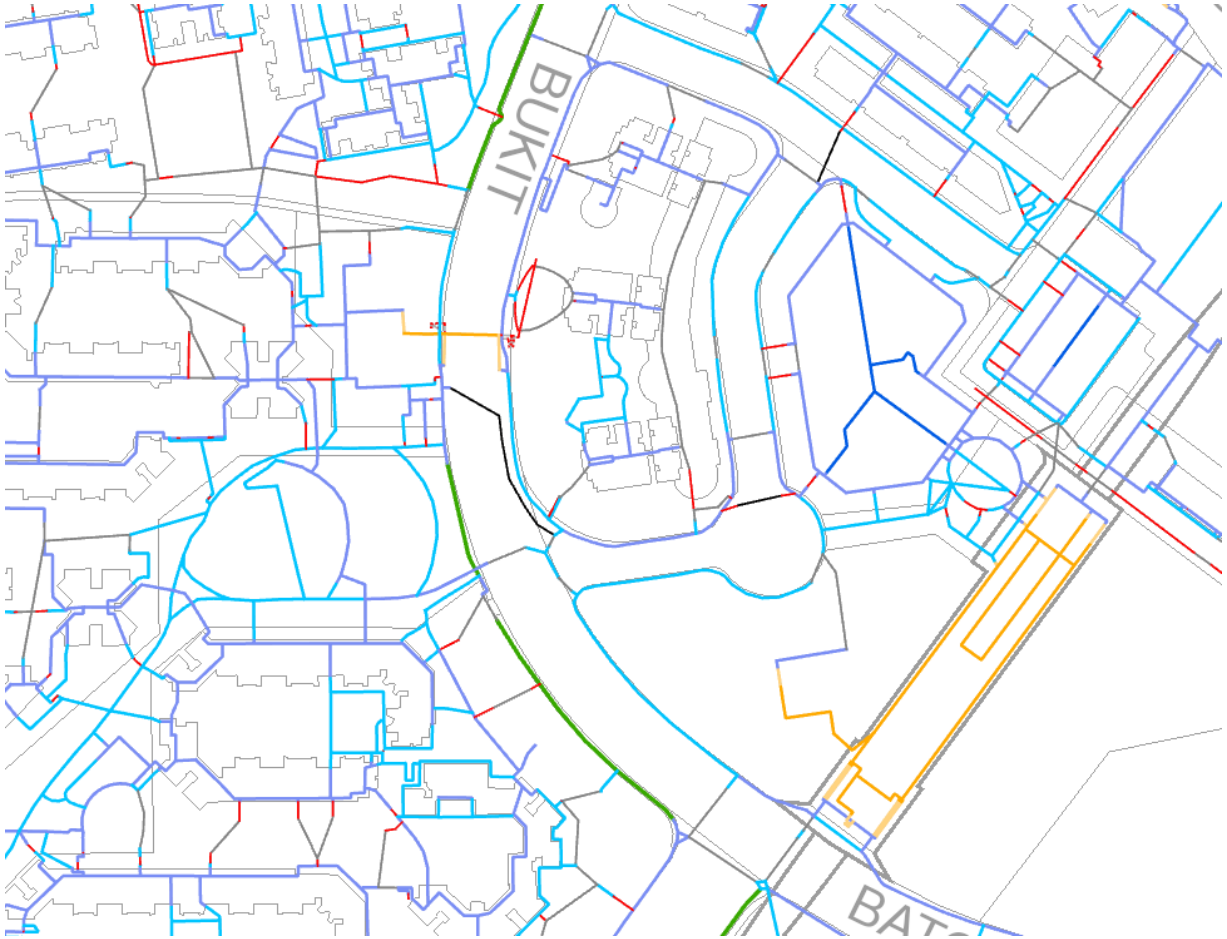


Network Buffer

Improving analysis with the use of network for better data-informed decision

- Improved granularity and accuracy
- Planning for all groups including elderly / people with disabilities

Data: Walking & Cycling Network



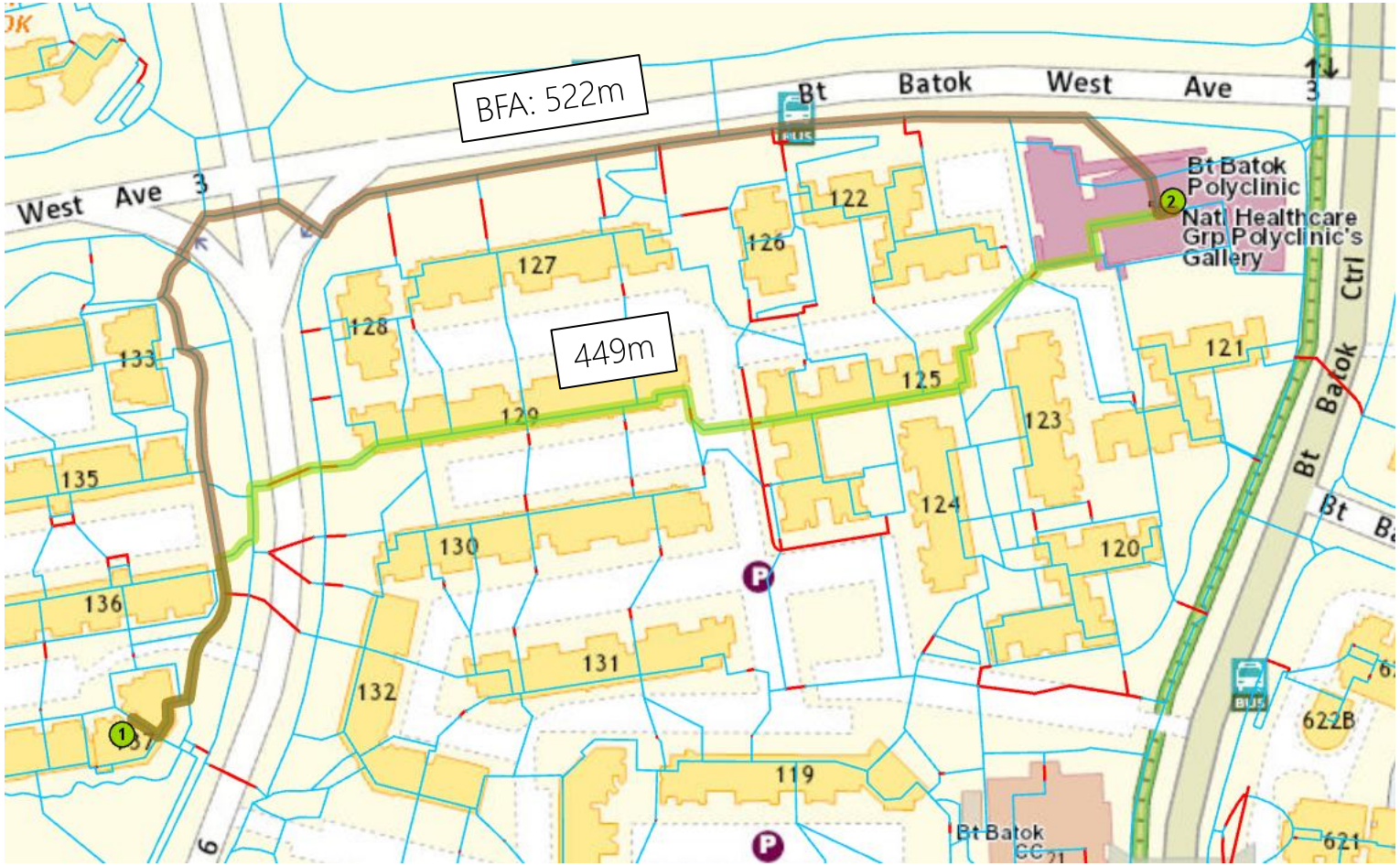
Walking & Cycling Network mapped at Bukit Batok

Walking network is the fundamental data for network analysis.

Capturing detailed network attributes enabled various studies such as barrier-free access as well as pedestrian comfort

- NON-SHELTERED
- SHELTERED
- AIR-CONDITIONED
- PCN
- CPN
- ABOVE GROUND
- LINK BETWEEN GROUND AND ABOVE GROUND
- LINK BETWEEN GROUND AND UNDER GROUND
- UNDER GROUND
- CROSSING
- DESIRABLE CROSSING POINT
- NON-BFA
- CLOSED

Routing: Going beyond distance

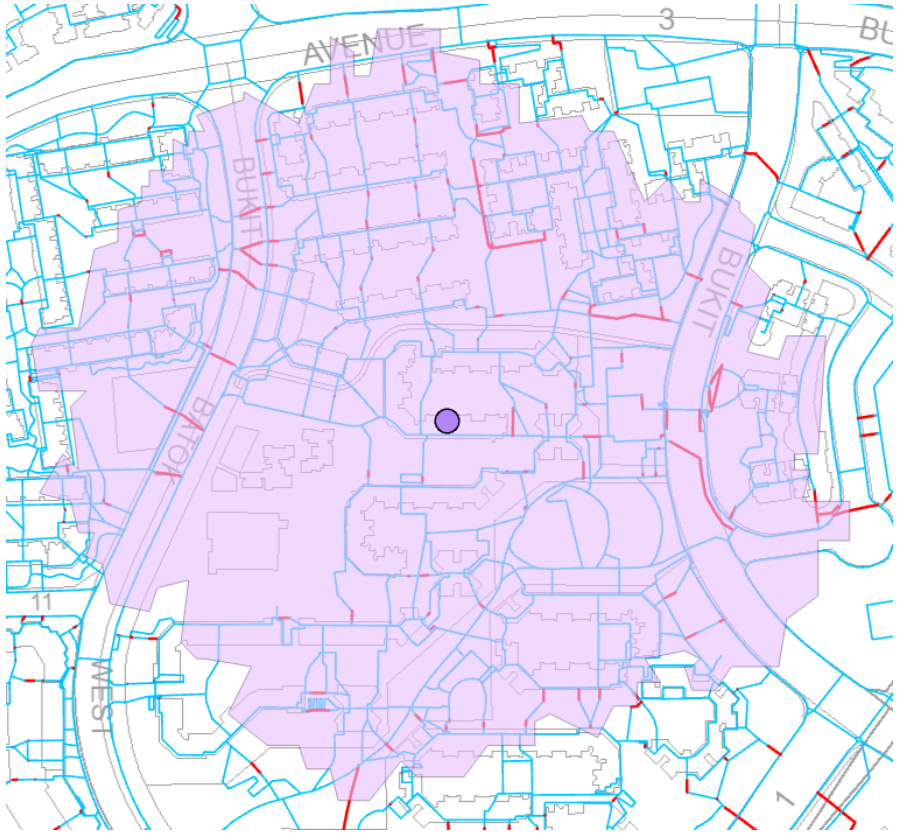


With the extensive collection of network attributes, it is now possible to analyse how different groups choose their route.

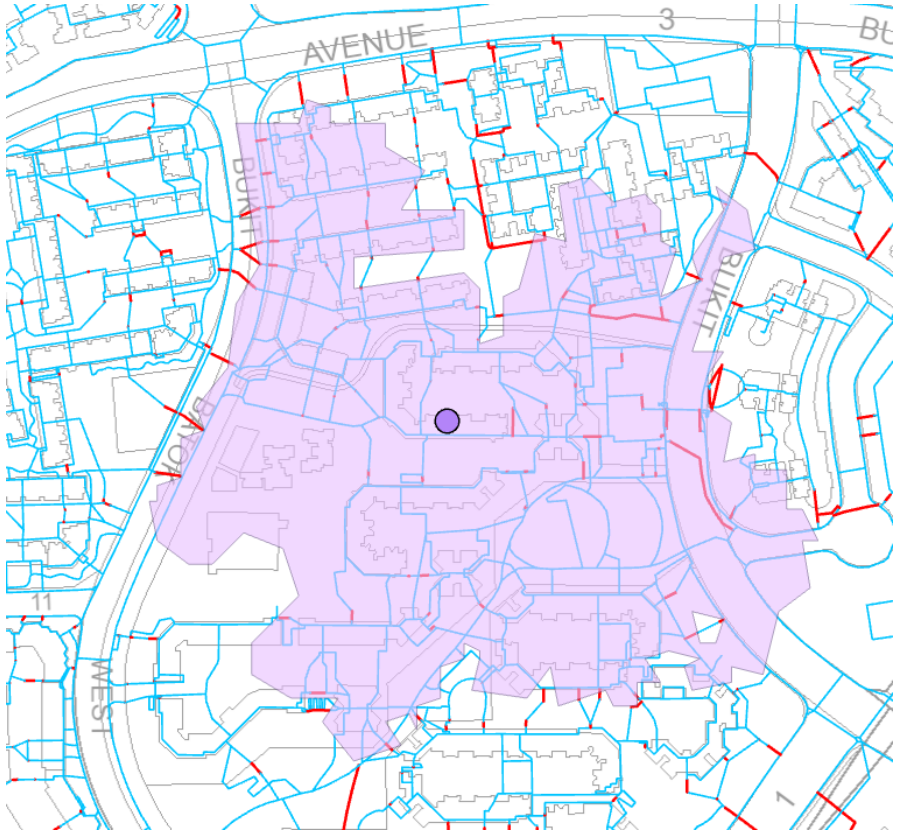
This allows us to ensure accessibility for all groups as well as comfort such as sheltered linkways to key destinations.

Similar application could be made available for the public when the data is updated in more areas.

Coverage and Gaps



Coverage of full network

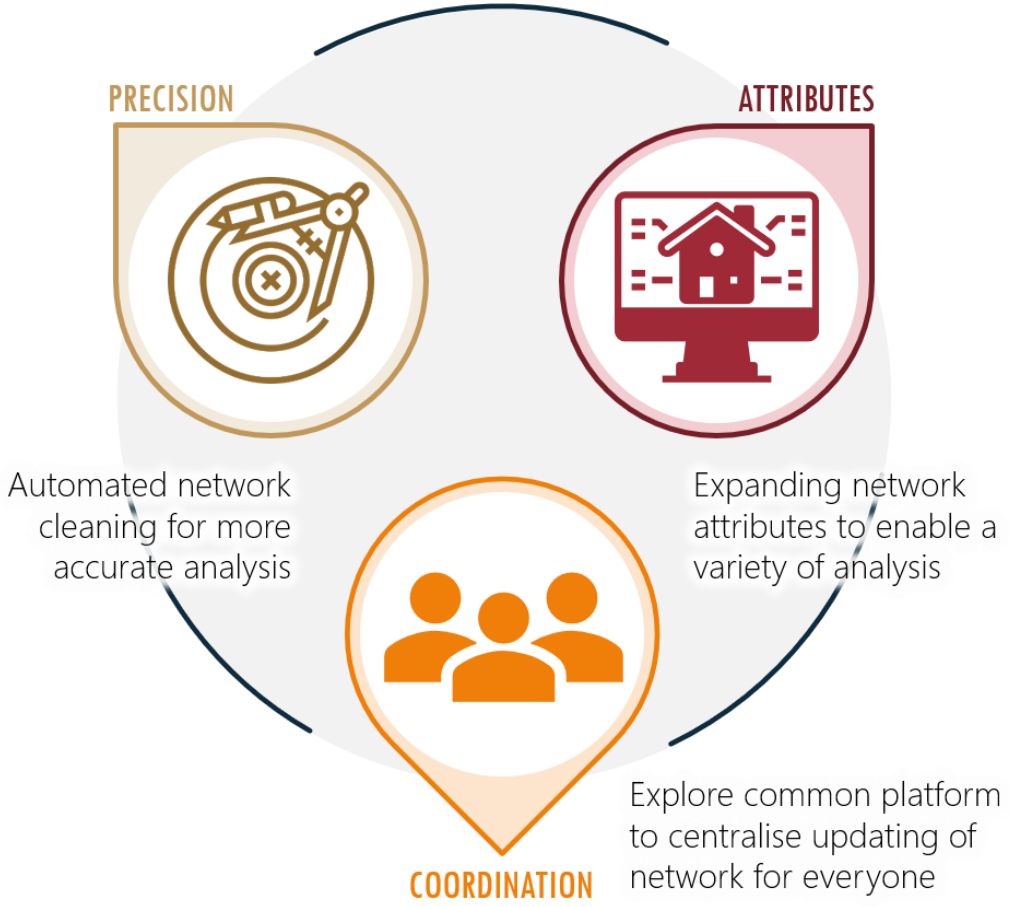


Reduced coverage of a barrier-free network

Coverage helps to study catchment of residents for various amenities are within walking distance.

By switching between full and barrier-free network, the reduced coverage then identify potential gaps in barrier-free access paths for consideration.

Maintaining the Walking & Cycling Network

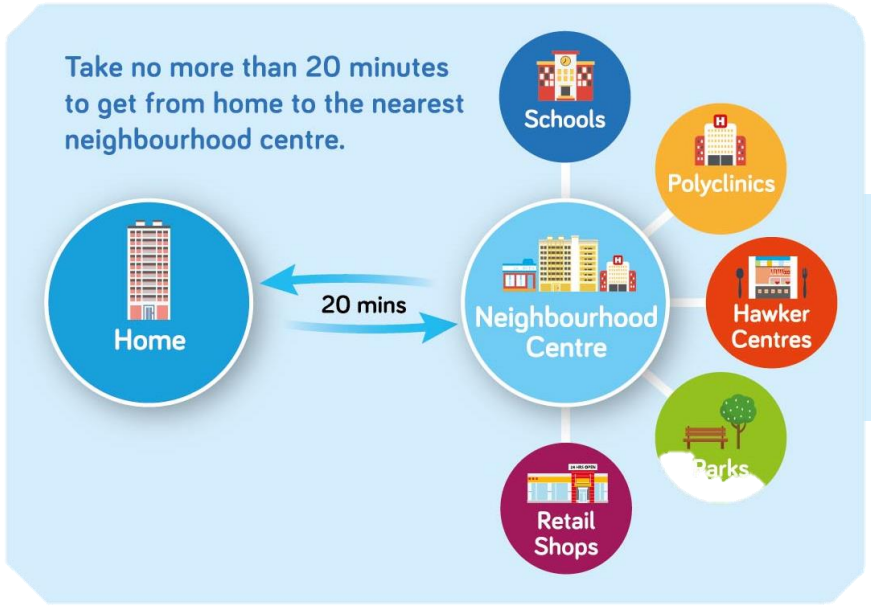


To sustain and update walking network in the long term, a group of mapping volunteers had been supporting the crowdsourcing effort to map out the data via mobile app – ArcGIS Field Maps.

Open to all to volunteer in this crowdsourcing effort! Onboarding training will be provided.

Register as mapping volunteer here!

AMENITIES PLANNING 2



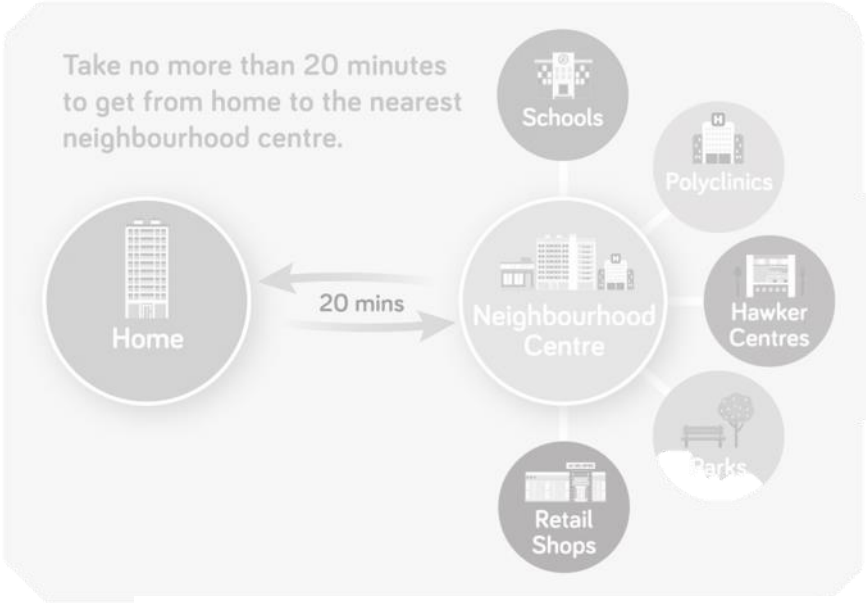
Source: LTA Land Transport Master Plan 2040

Target: 9 in 10

Plan Amenities near Home

Improving Transport Network & Services

AMENITIES PLANNING 2



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Target: 9 in 10

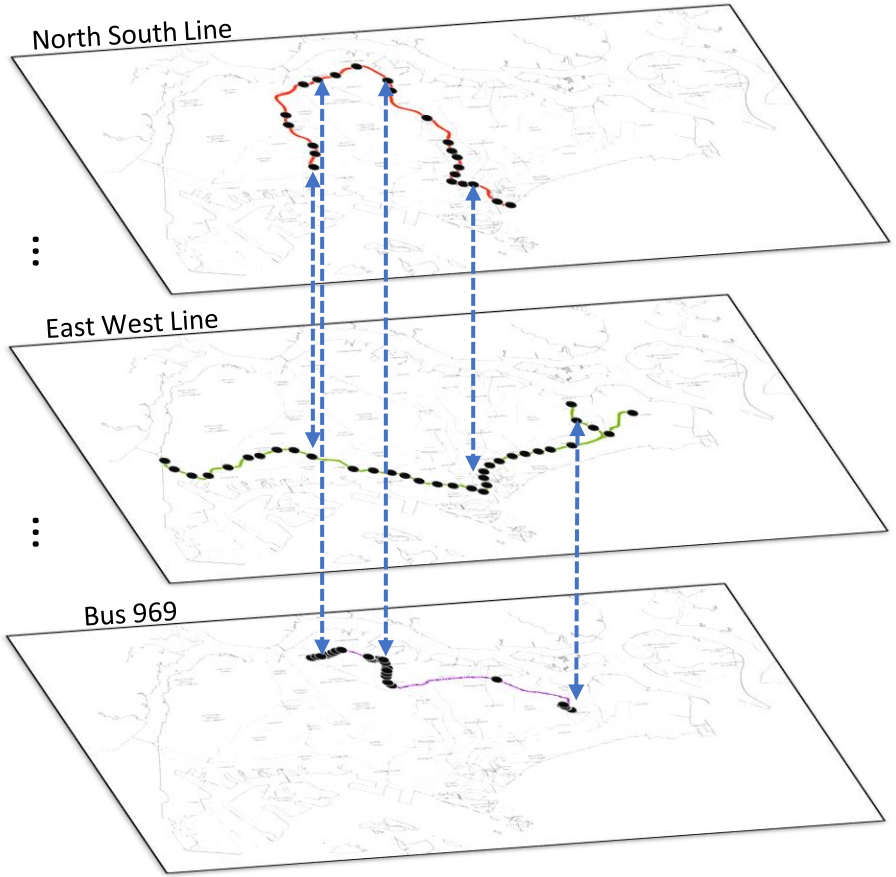
Plan Amenities near Home

Improving Transport Network & Services

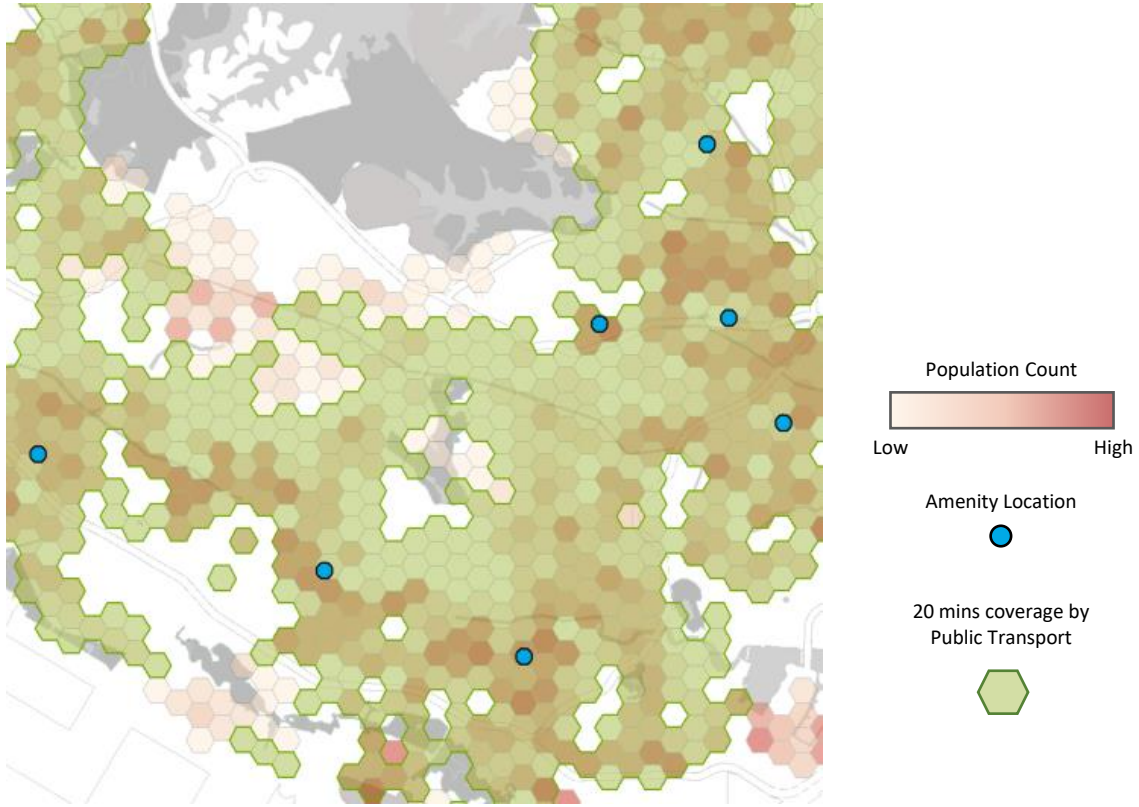
Go beyond walking network to include public transport as a combined network

Data: Public Transport Network

Create network dataset of all train, bus services and walking network

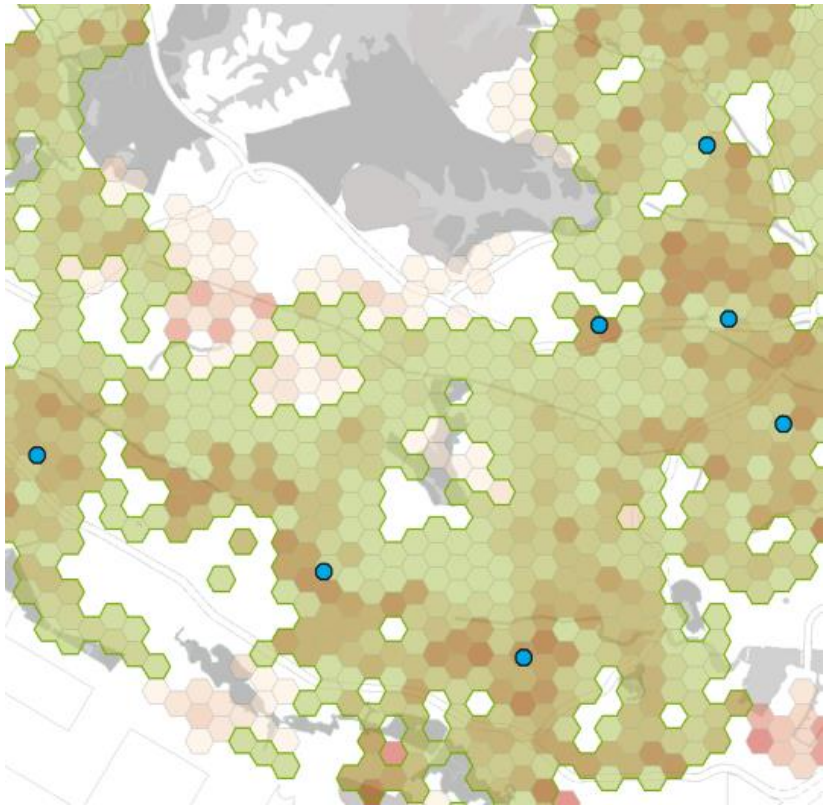


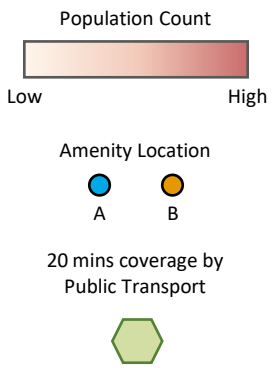
Analysing Gap & Coverage of Amenities by public transport travel time



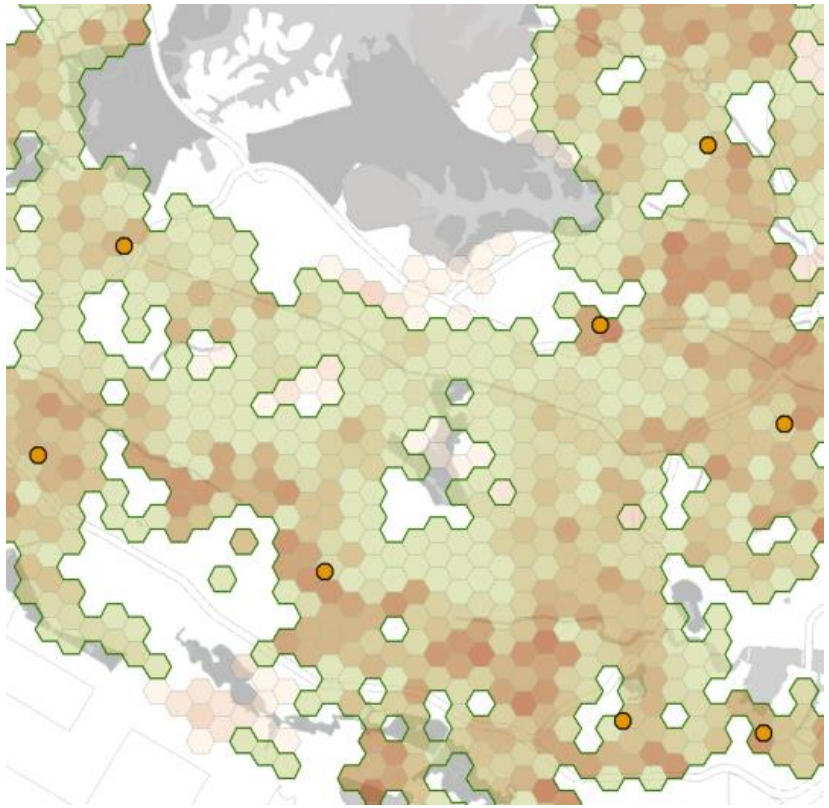
Scenario Planning and Trade-offs

Plan A





Plan B



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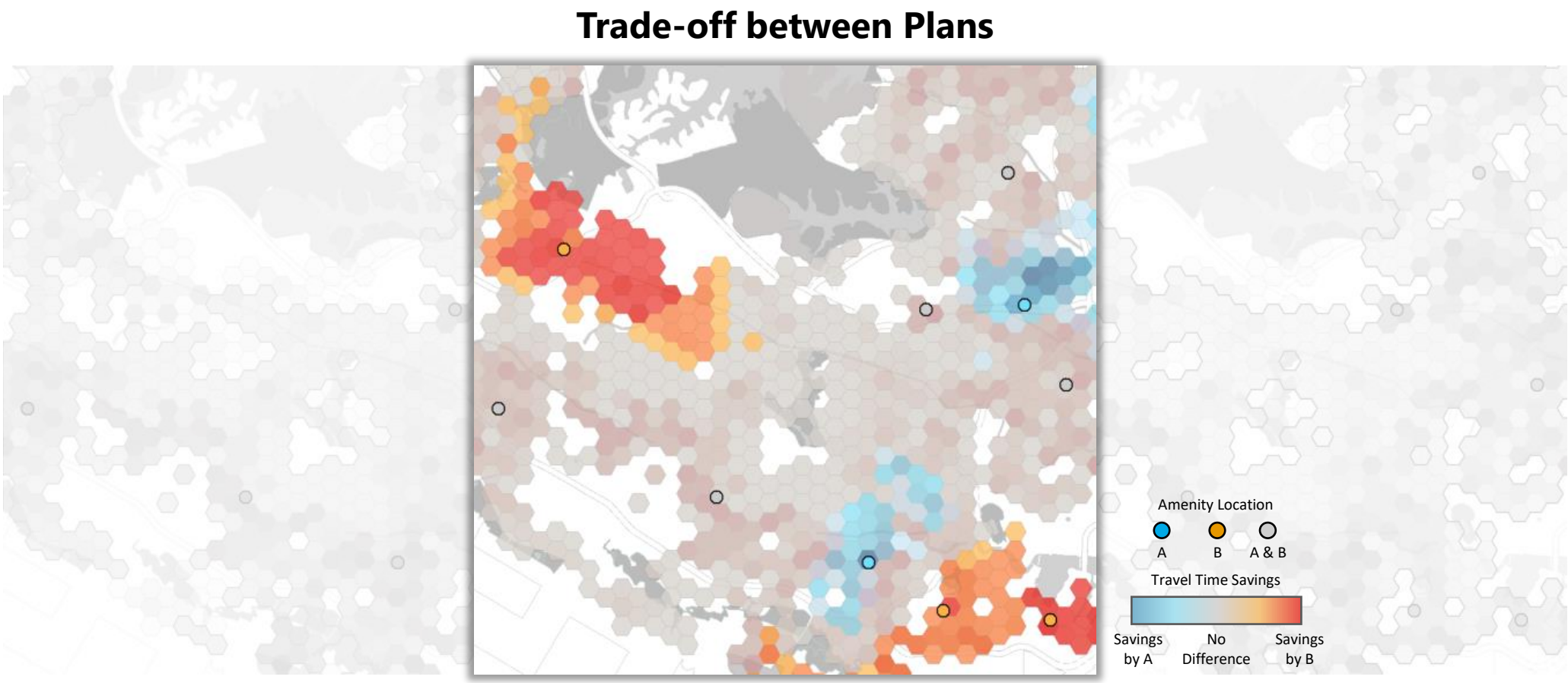
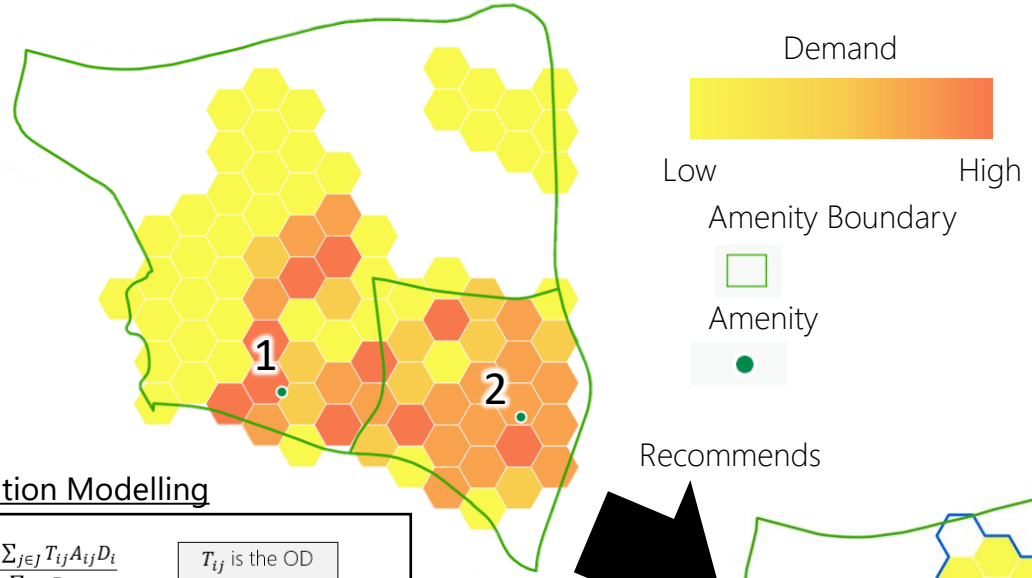
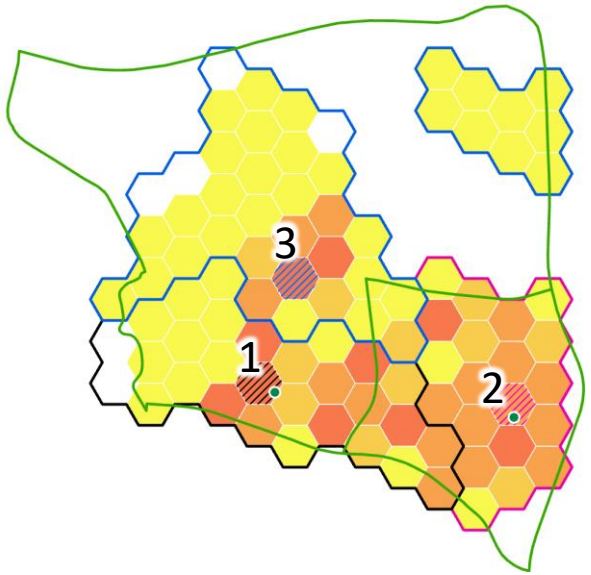


Planners can study trade-off between sites in order to right-site amenities and achieve optimal use of land

Amenities Planning coupled with Optimization Modelling



Recommends



Optimization Modelling

$$\min \frac{\sum_{i \epsilon I} \sum_{j \epsilon J} T_{ij} A_{ij} D_i}{\sum_{i \epsilon I} D_i}$$

T_{ij} is the OD cost matrix

$s.t.$

$$S_{j_1} S_{j_2} T_{j_1 j_2} \geq S_{j_1} S_{j_2} x \quad \forall j_1, j_2 \in J \text{ and } j_1 \neq j_2$$

$$S_j \sum_{i \in I} A_{ij} D_i \geq S_j L_{min} \quad \forall j \in J$$

$$\sum_{i \in I} A_{ij} D_i \leq L_{max} \quad \forall j \in J$$

$$\frac{\sum_{i \epsilon I} \sum_{j \epsilon J} T_{ij} A_{ij} D_i}{\sum_{i \epsilon I} D_i} \leq t$$

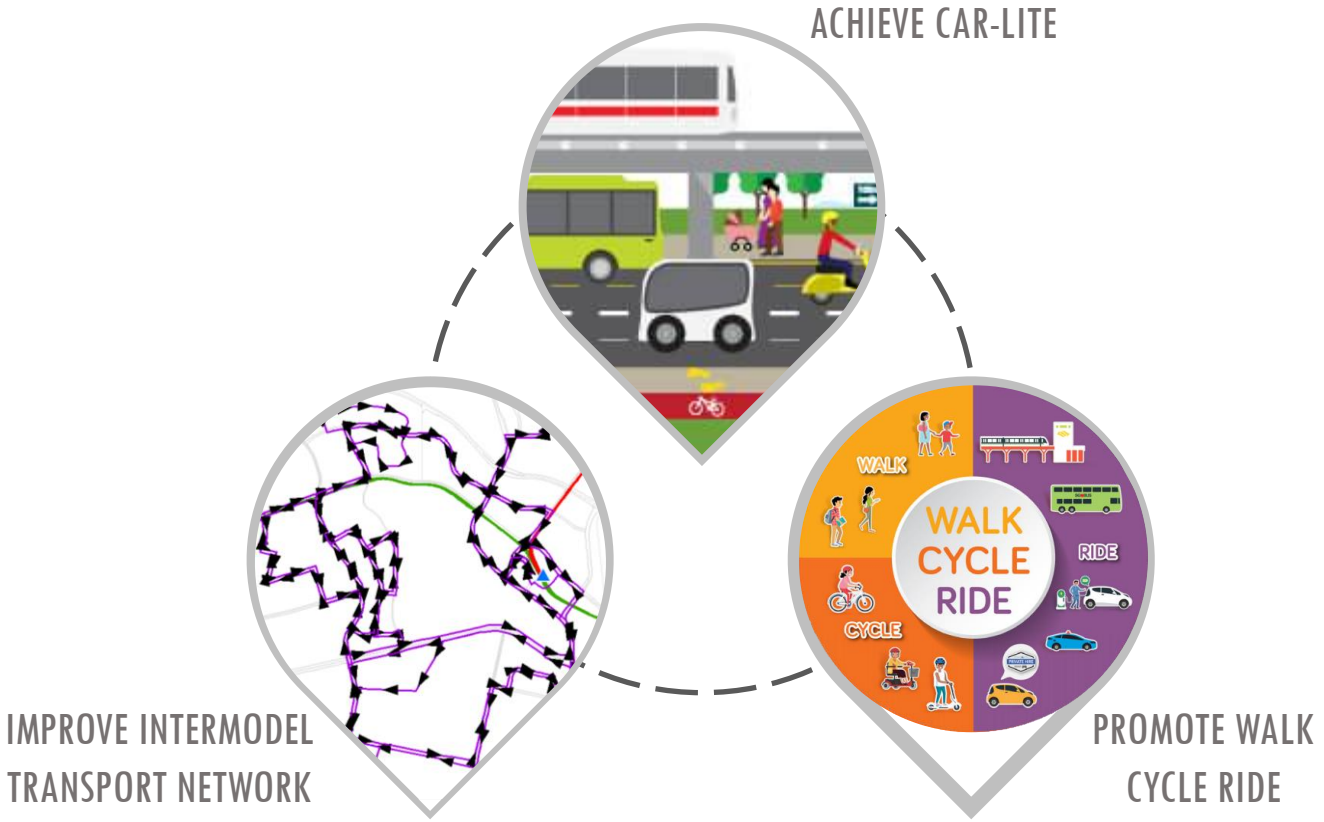
$\vdots$

Coupling with optimization modelling to create a recommendation engine to right-site, right-time and right-size amenities with objectives to

- Reduce travelling time of commuters
- Ensure balanced demand and supply at the right stage

Allow planners to have more time for qualitative assessments

3 INFRASTRUCTURE PLANNING



Source: LTA Land Transport Master Plan 2040

Sustainability: From Multimodal to Intermodal Transport Network

- Reduce congestion
- Reduce vehicular emission
- Seamless integration between modes. Eg: Walk, Cycle and Public Transport
- Improve safety and comfort of commuters

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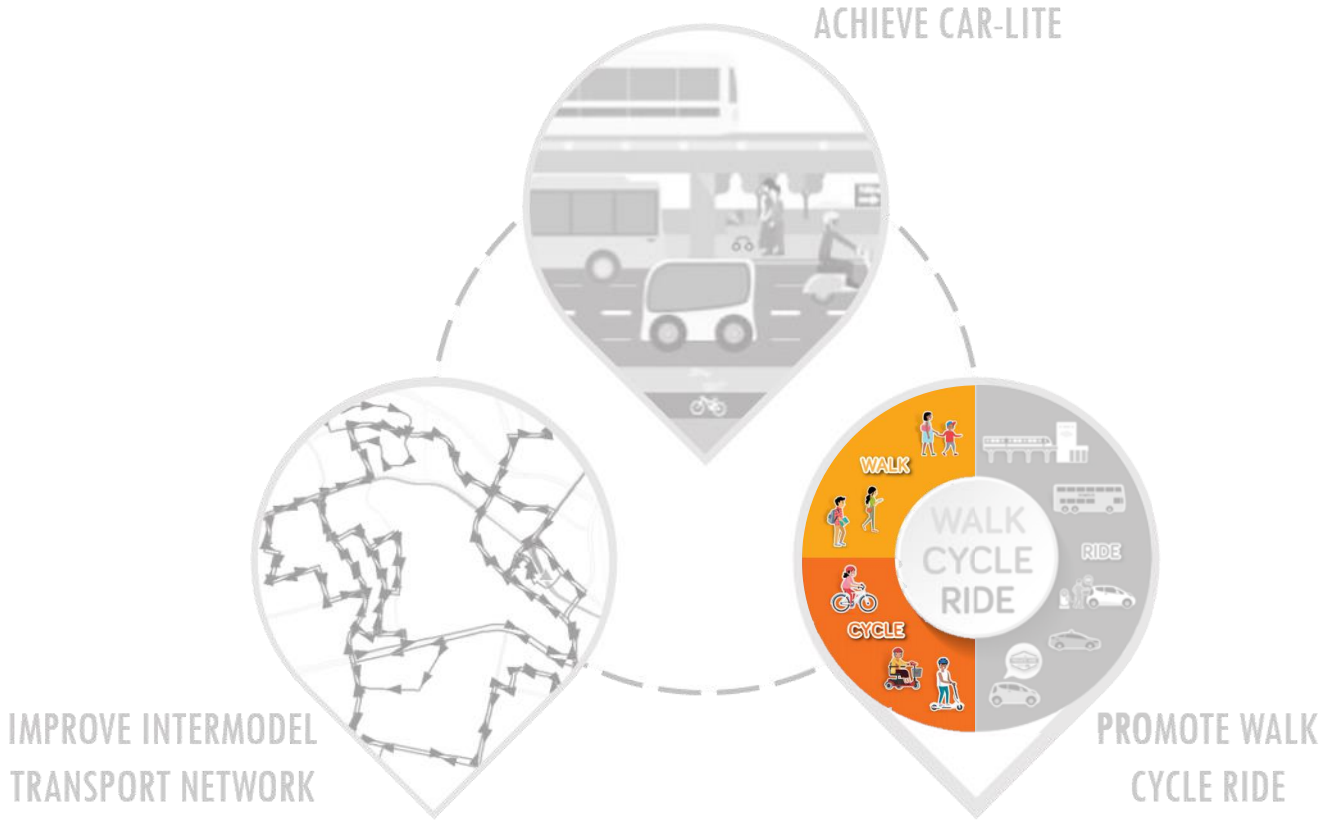

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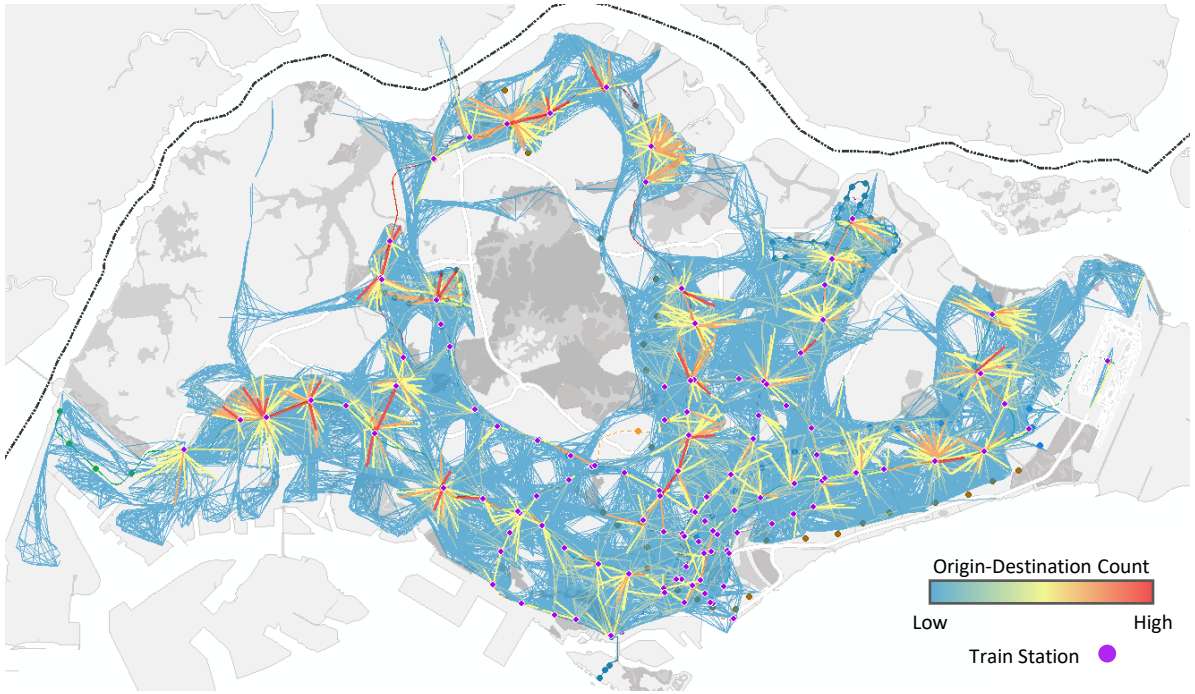
Data: Anonymised Public Transport EZ-Link Transactions



Straight Line Mapping of Public Transport OD commute ≤ 2km

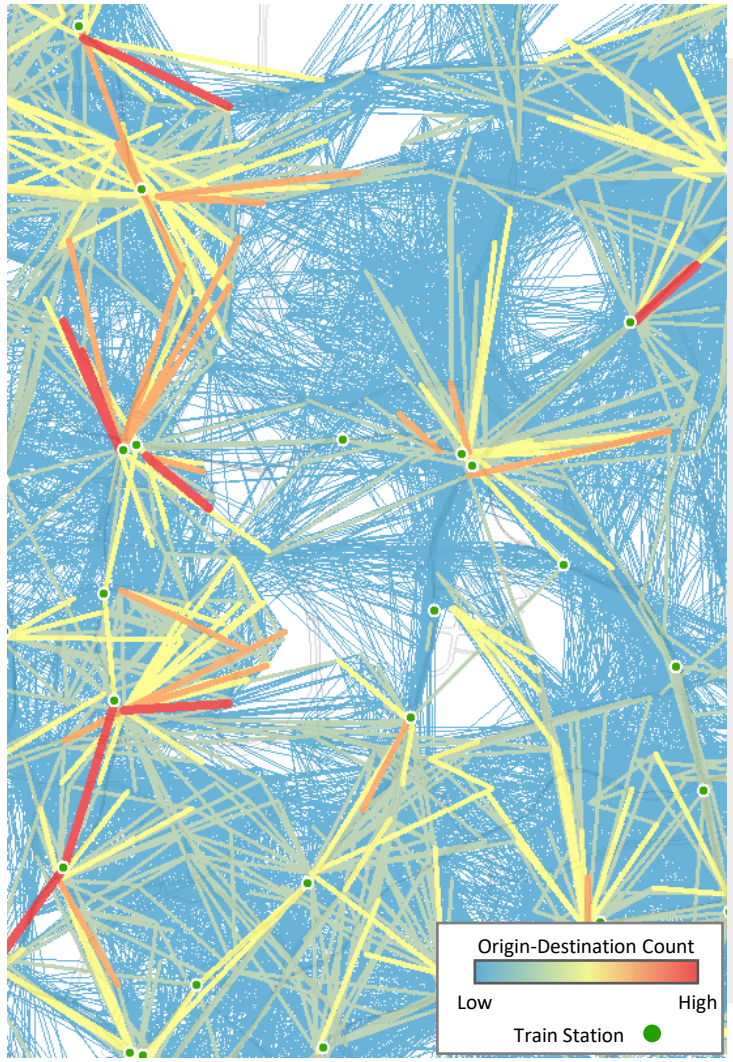
About 40% of all public transport trips are less than 2km

Cycling might be a viable alternative transport mode to support door-to-door commutes

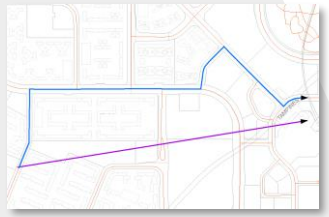
Analysing demand from EZ-Link allows us to integrate walking & cycling network with public transport network

However, it is not accurate to identify / plan for cycling paths without network data due to effect of compound demand

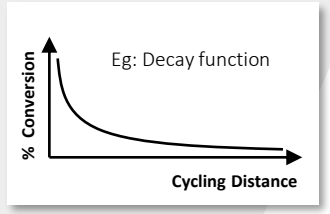
Deriving Estimated Cycling Demand with Network

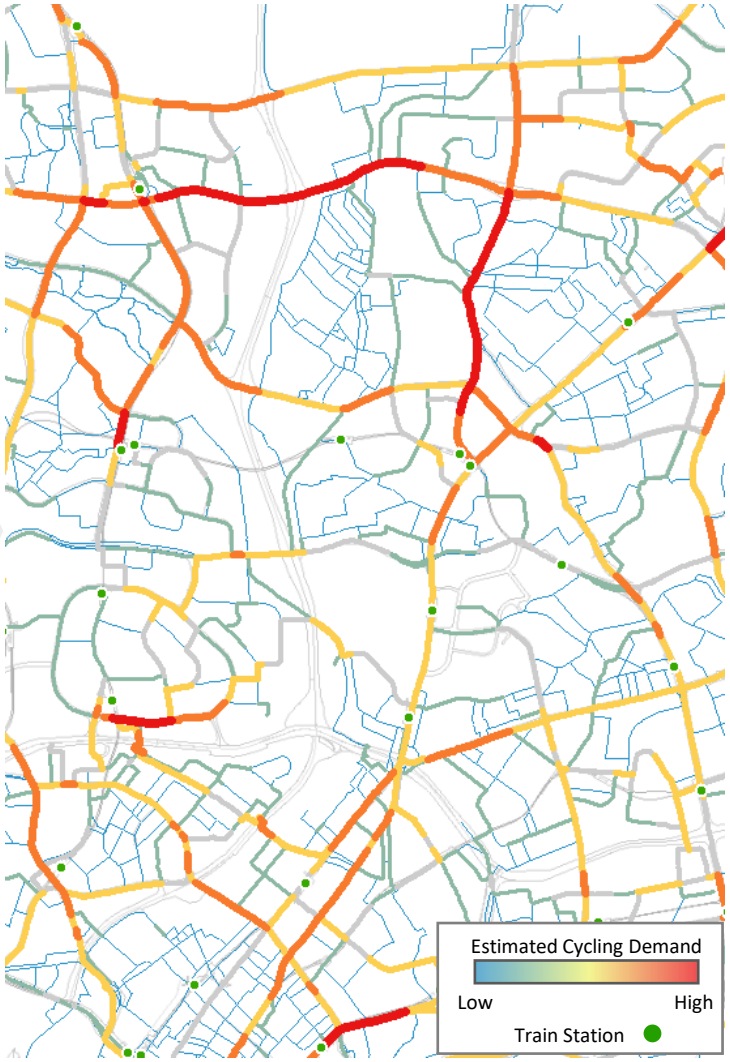


Network Analysis to find optimal cycling routes



Modelling to simulate commuters' propensity to cycle



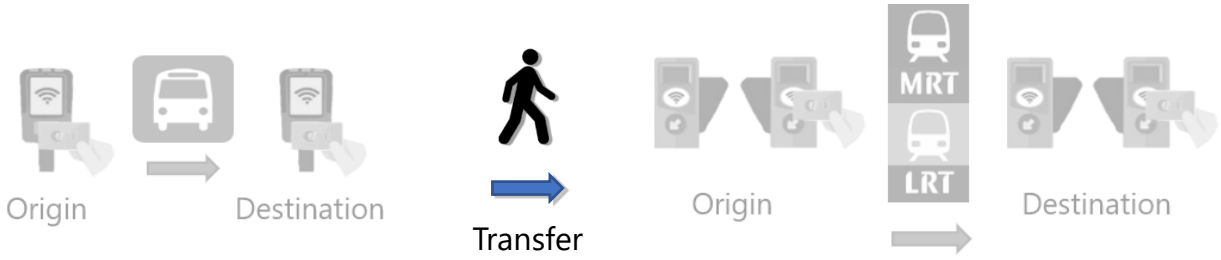


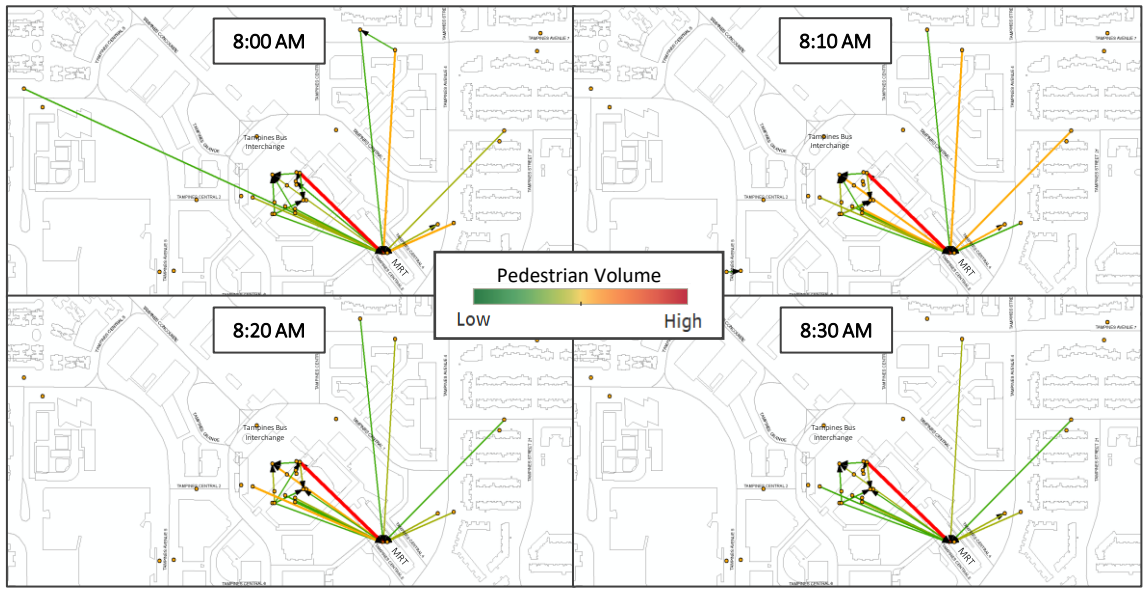
Network data allows analysis to compute compound demand for every segment of the network.

Analysis can be done on various scenarios to support planning of new cycling route or improve existing paths:

- Different commuters' preferences
- Different networks
- Intra-town vs Inter-towns demand

Data: Anonymised Public Transport EZ-Link Transactions





Mapping of public transport transfers between services around Tampines MRT station at 10 mins intervals

A by-product from EZ-Link is the transfers between services.

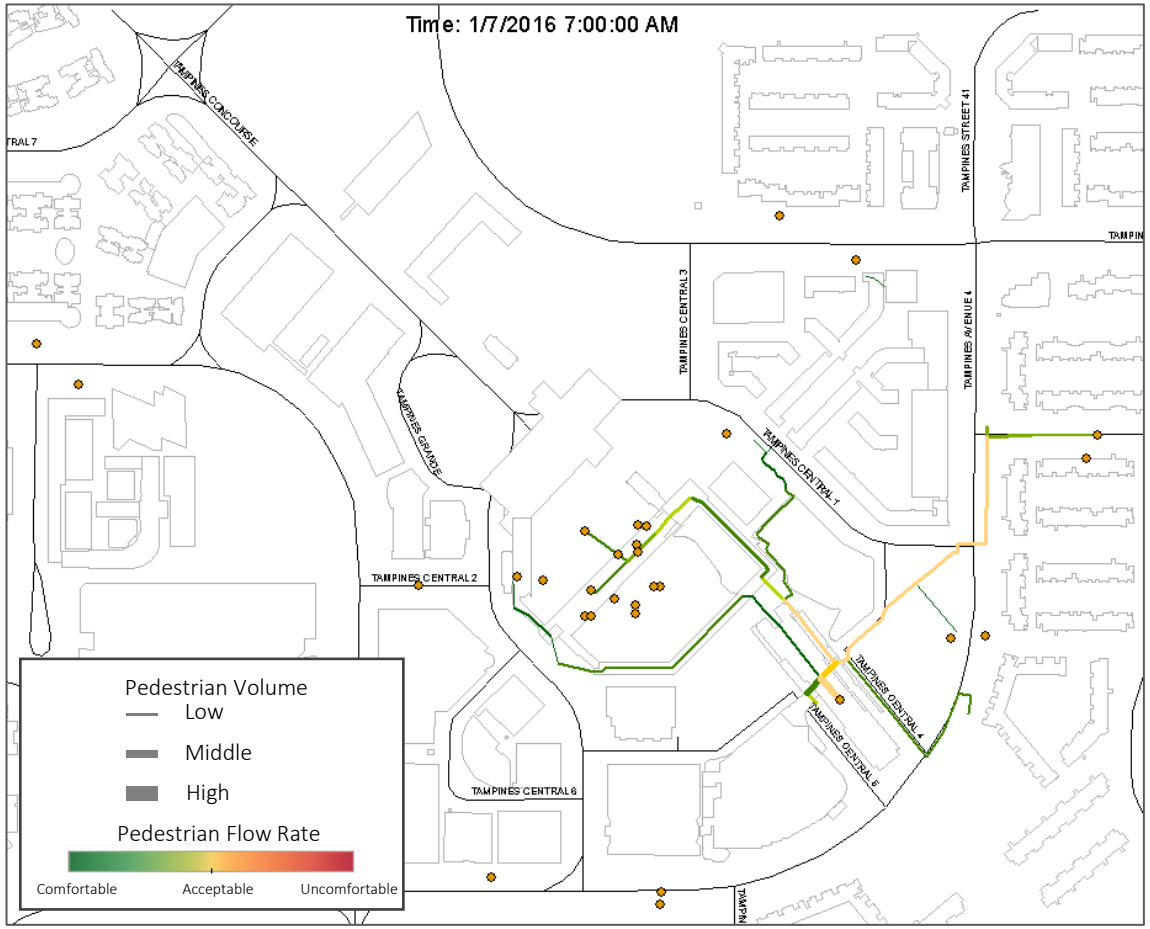
High volumes of transfers happened around major transport nodes such as train stations and bus interchanges which contributed to the heavy pedestrian volumes in the area

Network analysis can also be applied to potential walking route and calculate pedestrian density flow to plan new paths or improve existing paths

Evaluating Pedestrian Flow Rate

Data used:
EZ-Link (1st July 2016) – LTA

$$Pedestrian\ Flow\ Rate\ (ppmm) = Number\ of\ Pedestrian\ /\ Time\ /\ Footpath\ Width$$



This indicator is used by Transport for London (TfL) to assess pedestrian comfort level at different types of pathways.

Result highlighted segments which are uncomfortable based on volume of the flow and width of the paths.

Complement with ground observations, planners can then engage with stakeholders to find solutions and improve the pedestrian paths

Summary

- Network analysis enabled more granular and accurate analysis to understand how different groups of commuters could travel on the ground and pinpoint gaps to tackle.
- Coupled with modelling to improve analysis, work processes and create more time on qualitative assessment.
- Walking & cycling network dataset is the key → requires detailed and updated data to ensure accuracy.
  - **Mapping volunteers are welcomed** to support the mapping initiative!
- Extend use by sharing with public and industry for greater benefit.

Register as mapping volunteer here!


SHAPING OUR
DISTINCTIVE CITY,
TOGETHER
URBAN REDEVELOPMENT AUTHORITY
THANK YOU