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Development of a national database for land use-based trip and parking generation surveys: Challenges and opportunities

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Abstract

Effective land use planning requires practitioners to understand the complex interplay between land use and transport systems. In this regard, Land Use-based Trip and Parking Generation (LUTPG) surveys represent a key source of information that links transport considerations within the context of land use planning. The insights derived from these surveys shed light on the local movement and parking demands likely to be generated by a specific land use development proposal. Based on this information, practitioners can proactively plan transportation infrastructure and services to adequately cater for new land uses.

Currently, a decision support tool named TRIPS (Trip Rate Information Processing System) is being developed for Australia, with the goal of providing a centralised national database for curating LUTPG surveys.

This paper provides a summary of insights gained from the background research underpinning the TRIPS project. We will first delve into the specific use cases of LUTPG data and explore the limitations inherent in the current practice. Then, within the context of the TRIPS tool, we provide a review of the key features of analogous existing systems from around the world. Finally, we outline the high-level concept for the TRIPS tool and discuss how it can substantially add value to the transport engineering and planning industry. Our findings point to a strong need for the development of national procedural guidance to enable a harmonised way of data collection and reporting by practitioners.

1 Introduction

Land use and transport planning in Australia presents unique challenges for practitioners. The current housing crisis resulting from rapid population growth in major cities, coupled with the need for environmentally sustainable solutions, demands innovative decision support systems capable of integrating transport as a key component in land use planning.

A key piece of information that links land use planning with transport at the local level is Land Use-based Trip and Parking Generation (LUTPG) survey data, which sheds light on how many trips and how much parking demand are generated by a specific land use over a typical day or a specified time interval. These observations are generally carried out via tube counts or video recordings of a site's access points. In cases where detailed multi-modal observations are required, they are carried out via manual intercept surveys with enumerators enquiring pedestrians about their immediate travel mode before entering or after leaving the site. The trip and parking rates derived from these surveys are generally published as a function of an activity unit (e.g. the number of living units, gross floor area, the number of staff present in a business, the number of students in an educational establishment, etc).

LUTPG survey data play a vital role in enabling engineers and planners to understand and quantify the trip and parking demands likely to be generated by a given land use proposal on the local transportation system. This enables proactive planning of transportation infrastructure and services to adequately cater for new land uses or land use changes (Schneider, Handy, & Shafizadeh, 2014).

Since the insights from LUTPG surveys inform significant decisions that ultimately shape our environment at both local and city levels, it is important that transportation engineering and planning practitioners have access to a robust evidence base. On this front, the following observations are noted in the current Australian practice:

1) Australia lacks a well-maintained, policy-backed evidence base for LUTPG surveys. While these surveys are carried out for various developments at the planning stage as a part of transport impact studies, they are not collected and curated in a centralised system. This represents a missed opportunity.
2) Most of the data sources currently used by practitioners to identify suitable trip and parking rates for various land uses are either outdated or are lacking in sample size. Reliance on outdated datasets with limited sample sizes can misguide planning – for instance, overprovision of road capacities or parking can lead to induced demands for more private vehicle travel, which is counterintuitive to the sustainable behavioural changes the industry is aiming for (Clifton, Currans, & Muhs, 2012; Clifton, Currans, & Muhs, 2013).
3) The currently available data sources mainly focus on vehicle trips and miss other key user groups such as pedestrians, cyclists, and the users of shared vehicles, micromobility and public transport services. Focus on the single user class of private vehicles further bolsters the car-centric view the practitioners are trying to move away from and misses encouraging more sustainable travel modes through appropriately designed facilities (De Gruyter, 2019).

To fill the above gaps, efforts are currently underway as a part of a project co-funded by iMove Cooperative Research Centre, Transport and Main Roads QLD and the University of Sydney, to develop a system referred to as TRIPS (Trip Rate Information Processing System). TRIPS seeks to facilitate evidence-based decision-making by establishing a centralised national database for curating LUTPG surveys in Australia.

As a part of the TRIPS project, a Project Reference Group (PRG) has been established with representatives from numerous state and local government authorities as well as private practitioners and academics.

This paper will present the key findings from the background research and the PRG meetings, carried out as a part of the TRIPS project. The specific objectives of this research are to:

1) Understand the broader use cases of LUTPG data.
2) Investigate the challenges and limitations in the current practices involving LUTPG data.
3) Review the key functionalities of the existing systems similar to the proposed TRIPS tool, that are available around the world.
4) Present the high-level concept for the TRIPS tool and outline the opportunities presented by the development of this system.
5) Discuss the future directions for research and industry engagement in this area.

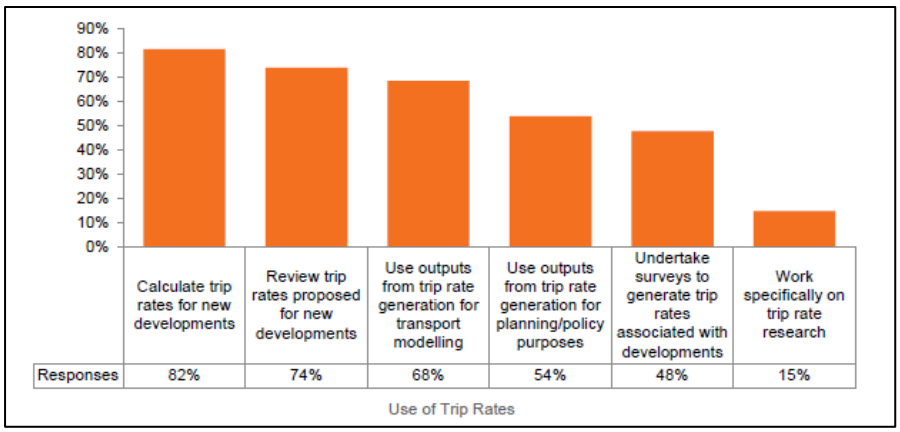
This paper is structured as follows: Section 2 provides a summary of the specific use cases for LUTPG data, Section 3 discusses the limitations and challenges in the current LUTPG-related practices, Section 4 provides a review of the existing LUTPG databases from around the world, Section 5 outlines the high-level concept for the TRIPS tool and Section 6 provides the conclusions of this study and future directions for this work.

2 Use cases of LUTPG data

A useful starting point for the ensuing discussions is to investigate the specific use cases for LUTPG data.

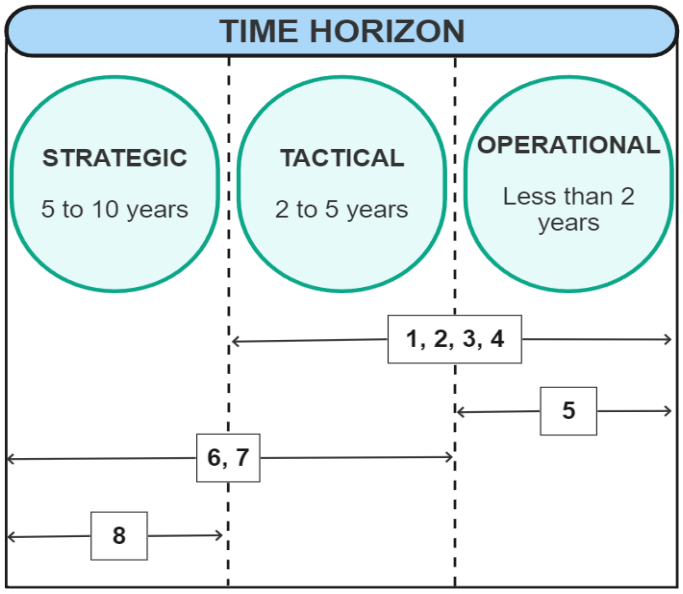
To inform the research study titled 'Trip Generation Rates for Australia and New Zealand' (Smith, Draper & Ingley, 2020), Austroads has undertaken a practitioner online survey. Among others, this survey queried the participants about the reason for using LUTPG data. This survey received responses from 130 respondents, where 60% of them were based in Australia with 39% based in New Zealand. **Figure 1** shows the summary of results from this survey.

Figure 1: Summary of survey results on the use of trip rates (Smith, Draper & Ingley, 2020)



From **Figure 1**, it is evident that LUTPG rates are most commonly used for calculating trip rates for new developments (82% of respondents). This is followed by using trip rates for: (1) reviewing trip rates proposed for new developments (74% of respondents), transport modelling (68% of respondents) and planning/policy purposes (54% of respondents). Further to the research findings by Smith, Draper & Ingley (2020), our research and discussions at the TRIPS PRG indicate that LUTPG data are currently used or could potentially be used for a myriad of purposes. **Figure 2** provides a summary of these use cases, which have been broadly categorised into 8 cases, and their respective decision time horizons.

Figure 2: Use cases for LUTPG data and their decision time horizons (numbers in the figure refer to each sub-section below)



The use cases identified in **Figure 2** are as follows:

2.1 Use case 1 - Transportation infrastructure planning

LUTPG rates are used in sub-regional and local transport models to predict the demands, inform the design, and plan the capacities of public infrastructure including roads, intersections, footpaths and cycleways. These models can assist in identifying the effects on delays and queues resulting from changes in the land use system variables.

LUTPG rates are also used to develop local area traffic management plans and to prioritise the allocation of road capacity between different users.

2.2 Use case 2 - Public Transportation (PT) service planning

Planners rely on LUTPG rates to assess the impact of new land uses on the cumulative demand experienced at bus/light rail stops and train stations. This information can then be used to optimise the services and stop locations. This is particularly relevant for Transit-Oriented Developments (TODs), where the goal is to integrate land uses with PT to reduce reliance on private vehicles (Ewing et al., 2017).

In response to the ongoing housing crisis, the NSW government has recently commenced the first stage of the TOD planning reforms with new planning controls introduced through the State Environmental Planning Policy (Housing) 2021. The amended planning controls will apply within 400 m of 37 train stations to deliver more affordable and well-located homes. Over the next 15 years, is estimated to deliver more than 170,000 new homes in mid-rise dwellings with new affordable homes, and apartment buildings that contain commercial space that adds to the amenity in convenient locations for everyday shopping and services (NSW Government, 2024).

With the intensification of the uses around the nominated 37 train stations, a key consideration for planners would be to understand and quantify the likely traffic and parking generation levels – in particular for non-car-based transport modes since vehicle trips are likely to make up only a minority of trips in these areas (De Gruyter, 2019). This would enable the practitioners and policymakers to proactively plan for sustainable transport futures in these precincts – thus, achieving more economical and practical outcomes, as opposed to reactive planning that would require retrofitting these precincts with infrastructure.

2.3 Use case 3 - Rationalising and managing parking demands

Understanding how many parking spaces are required for a given land use remains a challenging problem in transport planning. Planners rely on LUTPG rates to inform the development of parking policies, including establishing the statutory parking requirements for different land uses. Given the increasing need for transportation planners to adopt a nuanced approach to parking, considering all user groups (including cyclists, micro-mobility users, disabled users, taxi/rideshare vehicles and loading/servicing vehicles), LUTPG rates are vital for guiding the provision, design and allocation of parking facilities.

LUTPG rates are also used to assess the need for the effectiveness of parking policies and management strategies such as pricing and time restrictions. For example, within the context of the recently announced TOD scheme in Sydney, planners can use insights from LUTPG data to equitably allocate kerbside space and understand how statutory parking requirements for various land uses, including maximum parking rates, translate to vehicular trip generation.

2.4 Use case 4 - Development assessments

LUTPG rates play a key role in transport impact studies for developments. For instance, the design requirements in the Australian Standard AS 2890.1:2004 and the Austroads Guide to Traffic Management (Part 6: Intersections, Interchanges and Crossings Management), related to the provision of passing bays to manage two-way vehicular movements and access turn treatments are direct functions of the number of peak hour vehicle trips generated by the development.

Additionally, LUTPG rates are also required for other technical studies (beyond transport impact studies) associated with development planning. For instance, LUTPG rates inform environmental impact assessments by helping estimate vehicle emissions and air quality impacts associated with different land uses. LUTPG rates are also used to accurately estimate the noise impacts from the vehicular movements associated with new developments and provide suitable mitigation measures.

2.5 Use case 5 - Development contribution schemes

In some cases, LUTPG rates are used to determine equitable levels of monetary contributions by developers towards public infrastructure. For instance, in New South Wales, Section 7.11 of the Environmental Planning & Assessment Act (1979) enables consent authorities to levy developer contributions as a condition of development consent, towards the cost of providing local public infrastructure and facilities required as a consequence of a development.

In general, developer contributions are sought in situations where there is a clear nexus between the proposed development and the demonstrated demand for new or upgraded public and community infrastructure created by that development (e.g. heavy industrial developments and extraction sites). Where a contribution scheme is available for an active, local infrastructure project, developer contribution levels are usually calculated as a function of peak-hour vehicle trips likely to be generated by the development (Lake Macquarie City Council Development Contributions Plan, 2021; Section 7.11 Western Corridor Local Infrastructure Contributions Plan 2013, City of Newcastle 2020).

2.6 Use case 6 - Sustainable land use planning

Strategic planning involving zoning and land allocation decisions requires the identification of optimal land use mixes for precincts. Understanding LUTPG rates can support the planning of sustainable developments that aim to maximise intra-precinct trip containment, reduce dependency on single-occupancy vehicles and promote alternative modes of transportation.

Therefore, to achieve local decarbonisation goals, planners can consider LUTPG information for promoting energy-efficient land use patterns that minimize unnecessary travel.

2.7 Use case 7 - Transport vision development

The industry in Australia is rapidly transitioning from the traditional ‘predict and provide’ practice to the ‘vision and validate’ approach. *Vision and validate* involves setting a desired *vision* for the future and working backwards to proactively identify the required transport infrastructure and services to support this vision.

A similar approach, termed ‘decide and provide’, is used in the UK and New Zealand (Basford, 2022). In *decide and provide*, a decision is made upfront about future infrastructure and service provisions – thus enabling the transport system to determine user behaviour over time (i.e. a system-led approach), whereas the *vision and validate* approach starts with a desired vision of the future user behaviours and outcomes, and then validates whether the proposed transport interventions will achieve those targeted behaviours (G. McCabe, personal communication, August 29, 2024).

A key part of setting a vision in the *vision and validate* approach is mode shift modelling. For instance, the overarching vision may involve reducing dependency on private vehicles and increasing the uptake of sustainable transport modes to alleviate parking demand pressures. Such a vision can be benchmarked and validated by comparing the baseline projections for LUTPG with data from similar sites and their transportation infrastructure provisions.

LUTPG data, when collected at the precinct / local centre level across time, can also inform the business case development for larger transportation infrastructure projects by shedding light on the cross-elasticities of demand for substitute transport modes.

2.8 Use case 8 - Research

LUTPG data can inform a wide range of research in the areas of transportation / urban planning, transportation demand management and transportation economics. These research studies generally focus on understanding travel behaviour patterns, assessing the impact of land use changes on transportation systems, optimising transportation infrastructure, and developing sustainable urban environments. The findings of such studies can inform key decisions related to transportation / urban development projects and policy interventions aimed at improving mobility, reducing congestion, and enhancing the quality of life in urban areas (Clifton, Currans, & Muhs, 2012; Clifton, Currans, & Muhs, 2013; Schneider, Handy, & Shafizadeh, 2014; De Gruyter, 2019).

Additionally, LUTPG data can inform the planning of new businesses by revealing the impact of the location on the number of trips attracted by each transportation mode.

3 Limitations and challenges in the current practice

The current LUTPG-related practices in Australia rely extensively on the Guide to Traffic Generating Developments (the Guide) document that was published in 2002, by then Roads and Maritime Services (RMS, now Transport for NSW) and the Technical Direction with Updated traffic surveys that were published in 2013 by Transport for NSW (Smith, Draper & Ingley, 2020). These documents provide vehicular trip, and in some cases parking, rates for various land use types. The Guide (2002) is currently being updated and the draft of the new Guide is currently undergoing industry consultations before being officially released in late 2024. The detailed LUTPG survey reports that underpin the findings of the new Guide are available in the OpenGov.NSW website.

In addition to the NSW Guide, the Department of Transport and Main Road in Queensland has published land use-based traffic generation counts in the Queensland Government Open Data Portal. This dataset is presented as a spreadsheet with trip generation survey results (between 2006 to 2021) for several key land uses.

Further to the above-mentioned datasets that are publicly available, ad hoc surveys are being commissioned by transportation engineering and planning consultancy firms as part of transport impact studies for new development proposals. However, due to the lack of a centralised national database, these survey data are not being collected and curated in a single repository. This represents a missed opportunity, considering the resources spent on collecting this data and their value for future planning purposes.

In their research titled ‘Trip generation in Australia: practical issues’, Mousavi, Bunker & Lee (2012) surveyed 116 participants from the transportation engineering/planning industry. In this survey, 93 respondents (81.6%) agreed that there is an existing shortage or lack of data related to trip generation for use in transport impact studies in Australia. In the same survey, 82% of the respondents agreed that a centralised national database for LUTPG information is an appropriate solution moving forward.

Similar sentiments about the inadequacy of currently available datasets were observed by Austroads in their survey of 130 participants (Smith, Draper & Ingley, 2020). **Figure 3** shows the findings of this survey, where only 26% of the participants agreed that the current data sets are generally adequate.

Figure 3: Summary of survey results on the adequacy of the available vehicle trip rate information (Smith, Draper & Ingley, 2020)

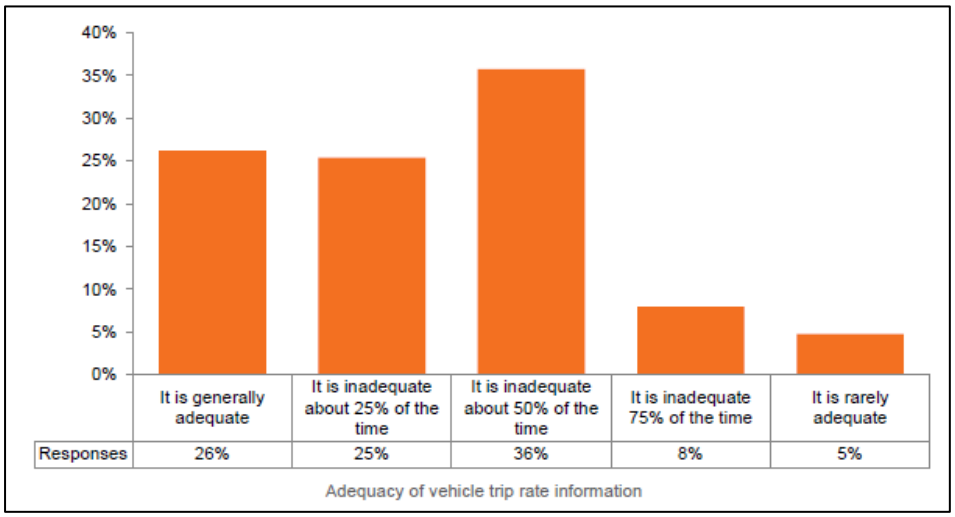


Table 1 provides a summary of limitations and challenges in current LUTPG-related practices.

Table 1: Limitations and challenges in current practice

Challenge	Description
Lack of a standard method for collecting and compiling survey data	A key limitation in the current data collection practices is the lack of a standardised method. In particular, data acquisition and reporting need to be standardised to facilitate the compilation of LUTPG data. Currently, there are large variations in the considered user classes and time scales across LUTPG surveys commissioned by different organisations. In this regard, some level of industry guidance must be published by a national body (like Austroads or NTRO) for adoption by the industry. Standard data collection and reporting practices will guarantee the quality, uniformity and – in readiness for the true AI revolution – interoperability of data (Collinge, 2015), for use beyond the single use case they are being collected for. Any new standard should strike a good balance between being prescriptive and being flexible.
Most available datasets are either outdated or lacking in sample size	Interestingly, some rates in the RMS Guide (2002) are derived from surveys that were undertaken in the 1980s and 1990s. Also, in many cases, insights are derived from limited data samples. Reliance on such outdated datasets with limited sample sizes can significantly misguide planning. The post-pandemic times we are currently living in is vastly different to the 1980s and 1990s. Therefore, using outdated datasets can lead to overprovision of road capacities or parking, which can in turn induce demands for more private vehicle travel, which is counterintuitive to sustainable behavioural changes the industry is striving towards.
Limited consideration of mixed-use developments	Current datasets predominantly focus on single land use types with no consideration of mixed-use developments. A key requirement noted by practitioners is the need to understand trip and parking generation levels from mixed-use developments and local centres/precincts (Smith, Draper & Ingley, 2020). To enable this type of survey, a sophisticated standard/questionnaire needs to be developed to find out, further to trip and parking generation rates, the level of trip containment and dwell times of those accessing the site as well as the levels of cross-purpose/passer-by trips.
Lack of multi-modal data	The currently available data sources mainly focus on vehicle trips and exclude other key user groups of the transport system such as pedestrians,

	cyclists, and the users of shared vehicles, micromobility and public transport services (Lake Macquarie City Council Development Contributions Plan, 2021; Section 7.11 Western Corridor Local Infrastructure Contributions Plan 2013, City of Newcastle 2020). Focus on the single-user class of private vehicles further bolsters the car-centric view planners are trying to move away from and misses catering for more sustainable travel modes through a mobility-as-a-whole approach. A fundamental paradigm change is needed that acknowledges the need to consistently account for multimodal trip generation by developments (De Gruyter, 2019).
Limited understanding of the development context	The current data reporting formats do not allow the users to analyse and understand how the broader geographical and socio-demographic context of a given development influences its trip/parking generation potential (Tian, Park and Ewing, 2019). For instance, the practitioners should understand how the trip/parking rates correlate with and vary in response to variables like the local residential density, car ownership rates, walkability, and the distance from public transport stops.
Lack of accountability in Travel Plans	While various large-scale developments across Australia are typically required to develop Travel Plans at the planning stage, outlining single-occupant vehicle travel reduction measures and ambitious future sustainable travel mode share targets, these targets are not monitored or validated after the completion of the development (De Gruyter et al. 2017).

It is noted that while a majority of the above-identified limitations and challenges can be overcome if a national LUTPG database is developed, some of these issues relate to process improvements (such as collecting multi-modal data and Travel Plan monitoring) that need to be implemented in practice. However, the development of a future-proofed national database is an ideal first step for facilitating these process improvements as it will prompt practitioners to transition into best practices over time.

4 Existing similar tools

The following sections provide an overview of existing centralised LUTPG databases from around the world.

4.1 TRICS UK

The Trip Rate Information Computer System (TRICS) was formed in the UK in 1989 by a consortium of seven county Councils. TRICS plays an essential role in supporting evidence-based decision-making and promoting sustainable and efficient transport systems in the UK by curating a large set of data related to trip and parking generation levels by various land uses across the country.

Figure 4 shows the user interface of TRICS.

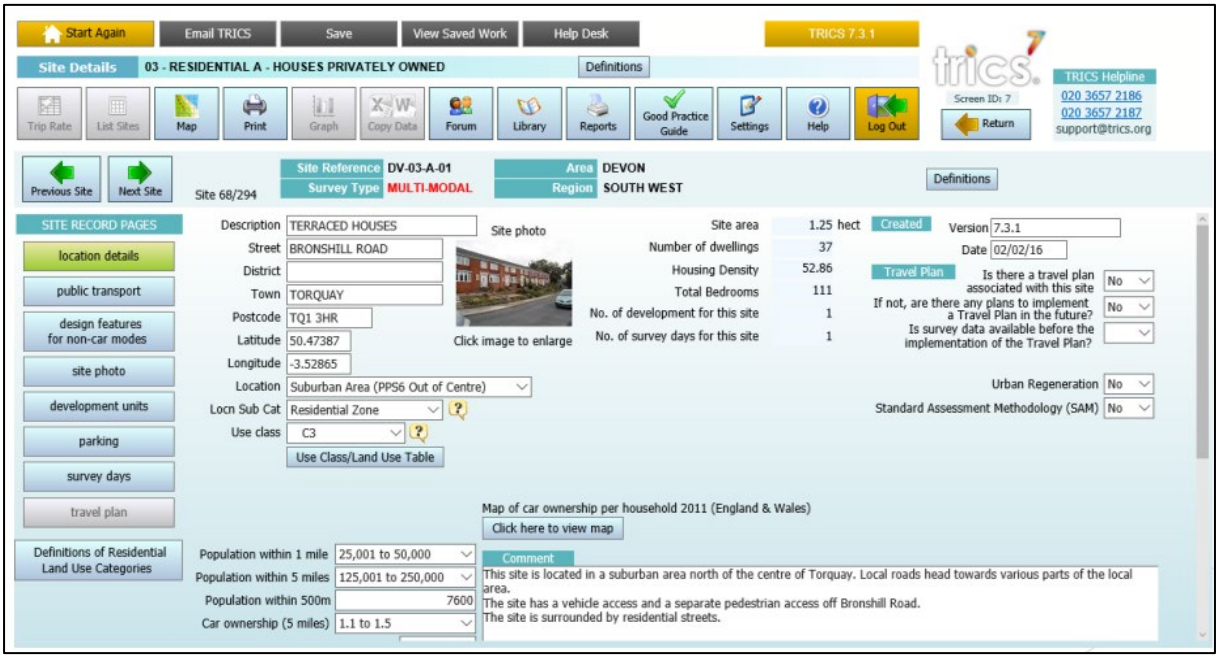
Currently, the TRICS database includes over 8,000 transport surveys. These surveys are generally carried out over a 12-hour period (7 am to 7 pm) on select days. In addition to inbound and outbound traffic and multi-modal counts, the TRICS records include descriptive details on a site's local environment and surroundings, information on the size, composition and functions of a site, and details of on-site and off-site parking facilities.

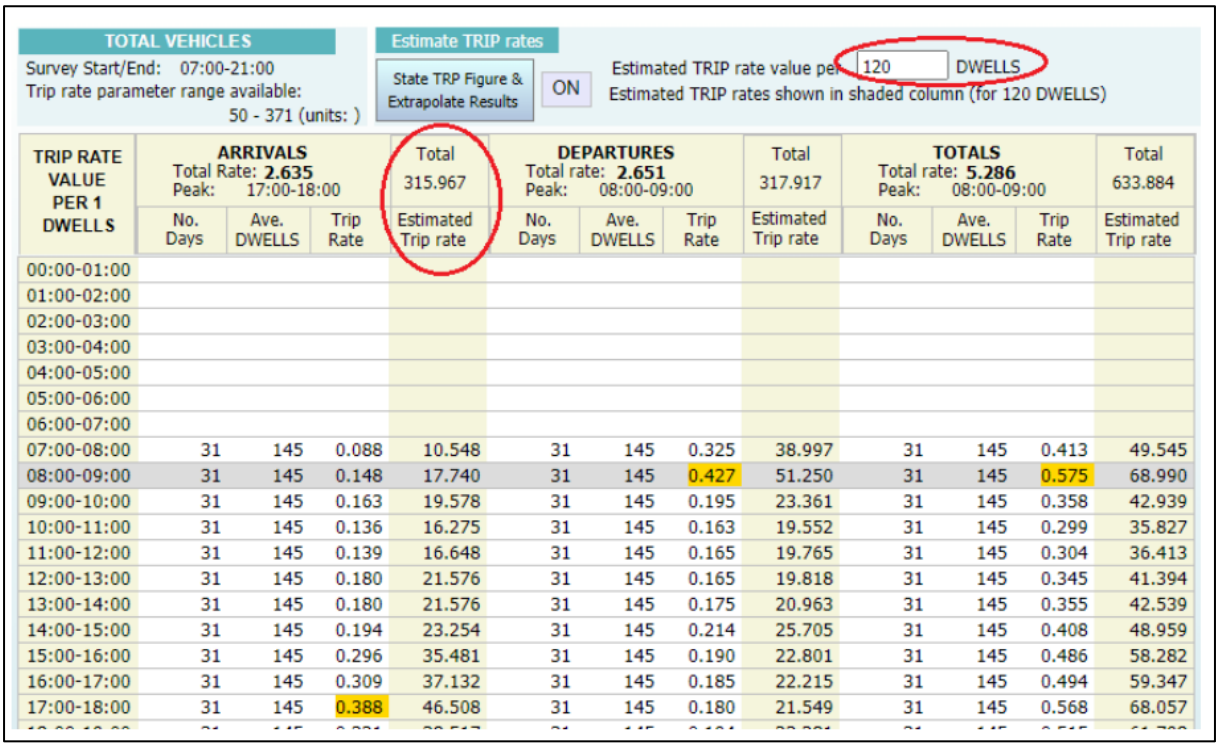
Access to TRICS is based on a subscription basis and the users can interrogate the database to access data at an individual site level or use a filtering criterion to narrow down the dataset to be representative of the land use/site they are working on. The filtering criteria include land use type (main and sub-use classes), trip rate parameter ranges (i.e. activity units such as gross floor area, number of employees, etc), parking space ranges, and location types. TRICS also provides the ability for authorities to audit the filtering criteria adopted by practitioners, thus eliminating potential biases in sample selection and increasing the efficiency of the assessment review process.

In addition to the core database function of TRICS, the TRICS organization has developed a Standardised Assessment Methodology (SAM) as a system that can enable the monitoring of travel plans through periodic multi-modal transport surveys. The survey results obtained via SAM surveys are hosted within the TRICS database.

Having evolved over some 35 years, TRICS is now an integral part of transportation planning practice in the UK and its use is recommended and encouraged by various policies and authorities including Transport for London.

Figure 4: The user interface of TRICS





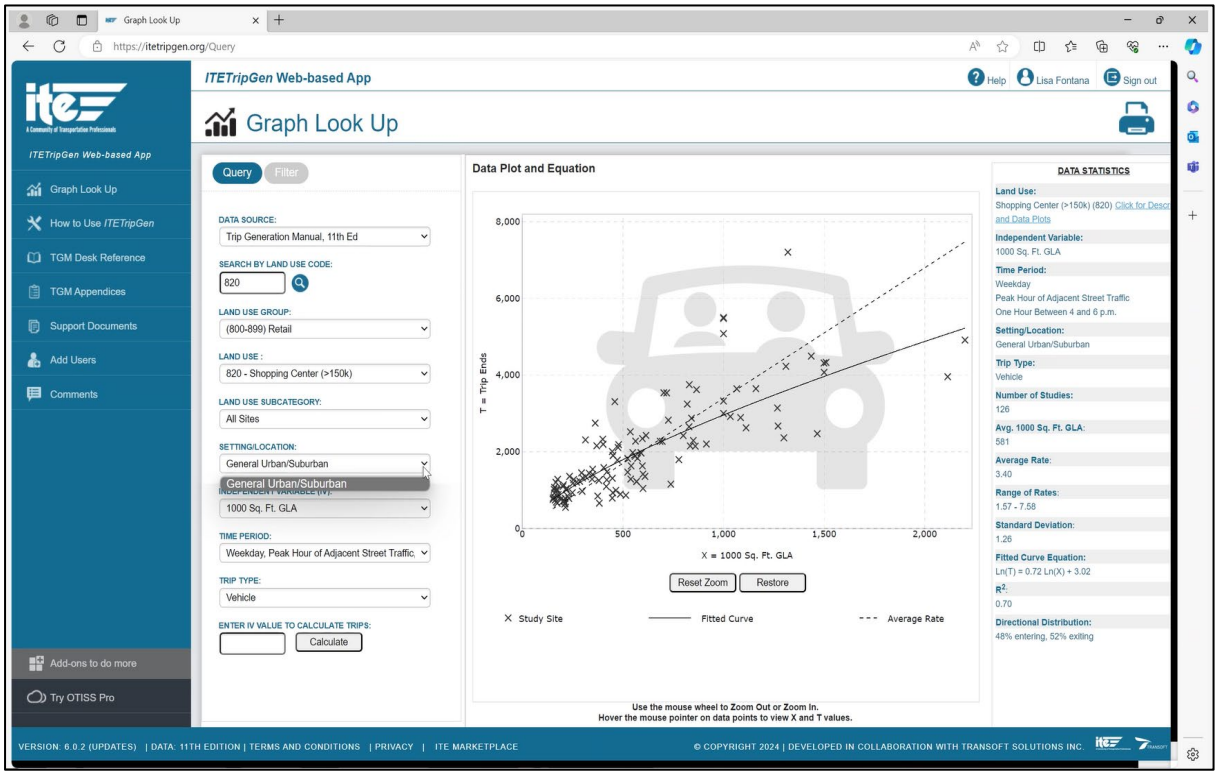
TRIP RATE VALUE PER 1 DWELLS	ARRIVALS Total Rate: 2.635 Peak: 17:00-18:00			Total 315.967	DEPARTURES Total rate: 2.651 Peak: 08:00-09:00			Total 317.917	TOTALS Total rate: 5.286 Peak: 08:00-09:00			Total 633.884
	No. Days	Ave. DWELLS	Trip Rate	Estimated Trip rate	No. Days	Ave. DWELLS	Trip Rate	Estimated Trip rate	No. Days	Ave. DWELLS	Trip Rate	Estimated Trip rate
00:00-01:00												
01:00-02:00												
02:00-03:00												
03:00-04:00												
04:00-05:00												
05:00-06:00												
06:00-07:00												
07:00-08:00	31	145	0.088	10.548	31	145	0.325	38.997	31	145	0.413	49.545
08:00-09:00	31	145	0.148	17.740	31	145	0.427	51.250	31	145	0.575	68.990
09:00-10:00	31	145	0.163	19.578	31	145	0.195	23.361	31	145	0.358	42.939
10:00-11:00	31	145	0.136	16.275	31	145	0.163	19.552	31	145	0.299	35.827
11:00-12:00	31	145	0.139	16.648	31	145	0.165	19.765	31	145	0.304	36.413
12:00-13:00	31	145	0.180	21.576	31	145	0.165	19.818	31	145	0.345	41.394
13:00-14:00	31	145	0.180	21.576	31	145	0.175	20.963	31	145	0.355	42.539
14:00-15:00	31	145	0.194	23.254	31	145	0.214	25.705	31	145	0.408	48.959
15:00-16:00	31	145	0.296	35.481	31	145	0.190	22.801	31	145	0.486	58.282
16:00-17:00	31	145	0.309	37.132	31	145	0.185	22.215	31	145	0.494	59.347
17:00-18:00	31	145	0.388	46.508	31	145	0.180	21.549	31	145	0.568	68.057

4.2 ITE TripGen and ITE ParkGen web application USA

ITE TripGen and ITE ParkGen web apps were developed in 2019 by ITE (Institute of Transportation Engineers) USA for storing trip and parking survey data, respectively. The ITE TripGen web app provides access to the 11th Edition of the ITE Trip Generation Manual while the ITE ParkGen web app provides access to the 5th Edition of the ITE Parking Generation Manual. Both these apps operate on a subscription basis.

Figure 5 illustrates the user interface of the ITE TripGen web app.

Figure 5: The user interface of the ITE TripGen web app



The ITE TripGen app allows users to estimate the number of motor vehicle, pedestrian, transit user, bicyclist, and truck trips, generated by a land use based on its characteristics and setting. The app offers functionality to filter data records by their land use class, age, region and development size. The results are displayed as averages of aggregate data with no site-level data available for interrogation by the users.

Unlike the TRICS UK system, the ITE web app does not have a travel planning component. New data are continually fed into this database through ITE-commissioned surveys or voluntarily submitted survey datasets from various practitioners.

4.3 TDB New Zealand

In 2002, the Trips Database Bureau (TDB) was formed in New Zealand to maintain and share a database of parking and trip surveys. The TDB uses the front end of the TRICS platform from the UK for curating the survey data from NZ as well as some data from NSW in Australia. Users can access this data through a paid subscription. The subscription funds are used by TDB to conduct new surveys.

Since TDB NZ uses the TRICS UK database system, it faces some issues that relate to the incompatibility of context, scale and maturity between the two systems. For instance, some subcategorises of land uses in the TRICS system are based on the planning framework in the

UK and are not representative of New Zealand. Also, the TRICS system has rigorous quality standards in relation to data collection and validation. Trip and parking generation surveys are expected to follow survey datasheets that require 12-hour-long multi-modal surveys. These datasheets are therefore not being used in surveys in New Zealand due to their impracticality.

While TRICS is backed by legislation in the UK and is a well-established tool in transport planning, this is not the case in New Zealand. As such, this system remains underutilised in New Zealand. This is evident by the results of the practitioner surveys carried out by Austroads (Smith, Draper & Ingley, 2020) – where out of 192 respondents, only 56 (29%) were aware of the TDB tool.

4.4 Ver_Bau Germany

The Ver_Bau program is a tool that was developed in Germany. It is also commonly used in Austria, Liechtenstein and Switzerland, with occasional use by other European countries such as France, Luxembourg, the Netherlands, Poland, the Czech Republic, Italy, and Iceland (De Gruyter, 2019).

Ver_Bau enables its users to estimate the traffic generated (by all modes of transport) by various land use proposals. The users can input various activity units (such as floor areas, residential units etc) for a specific land use to obtain outputs that provide indirect evidence in relation to trip and parking generation. The estimate is a single value or the bandwidth (minimum and maximum) of the daily number of total trips by each mode. The methodology used by Ver_Bau for estimating trips was first developed by the Hessian Road and Traffic Administration in 1998 and revised in 2007. Ver_Bau calculates trip estimates using Excel tables, which are stored with formulas. The relevant empirical values including commentary are available via hyperlinks to Word files (Bosserhoff, 2020).

Figure 6 shows the user interface of Ver-Bau, where users enter inputs into the grey-highlighted cells and obtain outputs from the unhighlighted cells.

Figure 6: The user interface of the Ver-Bau tool

Example: Estimation of the area-related resident traffic in residential use

Gebiet	Nutzung	Einwohner		Wege/ Einwohner/d		Wege/Werktag insgesamt		Anteil der Einw.wege außerhalb des Gebiets	Wege/Werktag gebietsbezogen		MIV-Anteil Einwohner		Pkw-Fahrten/d Einwohner	
				Wege/EW/d							in %		1,2 Pers./Pkw	
		Min	Max	Min	Max	Min	Max	in %	Min	Max	Min	Max	Min	Max
WR	EFH-B	225	350	3,5	3,5	788	1.225	15	669	1.041	80	90	446	781
								0						
								0						
								0						
WA	Misch-B.	800	1.125	3,5	3,5	2.800	3.938	10	2.520	3.544	60	70	1.260	2.067
Summe		1.025	1.475			3.588	5.163		3.189	4.585			1.706	2.848

The Ver_Bau program was acquired by BBW Software in early 2024. BBW Software is currently developing a web-based app to host the currently Excel-based Ver_Bau tool.

5 The TRIPS tool

The overall vision of the TRIPS project is to create a centralised database for curating LUTPG surveys, to facilitate the transition of transportation planning from a ‘vehicle-centric’ towards a 'mobility as a whole' approach.

The TRIPS platform will include three sub-systems, as follows:

1) The database - to facilitate the storage and convenient extraction of LUTPG survey data with the focus extending beyond private vehicle trips into all user classes including pedestrians, cyclists and shared vehicle, micromobility and public transport users.

2) Analysis and visualisation platform – to enable the users of the database to combine, analyse and visualise the LUTPG survey data, and explore their relationships and interdependencies with socio-economic and geographic variables.
3) Travel planning tool – to enable monitoring and validation of Travel Plans through a standardised data collection and storage procedure that enables assessment of travel mode share changes over time.

The above three sub-systems sequentially enable the users to first quantify the level of trip and parking demands generated by a given land use type (the database), then predict these for a specific site (the analysis and visualisation platform) and ultimately control (to a certain extent) the levels of trips and parking demands realised (through the travel planning tool).

Figure 7 visually illustrates how the above three sub-systems will function together in TRIPS.

Figure 7: Framework of the TRIPS tool

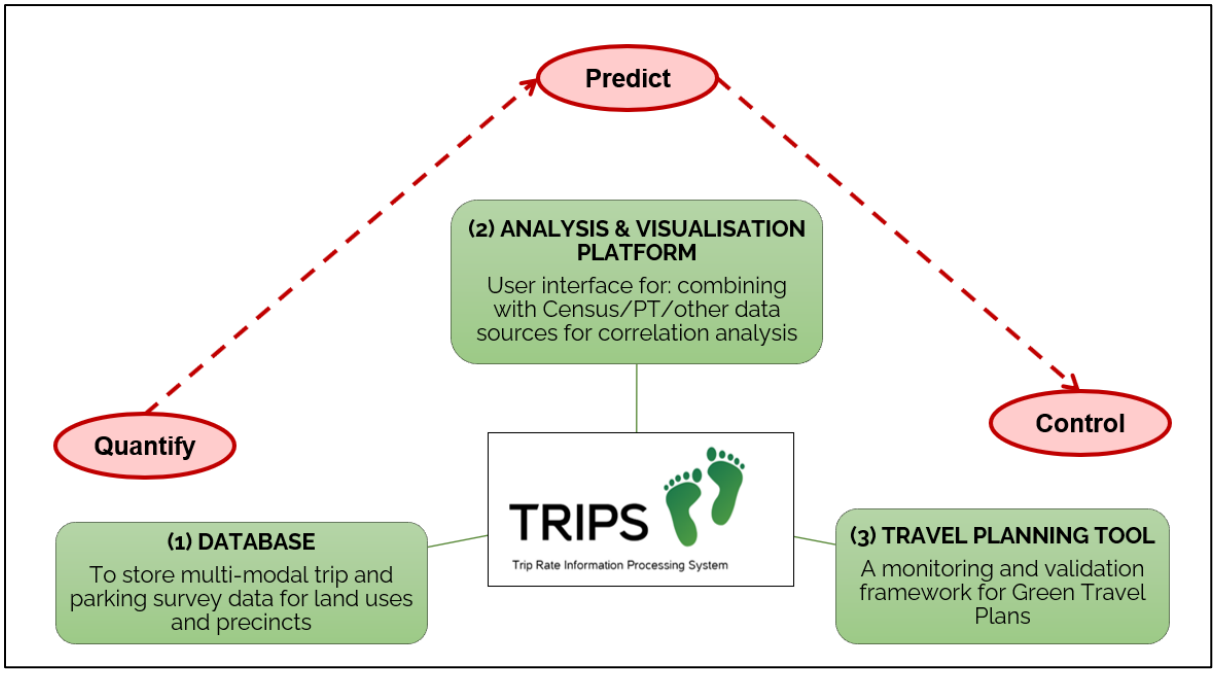


Table 2 provides a summary of opportunities that can be unlocked by the development of a centralised national LUTPG database like TRIPS.

Table 2: Opportunities unlocked by TRIPS

Opportunity	Description
Making a large sample of data available in one place	A centralised national database can enable the compilation of all LUTPG-related datasets in one place, which will make the findings more robust and reliable. As noted by (Barnard & Brindle 1985), the current methods used to predict LUTPG are functional, not causal, meaning they lack a theoretical foundation. Therefore, changes in environment and time may impact spatial and temporal transferability of results from one site to another. In this regard, one of the most pressing needs in traffic generation research in Australia is to extend the geographical coverage of current data sets (Barnard & Brindle 1985). A comprehensive database with accumulated datasets from various locations over long periods can help practitioners overcome the above problem.

Improved efficiency in the transport assessment process	The database can provide a common platform for consultants and authorities so that audits of transport impact assessments can be streamlined. This will eliminate any personal biases in assessments. The standardisation of data collection and reporting practices, associated with the development of the database tool will make the current practice more efficient and cost-effective.
Compilation of past survey data	There is an opportunity to enter into data-sharing agreements with traffic survey companies to obtain past LUTPG surveys for a multitude of land uses across various contexts. A challenge however is ascertaining information on the relevant site parameters (activity units) for each survey. This information will either need to be obtained by contacting the site operator/traffic consultant who commissioned the survey, or through development consent documents available from local Councils.
Consideration of contextual influences	A centralised LUTPG database can enable its users to interoperate this data with other datasets related to socio-economic (i.e. Census data) and accessibility-related variables (including public and active transport accessibility). Enabling the practitioners to understand how these variables influence LUTPG rates is a key requirement, particularly in the context of setting future transport visions.
Combining insights from different survey types	The database can facilitate the storage of results from surveys beyond the traditional LUTPG surveys. For instance, the insights from traditional surveys can be supplemented by combining data from other surveys such as dwell time surveys, origin-destination surveys, travel behaviour surveys and cross-purpose and passer-by trip surveys.
Identifying a clear nexus between developments and impacts	The availability of more accurate LUTPG data from large samples can enable authorities to clearly identify the nexus between a given land use proposal and the likely demand for new or embellished public and community infrastructure created by that development. This will allow the application of more equitable infrastructure contribution schemes. Most of the current contribution schemes are tied to peak vehicle trips (Lake Macquarie City Council Development Contributions Plan, 2021; Section 7.11 Western Corridor Local Infrastructure Contributions Plan 2013, City of Newcastle 2020). For instance, a clearer understanding of multi-modal trip generation patterns of land uses in dense urban areas will allow local authorities to seek more equitable contributions towards non-car-based infrastructure such as footpaths and public transport stops.
Validation and monitoring of Travel Plans	A system that enables long-term monitoring and validation of Travel Plans can effectively shift the responsibility and accountability for achieving sustainable transport outcomes to the development level. As noted by (De Gruyter et al. 2017), in jurisdictions where Travel Plan monitoring and validation are legislated, most developments have reported a reduction in car driver trips of 10–20 percentage points.
Unlocking the power of new data collection techniques	A centralised LUTPG database can facilitate the storage of survey data beyond those collected from traditional manual/video surveys. For instance, this system could also be a repository for mobile phone-based human movement surveys and traffic count data gathered from CCTV videos and SCATS. Additionally, data sources such as ‘Google Popular Times’ can be used to fill the gaps of incomplete datasets for understanding seasonal effects and the daily trip and parking generation profiles (Boghe, 2020).
Future-proofed system ready for AI revolution	The development of a centralised LUTPG database with big data integration capability is a promising first step for the AI revolution in the domain of transport planning. The large LUTPG datasets, when compiled in a single system, can be used to develop and train machine learning models that will be able to accurately quantify and predict the trip and parking generation characteristics of a given land use proposal.

6 Conclusions and future directions

This paper presented a summary of insights gained from the background research underpinning the TRIPS project which aims to develop a centralised national database for LUTPG surveys.

Our work reveals that LUTPG data could serve as a vital source of information for a broad range of use cases, from facilitating technical assessments and research to the development of effective policies related to land use planning and management.

The currently scattered data collection methods with datasets siloed within different organisations are not useful to the collective practice. While most of the limitations and challenges experienced in the current practice can be overcome if a national LUTPG database is developed, some of them are process-related and require the practice to evolve. However, the development of a future-proofed national database is an ideal first step for facilitating these process improvements as it will prompt practitioners to transition into best practices over time.

Existing similar tools from other countries reveal that it is important to enable the users of the system to have access to a robust filtering criterion so that they can identify a suitable sample from the overall dataset to represent the site they wish to develop forecasts for. In addition, this tool should provide an auditing capability so that authorities reviewing the assessments can independently verify the filtering criteria adopted by the consultants, to eliminate potential biases.

Industry engagement is critically important to ensure the long-term adoption of the database. The success of TRICS in the UK serves as a testament to how policy backing can encourage the long-term implementation of a decision-support tool. In this regard, a national industry body like Austroads or NTRO should be involved in the development of standards and procedural guidance, as well as the identification of a suitable governance structure for the long-term maintenance of this tool.

Considering the vital role of evidence-based decision-making in planning and creating sustainable cities, a well-standardised dataset that is available within a national LUTPG database is a crucial precursor for the industry to be able to derive benefits from the plethora of possibilities offered by recent advances in AI technology.

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8 References

Barnard, P. O. & Brindle, R. (1985). 'Traffic Generation Estimation - Suggestions on New Research Directions', *Australian Road Research Board*.

Basford, L. (2022). *TRICS Decide and Provide Guidance Summary*, Basfordpowers.

Boghe, K. (2020). *The Calendar of Billions at Your Fingertips*, medium.com, viewed 6 May 2024, <https://medium.com/analytics-vidhya/the-calendar-of-billions-at-your-fingertips-fa3dc2939fb2>.

Bosserhoff, D. (2020). *Program Ver_Bau: Estimation of traffic volumes generated by land use planning*, April.

Clifton, K. J., Currans, K. M., & Muhs, C. D. (2012). Contextual Influences on Trip Generation.

Clifton, K. J., Currans, K. M., & Muhs, C. D. (2013). Evolving ITE trip generation handbook: Proposal for collecting multimodal, multicontext, establishment-level data. *Transportation research record*, *2344*(1), 107-117.

Clifton, K. J., Currans, K. M., & Muhs, C. D. (2015). Adjusting ITE's trip generation handbook for urban context. *Journal of Transport and Land Use*, *8*(1), 5-29.

Collinge, A. (2015). *Building the City Data Market – London Datastore*, https://data.london.gov.uk/b, viewed 4 May 2024, <https://data.london.gov.uk/blog/building-the-city-data-market/>.

De Gruyter, C. (2019). Traffic impact assessments: Why current practice needs to change. *Planning News*, *45*(8), 26-27.

De Gruyter, C. (2019). 'Multimodal Trip Generation from Land Use Developments: International Synthesis and Future Directions', *Transportation Research Record: Journal of the Transportation Research Board*, vol. 2673, no. 3, pp. 136–152.

De Gruyter, C, Rose, G, Currie, G, Rye, T & van de Graaff, E. (2017). 'Travel plans for new developments: a global review', *Transport Reviews*, vol. 38, no. 2, pp. 142–161.

Ewing, R., Tian, G., Lyons, T. and Terzano, K. (2017). Trip and parking generation at transit-oriented developments: Five US case studies. *Landscape and Urban Planning*, *160*, pp.69-78.

Lake Macquarie City Council Development Contributions Plan 2021. (viewed 4 May 2024). <https://www.lakemac.com.au/files/assets/public/>

Mousavi, A, Bunker, J & Lee, B. (2012), 'Trip generation in Australia: practical issues', *Road and Transport Research*, vol. 21, no. 4, viewed 6 May 2024, <https://trid.trb.org/view/1245939>.

NSW Government. (2024). *Transport Oriented Development*, https://www.planning.nsw.gov.au/.

Schneider, R. J., Handy, S. L., & Shafizadeh, K. (2014). Trip Generation for Smart Growth Projects. *ACCESS Magazine*, *1*(45).

Section 7.11 Western Corridor Local Infrastructure Contributions Plan 2013, City of Newcastle 2020. (viewed 4 May 2024). <https://newcastle.nsw.gov.au/getmedia/D49D5C82-CD04-4076-B074-4C11A73B7622/Section-7-11-Western-Corridor-Local-Infrastructure-Contributions-Plan-Updated-2020.pdf>.

Smith, D, Draper, J & Ingley, S. (2020). *Trip Generation Rates for Australia and New Zealand*, June, Austroads.

Tian, G., Park, K. and Ewing, R. (2019). Trip and parking generation rates for different housing types: Effects of compact development. *Urban Studies*, *56*(8), pp.1554-1575.