Guideline

Pedestrian demand forecasting

February 2021

Queensland Government

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Contents

1 Introduction

1.1 Background

The Queensland Government is committed to ensuring Queenslanders of all ages and abilities can walk safely and comfortably, when and where they choose (*Queensland Walking Strategy 2019–2029*). To assist practitioners in determining the merits of providing pedestrian infrastructure, and the scale of that infrastructure, methods are required to forecast pedestrian demand.

1.2 Related documents

This document should be used in conjunction with the documents described in Table 1.2 which provide further detail on design considerations and supplementary information. Further detail of documents referenced in this guideline is provided in the Transport and Main Roads *Active transport users guidelines references*.

Table 1.2 – Related documents

Publisher	Title
Austroads	*Guide to Traffic Management Part 3: Transport Study and Analysis Methods* (2020)
	Development of the Australasian Pedestrian Facility Selection Tool (2015) (AP-R472-15)
	Australasian Pedestrian Facility Selection Tool [V2.1]: User Guide (2018) (AP-R592-18)
	Forecasting Demand for Bicycle Facilities (2001) (AP-R194)

1.3 Purpose

The intent of this document is to provide guidance to practitioners to forecast demand for pedestrians for new infrastructure such as:

- footpaths or shared paths, including 'missing links' in an existing path network
- unsignalised road crossings such as pedestrian refuges, zebra or wombat crossings or grade separated infrastructure, and/or
- signalised road crossings, including mid-block pedestrian operated signals and pedestrian crossings at signalised intersections.

This guidance does not consider pedestrian simulation modelling; that is, the modelling of crowd dynamics for purposes such as typical and emergency egress from train stations or sports stadiums.

1.4 Intended audience

This guidance is intended for transport planners proposing or designing pedestrian infrastructure who need to assess the likely pedestrian demand as part of assessing the viability of the infrastructure. Examples where pedestrian demand forecasts may be useful include:

- assessment of appropriate infrastructure using existing tools such as the *Australasian Pedestrian Facility Selection Tool*
- business case development (including cost-benefit analysis)

- new project planning either for standalone pedestrian projects or in conjunction with larger road or public transport projects, and/or
- development assessment where a new development (residential, office, commercial and so on) is proposed and the road authority wishes to understand the likely pedestrian demand effects, including possible developer contributions.

The user is assumed to have knowledge of transport planning but may have limited knowledge of transport modelling methods.

The scope of this guidance is limited to infrastructure; non-infrastructure programs such as travel behaviour change campaigns are excluded.

1.5 How to use this guidance

This guidance consists of a general overview of the methods available for pedestrian demand forecasting (Section 2), issues associated with data collection (Section 3) and three detailed procedures in sections 4, 5 and 6. Practitioners are advised to review the general advice in sections 2 and 3 before implementing the procedures in sections 4, 5 and 6 for their projects. These procedures are described in ascending order of complexity; however, every effort has been made to make them as simple and rapid for practitioners to implement as possible. Furthermore, the three methods have been implemented in an online tool at https://pedtools.com.au/forecasts. In most cases, it is anticipated that practitioners will use this guideline in conjunction with the online tool.

Because of the uncertainty associated with pedestrian demand forecasting, practitioners are advised to use all three procedures for a project to obtain a range of forecasts. In combination with professional judgment, this should then provide a plausible range of forecasts which can be used in further developing project proposals.

1.6 Limitations

Forecasting is inherently uncertain, and this is particularly true for pedestrian demand forecasting where:

- existing data on pedestrian activity is limited, and often of variable quality
- pedestrian activity, particularly in areas of predominantly recreational activity, is highly sensitive to weather and seasonal factors, and/or
- there is a wide variety of sociodemographic, land use and transport network-related variables which will affect pedestrian activity; not all of these are readily measurable.

The guidance in this technical document is indicative as the forecasts guide on the quantum of demand but are not precise indicators. The practitioner should treat the central estimates as a guide only and consider sensitivity testing demand within the stated prediction intervals or, where justified by local conditions, beyond these intervals.

Data limitations currently preclude the methods in this guidance from incorporating anticipated land use changes such as new residential and commercial development and new or expanded primary and secondary schools. Moreover, the forecasts apply to an average day and cannot be used to forecast demand during special events. Finally, the models are based on empirical data from projects implemented in Queensland over the past 10 years. The contexts in which these projects have been implemented vary, but many involve relatively modest pedestrian improvements in areas with modest pedestrian network quality and patchy network extent. Improved network quality would likely escalate pedestrian demands beyond those predicted by these procedures. The model may be unduly conservative in scenarios that seek to extrapolate beyond the realms of the existing data.

2 Methods selection

2.1 Overview

The most appropriate pedestrian demand forecasting method will depend on:

- the **scale** of the project – larger, more expensive projects present greater risks of wasted expenditure, should the project underperform and, in any case, would be expected to have more resources available to fund more sophisticated demand forecasting methods that the scale of expenditure warrants
- the **availability** of data – in some locations, there will be some pre-existing pedestrian data available, perhaps collected as part of a larger transport study: in many cases, only very limited data may be available
- **timing** and **budget** – sophisticated approaches require significant time and financial resources, which may not be available or warranted, and/or
- the **opportunities / complexity** of the project – projects in larger corridors which offer a range of outcomes may benefit more from further investigation of pedestrian demand to guide decisions around providing dedicated pedestrian infrastructure or sharing with other path users, including bicycle riders.

Note: Pedestrian demand forecasting methods are in their infancy and even sophisticated approaches may not necessarily produce more robust estimates than simpler approaches.

2.2 Methods

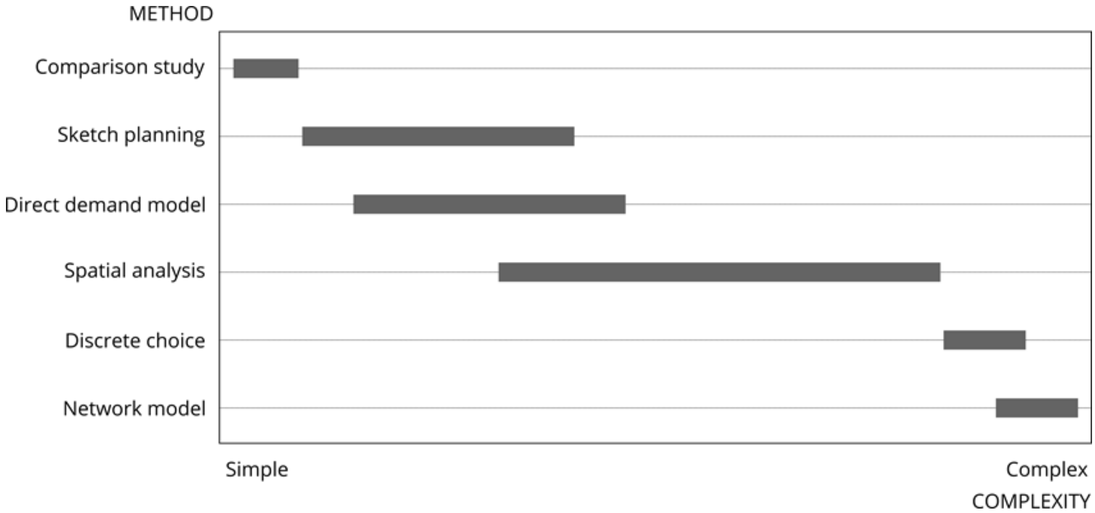
There are six general classes of pedestrian demand forecasting methods:

1. **comparison study** – obtaining counts for existing, similar projects and using these counts for the proposed location
2. **sketch planning** – relatively simple calculation based on land uses, assumed trip generation and distribution and often implemented in a spreadsheet; the details of the sketch planning method will vary, depending on the data available and nature of the site
3. **direct demand models** – regression equations linking land use and transport network characteristics to pedestrian demand
4. **spatial analysis** – an extension of sketch planning, and possibly involving direct demand models, implemented in geographic information system (GIS) mapping, so more detailed analysis of route choices may be undertaken to align with traditional traffic network models
5. **discrete choice** – probabilistic models of mode choice and, possibly, destination and route choice, that enable feedback between demand and infrastructure provision in a behaviourally realistic manner; the discrete choice method requires specialist expertise and is likely implemented as part of a network model, and
6. **network model** – simplified representation of a transport network, usually including discrete choice models for mode and destination choice and equivalent to models widely used in

motorised transport planning (and usually based on extensive traffic survey data) which have rarely been implemented for pedestrians.

Figure 2.2 compares pedestrian demand forecasting method complexity for the six methods described. Further details about these forecasting methods are provided in Austroads *Guide to Traffic Management Part 3 Transport Studies and Analysis Methods*.

Figure 2.2 – Pedestrian demand forecasting method complexity



Practically all pedestrian demand forecasting methods are simplified comparison studies or sketch plans, with only larger projects progressing to more sophisticated spatial analysis. As the methods become more complex, they have increasingly onerous data requirements. Existing data sources, such as the Census of Population and Employment and household travel surveys, provide limited or infrequent pedestrian data. In many cases, additional data will need to be collected as part of applying these methods (Section 3).

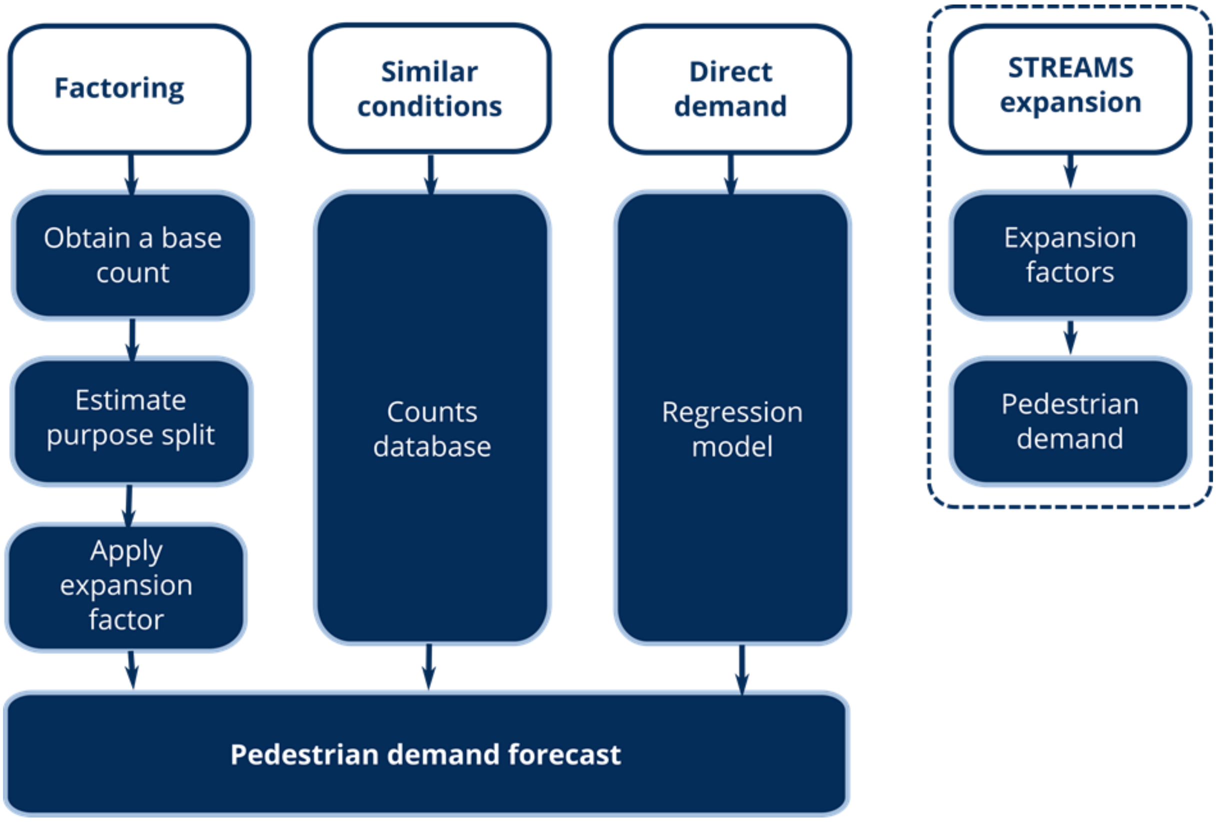
2.3 Procedures in this guideline

This guideline draws on two of the forecasting methods described in Section 2.2 to provide detailed guidance on the application of three forecasting procedures:

1. **factoring**: an approach using a pre-construction count and applying growth factors to this count to estimate post-construction demand (this is analogous to a comparison study)
2. **similar conditions**: a database of pedestrian counts from locations across Queensland that can be used to estimate demand for a project (that is, a comparison study), and/or
3. **direct demand model**: regression models linking land uses such as population, employment and schools to pedestrian demand.

Implementation of these procedures is either trivial (in the case of factoring) or assistance is provided to practitioners in the form of an online tool to enable rapid forecasting using these procedures. All three methods should be used for a project and practitioners should use these three estimates to determine the most likely demand. A summary of the procedures is provided in Figure 2.3 and each is described further in subsequent sections of this guideline.

Figure 2.3 – Summary flowchart of procedures



3 Data collection

3.1 Background

The collection of high-quality pedestrian data supports the development of improved pedestrian demand forecasting methods. This section considers two types of pedestrian data collection:

1. counts, and
2. perceptions of users of a facility or route ('user perceptions').

A third type of data collection could involve non-user perceptions; that is, understanding why people choose not to use a particular facility or route. This type of data collection is likely to be difficult and beyond the scope of most projects, given it will require surveys of a wider population. Not all data collection activities will be warranted for all projects; some pragmatism is warranted, depending on the scale and level of innovation of a project.

3.2 Counts

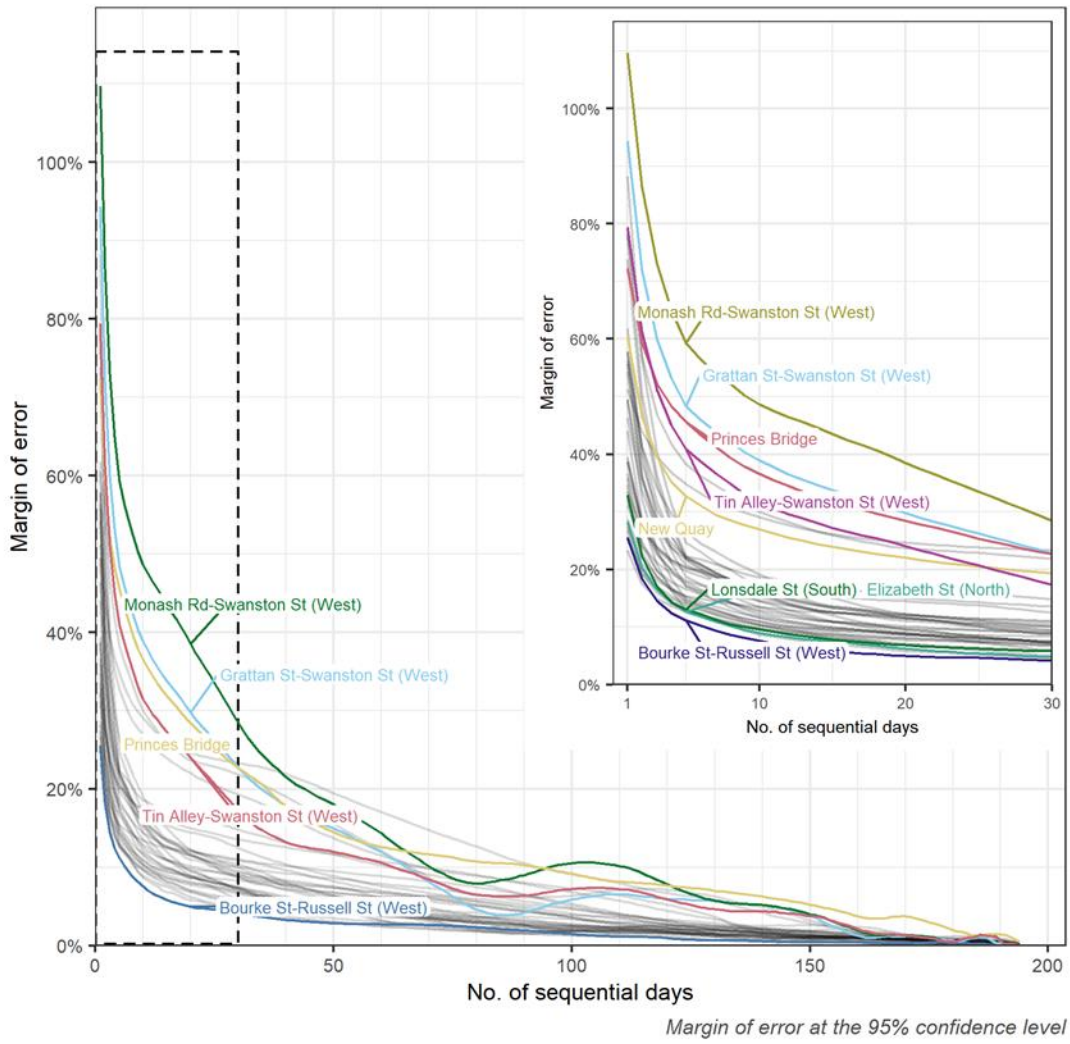
3.2.1 Counting duration

Pedestrian counts are usually used as an indicator of 'average' or 'typical' conditions. A short-period count over one or several days may not necessarily reflect this 'average' condition. Pedestrian demand will vary markedly across days, due to weather conditions, and across seasons. How much this demand will vary will depend on numerous factors such as:

- weather and seasonal variation: locations with more stable weather will experience less variation
- user mix: sites with a high proportion of discretionary recreation walking will exhibit much greater variation than locations with high transport walking activity
- proximity to variable trip generators: while many trip generators and attractors (for example, local shopping centres) will tend to have fairly stable trip movements, there will be more variability for other attractors (for example, schools will not generate much traffic in school holidays, major shopping centres may attract more movements during major sale events), and/or
- scale: smaller counts tend to have higher proportional variability – for example, a site with an average of 10 pedestrians per day is far more sensitive to the presence or absence of a very small number of pedestrians than a busy site: missing two pedestrians at a site with 10 pedestrians / day has a much larger proportional effect than a site with 100 pedestrians / day. Mathematically, counts are described using a Poisson process where the standard deviation is the square root of the count – this implies a standard deviation for a site of 10 pedestrians / day of 3.2 and, at 100 pedestrians / day, of 10. The proportional variability (as measured by the standard deviation) decreases from 32% to 10% across these two scenarios.

There has been limited investigation of the interday variability in pedestrian demand in Australia, as there has been limited long-period counting undertaken; however, evidence from permanent counters in inner Melbourne (Figure 3.2.1) suggests a one-day count can have a margin of error from 25% to over 100%. The error reduces rapidly if the count duration extends over at least three sequential days. For this reason, count periods should extend across at least three days and, ideally, longer. This duration is within the technical limitations of most battery-powered video cameras used for traffic counting and, except at very busy sites, is unlikely to impose a large burden on the subsequent manual count. As such, three days provides a reasonable balance between count accuracy and cost.

Figure 3.2.1 – Non-holiday weekday count accuracy over sequential days at inner Melbourne sites



3.2.2 Atypical conditions

Public holidays and school holidays should be avoided, as should days of extreme weather conditions; some weather variability (such as light showers) on at least one of the days is acceptable, noting that, in most locations, inclement weather is not atypical.

3.2.3 Count options

Four options for pedestrian counting are described in Table 3.2.3. In almost all circumstances, the video-based manual count and permanent (automatic) count are likely to be the recommended options. In some situations, it may be useful to obtain data that provide more specific information about users, such as gender or age. Some collection methods allow for data to be segmented so that sub-sets such as adult / child or male / female are identified.

Table 3.2.3 - Pedestrian counting options

Method	Description	Duration	Advantages	Disadvantages	Recommendation
Onsite manual count	Manually obtained onsite by one or more trained observers	2–3 hours	• Cost effective • Can fairly accurately segment count (for example, gender, child / adult)	Short count duration No possibility for auditing	Not recommended except where segmentation is required
Video-based manual count	Battery-operated video cameras are positioned to record the scene and the video is subsequently manually analysed	1–5 days (battery dependent)	• Cost effective • Can obtain far longer count duration than with onsite manual counting • Allows for independent auditing • Can crudely segment count (for example, gender, child / adult), depending on video quality	Moderate count duration	Almost always superior to onsite manual counting; recommended for most sites where a permanent counter is not justified
Video-based automatic count	Video cameras record the scene and automatically identify pedestrians (either onsite or in post-processing)	1 day – permanent	• Can measure seasonal variation (subject to camera power requirements) • Minimal labour requirement	• Video quality needs to be high • Calibration is essential, and can be time consuming • Video analytics methods can be challenged by low light, reflections, obscuration and clusters of pedestrians	Not recommended as calibration can be overly onerous for short-period counts; theoretical count accuracy is often not achieved in practical real-world deployment

Method	Description	Duration	Advantages	Disadvantages	Recommendation
Signalised intersection quasi-counts	Apply expansion factor to STREAMS signal logs to estimate demand	Permanent	• Cost effective • Long time series	• An approximation of pedestrian demand • Inaccurate at high demand sites (>20 pedestrians in 15 minutes)	May be useful for signalised intersections where no counts are available and demand is low
Permanent (automatic) count	Permanent systems installed to provide continuous counts (sensors include passive and active infrared detectors, video and 3D cameras)	Permanent	• Can measure seasonal variation • Accuracy >90% for high-quality systems installed in suitable locations • Minimal labour requirement once installed	• Can be costly ($4000+) • Cannot segment count (for example, gender, child / adult) • Can be inaccurate under adverse weather or crowding conditions (technology dependent) • Multiple devices may be required for large areas such as intersections	Recommended where high-quality, long duration data are warranted

Signalised intersection quasi-counts may be an option where there are inadequate resources to commission counts at a signalised intersection. In this method, the STREAMS signal logs are used as a proxy for pedestrian demand. Such logs are limited – they do not directly count pedestrians; however, as described in *Pedestrian Demand Forecasting Methods Guidance – Technical Report 2: STREAMS validation* (email CyclePedTech@tmr.qld.gov.au to request a copy of this document), an approximate level of demand can be estimated as follows:

1. pedestrian phase call-ups from the STREAM cycle analyser file are aggregated into 15-minute bins
2. an expansion factor of 2.3 is applied to these 15-minute total call-ups (the expansion factor of 2.3 was found to apply fairly consistently across the seven mid-block pedestrian operated signals described in Technical Report 2, and at different demand levels), and
3. the expanded 15-minute totals are summed to provide a daily demand estimate.

This estimate is appropriate only at signalised intersections with low to moderate pedestrian demand; where the 15-minute pedestrian count is likely to regularly exceed 20 pedestrians; the expansion will tend to underestimate true pedestrian demand. For sites at or below this demand, the expansion is likely to be accurate to within ±25%.

3.3 Count specification

In undertaking counts, the following minimum specification should be used:

- counts should extend over busy periods on at least three days
- survey location should be clearly indicated, including providing an aerial image or photograph of the site with mark-up to indicate the area in which counts were undertaken and the movements (if classified)
- classification may vary, depending on the count purpose, but will likely include mode (pedestrian, cyclist, scooter and, possibly, mobility-aided) as a minimum and, possibly, age (adult, child) and gender – the latter two are subjective and can be difficult to assess from a video record with reliability
- counts should be classified by movement (including direction of travel), and
- counts should be provided in a maximum of 15-minute intervals.

Counts should be provided in a tidy structure where each variable forms a column and every row represents an observation. An example of a tidy data structure is provided in Table 3.3(a) and an inappropriate format in Table 3.3(b).

Note: In Table 3.3(a), each row has one count, with columns indicating the time period, intersection arm and direction of travel. By contrast, in Table 3.3(b), there are four counts on each row. This structure can be more difficult to process into databases and in batch processing and is not recommended. Non-proprietary, machine-readable formats such as comma separated values (csv) are preferred to proprietary binary formats (for example, Microsoft Excel™).

Table 3.3(a) – Example of tidy data structure (recommended)

Time starting	Arm	Direction	Count
6:00	West	North	5
6:00	West	South	3
6:00	East	North	8
6:00	East	South	1
6:15	West	North	7
6:15	West	South	2
6:15	East	North	9
6:15	East	South	4

Table 3.3(b) – Example of wide data structure (not recommended)

Arm	West		East	
Direction	North	South	North	South
Time starting				
6:00	5	3	8	1
6:15	7	2	9	4

3.4 User perceptions and behaviour changes

In some cases, user perceptions will be useful to provide insight into shortcomings prior to construction of a project or will provide additional insight afterwards. Moreover, the effectiveness of treatments at encouraging new walking activity can be directly measured by asking users whether they have changed their behaviour as a result of the treatment. Most important is to identify whether (a) users would otherwise have travelled by a different mode of transport for their journey (that is, car, public transport or bicycle) or (b) they are making all-new walking trips directly as a result of the project.

The recommended method for identifying user perceptions is to conduct an intercept survey after construction. This survey should be conducted at relatively busy times (to maximise sample sizes) and seek to interview, as a general guide, around 100 pedestrians. Survey times should, as much as feasible, be representative of the user mix – for example, a weekday morning to capture commuting walking and weekend morning to capture recreational walking.

4 Factoring

4.1 Introduction

In this method, pedestrian counts are obtained prior to construction and these are factored up using indicative diversion rates from other completed projects to provide an estimate of the post-construction demand. This method consists of three steps:

1. obtain counts of existing pedestrians at the site(s) over at least three typical days between 6am–6pm (or longer)
2. estimate the split between transport and recreation walking activity expected on the proposed facility, and
3. factor up the observed demand using diversion rate factors described in this section.

Each of these steps is described in the following sections.

4.2 Obtain pre-construction counts

Pedestrian counts should be obtained at the site over a minimum of three typical days as described in Section 3.2. Public holidays and school holidays should be avoided, as should days of extreme weather conditions; some weather variability (such as light showers) on at least one of the days is acceptable, noting that, in most locations, inclement weather is not atypical.

Whether the counts should be obtained over three weekdays or over a combination of weekdays and weekend days will depend upon the primary motivation for the project:

- projects that are motivated primarily to provide for commuters or school students should use three weekdays of counts, and
- projects motivated by recreational use should have at least one weekend day and possibly up to three weekend days if the project is anticipated to be used only on weekends.

The count days need not be sequential, although, for logistical reasons, this is likely to be the most practical choice.

In most cases, the most practical and cost-effective counting method will be manual counts from video recordings. Doing so makes the long duration (minimum 36 hours, assuming 12 hours per day across three days) of counts practical and provides a means to audit the count when required. Automated computer vision-based algorithms are generally not recommended as the quality of video is generally high and calibration times overly onerous for short-period counts.

4.3 Purpose split

The walking trip purpose split is required to estimate the diversion rates (Step 3 in Section 4.1 of this guideline). Walking trips are divided into two groups:

1. transport: walking to work, personal business (for example, hairdresser, bank), shopping, to restaurants or cafes, or to visit friends or relatives, and
2. recreation: any walking activity where the act of walking is itself the purpose – this would include dog walking.

If the trip involves multiple purposes (for example, walking for both exercise and for a transport purpose, such as shopping, or a trip to a café), the trip is treated as having a transport purpose. This approach is consistent with purpose hierarchies assumed in travel surveys.

Typical pedestrian walking purpose splits for a range of suburban and regional footpaths and shared paths are given in Table 4.3. There will be instances where the expected purpose split will be significantly different from the values listed in Table 4.3; for example, in a central business district, the transport purpose split on weekdays will very likely be higher than the range stated in this table. Indeed, analysis of Queensland Travel Survey data from 2017–2019 suggests that only 24% of walking trips are for a recreation purpose. The practitioner should make an assessment based on the local context as to the most appropriate value.

The purpose splits by day of week in Table 4.3 add to above 100%. This reflects the average-of-averages approach used in their derivation. Practitioners should select a value in one cell about which they have most confidence and then derive the remainder; for example, if there is high confidence that the weekday transport purpose split is likely to be close to the typical value in Table 4.3 (that is, 37%), the recreation split should be set at 100 – 37 = 63%.

One overall weighted purpose split should be estimated across the analysis period. If the analysis period is only weekdays or weekend days, no weighting is required. If a combination of weekdays and weekend days is used, an overall weighted purpose split should be calculated as follows:

- Calculate the average weekday (AWT) and weekend (AWE) demand
- The weekday weighting W_{AWT} is:

$$W_{AWT} = \frac{5AWT}{5AWT + 2AWE}$$

- The weekend weighting $W_{AWT} = 1 - W_{AWT}$.

Table 4.3 – Typical purpose splits by day of week

Day of week	Transport	Recreation
Weekday	37% (24 – 51%)	70% (58 – 83%)
Weekend	18% (8 – 28%)	86% (77 – 94%)

1. Values in brackets are 95% confidence intervals.
2. Values are derived from intercept surveys of pedestrians after construction of 20 projects in Australia.
3. Practitioners should ensure the total purpose split is equal to 100% on any weekday or weekend.

4.4 Diversion rates

Diversion rates are the proportion of users after construction that are estimated to have changed their behaviour as a result of the project. There will be three potential user responses:

1. pre-existing:
    a. these users were already walking prior to construction; depending on the project they may have already been walking along the project corridor (for example, if the project involves upgrading an existing facility) or have used some other route if the corridor is altogether new
2. mode diversion:
    a. previously used a private vehicle (usually car), either as a driver or passenger, and/or
    b. previously used public transport, and
3. induced:
    a. new walking trips that would not otherwise have occurred in the absence of the project.

In most projects, the majority of pedestrians are likely to be pre-existing – they may, however, be attracted to use the project in preference to another, more circuitous or unattractive, pre-existing route.

The proportion diverting from motorised modes (private vehicle or public transport) will depend on (a) the proportion of transport versus recreation demand (higher levels of transport demand will lead to higher diversion), and (b) the relative attractiveness of the motorised modes. In many suburban and regional situations, the public transport mode shares will be low and diversion from public transport will be negligible. Conversely, in major city centres, there will be higher pre-existing public transport mode shares and lower car shares (due to congestion and parking limitations). Indicative diversion rates are shown in Table 4.4 and illustrated in Figure 4.4. These diversion rates are based on intercept surveys of pedestrians on new shared paths, footpaths and road crossings in Queensland. The practitioner should select values appropriate to the local context, taking into account factors such as:

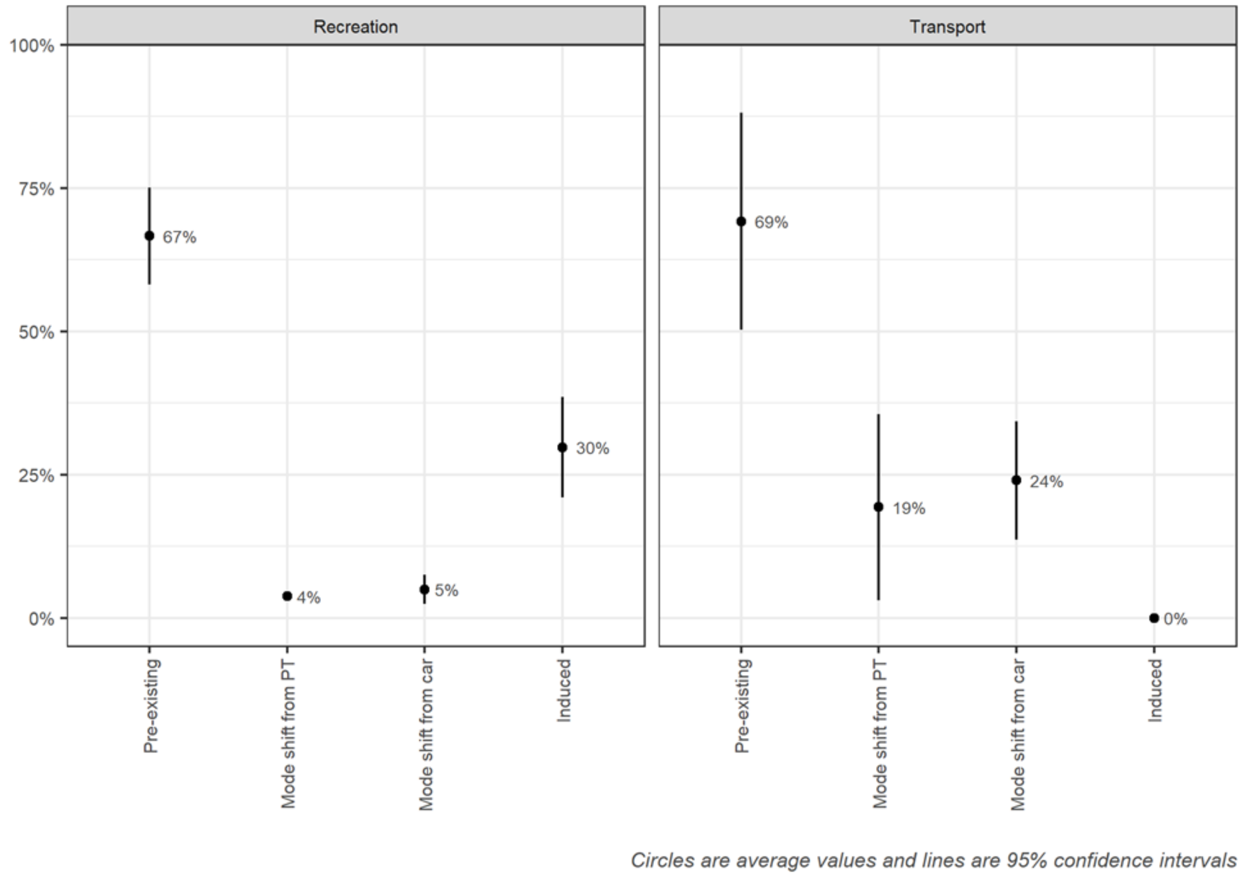
- pre-existing car and public transport mode shares along the corridor – for example, areas with negligible public transport use would be expected to have no mode shift from public transport
- the scale of the project relative to the existing condition – large, high-quality projects where there was previously very poor provision may have a greater mode shift and induced travel effect, and/or
- local amenity of walking – projects in areas of significant natural features (for example, parks, along waterfronts) or otherwise attractive to walking near residential or employment land uses may induce more recreation walking than projects in less amenable surrounds.

Table 4.4 – Typical diversion rates

	Trip purpose	
Diversion	**Transport**	**Recreation**
Pre-existing	69% (50–88%)	67% (58–75%)
Mode shift from car	24% (14–34%)	5% (2–8%)
Mode shift from PT	19% (3–36%)	0%
Induced	0% (21–39%)	30%

1. Values in brackets are 95% confidence intervals.
2. Values are derived from intercept surveys of pedestrians after construction of 20 projects in Australia.

Figure 4.4 – Diversion rates for pedestrian infrastructure projects based on purpose split



The diversion rates can be converted into uplift factors for the purpose of forecasting additional walking activity that the project may generate as follows:

$$D = \frac{D_0}{DR_{PE}}$$

where:

D	=	forecast demand
D_0	=	observed (pre-construction) demand
DR_{PE}	=	pre-existing diversion rate

For example, if the observed pre-existing demand at a location is 100 pedestrians per day, and all are assumed to be recreational travellers, then the forecast demand would be:

$$D = \frac{100}{0.67} = 149$$

4.5 Calculation method

The procedure is illustrated with the following example:

1. A new pedestrian crossing is proposed at a mid-block location.
2. Pedestrian counts within 50 m of the location over two weekdays found an average weekday crossing demand of 100 pedestrians. Crossing demand on a single weekend day was observed to be 30 pedestrians. The average day demand (D_{ADT}) is:

   $$D_{ADT} = \frac{100 \times 5 + 30 \times 2}{7} = 80$$

3. The location is a fairly typical suburban area dominated by residential dwellings interspersed with modest mixed-use development. It is assumed the purpose split on weekdays is 70% recreational and increasing to 90% on weekends (Table 4.3). The weighted purpose split is:

   $$W_{AWT} = \frac{5 \times 100}{5 \times 100 + 2 \times 30} = 0.893$$

   $$W_{AWE} = 1 - 0.893 = 0.107$$

   $$Average\ recreation\ split = 0.893 \times 0.7 + 0.107 \times 0.9 = 0.721\ (72\%)$$

   $$Average\ transport\ split = 1 - 0.721 = 0.279\ (28\%)$$

4. Obtain a purpose-weighted uplift factor (UF) from the diversion rates and the average purpose splits:

   $$UF = \frac{1}{Avg\ rec.\ split \times DR_{PE(rec)} + Avg\ trans.\ split \times DR_{PE(trans)}}$$

   $$UF = \frac{1}{0.721 \times 0.67 + 0.279 \times 0.69} = 1.48$$

5. Multiply the observed (pre-construction) demand by the uplift factor to obtain the demand forecast:

   $$D = 80 \times 1.48 = 118$$

In other words, for this project, the average daily demand is forecast to increase from 80 pedestrians per day prior to construction to 118 afterwards – an additional demand of 38 pedestrians per day.

5 Comparison methods

5.1 Background

Comparison methods represent the simplest means of forecasting demand for a pedestrian project. In this approach, the possible demand is estimated from one or more other similar sites. The counts at another site can be derived in one of two ways:

1. the practitioner can commission counts at one or more existing similar sites and infer from these counts the likely demand at the project site; for example, if the project is a mid-block pedestrian-operated signal across an arterial road in a predominantly residential area, counts could be obtained at existing pedestrian operated signals in similar locations, and/or
2. an existing counts database can be used to identify similar sites and deduce the likely demand.

Advice on counting for option 1 is provided in Section 3.2. The remainder of this section describes an existing counts database.

5.2 Counts database

An online database of pedestrian counts obtained in Queensland is available at https://pedtools.com.au/forecasts. The database tab in this tool is an implementation of the database described in this section.

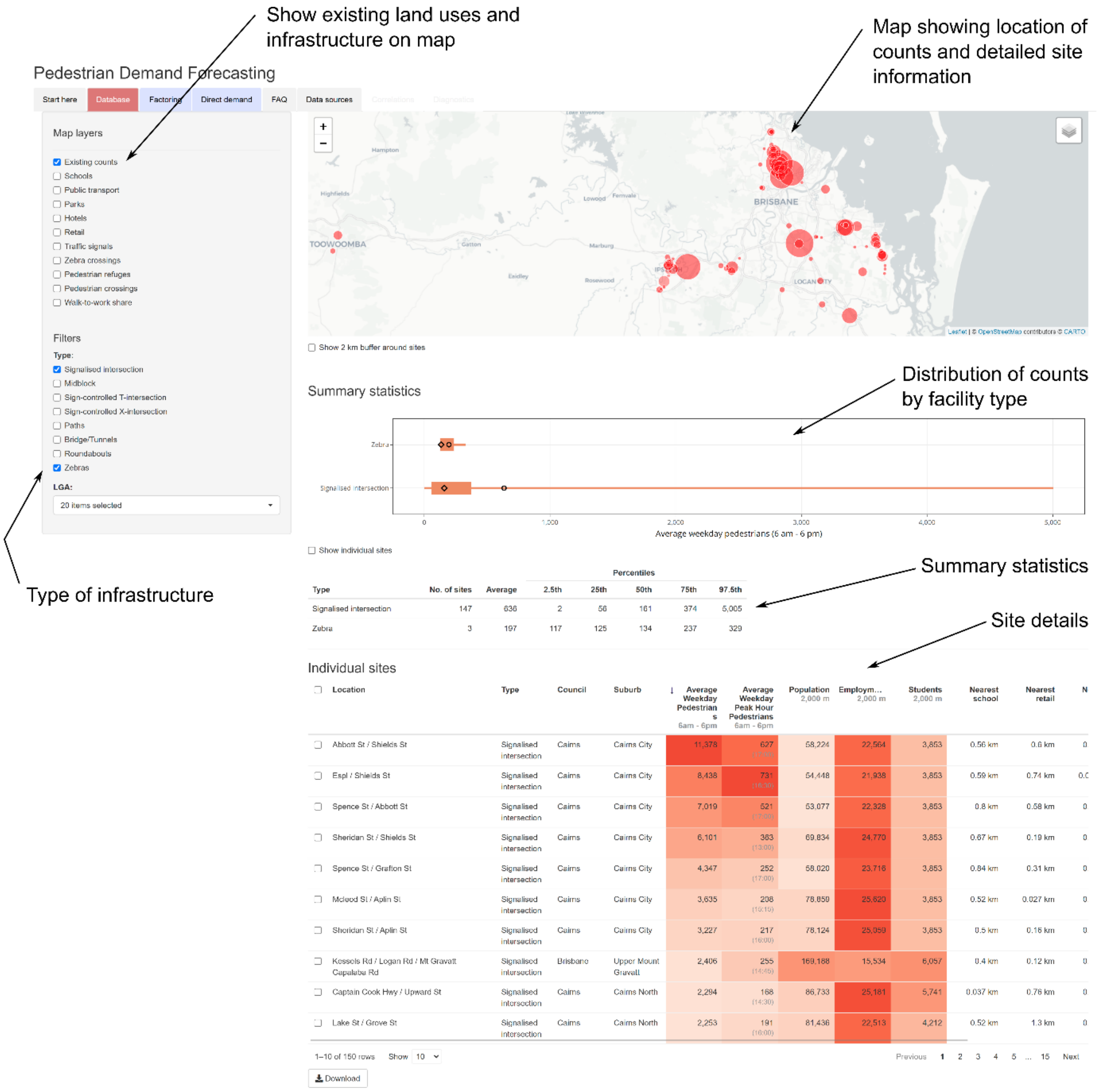
This database enables practitioners to search among 445 counts obtained since 2009 across a range of contexts including signalised intersections, paths and zebra crossings. The data were collated from counts commissioned in Transport and Main Roads and local governments and includes both short-period (one day, 6am–6pm) and long-period (automatic) counts.

Practitioners can filter the database by criteria:

- facility type: signalised intersection, sign-controlled intersection, paths, bridges, roundabouts, zebra crossings and mid-blocks, and/or
- local government area.

Statistics are provided for the average and median weekday (6am–6pm) and peak hour demand, as well as the interquartile range and 95% confidence intervals (Figure 5.2). Tables are provided listing each individual site and the population, employment and school students within a 2000 m catchment. In combination, the practitioner can use these data to estimate the plausible demand for a notional project. Given the inherent variability across sites, and the interday variability present within the counts, practitioners are advised to use the median values as initial guidance, then consider varying their estimates within the confidence intervals provided.

Figure 5.2 – Pedestrian counts database



6 Direct demand models

6.1 Background

This procedure is based on a statistical model relating land use attributes, such as population and the presence of retail facilities, with pedestrian demand. The model is based on counts at 425 sites in Queensland, obtained between 2009–2020, and is documented in *Pedestrian Demand Forecasting Methods Guidance – Technical Report 1: Direct demand models* (email CyclePedTech@tmr.qld.gov.au to request a copy of this document).

The data used in estimating this model were obtained over a long period of time, using different methods and with unknown levels of accuracy, and the predictor variables such as population, land uses and transport networks do not necessarily reflect the land uses at the time the count was undertaken. Given these limitations the models developed are subject to uncertainty and should be considered as a guide to the plausible level of demand only; the practitioner may have a compelling argument as to why demand at a subject site will be significantly less or greater than predicted by this model.

6.2 Model

The model is a generalised linear model with negative binomial errors and a log link function. The model predicts weekday pedestrian demand between 6am–6pm; the model coefficients are shown in Table 6.2(a). The key characteristics of this model are:

- higher commuting walking to work and public transport mode shares are associated with higher pedestrian demand
- higher household income is associated with slightly lower pedestrian demand
- higher median age is associated with higher pedestrian demand
- proximity to a school is associated with higher pedestrian demand
- proximity to, and higher areas of, parks or retail facilities are associated with higher pedestrian demand, and/or
- infrastructure such as footpaths (at mid-blocks), roundabouts and sign-controlled intersections are associated with lower pedestrian demand than off-road paths, signalised intersections and zebra crossings.

The marginal effects for this model are generally plausible; for example, for a shared path and average parameters, as shown in Table 6.2(b):

- increasing the walk mode share to work from 10% to 20% will increase weekday pedestrian demand by 433 pedestrians per day
- increasing public transport mode share to work from 10% to 20% will increase weekday pedestrian demand by 190 pedestrians per day
- increasing the distance of the nearest school from 300 m to 1000 m will reduce weekday pedestrian demand by just under 100 pedestrians per day
- areas with a median weekly household income of $1000 will have pedestrian demand around 117 pedestrians per day higher than areas with median weekly demand of $2000, and/or
- areas with a median age of 45 years will have pedestrian demand around 120 pedestrians per day higher than areas with a median age of 35 years.

Table 6.2(a) – Direct demand model

Predictor	Coefficient
(Intercept)	3.649***
	(0.000)
walk.share.wgt	9.157***
	(0.000)
pt.share.wgt	6.421***
	(0.000)
hh.income.wgt	-0.001***
	(0.001)
median.age.wgt	0.056***
	(0.000)
dist.school	-0.703***
	(0.000)
park.km2.wgt	2.7E-7
	(0.117)
retail.km2.wgt	6.69E-6***
	(0.001)
dummyFootpath	-1.155***
	(0.000)
dummyRbt	-0.432**
	(0.033)
dummySign	-0.753***
	(0.000)
Num.Obs.	425
AIC	5310.4
BIC	5359.0
Log.Lik.	-2643.203

Values in brackets are p-values

* p <0.1, ** p <0.05, *** p <0.01

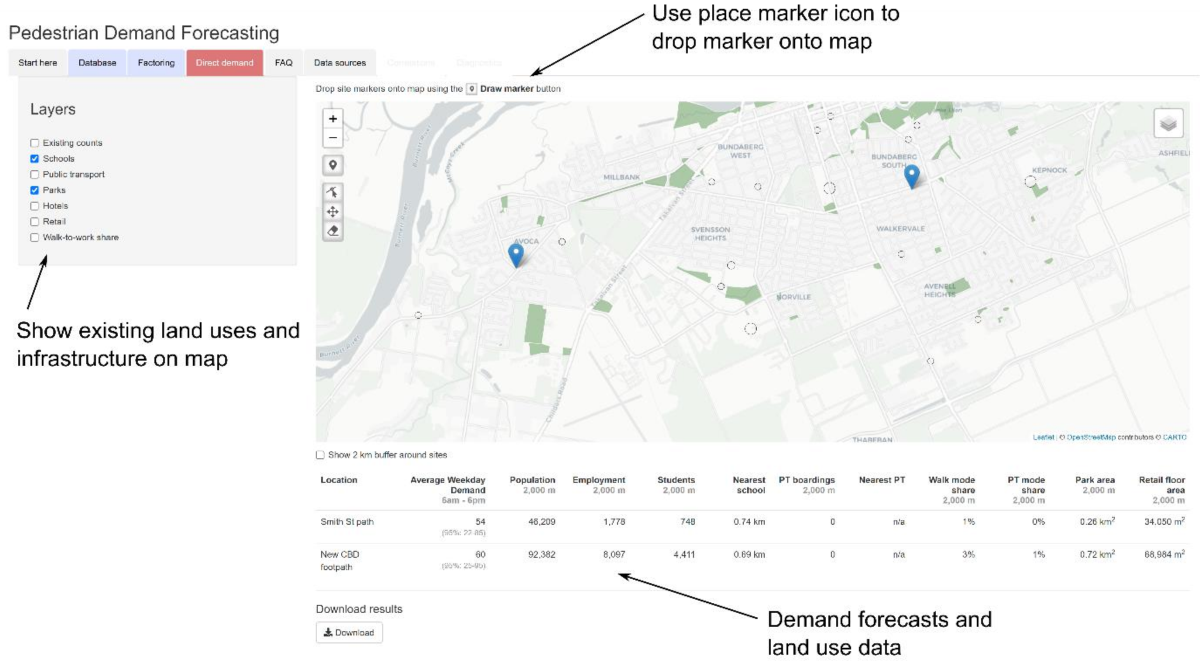
Table 6.2(b) – Variable description

Predictor	Description	Unit
walk.share.wgt	Distance-weighted proportion of walking trips (as a sole mode) to work, based on 2016 Australian Bureau of Statistics (ABS) *Census of Population and Housing*	0–1
pt.share.wgt	Distance-weighted proportion of public transport trips to work based on 2016 ABS *Census of Population and Housing*	0–1
hh.income.wgt	Distance-weighted median household weekly income based on 2016 ABS *Census of Population and Housing*	$ (2016 prices)
median.age.wgt	Distance-weighted median age based on 2016 ABS *Census of Population and Housing*	Years
dist.school	Crowfly distance to the centroid of the nearest primary or secondary school	km
park.km2.wgt	Distance-weighted crowfly distance to the nearest point of the nearest park multiplied by the park area	km^3
retail.km2.wgt	Distance-weighted crowfly distance to the nearest point of the nearest point of the nearest retail land use multiplied by the retail land area	km^3
dummyFootpath	Whether the count site is a footpath (that is, a walkway dedicated to pedestrians within a road-related area).	0 = not a footpath 1 = footpath
dummyRbt	Whether the count site is at a roundabout	0 = not a roundabout 1 = roundabout
dummySign	Whether the count site is at a roadway intersection that is sign-controlled (either give way or stop signs)	0 = not a sign-controlled intersection 1 = sign-controlled intersection

6.3 Implementation

To assist practitioners in the rapid use of this model, an online implementation is provided at https://pedtools.com.au/forecasts under the *Forecasting* tab. In this implementation, the user drops a marker onto the map at the project location and the model calculates the demand forecast, using the model described previously. The practitioner is provided with a table indicating the demand and 95% prediction interval, along with the key land use characteristics.

Figure 6.3 – Direct demand model



The model is based on data of variable quality, the model fit is modest and many significant factors likely to contribute to pedestrian demand are not explicitly accounted for, such as:

- population and employment
- size of nearby schools – that is, while the presence of a school and its proximity to the count site is incorporated, the number of students is not
- the quality of the walking facility and amenity of the immediate surrounds (aside from the presence of a park), and/or
- the presence of significant tourism-related pedestrian activity.

7 Worked example

This section illustrates the use of the procedures through a hypothetical example. In this example, the practitioner is considering a zebra pedestrian crossing at two locations in Toowoomba:

1. Hume Street south of Stenner Street, adjacent to a local shopping centre and residential area, and
2. Vacy Street west of Mirle Street, adjacent to a major shopping centre and school.

The practitioner is interested in assessing the site likely to have the highest pedestrian demand.

7.1 Comparison method

There are currently very few zebra crossings in the database; however, all are in suburban areas not entirely dissimilar to the subject sites. The median weekday crossing demand for these sites is 134 pedestrians per day with a range from 117–339 pedestrians per day. The limited number of sites in the database precludes estimating demand for the two sites in Toowoomba separately.

7.2 Factoring

Step 1: Observed demand

Assume pedestrian counts were obtained from 6am–6pm at each of the two subject sites over three typical weekdays. Assume average weekday demand at Hume Street was 150 pedestrians / day and, on weekends, was 100 pedestrians / day within 50 m of the potential crossing location. Further assume the average weekday demand at Vacy Street was 200 pedestrians / day and 20 pedestrians / day on weekends.

Step 2: Purpose split

Assume on weekdays the demand at Hume Street is evenly split between transport and recreational walking, on the basis that the local shopping centre will generate and attract transport walking activity. On weekends, assume there is more recreational walking, such that 70% of pedestrian crossing events are for recreation. Vacy Street pedestrian demand is likely to be dominated by school students and those accessing the nearby shopping centre. Assume, on weekdays, that more trips are for transport (80%), but that this share is much reduced on weekends (20%).

Step 3: Pre-existing walking

The zebra crossings are assumed to have only a marginal effect on walking activity; they are unlikely to encourage mode shifting towards walking but may encourage pedestrians to cross at this location as opposed to elsewhere along the street. Assume, at Hume Street, that 80% of crossing events for recreation after the zebra crossing is installed would have occurred here anyway, and that 90% of transport walking did similarly. A higher proportion is assumed for transport on the assumption that these pedestrians are likely to be more time-sensitive and less likely to divert to use the crossing. Assume the same pre-existing walking shares for the Vacy Street location.

Calculations

Using these assumptions and the procedure documented in Section 4, the average weekday demand will be:

$$D_{hume} = \frac{1}{0.50 \times 0.80 + 0.50 \times 0.90} \times 150 = 176$$

$$D_{vacy} = \frac{1}{0.80 \times 0.80 + 0.20 \times 0.90} \times 200 = 227$$

The average weekend demand will be:

$$D_{hume} = \frac{1}{0.30 \times 0.80 + 0.70 \times 0.90} \times 100 = 120$$

$$D_{vacy} = \frac{1}{0.20 \times 0.80 + 0.80 \times 0.90} \times 20 = 24$$

Under these assumptions, the best estimate is that weekday demand will increase by 18% or 26 pedestrians/day at Hume Street and by 14% or 27 pedestrians/day at Vacy Street.

7.3 Direct demand

The direct demand model can only practically be implemented using the online tool at https://pedtools.com.au/forecasts. Doing so gives the forecasts shown in Table 7.3. The model estimates demand at Vacy Street of 342 pedestrians per day compared to 228 pedestrians per day at Hume Street. There are a number of factors contributing to this higher estimated demand at

Vacy Street, of which the most significant are the much larger retail area within the catchment and higher walking mode share for travel to work. The population is also higher than for Hume Street, but total employment and school students are lower for Vacy Street.

Table 7.3 – Direct demand forecasts for example sites

		Site	
		Hume Street	**Vacy Street**
Weekday demand (6am–6pm)	Estimate	228	342
	95% confidence interval	172–283	253–431
Catchment (within 2 km)	Population	95,054	139,694
	Employment	18,105	4751
	Students	6413	2718
	Walking mode share to work	3%	8%
	Retail floor area	2,069 m²	46,753 m²

7.4 Summary

The procedures provide three estimates for weekday demand:

1. the comparison method suggests demand of around 134 pedestrians per day, and a range from 117–339 pedestrians per day
2. the factoring procedure suggests demand at Hume Street of 176 pedestrians per day increasing to 227 pedestrians per day at Vacy Street, and/or
3. the direct demand procedure suggests demand at Hume Street of 228 pedestrians per day (with a 95% confidence interval of 172–283) and 342 pedestrians per day (95% confidence interval of 253–431) at Vacy Street.

In summary, the procedures appear to suggest demand at both sites will exceed 100 pedestrians per day and most likely be under 400 pedestrians per day, and the factoring and direct demand procedures are consistent, suggesting Vacy Street will have higher demand than Hume Street.

8 Conclusion

This guideline provides three procedures for forecasting pedestrian demand for new pedestrian infrastructure. The procedures should not be considered as definitive predictors of demand but rather reasonable indicators based on the current state of knowledge. The procedures are limited in several ways:

- there are very few sources of high-quality, multi-day pedestrian counts from which to develop forecasting procedures in Queensland
- detailed, up-to-date land use and pedestrian network spatial datasets covering all of Queensland are limited

- pedestrian demand is associated with a complex association of local population and socio-demographics, transport network and topography, land use types and distribution among numerous other factors – disentangling these factors, especially with the data limitations, remains an ongoing challenge, and
- the procedures are based on existing conditions in Queensland, where the pedestrian network quality and extent is often limited. These procedures are likely to underestimate demand associated with very substantial, widespread improvements in pedestrian infrastructure.

Given the limitations, practitioners should use these procedures as a guide and apply local knowledge to adjust the forecasts as appropriate to the local context. Practitioners should undertake multiday pedestrian counts to improve data quality, and that these data can be used to update and improve these procedures over time.