Performance indicators and measures for the place function of state highways and arterial roads in urban contexts

March 2015

Bridget Burdett, TDG
Catherine Mills, TDG
Judith Makinson, TDG
Julie Ballantyne, TDG
Will Thresher, Thresher Associates

NZ Transport Agency research report 567
Contracted research organisation – TDG

ISBN 978-0-478-44507-7 (electronic)
ISSN 1173-3764 (electronic)

NZ Transport Agency
Private Bag 6995, Wellington 6141, New Zealand
Telephone 64 4 894 5400; facsimile 64 4 894 6100
research@nzta.govt.nz
www.nzta.govt.nz

Burdett, B, C Mills, J Makinson, J Ballantyne and W Thresher (2015) Performance indicators and measures for the place function of state highways and arterial roads in urban contexts. *NZ Transport Agency research report 567.* 50pp.

TDG was contracted by the NZ Transport Agency in 2014 to carry out this research.

Keywords: destination, human scale, link function, measurement, place function

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Acknowledgements

The project team would like to thank the members of the Steering Group for their time and helpful comments:

- Luca De Marco, NZ Transport Agency
- Jacque Bell, NZ Transport Agency
- Sam Bourne, NZ Transport Agency
- Philip King, Tauranga City Council
- Robert Lipka, Auckland Transport

We would also like to thank our peer reviewers:

- Professor Glenn Lyons, University of the West of England, Bristol
- Hamish Mackie, Mackie Research

Abbreviations and acronyms

AADT	average annual daily traffic
ARTISTS	Arterial Streets Towards Sustainability
AT	Auckland Transport
CAS	Crash Analysis System
CBD	central business district
GIS	geographic information system(s)
HCV	heavy commercial vehicle
LoS	level of service
LTMA	Land Transport Management Act
NACTO	National Association of City Transport Officials
NZ	New Zealand
ONRC	One Network Road Classification
RCA	road controlling authority
SH	state highway
TGSI	tactile ground surface indicator
vpd	vehicles per day

Contents

Executive summary

The NZ Transport Agency has a mandate within the Land Transport Management Act (LTMA) to contribute to an effective, efficient and safe land transport system in the public interest. These objectives are broad and complex. Measurement contributes to the understanding of how the NZ Transport Agency and other road controlling authorities (RCAs) in New Zealand balance objectives and deliver transport for all road users.

Measurement of link performance has a strong and clear history. Link performance is measured with traffic volumes, composition and speed data, and is collected extensively and effectively throughout the network. Measurement of place function is much less extensive in New Zealand. Defining what is meant by place function, and clarifying how its performance can be measured, enables transparency in communicating how competing objectives for land transport are balanced.

The purpose of this project was not to provide a means to directly trade off link and place function, or to establish targets or level of service thresholds for place performance. The aim of this research was to identify performance measures for the place function of state highways and arterial roads in an urban context. Steps to meet this aim included:

- providing an historical perspective to the design of roads and public places, and how this has changed in the last century
- discussing current approaches to road design and planning in New Zealand, and how place function contributes to these
- looking at how place function is considered in academic literature, regulations and guidance documents from the perspectives of urban design, land use planning, transport planning and traffic engineering, with a focus on relevance for urban roads
- identifying workable definitions of link and place.

As mobility increased throughout the twentieth century, roadway design parameters such as the number of lanes and road width were largely determined by demand/capacity formulas. This resulted in roads becoming wider as populations increased. This has had negative economic, social and environmental consequences including more vehicle-kilometres driven every day in cars, more congestion, more crashes, more pollution, more suburban sprawl and less walking. The place function of roads was not a primary concern during the rapid increase in vehicle-based mobility in the second half of the twentieth century.

Currently in New Zealand, there is an explicit acknowledgement of the importance of place function in road design. This is most prevalent in two documents, NZS4404:2010 *Land development and subdivision infrastructure*, which aims to promote liveable streets and urban design; and the One Network Road Classification (ONRC), which defines road assessment factors related to both link and place. However, NZS4404:2010 specifically excludes arterial roads and state highways from its scope, and performance measures for place defined in the ONRC are not as readily measurable as those for link performance. The ONRC is a document in development and at the time of this research was not complete or finalised. Therefore, despite place being an important consideration in transport policy and land use planning, difficulties with its measurement result in a less than clear assessment of how particular streets perform in terms of place function.

The review of literature highlighted the importance of considering link and place together. Although it was not the aim of this project to directly compare or contrast link and place performance, it was considered

helpful to define them both. Definitions of link and place were derived from a review of the literature in the context of their measurement for New Zealand urban arterial roads and state highways:

> *Link function is performance of a street in terms of its use as a movement corridor. It is measured by structure (capacity and designation for different movement modes), and by the extent and nature of movement (traffic volume and speed by mode, including rules and restrictions governing movement). Performance can be measured in-situ (actual movement performance) or appraised according to the desired link function of a street within a network.*
>
> *Place function is performance of a street in terms of its use as a destination. Place function is measured by structure (physical space and land use context); the extent and nature of activity taking place (including rules and restrictions governing this activity); and the number and nature of users of the street. Performance can be measured in-situ (actual place performance) or assessed according to the desired place function of a street within an urban area.*

Potential indicators for the measurement of place function were found based on a review of academic literature from urban design and transport; from local and international guidance and policy documents associated with land use and transport planning; and from factors associated with road design and traffic engineering. These indicators are summarised according to their relevance to place function, and how readily available they are. They enable desktop review of quantitative, transport-specific aspects of place in a framework. In line with the project aims, the research has not resulted in a measurement framework that defines level of service for place, or that gives an indication of what quantitative indicators mean in terms of 'good' or 'bad' place performance. Rather, the tool provides an initial perspective on the relative contribution of transport metrics to relative place performance of road sections.

The framework assessment of quantitative indicators of place performance was trialled with three case study street sections. The assessment included only those measures that were readily available. The relative place performance scores for each site are summarised in table ES.1.

Table ES.1 Place performance measurement for case study sites

Case study site	Dominion Road, Auckland	Normanby Road, Paeroa	Greenwood Street, Hamilton
Place performance score	+5	+12	-34

The assessment framework shows there are readily available measures of place, and other indicators that require specific data collection. The measurement framework shows promise as a tool to help transport planner and practitioners to:

- understand the existing place performance of streets within a network
- identify whether or not a site-specific, qualitative assessment is warranted
- identify place performance detriments for particular streets as a whole
- determine the relative ease of improving place performance, based on different performance measures.

Ultimately, measurement of place following a framework such as that proposed by this research has potential to help the NZ Transport Agency contribute to an effective, efficient, and safe land transport system in the public interest.

The measurement framework presented in this research provides a useful tool for the transport industry to better understand place performance of urban arterial roads and state highways. The process would

benefit from continued refinement through application to a wider variety of sites. In particular, it is recommended that:

- The place performance measurement framework be applied to a wider sample of streets, including those in different land use contexts of major urban, regional urban and rural centre streets.
- Different weightings and scores for different factors be investigated to adapt the framework to best suit a variety of RCA contexts.
- The process framework be used to identify streets that would benefit from secondary investigation (based on particular times of the day or year, or assessment of place for one-off events); and qualitative investigation, to provide more than an average overview of quantitative indicators of place performance.
- An analysis of user perceptions of overall place function be used in conjunction with quantitative data collection, to refine weightings in the performance measurement framework.
- This research and its findings be discussed within the wider transport industry, so that its direction can be most useful to practitioners across a range of RCAs.

It is crucial that the performance assessment matrix is considered in conjunction with the process framework. There is no way of understanding place performance based on quantitative transport metrics in isolation. The tool provides relative ranking, so that more investigation can identify sites that warrant changes made and business cases developed to improve place performance.

Abstract

Roads have a link function based on movement, and a place function based on being a destination in their own right. The transport industry has effective and reliable measures of link function, but place function has an unclear definition and no reliable or consistent means of assessment. This research involved the identification of potential indicators to measure the place performance of state highways and urban arterial roads. A place performance assessment framework was developed which includes quantitative assessment of transportation-specific indicators of place. Three case study streets were assessed using this framework. Their scores ranged from +5 to -34 out of a possible range of +/- 100. The framework shows promise as a tool to understand the existing relative place performance of streets within a network, so that the need for a more in-depth qualitative assessment can be assessed. It would benefit from refinement and application to a wider variety of sites. It is recommended that data collection be extended to include measures not currently readily available; an analysis of user perceptions of overall place function be used in conjunction with quantitative data collection; and that this research and its findings be discussed within the wider transport industry.

1 Introduction

The NZ Transport Agency has a mandate to provide an effective, efficient, safe, responsible and resilient transport system that supports a thriving New Zealand. These objectives are broad and complex. Measurement contributes to understanding of how the NZ Transport Agency (the Transport Agency) and other road controlling authorities (RCAs) in New Zealand balance objectives and deliver transport for all road users.

Within the land transport system, roads and roadsides have link and place functions. These contribute in different ways to meeting the broad objectives for transport. Measurement of link performance has a strong and clear history. Link performance is measured with traffic volumes, composition and speed data, collected extensively and effectively throughout the network. Measurement of place function is much less routine in New Zealand. Defining what is meant by place function, and clarifying how its performance can be measured, enables transparency in communicating how competing objectives for land transport are balanced. Measurement of place function also helps to prioritise investment fairly by providing data to support sound decision making.

This research project was carried out from July to December 2014 in New Zealand, based on local and overseas literature. The purpose of the project was not to provide a means to directly trade off link and place function, or to establish targets or level of service thresholds for place performance. The aim of this research was to identify performance measures for the place function of state highways and arterial roads in an urban context.

2 Literature review

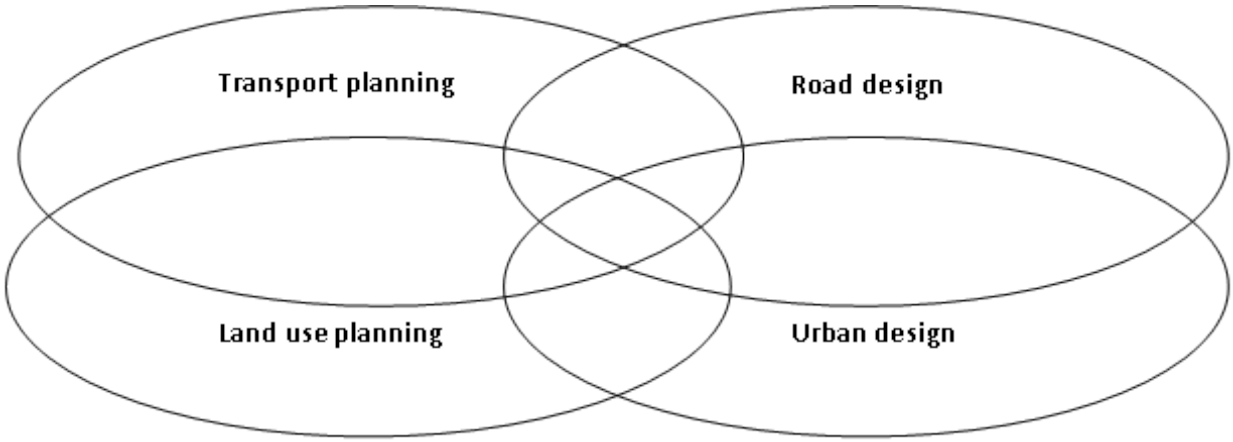
The aims of the literature review were to:

- provide an historical perspective to the design of roads and public places, and how this has changed in the last century
- discuss the current approaches to road design and planning in New Zealand
- present an overview of how place function is considered in academic literature, regulations and guidance documents from the perspectives of urban design, land use planning, transport planning and traffic engineering, with a focus on relevance for urban roads
- disseminate the literature into workable definitions of link and place
- identify useful indicators and measures for place function to trial in the case studies.

Place and its measurement is a complex topic spanning several disciplines. From the perspective of planning and design for transport, a sense of place is increasingly recognised as important, in particular in planning and design for walking. However, transport system planning and design has largely focused on roads and motor vehicles in recent decades.

To provide context, this review summarises literature from urban design, land use planning, road design and transport planning. Place is present at the crossover of all four of these disciplines, as well as others. Figure 2.1 provides a simplified summary of the way urban design, land use planning, road design and transport planning interact. Place function can be considered from any of these perspectives individually, and all domains have perspectives to offer when considering ways to measure place. The purpose of presenting the literature summary by these headings is to provide perspective for different practitioners and researchers, and to highlight that these differences in approaches can be used to provide the indicators that are both meaningful, from different perspectives, and relevant as transport industry metrics. Transport industry practitioners can then understand and evaluate place function alongside the more traditional and better understood evaluation of link function.

Figure 2.1 Interaction of urban design, land use planning, road design and transport planning



2.1 Background

2.1.1 Evolution of 21st century streets

Until the twentieth century, place function was paramount and implicit on urban streets. These roadways were primarily places of interaction and of trade; 'vessels of urban activity' (Plowright and Marshall 2004). A diverse range of activity continues to take place today on many urban streets. However, in developed countries such as New Zealand, pedestrians have been largely consigned to footpaths and designated road crossings on urban arterial streets since the 1920s; for the last one hundred years, there has been a progressive increase in the dominance of motor vehicle traffic on urban roads, with a subsequent change in the nature of street-level activity (figure 2.2).

Figure 2.2 Interaction of urban design, land use planning, road design and transport planning

Note: Evolution of function of New Zealand urban streets. 1: Christchurch, intersection of High Street and Colombo Streets, circa 1884; 2: Beginning of separation of pedestrians and traffic, Wellington, circa. 1920; 3: Victoria street, Hamilton, 1950; 4: Queen Street, Auckland, 2014.

Photo sources:

http://lostchristchurch.org.nz/high-street-and-colombo-street-junction

www.teara.govt.nz/en/photograph/20677/directing-traffic

www.teara.govt.nz/en/photograph/24987/cars-in-hamilton

http://epickup.co.nz/tag/queen-street/

Internationally, the nature and function of road space has changed over the last century, resulting in changing ways to measure and categorise different types of roads. Around the same time as pedestrians were shifted more exclusively to footpaths, town planners began to separate roads that perform a through-movement function from neighbourhood streets that foster community activity (New York Regional Survey, cited in Appleyard 1980).

During the 1960s and 1970s, functional classification of roads was criticised for its lack of a place function, resulting in a severely reduced and oversimplified choice of thoroughfare types. There was limited concern for pedestrians or for the environmental quality of streets and their contexts. Roadway design parameters such as the number of lanes and road width were largely determined by demand/ capacity formulas, which resulted in roads becoming wider as populations increased. This has had negative economic, social and environmental consequences including more vehicle-kilometres driven every day in cars, more congestion, more crashes, more pollution, more suburban sprawl and less walking (Aurbach 2009; Jacobs et al 2003; Kulash 1996; LaPlante 2007).

2.1.2 Current situation: road performance and function

A European review of the ways different RCAs now classify streets found that transport measures dominate and classification relates largely to vehicular traffic (ie link function), with very little inclusion of activity or even of walking and cycling at the arterial scale (Svensson 2004). Perhaps due to complexities in defining place function, the role of streets as public space was found to be 'more or less entirely absent' in classification criteria (Plowright and Marshall 2004, p5C3.6).

In New Zealand, the focus on design for capacity is largely informed by standards such as the Austroads guides to engineering practice and their New Zealand supplements (Austroads 2014; NZ Transport Agency 2014d). Typically, designers have used separate documents to inform road and pavement design from those used to design for pedestrians, cyclists and urban amenity. Therefore, the overall place function of any particular road section has not been assessed holistically.

Two relatively recent mechanisms to address the lack of holistic overview of link and place in road design are the development of the New Zealand Standards NZS4404:2010 *Land development and subdivision infrastructure* (Standards New Zealand 2010) and the NZ Transport Agency One Network Road Classification (ONRC) (NZ Transport Agency 2014a). NZS4404 aims to encourage holistic, sustainable development, incorporating urban design principles to create better spaces. The ONRC is a document under development. It aims to provide a more holistic assessment framework for roads, incorporating movement of people and goods as well as economic and social performance criteria.

2.1.3 NZS4404:2010 Land Development and Subdivision Infrastructure

Guidance for design that considers the 'place and link context' of roads is provided in NZS4404:2010. The land development and subdivision infrastructure standard was revised from its 2004 version with a refreshed emphasis on the context of infrastructure in the community. In the chapter on road design, the standard states 'the two fundamental roles of a road are to provide a space for interaction between people for a range of purposes and access to land uses so that movement between places can occur' (p61). This description provides a strong directive for designers to consider people and their interaction in conjunction with the movement of vehicles. Different types of land use (for example, 'live and play' and 'shop and trade') are described in the standard according to how transport can be incorporated to balance link and place in rural, suburban and urban environments. However, the standard also states that 'arterial roads and motorways are not included in this standard' (p64). Therefore, the place function of arterial roads in urban contexts is outside the scope of this standard.

2.1.4 One Network Road Classification

The ONRC is currently being developed to provide a standard categorisation of roads across New Zealand. Consideration of the ONRC as part of this research project has been to provide additional context only and it is recognised that the categories and assessment matrices discussed in this section are subject to on-going discussions and may change in the future. It is also recognised that the definition of place function

and performance in the ONRC is *different* from the way place is considered in this research. Within the ONRC, place refers in particular to important places and the way they are accessed, in particular connectivity for remote regions, critical routes, ports, airports, tourism destinations and hospitals. The ONRC does not have any clearly defined performance metrics for place function.

The classification currently has two assessment matrices (functional criteria and customer level of service descriptions) and a set of performance measures. The first assessment matrix includes functional criteria for categorising streets. This matrix includes reference to factors more associated with link and those more associated with place. Link factors are clearly defined according to traffic volume and composition (heavy vehicles) for example. Place factors, for example 'Active modes', are less clearly defined. 'Significant numbers of pedestrians and cyclists' is used as a criterion to potentially reduce a road from 'regional' to 'arterial' classification, but no definition of 'significant' is provided. The categories and criteria are:

- national
- regional
- arterial
- primary collector
- secondary collector
- access.

As a functional classification, it is unsurprising that the categories are presented in descending order of traffic volume. This annual average daily traffic (AADT) criterion is not essential for classification, but the nature of the matrix means it is easier to classify streets by their link than by their place function.

The second criterion informing classification is customer levels of service (LoS) (NZ Transport Agency 2014b). Within the associated (provisional) assessment matrix, place function is most obvious in the 'accessibility' criterion. Land use access for road users is described according to the nature of restriction. For national, regional and arterial roads, there are expected to be restrictions to access, because of the dominant link function of these roads. Roads in the 'arterial' category can be 'mixed use', resulting in a potentially wide range of levels of access, travel speeds and traffic compositions in this category in particular.

Performance measures and targets for the ONRC are provided to link functional and LoS categories to decision making (NZ Transport Agency 2014c). The measures are new and not fully implemented. Over time RCAs will be required to report on a variety of outcome, output, input and efficiency measures relating to performance of their roads according to ONRC criteria. Input and efficiency measures relate primarily to how RCAs deliver the road network. Outcome and output measures have their own assessment matrices, incorporating the following factors:

- Outcome measures: primary means of quantifying performance of the network in terms of customer outcomes:
  - value for money: efficient and effective maintenance of the roading network to deliver other LoS outcomes
  - safety: roads and roadsides are becoming safer to drive on, and are maintained in a way that means drivers feel safe using them
  - resilience: acceptable level of journeys impacted by unplanned events; acceptable level of effort put into roads where necessary due to unplanned events

  - amenity: ride quality meets customer expectations
  - travel time reliability: travel time is predictable relative to the importance of the road
  - accessibility: road, corridor and traffic composition are appropriate for land use served
- Output measures: defining what the customer needs and how it will be provided:
  - efficiency: affordable customer levels of service and value for money
  - safety: how road users experience the safety of the journey
  - resilience: the availability and restoration of road function when there is a weather or unplanned emergency event
  - amenity: the level of travel comfort and road user experience
  - travel time reliability: travel time consistency
  - accessibility: ease of reaching destinations, including access to land and network connectivity.

In summary, existing performance measures for New Zealand roads within the ONRC being developed are extensive and complex. This highlights that place function is one of a raft of objectives served by roads. Separation of link and place function is particularly difficult for urban state highways and other urban arterial roads. The matrix assessment approach is a useful tool already used by transport professionals to balance competing objectives. A complementary assessment process for place has the potential to be helpful for policy makers and transport practitioners to evaluate place function within the context of competing demands.

2.1.5 International guidance example: NACTO

In addition to New Zealand-specific guidance, internationally guidance for street design is evolving to include a more holistic approach to considering link and place. The NACTO (2013) *Urban street design guide* is a recent example of international best practice.

The guide references hundreds of other research and guidance documents, giving practitioners the tools to promote evidence-based best practice. It separates its guidance depending on the type of street, for example 'downtown thoroughfare' and 'commercial shared street'. Within the guidance for each type of street, elements are described in descending importance as either 'critical', 'recommended' or 'optional'.

It is particularly relevant to note the NACTO guide advises that street design is complex and good engineering judgment should be applied in all cases. Thus overall, the guide combines clear descriptive advice around design elements, while promoting a wider, holistic view of the street as judged by industry practitioners.

2.2 Urban design aspects of place

Historically, discussion of place has had more prominence in urban design than in transport planning or in traffic engineering design. This section discusses the notion of place function from an urban design perspective, which has strong social and cultural influences. Gehl (1987) centred the discussion around public spaces in a social and cultural context. The difference between the link and place function of roads is clear from this perspective. Activity in urban places is described as either 'necessary', 'optional' or 'social'. Place function is largely related to activity in the 'optional' and 'social' categories, whereas necessary movement through a place (ie link function) is more clearly understood as an 'access and mobility' objective of road network planning.

In an international symposium, Gehl (2003) discussed how public spaces have operated in the past and what challenges we currently face in their development. Relevant points included:

- Public spaces have traditionally had three important functions in relation to the life of cities: as a meeting place for social exchanges; as a market place for trade; and as a connection/traffic space for access.
- Policies for public spaces in various cities have resulted in the following outcomes: the 'invaded city', where pedestrians are being squeezed out by cars; the 'abandoned city' where walking and public life have been completely phased out; and the 'reconquered cities', where several decades of investment and planning into high-quality public spaces have resulted in a better balance between traffic, market and meeting place issues.
- Activities in the city resulting from transport policies which are allowed to continue for a long period of time can dramatically change the character of the city, eg in terms of increasing public life or decreasing it through policies which favour the use of space for traffic and access.
- Due to the technological advances we have today (eg internet, email) and the privatisation of vehicles and property it is no longer a necessity for people to use public spaces for market/trade activities and as meeting places. Therefore, when people use public spaces now, it is usually because they like to, rather than they have to use them. It is crucial that public spaces are designed to be inviting to pedestrians to encourage high use of the public space, rather than being designed only with aesthetics in mind, which will only encourage the public space to become a show piece.

Gehl (2003) highlights that cities with successful places, including roads with a significant and positive place function, have strong programmes of measurement to support and justify investment in place. A number of policies to implement better public spaces are recommended, including the implementation of strategic monitoring surveys of public spaces within the city, detailing how the public space is used, how the use is changing over time, and where improvements are called for.

In a recent work, Gehl and Svarre (2013) discuss the design of public infrastructure to support sustainable twenty-first century cities. Several relevant aspects of measurement of place are discussed in this text. The authors argue that manual counting of people is a useful tool to contribute towards performance assessment, because the subjective overview provided by human assessment of people and place is important. However, as others have pointed out, this approach also has weaknesses, because any subjective assessment is implicitly biased toward the perspective of the assessor (Swanson 2014). Ultimately, a combined approach of objective, quantitative, subjective and qualitative assessment may provide the best overall performance measurement framework.

2.2.1 Liveable and sustainable streets

There are links between social and cultural aspects of place function and the liveability of neighbourhoods, communities and cities. In a study that has links with urban design and traffic engineering, Appleyard (1980) defines why and how local streets function within neighbourhoods. The study considers the ideal street from a dweller's point of view. The three main types of street network structures and regulations are examined, including the 'neighbourhood unit', the 'environmental area' or 'precinct' and the 'Woonerf'.

Appleyard (1980) found that neighbourhood units provide good protection from traffic but poor accessibility to transport, since the shopping/amenity centre of the neighbourhood unit is placed far from the arterial roads providing access to the neighbourhood. The precinct method uses the geometric alignment of streets to create protected neighbourhoods, so that arterial roads with a straight alignment provide access to external areas, whereas local roads with curvilinear geometric alignment provide access to households. The Woonerf method uses regulation and traffic control devices such as contrasting paving

and planter boxes to create a pedestrian-friendly environment on local roads, similar to the increasingly common 'shared space' design in New Zealand.

Importantly, this review concluded that standards used for traffic control devices primarily serve objectives of safe and fast travel, and that these standards should be reassessed to create more liveable streets. It is pertinent to note that over 30 years since this landmark work, planners and policy makers continue to use a range of clearly defined measures for traffic safety and efficiency. Although place function is increasingly mentioned in policy, it remains less easily quantified than link function, and therefore is less consistently or meaningfully assessed, particularly for state highways in urban areas and for arterial roads (NZ Transport Agency 2014a).

Some land use-related research has considered the relationship between the built environment and street liveability. For example, the ARTISTS project (Svensson 2004) included analysis of the usefulness of a range of measures of 'comprehensive sustainability' of arterial streets, including economic, social and environmental dimensions; all of which are arguably related to place function. For each dimension, measurable indicators were selected, for example commercial rents (economic); residential and working population (society); pollutants and noise levels (environmental). These measures were combined with 60 'descriptors' under headings of built form, regulation and management, and patterns of use. The measures and descriptors were trialled by five researchers across 40 case study streets to determine their effectiveness at measuring the 'comprehensive sustainability' of arterial streets.

The measurement process trialled by ARTISTS showed some promise and some limitations. In its favour was the finding that broadly, the criteria used for assessment were found to relate positively with the aims and principles adopted in guidance across different city contexts in Europe. That is, the project was successful to some extent in measuring what only existed beforehand as goals and policy statement. However, there were serious challenges around data availability. Only one measure (road casualties) was consistently available across all jurisdictions. Generally, it was concluded that measurement would need to be developed further before it could be adopted as a tool to prioritise street improvements in terms of their sustainability (or place function).

2.2.2 Walkability

Discussion of public spaces in urban design frequently involves consideration of walking and walkability, defined as 'the extent to which the built environment is walking friendly' (Abley and Turner 2011). For over 50 years walkability has been equated with strong place function and liveable spaces (Jacobs 1961). Walkability is particularly useful in consideration of indicators and measures of place for urban arterial roads because while walking for transport is a common metric, there are social and cultural influences on the desire to walk, and on the walking 'friendliness' of a particular place. Therefore, measuring walking is important for a range of transport and place objectives. The discussion of walkability in urban design defines walking as a social and cultural activity as well as a transport mode.

Ewing and Handy (2009) suggested that physical features, urban design qualities and personal perception all contribute to walking friendliness, or a person's desire to walk in a place. It is important to define measures relating to 'desire to walk' given that Gehl (2003) highlighted the importance of desire over necessity in peoples' presence in public spaces. Ewing and Handy (2009) derived five measures of walkability:

1 Imageability: a distinctiveness in some aspect of the space; a factor most closely associated with a subjective 'sense of place'

2 Enclosure: factors such as fences and building defining an 'outdoor room'

3 Human scale: the extent to which building size and proportion, and speeds within the space, reflect human size and speed

4 Transparency: the degree to which people can see or perceive human activity beyond the edge of a street

5 Complexity: visual richness of a place.

These factors were disseminated by a panel of urban design and planning experts, from a wider list of dozens of contender 'perceptual qualities' that define some aspect of the walking experience. The measures were tested on 48 video clips of public spaces, with over 100 'features' per scene assessed according to their contribution toward walkability. It is clear that this methodology of deriving social and cultural measures of place is comprehensive, but necessarily time-consuming and complex.

In a recent investigation of the relevance of walkability measures, Gilderbloom et al (2015) studied the impact of walkability on a neighbourhood's sustainability, within the context of housing values, foreclosures and crime. The study used 'walkscores' to assess 170 neighbourhoods in Louisville, Kentucky. The study concluded that walkability was statistically correlated with increased housing values and reduced foreclosures for each neighbourhood, and that increased walkability was correlated with reduced crime. That is, high walkability is desirable, and therefore could have positive correlation with the success of the place function.

Developments in the measurement of walkability have resulted in a range of tools to assess the attractiveness of particular routes according to different measures. The walkscore used in the Gilderbloom et al (2014) study was derived according to a procedure validated by Duncan et al (2011), using an assessment of proximity to amenities such as schools and shops. A geographic information system (GIS)-derived 'walkability scale' includes a measure of access to destinations based on residential and intersection density, land use and retail floor area (Frank et al 2006). A New Zealand 'walkability' score has been developed based on similar measures (Abley and Turner 2011). However, the walkscore values proximity (a measure of ability to walk); whereas walkability includes measures of attractiveness (the desire to walk). The relationship between walkability, walking for transport, and the role of both in the measurement of place function remains unclear (Manaugh and El-Geneidy 2011).

2.2.3 Potential indicators of place function from urban design context

Table 2.1 lists potential indicators of place function from urban design literature and guidance. Measures are described as 'quantitative' when they can be measured according to a numeric scale. Categorical measures require further definition of categories. Different measures will have different relationships between the number and nature of categories, and how these relate to place function.

Table 2.1 Indicators of place function from urban design context

Measure	Description	Availability and relevance ✓✓ Direct relevance to place function ✓ Indirect relevance to place function		
		Readily available: existing dataset	Sometimes available; on request or with minimal investigation	Requires collection: not currently collected
Pedestrian dwell time	Quantitative measure: average and/or 85th percentile amount of time spent in the place by pedestrians			✓✓
Surface texture of walking space	Categorical measure: asphalt, concrete, paved or 'green' surface texture		✓	
Amount of planting	Categorical measure		✓	
Amount of greenery	Categorical measure		✓	
Commercial rent	Quantitative measure: average commercial rent $/m^2/month		✓	
Local resident population	Quantitative measure: number of residents in defined catchment/Census meshblock	✓		
Local commercial population	Quantitative measure: number of businesses in defined catchment/ Census meshblock	✓		
Pollutants	Quantitative measure of air pollution			✓
Noise levels	Quantitative measure of noise levels			✓
Walkability index	Categorical measure: walkability index according to defined criteria			✓✓
Walkscore	Categorical measure: 'walkscore' according to defined criteria			✓
Imageability	Categorical measure: space distinctiveness			✓
Enclosure	Categorical measure: fences, walls, buildings defining outdoor 'room'			✓
Human scale	Categorical measure: extent to which space fits human scale		✓	
Transparency	Categorical measure: perception of activity continuing beyond street edge			✓
Complexity	Categorical measure: visual richness			✓

Indicators from urban design are potentially the most meaningful descriptors of how roads actually perform in terms of place function; however, most of these rely on data that is not routinely collected or even clearly defined.

2.3 Land use planning

2.3.1 Land use descriptions

The nature of land use adjacent to a road link can be an indicator of actual or potential place function. Land use categories can be broad (a small number of categories) or refined (a larger number of categories) according to the road network complexity, and desired outcomes from the analysis. For example, the following six land use categories have been used in New Zealand to compare place and link functions (Christchurch City Council 2014):

- rural (agricultural and undeveloped areas)
- semi-rural (transition between rural and urban and peri-urban)
- urban (industrial) (industrial areas and suburban office parks)
- urban (residential) (built up area within the city limits including urbanised settlements on Banks Peninsula and excluding the central city)
- urban (centres) (key activity centres, retail or commercial centres, significant public facilities (such as the University of Canterbury), and the central city (within and including the four avenues, except for the central business district (CBD)), or
- urban (CBD) (the compact central business district, as defined in the draft Central City Recovery Plan (bounded by Manchester Street, Lichfield Street and the Avon River)).

In addition to the type of land use ranging from rural to urban, the nature of facilities within the area is also important for place. Examples include the presence of 'regionally significant facilities', presence of schools, and places that serve 'town centres' (Auckland Transport 2014). Property leasing values and retail occupancy rates can also serve as an indicator of place. The purpose of defining these land uses in conjunction with factors describing movement function is to classify a road network, so that investment can be prioritised according to different levels of service requirements for different boxes in the matrix.

An advantage of land use description as an indicator of place is that the information is readily available, stored by local authorities and typically accessible online or from brief observation from the road. However, a disadvantage is that land use is an indirect measure of place, because it does not portray how the road is actually used by people.

2.3.2 Catchment descriptions

One of the common measures of place is a broadly geographic, land use measure; the 'geographical scale of the destination it serves' (UK DfT 2007). This can be used to inform both the place and movement functions for a particular road segment on a place/movement matrix. Movement function can be defined by the size of the catchment where the majority of vehicles come from for any particular link. Place function can be defined by the size of the catchment where the majority of people in the space come from.

An advantage of the catchment method of measuring place function is that it captures the nature of people using the space, and therefore its relative significance as a place, relative to other streets in the network. Catchment served is an example of a direct indicator of actual use of a road as a place. A disadvantage of catchment served is that it relies on labour-intensive qualitative data collection methods (that is, asking people where they travelled from).

2.3.3 Potential indicators of place function from land use

Table 2.2 lists potential indicators of place function from land use literature and guidance.

Table 2.2 Indicators of place function from land use

Measure	Description	Availability and relevance ✓✓ Direct relevance to place function ✓ Indirect relevance to place function		
		Readily available: existing dataset	Sometimes available; on request or with minimal investigation	Requires collection: not currently collected
Land use category	Categorical measure: eg rural, suburban, urban; residential, commercial, industrial; school, church, town centre.	✓✓		
Significant facilities	Categorical measure: number and nature of locally/regionally/nationally significant features or facilities, for example buildings, function centres.		✓	
Catchment served	Categorical measure: origin of people within the space; how far are people willing to travel to participate here.			✓✓

The land use category and catchment served measures are both directly relevant to measuring the performance of place function but require data that is not currently collected in a consistent way across RCAs.

2.4 Road design

Most of the operational focus on place function from the perspective of traffic engineering is found in policy and guidance manuals, with reference to desirable infrastructure standards that promote a sense of place. Principles that support a strong place function are used to inform design whether or not place function is mentioned as a specific outcome, for example, carriageway cross-section and design speeds.

As an example, guidance that mentions place function for roads also typically places pedestrians as the first consideration in any user hierarchy (eg UK DfT 2007). Qualitative and quantitative measures can be used on existing streets to assess whether or not pedestrians are the dominant mode on any street, in terms of their presence (volume), priority and provision given for their use of the street as a place. These transport metrics are different from the more qualitative 'walkability' measures discussed as part of urban design above.

A useful infrastructure measure of place potential is footpath widths and their provision for different activity. Figure 2.3 (from UK DfT 2007, p68) demonstrates this.

Figure 2.3 Example of guidance that can be used as performance indicator: footpath width

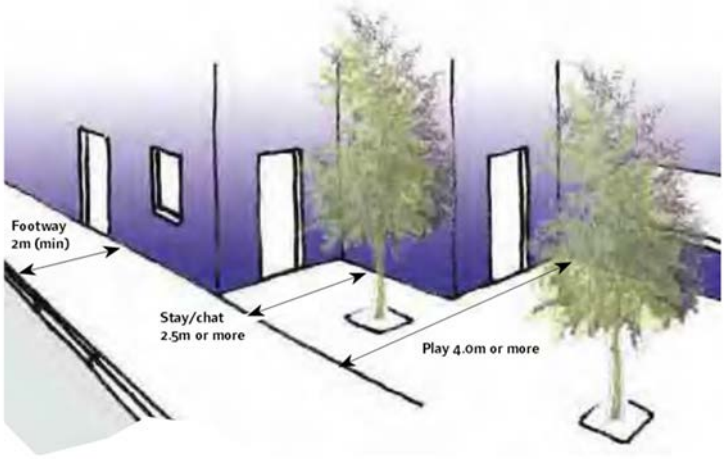


Figure 6.8 The footway and pedestrian areas provide for a range of functions which can include browsing, pausing, socialising and play.

Source: UK DfT (2007, p68)

A disadvantage of infrastructure measures is that in isolation they do not necessarily correlate with place performance measures. That is, the 'potential' place status does not necessarily correlate with how it is used by people. This factor further emphasises the need for a range of quantitative and qualitative measures of place characteristics and place use, to best assess overall place function.

Consideration of place function and promotion of walking and cycling is typically (but not exclusively) discussed in traffic design guidance in relation to low-volume roads, (eg 'low-trafficked and local streets', (Government of South Australia 2012)) and/or those with a lower movement function in a road hierarchy (eg 'Arterial roads…are not included in this Standard' from Standards New Zealand (2010, p60). The outcome of this focus on local roads in guidance results in some statements that may seem incongruent with state highways or arterial roads in urban areas, for example 'Pedestrians and cyclists should generally be accommodated on streets rather than routes segregated from traffic' (UK DfT 2007, p42). Therefore, reliance on guidelines alone to assess place function could result in an impractical attempt to consider all state highways and arterial roads in terms of people interacting with traffic. Alternatively, application of place function only to local residential streets or shared zones results in no acknowledgement of the intermediate place functions of a range of urban roads.

There are several design indicators that promote pedestrian use of place, including the following from the *Pedestrian planning and design guide* (Land Transport NZ 2007):

- footpath width
- footpath crossfall
- number of vehicle crossings that interrupt the footpath
- number and nature of pedestrian crossings
- presence of tactile ground surface indicators for the visually impaired
- presence of bicycle parking facilities
- extent of seating.

In addition to these infrastructure features, the number and nature of road users by mode (that is, number of pedestrians; whether or not pedestrians use mobility aids; number of cyclists; amount and nature of on-

road traffic (ie proportion of heavy vehicles; traffic volume and speed) is commonly collected by RCAs. It is helpful to include these metrics in the measurement of the performance of place, so that over time their relative contribution to place function can be better understood.

2.4.1 Potential indicators of place function from road design

Table 2.3 lists potential indicators of place function from road design.

Table 2.3 Indicators of place function from road design

Measure	Description	Availability and relevance ✓✓ Direct relevance to place function ✓ Indirect relevance to place function		
		Readily available: existing dataset	Sometimes available; on request or with minimal investigation	Requires collection: not currently collected
Footpath width	Quantitative measure: average/ minimum/ maximum footpath width within defined section		✓	
Footpath crossfall	Quantitative measure: average/ maximum footpath crossfall within defined section		✓	
Number of vehicle crossings that interrupt the footpath	Quantitative measure: number of vehicle crossings (driveways) in defined section		✓	
Number and nature of pedestrian crossings	Categorical measure: nature of crossing facilities (eg zebra/raised platform/ signalised crossing) within the section		✓	
Presence of tactile ground surface indicators for the visually impaired	Quantitative measure: number of crossings with tactile ground surface indicators (TGSIs) in defined section		✓	
Presence of bicycle parking facilities	Quantitative measure: number of bicycle parking spaces in defined section or per 100m		✓	
Extent of seating	Quantitative measure: number of seats in defined section or per 100m		✓✓	
Number of pedestrians	Quantitative measure: number of pedestrians per hour/day/month		✓✓	
Number of mobility-impaired pedestrians	Quantitative measure: number/proportion of pedestrians using a visible mobility aid			✓✓
Number of cyclists	Quantitative measure: number of cyclists per hour/day/month		✓✓	
Number of vehicles	Quantitative measure: annual average daily traffic volume	✓		
Number/proportion of heavy vehicles	Quantitative measure: annual average daily proportion of heavy commercial vehicles	✓		
Traffic speed	Quantitative measure: average/85th percentile traffic speed	✓✓		

Of the five metrics directly relevant to measuring the performance of the place function, four rely on data that is or may be available, and one requires data that is not currently collected.

2.5 Transport planning

2.5.1 Transport rules and regulations

Transport planning principles can also be used to estimate the existing place function for roads that were designed before consideration of place was central to their development, and to promote new road construction that communicates some desired level of place function. Transport planning rules and policy can prescribe levels of development and desired traffic composition (UK Department for Transport 2007). They also prescribe how streets are designated and constructed, and how they are used in terms of traffic, infrastructure and street furniture. Although measurement of place is not often explicitly considered in planning, road classification has direct and indirect influences on the nature of activity in a street and therefore on its place function. In particular, interaction between people and land use is an important component of the way that streets perform as place.

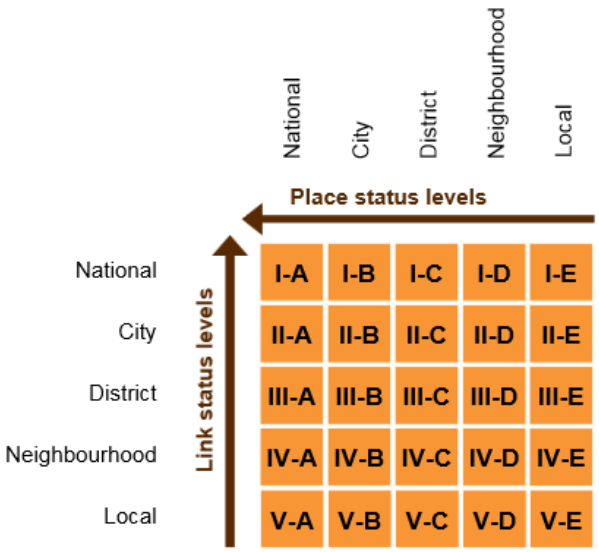
Some of the relevant rules, regulations and restrictions relevant to measurement of place function include:

- spacing of crossing opportunities
- frequency and duration of signalised pedestrian crossing opportunities
- presence of temporary street furniture, for example advertising boards
- nature and extent of street parking provided for or regulated against
- proximity of structures to traffic lanes, eg fences, buildings and poles.

2.5.2 Transport planning guidance

One of the most widely cited international guidance documents in transport planning is *Link and place: a guide to street planning and design* (Jones et al 2007; see also Jones and Boujenko 2009). The guidance recommends an approach to planning based on wider considerations than movement of traffic. Place function relates to the street as destination in its own right. Jones and Boujenko (2009) propose five categories of 'place status' (local; neighbourhood; district; city and national) to be used in a matrix assessment with link function assigned across the same categories (figure 2.4).

Figure 2.4 Link/place street classification matrix



Source: Jones et al (2007, example 6)

Using the assessment criteria in figure 2.4 can be assessed at a network level. For example, an urban arterial road might have 'city' link status and 'local' place status because it does not attract people from the wider district or city. The 'link status level' can be changed directly, through planning rules, or indirectly, by adding or removing traffic lanes, for example, and therefore changing the nature of trips through the link. The 'place status level' can also be changed through designation, or by changing physical features and land use that influence how the place is used.

Converting policy and guidance to practice and outcomes is a challenge when changes to design standards do not keep up with changes to policy. Garrick and Wang (2006) suggest that our design standards are lagging behind policy advancements. Changing the place status of an arterial road is an important example, given that the standards used for arterial roads are typically different (and more link-focused) to the more place-sympathetic guidance such as NZS4404:2010 that largely applies to local streets only.

2.5.3 Potential indicators of place function from transport planning

Table 2.4 lists potential indicators of place function from transport planning.

Table 2.4 Indicators of place function from transport planning

Measure	Description	Availability and relevance ✓✓ Direct relevance to place function ✓ Indirect relevance to place function		
		Readily available: existing dataset	Sometimes available; on request or with minimal investigation	Requires collection: not currently collected
Place status	Categorical measure: actual place status as measured by the origin of users (similar measure to 'catchment served' from land use indicators in table 2.2)		✓✓	
Link status	Categorical measure usually based on quantitative traffic volume data	✓		

The data required to measure the performance of the place function from a transport planning context is sometimes collected.

2.6 Definitions of link and place for measurement

As noted by Svensson (2004), although concepts such as classification and definition of place function are rather abstract, their measurement is important because they have 'very concrete consequences' (p5C3.3). In order to measure place function it is essential that these constructs are operationally defined. Given that place is almost always considered in conjunction with link function, a definition for link function is also included. These definitions have been developed as part of this paper for the purposes of trialling measures of the performance of the place function.

> *Link function is performance of a street in terms of its use as a movement corridor. It is measured by structure (capacity and designation for different movement modes), and by the extent and nature of movement (traffic volume and speed by mode, including rules and*

restrictions governing movement). Performance can be measured in-situ (actual movement performance) or appraised according to the desired link function of a street within a network.

Place function is performance of a street in terms of its use as a destination. Place function is measured by structure (physical space and land use context); the extent and nature of activity taking place (including rules and restrictions governing this activity); and the number and nature of users of the street. Performance can be measured in-situ (actual place performance) or assessed according to the desired place function of a street within an urban area.

2.7 Conclusions drawn from literature review

Traditional road classification results in an idealised polarisation of streets based almost primarily on link function, so that place function is considered only for local access situations such as shared spaces and pedestrian precincts. However, given that 'sustainable arterial streets' (Plowright and Marshall 2004, p5C3.7) (commonly referred to in New Zealand as 'mixed use arterial roads') are an important and prevalent component of urban road networks, the current challenge is to acknowledge their multiple functions with appropriate classification and measurement methods that reflect their true complexity. This paper is concerned with translating the intention of rules, regulations and guidance around street-level activity into measurable indicators that RCAs can use to evaluate 'place' performance of urban arterial roads and state highways in New Zealand.

From the literature review, it appears that measures of land use, people and traffic have not before been used in combination to provide an overall assessment of place function. To make these measures useful, some important considerations are required.

2.7.1 Actual or potential place function

Establishing a place definition for a section of road in an urban area can relate to its existing performance, or can reflect a strategic vision of the potential place function. These alternatives have been described as 'current' and 'desired' designations (Government of South Australia 2012). Measures proposed by this project will reflect the current operation of a section of road in terms of its place performance. This measurement does not preclude strategic analysis of 'desired' place function. A gap analysis of where this is different from existing performance will help to identify where improvements are desired, and scores for different measures will help to highlight areas for intervention.

2.7.2 Static and dynamic indicators

Some measurements are of static indicators, such as infrastructure measures (footpath width and presence of seating, for example) while others are dynamic, changing over the course of a day, week, season and across different years. Therefore, there are aspects of place that remain constant, and others that fluctuate depending on activity. A street may be an important arterial through-road during peak weekday periods, but may also be closed to traffic on occasion for a regional celebration; clearly the place function during these different situations will be markedly different. It is important that measures of place have flexibility to reflect different levels of activity.

2.7.3 Qualitative and quantitative data

Measures of place can be either quantitative or qualitative, which affects how they are weighted and ranked. Further research will help to establish relative indicators, so that qualitative measures (such as

land use descriptions or subjective feelings of 'place value') can be meaningfully compared with more quantitative measures such as traffic characteristics.

2.7.4 Existing and new data

Some of the proposed measures relate to data that is already collected (such as traffic volume and speed); some is not routinely collected but its collection method is inherent (such as pedestrian density or dwell time), and some requires novel data collection approaches. Therefore, different measures have different costs, which will affect their ease of uptake and the likelihood that they can become realistic measures of place function in the short term. It may be that proxy indicators of place function (based on existing data) are best used before measurement of place becomes a routine process on its own. Assessment of the usefulness, validity and cost effectiveness of different data sets is discussed in section 3.4.

2.7.5 Wider network considerations

Analysis of a street section without consideration of the wider network context ignores the broader land use setting of the local street and community. What qualifies as 'vibrant' pedestrian activity in a smaller rural centre, for example, may not be comparable to the same level of pedestrian activity within a busy metropolitan business district. Therefore it may be that only street sections in similar contexts (for example, large urban; regional centre; rural centre) should be compared in terms of place performance.

3 Place performance measurement framework

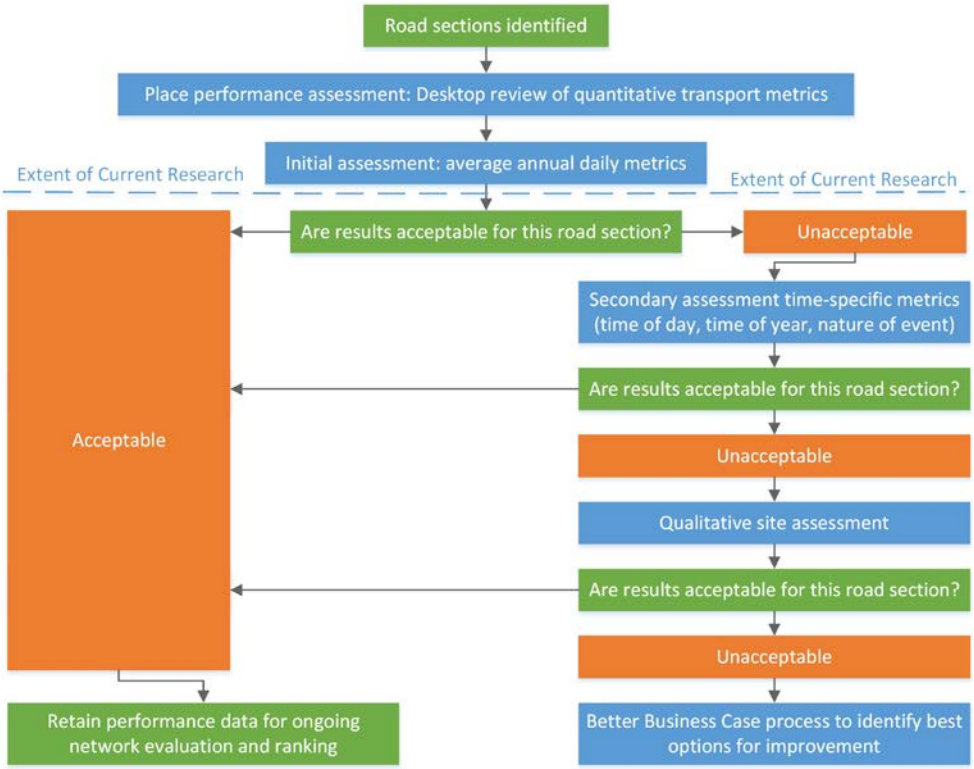
3.1 Measuring place performance: context of a quantitative assessment

Our research aimed to provide quantitative, transport-specific performance measures of place that can be used as a contribution toward assessment of place for urban arterial roads and state highways in an urban context. The previous sections summarised such performance measures from literature associated with urban design, land use planning, road design and transport planning.

It is crucial to note that the measures identified in this report do not suggest an overall 'good' or 'bad' place function. As demonstrated by the review of literature, place is a complex construct. Although there are quantitative variables that can provide insight into likely or relative place performance, the whole will always be greater than the sum of these discrete parts. Nevertheless, given that these indicators are readily available, and provided that they are considered in the context of an initial transport-specific measurement of place for a discrete situation, they can contribute toward a more comprehensive assessment of place for urban networks.

It is recommended that the measures defined in this paper be used as part of an overall place evaluation process, defined in figure 3.1. Factors affecting place performance such as time of day and isolated events, for example, can then be considered as and when required by the agency carrying out the performance assessment.

Figure 3.1 Place evaluation process including quantitative assessment as initial desktop study

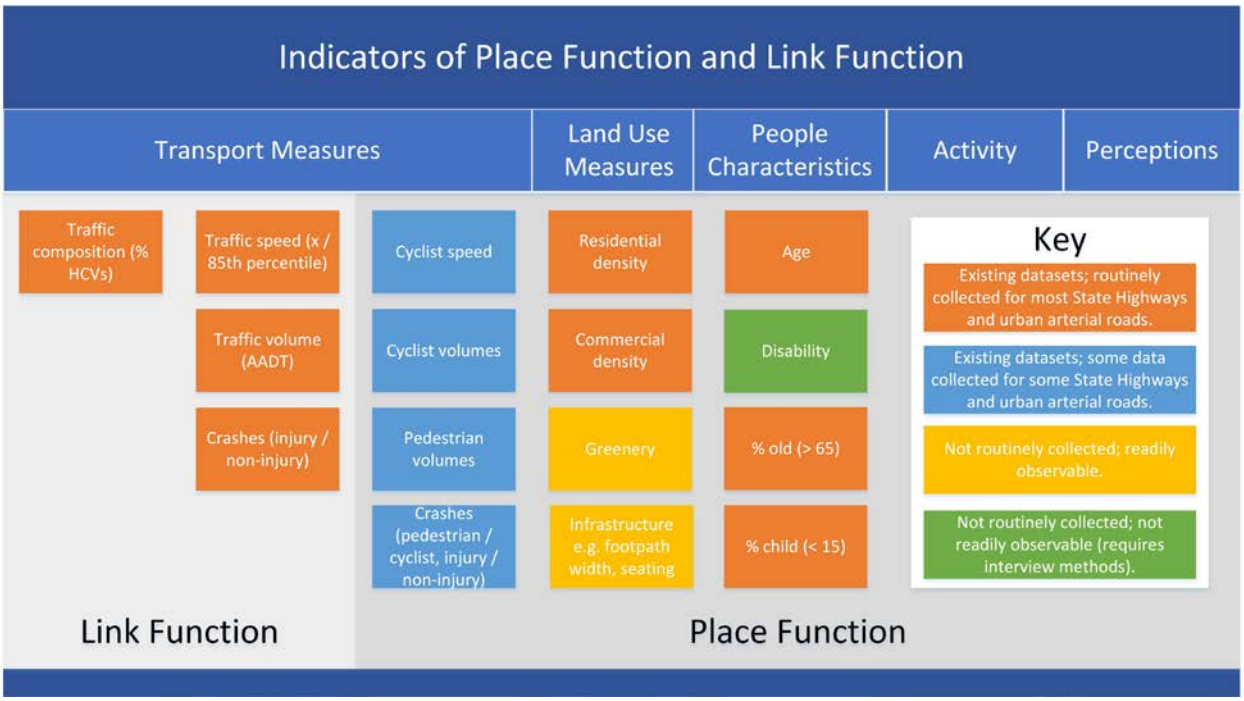


3.2 Place performance measures

Measures defined in this section are a result of the review of literature and subsequent definition of place function. In line with the purpose of this research, there are quantifiable transport metrics that can be used to provide an initial indication of relative place performance of a road section in terms of transport metrics. The initial assessment can be used to determine whether or not a more extensive investigation into the place performance of a particular link is warranted. The range of measures is then refined into 'readily accessible' measures (that is, those with data available for a desktop assessment) for application to case study New Zealand streets.

Figure 3.2 summarises potential measures of place function, gathered from the literature, and measures that are readily accessible but not explicitly derived from literature. There is some overlap between measures traditionally used to understand link function, and those that might describe place function. The more a measure relates to how people actually use a road as place, the more significant the measure is. Figure 3.2 also includes measures that are available but are not explicitly derived from literature. As discussed earlier, observable data is likely to be cheaper and easier to collect, because it is not dependent on subjective responses; it can be collected in person or from video (and therefore could be collected remotely by trained technicians); and its collection could therefore be more consistent across different road contexts.

Figure 3.2 Indicators of place performance



3.3 Performance framework: scores and weighting

This section discusses the performance measures selected for the quantitative assessment component of the framework. Performance for each metric is defined as positive (a score of +1), negative (a score of -1) or neutral (a score of 0). The divisions between positive, negative and neutral place performance are generally and necessarily arbitrary. They are provided so the overall score can be used to rank different street sections according to their average annual daily place performance. Over time, or for different

contexts, it may be that the weightings and score thresholds are changed. The purpose of this research and the way the matrix is presented is to provide a tool for initial assessment. Any overriding site-specific issues can be addressed with the recommended on-site, qualitative assessment, followed where necessary by a business case approach to investigate improvement options.

This assessment method has advantages and disadvantages. In its favour are that a clear overall place assessment 'number' can be derived, which enables ranking of different sites according to their place function. If some desired level of place performance is selected, current detriments can be identified and addressed. Furthermore, the relative ease of improving place function can be readily identified. For example, if a lack of greenery is contributing to a low score, more planting can be scheduled. If land use designation is contributing to a lack of place function, this is less easily changed, at least in the short term.

A disadvantage of this assessment method is that assessment categories are necessarily arbitrary. The method relies on data that is relatively easily collected, which ignores many central aspects of place as derived from the literature review. Finally, by summing individual components, the method ignores the overall 'sense of place' that may or may not be related to the sum of these individual components.

Over time, it is likely that the method, and relative weighting of different components, could be refined so the best balance of effort and outcome in measuring place can be reached. If a proposed method is time consuming and costly, with little real meaning, it is less likely to be adopted. However, if some usefulness can be found for a relatively low-cost initial measurement method, it can be refined over time to add more value, and to provide the best outcomes for the assessment of link and place for the New Zealand road network.

In terms of weightings for each criterion, these vary between 1 and 10, with 10 being the most relevant for measurement of place and 1 the least relevant. A points value of negative one (weak place function) results in a negative overall score and vice versa.

3.3.1 Transport measures

Scores and weightings for traffic volume, speed and composition are based on a general range of likely values for different urban sites around New Zealand. Traffic speed scores are based on survivability rates for collisions. The highest scores for speed, traffic volume and composition reflect what is typically found in the highest performing shared zones, where people and traffic frequently and successfully interact.

Performance measures in terms of safety for drivers, cyclists and pedestrians are based on the notion that in a safe system, there are zero deaths or serious injuries; good places will reflect this vision. Allowing one to two injury crashes in the 'neutral' category allows for the random nature of crashes, where there is limited statistical inference that can be made from one or two crashes across a typical five-year analysis period. However, where there are more than two injury crashes, causal factors affecting crash risk ought to be investigated, hence the low score for any sites where these higher crash rates are observed.

Cycle speeds reflect the use of a street section as place or more exclusively as a transport corridor. Although high volumes of cyclists and pedestrians could be using a particular link as a place, they are less likely to do so if it is not designed for their presence, hence the inclusion of volumes as well as speeds.

3.3.2 Land use and people measures

Residential and commercial density scores reflect the range of values likely to be observed on streets around New Zealand. These variables are an example of where 'good' performance might be different depending on the land use context (large urban, regional urban or rural centre). The scores and weightings in the base matrix are intended to be average across all contexts.

The greenery score is a basic assessment of the relative amount of planting that can be assessed with online mapping tools. Footpath width scores reflect street performance against best practice provision, while seating provision demonstrates the potential for the street section to work as a place.

The proportions of older and younger people active within the street section are perhaps the least readily available data, although these could be estimated during routine manual pedestrian counts. There may be data from local schools about the nature of travel to and from schools in the area which could contribute to these metrics. Bands for the people-specific scores are based on how the street section reflects the local community. Good performance equates to high diversity of people on the street, relative to the demographics in the local community.

3.3.3 Activity

Some authorities or commercial entities may collect information related to dwell time within a street, as part of routine pedestrian data collection methods or otherwise. The bands for activity represent the use of the street as a destination. Short dwell times are more likely to relate to the use of the street as transport. Longer dwell times are more likely to mean people are spending time in the street because of its inherent place qualities.

3.3.4 Performance matrix

The performance matrix presented below is an initial example of how performance metrics might be useful to evaluate place. It is intended to be trialled and refined so it becomes a validated, useful tool that RCAs can use to measure place performance for different contexts. Where no reliable data is available for any row, the criterion receives a neutral (zero) score.

Table 3.1 Place performance measurement criteria and weighting

		Place criteria measurement indices and units			Weighting: relative importance of criterion
		Low or weak place function (-1 point)	Medium or neutral place function, or no available data (0 point)	High or strong place function (1 point)	
Transport measures	Traffic composition (% HCVs)	>10%	2%–10%	<2%	5
	Traffic speed (85th percentile)	>50km/h	30–50km/h	<30km/h	8
	Traffic volume (AADT)	>10,000 vpd	5,000–10,000 vpd	<5,000 vpd	5
	Vehicle crashes (injury/non-injury) 2009–2013	> 2 injury crashes/5 years	1–2 injury crashes/ 5 years	0 injury crashes/ 5 years	4
	Cyclist speed	>10km/h	5–10km/h	<5km/h	4
	Cyclist volumes	<10 cyclists/hour	10–50 cyclists/hour	>50 cyclists/hour	4
	Pedestrian volumes	<100 pedestrians/ hour	100–500 pedestrians/ hour	>500 pedestrians/ hour	10
	Cyclist crashes (injury/non-injury) 2009–2013	>2 injury crashes/ 5 years	1–2 injury crashes/ 5 years	0 injury crashes/ 5 years	4
	Pedestrian crashes (injury/non-injury) 2009–2013	>2 injury crashes/ 5 years	1–2 injury crashes/ 5 years	0 injury crashes/ 5 years	6
Land use and people measures	Residential density	<500 persons/km^2	500–1,500 persons/km^2	>1,500 persons/km^2	5
	Commercial density	<500 persons/km^2	500–1,500 persons/km^2	>1,500 persons/km^2	5
	Greenery score	No greenery	Up to 1 plant or 1m^2 of planting per 50m length of street	>1 plant or 1m^2 of planting per 50m length of street	8
	Infrastructure: footpath width	Average footpath width <1m	Average footpath width 1m –2m	Average footpath width >2m	5
	Infrastructure: seating	No seating	One seat/100m footpath length	More than one seat/ 100m footpath length	7
	% old (>65)	Less than locally resident proportion by more than 5% (absolute)	Within 5% (absolute) of locally resident population proportion	More than locally resident proportion by more than 5% (absolute)	5
	% child (<15)	Less than locally resident proportion by more than 5% (absolute)	Within 5% (absolute) of locally resident population proportion	More than locally resident proportion by more than 5% (absolute)	5
Activity	Dwell time	<1 minute average dwell time per person	1–2 minutes average dwell time per person	> 2 minutes average dwell time per person	10
Overall place function score: sum of individual points x weighting					

3.4 Data collection considerations

3.4.1 Transport measures

Most state highway traffic volume and composition data is available from the Transport Agency website. In some situations, the traffic count survey site may be far from the section of state highway under consideration, so approximate AADT traffic flows can be obtained using data within the Transport Agency's Crash Analysis System (CAS), or by commissioning custom surveys.

Traffic data for local roads can usually be obtained from RCAs; however, there can be delays in obtaining data for these roads, or applicable data may not be available. Data on the number of pedestrians and cyclists using a road is also the responsibility of the RCA, and can sometimes be obtained on request, depending on whether or not the RCA collects this information. Data collection programmes for pedestrian and cyclist volumes tend to be undertaken on a smaller scale compared with traffic volume measurement programmes, so it is more likely custom surveys will be required to obtain relevant data for these. Cyclist speeds are currently not measured as part of transportation data collection programmes run by any RCA, so custom surveys using a radar gun (or similar equipment) are necessary to measure cyclist speeds.

Crash and injury data for all road users is available from CAS. It is recommended that either a five-year or 10-year crash search period is utilised for any site, to align with best practice when performing a crash search in crash reduction studies.

3.4.2 Land use measures

Data for calculation of approximate density for residential and commercial land around each of the case study sites can be obtained from Statistics NZ, including the names of the meshblocks adjacent to the site; the 'usually resident' population and employment of each of the meshblocks for residential and commercial densities, with the size of each of the meshblocks readily calculated using GIS. Scores for greenery and street infrastructure have been calculated using online mapping software.

3.4.3 Activity

Specific surveys using wifi or Bluetooth receivers could be conducted to collect dwell time data. Manual dwell time calculations can also be carried out as part of routine or one-off pedestrian surveys.

4 Case studies

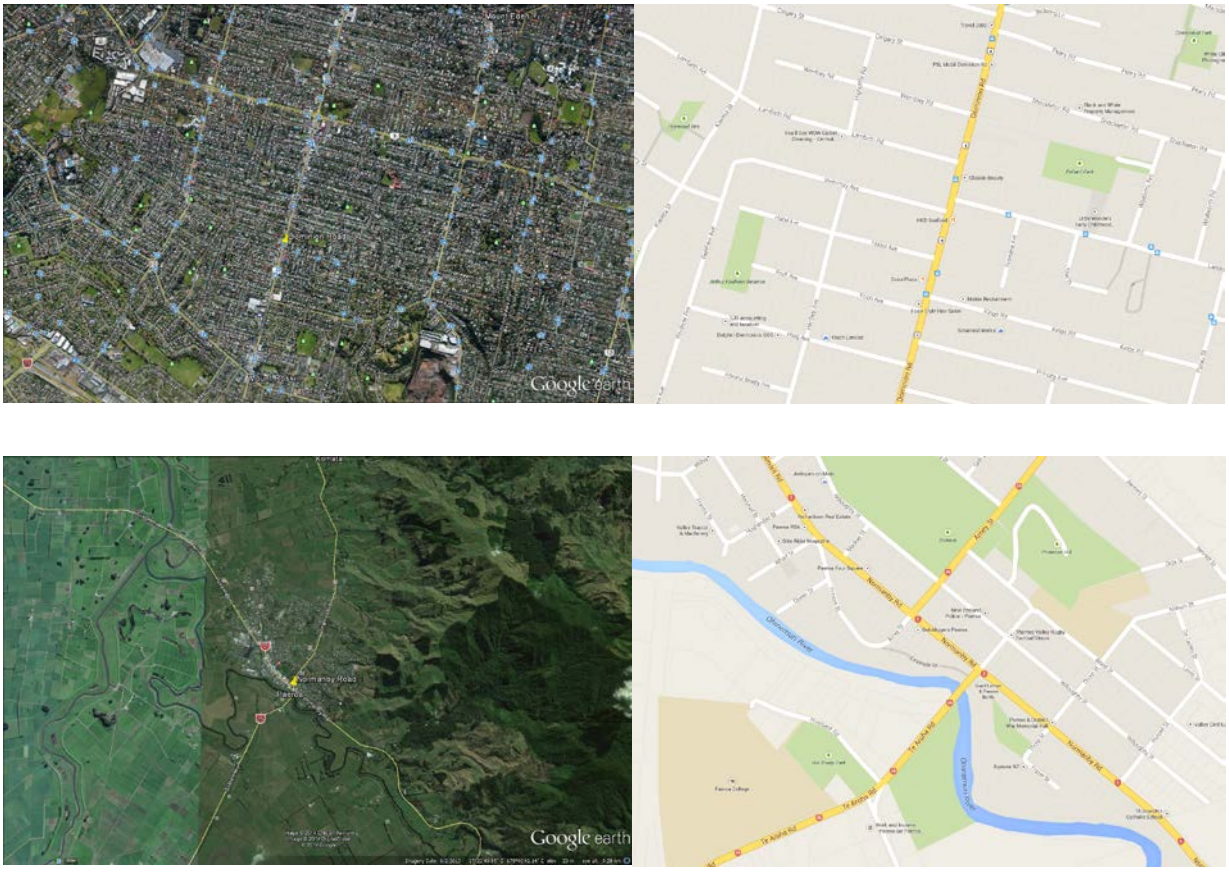
4.1 Case study locations

Three separate sites were selected for case studies of urban arterial roads and state highways in New Zealand, including:

- Dominion Road in Auckland, between Lambeth Road and Landscape Road
- Normanby Road (SH2/SH26) in Paeroa, between Te Aroha Road and Arney Street
- Greenwood Street (SH1) in Hamilton, at its intersection with Massey Street.

These sites were selected on the basis of being either a state highway or an arterial road in a non-rural setting (surrounded by residential and other land uses). Each site encompasses a different context in terms of adjacent land uses and urban population. The Dominion Road site has mixed residential and commercial land uses within a large urban centre (Auckland) and is a major arterial road carrying high traffic volumes. Normanby Road is a state highway that runs through a small rural town, with a mixture of residential and commercial land use. Greenwood Street is a busy arterial road and state highway in a mid-sized city (Hamilton), surrounded by predominantly industrial land use. Site locations are shown in figure 4.1 and 'Streetview'® images of each site are shown in figure 4.2.

Figure 4.1 Case study locations, from top: Dominion Road, Auckland; Normanby Road, Paeroa; Greenwood Street, Hamilton



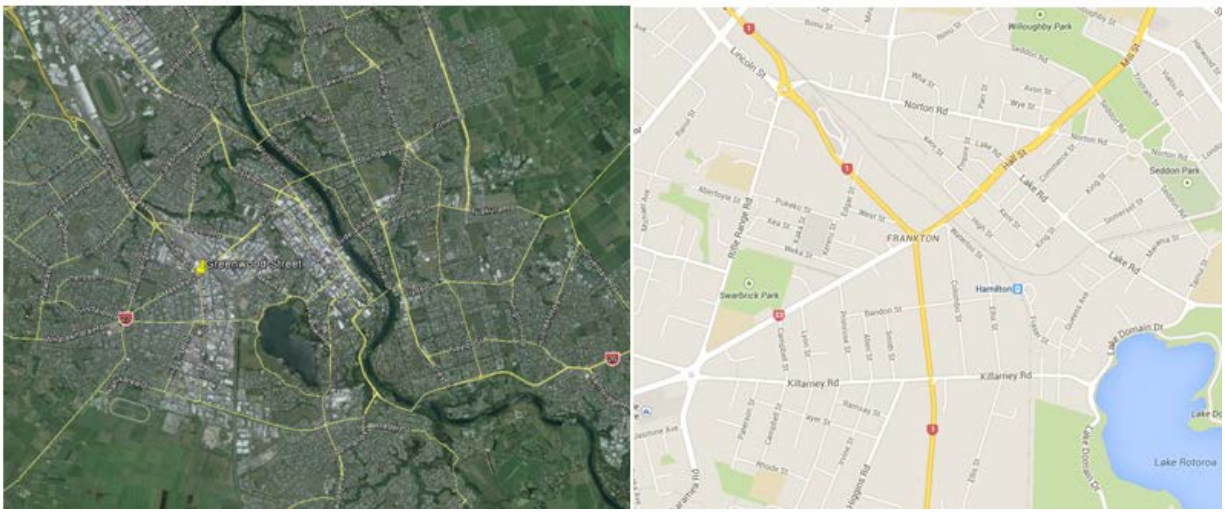


Figure 4.2 Case study Streetviews, from top: Dominion Road, Auckland; Normanby Road, Paeroa; Greenwood Street, Hamilton

Data for each of these sites has been collected where possible from RCAs in New Zealand. The measurement indices for which data has been collected or requested are shown in figure 3.2.

Information about the particular data sources for each site is included in appendix A.

4.2 Data summary

For each of the sites, data has been collected for a 200m section of road (100m along the road in each direction from the site). Specifying a particular section is necessary to create boundaries for measurement indices for greenery, and the activity indices should these be surveyed. Data collected from Statistics NZ was disaggregated to the area unit level. Table 4.1 shows data which has been collected or requested for each of the case study sites.

Table 4.1 Data collected for each of the case study sites

Measurement indices		Measurement area	Dominion Rd, Auckland	Normanby Rd, Paeroa	Greenwood St, Hamilton
Transport measures	Traffic composition (% HCVs)	Survey site	3.70%	7.50%	9.10%
	Traffic speed (85th percentile)	Survey site			
	Traffic volume (AADT)	Survey site	24,252 vpd	23,999 vehicles per day (vpd)	10,528 vpd
	Vehicle crashes (injury/non-injury) 2009-2013	100m along road from survey site	5 injury, 13 non-injury	6 injury, 30 non-injury	4 injury, 10 non-injury
	Cyclist speed	Survey site			
	Cyclist volumes	Survey site			
	Pedestrian volumes	Survey site			
	Cyclist crashes (injury/non-injury) 2009–2013	100m along road from survey site	0 injury, 0 non-injury	0 injury, 1 non-injury	1 injury, 0 non-injury
	Pedestrian crashes (injury/non-injury) 2009–2013	100m along road from survey site	1 injury, 0 non-injury	0 injury, 0 non-injury	1 injury, 3 non-injury
Land use measures	Residential density (persons/km^2)	Area unit(s)	3,528 persons/km^2 (+20.1% since 1996)	1,340 persons/km^2 (+7.4% since 1996)	310 persons/km^2 (-3.9% since 1996)
	Commercial density (persons/km^2)	Area unit(s)	640 persons/km^2	2,144 persons/km^2	153 persons/km^2
	Greenery	100m along road from survey site	Up to 1 plant or 1m^2 of planting per 50m length of street	>1 plant or 1m^2 of planting per 50m length of street	>1 plant or 1m^2 of planting per 50m length of street
	Footpath width	100m along road from survey site	Footpath width = 2.6m each side	Footpath width = 3.0m (east), 1.9m (west)	Footpath width = 2.8m each side
	Seating	100m along road from survey site	One seat/ 100m footpath length	No seating	No seating
	% old (> 65)	Area unit(s)	No data	No data	No data
	% child (< 15)	Area unit(s)	No data	No data	No data

4.3 Place performance for case study sites

Tables on the following pages summarise the place performance scores for each case study site, based on categories and weightings proposed. The score for each measure is low, medium/neutral or high, represented by bold text and shaded cells in the tables. These scores (-1, 0 or +1) are multiplied by the weighting to provide the score per measure in the column on the far right. A score in italics represents a category that was estimated because of a lack of available data.

4.3.1 Place performance of Dominion Road, Auckland

Table 4.2 Place performance, Dominion Road

		Place criteria measurement indices and units			Weighting: relative importance of criterion	Score
		Low or weak place function (-1 point)	**Medium or neutral place function, or no available data (0 point)**	**High or strong place function (1 point)**		
Transport measures	Traffic composition (% HCVs)	>10%	**2%–10%**	<2%	5	0
	Traffic speed (85th percentile)	>50km/h	***30–50km/h***	<30km/h	8	0
	Traffic volume (AADT)	**>10,000 vpd**	5,000–10,000 vpd	<5,000 vpd	5	-5
	Vehicle crashes (injury/non-injury) 2009–2013	**>2 injury crashes/ 5 years**	1–2 injury crashes/ 5 years	0 injury crashes/ 5 years	4	-4
	Cyclist speed	***>10km/h***	5–10km/h	<5 km/h	4	-4
	Cyclist volumes	<10 cyclists/hour	10–50 cyclists/ hour	***>50 cyclists/hour***	4	4
	Pedestrian volumes	<100 pedestrians/ hour	***100–500 pedestrians/hour***	>500 pedestrians/ hour	10	0
	Cyclist crashes (injury/non-injury) 2009–2013	>2 injury crashes/ 5 years	1–2 injury crashes/ 5 years	**0 injury crashes/ 5 years**	4	4
	Pedestrian crashes (injury/non-injury) 2009–2013	>2 injury crashes/ 5 years	**1–2 injury crashes/ 5 years**	0 injury crashes/ 5 years	6	0
Land use and people measures	Residential density	<500 persons/km^2	500–1,500 persons/km^2	**>1,500 persons/km^2**	5	5
	Commercial density	<500 persons/km^2	**500–1,500 persons/km^2**	>1,500 persons/km^2	5	0
	Greenery score	No greenery	**Up to 1 plant or 1m^2 of planting per 50m length of street**	>1 plant or 1m^2 of planting per 50m length of street	8	0
	Infrastructure: footpath width	Average footpath width <1.0m	Average footpath width 1m–2m	**Average footpath width >2m**	5	5
	Infrastructure: seating	No seating	***One seat/100m footpath length***	More than one seat/ 100m footpath length	7	0
	% old (>65)	Less than locally resident proportion by more than 5% (absolute)	***Within 5% (absolute) of locally resident population proportion***	More than locally resident proportion by more than 5% (absolute)	5	0
	% child (< 15)	Less than locally resident proportion by more than 5% (absolute)	***Within 5% (absolute) of locally resident population proportion***	More than locally resident proportion by more than 5% (absolute)	5	0
Activity	Dwell time	<1 minute average dwell time per person	***1–2 minutes average dwell time per person***	>2 minutes average dwell time per person	10	0
Overall place function score: sum of individual points x weighting						**+5**

4.3.2 Place performance of Normanby Road, Paeroa

Table 4.3 Place performance, Normanby Road

		Place criteria measurement indices and units			Weighting: relative importance of criterion	Score
		Low or weak place function (-1 point)	**Medium or neutral place function, or no available data (0 point)**	**High or strong place function (1 point)**		
Transport measures	Traffic composition (% HCVs)	>10%	**2%–10%**	<2%	5	0
	Traffic speed (85th percentile)	>50km/h	***30–50km/h***	<30km/h	8	0
	Traffic volume (AADT)	**>10,000 vpd**	5,000–10,000 vpd	<5,000 vpd	5	-5
	Vehicle crashes (injury/non-injury) 2009–2013	**>2 injury crashes/ 5 years**	1–2 injury crashes/ 5 years	0 injury crashes/ 5 years	4	-4
	Cyclist speed	>10km/h	***5–10km/h***	<5km/h	4	0
	Cyclist volumes	<10 cyclists/hour	***10–50 cyclists/hour***	>50 cyclists/hour	4	0
	Pedestrian volumes	<100 pedestrians/ hour	***100–500 pedestrians/hour***	>500 pedestrians/ hour	10	0
	Cyclist crashes (injury/non-injury) 2009–2013	>2 injury crashes/ 5 years	1–2 injury crashes/ 5 years	**0 injury crashes/ 5 years**	4	4
	Pedestrian crashes (injury/non-injury) 2009–2013	>2 injury crashes/ 5 years	1–2 injury crashes/ 5 years	**0 injury crashes/ 5 years**	6	6
Land use and people measures	Residential density	<500 persons/km^2	**500–1,500 persons/km^2**	>1,500 persons/km^2	5	0
	Commercial density	<500 persons/km^2	500–1,500 persons/km^2	**> 1,500 persons/km^2**	5	5
	Greenery score	No greenery	Up to 1 plant or 1m^2 of planting per 50m length of street	**>1 plant or 1m^2 of planting per 50m length of street**	8	8
	Infrastructure: footpath width	Average footpath width <1.0m	Average footpath width 1m–2m	**Average footpath width >2m**	5	5
	Infrastructure: seating	**No seating**	One seat/100m footpath length	More than one seat/ 100m footpath length	7	-7
	% old (>65)	Less than locally resident proportion by more than 5% (absolute)	***Within 5% (absolute) of locally resident population proportion***	More than locally resident proportion by more than 5% (absolute)	5	0
	% child (<15)	Less than locally resident proportion by more than 5% (absolute)	***Within 5% (absolute) of locally resident population proportion***	More than locally resident proportion by more than 5% (absolute)	5	0
Activity	Dwell time	<1 minute average dwell time per person	***1–2 minutes average dwell time per person***	>2 minutes average dwell time per person	10	0
Overall place function score: sum of individual points x weighting						**+12**

4.3.3 Place performance of Greenwood Street, Hamilton

Table 4.4 Place performance, Greenwood Street

		Place criteria measurement indices and units			Weighting: relative importance of criterion	Score
		Low or weak place function (-1 point)	**Medium or neutral place function, or no available data (0 point)**	**High or strong place function (1 point)**		
Transport measures	Traffic composition (% HCVs)	> 10%	**2%-10%**	<2%	5	0
	Traffic speed (85th percentile)	***>50km/h***	30-50km/h	< 0km/h	8	-8
	Traffic volume (AADT)	**>10,000 vpd**	5,000-10,000 vpd	<5,000 vpd	5	-5
	Vehicle crashes (injury/non-injury) 2009-2013	**>2 injury crashes/ 5 years**	1-2 injury crashes/ 5 years	0 injury crashes/ 5 years	4	-4
	Cyclist speed	***>10 km/h***	5-10km/h	<5km/h	4	-4
	Cyclist volumes	<10 cyclists/ our	***10-50 cyclists/hour***	>50 cyclists/hour	4	0
	Pedestrian volumes	<100 pedestrians/ hour	***100-500 pedestrians /hour***	>500 pedestrians/ hour	10	0
	Cyclist crashes (injury/non-injury) 2009-2013	>2 injury crashes/ 5 years	***1-2 injury crashes/ 5 years***	0 injury crashes/ 5 years	4	0
	Pedestrian crashes (injury/non-injury) 2009-2013	>2 injury crashes/ 5 years	**1-2 injury crashes/ 5 years**	0 injury crashes/ 5 years	6	0
Land use and people measures	Residential density	**<500 persons/km²**	500-1,500 persons/km²	>1,500 persons/km²	5	-5
	Commercial density	**<500 persons/km²**	500-1,500 persons/km²	>1,500 persons/km²	5	-5
	Greenery score	**Up to 1 plant or 1m² of planting per 50m length of street**	Up to 1 plant or 1m² of planting per 50m length of street	>1 plant or 1m² of planting per 50m length of street	8	-8
	Infrastructure: footpath width	Average footpath width < 1.0m	Average footpath width 1m-2m	**Average footpath width >2.0m**	5	5
	Infrastructure: seating	No seating	**One seat/100m footpath length**	More than one seat/ 100m footpath length	7	0
	% old (>65)	Less than locally resident proportion by more than 5% (absolute)	***Within 5% (absolute) of locally resident population proportion***	More than locally resident proportion by more than 5% (absolute)	5	0
	% child (< 5)	Less than locally resident proportion by more than 5% (absolute)	***Within 5% (absolute) of locally resident population proportion***	More than locally resident proportion by more than 5% (absolute)	5	0
Activity	Dwell time	<1 minute average dwell time per person	***1-2 minutes average dwell time per person***	> 2 minutes average dwell time per person	10	0
Overall place function score: sum of individual points x weighting						**-34**

4.4 Summary of place performance measures

The place performance scores for each site are summarised in table 4.5.

Table 4.5 Summary of place performance measures

Case study site	Dominion Road, Auckland	Normanby Road, Paeroa	Greenwood Street, Hamilton
Place performance score	+5	+12	-34

Scores in table 4.5 show it is possible to compare streets based on their place performance, and indicators that would improve this performance can be readily identified. Some clear distinctions can be observed between each of the case study sites, including:

- lower traffic volumes on Normanby Road, in the 'rural centre' setting
- higher non-injury crash volumes on Greenwood Street, perhaps related to the proximity of the site to a major intersection
- low residential density for the Normanby Road site (rural centre) compared with higher residential density and growth for the Dominion Road site in Auckland
- higher commercial density for the Greenwood Street site, showing the strong 'industrial' type land uses adjacent to the case site
- higher number of people over the age of 65 around Normanby Road in Paeroa, although it is unknown whether this is reflected in the diversity of people using the street as place.

The different place performance scores in these different contexts highlight the complexity of measuring place performance. Over time as more sites are evaluated, the overall usefulness of measuring place performance will be realised. In the meantime it is important that any overall score is considered as a trial of the evaluation process. Scores do not reflect 'good' or 'bad' place performance overall, because the street context is lost when it is reduced to the sum of quantifiable parts. However, the factors influencing that score can be explored, so the street performance can be improved if this is a wider objective for the local community. This is the reason for the overall assessment process as outlined in figure 2.1. Quantitative metrics are useful, but do not tell the complete story of place function for any particular street section.

4.4.1 Sensitivity discussion

Individual components of the evaluation matrix have different effects on the score due to their different weightings. The weightings and thresholds for different contributions toward place performance can be changed to suit different contexts. For example, in a rural village setting it may be considered that 100 pedestrians per hour is indicative of high or strong place function. If this were the case in Paeroa for example, the score for the case study site would increase from +12 to +22. It may also be considered that residential density is not as important as the presence of people. If the residential density weighting was reduced from 5 to 1 in Paeroa, and pedestrian volume weighting were increased from 10 to 14, the score would increase further from its original number of +12 to +26. These types of sensitivities are important to consider as the framework is used and its usefulness evaluated.

4.5 Benefits of performance assessment of place

The aim of this research was to identify performance measures for the place function of state highways and arterial roads in an urban context. This has been addressed by:

- providing an account of the historical perspective to the design of roads and public places, and how this has changed in the last century
- discussing current approaches to road design and planning in New Zealand, and how place function contributes to these
- identifying ways place function is considered in academic literature, regulations and guidance documents from the perspectives of urban design, land use planning, transport planning and traffic engineering, with a focus on relevance for urban roads
- providing workable definitions of link and place
- translating literature, guidance and performance measures into an assessment framework for initial measurement of quantitative indicators of place performance.

The assessment framework shows there are readily available measures of place, and other indicators that require specific data collection. The measurement framework shows promise as a tool to help transport planner and practitioners to:

- understand the existing place performance of streets within a network
- identify desired or 'target' levels of place performance
- identify place performance detriments for particular streets as a whole
- determine the relative ease of improving place performance, based on different performance measures
- replicate a place performance measurement process
- begin an investment logic mapping process
- focus investment where it is most needed
- use known and existing data sets – keeps data collection costs/time low at early stages of the process

Ultimately, measurement of place following a framework such as that proposed by this research has the potential to help the Transport Agency provide an effective, efficient, safe, responsible and resilient transport system that supports a thriving New Zealand.

4.6 Limitations

The main limitation of this research is that place cannot be wholly described or measured in terms of quantitative performance indicators. There is a danger in presenting such an assessment process that practitioners will attempt to label places as good or bad based on an assessment indicator, without consideration of the wider and rich context that makes up each street as a place. Therefore, the main risk arising from dissemination of this research is that the quantitative performance assessment framework will be adopted in isolation, and place 'levels of service' assumed based on what are arbitrary scores when considered outside of the streets' wider contexts.

This concern has been addressed by placing this research in the context of a performance measurement process. The quantitative indices are intended to provide only an initial assessment of place to group/rank sites of interest. It is based on annual average metrics for 200m sections of urban streets. When the resulting scores are compared with other street sections that have been evaluated in the same way, decisions can be made about their relative ranking and whether this represents acceptable place performance, in the context of the wider street network, the desired role of the road and local land use characteristics.

A further limitation of this research is that the initial assessment does not account for the natural and rich variation in place performance that any street experiences over a day, at different times of the week and across seasons. There is no allowance in the annual average metrics for one-off events where place is paramount (or where link function is temporary emphasised).

The 'annual average daily' nature of the assessment is also accounted for within the process. The assessment process allows for one-off or customised place assessment according to different times of the day, week or year, or for one-off events, where this would help to provide context for place performance. Over time, an increasing understanding of relative performance for different streets in different time and land use contexts will improve understanding of how measurement can contribute toward understanding the existing place asset that streets provide, as well as how to prioritise transport investment to improve aspects of street design where this would be beneficial.

The framework also allows transport stakeholders to identify their relative contribution to place performance. There will always be aspects of place related to culture and atmosphere for example, that are well outside the influence of transport. This framework can help to identify where metrics identify strong transport-related place performance, so that any resulting deficit can be addressed by local bylaws, or by stakeholders involved in local and regional planning, for example for parks and gardens.

5 Recommendations

The measurement framework presented in this research provides a useful tool for the transport industry to better understand the place performance of urban arterial roads and state highways. The process would benefit from continued refinement through application to a wider variety of sites. In particular, it is recommended that:

- The place performance measurement framework be applied to a wider sample of streets, including those in different land use contexts of major urban, regional urban and rural centre streets.
- Different weightings and scores for different factors be investigated to adapt the framework to best suit a variety of RCA contexts.
- The process framework be used to identify streets that would benefit from secondary investigation (based on particular times of the day or year, or assessment of place for one-off events); and qualitative investigation, to provide more than an average overview of quantitative indicators of place performance.
- An analysis of user perceptions of overall place function be used in conjunction with quantitative data collection, to refine weightings in the performance measurement framework.
- This research and its findings be discussed within the wider transport industry, so that its direction can be most useful to practitioners across a range of RCAs.

It is crucial that the performance assessment matrix be considered in conjunction with the process framework. In isolation, there is no way of understanding place performance based on quantitative transport metrics in isolation. The tool provides relative ranking, so that more investigation can identify sites that warrant changes made and business cases developed to improve place performance.

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Appendix A: Data sources

Table A.1 Data requirements for Greenwood Street, Hamilton

Measurement indices			Readily available online	Available on request
Link function	Transport measures	Traffic composition (% HCVs)	www.nzta.govt.nz/resources/state-highway-traffic-volumes/docs/shtv-2009-2013-by-region.xls RS 552	
		Traffic speed (85th percentile)		From NZ Transport Agency
		Traffic volume (AADT)	CAS, www.nzta.govt.nz/resources/state-highway-traffic-volumes/docs/shtv-2009-2013-by-region.xls	
		Vehicle crashes (injury/non-injury)	CAS	
Place function		Cyclist speed		
		Cyclist volumes		From Hamilton City Council
		Pedestrian volumes		From Hamilton City Council
		Pedestrian/cyclist crashes (injury/non-injury)	CAS	
	Land use measures	Residential density		
		Commercial density		
		Greenery	Google Earth/Maps street view	
		Vista	Google Earth/Maps street view	
		Infrastructure, eg footpath width, seating	Google Earth/Maps street view	
	People characteristics	Age	Statistics NZ Tables - use age by sex on Census night	
		Mobility aid use		
		Disability	Statistics NZ Disability Tables – Aggregated at National Level	
		% old (>65)	Statistics NZ Tables – use age by sex on Census night	
		% child (<15)	Statistics NZ Tables – use age by sex on Census night	
	Activity	Dwell time		
		Activity type, eg eating, talking, photography, entertainment		
	Perceptions	User perceptions		
		Non-user perceptions		

Table A.2 Data requirements for Dominion Road, Auckland

Measurement indices			Readily available online	Available on request
Link function	Transport measures	Traffic composition (% HCVs)	https://at.govt.nz/media/670244/Traffic-Count-Data-Entire-Region-June-2014.xlsx	
		Traffic speed (85th percentile)		From AT
		Traffic volume (AADT)	CAS, https://at.govt.nz/media/670244/Traffic-Count-Data-Entire-Region-June-2014.xlsx	
		Vehicle crashes (injury/non-injury)	CAS	
Place function		Cyclist speed		
		Cyclist volumes		From AT
		Pedestrian volumes		From AT
		Pedestrian/cyclist crashes (injury/non-injury)	CAS	
	Land use measures	Residential density		
		Commercial density		
		Greenery	Google Earth/Maps street view	
		Vista	Google Earth/Maps street view	
		Infrastructure, eg footpath width, seating	Google Earth/Maps street view	
	People characteristics	Age	Statistics NZ Tables – use age by sex on Census night	
		Mobility aid use		
		Disability	Statistics NZ Disability Tables – Aggregated at National Level	
		% old (>65)	Statistics NZ Tables – use age by sex on Census night	
		% child (<15)	Statistics NZ Tables – use age by sex on Census night	
	Activity	Dwell time		
		Activity type, eg eating, talking, photography, entertainment		
	Perceptions	User perceptions		
		Non-user perceptions		

Table A.3 Data requirements for Normanby Road, Paeroa

Measurement indices			Readily available online	Available on request
Link function	Transport measures	Traffic composition (% HCVs)	www.nzta.govt.nz/resources/state-highway-traffic-volumes/docs/shtv-2009-2013-by-region.xls RS 72	
		Traffic speed (85th percentile)		From NZ Transport Agency
		Traffic volume (AADT)	CAS, www.nzta.govt.nz/resources/state-highway-traffic-volumes/docs/shtv-2009-2013-by-region.xls	
		Vehicle crashes (injury/non-injury)	CAS	
Place function		Cyclist speed		
		Cyclist volumes		From Hauraki District Council, or from NZ Transport Agency
		Pedestrian volumes		From Hauraki District Council, or from NZ Transport Agency
		Pedestrian/cyclist crashes (injury/non-injury)	CAS	
	Land use measures	Residential density		
		Commercial density		
		Greenery	Google Earth/Maps street view	
		Vista	Google Earth/Maps street view	
		Infrastructure, eg footpath width, seating	Google Earth/Maps street view	
	People characteristics	Age	Statistics NZ Tables – use age by sex on Census night	
		Mobility aid use		
		Disability	Statistics NZ Disability Tables – aggregated at national level	
		% old (>65)	Statistics NZ Tables – use age by sex on Census night	
		% child (<15)	Statistics NZ Tables – use age by sex on Census night	
	Activity	Dwell time		
		Activity type, eg eating, talking, photography, entertainment		
	Perceptions	User perceptions		
		Non-user perceptions		