

Land Use & Public Transport Accessibility Index (LUPTAI) Tool - The development and pilot application of LUPTAI for the Gold Coast

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1 Abstract

LUPTAI is a decision-aiding tool to enable local and state governments to optimise land use and transport integration. In contrast to mobility between land uses (typically via road), accessibility represents opportunity and choice to reach common land use destinations by public transport and/or walking. LUPTAI uses a GIS-based methodology to quantify and map accessibility to common land use destinations by walking and/or public transport. The tool can be applied to small or large study areas. It can be applied to the current situation in a study area or to future scenarios (such as scenarios involving changes to public transport services, public transport corridors or stations, population density or land use). The tool has been piloted on the Gold Coast and the results are encouraging. This paper outlines the GIS-based methodology and the findings related to this pilot study. The paper demonstrates benefits and possible application of LUPTAI to other urbanised local government areas in Queensland. It also discusses how this accessibility indexing approach could be developed into a decision-support tool to assist local and state government agencies in a range of transport and land-use planning activities.

2 Introduction

The Land Use & Public Transport Accessibility Index (LUPTAI) seeks to measure how easy it is to access common destinations (e.g. health, education, retail, banking and employment) by walking and/or public transport. This is in contrast to the traditional method of measuring accessibility by road distance, and is the first of its kind to consider public transport as a means of access, rather than a facility to be accessed.

The tool produces a GIS based map giving a visual representation of the opportunity to reach places by public transport and/or walking. A five colour scale shows the levels of access for any given area, highlighting areas of No, Poor, Low, Medium or High accessibility. This initial output can be weighted with population density for additional information depending on the task. Then services, land use and/or infrastructure can be iteratively adjusted before it is run again with a view to optimising accessibility.

The LUPTAI has been produced via the use of destination-based accessibility analysis in a GIS, applied to datasets obtained from a number of sources, and using information relating to the land use destinations, the road/pedestrian network, and the public transport network.

LUPTAI will assist planners and decision-makers at the state and local level to determine where to focus urban growth, how to maximise land use and transport integration, assess large scale developments, in writing policy, and prioritising funding. It will give officers the

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opportunity to visualise the impact their projects will have on achieving accessible communities.

The LUPTAI has been applied to two pilot studies within Gold Coast City to assess its practicality and effectiveness. The whole Gold Coast LGA is selected as the first pilot study to explore accessibility levels at a strategic level. A master planned case study within the Gold Coast region was selected as the second pilot area to explore accessibility levels at the finer-grained local level.

This paper provides a brief summary of current accessibility research, outlines the LUPTAI tool development, discusses the pilot application on the Gold Coast and presents key learnings.

3 Background to Accessibility

There is growing interest in the transport and planning fields in the concept of 'accessibility'. Accessibility essentially describes an individual's ability to reach desired goods, services, activities and destinations – collectively, 'opportunities' (Litman, 2003). Although a seemingly simple concept, accessibility has proven elusive to define and measure. Geurs & van Wee (2004) state that despite the important role that accessibility plays in policy making, it is often misunderstood, poorly defined and poorly measured construct. This is a reflection of the underlying complexity of accessibility as a multi-faceted concept, which can be viewed from different perspectives.

Accessibility is closely related, but not analogous to, mobility. Mobility refers to the ability of an individual or goods to move, and as such, defines transportation problems and solutions in terms of constraints on physical movement. While recognising that accessibility is the ultimate aim of mobility, the philosophy that more mobility equates to more accessibility is questionable. Taking an accessibility approach means that improved mobility (by any mode) is desired only to the extent that it furthers accessibility (Levine & Garb, 2002).

The corollary of this is that accessibility goes beyond transportation systems themselves, with roles played by land use, temporal components, and individual factors. This broadens the scope of transport planning issues, supporting a more integrated approach with land use and consideration of all access options (including non-motorised modes and mobility substitutes).

An assessment of transport from an accessibility approach could also be seen to address issues of equity and transport disadvantage. This is a desirable outcome, as a socially just transport system provides a fair distribution of transport services and equal access to employment, housing, education, health services and recreation (Transport 2007).

It is critical that consideration of accessibility becomes integral to local and state governments' planning processes. Planning for accessibility rather than mobility can create benefits by reducing travel distances, expanding options to use more sustainable modes (e.g. walking, cycling, public transport) and reducing the need to use private motor vehicles. An assessment of transport from an accessibility approach could also address issues of equity and transport disadvantage. This is a desirable outcome, as a socially just transport system provides a fair distribution of transport services and equal access to employment, housing, education, health services and recreation.

A valid and understandable tool is needed to quantify and map levels of accessibility to inform land use and transport planning processes. We need to be able to quantitatively assess how well projects and initiatives integrate land use and public transport and walking. For this reason, in 2005 QT commissioned Griffith University's Urban Research Program to develop and pilot a suitable tool. It is called the *Land Use and Public Transport Accessibility Index* (LUPTAI).

4 Current Australian Experience

The only tool available in Australia to measure accessibility is the Metro ARIA (Metropolitan Accessibility / Remoteness Index of Australia). This index was developed in Adelaide and Melbourne to quantify service accessibility within metropolitan areas. It was developed by The National Centre for Social Applications of GIS (GISCA) at the University of Adelaide. According to GISCA, it is a composite index that aims to reflect the ease or difficulty people face accessing basic services within the metropolitan area. It quantifies levels of accessibility by measuring the road distances people travel from their home to reach different types of services. It applies 5 themes (health, shopping, education, public transport, financial and postal) and component services which when combined produce the final Metro ARIA index.

Metro ARIA has been used by various government and private agencies to determine the best locations for services such as medical facilities, general practitioners (GPs), aged care centres and Centrelink offices.

A weakness with the Metro ARIA approach is that it's based on a measurement of road distance to a destination. This tends to favour road based mobility with the motor vehicle as the preferred mode of travel. The Metro ARIA analysis also conceives public transport solely as a service to be accessed, and not as a means of potential access.

5 Introducing LUPTAI

The LUPTAI tool measures accessibility by modes other than the private motor vehicle and will be more useful in determining sustainable transport/land use outcomes. It is based on a combination of indicators that best reflect the likely mode or modes chosen for travel to reach a common destination (other than the car). The LUPTAI considers walking distance, travel time by public transport and public transport service frequency etc.

The LUPTAI project applies the Metro ARIA approach in principle to achieve an integrated index. It produces a composite of layers (i.e. public transport, employment, health, shopping, education, financial & postal) that reflects the extent of interaction between an area's development patterns and transportation supply modes that can be used to identify areas with overall poor, low, medium or high accessibility.

LUPTAI's approach to trips is more realistic than other accessibility models (e.g. The Metro ARIA). It considers a trip which starts from an origin and includes all trips taken to reach a destination; walking to a public transport stop, public transport travel time, walking to a destination from a public transport stop. Another methodology advantage of the Metro ARIA is that the LUPTAI accommodates public transport frequencies. Moreover different public transport service periods (i.e. AM peak) are associated with relevant land use destinations. For example employment is measured with PT AM and PM peaks (see Figure 3), representing the times that accessibility to employment is most needed.

The LUPTAI tool is considered to be representative of the urban systems in South East Queensland, readily repeatable by others and straightforward and transparent enough to be understood by the general public. The LUPTAI is also relatively inexpensive and fast to run for a study area when compared to traditional transport models.

6 The LUPTAI Methodology

6.1 A Destination-Based Approach

The LUPTAI is an accessibility measure or more accurately a composite index of measures which seeks to measure and quantify the accessibility of a location. LUPTAI uses a series of destination-based accessibility analyses that quantifies the ease with which a destination can be reached.

The LUPTAI seeks to quantify the accessibility of locations to destinations via walking and the public transport network. LUPTAI considers walking in one of two ways: it may be either the single mode used to access a destination, or it may be the mode by which a person accesses public transport services. For the pilot, public transport was conceived as comprising scheduled bus services and rail services only. The land use destinations upon which accessibility was measured are as follows:

- Employment: Commercial zones (which represent employment opportunities);
- Health: Chemists, dentists, doctors and hospitals;
- Shopping: Major shopping centres, newsagents (used as a measure of local shopping centres);
- Financial and postal: Automated teller machines (ATMs), banks, post offices; and
- Education: Primary schools.

The LUPTAI seeks to quantify and determine the accessibility of a location by developing a composite index of measures. It uses a series of 'value measures' of accessibility for the purposes of quantification – these values primarily relate to travel distance and/or time measurements between two locations via the transport network. These measures are applied to data within a GIS, which allows for the manipulation of large quantities of spatial information necessary for such an analysis.

A destination-based approach – instead of an origin-based approach – provides significant computational advantages for the LUPTAI's series of accessibility analyses, which quantifies the ease of reaching a destination (i.e. access of the destination as opposed to access from an origin). The destination-based accessibility approach (see Figure 1) follows five logical steps:

1. Selecting public transit stops (PTS-X in Figure 1) within a specific walking distance (400m for bus stops, 800m for train stations) from each destination (e.g. hospital).
2. Selecting public transit stops (PTS-Y in Figure 1) on public transit routes that are within a given travel time (e.g. 0-20 min, 20-40 min, etc.) from public transit stops (PTS-X) within the walking distance from each destination.
3. Measuring and selecting road networks which are within a certain distance (e.g. 350m for bus stop, 750m for train stations) from these public transit stops (PTS-Y).
4. Applying a 50 metre buffer around the selected road network allows selection of the land parcels within 50 metres of the road network. This increases the measured distances from the origin to public transit stops by 50 metres. The measured maximum distances from the origin to bus stops becomes 400 metres and for train stations this becomes 800 metres.
5. Assigning an accessibility index value for the land parcels to represent these parcels' accessibility levels in regard to particular destinations (e.g. hospitals).

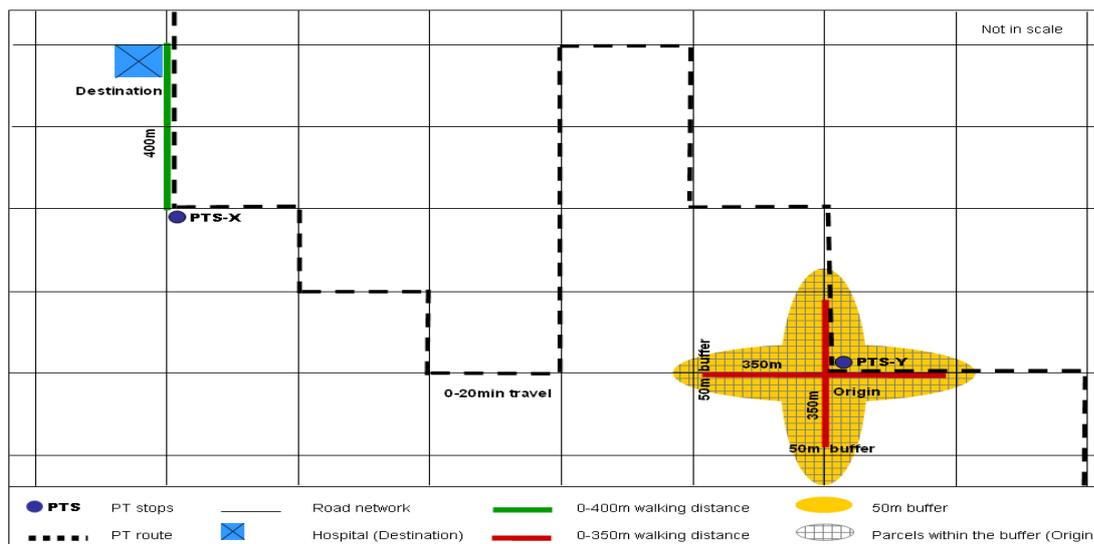


Figure 1: Schematic Description of Destination Based Approach

6.2 Accessibility Measures

In the project development phase, various criteria were used to consider different access sensitivities for each type of common destination. This led to the decision that trips to employment were to be modeled using slightly different accessibility measures than all other destinations.

The LUPTAI accessibility measures were also developed to consider and allow for diverse choice options in personal trip-making, especially in terms of walking to a public transit stop. This approach extends upon the standard walking distances to public transit are often conceived as maximum trip-lengths of 400m (approximately 5min walk) to bus stops and 800m (10min walk) to train stations (i.e. see Queensland Department of Transport 1997; 1999a).

Accessibility measures within the LUPTAI expand on the strict boundary limitations applied to walking in previous studies. This expansion improves accessibility measures in the index by allowing a degree of choice, between walking a short distance to public transport for a long trip, and walking a longer distance to public transport for a shorter trip. Walking distances to public transit have been categorised into four distance-based categories: high, medium, low and poor. Twelve hundred metres (a 15min walk) is the maximum distance (the limit to walking) applied within the health, shopping, financial and postal, and education accessibility measures. Sixteen hundred metres (20min walk) is applied as the maximum walking distance for the employment accessibility measure. Walking distances at both ends of the trip are considered in the methodology (see **Figure 1**).

A number of ways of developing more refined measures of accessibility were explored, based on enhancing existing accessibility planning models and tools, and creating a new accessibility indexing methodology. The accessibility measures developed during the pilot project are displayed in **Tables 1, 2 and 3** and comprise three sections:

- Table 1: Public transport accessibility measures (used solely for the purposes of modelling the accessibility of the public transport system, prior to analysis of accessibility to destinations);
- Table 2: Health, shopping, financial and postal, and education accessibility measures, and
- Table 3: Employment accessibility measures.

Layer	Mode	High	Medium	Low	Poor
Public Transport	Bus	Up to 300m walk & up to 10 min service freq	Up to 400m walk & up to 30 min service freq	Up to 800m walk & up to 60 min service freq	Up to 1000m walk & all running bus services
	Train	Up to 600m walk & up to 15 min service freq	Up to 800m walk & up to 30 min service freq	Up to 1000m walk & up to 60 min service freq	Up to 1200m walk & all running train services

BUS	Service Frequency (min)			
	≤10	30	60	>60
>0	H	M	L	P
100	H	M	L	P
200	H	M	L	P
300	H	M	L	P
400	M	M	L	P
500	L	L	L	P
600	L	L	L	P
700	L	L	L	P
800	L	L	L	P
900	P	P	P	P
1000	P	P	P	P
1100	N	N	N	N
1200	N	N	N	N
1300+	N	N	N	N

TRAIN	Service Frequency (min)			
	≤15	30	60	>60
>0	H	M	L	P
100	H	M	L	P
200	H	M	L	P
300	H	M	L	P
400	H	M	L	P
500	H	M	L	P
600	H	M	L	P
700	M	M	L	P
800	M	M	L	P
900	L	L	L	P
1000	L	L	L	P
1100	P	P	P	P
1200	P	P	P	P
1300+	N	N	N	N

H: High M: Medium L: Low P: Poor N: None

Table 1: Public Transport Accessibility Measures

Sub Layer	Mode	Walk to PT	High	Medium	Low	Poor	
Commercial Zone	Walking	Direct, no PT trips involved	Up to 800m	800 – 1000m	1000 – 1200m	1200 – 1600m	
		Bus	Up to 300m walk	Up to 20min travel time via PT	20 – 30min travel time via PT	30 – 50min travel time via PT	> 50min travel time via PT
	Train	300 – 400m walk	N/A	Up to 20min travel time via PT	20 – 30 min travel time via PT	30 – 50min travel time via PT	
		400 – 800m walk	N/A	N/A	Up to 20min travel time via PT	20 – 30min travel time via PT	
		800 – 1000m walk	N/A	N/A	N/A	Up to 20min travel time via PT	
		Up to 600m walk	Up to 20min travel time via PT	20 – 30min travel time via PT	30 – 50min travel time via PT	> 50min travel time via PT	
		600 – 800m walk	N/A	Up to 20min travel time via PT	20 – 30min travel time via PT	30 – 50min travel time via PT	
		800 – 1000m walk	N/A	N/A	Up to 20min travel time via PT	20 – 30min travel time via PT	
	1000 – 1200m walk	N/A	N/A	N/A	Up to 20min travel time via PT		

WALK (m)	>0	100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700+
H	H	H	H	H	H	H	H	H	M	M	L	L	P	P	P	P	P	N

BUS	Travel time via PT (min)								TRAIN	Travel time via PT (min)							
	>0	10	20	30	40	50	60	70+		>0	10	20	30	40	50	60	70+
>0	H	H	H	M	L	L	P	P	H	H	H	M	L	L	P	P	
100	H	H	H	M	L	L	P	P	H	H	H	M	L	L	P	P	
200	H	H	H	M	L	L	P	P	H	H	H	M	L	L	P	P	
300	H	H	H	M	L	L	P	P	H	H	H	M	L	L	P	P	
400	M	M	M	M	L	L	P	P	H	H	H	M	L	L	P	P	
500	L	L	L	L	L	L	P	P	H	H	H	M	L	L	P	P	
600	L	L	L	L	L	L	P	P	H	H	H	M	L	L	P	P	
700	L	L	L	L	L	L	P	P	M	M	M	M	L	L	P	P	
800	L	L	L	L	L	L	P	P	M	M	M	M	L	L	P	P	
900	P	P	P	P	P	P	P	P	L	L	L	L	L	L	P	P	
1000	P	P	P	P	P	P	P	P	L	L	L	L	L	L	P	P	
1100	N	N	N	N	N	N	N	N	P	P	P	P	P	P	P	P	
1200	N	N	N	N	N	N	N	N	P	P	P	P	P	P	P	P	
1300+	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	

Table 2: Health, shopping, financial & postal, and education Accessibility Measures

Sub Layer	Mode	Walk to PT	High	Medium	Low	Poor
Chemists Dentists Doctors Hospitals	Walking	Direct, no PT trips involved	Up to 600m	600 – 800m	800 – 1000m	1000 – 1200m
	Bus	Up to 400m walk	N/A	Up to 20min travel time via PT	20 – 40min travel time via PT	> 40min travel time via PT
Major Shopping Centres Newsagents	Train	400 – 800m walk	N/A	N/A	Up to 20min travel time via PT	20 – 40min travel time via PT
		800 – 1000m walk	N/A	N/A	N/A	Up to 20min travel time via PT
ATMs Banks Post Offices	Train	Up to 800m walk	N/A	Up to 20min travel time via PT	20 – 40min travel time via PT	> 40min travel time via PT
		800 – 1000m walk	N/A	N/A	Up to 20min travel time via PT	20 – 40min travel time via PT
		1000 – 1200m walk	N/A	N/A	N/A	Up to 20min travel time via PT
Primary Schools Secondary Schools Tertiary Education						

WALK (m)	>0	100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600+
H	H	H	H	H	H	H	M	M	L	L	P	P	P	N	N	N	N

BUS	Travel time via PT (min)								TRAIN	Travel time via PT (min)							
	>0	10	20	30	40	50	60	70+		>0	10	20	30	40	50	60	70+
>0	M	M	M	L	L	P	P	P	M	M	M	L	L	P	P	P	
100	M	M	M	L	L	P	P	P	M	M	M	L	L	P	P	P	
200	M	M	M	L	L	P	P	P	M	M	M	L	L	P	P	P	
300	M	M	M	L	L	P	P	P	M	M	M	L	L	P	P	P	
400	M	M	M	L	L	P	P	P	M	M	M	L	L	P	P	P	
500	L	L	L	L	L	P	P	P	M	M	M	L	L	P	P	P	
600	L	L	L	L	L	P	P	P	M	M	M	L	L	P	P	P	
700	L	L	L	L	L	P	P	P	M	M	M	L	L	P	P	P	
800	L	L	L	L	L	P	P	P	M	M	M	L	L	P	P	P	
900	P	P	P	P	P	P	P	P	L	L	L	L	L	L	P	P	
1000	P	P	P	P	P	P	P	P	L	L	L	L	L	L	P	P	
1100	N	N	N	N	N	N	N	N	P	P	P	P	P	P	P	P	
1200	N	N	N	N	N	N	N	N	P	P	P	P	P	P	P	P	
1300+	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	

Table 3: Employment Accessibility Measures

6.3 Methodology of application

The LUPTAI methodology consists of:

- measuring accessibility based on walking distances;
- measuring accessibility based on public transit travel time; and
- combining both accessibility measures based on walking distances and public transit travel time/service frequencies and assigning accessibility index values to each grid cell.

Figure 2 illustrates how this methodology is applied in the pilot study. First, accessibility levels to land-use destinations (e.g. primary schools) are measured using walking distances (i.e. 600, 800, 1000 and 1200m). Next, accessibility levels are measured using public transit travel times (i.e. for bus 0-20min, 20-40 and 40 plus). These two values are then merged together to form accessibility levels of the land parcels to selected land-use destinations. The label of 'none' represents areas which are not accessible via public transit and walking modes, and did not fall into poor, low, medium or high accessibility categories.

The details of the application of each measure via the computing process are in five steps, as follows:

- A network analysis is performed on the road/pedestrian network to determine the level of accessibility to the destination from other land parcels;
- The nearest public transit stop is determined by running network analysis on the road network;
- Public transport travel time analysis is conducted on the public transit network to find the locations that could be reached (the catchment area) from the destination land use for a given travel time. This identifies and selects public transport stop locations within the catchment area;
- The road/pedestrian network is selected for given walking distances from these selected public transport stops. Once the road/pedestrian network has been selected, a buffer area is drawn around this network highlighting the 'accessible' land parcels; and
- The highlighted land parcel's accessibility values are then transferred to a 50m grid that is placed across the urban area for ease of display and analysis. The grid files showing the accessibility of each 50m grid square to the destination are then available for the creation of a composite index map providing a measure of accessibility to all destinations.

6.4 LUPTAI Weightings

One of the key outputs of the LUPTAI project is a composite index that provides a measure of the level of accessibility for all the land use destinations considered within the analysis. The composite index is based on a rudimentary weighting system whereby each layer (i.e. education, health, shopping, etc.) is weighted as having equal value in terms of the influence each layer has on the overall composite index.

Each sub-layer within the index was firstly combined with one or more public transport layer(s) to add a frequency measure to each sub-layer, which can affect people's travel behaviour. The public transport layers chosen for each sub-layer were chosen based on when people would generally access each service.

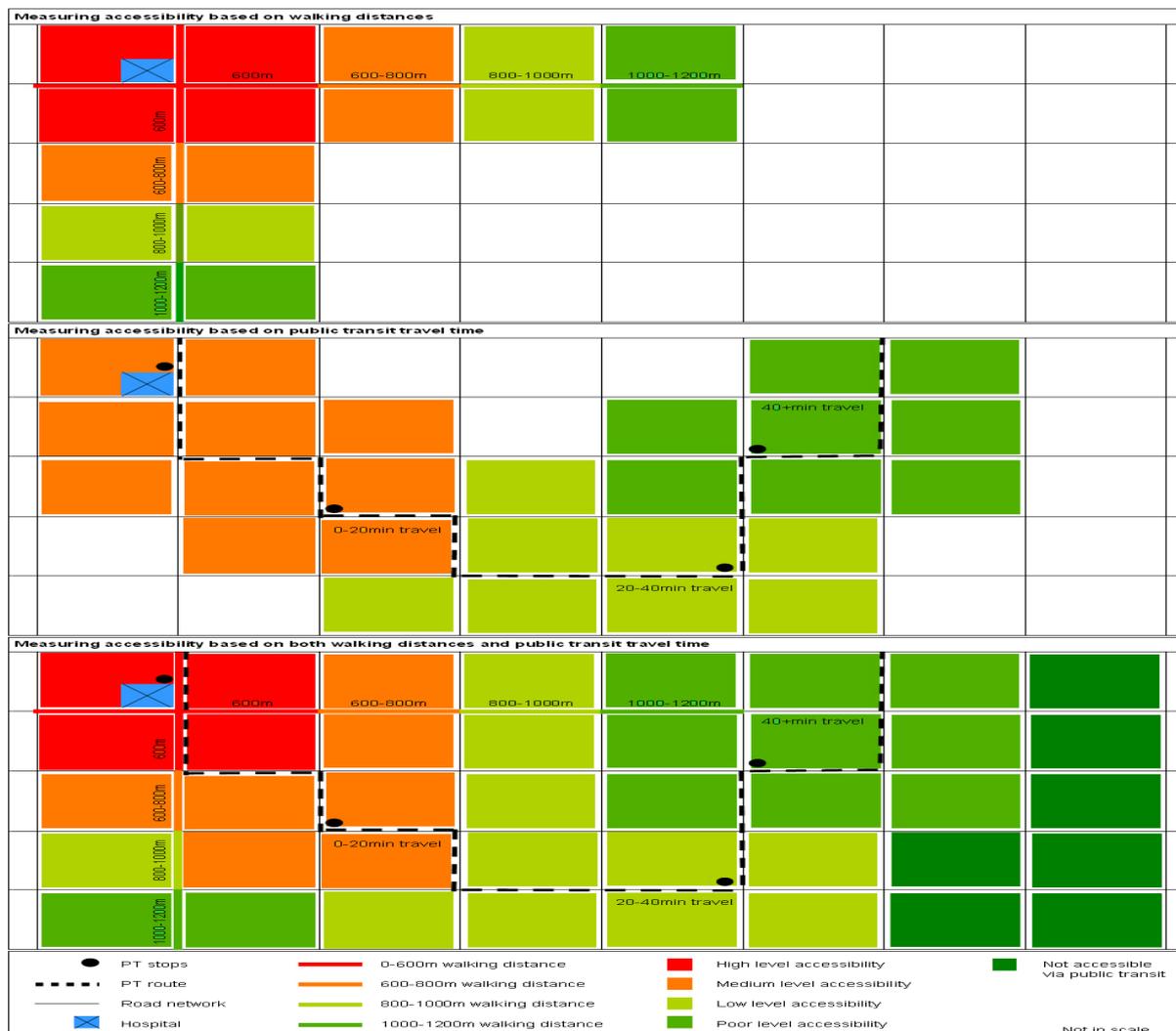


Figure 2: Schematic Description of Methodology

6.5 LUPTAI Visual Displays

The LUPTAI methodology allows measures of accessibility to be displayed both in terms of geographic accessibility, which is purely spatial, and demographic accessibility, which is spatial information weighted to population density. Population density is used in grid cells instead of population to avoid assigning population on non-residential uses such as parks and large vacant lands. Population densities (number of persons per square kilometre) are transferred from census collection districts to 50m grid cells by using the spatial analysis extension feature of the GIS software – ArcGIS.

The use of this population weighted accessibility index is intended to identify areas where there is a major imbalance of accessibility vs. population density. Areas deemed to have a comparative level of accessibility and population density should not automatically be excluded as an area where increases in population density or accessibility are not needed. This index should also be used in conjunction with the composite (non-population weighted) index to identify areas with inadequate accessibility.

This approach allows for the measurement of accessibility per capita for a given area and is also potentially useful for local government land use and transportation planning purposes. Using these two approaches the methodology produces a reasonable measure of accessibility.

7 The Gold Coast Pilot

7.1 LUPTAI and Gold Coast's LGMS

The application of LUPTAI on the Gold Coast provides a mechanism to influence the development of its Local Growth Management Strategy (LGMS) to deliver integrated transport and land use outcomes through a partnership approach between Queensland Transport and Gold Coast City Council.

This section of the paper provides a snapshot of the LUPTAI outputs and how it is assisting Gold Coast develop its LGMS within an integrated transport and land use framework.

7.2 How Accessible is the Gold Coast?

The LUPTAI composite map shown in **Figure 3** shows the current levels of accessibility for the Gold Coast urban footprint. In terms of the existing population, **Table 4** shows the population levels of accessibility to common land use destinations.

Approximately 60% of the population within the Urban Footprint has low to medium levels of accessibility. Another 39% of the population has no to poor levels of accessibility. Urban areas that benefit from high levels of accessibility account for only 1% of the population.

As discussed previously, accessibility is a product of land use as well as public transport and essentially reflects how well we are integrating the two. A key challenge for the Gold Coast City Council and relevant state agencies is to work collaboratively to achieve an increase in the levels of accessibility across the Urban Footprint for existing communities as well as future urban growth areas. The LGMS provides an important mechanism to achieve this.

Table 4: LUPTAI Composite Overall Population for Urban Footprint

LUPTAI	High	Medium	Low	Poor	None
Composite Index	0.07%	38.98%	22.73%	3.33%	34.88%
Public Transport	0.07%	24.25%	33.73%	6.79%	35.15%
Employment	24.12%	26.91%	12.51%	3.28%	33.18%
Health	0.46%	33.78%	26.80%	4.08%	34.88%
Shopping	3.93%	39.58%	18.47%	3.06%	34.96%
Financial & Postal	2.06%	35.15%	24.73%	3.23%	34.83%
Education	0.00%	35.39%	26.00%	3.61%	35.00%

7.3 Regional Plan Population and Dwelling Targets

LGMS's are required to demonstrate how LG proposes to achieve the dwelling targets and other key urban development policies set out in the SEQ Regional Plan, based on detailed local investigations.

The SEQ Regional Plan includes indicative targets for additional dwellings and an estimated resident population for the Gold Coast city up to 2026. **Table 5** is an excerpt from the SEQ Regional Plan and identifies minimum new and infill dwelling targets, for the 2004-2016, 2016-2026 projection cohorts, to accommodate the projected growth.

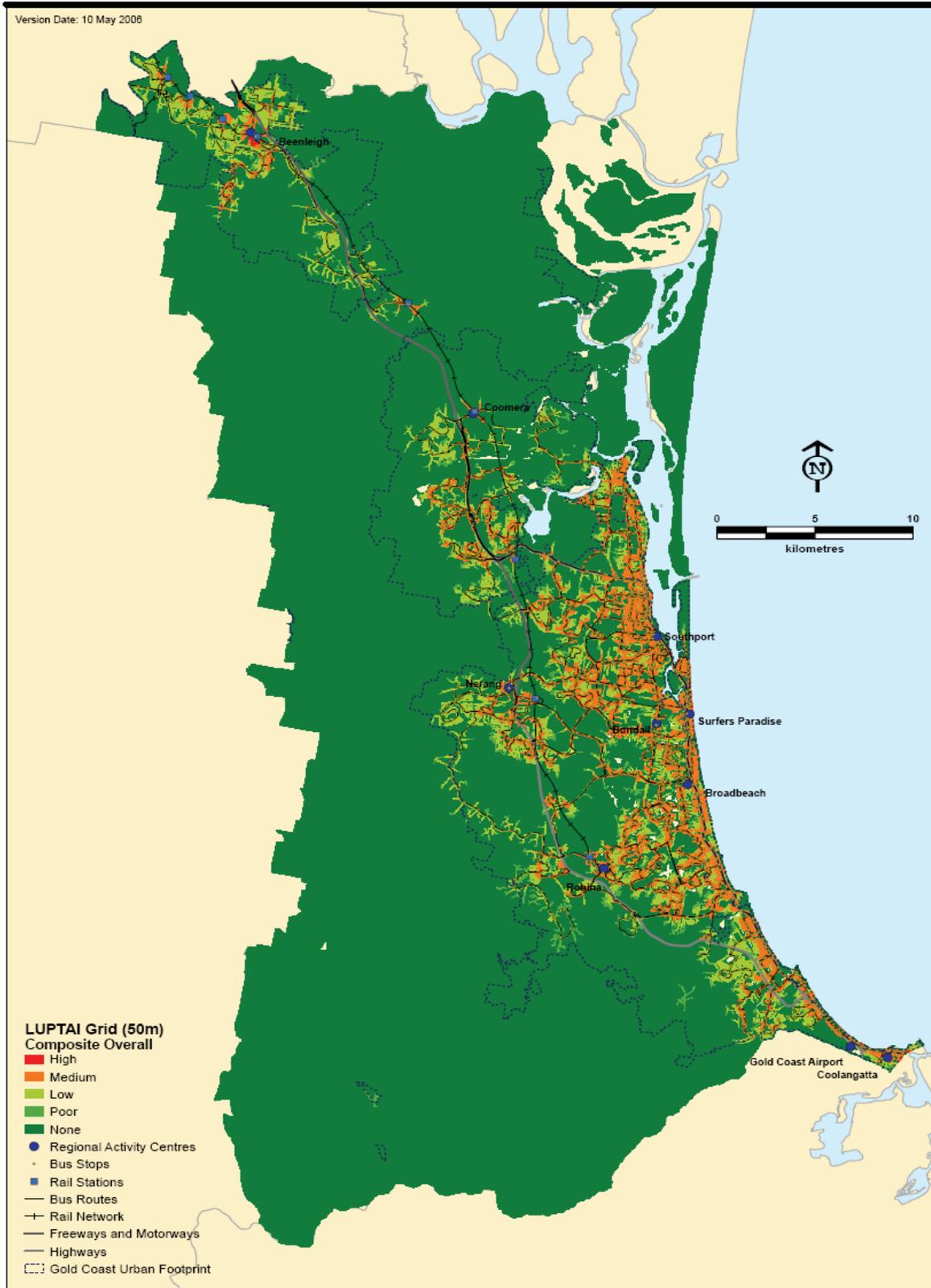


Figure 3: LUPTAI Composite Index for Gold Coast LGA

Table 5: Excerpt from SEQ Regional Plan Table 6 – Dwellings for GCCC

LGA	2001	2004-2016		2016-2026		2004-2026	
	Existing dwellings	Total new dwellings	Infill dwellings	Total new dwellings	Infill dwellings	Total new dwellings	Infill dwellings
Gold Coast City	180 900	74 000	35 000	62 500	30 000	136 500	65 000

The Regional Plan also identifies the following Regional Activity Centres for the Gold Coast, including Beenleigh; Coomera; Nerang; Southport; Bundall; Surfers Paradise; Broadbeach; Robina and Coolangatta/Tweed.

If not already, these centres will need to provide a very high level of accessibility and accommodate higher density residential uses to increase vitality and provide more convenient access to services and transit. The Regional Plan sets baseline density guidelines (refer to Table 7 of the Regional Plan) for these centres and transit oriented communities as follows:

- Activity Centre: between 30 and 120 dwellings per hectare (net) or greater
- Transit oriented community: between 30 and 80 dwellings per hectare (net) or greater.

7.4 Recommended Residential Densities

When the LUPTAI Overall Composite map is overlaid with population density values, a population-weighted index map, as shown in **Figure 4**, can be produced. The use of the population weighted accessibility index is intended to identify areas where there is a major imbalance of accessibility versus population density. The output is a three tiered coloured map that identifies areas that have good levels of accessibility but low levels of population (purple); areas that have good levels of population density but low levels of accessibility (orange); and, areas that have an appropriate mix of accessibility and density (yellow). **Table 6** LUPTAI Population Weighted provides a snapshot of Gold Coast's current population densities compared to its current levels of accessibility.

Table 6: LUPTAI Population Weighted

Population Density (Dw/Ha Net)	LUPTAI					Total
	None	Poor	Low	Medium	High	
Very Low (0 – 5)	14.76%	0.84%	2.93%	2.21%	0.07%	20.81%
Low (5 – 10)	10.94%	1.14%	6.62%	6.59%	0.00%	25.29%
Medium (10 – 15)	4.49%	0.84%	7.04%	8.85%	0.00%	21.23%
High (15 – 30)	3.77%	0.43%	5.40%	13.09%	0.00%	22.69%
Very High (30 – max)	0.92%	0.08%	0.74%	8.25%	0.00%	9.98%
Total	34.88%	3.33%	22.73%	38.98%	0.07%	100.00%

 Generally Inappropriate (explore increases in density)

 Comparative Mix of Accessibility & Density

 Generally Inappropriate (improve accessibility)

LUPTAI - Composite Overall (Population Weighted)
Gold Coast Study Area

Working Draft Only
Not Commonwealth, State
or Local Government Policy

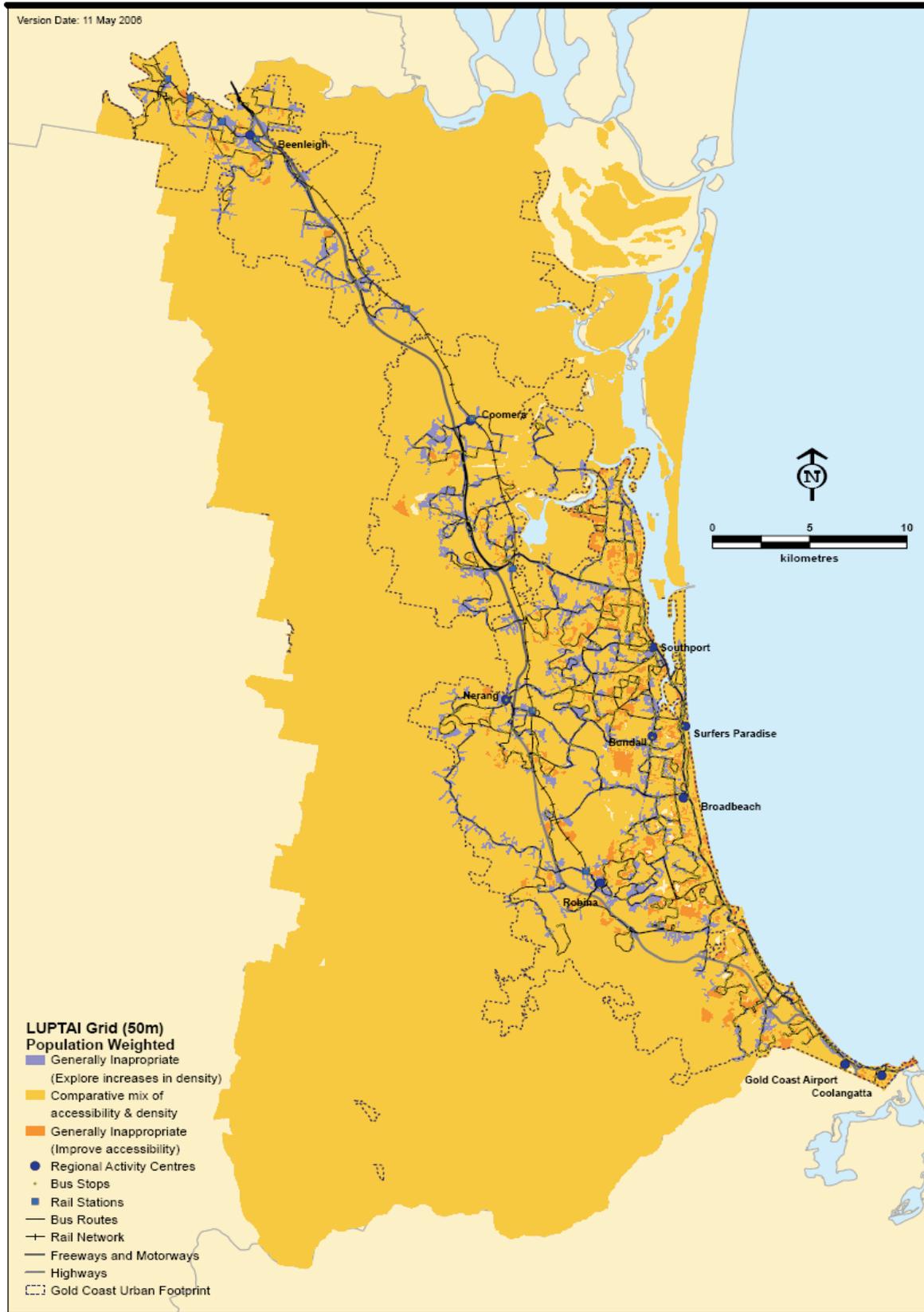


Figure 4: LUPTAI Population Weighted Index for Gold Coast LGA

To achieve an appropriate mix of density and accessibility, opportunities to increase the residential density within the purple areas of **Figure 4** could be considered, with a focus on Regional Activity Centres and Transit Oriented Communities as a priority.

There are also limited Greenfield opportunities within the urban footprint including Coomera and Reedy Creek for example. The sequencing and location of which should be aligned with the delivery of key transport infrastructure/service upgrades and extensions as outlined within SEQIPP. This can be achieved through LUPTAI scenario testing which is discussed in section 5.9.

Areas deemed to have a comparative level of accessibility and population density should not automatically be excluded as an area where increases in population density or accessibility are not needed. For example, even though there may already be high to very high levels of population density within areas of high accessibility, these areas are likely to be able to accommodate further densification. This is especially the case for Regional Activity Centres and Transit Oriented Communities.

Table 7 below identifies the recommended residential densities required to achieve an appropriate mix of density and accessibility which aligns with the intent of the Regional Plan.

Table 7: Recommended Residential Densities for LUPTAI Accessibility Levels

Accessibility Levels	Dwellings per Hectare (net)	
	Low	High
High	30	max
Medium	15	30
Low	10	15
Poor	5	10
None	0	5

7.5 Public transport infrastructure/service provision

Appropriate mix of density and accessibility can also be achieved in some areas by encouraging a better mixture of land uses, improving the level of public transport service provision and creating connected walkable street networks. These areas are highlighted in orange in Figure 6.2 and identify areas that have good levels of population density, however less than adequate levels of accessibility.

TransLink are in the process of developing its 10 year public transport network plan for the Gold Coast and LUPTAI is being considered to inform its development. Ensuring this network plan supports the LGMS process is crucial, with future investments in public transport infrastructure/services appropriately servicing urban growth to maximise accessibility.

7.6 Transit Oriented Development

Achieving Transit Oriented Development (TOD) is a key feature of the Regional Plan with TOD locations to be identified through the LGMS process. LUPTAI provides a basis for which to deliver on many of the Regional Plan's principles for TOD including:

- TOD should occur within high accessibility areas which represent locations that high levels of transit service frequency and mixture of land uses exist.
- LUPTAI establishes minimum residential densities that align with levels of accessibility in order to achieve an appropriate mix for TOD outcomes.
- Employment densification and provision within TOD sites will contribute towards increasing accessibility.

- LUPTAI is based on actual walking distances and transit travel time & frequencies to reach common land use destinations. The more integrated and connected a precinct is the more accessible it will become.
- Car parking provisional rates could be set to reflect varying levels of accessibility, thereby ensuring parking is only regulated within close proximity to common destinations and/or where alternate means of travel are available to reach those destinations.
- Urban growth is focussed where medium to high levels of accessibility can be achieved.

Based on the existing LUPTAI Overall Composite map shown in **Figure 3**, it is possible to identify potential TOD sites for infill/redevelopment that warrant closer examination. These sites have medium to high accessibility levels, comprising some or all of the common land use destinations coupled with good levels of public transport service and therefore displaying attributes of the TOD principles outlined in the Regional Plan.

By implementing transit oriented development initiatives in locations of good accessibility, areas with good land use mix can be complemented by better transport services and areas with good or planned transport services can be complemented by improved land use mix. In this way, the LUPTAI can also inform prioritisation of potential TOD projects through relative comparison of accessibility gains from different TOD sites.

GCCC are currently using LUPTAI to assist in identifying TOD/TOC sites to accommodate its proportion of the Regional Plan's infill/redevelopment targets.

7.7 Corridor Development

In addition to consolidating urban growth within Activity Centres and TOD/TOCs, there are opportunities to accommodate growth along major high frequency public transport corridors. The purple areas (where increases in density should be considered) provide a sound basis to consider possible public transport corridors that could accommodate growth and/or increased service frequencies. Future upgrades to public transport infrastructure / services outlined within SEQIPP, the TransLink Network Plan and GCCC's major transport projects need to also be considered. Similarly, corridors identified to accommodate additional growth can inform the delivery of additional public transport service improvements in the future.

7.8 Structure Planning and Master Planning

Detailed Structure Plans and Master Plans will be required for all Activity Centres / TOD sites that are expected to accommodate future urban growth.

Structure and master plans provide for detailed and coordinated forward planning for significant or large areas of new population growth or infill development within a local government area. These plans guide major changes to land use, transportation networks, built form and public spaces that together achieve economic, social and environmental objectives for the local government area or a region.

LUPTAI can add value to the planning and assessment of master planned and structure planned sites to achieve:

- integration of land uses with existing and future committed public transport infrastructure/services;
- connective street networks that promote pedestrian activity and facilitate future public transport connections;
- appropriate mixture of land uses; and
- appropriate densities to take advantage of the high levels of accessibility produced.

A case study of a Master Planned site on the Gold Coast has demonstrated that LUPTAI can be a powerful tool in informing assessment of master planned communities. The pre- and post-development accessibility levels (both population weighted and non-population weighted indices) were calculated using the LUPTAI methodology. The LUPTAI results helped to focus attention on those areas with low accessibility. The results also provided the basis for making suggested improvements to increase accessibility. Some of the most obvious improvements included:

- The creation of a bus route and associated stops through the case study area;
- Upgrading service frequency of the existing bus route in the area;
- Adding a new bus stop on an existing route;
- Constructing a new pedestrian bridge, and
- Upgrading a pedestrian bridge to a vehicular bridge.

After these suggested improvements were included in the development proposal, LUPTAI was rerun and the results showed significantly increased levels of accessibility

LUPTAI can be also used by local governments to ensure:

- Maximum accessibility for the public is maintained; and
- The road and pedestrian networks are available and reliable for all users, including public transport, pedestrians and cyclists.

7.9 Testing Possible Growth Management Strategies

One of the key benefits of LUPTAI is its ability to visualise the impact various urban growth scenarios will have on achieving accessible communities. Possible growth management strategies that accommodate the dwelling targets of the Regional Plan can be tested. Scenarios may range from a predominately transport infrastructure driven approach to managing growth, to strategies that focus on accommodating the majority of the growth targets through infill/redevelopment contained within Activity Centres and Transit Oriented Communities.

The LUPTAI methodology has the versatility to enable additional layers to be included. In the case of testing scenarios, future public transport infrastructure/service upgrades and extensions together with population projection locations are added to the base (existing) layer. The analysis is re-run and new scenario outputs are generated. This can be seen schematically in **Figure 5** below.

The LUPTAI scenario outputs can then be assessed according to how accessible each growth management strategy policy is. Effectively, LUPTAI enables local and state governments to quantitatively and relatively assess how well projects and initiatives integrate land use planning with public transport and walking.

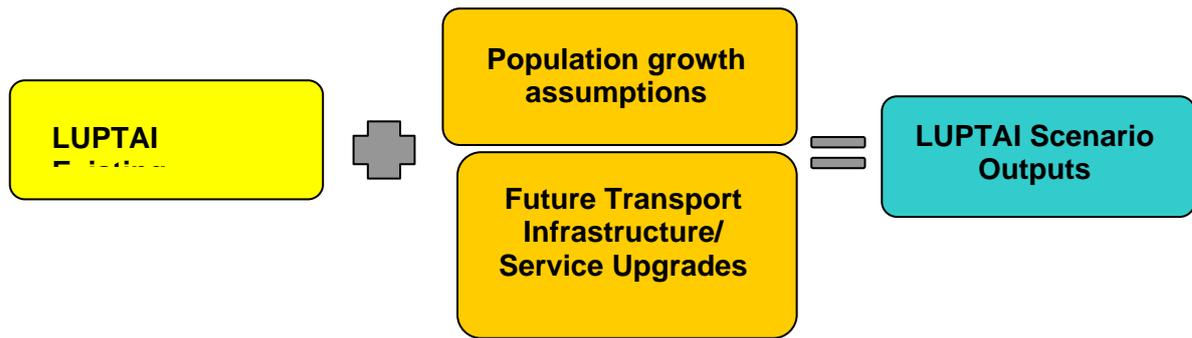


Figure 5: LUPTAI Methodology Adaptation for Scenario Testing

8 Learnings from the Gold Coast Pilot

LUPTAI is informing Gold Coast's LGMS development to achieve integrated transport and land use outcomes in the following ways:

- Highlight areas for potential transit-oriented development;
- Highlight areas with high accessibility due to public transport provision and land use mix where it would make sense to consider increasing population densities;
- Highlight areas where low accessibility exists where it would make sense to improve public transport provision and/or land use mix;
- Identify areas of social exclusion and transport disadvantage;
- Co-locate future urban growth around future major public transport investments in the Gold Coast;
- Assess the current draft Priority Infrastructure Plan (PIP) growth assumptions;
- Inform Structure Plans and Master Plans by assessing current proposals and testing alternate development outcomes to deliver more accessible communities;
- Sequence urban growth with provision of major public transport infrastructure and services; and
- Visualise and quantify the impact various growth management strategies will have on achieving accessible communities.

8.1 Transport Benefits

LUPTAI is a tool that delivers integrated transport and land use outcomes by introducing accessibility as a key planning and assessment indicator. In particular it focuses on:

- Achieving an appropriate land use mix
- Achieving an appropriate mix of density and accessibility
- Achieving an appropriate provision and level of public transport service
- Achieving connected street networks that maximise pedestrian access to common land use destinations and public transport services

The transport benefits that flow on from that include:

- Reduce the need to travel and the length of trips
- Promote social equity by providing a choice of travel options and promote sustainable choices
- Supporting active transport modes such as walking and cycling
- Utilise existing infrastructure and services (i.e. public transport, water, energy) and minimise the need for new infrastructure where possible
- Support local business and activity centres

9 Conclusions

9.1 The Innovation of LUPTAI

The LUPTAI tool is innovative and representative of the Smart State of Queensland. It is best practice in that it builds on the principles of existing accessibility indices to create a first for Australia and one of the few tools existing elsewhere.

The LUPTAI enables us to measure how well land use and public transport and/or walking are integrated. The LUPTAI quantifies and maps accessibility by walking and/or public transport and therefore is more useful in determining sustainable transport/land use outcomes. Other tools in Australia only consider the road network. The LUPTAI considers walking distance, travel time by public transport and public transport service frequency etc.

It is critical that consideration of accessibility becomes integral to local and state governments' planning processes. The LUPTAI initiative can facilitate this. Planning for accessibility rather than mobility can create benefits by reducing travel distances, expanding options to use more sustainable modes (e.g. walking, cycling, public transport) and reducing the need to use private motor vehicles. An assessment of transport from an accessibility approach could also address issues of equity and transport disadvantage. Moreover, accessibility is a technical performance indicator within Queensland Transport's (QT's) Strategic Plan and the *SEQRP* and at present it is unable to be easily quantified or measured.

The LUPTAI is considered to be representative of the urban systems in South East Queensland, able to be repeated by others without too much effort and straightforward and transparent enough to be understood by the general public. The LUPTAI is also relatively inexpensive and fast to run for a study area when compared to traditional transport models.

The Technical Working Group (comprising the Local Government Association of Queensland, the Office of Urban Management and TransLink among others) which reviewed the LUPTAI methodology development has unanimously agreed that the tool is feasible and has the potential to benefit a range of planning processes. Gold Coast City Council has been impressed by the initial pilot outcomes and has agreed to continue piloting the tool for application to its LGMS. A second pilot in partnership between Queensland Transport and Ipswich City Council, is about to begin and will assist Ipswich with its LGMS preparation and transport/land use corridor planning.

9.2 Summary

LUPTAI will provide land use and transport planners a visual quantitative tool to measure and quantify how their proposals might impact on individuals' accessibility to common land use destinations via walking and public transport. Iteratively the tool can be used to inform various planning scenarios to maximise accessibility and where necessary, trade it off against other planning objectives, such as land supply. The tool can also be used to monitor improvements in accessibility over time.

Planning for accessibility can create benefits by reducing travel distances, expanding options to use more sustainable modes (e.g. walking, cycling, public transport) and reducing the need to use private motor vehicles. The LUPTAI initiative is a best practice innovative tool that is not currently available in Australia. Its implementation will enable state and local government planners of transport and land use to quantify how their projects impact on individuals' opportunities and choice to access common destinations via public transport and/or walking. The tool can be used to inform a wide range of planning exercises from strategic land use planning to development assessment to corridor alignments to policy

making. It is relatively cost effective and fast to use and early indications are that user groups see the tool of great benefit to their work.

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