Developing methodologies for improving customer levels of service for walking

September 2020

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NZ Transport Agency research report 667
Contracted research organisation – Abley Ltd

ISBN 978-1-98-856185-1 (electronic)
ISSN 1173-3764 (electronic)

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Waka Kotahi NZ Transport Agency (2020) Developing methodologies for improving customer levels of service for walking. *Waka Kotahi NZ Transport Agency research report 667.* 87 pp.

Abley Limited was contracted by Waka Kotahi NZ Transport Agency in 2019 to carry out this research.

Keywords: access, level of service, pedestrian design, pedestrian planning, safety, walkability

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At the time of publishing, Waka Kotahi and the Road Efficiency Group were due to publish the Stage 1 High Level Design document for the new One Network Framework (ONF). Stage 2 of the project will see detailed design, levels of service/performance measures and new tools and templates published later in 2020. The new ONF classification system and relating street families may differ somewhat from those mentioned in this research report and any national pedestrian levels of service framework will be adapted to integrate with the ONF as it gets confirmed.

Acknowledgements

The research team would like to acknowledge the support and guidance of Jo Chang (Waka Kotahi) and David Turner (Waka Kotahi) as client project managers as well as the project reference group members Claire Pascoe (Waka Kotahi), Nadine Dodge (WCC) and Kathryn King (Waka Kotahi).

Our thanks go out to the team at Kantar TNS for the qualitative customer insight research which supports this research. We would also like to extend our thanks to the practitioners who participated in workshops and testing of the online tool.

Abbreviations and acronyms

CSRs	community street reviews
DPLOS	Disabled Pedestrian Level of Service
GPLOS	General Pedestrian Level of Service
LOS	level of service
NOPS	network operating plans
ONF	One Network Framework
ONRC	One Network Road Classification
PLOS	Pedestrian Level of Service
PPDG	*Pedestrian planning and design guide* (NZ Transport Agency)

Contents

Executive summary

This study sought to develop a walking level of service framework to support better decision making when providing for pedestrians by focusing on the barriers and motivators to walking. The framework is based around factors that are important to pedestrians so these are all considered within the planning, design and operation of the transport network.

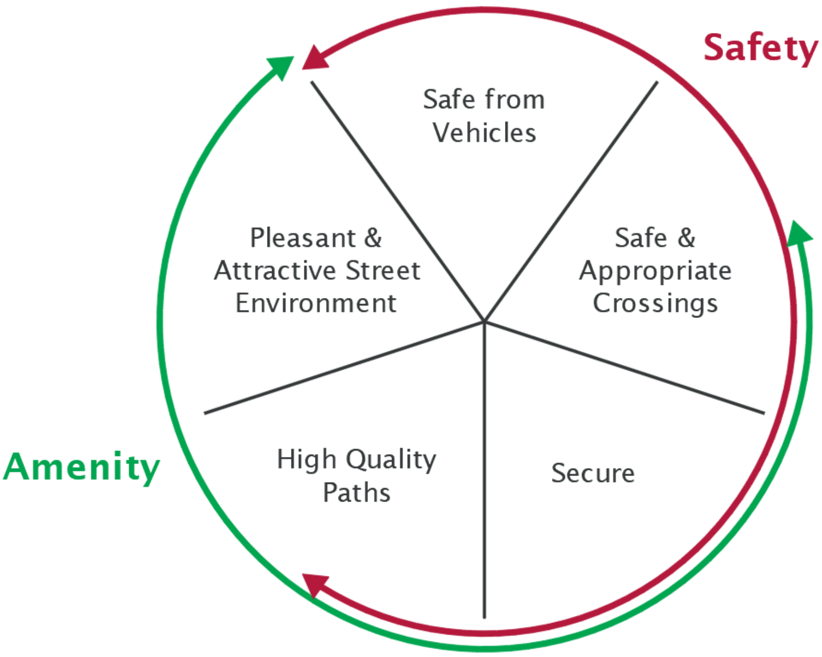
The research commenced with a targeted New Zealand and international literature and practice review. This review identified that factors affecting whether people choose to walk or choose not to walk are numerous and complex. While many level of service factors were identified in the literature, these were generally not customer focused or evidence based. It was concluded that further research was needed to identify which pedestrian environment factors most significantly affected people's choices about whether or not to walk.

Level of service systems ranged from simply identifying which factors should be considered, through to qualitative and quantitative approaches for rating factors. A wide variety of approaches were also identified for developing a Pedestrian Level of Service (PLOS) Framework; however, there is little evidence as to which approach best allows practitioners to assess walking environments based on pedestrian needs. The lack of consensus and limited uptake of the various models demonstrates there is room for improvement in the role pedestrian level of service frameworks play in contributing to industry practice and influencing decisions. While there are numerous PLOS models available, very few appear to have been implemented on a regular basis in decision making. Developing a method that is practical for practitioners to implement, and provides insights useful for decision making, may be as important as the underlying technical foundations of the model itself.

Following this review, qualitative customer insights research was undertaken by Kantar TNS to identify which environmental factors most significantly affect people's choices about whether or not to walk and what elements influence a positive walking experience. This work identified that safety, including both physical and perceived safety, is the highest priority for people walking (feeling unsafe represents a significant barrier to walking), and secondly, a pleasant and attractive environment (amenity factors) act as a motivator to walking. The customer insights research also identified priority factors that contribute most to a positive pedestrian experience and how these priorities change depending on the pedestrian environment. The research identified that the importance of individual factors increases or decreases depending on the characteristics and ability of the pedestrian as well as the characteristics of different environments or street types. The qualitative research was focused on the experiences of the general population and did not specifically consider the perspectives and needs of people with disabilities.

The PLOS Framework was developed through an iterative approach drawing on findings from customer research, guidance and design standards and practitioner input, testing and feedback. The framework identifies five outcomes that contribute to pedestrian level of service. These are:

- safe from vehicles
- safe and appropriate crossings
- secure
- high-quality paths
- pleasant and attractive street environment.



As illustrated, each of the five outcomes relates to either or both of the overarching PLOS considerations of safety and amenity identified in the customer insights research.

The framework is based on 19 built environment metrics that can be measured at a street level and contribute to the level of service outcomes outlined above. A scoring system has been developed for each metric based on applicable standards and guidelines where possible. The scoring of most metrics varies by movement and place street type to reflect the different priorities and needs on streets with different functions. The PLOS results include metric scores, outcome scores and an overall PLOS score as it is anticipated the framework will be used for a variety of applications such as identifying network gaps, comparing design ideas and identifying priority issues in local areas. For ease of practitioner use, an online version of the framework and assessment tool was developed. The framework is intended to assist practitioners in identifying areas for improvement; however, it does not specify how such improvements should be made and instead broadly quantifies how a change in the street environment is likely to improve or reduce PLOS.

The framework and assessment tool, although informed by customer insights research, have not been validated or verified as reflecting pedestrians' needs or perceptions, particularly with regard to the effect factors have on the pedestrian experience and the relative importance of these factors. Hence before the framework is deployed, it is necessary that the framework and assessment tool reflect customer ratings for a range of street types to ensure they capture pedestrians' needs and perceptions.

The following areas of further research have also been identified:

- Test whether the framework aligns or otherwise with the barriers and motivators of people with disabilities
- Validate whether the tool reflects pedestrian volumes, ie establish if pedestrian volumes increase following improvements in PLOS scores.
- Adjust and potentially expand the PLOS Framework and assessment tool to reflect the nationwide street families once these are confirmed through the One Network Framework (ONF) project.
- Map the PLOS Framework and assessment tool to other jurisdictions' movement and place frameworks if necessary.
- Apply the assessment tool to a range of different street environments around New Zealand, particularly in smaller towns and townships where the tool has yet to be tested.

- Identify how the five identified PLOS outcomes and the framework can be used at a network level and, in particular, to inform the ONF customer service level statements. Data requirements will also need to be established.
- Identify how the online assessment tool can be developed to enable PLOS assessments of journeys, for example through the inclusion of distance and directness.
- Identify how intersections should be assessed within the tool or whether other tools or a separate intersection assessment tool would be more effective.

Abstract

This study sought to develop a walking level of service framework to support better decision making when providing for pedestrians by focusing on the barriers and motivators to walking. The framework is based around factors that are important to pedestrians so these are all considered within the planning, design and operation of the transport network.

Qualitative customer insights research informed the development of a Pedestrian Level of Service Framework for New Zealand. This framework and an accompanying online assessment tool were developed in collaboration with transport practitioners as a starting point for a consistent approach to measuring and evaluating pedestrian level of service in urban areas of New Zealand.

The framework applies to street families within a movement and place functional street classification and consists of 19 metrics that contribute to five pedestrian level of service outcomes. The framework includes both safety and amenity drivers that are fundamental to people walking. The proposed assessment tool, once validated, will support smarter decision making around street environments to encourage walking, and contribute to more liveable and vibrant communities.

1 Introduction

1.1 The project

This research project on developing methodologies for improving customer levels of service for walking was commissioned as part of the Waka Kotahi NZ Transport Agency research programme.

The research was undertaken by Abley Ltd (Abley) and informed by qualitative research undertaken by Kantar TNS.

1.2 Background

There is currently a gap in terms of national models and tools that provide customer levels of service information regarding the walkability of New Zealand's transport networks. While motor vehicle efficiency focused tools are available and widely used, decision makers require better information from the perspective of other road users. It is understood that Waka Kotahi is currently undertaking research to develop frameworks to assess customer levels of service for public transport, and a Waka Kotahi research project examining levels of service for cycling has recently been published. This research project has sought to address the knowledge gap for pedestrian levels of service (PLOS).

Level of service (LOS) can be defined as the perceived quality of a road or transport service (Green and Espada 2015). The LOS concept first considered delays to vehicles travelling on a highway; however, this has since been expanded to consider other factors and LOS frameworks have also been developed for other road users such as walking, cycling, public transport and freight that take into account the quality of provision beyond simply travel time savings.

Fruin (1971) is known for developing the first LOS standard for pedestrians which is based purely on the density of pedestrians on a walkway or within a space. Although this is useful for the field of crowd science, it does not consider other factors that have been identified as barriers or motivators to walking.

A customer LOS model is of interest to transportation practitioners, local government and the Waka Kotahi investment decision makers. It has the ability to enable inclusive access, well-being, liveability, and healthy and safe people transport outcomes.

Relating to this research is the concurrent refresh of the Waka Kotahi One Network Framework (ONF). The framework is evolving from the current One Network Road Classification (ONRC), a vehicle efficiency-based asset management framework to incorporate different customer types and needs across New Zealand. One of the statements of intent is to 'describe service levels and outcomes for land transport modes that are appropriate for urban and rural contexts and functions consistent with the wider network and adjacent land use'. The ONF project will consider the movement and place functions of streets (at least in urban areas). Following engagement with Waka Kotahi, this PLOS research will be a key input for the ONF project. The PLOS inputs required by the ONF must be meaningful and measurable, and able to be implemented based on existing datasets or able to be captured in the future. There is a preference for the PLOS Framework to capture the most significant factors but to limit the number of factors so the data capture and analysis requirements are manageable. This PLOS research can also assist the ONF project in forming the pedestrian outcome areas.

PLOS is also an important input to network operating plans (NOPs), which seek to identify the relative LOS operating gaps, so investment decisions can focus on where maximum return on investment can be achieved. Currently NOPs are using a range of methods to define pedestrian LOS including not defining it at all. To be consistent with the LOS inputs required for the ONF, PLOS inputs must be meaningful and measurable, ideally based on existing data sets available to road controlling authorities, or able to be captured in the future.

In addition to network-level applications such as the ONF and NOPs, a clear and consistent PLOS Framework is an important resource for infrastructure planners and designers working on street level projects. This would ensure that infrastructure treatments enhance the pedestrian customer experience and result in facilities that are not only safe, efficient and comfortable, but also perceived by the users as being safe, efficient and comfortable. A PLOS Framework can be applied to a specific site or sites by planners and designers. This means it would be less constrained at street level in terms of the number of inputs or factors and the availability of data than network-level applications. Factors that are identified as important elements to enhance pedestrian experience can be captured on-site and/or as part of the design. However, it is still important for the factors to be measurable and quantitative as far as practicable, so the outputs can be replicated by different practitioners for the same site and comparisons can be drawn from site to site or from scheme to scheme. The key here is to identify which factors are the most important, but also to identify those of lesser importance so they can be designed into (or may be removed from or lessened in) walking environments.

A parallel project is being undertaken by Waka Kotahi to understand the barriers to accessing social and economic opportunities among people with disabilities and people with limited financial means. The research is also using a qualitative customer centric approach and it is anticipated that liaison between the respective research teams will enable the findings to be shared and compared with this project.

1.3 Definitions

For the purposes of this research, pedestrians are defined as:

> *Any person on foot or who is using a powered wheelchair or mobility scooter or a wheeled means of conveyance propelled by human power, other than a cycle* (NZ Transport Agency 2009).

Several terms are used throughout literature to refer to the quality of walking environments. ‘Walkability’ and ‘pedestrian level of service’ are sometimes used interchangeably; however, in general, the term ‘walkability’ is broader than ‘pedestrian level of service’ as it also considers accessibility in terms of distance and destinations. Although precise definitions of these terms are elusive, for the purposes of this research PLOS has been defined as:

> *Pedestrian level of service: an overall measure of walking conditions of a route, path or facility, reflecting the pedestrians’ experiences of the degree to which the street environment is pedestrian friendly.*

This definition is based on Gallin’s definition (2001) but extended to include pedestrians’ ‘experiences’ rather than ‘perceptions’ and expanded to ‘street environment’ rather than ‘facility’.

1.4 Objectives and scope

This research aimed to develop a PLOS Framework to support better decision making on providing for pedestrians on different streets by focusing on pedestrians’ needs. The framework is intended to provide insight into pedestrians’ experiences, feed into the ONF and indirectly support the uptake of walking through the provision of better walking environments.

The objectives of this research study were to:

- understand the factors that make people choose to walk or choose not to walk
- consider the needs of all customers including mobility and visually impaired pedestrians
- develop a robust LOS framework that reflects these factors and customer needs
- consider customer experience as a journey as well as from an 'all-of-network' perspective
- test the LOS framework on case studies.

The intent of this research was to deliver a consistent framework which captures the factors that are important to pedestrians so these are considered within the planning, design and operation of transport systems. Key applications of this framework have been identified at both street and network levels. It is intended that practitioners can use the PLOS Framework at street level to assess and compare existing and potential upgrade options, and at the network level to identify shortcomings and/or priorities in the pedestrian environment.

1.5 Report structure

Following this introductory chapter, the report is structured as follows:

- Chapter 2 outlines the project methodology.
- Chapter 3 discusses the literature and practice review.
- Chapter 4 summarises the development of the PLOS Framework, including the involvement of stakeholder reference groups and the project steering group, case studies and practitioner testing.
- Chapter 5 presents the final PLOS Framework and assessment tool.
- Chapter 6 provides a discussion and recommendations.
- Chapter 7 provides a reference list for this report.

2 Methodology

2.1 Overview

The project began with a literature and practice review. The findings of this were used to shape the customer insights research, which involved customer focus groups and interviews. Drawing on the literature review and customer surveys, the PLOS Framework was developed with input from stakeholder reference groups and the project steering group.

The research team then undertook case studies and practitioner testing to refine the framework.

2.2 Literature and practice review

A literature review was undertaken in the early stages of this research. While there is extensive literature available about PLOS, the scope of the review was limited to four key sources that were identified by Waka Kotahi as outlined in chapter 3.

These sources were used to address (as far as possible) the following focus areas:

- measuring LOS for poor quality facilities and routes
- assessment of road crossing facilities
- the needs of mobility and vision impaired pedestrians
- updating for current day context including new technologies/uses of footpaths, eg e-scooters
- assessment along the length of a journey and at a network-level
- factors that make people choose to walk or choose not to walk
- any further elements highlighted as part of the customer insights stage of the research.

In addition to the literature review, community street reviews (CSRs) were identified as a potential information source for this research. Local authorities were contacted to request copies of any CSR datasets, however very few datasets were received. Review and analysis of CSR data was therefore removed from the scope of this research.

2.3 Customer insights research

Customer insight surveys were undertaken to understand customer needs and experiences of the walking network. Waka Kotahi engaged Kantar TNS to carry out customer insight focus groups and interviews. The scope of the insight surveys was informed by the literature review. Abley briefed Kantar TNS and guided their research. In particular, the Abley research team identified five street types within a movement and place framework which Kantar used in their discussions with customers. This included the provision of stimulation material including short descriptions, and example photographs and videos of the five street types.

The key focus areas of the customer insight surveys were:

- What makes customers choose to walk regularly?
- What makes customers choose not to walk regularly and/or not walk at all?

- How do needs differ between different customer profile groups?
- How do customers consider their experience: as a journey or across the network?

Customer insights surveys were carried out in Auckland, Napier and Oamaru. These centres were chosen to ensure a range of urban size and geographic location. The research used an iterative approach involving three phases:

1. Phase 1: 'Light touch' immersion
2. Phase 2: Six group discussions with the core pedestrian audience
3. Phase 3: Six targeted deep dives with youth and elderly audiences.

The purpose of phase 1 was to provide real-life context for the group discussions and to help refine areas for probing and the appropriate language to use within the next phase of research to ensure a customer centric approach.

The purpose of the group discussions was to gain deep insight into the walking experience facilitated by real 'in the moment' stimulus captured through a detailed walking diary during the week before the group discussions. The group then spent some time viewing photographs and videos of different types of street with discussion around how they felt on these streets, when they might walk along them, and what the most important factors were for a positive walking experience on each street type.

The in-depth interviews in phase 3 were carried out to capture the perspectives of a wider pedestrian audience using a methodology that suited their needs, and to provide confidence that the main pedestrian needs and priorities had been captured.

People with disabilities were not included in the customer insights work for this project. It was understood that a parallel Waka Kotahi project was likely to collect information that would address this gap. The concurrent project investigated in depth the barriers that people with disabilities and people with limited financial means faced when accessing social and economic opportunities. However, the outputs of that project were complex and did not provide sufficient breadth of information about the built environment from the perspective of these users. Therefore outputs of that project were not used to inform this research. Although aspects of accessibility for all are included generally within this research, it does not have a specific goal of promoting inclusive access.

Further detailed methodology on the customer insights research is provided in an internal Waka Kotahi report.

2.4 Design user

The concept of 'design users' is often applied to ensure the needs of different users are catered for in built environments. For example, Auckland Transport (2020) summarises the needs of 12 people, including an ambulance officer and a wheelchair user. Consideration of design users can assist in achieving universal design by providing a more accessible and inclusive built environment.

As the qualitative customer insights research focused on the general population, no specific design user was applied in the development of this framework. The framework has sought to achieve broadly suitable walking environments by considering principles of accessible and inclusive design, such as avoiding sudden changes in height and obvious definition of road user spaces. However, it is important that practitioners do not use the PLOS Framework as an inclusive access audit or design tool, and instead refer to appropriate guidance and standards.

2.5 PLOS Framework development

Drawing on the literature review and customer insights surveys, a skeleton framework for measuring PLOS was developed.

The skeleton framework was presented at stakeholder workshops in Christchurch and Auckland and developed further based on feedback. The workshop attendees were transportation professionals from a variety of local and central government organisations being the predominant intended users of the PLOS Framework. The Christchurch workshop had 10 attendees (excluding the research team), including staff from Ashburton, Timaru and Christchurch district councils and Waka Kotahi staff involved in the development of the ONF. The Auckland workshop included staff from Auckland Council, Wellington City Council, Auckland Transport and Waka Kotahi. The half-day workshops began with an overview of the research undertaken thus far, including the literature review and customer insights research. A Waka Kotahi representative provided a summary of the ONF project and the attendees discussed how the PLOS Framework could be integrated with it. The group then reviewed and discussed the skeleton framework, including the factors, outputs and scoring systems. As the workshops were held on different days, the skeleton framework was adjusted to address feedback from the first workshop before being presented to the second workshop.

The draft framework was then presented to the Project Steering Group for the purposes of refining and further developing the skeleton LOS framework.

2.6 Piloting and refining the framework

The research team applied the draft framework to case studies that included a variety of street types in different locations. Following some refinements, a beta online PLOS assessment tool was developed to allow practitioners to enter PLOS information and calculate scores.

The beta PLOS assessment tool and a brief overview of the research to date was shared with steering group members and practitioners who attended the Auckland and Christchurch workshops. The draft framework was also presented at a workshop with Auckland Transport. Practitioners were invited and encouraged to apply the framework in their jurisdictions and provide feedback to the research team for consideration when finalising the framework. Feedback was received from practitioners based in Auckland, Christchurch and Wellington. This was used to finalise the PLOS Framework and assessment tool.

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3 Literature review

3.1 Introduction

To develop methodologies for improving customer levels of service for walking, it is important to understand how existing studies and frameworks relate to the objectives of this study. This research included a literature review that explored current and emerging PLOS practice in New Zealand and internationally. The literature sources were used to review the following focus areas:

- measuring LOS for poor-quality facilities and routes
- assessment of road crossing facilities
- walkability for mobility and vision impaired pedestrians
- updating for current day context including new technologies/uses of footpaths, eg e-scooters
- assessment along the length of a journey and at a network-wide level
- factors that make people choose to walk or choose not to walk.

The scope of the literature review was restricted by Waka Kotahi to four key sources as follows:

- *Predicting walkability*, NZ Transport Agency research report 452 (summarised in section 3.3)
- Transport for London's Healthy Streets approach and background work such as the Pedestrian Environment Review System (PERS) (summarised in section 3.4)
- Pertinent papers identified in *What are the most important factors for pedestrian level-of-service estimation? A systematic review of the literature* by Raad and Burke (2018) (discussed in section 3.5)
- *The pedestrian experience literature review* (NZ Transport Agency 2019) identifies research gaps for the New Zealand context (provided in section 3.6).

Community street reviews were also investigated. A practice review is provided in section 3.7. The Austroads LOS framework is also briefly reviewed in section 0.

The chapter concludes with a comparison of the sources reviewed and a brief summary of the literature (section 3.9).

3.2 Definitions

Predicting walkability (Abley and Turner 2011) defines 'walkability' as 'the extent to which the built environment is walking friendly'. This is similar to the definitions provided within *The pedestrian experience literature review*, which include 'a measure of how friendly an area is to walk' and 'the degree to which pedestrians can walk comfortably' (NZ Transport Agency 2019). This 2019 review considers 'pedestrian experience' as 'a concept that expands the concept of walkability to mirror diverse experiences of pedestrians… dependent upon numerous qualitative factors that are not addressed in customary level of service analysis'. However, it is noted that qualitative factors are incorporated into several of the PLOS systems described in other sources such as the Raad and Burke (2018) review.

Gallin (2001) defines PLOS as 'an overall measure of walking conditions on a route, path or facility. This is directly linked to factors that affect pedestrian mobility, comfort and safety. It reflects the pedestrians' perceptions of the degree to which the facility is pedestrian friendly'. LOS is typically rated from A to F, with A being the best operating conditions and F the worst.

3.3 Predicting walkability

The NZ Transport Agency commissioned research in 2011 that developed models for rating pedestrian facilities by quality. Titled *Predicting walkability*, the study filled some of the ‘walking’ knowledge gap and provided a technique for practitioners to quantify the quality of the pedestrian environment. The research addressed the subjectivity of ‘walkability’ by combining methodologies from the NZ Transport Agency’s (2010) *Guide to undertaking community street reviews* and Abley’s *Walkability research tools – variables collection methodology* (2006) to calculate qualitative walkability results from quantitative measurements (Abley and Turner 2011). The predicting walkability research was reviewed to identify and inform potential PLOS metrics and understand how these can be combined into an overall assessment of PLOS.

The following predictive formulas for the quality of the walking environment when walking along the road (path length) and crossing the road (road crossing) were derived:

$$Walkability_{path\ length} = 4.426 + 0.561\ footcn + 0.300\ green - 0.378\ vspeed + 0.294\ comfort - 0.464\ devi + 0.415\ pa{+}res + 0.170 min\ ewidth - 0.186\ numhide - 0.0034\ Avg\ stepav + 0.21\ dese \qquad \text{Equation 3.1}$$

$$Walkability_{zebra\ crossings} = 5.51 + 1.40\ rdcon + 0.477\ tpva - 0.052\ crosdi - 0.01\ delay$$

$$Walkability_{uncontrolled\ crossings} = 5.06 - 0.819\ vspeed + 0.640\ vis\ tra - .091\ delay + 0.377\ footcon + 0.706\ rist - 0.05\ crosdi$$

The above path length walkability model is for all ages. Models were also developed for specific age groups (18–59 and >60) and environmental criteria (safe from falling and pleasant). These models use different coefficients for each factor.

The models use a combination of continuous and discrete variables. Tables 3.1, 3.2 and 3.3 describe the variables used in the models and the possible values that can be assigned to each. Each variable requires some level of data collection. Some of the variables are objective, such as the path width and presence of tactile aids. However, some factors, for example quantity of greenery, are not so clearly defined.

For the walkability of a path the models indicate that footpath condition, amount of greenery, presence of comfort features, vehicle speed, land use (parkland or residential) and deviation around obstacles are the major factors that affect walkability. The minimum effective width along the path has a positive relationship with walkability which suggests that wider paths are rated to be more walkable, but the walkability rating is affected more by the presence of obstacles leading to the path being narrow rather than by the average or maximum widths of the path. Higher design effort, including the presence of functional streetscaping items and the absence of steps along the path also improve its walkability rating.

For crossings, models were developed for zebra crossings and uncontrolled crossings (the sample data available for the signalised crossings did not produce a significant model). For zebra crossings, crossing delay, crossing distance, road condition and the presence of tactile aids were significant factors. For uncontrolled crossings, vehicle speed, visibility to traffic and the presence of a central island were also significant. The research noted limited availability of data on traffic volumes, and traffic flow was not included in the walkability models; however, it was recommended that traffic flow data should be used in future walkability models.

Table 3.1 Path length model variable descriptions (Abley and Turner 2011)

Variable	Description	Possible values
footcon	Footpath condition	Poor footpath condition = -1 Average footpath condition = 0 Good footpath condition = +1
green	Quantity of greenery	Little or no greenery = -1 Moderate greenery = 0 Significant greenery = +1
comfort	Presence of comfort features	Comfort features not present = 0 Comfort features present = 1
devi	Deviation around obstacles	Little or no deviation = -1 Small amount of deviation = 0 Significant deviation = +1
Min ewidth	Minimum path effective width	In metres
vspeed	Vehicle speed	Below speed limit = -1 At speed limit = 0 Above speed limit = +1
avg stepav	Average step height	In millimetres
dese	Design effort	Not designed/very low design effort = -1 Low to medium design effort = 0 High to very high design effort = +1
numhide	Number of hiding places	Number of hiding places along the path
pa + res	Parkland or residential land use	Parkland or residential = 1 Other land use = 0

Table 3.2 Zebra crossings model variable descriptions (Abley and Turner 2011)

Variable	Description	Possible values
delay	Crossing delay	In seconds
crosdi	Crossing distance	Distance in metres
rdcon	Road condition	Poor road condition = -1 Average road condition = 0 Good road condition = +1
tpva	Presence of tactile aids at crossing	Tactile aids present = 1 Tactile aids absent = 0

Table 3.3 Uncontrolled crossings model variable descriptions (Abley and Turner 2011)

Variable	Description	Possible values
vspeed	Vehicle speed	Below speed limit = -1 At speed limit = 0 Above speed limit = +1
vis tra	Visibility to traffic	Poor visibility = -1 Medium visibility = 0 Good visibility = +1

Variable	Description	Possible values
footcon	Footpath condition	Poor footpath condition = -1 Average footpath condition = 0 Good footpath condition = +1
delay	Crossing delay	In seconds
crosdi	Crossing distance	Distance in metres
rist	Presence of central island	Tactile aids present = 1 Tactile aids absent = 0

The variables used in the models were limited to the availability of data from the community street reviews, therefore they may exclude less-measurable variables that still affect walkability. The predicting walkability research identified the following key limitations and recommendations for further study:

- Data collection: The limited availability of data and limited study sites in the sample set meant that the study did not include a sufficient number of sites at LOS D, E and F to enable assessment and prediction of walkability scores for poorer walking environments, no statistically significant model could be developed for signalised crossings, and time of day and traffic volume were not included as variables in the models. To address these limitations, further data collection of traffic volumes, different time periods and a broader range of sites is recommended.
- Walkability for impaired pedestrians: The models developed did not differentiate between walkability for able-bodied pedestrians and those with physical and/or visual impairments. This was identified as a topic needing further research.

3.4 Healthy Streets and supporting tools

3.4.1 Healthy Streets for London

Transport for London's (TfL) *Healthy streets for London* includes 10 indicators for healthy streets (figure 3.1).

Figure 3.1 Healthy Streets indicators (Transport for London 2017)

3.4.1.1 Healthy Streets Check for Designers

The accompanying Healthy Streets Check for Designers is a tool that consists of 31 metrics which contribute to the 10 indicators (Transport for London 2019). The metrics are quantitative and the tool includes advice for consistent measurement. Each metric is scored from 0–3 for both existing and proposed layouts. The contribution of metrics to applicable indicators is weighted within the Healthy Streets Check for Designers tool. For example, the metric 'walking distance between resting points' contributes more to the 'place to stop and rest' and 'things to see and do' indicators than the 'pedestrians from all walks of life', 'people choose to walk' and 'people feel relaxed' indicators. In addition to an overall score, the check for designers produces individual scores for each of the indicators. This allows for easy identification of design strengths and weaknesses. It is not possible to gain the maximum overall score (100%) due to conflicting metrics.

The Healthy Streets Check for Designers was developed for London and therefore poses some challenges for application in the New Zealand context. For example, NO_2 concentration is a metric that contributes to the 'pedestrians from all walks of life', 'people choose to walk, cycle and use public transport' and 'clean air' indicators. The scoring system for this metric is based on the London Atmospheric Emission Inventory which has a modelled annual mean concentration for each postcode in London. NO_2 emission data is not as easily attainable throughout New Zealand.

Explanation of the process used to develop the Healthy Streets indicators and metrics is not widely available. We sought personal communication with the Healthy Streets developer, public health specialist Lucy Saunders, to understand how the metrics were developed and whether the background research was specific to London or from wider contexts. Saunders confirmed the tool was developed through a process of compromise and consensus with involvement from design experts, engineers and herself, rather than a research-based approach. The aim was to 'identify the minimum number of metrics that would give an overall assessment of the health impacts of the street design, metrics had to be based on existing standards and best practice; easily, consistently and quickly measurable across all kinds of streets and set to a standard that would deliver a meaningful health benefit'. Saunders highlighted that significant user testing was used throughout the development of the tool and that the resulting metrics are particularly specific to London. While the principles of the tool are not context-dependent, Ms Saunders' view was that revision of some metrics would be required for applicability in the New Zealand context.

Healthy Streets is intended for application to links rather than journeys or networks. As the Healthy Streets Check is for designers, it consists of factors that designers and engineers can influence. Other practitioners such as planners and developers can also influence Healthy Streets, therefore there is potential to develop further assessment methods (Healthy Streets 2017).

Although the Healthy Streets indicators are not assessed separately for people with mobility and vision impairments, the metrics incorporate the broad needs of different pedestrians. As identified in NZ Transport Agency (2019), Healthy Streets is asset-centric and aggregates information, meaning the tool risks diluting the needs of minority groups.

3.4.1.2 Healthy Streets Surveys

Transport for London has also developed *Healthy Streets Surveys* to monitor progress towards the Healthy Streets approach (Transport for London 2017). The surveys involve customer questionnaires to analyse how people's experiences relate to the Healthy Streets indicators. Surveys involved over 8,000 respondents on 80 streets between 2014 and 2017. Respondents were asked to score their experiences relating to the Healthy Streets indicators from 0 to 10 during interviews that lasted approximately 10 minutes. An overall Healthy Streets score was calculated by averaging the scores for each indicator.

The results showed little variation in the aggregated experience scores for each street, but more significant differences in scores for each indicator. This implies it is useful to assess and present results for several indicators rather than one overall score. The 'things to see and do', 'people feel relaxed' and 'people feel safe' indicators had the strongest influence on customer satisfaction. It was also found that customer expectations are typically higher than their experiences.

The survey locations were chosen to include a range of street types, which were classified based on movement and place classifications. It was found that streets with lower movement function and higher place function scored better, and there was stronger correlation with movement function than place function.

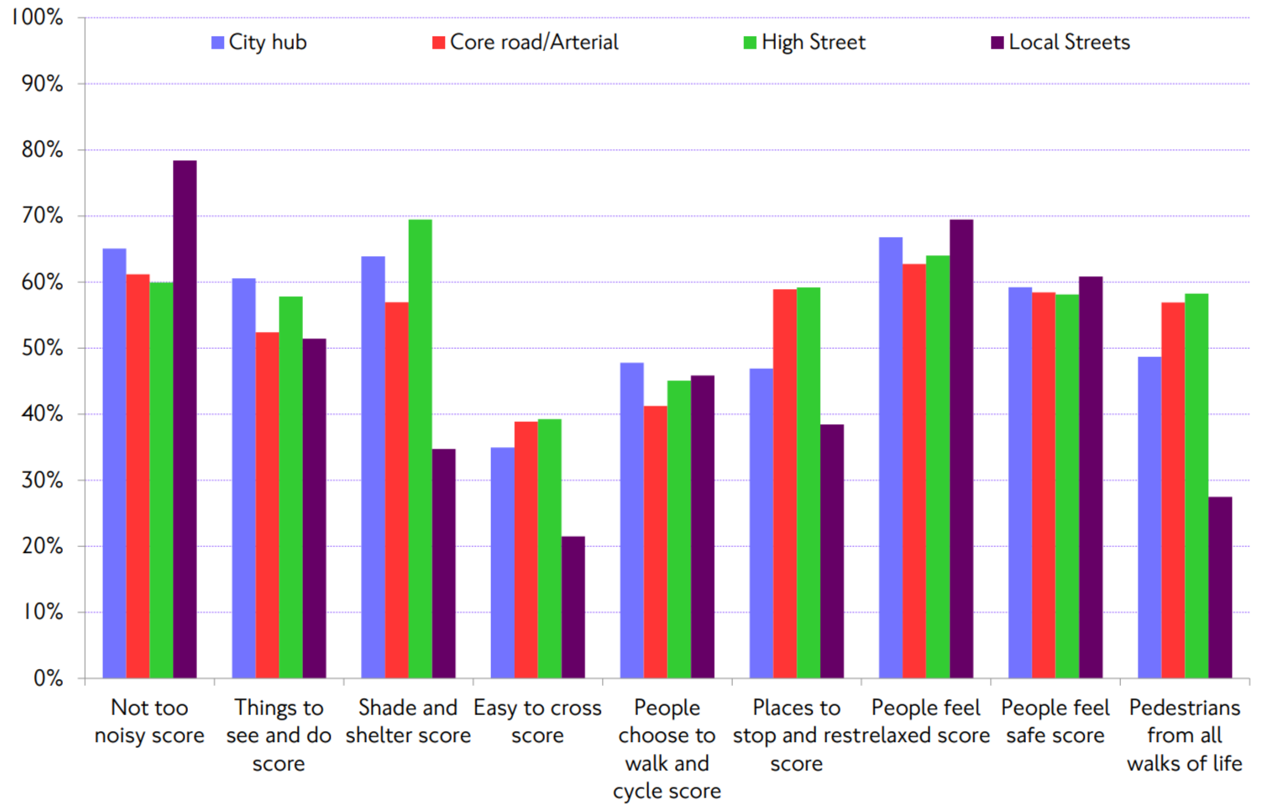
The Healthy Streets surveys are based on customer experience; however, they are used to evaluate the indicators, which were developed by 'experts', rather than establish what indicators affect customer experience. While the surveys are beneficial in assessing the impact of the Healthy Streets approach for people, they are more a validation process than an assessment process. Because the surveys were undertaken with on-street passers-by, they excluded the experiences of people not using the street.

3.4.1.3 Healthy Street Mystery Shopper Survey

Transport for London uses mystery shopper surveys to assess the quality and performance of transport environments and provide consistent feedback across a range of contexts (Transport for London 2018). Surveyors assessed approximately 100 metrics that were attributed to the Healthy Streets indicators and undertook brief walking and cycling counts at 48 sites in London. The 'clean air' indicator was excluded due to measurability. The metrics were weighted to 'reflect the key drivers affecting each indicator'. The metrics and weightings have not been published and there is no evidence as to how they were developed.

The survey sites were classified into nine geographic areas and four street types (city hubs, core roads/arterials, high streets and local streets). Scores were generally consistent across different geographic areas, with average scores varying by 10%. Local streets typically scored lower than high streets, with average scores of 59.3% compared with 48.6%. The score difference by street type was relatively minor and it was noted that street types were not distinct. The average scores for each indicator by street type are shown in figure 3.2. The results show that applying the same criteria to different street types results in significant score differences for some indicators. This raises the issue that appropriate levels of provision may differ for different street types. For example, it is intuitive that the 'shade and shelter' score is much higher for high streets (approximately 69%) than local streets (approximately 35%) because more shelter is likely to be more beneficial on streets with high levels of pedestrian activity and areas where people are expected to spend time.

Figure 3.2 Mystery Shopper Healthy Streets Survey overall scores by street type and indicator (Transport for London 2017)



Source: Strategic Analysis, TfL City Planning.

3.4.2 Pedestrian Environment Review System (PERS)

Transport for London's *Pedestrian environment review system* (PERS) is a walking audit tool used to review links, crossings, routes, public transport waiting areas, interchange spaces and public spaces (Transport for London nd). Transport for London recommends incorporating a PERS audit into applications for new developments. The tool includes quantitative factors such as dropped kerb gradients as well as qualitative factors that rely on the auditor's judgement, eg personal safety. A scoring system of -3 to +3 is applied for each of the factors listed in table 3.4.

Table 3.4 PERS review parameters by component type (adapted from Gould 2011)

Link	Crossing	Public transit waiting area
Effective	Crossing provision	Information to the waiting area
Dropped kerbs	Deviation from desire line	Infrastructure to the waiting area
Gradient	Performance	Boarding public transit
Obstructions	Capacity	Information at the waiting area
Permeability	Delay	Safety perceptions
Legibility	Legibility	Security measures
Lighting	Legibility for sensory impaired people	Lighting
Tactile information	Dropped kerbs	Quality of the environment
Colour contrast	Gradient	Maintenance and cleanliness
Personal security	Obstructions	Waiting area comfort
Surface quality	Surface quality	
User conflict	Maintenance	
Quality of the environment		
Maintenance		
Interchange space	**Public space**	**Waling route**
Moving between modes	Moving in the space	Directness
Identifying where to go	Interpreting the space	Permeability
Personal safety	Personal safety	Road safety
Feeling comfortable	Feeling comfortable	Personal security
Quality of the environment	Sense of place	Legibility
Maintenance	Opportunity for activity	Rest points
		Quality of the environment

This tool requires specific PERS software, which generates overall scores, reports and charts. The software allows for prioritisation of factors to suit local context and needs. It also accounts for the relative importance of the pedestrian environment. For example, to receive the same overall score, a strategic route must have a higher score than a local route. While PERS was developed for the United Kingdom, the flexibility within the software means it can be adjusted for other contexts.

3.5 Raad and Burke (2018) sources

Raad and Burke (2018) undertook a literature review of 58 PLOS papers from different contexts. The study highlighted how PLOS models have traditionally been capacity based (referred to as *geometricians*), but some recent studies use experience-based qualitative frameworks (referred to as *experientialists*). Raad and Burke identified that the geometricians' approach was more straightforward and replicable; however, it risks overlooking wider considerations of walkability. Conversely, the experientialists' approach allows for consideration of a much greater range of factors, including ones which are subjective. However, there is little agreement about which factors should be considered and how they should be measured. Some frameworks apply a combination of both methods. Interestingly, Raad and Burke concluded there is no agreement as to which method is most effective in evaluating PLOS.

Raad and Burke identified several limitations and opportunities in PLOS research:

- Many of the PLOS factors have not been empirically studied.
- Few studies identify the importance of specific factors and treatments.

- PLOS frameworks are rarely tested for inter-rater reliability.
- Most PLOS studies are context specific and an overall framework with factors that are adaptable for different contexts would be beneficial.
- PLOS factors affecting people with disabilities have not been well researched.
- Development of separate PLOS measures for facility types and street types may be beneficial.

Seven sources considered in the Raad and Burke paper were reviewed further because of their applicability to this study. Those selected focused on qualitative survey methods, the Australasian experience and the needs of pedestrians with disabilities.

3.5.1 *Quantifying pedestrian friendliness – guidelines for assessing pedestrian level of service* (Gallin 2001)

Gallin (2001) developed guidelines for assessing PLOS in Western Australia. Primarily using stakeholder consultation, in conjunction with information from the Austroads PLOS guidelines and literature, factors affecting PLOS were identified and a model was developed. The model consists of 11 factors grouped into design, location and user categories. Table 3.5 specifies the factors and corresponding weightings, metrics and scores. Table 3.6 shows the LOS grade scales for the total weighted score of a path segment.

Table 3.5 Assessment model for pedestrian levels of service (Gallin 2001)

Category	Factor	Weight	0 points	1 point	2 points	3 points	4 points
Design factors (physical characteristics)	Path width	4	No pedestrian path	0–1 m	1.1–1.5 m	1.6–2.0 m	More than 2 m wide
	Surface quality	5	Unsealed and/or many cracks/bumps, ie very poor quality	Poor quality	Moderate quality, ie some cracks/bumps etc.	Reasonable quality, ie acceptable standard	Excellent quality (continuous surface with very few bumps/cracks etc)
	Obstructions	3	More than 21 obstructions per km	Between 11 and 20 obstructions per km	Between 5 and 10 obstructions per km	Between 1 and 4 obstructions per km	No obstruction
	Crossing opportunities	4	None provided, difficult to cross	Few provided and poorly located	Some provided and are reasonably well located but more are needed	Adequate crossing facilities are provided and are reasonably well located OR none are provided as they are unnecessary	Dedicated pedestrian crossing facilities are provided at adequate frequency
	Support facilities	2	Non existent	Few provided and poorly located	Few provided and reasonably well located	Several provided and well located OR absent but unnecessary	Many provided and well located
Location factors	Connectivity	4	Non existent	Poor	Reasonable	Good	Excellent
	Path environment	2	Unpleasant environment, close to vehicular traffic	Poor environment, may be within 1m of kerb	Acceptable environment, between 1 m and 2 m of kerb	Reasonable environment, between 2 m and 3 m from kerb	Pleasant environment, pedestrians more than 3 m from kerb
	Potential for vehicle conflict	3	Severe, more than 25 conflict points per kilometre	Poor situation, between 16 and 25	Moderate, ie 10 to 15 potential	Reasonable, 1 to 10 or less conflict points per km	No vehicle conflict opportunities

Category	Factor	Weight	0 points	1 point	2 points	3 points	4 points
				conflict points per kilometre	conflict points per km		
User factors	Pedestrian volume	3	More than 350 per day	226 to 250 per day	151 to 225 per day	81 to 150 per day	Less than 80 per day
	Mix of path users	4	Majority of path users are non-pedestrians	Approx 51% to 70% of path users are non-pedestrians	Between 21% and 50% non-pedestrian path users	Less than 20% non-pedestrians	Pedestrians only
	Personal security	4	Unsafe	Poor	Reasonable	Good	Excellent security provided

Table 3.6 Corresponding pedestrian levels of service grade scale (Gallin 2001)

LOS grade	Range of scores
A	132 or higher
B	101 to 131
C	69 to 100
D	37 to 68
E	36 or lower

As described in table 3.5, a combination of qualitative and quantitative measures is used. Both a desktop and site assessment are required for this model. The model was developed to assess path segments rather than routes or networks. The factors have a universal design approach, with consideration of provision for people with mobility or vision impairments incorporated into factors such as ‘obstructions’. The study found that there was limited literature relevant to Western Australia and instead most models had been developed for cities with higher densities and pedestrian volumes.

3.5.2 *Pedestrian level of service based on trip quality* (Jaskiewicz 2000)

Jaskiewicz (2000) identifies nine measures for the evaluation of pedestrian experience, based on urban design principles from *History and precedent in environmental design* (Rapoport 1990) and safety and capacity considerations. No evidence is provided for the measures. The paper notes that some of the measures are highly context dependent so more general recommendations are provided for these. This study was carried out in Florida, USA.

The nine factors, based on aesthetics, safety and ease of movement are as follows:

- Enclosure/definition: The level of definition of the street edges. Good enclosure means people’s eyes are focused along the street. Buildings and street trees can provide this. Enclosure affects both safety and amenity. Increased enclosure can result in lower vehicle speeds due to perceived narrowness. Additionally, proximate buildings can provide passive surveillance to pedestrian areas.
- Complexity of path network: A complex path provides high connectivity between activities and provides a variety of routes including the most direct route.
- Building articulation: Building faces can add interest for pedestrians, through diverse use of materials, design, colour and décor. The scale of street frontages should be designed for pedestrian speeds rather than vehicle speeds, which can result in monotonous walks.
- Complexity of spaces: Varied orientation and character improves level of interest. Geometry should enable interesting and rapidly changing views, with sectors of heightened interest.

- Overhangs/awnings/varied roof lines: Items above street level affect aesthetics and functionality. Aesthetically, diverse materials and décor improve pedestrian experience. Functionally, these items can improve comfort by providing weather protection. Street trees can assist this in residential areas.
- Buffer: Separation between pedestrians and moving vehicles improves actual and perceived safety. Where only narrow buffers are possible, the addition of large street trees greatly increases the benefit of the buffer. High occupancy on-street parking can also provide a buffer.
- Shade trees: Trees improve comfort in sunny and wet weather. They are also aesthetically pleasing.
- Transparency: Transparency can improve the transition between public and private spaces, bringing each into the view of each other and providing a smooth interface.
- Physical components/condition: These components include footpath configuration and condition, vehicle speeds (based on design speed not posted speed limit) and lighting. Dimmer, closely spaced and low-mounted lamps are preferable because they provide a more consistent environment for pedestrians.

Jaskiewicz's LOS model is based on a points-based rating scale of 1 (very poor) to 5 (excellent) for each factor. While the scores can be aggregated and averaged for an overall LOS, the study recommends keeping the nine scores separate to enable identification of specific deficiencies. The scoring method is qualitative and relies on observation. No metrics/guidelines are provided to advise the assignment of different scores for each factor, meaning inconsistencies may arise in different applications of this tool.

The PLOS model was applied to a mobility study in Florida. While not directly applicable to New Zealand, the study included both very good and very poor walking environments. Neighbourhoods with consistent neighbourhood character were assessed as whole districts, whereas more diverse areas were evaluated on an individual basis. The evaluations were used to develop pedestrian improvement recommendations, highlighting the benefits of maintaining scores for different factors separately.

3.5.3 *Determination of service levels for pedestrians, with European examples* (Sarkar 1993)

Sarkar (1993) developed a qualitative service level evaluation method for pedestrian precincts. Analysis of pedestrian environments in Munich and Rome was used to develop six service levels.

The study considered the needs of 'captive pedestrians' and essentially took a universal design approach, noting the importance of 'designing pedestrian environments that are coherent and nonthreatening while being stimulating and pleasing for all kinds of pedestrians'.

Three criteria are specified for the successful pedestrian design:

- User friendly environments should offer amenities for various pedestrian groups. The description of this factor notes the visual surroundings indicate the mode that dominates the streetscape, the functional needs of pedestrians and the benefits of good intermodal connectivity.
- Pedestrian environments should be unique and must blend with the architectural vocabulary of the area. This relates to visual quality and legibility, with the aim of easily identifiable places and distinct images.
- Visually stimulating and exciting environments should capture the spirit of the people and the city. Streetscape design should incorporate excitement and foster diverse activities.

The service levels have descriptive definitions. While some specify quantitative measures such as ranges of noise levels and footpath width, the LOS system is qualitative. Each level (A to F) is described based on the following categories:

- Safety – level of horizontal or vertical separation of modes

- Security – lighting, sight lines, passive surveillance, presence of other pedestrians
- Convenience and comfort – level of free pedestrian movement, obstacles, ramped kerb cuts, presence of amenities such as benches and toilets, noise levels and pollution levels
- Continuity – continuous stretches of pedestrian networks, appearing as a single entity with consistent design standards
- System coherence – utilisation of urban space and distinguishability of spaces
- Attractiveness – vitality, combination of scale, colour, shape, street character and view.

It is not clear how these categories were developed with reference to the three criteria specified above; however, they provide a useful distinction of how different factors affect walkability. 'Right of way' is also used as a key measure for determining different levels of service. Level A walkways have exclusive pedestrian right of way, whereas Level F environments have right of way preference for vehicles only.

While this study does not provide evidence-based LOS factors or assessment systems, it identifies qualitative factors affecting pedestrian experience which are not commonly referred to in other systems and suggests alternative measures of walkability such as the diversity in user activities, diversity in users and level of use by captive groups. The paper focuses on urban areas. While the example evaluations are for walkways, the descriptive system may be applicable for journey or network-based assessment.

3.5.4 *Evaluation of pedestrian facilities: beyond the level of service concept* (Khisty 1994)

This study highlights the need for a people-focused approach to pedestrian provision, where the built environment is designed to adapt to the needs of human beings. Khisty (1994) developed a qualitative framework for evaluating PLOS to supplement the quantitative *Highway capacity manual* approach, which focused on flow, speed and density. The study was undertaken in the US.

Seven qualitative performance measures were determined based on a literature review. These measures are the same as those identified by Sarkar (1993); however, the descriptors are different:

- Attractiveness – aesthetic design, pleasure, delight, interest and exploration
- Comfort – weather protection, climate control, shelters, seating, odour, ventilation, noise, vibration, crowding
- Convenience – directness, grades, ramps, wayfinding, connections, obstructions, kerb cutdowns, tactile trails
- Safety – ease of movement, vehicle free areas, control devices, time and space separation from vehicular movement
- Security – unobstructed sight lines, good lighting, absence of concealed areas, television surveillance
- System coherence – mental imagery and selectivity, orientation, direction
- System continuity – continuity and connectivity, particularly for multimodal facilities connected to pedestrian paths.

The LOS system relies on descriptions rather than metrics. The factors were prioritised and weightings were assigned to reflect perceived importance. This was done by people who were familiar with the situations being assessed. The study uses a constant-sum, paired-comparison method to determine the relative importance of the factors. This provides a group consensus and a feel for a group's priorities. This system allows users of a pedestrian area to rank the priorities and develop a LOS evaluation system that is specific to the context in which it is being applied. The resulting LOS model is quantitative, although the measures are assessed qualitatively.

The system was applied to an urban campus setting in Chicago, with 320 regular users surveyed to develop the ranking system and the LOS for 15 routes and segments on the campus. The respondents rated the various factors using a five-point satisfaction scale.

This methodology incorporates flexibility to ensure the LOS evaluations reflect the priorities of those who use the area. However, it does not incorporate the perceptions of people who do not walk in the area. Relying on people who are already using the area means it risks overlooking the changes required to meet the walking needs of others, which arguably is the most important outcome.

While the paper states that the methodology applies to links and networks, the user perception element means it may be well suited to evaluating PLOS along a journey/route.

3.5.5 *Disabled pedestrian level of service method for evaluating and promoting inclusive walking facilities on urban streets* (Asadi-Shekari et al 2013)

Developed in the context of Singapore, this study considers the needs of pedestrians with disabilities and able-bodied pedestrians separately with the aim of developing an inclusive and complete street PLOS evaluation. The study considers walking needs for people with disabilities in general as opposed to specific disabilities such as mobility or vision impairments.

Factors influencing disabled PLOS (DPLOS) were identified through review of literature and guidelines. The factors identified are specific and consider the effects of micro-level infrastructure such as ramps and drinking fountains. Ten indicators were developed for DPLOS, consisting of the provision of elevators, kerb ramps, wheelchair-accessible drinking fountains, slope, tactile pavement, ramps, toilets, grades and signals.

Factors affecting general PLOS (GPLOS) were identified using the same method. The resulting 20 indicators consisted of traffic speed, buffers and barriers, number of traffic lanes, crossing distances, mid-block crossings, social spaces, landscape and trees, facilities, furniture, footpath pavement, markings, pedestrian refuge and median, corner island, sidewalks on both sides, stop bars, footpath width, driveways, lighting, signage and bollards.

A points-based model was developed. Weightings were used to reflect the relative importance of the different factors. These coefficients were determined based on the prominence and level of detail of the indicators in literature and guidelines. Calculation methods were developed to determine the disabled pedestrian indicator score for each factor. The scores ranged from 0 to 1 and were determined by comparing existing street conditions to the standards for each indicator. A DPLOS percentage was also developed to compare how the existing DPLOS compared with the ideal DPLOS. A GPLOS model was determined using the same process but applied to the 20 GPLOS indicators. This was combined with the DPLOS to determine the overall PLOS. The overall PLOS model weighted the GPLOS by 66.7% and the DPLOS by 33.3%. The reasoning for this is not explicit; however, it appears this is due to the GPLOS and DPLOS being influenced by 20 and 10 factors respectively.

Asadi-Shekari et al's methodology is applicable to streets of different hierarchies. The quantitative and prescriptive nature of the system means it should guide independent assessors to rate a particular walking environment in the same way and result in good inter-rater reliability. The method enables identification and prioritisation of pedestrian improvements. This means it can assist with project prioritisation for pedestrian treatments. Some metrics would require 'translation' to the New Zealand context, for example tactile paving standards differ from those specified. The evaluation factors have more of a focus on crossing facilities than many other systems, and it is noted that the LOS system can be applied to street segments and intersection facilities.

3.5.6 *Assessment of level of service at pedestrian streets and qualitative factors: a pedestrian's perception approach* (Lazou et al 2015)

Lazou et al (2015) undertook a study to evaluate PLOS using the perceptions of pedestrians. Two suburban streets in Greece were reviewed for this study.

Based on a literature review, several qualitative factors were identified for the perception evaluation. These included social characteristics, namely gender, age and frequency of using the pedestrian street. Mobility characteristics were also posed: attractiveness, comfort, road safety, personal safety, public transport service, parking service, traffic delays, disabled people service, bicycle service and pedestrian service.

People using the study streets were asked to rate each factor as either problematic, average, good or very good. Respondents were also asked to rate the overall LOS from A to F. Three hundred responses were gathered and the results were used to develop a 'perceived LOS' model. The outcomes showed that LOS perception related to both gender and age, with men and older pedestrians perceiving a higher LOS. All qualitative factors were found to correlate with perceived LOS, with perceived comfort and 'pedestrian service' having the most significant correlation. The final regression model incorporated gender, age, frequency of walking, comfort, 'disabled people facilitation' and traffic flows and delays in the surrounding area.

Interestingly, the results of this study showed that people who walk more frequently on the streets perceived higher scores compared with infrequent pedestrians. This indicates that relying on regular users for PLOS evaluation may result in a biased model.

This study shows how pedestrian perceptions can be evaluated in a relatively simple manner and used to develop a PLOS model. However, the model was developed for two specific streets, meaning it cannot be relied on for wider application. While it is a link-based method, the same technique could be applied to journeys and networks.

3.5.7 *Qualitative evaluation of comfort needs in urban walkways in major activity centers* (Sarkar 2002)

Sarkar (2002) proposed guidelines for evaluating level of comfort along walkways in major activity centres (defined as 'urban areas which have become destinations owing to higher density mixed-use developments'). Based on literature and examples of areas perceived as comfortable pedestrian environments in the United States and Europe, two qualitative evaluation methods were developed. The first involves service levels which evaluate comfort levels at the macro level. The evaluation criteria for this method focuses on the physical effort needed for general pedestrians, the physical effort needed for pedestrians with special needs and the diversity of pedestrian activities accommodated. The second method, referred to as quality levels, provides a micro-level assessment. The components of this model are provision of stopping places, protection from adverse weather, level of noise and level of air pollution.

The assessment method for the two models consists of a detailed site survey, comparison of the characteristics of the site to specified service level standards and selection of service and quality levels. This is done in block lengths with separate assessments of each side of a street. The levels are then combined using a matrix system and an overall grade (A–F) for each side of a length of path is determined. This is based on the systems evaluation principle that 'minimum capacity defines the capacity of a line'.

This system focuses on the comfort aspect of walkability. The limitations of this LOS system include that the assessment method is resource-heavy (with detailed surveys required for each block), the subjectivity of some assessment factors leaves opportunity for biased results, and the model was developed for major urban activity centres. Nevertheless, Sarkar illustrates a way to extend link-based service levels to wider journey or network assessments through application of the systems evaluation principle. The collection of micro and macro-level information enables strengths and weaknesses to be identified at different scales. The information collected also lends itself to spatial display, which is identified as another possibility for extending the link assessments to network models.

3.6 The pedestrian experience

The pedestrian experience (NZ Transport Agency 2019) considers how pedestrian behaviours, needs, incentives and barriers differ on an individual basis. The paper highlights how ‘making a better walking environment means taking into consideration the needs of different pedestrians’. The literature review notes that pedestrian ability is fluid and can change on a journey basis and during a journey. Pedestrian ability is grouped into physical, psychomotor, sensory and cognitive abilities.

The study considers pedestrian behaviours for various ages, disabilities, genders, trip purposes and trip destinations. Spatial and personal factors and barriers are identified for each group of pedestrians. The following factors (in no particular order) were identified as affecting pedestrian experience for a combination of various types of pedestrians and people in general:

- surface condition
- traffic volumes
- traffic speeds
- presence of crossings
- crossing distance
- lighting
- rest opportunities
- openness of surroundings
- presence of others/sociability
- route directness
- free of obstacles
- enjoyable scenery
- footpath width
- footpath gradient
- proximity of motorised vehicles
- pedestrian only areas
- kerbs
- shelter from weather
- wayfinding
- noise level
- mixed land use
- ramps
- aesthetics
- public space
- natural space
- interesting environment
- land use density
- cleanliness
- crossing waiting time
- space available while waiting to cross
- provision of toilets
- presence of non-walking modes on footpath
- visibility
- passive surveillance

The various factors affecting different pedestrians highlights the need for logical and transparent design in order to create environments that are inclusive, incorporating choices that are safe and suitable for all people. *The pedestrian experience* identified several research gaps, including:

- Diversity needs and desires of different people – pedestrians are very heterogenous and infrastructure needs can be conflicting, therefore accessibility assessments should not focus on singular pedestrian groups.
- Fluidity of pedestrian experience – much of the current literature relies on ‘snapshot’ studies.
- Incorporating individual preferences – assessment frameworks are asset-centric.

- Evidence of the pedestrian experience of people with a broad range of physical, sensory, intellectual and behavioural conditions, and the experience of people who do not walk.
- Rural pedestrians – environmental factors affecting the pedestrian experience may differ for rural areas.

While the paper highlights important factors that affect people's walking choices, it does not detail methods for measuring or assessing the factors. The paper concludes that there is a need for 'customer-level information on walking decisions that provide a deeper understanding of individual and environmental context from day to day and place to place' (NZ Transport Agency 2019).

3.7 Community street reviews

A practice review of completed community street reviews (CSRs) carried out in New Zealand was undertaken. Potential differences in PLOS factors and measures in different areas, and gaps or weaknesses in the CSR process were also identified.

CSRs are a tool measuring walkability in New Zealand, focused on route-based assessments from the perspective of people using the route. CSRs incorporate both qualitative consumer assessments and quantitative asset ratings. CSRs involve the collection of data on safety, functionality, ease of crossing, urban design effects and other factors (Abley et al 2011).

CSRs involve an audit process with at least five participants assessing a route. The route is split into sections of path lengths and crossing points, which are evaluated separately by each auditor. For each section, assessors rate the overall walkability and other characteristics on a scale of 1 (very bad) to 7 (very good). There are different characteristics for the assessment of path lengths and crossings, as described in table 3.7. Assessors are then asked to rate how much their overall 'walkable' opinion would change if various variables (listed in table were improved. The scoring system for these variables is 'none' / 'a little' / 'a lot'. Assessors are also prompted to comment and identify problems and opportunities for each section (NZ Transport Agency 2010).

Table 3.7 Descriptions of path length and crossing characteristics used in CSRs (NZ Transport Agency 2010)

Characteristic	Path length description	Crossing description
Walkable (overall)	I feel this path length is walking friendly	I feel this crossing is walking friendly
Safe from traffic	I feel safe from traffic danger	
Safe from falling	I feel safe from trips, slips, and falls	
Obstacle free	I was able to move around unhindered by physical features	I was easily able to enter the crossing and crossed unhindered by physical features
Secure	I feel safe from intimidation or physical attack	N/A
Efficient	I was not impeded by others	N/A
Pleasant	I enjoyed being in this place, to interact with others and it wasn't just for movement	N/A
Delay	N/A	I crossed without having to wait for lights, traffic or others
Direct	N/A	I did not have to detour to use this crossing

Table 3.8 Variables for changing the walkability of path lengths and crossings (NZ Transport Agency 2010)

Variable type	Path length variables	Crossing variables
Traffic	• More priority over motor vehicles • Less traffic • More separation from roadway • Fewer cyclists or skateboarders etc • Better view of vehicles crossing path	• More priority over motor vehicles • Less traffic • Slower traffic • Better view of approaching traffic
Engineering	• More direct route • More or better tactile and visual aids • Better street lighting • Smoother and more even surface quality • Gentler slope along path and or no steps • Wider path • Gentler side slop across path	• More direct route • More or better tactile and visual aids • Better street lighting • Smoother and more even surface quality • Gentler slope of kerb crossing approach/exit • Wider kerb/gutter crossing • Advance 'walk' signal before motor vehicles • Narrow roadway • Longer 'walk' signal time • Audible 'walk' signal • Add traffic island • Less delay waiting to cross
Environment	• Better streetscape or public art • Better landscaping or more greenery • Cleaner • Fewer footpath obstructions • More seats, drinking fountains etc • More street activity and natural surveillance	

Individual ratings against each factor can be combined into an overall score for a path length section or a crossing. Additionally, the scores for each segment can be averaged to obtain an overall LOS (ranging from A to F) for a route.

CSR reports for Kaiapoi town centre (Waimakariri), Mangere Bridge (Auckland), Mt Roskill (Auckland), Papakura (Auckland), Brooklyn (Wellington), Wellington Railway Station and North Dunedin were reviewed. The CSR reports highlighted the benefits of separate ratings against each factor for each section. The CSR reports all resulted in identification of specific shortfalls and recommendations for improvement along the route. While the results can be aggregated to obtain an overall rating, other methods that only report an overall PLOS could result in overlooking critical issues and opportunities. The reports also showed how comments from auditors can provide valuable insights. While the variables are applicable for most contexts, the comments often identified context specific issues and possible mechanisms to address them. The recruitment of auditors also allows for specific consideration of stakeholder groups. Local people with lived experience of disability were sometimes involved in the CSRs. The ability to select auditors means that the review can be tailored towards the purpose of the CSR and ensure appropriate consideration of people with different mobility levels and experiences.

3.8 Austroads level of service framework

Austroads (2015) developed a LOS framework for network operations that incorporated motorists, public transport users, freight, pedestrians and cyclists. The framework was based on five transport needs for all road users, which were identified as mobility, safety, access, information and amenity. A literature review, consultation with stakeholders and case studies were used to develop the framework. The resulting framework can be used to balance competing demands and to identify gaps in network assessments. Table 3.9 contains an overview of the LOS framework, including the measures used for pedestrian needs. Each measure is rated A to F or 'not applicable'. The measures do not require data. This qualitative approach was used based on practitioners' needs for network operations planning and considering limited budgets. Aside from a brief literature review, there is little explanation of and justification for how the measures were developed. The research did not extend to user surveys.

Table 3.9 Overview of the LOS proposed framework (adapted from Austroads 2015)

Road user	LOS needs	LOS measure
Private motorist	Mobility	Congestion, travel time reliability, travel speed
	Safety	Crash risk
	Access	Ability to park close to destination; ability to access roadside land or ability to depart an intersection
	Information	Traveller information available
	Amenity	Aesthetics, driving stress, pavement ride quality
Public transport user	Mobility	Service schedule reliability, operating speed
	Safety	Crash risk of public transport vehicle, crash risk of public transport users while accessing/egressing public transport vehicle
	Access	Service availability (urban services only), level of disability access, access to public transport passenger stops/stations from key origins and destinations
	Information	Traveller information available
	Amenity	Pedestrian environment, on-board congestion, seat availability, security, comfort and convenience features, aesthetics, ride quality
Pedestrian	Mobility	Footpath congestion, grade of path, crossing delay or detour
	Safety	Exposure to vehicles at mid-blocks, exposure to vehicles at crossings, trip hazards
	Access	Crossing opportunities, level of disability access
	Information	Traveller information available including signposting
	Amenity	Footpath pavement conditions, comfort and convenience features, security, aesthetics

3.9 Summary

The objectives of this research are addressed below in the context of the literature and practice review.

3.9.1 Level of service factors

The literature review highlighted that a diverse range of factors affect PLOS. Table 3.10 summarises the factors identified in each literature source. The rows are ranked from most commonly to least commonly referred to. Overall, the most frequently used factors were surface quality, presence of obstructions, proximity of motor vehicles, provision of kerbs/ramps/steps, lighting, footpath width, trees/greenery, vehicle speeds and resting opportunities. Little evidence was provided in the literature as to how the factors and corresponding measures were identified. Rather, most PLOS factors and scoring systems were developed through discussions and workshops with 'experts', ie built environment practitioners.

Table 3.10 Factors identified as affecting PLOS in each source reviewed

Factor	Predicting walkability	Healthy Streets	PERS	Gallin (2001)	Jaskiewicz (2000)	Sarkar (1993)	Khisty (1994)	Asadi-Shekari (2013)	Lazou (2015)	Sarkar (2002)	Pedestrian experience	Community street reviews
Surface quality	□	□	□	□	□			□		□	□	□
Obstructions	□		□	□		□	□	□		□	□	□
Proximity of motor vehicles		□		□	□	□	□	□		□	□	□
Steps / dropped kerbs / ramps	□	□	□			□	□	□			□	□
Lighting		□	□		□	□	□	□			□	□
Footpath width	□	□	□	□				□		□	□	□
Trees and greenery	□	□			□			□		□	□	□
Vehicle speed	□	□			□			□		□	□	□
Resting areas		□	□			□	□			□	□	□
Directness			□			□	□			□	□	□
Crossing provision		□	□	□				□			□	
Attractiveness/aesthetics					□	□	□		□		□	
Noise		□				□	□			□	□	
Tactile paving or visual aids	□		□				□	□				□
Crossing delay	□		□						□		□	□
Surveillance		□				□	□				□	□
Gradient			□				□	□			□	□
Presence of pedestrians				□		□	□				□	□
Support at crossings		□		□				□			□	
Sheltered areas		□					□			□	□	
Crossing distance	□							□			□	□
Interest					□		□				□	□
Mix of path users		□		□							□	□
Traffic volume		□								□	□	□
Potential for conflict (including driveways)			□	□				□				
Connectivity				□	□		□					
Sight lines						□	□				□	
Toilets						□		□			□	
Comfort features	□								□	□		
Air quality		□				□				□		
Continuity						□	□			□		
Diversity of activities / land use						□				□	□	
Refuge island	□							□				□
Personal security			□	□								□
Cleanliness			□								□	□

Factor	Predicting walkability	Healthy Streets	PERS	Gallin (2001)	Jaskiewicz (2000)	Sarkar (1993)	Khisty (1994)	Asadi-Shekari (2013)	Lazou (2015)	Sarkar (2002)	Pedestrian experience	Community street reviews
Drinking fountains (including wheelchair accessible)								□		□		□
Hiding places	□						□					
Crossing capacity			□								□	
System coherence						□	□					
Wayfinding							□				□	
Signalisation of crossings								□			□	
Social / public spaces								□			□	
Items above street level					□					□		
Street furniture								□			□	
Visibility to traffic	□											□
Quality of the environment			□									□
Safety perceptions			□									□
Sense of place			□									□
Transparency between public/private spaces					□							□
Parkland or residential land use	□											
Design effort	□											
Road condition	□											
Restricted private car access		□										
Comfort of crossing		□										
Provision of cycle parking		□										
Bus stop accessibility		□										
Permeability			□									
Legibility			□									
Maintenance			□									
Transit information			□									
Enclosure/definition					□							
Building articulation					□							
Complexity of spaces					□							
Odour							□					
Ventilation							□					
Vibration							□					
Provision of elevators								□				
Number of traffic lanes								□				
Footpath on both sides								□				
Public transport service											□	
Land use density											□	
Openness of surroundings											□	
Advanced 'walk' signal at crossings												□
Audible 'walk' signal												□

3.9.2 LOS systems and methodologies

The level of detail in PLOS systems ranges from merely identifying which factors should be considered, through to points-based systems and detailed standards for rating each factor. Table 3.11 summarises the PLOS systems that were reviewed. There was a mix of qualitative and quantitative approaches, both for rating factors and developing a framework. Most systems evaluated PLOS for links, although some were more widely applicable on a district-level and others could be altered to use on a journey/route basis. Consideration of people with mobility and vision impairments was typically incorporated into general LOS assessments, which has been referred to as a 'universal design' approach for the purposes of this comparison. The exception was Asadi-Shekari et al's (2013) study, which developed separate systems for disabled and able-bodied pedestrians and combined these for an overall PLOS. There was a prominence of urban-focused PLOS systems and many were tested in higher-quality walking environments. Assessment of crossing facilities was generally incorporated into the evaluation of pedestrian links, although *Predicting walkability* specified a separate model for assessing the walkability of crossings.

Table 3.11 Summary of PLOS systems

LOS system	Quantitative / qualitative	Link / journey / network	Consideration of people with mobility and vision impairments	Environment	Applied to poor-quality walking environments	Assessment of crossing facilities
Predicting walkability	Quantitative	Links	Universal design	Urban	No	Separate
Healthy streets check for designers	Combination	Link	Universal design	Urban	Yes	Incorporated
Community street reviews	Combination	Journey	Universal design	Adjustable	Yes	Separate
Gallin (2001)	Combination	Link	Universal design	Combination of urban and rural (Western Australia)	Yes	Incorporated
Jaskiewicz (2000)	Qualitative	Link & District	Universal design	Urban	Yes	Incorporated
Sarkar (1993)	Qualitative	Precinct	Universal design	Urban	Yes	Incorporated
Khisty (1994)	Qualitative	Link & Network	Universal design	Not specified (methodology is context-dependent)	Yes	Incorporated
Asadi-Shekari (2013)	Quantitative	Link segments and intersections	Separate 'disability' and 'general' and combined PLOS	Independent of context	Not specified	Incorporated
Lazou (2015)	Qualitative	Link	Universal design	Suburban (Greece)	No	Incorporated
Sarkar (2002)	Qualitative	Link	Universal design	Urban (major activity centres)	Not specified	Incorporated

3.9.3 Discussion

Several of the frameworks were applied to poor quality walking environments as case studies. There was recognition in the literature that PLOS systems can be context dependent and should therefore be applied to a variety of environments if they are intended to be used widely.

Most frameworks employed a universal approach to considering needs for people with disabilities that affect their walking needs/experiences. Rather than considering people with disabilities separately, which could be at risk of being overlooked, the universal approach seems beneficial in encouraging inclusive design and focusing on providing for all people. However, the models using the universal approach provided little evidence as to how the needs of people with disabilities were determined and integrated into the framework.

The literature did not identify methods to manage and assess the impacts of new technologies and uses of footpaths. This is somewhat expected due to the timeframes in which the frameworks were developed and the recent developments of micro-mobility devices. Gallin (2001) included a metric specifying the proportion of non-pedestrian path users. The definition of 'pedestrian' therefore becomes particularly important.

Most of the systems reviewed in this study were developed to assess PLOS of links rather than journeys or networks. However, it was noted that many of the factors and systems were applicable to journey and network assessments, potentially by combining PLOS scores for the component links. One possibility is assuming that PLOS along a journey is as strong as its weakest link. However, the sources did not provide guidance about how best to approach a journey assessment.

Assessment of crossing facilities was generally considered within assessments of links, although *Community street reviews* and *Predicting walkability* had separate models for crossings. While some factors affecting PLOS at crossings are different to factors affecting PLOS along paths, considering them together assists the ability to widen link assessments to journeys and networks. An incorporated approach to crossings and paths may also help to keep the focus on customer needs and experience. For example, the benefits of an excellent crossing facility are minimal if they are not located along desire lines and accompanied by appropriate paths.

Factors making people choose to walk or choose not to walk are clearly numerous and complex. While many PLOS factors were identified in the literature, these were generally not customer identified or evidence based. Further research is needed to identify which pedestrian environment factors most significantly affect people's choice about whether or not to walk.

PLOS frameworks have existed for some time, in fact this literature review includes research from over 25 years ago. Nevertheless, no framework has been widely accepted and used to measure customer LOS for walking. The literature highlighted how there are a wide variety of approaches to developing a model; however, there is little evidence as to which approach best allows practitioners to assess walking environments based on pedestrian needs. The lack of consensus and limited uptake of the various models demonstrates there is room for improvement in the role that PLOS frameworks have in terms of contribution to industry practice and influencing decisions. While there are numerous PLOS models available, very few appear to have been implemented on a regular basis in decision making. Developing a PLOS method that is practical for practitioners to implement, and provides insights useful for decision making, may be as important as the underlying technical foundations of the model itself.

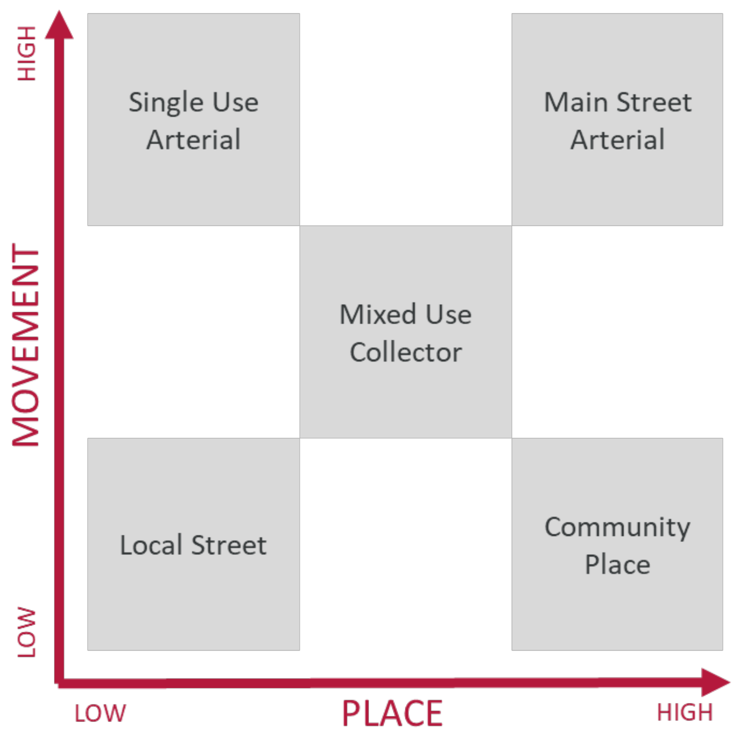
Of the sources considered in this review, Transport for London's Healthy Streets Check for Designers is the most widely recognised and operationalised framework. The Healthy Streets approach is used in New Zealand; however, practitioners have found that the check for designers is not directly applicable to the New Zealand context and there is currently no agreed or standardised modification. While Healthy Streets includes cycling and public transport needs rather than focusing on PLOS, Healthy Streets demonstrates how frameworks can consider a wide range of factors and focus on outcomes. The visual qualities of Healthy Streets, ability to have three levels of scoring, potential for using outcomes to define network PLOS and ease of application were also considered positives. For these reasons, the Healthy Streets Check for Designers provides a good starting point for this research. However, the successes and limitations of the other sources are valuable considerations to ensure the resulting PLOS Framework is fit for purpose and helpful for decision makers.

4 Framework development

4.1 Street type examples

While this research was underway the ONF street types were not yet confirmed. However, it was anticipated that a movement and place classification would be proposed. Hence, for the purposes of developing the PLOS Framework, five street types were selected to cover a range of movement and place functions, as shown in figure 4.1. Vehicle movement was considered the main factor of movement function when determining street type. It is understood that the concurrent ONF project may result in the movement function being informed by multiple modes; however, this is not yet confirmed. The place function relates to the extent to which the street attracts people to spend time there. While referred to as 'low' and 'high' place function in this research project, it is important to note that each level of place function is significant within its own location and context. 'High' place function may be considered as regional significance while 'low' place function represents local place significance.

Figure 4.1 Street types used to develop the framework



4.2 Summary of customer insights findings

The customer insights research is reported in an internal Waka Kotahi NZ Transport Agency report, prepared by Kantar TNS. The findings of that research informed the development of the PLOS Framework. There were several considerations relating to how the findings were interpreted and applied to the framework, including language use and limitations associated with experience-based research and identifying priorities based on street type. These are described in appendix A.

It should be noted that the customer insights research did not include people with disabilities. While it was intended that the concurrent Waka Kotahi transport disadvantaged research findings would inform the development of the PLOS Framework, the findings were too nuanced for application to a generalised LOS system. It is likely that pedestrians with disabilities have different needs and consequently prioritise different aspects of street environments differently from the participants of the customer insights research. While customer insights for people who are transport disadvantaged were not available, the principles of inclusive access were considered and incorporated throughout this research project.

The customer insights research identified safety and amenity as the two overarching factors that contribute to a positive pedestrian environment and a relaxing walking experience. Safety was found to be the number one priority, while amenity was a motivator to walking. As shown below in figure 4.2 multiple factors contribute to overall pedestrian safety. Similarly, amenity relates to the footpath, the street and the wider environment.

Figure 4.2 Pedestrian safety factors (Kantar TNS)

Safety from vehicles

- Cars veering off the road and hitting pedestrians
- Being forced onto the road and into traffic
- The unexpected happening such as at entranceways and driveways where vehicles can appear in pedestrians' space without warning
- Vehicles not seeing pedestrians and not stopping at pedestrian crossings
- Larger / heavier vehicles (e.g. trucks) are more intimidating – you can feel them move past you, the fear of them swerving is greater as they would cause much more serious accidents, and crossing the road is more dangerous as heavy vehicles take longer to slow down

Safety from other people

- Narrow alleyways with reduced visibility
- Dark streets / poor lighting
- Closed in due to overgrown greenery, lack of space and visibility
- Being alone and feeling vulnerable as no one else around
- Threatening neighbourhoods

Safety from other footpath users

- Bikes, scooters, skate boards
- Mobility scooters
- People walking their dogs
- Getting in each other's way, not knowing where you should walk or look

Safety from hazards on the footpath

- Falling / slipping over and hurting yourself
- Falling into the road / traffic
- Falling off scooter / bike

Eleven factors were identified as the measurable factors that contribute most to a positive pedestrian experience: footpath width, traffic speed, traffic volume, composition of traffic, visibility, pedestrian crossings, separation from traffic, footpath quality, signs and markings, lighting and greenery. Different factors were identified as more or less important for different street types. Comparisons of the importance of different factors or how much the factors change on the different street types was not possible to elicit due to the qualitative methodology employed.

An explanation of how the factors informed development of the PLOS Framework is provided in appendix A.

4.3 Other guidance and inputs

Due to the absence of quantitative data regarding pedestrian's perceptions and preferences, industry guidance, design standards and best practice were drawn on when developing the scoring and weighting of the metrics. This is discussed in more detail in section 5.3.

4.4 Framework development process

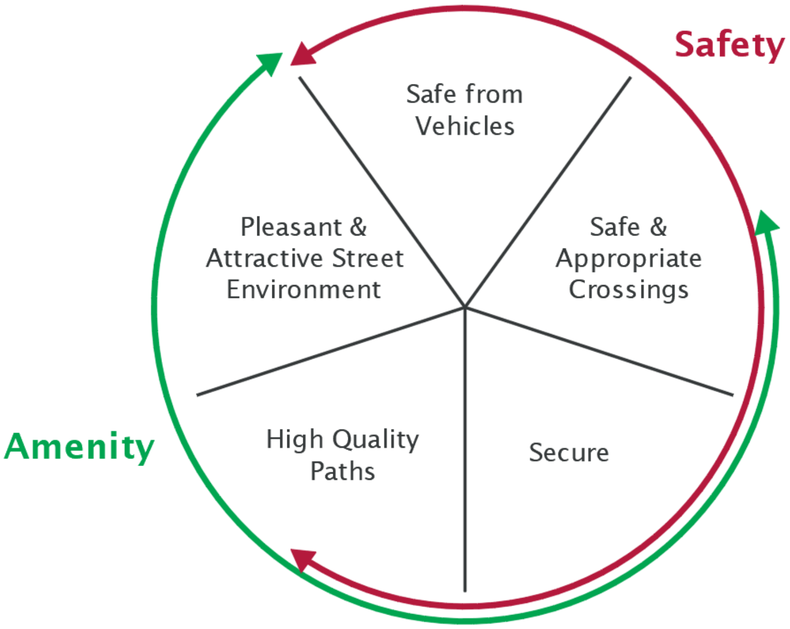
The PLOS Framework was developed through an iterative approach. Appendix A summarises the development of the final PLOS Framework. This includes interpretation and application of the customer insights research, development of a skeleton framework, case studies and practitioner testing.

5 Final PLOS Framework and assessment tool

5.1 Summary

The PLOS Framework is applicable for network, street and journey assessments. The framework consists of five PLOS outcomes, which were informed from the customer insights research and workshopped with practitioners. As illustrated in figure 5.1, the five refined PLOS outcomes all relate to either or both of the overarching PLOS considerations of safety and amenity identified in the customer insights research.

Figure 5.1 PLOS outcomes and overarching safety and amenity considerations



It should be noted that the PLOS Framework is a generalised, as most LOS systems are. The framework is not specific to a certain design user and instead provides a generalised assessment of PLOS. Different people experience different PLOS and their experience is expected to vary by day and by trip purpose.

5.2 Network level application

Through consultation with Waka Kotahi, it was understood that the One Network programme sought high-level inputs for PLOS. It is recommended the five outcomes are used as network-level PLOS factors, which could be referred to in both the ONF and NOPs. To operationalise the use of PLOS at a network level, measurable network-level metrics should be developed for the five outcomes once the structure and specific needs of the ONF are finalised.

5.3 Street level application

5.3.1 Assessment tool and scoring system

A metric-based assessment tool was developed for applying the PLOS Framework at street level. Originally developed as a spreadsheet tool, the assessment tool is now available at the following link:

http://maps.abley.com/nzta/pedestrian-los-tool/

The iterative framework development process resulted in 19 metrics that contribute to the five PLOS outcomes. These metrics and the proposed scoring system for each are discussed in the following subsections and applied in the assessment tool. Where possible, the scores are based on applicable design standards and guidelines.

An integer step-function scoring system has been developed for each metric. As per the Healthy Streets Check for Designers, a value of 0 is used for factors that directly relate to safety. This reflects the customer insights research conclusion that safety is a fundamental requirement for people to choose to undertake a walking trip. While the Healthy Streets Check for Designers uses scores of 1, 2 and 3, scores up to 4 are proposed. This is based on stakeholder feedback that Healthy Streets does not provide sufficient differentiation for some indicators. As the customer insights research did not establish quantitative information about the effects of a change in a factor, eg how beneficial is a 0.5 m increase in footpath width, professional judgement was required to establish the thresholds for the metric scores. Similarly, quantitative information about the importance of one metric compared with another was not available, meaning equal weights were assumed for each metric.

The scoring of most metrics varies by street type, reflecting the finding from the Healthy Streets approach that streets score differently based on their movement and place functions. Several metrics such as surface quality are independent of street type and therefore have a uniform scoring system. Table 5.1 summarises the scoring system for each metric. The range of possible scores for each metric is also listed in table 5.1, reflecting that some metrics relate to safety issues where poor provision can result in a score of 0. Each metric contributes to one or more of the PLOS outcomes, as indicated in table 5.1. Further explanations of each metric are provided in the following subsections of this chapter.

Table 5.1 Summary of metric scoring system

Metrics	Scoring by street type	Range of scores	Safe from vehicles	Safe and appropriate crossings	Secure	High quality paths	Pleasant & attractive street environment
1. Footpath width	Variable	0 to 4				4	
2. Surface quality	Uniform	0 to 4				4	
3. Gradient	Uniform	0 to 4				4	
4. Crossfall	Uniform	0 to 4				4	
5. Separation from moving traffic	Variable	0 to 4	4				
6. Traffic volume	Variable	1 to 4	4				4
7. Heavy vehicle volume	Variable	1 to 4	4				4
8. Traffic speed	Variable	0 to 4	4				
9. Crossing the street – frequency and type	Variable	0 to 4		4			
10. Crossing the street – quality	Uniform	0 to 4		4			
11. Crossing side streets – frequency and type	Uniform	0 to 4		4			
12. Crossing side streets – quality	Uniform	0 to 4		4			
13. Vehicle accessways	Variable	0 to 4	4				
14. Mix of path users	Uniform	0 to 4	4				4
15. Surveillance	Variable	1 to 4			4		

Metrics	Scoring by street type	Range of scores	Safe from vehicles	Safe and appropriate crossings	Secure	High quality paths	Pleasant & attractive street environment
16. Lighting	Uniform	1 to 4			4		
17. Greenery	Uniform	1 to 4					4
18. Comfort features	Variable	1 to 4					4
19. Engaging surroundings	Variable	1 to 4					4

In addition to scores for each metric, scores for the five PLOS outcomes and an overall score are calculated in the assessment tool. This ensures the outputs of the framework are useful for a variety of applications, such as identifying network gaps, comparing design ideas and identifying priority issues in local areas.

The outcome scores are calculated as the average of the scores for the metrics that contribute to the outcome and scaled to 10:

$$PLOS\ Outcome\ Score = \frac{10 \times \sum_{1}^{n}[scores\ of\ metrics\ contributing\ to\ outcome]}{4n}$$ Equation 5.1

Where *n* is the number of metrics contributing to the outcome.

Similarly, the overall PLOS score was calculated as the average of all metric scores and scaled to 10. This is different from the average of the outcome scores because some metrics contribute to multiple outcomes, so an average of the outcome scores would be more affected by a metric that contributes to two outcomes than by a metric that contributes to one outcome.

$$Overall\ PLOS\ Score = \frac{10 \times \sum_{1}^{19} metric\ score}{4 \times 19}$$ Equation 5.2

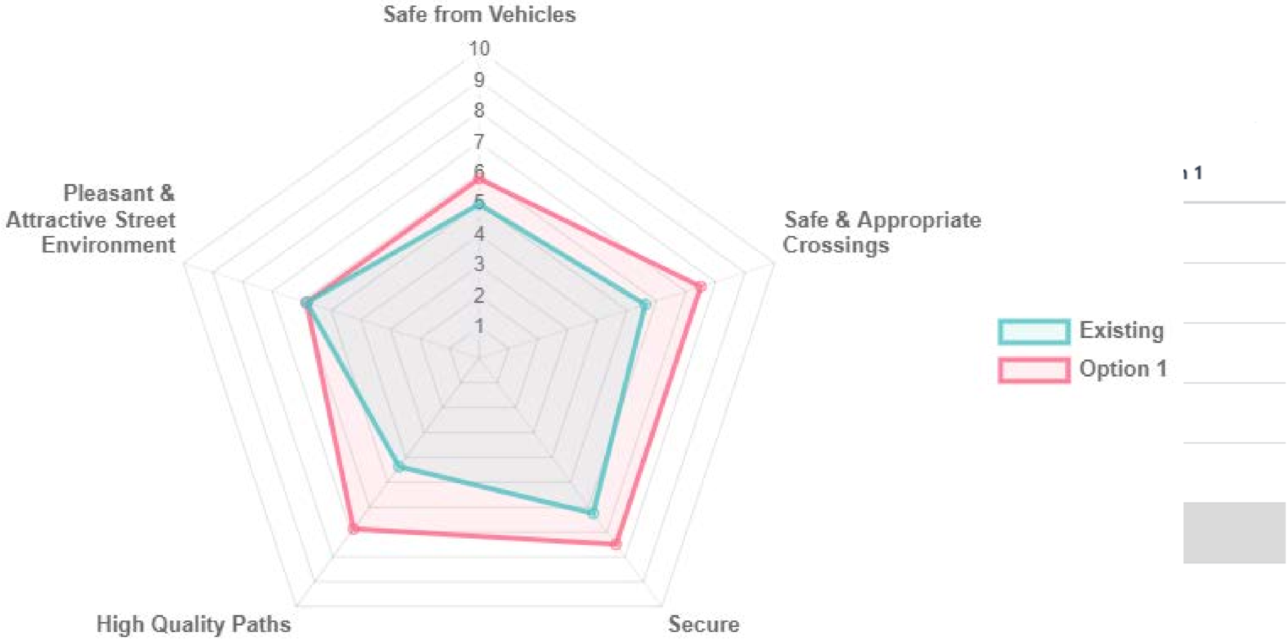
'Key deficiencies' are also identified. These are any metrics with a score of 0, meaning they are likely to be key safety issues for pedestrians.

The online PLOS assessment tool allows users to assess an existing street layout and up to four options assuming a specific street type. The tool prompts users to enter background details and then displays the metrics with the scoring details specific to the street type. Once scores are entered for all metrics, additional options can be assessed. The tool then calculates and presents outcome and overall scores and key deficiencies for the existing environment and each option. An example of results outputs is shown below in figures 5.2 and 5.3. Results cannot be saved so users are recommended to print the results webpage to PDF or take screenshots.

Figure 5.2 Example results from the assessment tool

	Existing	Option 1
Safe from vehicles	5.0	5.8
Safe and appropriate crossings	5.6	7.5
Secure	6.3	7.5
High-quality paths	4.4	6.9
Pleasant and attractive street environment	5.8	5.8
Overall score (maximum 10)	**5.4**	**6.6**
Critical deficiencies (metric score of 0)	Footpath width	

Figure 5.3 Example spider diagram results from the assessment tool



The PLOS assessment can generally be undertaken from a desktop review provided recent aerial and street view imagery is available. However, it is strongly recommended to incorporate a site visit in the assessment to make observations and ensure accurate scoring of metrics such as surface quality. Where possible, night-time site visits help to accurately score the lighting metric.

Further explanations of each metric are provided in the following subsections of this chapter. The considerations for each metric include findings from Kantar TNS's customer insights research and relevant design standards and guidance. The metric scoring provides an overview of the scoring methodology for each metric, which was informed by the corresponding considerations. The scoring descriptions for each metric and each street type are not provided in this report but are presented in the online assessment tool.

5.3.2 Footpath width

5.3.2.1 Considerations

The customer insights surveys identified path width as a key factor affecting pedestrians' ability to relax, walk next to companions and accommodate a variety of path users. The insights relate to pedestrian volumes, noting that overcrowded paths can cause disruption and delay, whereas empty paths can feel unsafe and have less atmosphere. They also highlighted the importance of directness and minimising obstacles that break people's rhythm and require them to be more vigilant.

The *Pedestrian planning and design guide* (PPDG) (NZ Transport Agency 2009) uses the term 'through route' for clear width, which is defined as 'the area where pedestrians normally choose to travel (this should be kept free of obstructions at all times)'. Minimum footpath dimensions are specified in the PPDG for different street types. The minimum width is 1.5 m and is allowable for local roads in residential areas. The PPDG also states that a width of 1.8 m is required to allow two wheelchairs to pass each other. At least 1.8 m is required for collector roads and commercial/ industrial areas outside the CBD, and a minimum of 2.4 m is specified for arterial roads in pedestrian districts, CBD areas and alongside major pedestrian generators such as schools and parks.

RTS14 (NZ Transport Agency 2015) provides information on accessible and direct paths. It specifies a preferred width of 1.8 m (minimum 1.5 m) for a continuous and direct path that is free of temporary or permanent obstacles at all times. Where a straight path is not possible, transitions should be clear and simple (NZ Transport Agency 2015). The PPDG states that any protrusions into the footpath shall have an element within 150 mm of the ground, so that it can be detected by people who are vision impaired. Acceptable protrusions should be between 0.7 m and 2 m in height and have a maximum protrusion of 100 mm for items attached to walls or 300 mm for items that are freestanding or mounted to walls.

Path crowding was considered for inclusion in this metric. However, crowding is somewhat subjective and some crowding can have positive effects on PLOS. Crowding is indirectly addressed in this metric because the width requirements increase for streets of higher place function, which are expected to have more path activity and lingering opportunities and therefore are more likely to have crowding. Furthermore, a street with path crowding has attracted many pedestrians, meaning it is unlikely to reflect a bad walking environment, and this framework is intended to encourage walking.

5.3.2.2 Metric scoring

Reflecting the customer insights research, the proposed ‘footpath width’ factor is based on clear width and also addresses deviation in path.

Based on the standards and guidance considered above, an absolute minimum width 1.5 m has been applied for both sides of single use arterials, mixed use collectors and local streets. An absolute minimum width of 1.8 m has been specified for main street arterials and community places. Where these minimums are not provided, the score is 0. A score of 3 is attained when the clear widths meet PPDG requirements. A score of 4 is achieved when the width exceeds the PPDG requirement by at least 0.3 m to reflect an above standard score. Deviation has been incorporated into the scoring of this metric, with scores being reduced by 1 if there are deviations in the path, ie the clear width moves around obstacles such as street furniture, advertising boards, utility boxes and outdoor dining areas.

5.3.3 Surface quality

5.3.3.1 Considerations

The customer insights research highlighted the impact that surface quality has on PLOS in terms of concentration and ability to relax. Footpaths should be smooth, even and well-maintained. More specifically, cracks, potholes, tree roots, crumbling surfacing, changes in surfacing, gravel from adjacent unsealed areas, pooled water, slipperiness, moss, ice and leaves were identified in the focus groups. The insights also noted that surface quality affects both safety and aesthetics.

The PPDG specifies that any sudden changes in height should be less than 5 mm, and undulations should be less than 12 mm (NZ Transport Agency 2009). Additionally, utility grates and covers should be located outside the accessible path (NZ Transport Agency 2015; Austroads 2016).

5.3.3.2 Metric scoring

Surface quality requirements do not vary significantly by street type, so the scoring system for this factor is the same across the five street types. The maximum score is achieved when ‘the path is firm, stable and slip resistant, with no sudden changes in height exceeding 5 mm, no pooled water when wet, and grates and covers are located outside the clear path’. The score is reduced to 3 when flush grates/covers are within the clear path, which reflects the potential for a change in surfacing or long-term change in level. It is further reduced to 2 for occasional minor defects such as debris and cracking and 1 if there are frequent minor defects. A path is scored 0 if it is unsealed or has major trip/slip hazards. Photos would be a helpful inclusion in the assessment tool to reduce subjectivity relating to the definitions of ‘occasional’ and ‘frequent’.

5.3.4 Gradient

5.3.4.1 Considerations

Gradient refers to slope in the direction of travel.

The customer insights research found that gradient was particularly important for people aged 65 years and over. Where steep gradients are unavoidable, it was noted that an alternative to steps was supported, with supportive measures such as handrails and non-slip surfacing also helpful. In these contexts, the importance of surface quality such as loose gravel was heightened.

The PPDG (NZTA 2009) recommends consideration of three aspects of gradient for pedestrians:

- Mean gradient: The change in vertical elevation measured between two points (maximum 5%). Rest areas are required where the mean gradient exceeds 3%.
- Maximum gradient: The change in vertical elevation measured at 0.6 m intervals along a route (8%, over a distance no greater than 9 m)
- Rate of change of gradient: The total variation in slope measured at 0.6 m intervals along a route (maximum 13%).

5.3.4.2 Metric scoring

The scoring of this metric is based on the PPDG requirements. Path gradient is essentially independent of street type, so the scoring is the same for all street types. An essentially flat path scores 4, a path up to 3% gradient scores 3, a path between 3% and 5% gradient scores 2, and a path between 5% and 8% scores 1 if this only occurs for short distances (less than 9 m). A path with a gradient over 8% scores 0 because it represents a safety issue for pedestrians.

5.3.5 Crossfall

5.3.5.1 Considerations

Crossfall refers to slope perpendicular to the direction of travel.

The customer insights work did not identify crossfall as a specific factor, however, it is known that excessive path crossfall affects people's balance and stability. Due to the selected focus groups, it is likely that the participants may not have encountered or not been affected by poor crossfalls when walking. Excessive crossfall requires people using wheelchairs or other mobility devices to use extra energy to resist the sideways forces. Furthermore, path crossfall is usually towards the road carriageway so anyone losing their balance is directed towards motorised traffic (PPDG 2009). This means that crossfall is an important consideration of inclusive access for pedestrians.

The crossfall of clear path widths should be between one percent and two percent (some crossfall is required for drainage). Where paths border areas with crossfalls exceeding 25% or a level difference exceeding 1 m, measures should be in place to prevent pedestrians from entering the area. Possible measures include a 1.2 m wide contrasting strip between the path and the hazard, a raised mountable kerb with a 0.6 m wide contrasting strip between the kerb and the hazard, or a barrier that is at least 1.1 m high (NZ Transport Agency 2009).

5.3.5.2 Metric scoring

The scoring is the same for all street types and is based on the above guidance. As practitioners indicated it would be unreasonable to measure crossfall frequently along a path and that it is difficult to guess the difference between 1% and 2%, the PPDG requirements have been slightly simplified. While a crossfall of at least 1% is recommended for drainage, the surface quality metric considers pooled water, therefore a lack of crossfall has not been included in the scoring for this metric. A score of 4 is achieved when path crossfall is not noticeable (ie less than 2%), including at vehicle crossings and no adjacent fall hazards exist. The score is reduced to 3 if the path crossfall is noticeable (exceeds 2%) at vehicle crossings only and any adjacent fall hazards have been mitigated. If the crossfall is noticeable outside of vehicle crossings and any adjacent fall hazards are mitigated the score is 2. A path with crossfall frequently exceeding 2% is scored 1 provided that any fall hazards are mitigated. Any paths without mitigation measures for adjacent fall hazards score 0. For the purposes of this metric, fall hazards have been defined as where a path borders areas with a downwards crossfall exceeding 25% or a level difference exceeding 1 m.

5.3.6 Separation from moving traffic

5.3.6.1 Considerations

Buffers and barriers between walking areas and moving traffic were identified in the customer insights research as important mechanisms to improve PLOS. Buffers were described as helping to make walking more relaxing and quieter, reducing the feeling of traffic rushing past and reducing splashing from vehicles on wet roads. The desired width of buffers increases with vehicle volumes and speeds. Barriers were considered for roads where speeds exceed 60 km/h to make people feel more physically separated and less vulnerable to impact from vehicles.

5.3.6.2 Metric scoring

In addition to berms and street furniture areas, cycle lanes and on-street parking contributes to separation from vehicular traffic. The metric scoring is therefore based on the distance between the roadside edge of the clear path and the kerbside edge of the nearest traffic lane. Note that a very wide footpath does not contribute to the separation distance. Similarly, the path edge is used rather than the path midpoint because people may choose to or be forced to walk away from the path centre. Barriers are incorporated in the scores as a mitigation for small buffers for single use arterials, mixed use collectors and main street arterials because these are higher movement streets that typically have higher vehicle speeds. Barriers are only considered as the difference between a score of 0 and a score of 1 for these street types. For the same reason, a minimum score of 0 was specified for these three street types whereas a minimum score of 1 was used for the other street types. This reflects the fact that separation from traffic affects pedestrian safety more directly on higher speed streets, while it is more important for perceived safety and comfort in lower speed areas.

There is limited guidance about appropriate widths for separation from traffic on different street types. A width of 0.5 m has been assumed as a minimum separation distance. Single use arterials, mixed use collectors and main street arterials score 0 for separation from moving traffic if there is less than 0.5 m separation and no barriers. If barriers are present, the score is increased to 1 for these street types. Local streets and community places receive a score of 1 if there is less than 0.5 m separation. The remaining scores are based on separation widths of 0.5 m–1.5 m, 1.5 m–2.5 m and over 2.5 m (resulting in a score of 4).

5.3.7 Traffic volume

5.3.7.1 Considerations

In the customer insights research, higher volumes were highlighted as negatively affecting pedestrian experience by increasing noise, reducing air quality, making it harder to cross the street, and generally contributing to a less pleasant and relaxing walking environment. It was noted that noise impact of higher traffic volumes can reduce the ability to socialise with others and ideally pedestrian areas should be quiet enough to hear birds. Free-flowing traffic was also noted as a positive, with people feeling that frustrated drivers negatively impact pedestrian experience.

The Auckland Transport Roads and Streets Framework specifies characteristic traffic volumes for streets with different movement and place functions (Auckland Transport 2018). The volume categories listed in the framework are based on vehicles per day and sometimes consider the number of traffic lanes, as shown in table 5.2.

Table 5.2 Typical traffic volumes for different street types based on movement and place functions (AT 2018)

Street type	Movement function	Place function	Typical volume per day
Centre – plaza/square/shared spaces	Low	High	'Low volume'
Main street collector	Medium	High	3,000+
Main street arterial	High	High	15,000+ (4–6 lanes) 5,000+ (2–4 lanes)
Centre – local street	Low	Medium	200–1,000
Mixed use collector	Medium	Medium	3,000+
Mixed use arterial	High	Medium	15,000+ (4–6 lanes) 5,000+ (2–4 lanes)
Local street	Low	Low	200–1,000
Neighbourhood collector	Medium	Low	3,000+
Single use arterial	High	Low	15,000+ (4–8 lanes) 5,000+ (2–4 lanes)
Rural local roads	Low	Low	50–200+
Rural collector roads	Medium–low	Low	200–1,000
Rural arterial roads	High–medium	Low	10,000+ (4–6 lanes) 3,000+ (2–4 lanes)

The ONRC system specifies typical traffic volumes as part of the functional classification criteria. These are shown in table 5.3, where 'U' and 'R' refer to urban and rural respectively (REG nd). To be classified as a particular category, roads need to meet certain numbers of criteria (specified in the first column in table 5.3) so the traffic volumes are indicative only. It should also be noted that the traffic volumes specified in ONRC are efficiency based and not developed for assessing PLOS. The volume categories may also change with the ONF and could possibly be used to inform the scores for this metric in the future.

Table 5.3 ONRC functional classification criteria for movement of people and goods (REG nd)

Road& street categories/criteria	Movement of people and goods			
	Link		Place	
	Typical daily traffic (AADT)	Heavy commercial vehicles (daily flows)	Buses (urban peak)	Active modes
National Meet 3 criteria (incl at least 1 of typical daily traffic, HCV or buses & 1 economic or social)	U = > 25,000 R = > 15,000	> 800	> 40 buses or 2,000 people per hour	
(High volume) Meet at least 1 high volume (typical daily traffic or HCV)	U = > 35,000 R = > 20,000	> 1,200		
Regional Meet 2 criteria (incl at least 1 of typical daily traffic HCV or buses and 1 economic or social)	U = > 15,000 R = > 10,000	> 400	> 40 buses or 2,000 people per hour	

Road& street categories/criteria	Movement of people and goods			
	Link		Place	
	Typical daily traffic (AADT)	Heavy commercial vehicles (daily flows)	Buses (urban peak)	Active modes
Arterial Meet 2 criteria (incl at least 1 of typical daily traffic, HCV or buses)	U = > 5,000 R = > 3,000	> 300	> 15 buses or 750 people per hour	Significant numbers of pedestrians and cyclists (urban peak) or part of identified cycling or walking network
Primary collector Meet 1 criteria (incl at least 1 of typical daily traffic, HCV or buses)	U = > 3,000 R = > 1,000	>150	> 6 buses or 350 people per hour	
Secondary collector Meet 1 criteria (incl at least 1 of typical daily traffic, HCV or buses)		> 25		
Access All other roads	U = < 1,000 R = < 200			
(Low volume) Meet low volume typical daily traffic	U = < 200 R = < 50			

5.3.7.2 Metric scoring

The scores for the traffic volume metric have been based on the volumes listed in Auckland Transport (2018) Roads and Streets Framework. The maximum score of 4 is achieved when the traffic volume is less than the volume specified by Auckland Transport. The minimum score for this factor is 1, because there is no defined traffic volume that causes streets to be directly unsafe for pedestrians. The volume ranges for scores of 3, 2 and 1 were determined using the next 'brackets' of volumes listed in the Auckland Transport (2018) and the ONRC criteria, as shown in table 5.4.

Table 5.4 Traffic volume brackets and corresponding scores for each street type

	Average daily traffic (vpd)										
Street type	No vehicle access	Restricted vehicle access & <100	100 – <200	200 – <1,000	1,000 – <3,000	3,000 – <5,000	5,000 –<10,000	10,000 – <15,000	15,000 – < 20,000	20,000 – <25,000	25,000+
Single use arterial	4	4	4	4	4	4	3	2	1	1	1
Main street arterial	4	4	4	4	4	4	3	2	1	1	1
Mixed use collector	4	4	4	4	4	3	2	1	1	1	1
Local street	4	4	4	3	2	1	1	1	1	1	1
Community place	4	3	2	1	1	1	1	1	1	1	1

5.3.8 Heavy vehicle volume

5.3.8.1 Considerations

The customer insights research for heavy vehicle volumes strongly relates to the above description for traffic volume. Heavy vehicles contribute more significantly to noise levels and air quality than general traffic. It was also noted that intersections need to be designed to accommodate expected heavy vehicles to avoid turning vehicles impinging on pedestrian areas. It was also suggested that heavy vehicles should be diverted out of main town centre areas.

While percentage of vehicle composition is often used when quantifying heavy vehicle volumes, the stakeholder workshops suggested that the number of heavy vehicles may be more relevant to PLOS than the proportion of heavy vehicles.

5.3.8.2 Metric scoring

To create scores based on volume rather than percentage composition, percentages have been applied to the volumes used for the traffic volume factor.

To align with traffic count data, 'heavy vehicles' include MCV, HCV1 and HCV2 vehicles (classes 3 to 13). This is based on the scheme developed by Transit New Zealand in 1999 (MetroCount 2013).

A score of 4 is achieved for streets that have no heavy vehicles. Less than 2% of the corresponding traffic volume for a score of 4 results in a score of 3 for heavy vehicle volume. A score of 2 is obtained for between 2% and 5%, and more than 5% results in a score of 1. The assessment tool specifies heavy vehicle volumes, which equate to the corresponding proportions of the volume specified for a score of 4 in the traffic volume metric. Because the traffic volume metric for community places specifies no vehicle access for a score of 4, the threshold for a score of 3 for heavy vehicle volume is instead 10 heavy vehicles per day restricted to outside of peak pedestrian times. The score is reduced to 2 if there are no time restrictions and less than 10 heavy vehicles per day, and the minimum score of 1 is applied to community places with more than 10 heavy vehicles per day.

5.3.9 Traffic speed

5.3.9.1 Considerations

The customer insights focus groups highlighted how traffic speeds impact on physical safety, ease of crossing and the ability to relax and enjoy walking. They also noted how higher speeds cause more noise, which is distracting and makes it harder to talk with companions.

Pedestrian trauma risk was considered when setting the minimum scores. As vehicle speeds increase above approximately 25 km/h, small changes in speed result in relatively large increases in risk of pedestrian serious injury or death (Tefft 2011). At a speed of approximately 40 km/h, the estimated risk of serious injury is 40% and the risk of death is 12%. At 65 km/h, the risk of serious injury and death is approximately 79% and 45% respectively.

5.3.9.2 Metric scoring

The scores for this factor are based on the Auckland Transport (2018) Roads and Streets Framework target design speeds for streets with different movement and place functions. Streets with an 85th percentile speed below the equivalent target design speed obtain a score of 4.

The minimum score for traffic speed is 0 because high vehicle speed directly affects pedestrian safety. Because speed limits of 25 km/h are not used in New Zealand, 30 km/h has been used as a score threshold. A score of 0 is therefore obtained for town centre spaces when the 85th percentile speed is greater than

30 km/h. This is because pedestrians are encouraged to frequent town centre spaces and vehicles may mix with pedestrians. The remaining scores are based on 10 km/h increases from the target design speeds.

Where vehicle speed counts are not available or attainable, the speed limit can be used in place of the 85th percentile speed.

5.3.10 Crossing the street and side roads

5.3.10.1 Considerations

Crossings were identified in the customer insights research as an important and complex factor affecting PLOS in terms of both safety and convenience. Considerations included visibility between pedestrians and other road users, visual cues, clear priority, gradients and alignment with desire lines. They noted tactile paving is an important cue for crossings that benefits people who are visually impaired as well as others. However, it was noted they can be hazardous, for example slippery when wet. The focus groups highlighted how crossing needs differ for different street types and identified a preferred crossing facility type for different streets.

Considerations relating to design standards and guidance are included in the scoring description for each crossing metric below.

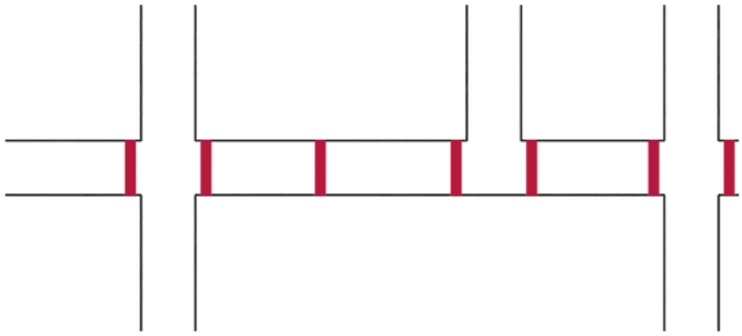
5.3.10.2 Metric scoring

Crossing the street and crossing side roads have been separated for the PLOS scoring because one street could have best practice facilities for crossing the street but poor provision for crossing side streets, and vice versa. Given the complexity of crossings, frequency and type of crossing, and quality of crossings are separate metrics for both crossing the street and crossing side streets. This means there are four separate metrics assessing the safety and appropriateness of crossings.

5.3.10.3 Crossing the street – frequency and type of crossing

This metric assesses opportunities to cross the street both at intersections and midblock, as illustrated in figure 5.4. Streets with different movement and place function have different requirements for frequency of crossing, meaning the score descriptions vary by street type. For example, higher movement function streets will typically require more formalised crossings than local streets, at which courtesy crossings may be more suitable. Appropriate types of crossings are dependent on a range of factors including the movement and place function of the street as well as traffic volumes, speeds and road space allocation. This means the scoring does not specify what type of crossing each street should have, and instead refers to the Austroads (2018) *Pedestrian facility selection tool* for guidance. For streets with medium and high movement function, the scoring specifies minimum spacings between formal crossings (signalised or raised zebras) and informal crossings separately. The crossing spacings specified in the scoring were informed by the Auckland Transport (2018) Roads and Streets Framework.

Figure 5.4 Example of opportunities to cross the street that is being assessed



5.3.10.4 Crossing the street – quality of crossings

This metric relates to the design and supporting elements for crossing the street that is being assessed at intersections and midblock (as illustrated in figure 5.5). Crossings should be designed to best practice, meaning they should be step free, obvious, minimise crossing distances and have appropriate visibility. Because the details of these requirements vary for crossing type, the PPDG is referred to for best practice (NZ Transport Agency 2009). Supporting elements should ensure all pedestrians are comfortable and safe. These can include kerb ramps, signs, markings, hand rails, no stopping lines, tactile indicators, audio tactile traffic signals and signal phasing that minimises delay. To achieve a score of four, crossing designs and supporting elements must all be best practice. The score is reduced to 3 if some supporting elements are missing. If some crossings are not best practice, the score is 2, and if most are not best practice the score is reduced to 1. A minimum score of 0 is applied if crossings are poorly designed, missing supporting elements and/or expose pedestrians to significant safety risks.

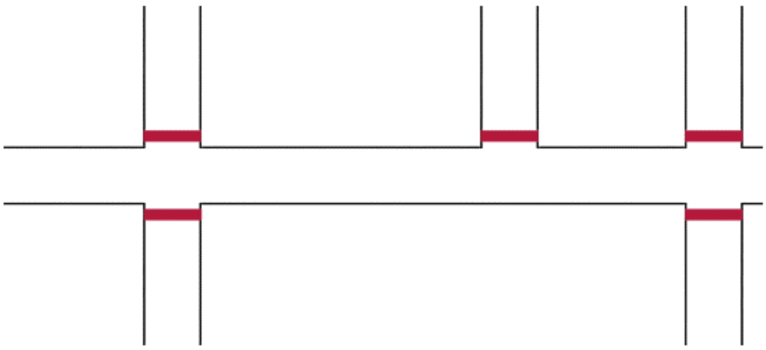
5.3.10.5 Crossing side streets – frequency and type of crossing

This metric assesses frequency and type of crossings at side streets, as illustrated in figure 5.5. The presence of side streets is not significantly dependent on street type, therefore the scoring relating to frequency of crossings is the same for all streets. While appropriate types of crossings relate to more than the street type, they are impacted by place function so the scoring descriptions vary slightly by street type. As with the crossing the street metric, this metric does not specify what type of crossing is required and refers to the Austroads (2018) *Pedestrian facility selection tool* for guidance; however, it does specify that pedestrians should have priority crossing side streets along a high place function street (main street arterials and community places).

Streets without any side streets are scored 4. Side streets without crossing facilities within 20 m of the street being assessed result in a score of 0. Scores 1–3 are based on the frequency of side streets and appropriateness of crossing facilities for the context of the street. A +1 is applied to the score if there are turning restrictions at side streets, eg left turns only or the side street is one way.

Crossings of any intersecting railway, light rail or tram lines should also be considered within this metric.

Figure 5.5 Example of crossing side streets along the street being assessed



5.3.10.6 Crossing side streets – quality of crossings

This metric relates to the design and supporting elements for crossing side streets (as illustrated in figure 5.6). As described in the crossing the street – quality of crossings metric, crossings should be designed to best practice, meaning they should be step free, obvious, minimise crossing distances and have appropriate visibility. Because the details of these requirements vary for crossing type, the PPDG (NZ Transport Agency 2009) is referred to for best practice. Supporting elements should ensure all pedestrians are comfortable and safe. These can include kerb ramps, signs, markings, hand rails, no stopping lines, tactile indicators, audio tactile traffic signals and signal phasing that minimises delay. To achieve a score of 4, crossing designs and supporting elements must all be best practice. The score is reduced to 3 if some supporting elements are missing. If some crossings are not best practice, the score is 2, and if most are not best practice the score is reduced to 1. A minimum score of 0 is applied if crossings are poorly designed, missing supporting elements and/or expose pedestrians to significant safety risks.

5.3.11 Vehicle accessways

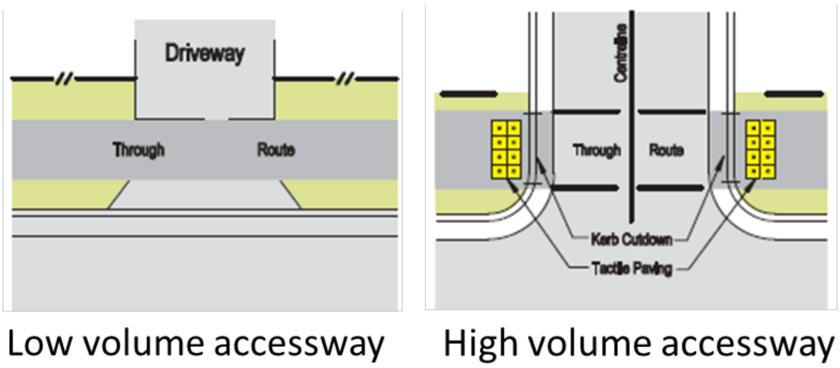
5.3.11.1 Considerations

The need for good visibility and warnings at vehicle crossings was highlighted in the customer insights research. Measures identified as positively affecting pedestrian experience at vehicle crossings included a buffer between paths and property boundaries, open driveways, visual cues and clear priority.

The PPDG provides design guidance for driveways and intersections. These are instead referred to as low-volume and high-volume accessways in this framework. High-volume accessways (referred to as intersections in the PPDG) typically have at least 500 vehicles per day and/or the traffic volume is substantially greater than the pedestrian path volume. High-volume accessways should have changes in colour and texture between the footpath and vehicle crossing, tactile indicators and kerb ramps, and the accessway should be kerbed and continuous with the road surface. Low-volume accessways should cross the footpath at grade, change in colour and texture to cross the pedestrian path, and the pedestrian path should be continuous in grade, crossfall, colour and texture across the accessway (NZ Transport Agency 2009).

Figure 5.6 illustrates the design recommendations for low and high-volume accessways.

Figure 5.6 Accessway design (NZ Transport Agency 2009)



5.3.11.2 Metric scoring

The scores for this metric are based on frequency, intensity and design of vehicle accessways. The intensity and design requirements were informed by the PPDG considerations above, whereas the frequency varies by street type. The scoring specifies rates of low-volume and high-volume accessways, based on the PPDG definitions and design guidance for driveways and intersections. The frequency of low and high-volume accessways are specified separately as rates per 100 m:

$$Frequency\ of\ low\ volume\ accessways = \frac{[\#\ low\ volume\ accessways] \times 100}{footpath\ length\ (in\ metres)} \quad \text{Equation 5.3}$$

$$Frequency\ of\ high\ volume\ accessways = \frac{[\#\ high\ volume\ accessways] \times 100}{footpath\ length\ (in\ metres)}$$

Where footpath length is typically twice the length of the assessment area.

A score of 4 is achieved for all street types if there are no vehicle accessways along the assessment area length. The requirements of scores of 0–3 vary for each street type, reflecting the different movement and place functions.

5.3.12 Mix of path users

5.3.12.1 Considerations

Providing road space to accommodate different users, mix of path users and clarity were identified as factors affecting PLOS in the customer insights research. The focus groups highlighted how pedestrian experience is affected by provision for other modes. For example, having appropriate cycle lanes reduces the likelihood of sharing a footpath with cyclists, and parking should be managed so that vehicles do not overhang pedestrian areas. There was also a desire for more clarity on shared paths to avoid confusion as to who should be where. It was also noted that dogs should be on leads in public walking environments.

Path users travelling between 10 and 15 km/h may include cyclists and wheeled recreation/micro mobility devices. Practitioners noted difficulty in measuring path speeds. For reference, typical walking, running and cycling speeds are 5 km/h, 10 km/h and 15–20 km/h respectively.

5.3.12.2 Metric scoring

The scoring for this metric does not vary by street type and ranges from 0 to 4. A score of 4 is achieved when the road space allocation and design means there is no reason for people/vehicles travelling more than 10 km/h to use the pedestrian area because there are adequate spaces and facilities for them. Paths that are likely to be used by people/vehicles travelling at more than 15 km/h with few opportunities for safe passing are scored 0. Streets are scored 1, 2 or 3 if some path users travel between 10 km/h and 15 km/h. The difference between scores 1, 2 and 3 is based on opportunities for safe passing because the impact of higher speed path users is less significant on pedestrian safety and comfort if the path width and pedestrian demand allows comfortable passing space.

5.3.13 Surveillance

5.3.13.1 Considerations

The customer insights surveys found that openness, presence of others, visibility of other pedestrians and good lighting impact people's walking experiences. Presence of other pedestrians and overlookers contributes to a more sociable, friendly and secure walking experience. 'Rough' neighbourhoods can require more alertness and feel less safe and pleasant.

'Surveillance and sight lines' form one of the seven qualities described in the *National guidelines for crime prevention through environmental design in New Zealand* (Ministry of Justice 2005). The guidelines highlight that the presence of overlookers, clear sight lines and good lighting significantly impact both feeling and being safe. Sight lines and lighting are considered in separate metrics.

Surveillance is significantly influenced by surrounding land use. This means that many design options would not improve the metric score for surveillance. Nevertheless, surveillance was identified as a key factor for PLOS and is therefore included in the framework.

Forms of surveillance differ for different street types. For example, town centre spaces should have on-street activities such as outdoor dining areas which provide onlookers. On local suburban streets, good casual surveillance can be in the form of low fences and overlooking windows.

5.3.13.2 Metric scoring

The scoring for this metric is based on descriptions reflecting the appropriate provision for each street type. Considerations include presence of active and overlooking building frontages, concealment and isolation opportunities and variability at different times of the day. Presence of on-street activities is included in the surveillance scoring descriptions for streets with high place functions (community places and main street arterials). This is because high place function streets are expected to attract people to spend time, therefore they provide a further opportunity for providing passive surveillance. While treatments that increase pedestrian demand may improve passive surveillance on all street types, the qualitative research identified mixed customer insights regarding the impact of presence of other path users on perceived safety.

5.3.14 Lighting

5.3.14.1 Considerations

The customer insights focus groups noted that lighting makes walking environments feel safer and reduce the need to concentrate by allowing people to see where they are going and who is around. They specified that streets with lights on both sides of the road are better for walking.

Ministry of Justice (2005) provides guidance about how lighting can be used to improve pedestrian environments with the 'surveillance and sight lines' quality description. Lighting should:

- provide good visual guidance and orientation
- support visibility for pedestrians as well as motorists
- ensure visibility for a reasonable distance
- be placed to ensure uniformity of lighting levels over an area

- avoid glare
- reduce the contrast between shadows and illuminated areas, except when highlighting a specific area or feature
- be placed to ensure vegetation or other elements do not interfere with its effectiveness
- not be provided in areas not intended for night-time use, which may result in a false impression of safety (Ministry of Justice 2005).

The Austroads *Guide to road design part 6A* (2017) also highlights the needs for pedestrian lighting. Lighting affects both physical safety and personal security and should enable pedestrians to perceive hazards and orientate themselves. Wider design elements such as vegetation should be considered for their impacts on lighting (Austroads 2017). The guide also specifies that lighting of paths should be designed in accordance with *AS/NZS 1158.3.1:2005: Lighting for roads and public spaces: pedestrian area (category P) lighting performance and design requirements* as well as with local jurisdiction lighting requirements.

The lighting standard AS/NZS 1158.3.1:2005 contains detailed technical considerations which would require assessment by lighting practitioners.

5.3.14.2 Metric scoring

To ensure the PLOS Framework meets stakeholder expectations/needs, the lighting metric scoring is based on descriptions rather than compliance with standards. The descriptions are based on the above considerations from the Ministry of Justice (2005) and Austroads (2017). The scores range from 1 to 4 and are independent of street type. While a minimum score of 0 was considered, it was not included. This is because the CPTED guidelines (Ministry of Justice 2005) state that lighting should not be provided where night-time use is not encouraged.

5.3.15 Greenery

5.3.15.1 Considerations

The customer insights research highlighted that well-kept greenery not overhanging through-routes or blocking visibility contributed to a pleasant walking experience. Air quality and shade benefits were also highlighted; however, it was noted that trees can drip unpleasantly when it rains.

5.3.15.2 Metric scoring

The scores for greenery are based on descriptions that are the same for all street types. Supporting photos illustrating examples for each street type may be a useful enhancement to this metric. To achieve a score of 4, streets need frequent street trees and substantial greenery (planting/ grass berm) at footway level on both sides of the road. A score of 3 requires some trees or greenery on each side of the road, whereas a score of 2 requires some on one side and /or in a central median. The minimum score for this metric is 1 because provision of greenery does not directly affect safety. A score of 1 is applied to streets with very infrequent or no trees or greenery. It is recommended that photos are sourced to provide an example of greenery for each score for each street type.

5.3.16 Comfort features

5.3.16.1 Considerations

The customer insights research highlighted that street furniture and comfort features affect walking experiences both positively and negatively. Shelter from rain, sun and wind is beneficial; however, there was support for a mix of sun and shade. People preferred having the option of shade, for example on one side of the road, and identified trees as providing good intermittent shade. ‘Clean and tidy’ was also identified as a priority, which reflects the need for adequate rubbish bins and avoiding clutter such as commercial signage in footpath areas. Seating was particularly supported around bus stops and along scenic paths. It was noted that seating helps to emphasise pedestrian friendly zones, but care needs to be taken to ensure it does not cause obstructions. Public toilets were identified as a positive for busy pedestrian areas. It was also noted that designated parking for scooters would help to keep pathways clear.

The availability of comfort features contributes to the amenity of walking environments, but they need to be designed and placed appropriately. Comfort features should be located outside the clear path, placed consistently within the same environment, and be detectable by people who are vision impaired by being within 150 mm of the ground for its full length and at least one metre high where possible (NZ Transport Agency 2009). To ensure the provision of comfort features does not have a negative impact on pedestrians' ability to relax and their personal safety, they should be designed and located to eliminate concealment, isolation and entrapment spots (as considered in the surveillance metric). Where this is not possible these locations should be secured with visibility aids incorporated (Ministry of Justice 2005).

Different street types typically require different provision of comfort features. For example, public art and cycle parking is more important for community places where people are expected to linger than on local streets. Geography and climate also affect demands for comfort features. For example, the need for shelter from the elements vary. Auckland Transport (2019) highlights that the prevailing wind direction should be considered in street design.

Table 14.9 of the PPDG provides recommendations for size, location and frequency of different types of comfort features (NZ Transport Agency 2009). The different forms of comfort features in this table should be considered, as well as other demands observed/ identified for specific streets. Comfort features need to be located outside the clear width of paths; however, this is addressed in the footpath width metric rather than in the comfort features metric.

5.3.16.2 Metric scoring

Because of its complexity and dependency on context, the comfort features metric is based on descriptions. A score of 4 is achieved when the provision of comfort features is appropriate and accessible. A score of three is achieved when appropriate types of comfort features are provided at suitable frequencies and locations. The descriptions differ by street type. For example, the descriptions for community places are:

- 4 = Frequent opportunities for seating and a variety of comfort features provided frequently, such as shade and shelter, public toilets, drinking fountains, rubbish bins and wayfinding systems. Comfort features facilitate incidental street activity and lingering.
- 3 = Some seating and comfort features are provided on both sides of the street.
- 2 = Few comfort features and seating are provided on one or both sides of the street.
- 1 = Comfort features are only provided on one side of the street or not at all.

The scoring descriptions are subjective, in particular the difference between 'some' and 'few' comfort features. Provision of comfort features is very context dependent; however, there is currently a lack of guidance to determine appropriate rates of comfort features for streets with different movement and place functions. This is a potential area for improvement in future.

5.3.17 Engaging surroundings

5.3.17.1 Considerations

Participants in the customer insights research expressed the role of points of interest in a positive walking experience. Things to look at such as scenic views, shops, nice houses and information boards were all identified as beneficial factors. Additionally, it was noted that points of interest can help to attract people and create a social experience, which contributes to a positive pedestrian environment.

The role of points of interest in improving pedestrian environments is acknowledged in the CPTED guidelines, which state that public spaces should attract people to visit and stay, and provide a range of complementary activities that are enjoyable for different cultural and age groups at the same time (Ministry of Justice 2005).

5.3.17.2 Metric scoring

The scoring for this metric is based on descriptions which vary for different street types. For streets with low or medium place function (single use arterials, local streets and mixed use collectors), the scores primarily focus on how adjacent properties provide visual interest, with a +1 applied to the score if there are things to see and do within the public space. Streets with high place functions (main street arterials and community places), the maximum score of four requires things to see and do in the public space for a variety of people, as well as adjacent properties providing consistent visual interest. The minimum score of this metric is 1, because a lack of engaging surroundings is not a direct safety issue. Streets are scored 1 if adjacent properties provide no visual interest and there are no things to see and do within the public space.

5.3.18 Other metric considerations

Other factors were considered for inclusion in the PLOS Framework. These are discussed in section 6.3.

5.3.19 Score calculation example

Table 5.5 provides an example of metric scores for a street and the calculation process for the overall and outcome scores for a street level assessment. As outlined in section 5.3.1, the overall score is calculated as the average of all metric scores, scaled to provide scores out of 10 rather than 4. This is stepped through in table 5.5 as the sum of all metric scores (a=44) divided by the number of metrics (n=19) and scaled to a maximum of 10 rather than 4:

$$\begin{aligned} Overall\ PLOS\ Score &= \frac{10 \times \sum_1^n metric\ score}{4 \times n} \\ &= \frac{10 \times 44}{4 \times 19} \\ &= 5.8 \end{aligned}$$

Equation 5.4

Similarly, the outcome scores are the sum of the contributing metric scores (referred to as (a) in the table below), divided by the number of contributing metrics (referred to as (n) in the table below) and scaled to a maximum of 10 rather than 4. For example, the score for the high-quality paths outcome is calculated as:

$$\begin{aligned} PLOS\ Outcome\ Score &= \frac{10 \times \sum_1^n metric\ score}{4 \times n} \\ High\ Quality\ Paths\ Score &= \frac{10 \times 12}{4 \times 4} \\ &= 7.5 \end{aligned}$$

Equation 5.5

Table 5.5 Scoring calculation example

Metric	Metric score	Contribution to outcome scores				
		Safe from vehicles	Safe and appropriate crossings	Secure	High quality paths	Pleasant & attractive street environment
1 Footpath widths	2				(2)	
2 Surface quality	3				(3)	
3 Gradient	4				(4)	
4 Crossfall	3				(3)	
5 Separation from moving traffic	3	(3)				
6 Traffic volume	2	(2)				(2)
7 Heavy vehicle volume	1	(1)				(1)
8 Traffic speed	2	(2)				
9 Crossing the street – frequency and type	0		(0)			
10 Crossing the street – quality	2		(2)			
11 Crossing side streets – frequency and type	2		(2)			
12 Crossing side streets – quality	1		(1)			
13 Vehicle accessways	3	(3)				
14 Mix of path users	3	(3)				(3)
15 Surveillance	2			(2)		
16 Lighting	3			(3)		
17 Greenery	4					(4)
18 Comfort features	2					(2)
19 Engaging surroundings	2					(2)
Calculation of outcome and overall scores						
	Overall score	Safe from vehicles	Safe & appropriate crossings	Secure	High-quality paths	Pleasant & attractive street environment
Sum of contributing metric scores (a)	44	14	5	5	12	14
Number of contributing metrics (n)	19	6	4	2	4	6
Average score out of 4 (b=a/n)	2.32	2.33	1.25	3.00	2.33	5.83
Score Scaled to a maximum of 10 rather than (C=10*a/4) and rounded to one decimal point	5.8	5.8	3.1	6.3	7.5	5.8

5.4 Journey application

The PLOS assessment tool developed for street level applications (as detailed in section 5.3) could potentially be used to assess PLOS along a journey. This could be achieved by dividing a journey into sections with the same street type (same movement and place function) and similar cross sections. If an overall and/or outcome score is required for a full journey, the lowest scores from each of the assessment sections should be used, because it is likely that the journey PLOS is most significantly affected by its weakest link. Any critical deficiencies from each section should also be considered in any overview.

Further research is recommended to incorporate directness into PLOS for journeys.

6 Discussion and recommendations

6.1 Customer insights research

The PLOS Framework was based on qualitative research about customer experience. This means that factors people are unfamiliar with are unlikely to have been identified as being important. For example, if people are not used to walking in environments with drinking fountains, they are unlikely to identify drinking fountains as a factor that is important even if it would improve their walking experience.

A further limitation of the customer insights research relates to the level of importance of key factors on different street types. While 11 key factors were identified as being important for all street types, certain ones were ‘dialled up or down’ and additional factors were listed for different street types. It is likely the research did not identify some factors as important for certain street types because they are generally already included in the design for these streets. For example, traffic volumes and speed were not identified as key factors for local suburban streets. This may be because volumes and speeds are typically low on these streets. Higher volumes and speeds could have a significant impact on pedestrian experience; however, this was not identified in the customer insights research. The stimulation material did include ‘poor quality’ environments for each street type, which may have partially addressed this issue.

The customer insights research included street environments that participants did not normally walk in, which assisted in identifying barriers to walking.

While the customer insights research was used to develop the initial framework and referred back to throughout refinement, it would be beneficial to undertake further research to validate the final PLOS assessment tool’s reflection of customer experience. While the metrics and scoring details are more relevant to practitioners, it is recommended that the scores (particularly outcome and overall scores) are compared with customer ratings for a given street.

6.2 Limitations

6.2.1 Framework application limitations

This framework has been developed to assess PLOS in New Zealand and address a long-term goal of increasing walking as a travel mode. The PLOS Framework is planned to support better decision making, which should result in improved safety and amenity of walking environments and therefore encourage more walking. The resulting framework provides an assessment tool, meaning it is not intended to be a design tool or replace guidance. The framework has been developed to assist practitioners identify potential areas for improvement; however, it does not provide design guidance and instead broadly quantifies how a change in the street environment is likely to improve or reduce PLOS. It incorporates existing guidance into metric scoring and refers practitioners to other sources for more detail.

The threshold scores and weighting of metrics, although informed by the customer insights research, is largely based on professional judgement as quantitative information about pedestrian preferences regarding different factors was not available.

The framework is based on a universal design approach, that is the needs and experiences of all people, including those with mobility and vision impairments, should be incorporated into the PLOS assessment. The customer insights research that informed the PLOS Framework considered pedestrians with a range of ages from a range of urban locations. However, it did not identify customer needs specifically for mobility and visually impaired pedestrians. It was intended that the concurrent Waka Kotahi research findings would inform the framework with data on those who are transport disadvantaged. However, the findings of the transport disadvantaged research were too nuanced and complex to be incorporated into a generalised and metric-based PLOS Framework. Further research is recommended to determine whether this PLOS Framework reflects the needs of all customers and to refine the assessment tool where necessary. While the PLOS Framework has considered inclusive access features, such as tactile indicators, path width and step-free surfaces, the framework does not seek to provide universal design guidance or inclusive access audit resources.

There are some limitations in the applicability of this framework in certain environments. The assessment tool has not been developed for streets with shared paths. Such streets could be assessed for PLOS; however, further testing is recommended to determine the framework's appropriateness. It is also recommended that PLOS is considered in conjunction with cycling LOS for shared paths. This is important because an improvement in the LOS for one travel mode may negatively affect another travel mode.

The assessment tool has not been tested on streets without defined pedestrian areas (eg paths). While further testing is recommended, it is anticipated that the framework could be applied to urban streets with no footpaths. This is because the metrics are still relevant and the absence of a path would simply result in many metrics being scored the minimum option. These metrics include footpath width, separation from traffic, quality of crossings and mix of path users.

The assessment tool has been developed predominantly to assess street segments. However, some projects may in fact be changes to an intersection rather than a length of street where understanding the effect on PLOS may be helpful to inform, for example, the choice of intersection control. This potentially overlaps or would require harmonisation with the Austroads (2018) Pedestrian Facility Selection Tool and is an area for further investigation.

It should be noted that this research has focused on urban environments and has not been tested in rural settings. The typically high-speed context and different customer expectations for walking in rural areas mean the PLOS assessment tool would likely report very low scores for rural streets, which may not reflect customer experience.

For the purposes of this research, the PLOS Framework and assessment tool only apply to five street types and it is not yet known whether these correspond with the concurrent ONF project to develop a national set of street families. It is noted for the purposes of this study, vehicle movement was considered as the main factor of movement function; however, this assumption may differ in the emerging ONF movement and place matrix.

6.2.2 Scoring limitations

While the assessment tool metric scores were informed by standards, guidance and customer insights research, professional judgement was required to establish thresholds between different scores. Validation of these is recommended.

The research team considered allowing users to apply their own weightings to metrics or outcomes. This would allow councils or designers to prioritise certain objectives or outcomes. However, this was not pursued because Waka Kotahi identified a need for national consistency in PLOS. The inclusion of the three levels of scoring allows users to understand how street environments affect outcomes. Rather than applying their own weightings, the framework gives users the option of prioritising certain objectives by choosing to make decisions based on a score for a specific outcome, eg appropriate crossings, instead of the overall PLOS score.

The mapping of metrics to outcomes aimed to minimise the number of metrics contributing to multiple outcomes. This minimises the 'smoothing effect' where metrics contribute to many of the outcomes which dilutes the effect a metric score change has on the outcomes. It also simplifies the assessment tool ensuring it does not operate as a 'black box', which the stakeholder workshops identified as an important consideration. 'Tool tips' that highlight which metrics contribute to each outcome score are provided on the assessment tool results page.

The customer insights research identified priority factors but was not able to specify the relative importance of each factor. While the literature review identified instances of weighted factors, these used a quantitative approach comparing customer rating scores with measurable factors. Further, some metrics will likely be more important than others depending on the characteristics of a particular pedestrian (age, mobility etc), as well as their trip purpose (recreational, commuting etc) on a particular street type. Therefore, the assessment tool was developed with equal weighting of metric scores in the calculations of outcome and overall scores. This may be an area of further research to understand how the scores compare with pedestrian experience ratings.

As the overall and outcome scores are calculated as the average of contributing metric scores (and scaled to provide a score out of 10), the scoring system is sensitive to the number of metrics. As noted in the framework development description (appendix A), separating the initial two crossings metrics into four metrics resulted in crossings factors having a more significant impact on the overall score. Reporting metric and outcome scores as well as an overall PLOS score reduces the impact of the sensitivity to the number of metrics.

The PLOS assessment tool reports numerical scores rather than A to F scores that are typically found in LOS frameworks. While thresholds for A to F could be based on equal overall PLOS score ranges (ie equal bin widths), it may be more useful to base them on other criteria. To do this effectively, significantly more case studies would need to be tested to establish A to F thresholds for each street type from the metric scores. While the A to F thresholds for motor vehicle LOS are well established, there is limited evidence as to how the A to F thresholds have been developed for other modes, such as cycling and public transport. This means that specifying A to F thresholds would risk inaccurate comparison with LOS for other modes. Most importantly, reporting scores as A to F would require a more complex system if it is to maintain the benefits of the outcome scores. To score an A, a street should ideally have no key deficiencies (metrics scored 0), outcome scores over a certain threshold or an overall score over a certain threshold. An alternative option is to report qualitative categories such as 'excellent' to 'poor'; however, this would also require consideration of the three scoring levels. Furthermore, the intention is to map the PLOS Framework to the ONF work, of which the LOS reporting has not yet been determined.

6.3 Alternative metrics and outcomes

As detailed in section 5.3, the metrics have been informed by the customer insights research, the literature review, industry guidance and design standards and practitioner feedback. Several alternative metrics and outcomes were considered in the development of the PLOS Framework.

It should be noted that some of the factors initially included in the skeleton tool and others suggested in the stakeholder workshops have not been included as individual metrics. Because they are sometimes addressed through other metrics, they were not identified in the customer insights research or they are not applicable to LOS. Examples include destinations, the number of people present and pedestrian volumes.

Proximity to destinations and the ability to visit multiple destinations in one trip arose in the customer insights research. Components of this are incorporated into the points of interest metric, and the presence of destinations also contributes to the surveillance factor. The other aspects of destinations relate more to accessibility, which is the ‘ability or ease with which activities, either economic or social, can be reached or accessed’ (Abley 2010).

The number of people around was initially included as a metric in the skeleton framework. This arose from the customer insights findings relating to sociability and sense of community. Other findings also included negative experiences relating to crowding and feeling unsafe. It was concluded that the number of people around would be best considered as an outcome rather than a metric of PLOS. Streets that score highly with the PLOS Framework are likely to attract an acceptable level of pedestrian activity. For instance, people are more likely to be present if there are points of interest and suitable comfort features.

Both stakeholder workshops suggested pedestrian volumes as a metric. The customer insights research did not identify volumes as a factor; however, it occasionally referenced crowding. As well as pedestrian volumes, path width affects crowding. Adjacent land use contributes to crowding and the movement and place functions of the different street types reflect surrounding land use in a broad sense. As the path width metric scoring differs for each street type, pedestrian volumes are not considered necessary as a separate metric. Pedestrian volume data is not often available and there can be difficulties in forecasting the level of pedestrian activity in proposed streetscapes, particularly if there is latent demand. Some streets may have significantly higher volumes than expected for their movement and place function due to land use activities that are high pedestrian generators, such as schools. In these cases, the path width specified in the PLOS Framework may not reflect the need to manage crowding. However, design standards and district plan requirements specify wider paths adjacent to high pedestrian generating activities. The PLOS Framework is not intended to replace standards and guidance, as it is expected design standards and district plan requirements would be referred to when assessing path widths that cater for a high volume of pedestrians.

Some practitioners also suggested that delay at crossings should have more emphasis in the framework. Delay is incorporated into the crossings metrics as a factor of the type of crossing (formal or informal) and a potential supporting design element (signal phasing to minimise pedestrian delay).

Another suggestion was that users should be able to input raw numbers into the assessment tool where possible, eg footpath width, traffic volumes and speeds, and scoring should be continuous rather than based on ranges as a step function. While this would achieve more granularity in scores, the framework is primarily based on qualitative research which has identified priority factors but not the relative importance of each factor nor the relative PLOS improvement. Nevertheless, even without scaled scoring, allowing users to input raw numbers may improve accuracy and make the tool more user friendly by automating scoring.

Practitioner feedback also suggested that carriageway width should be included as a key factor for PLOS. The customer insights research did not identify carriageway width so this has not been included as a metric. While carriageway width may have some effect on pedestrian safety and amenity, the primary aspects of this relate to traffic volume (and its effect on the pleasant and attractive street environment outcome), traffic speed, separation from moving traffic and the crossings metrics and outcome (through consideration of crossing distance).

6.4 Assessment tool enhancements

Several opportunities for further enhancement of the PLOS assessment tool have been identified. These enhancements would support better decision making for improved walking environments and increased uptake of walking.

The assessment tool should be mapped to the ONF when its movement and place framework and associated street families are finalised. The PLOS outcomes can also be used to inform the pedestrian customer service level statements. To ensure consistent application, the PLOS Framework should also be mapped to any other jurisdictions' movement and place interpretations as necessary.

Crossings were identified as a highly complex PLOS factor. The tool would be greatly enhanced if it linked to, or incorporated, the Austroads (2018) Pedestrian Facility Selection Tool. This would also address practitioners' recommendation to have the tool consider delay more directly.

The following were also recommended as enhancements to the assessment tool:

- Allow users to enter raw data in the tool (as noted above) and automate scoring where possible to improve accuracy and user friendliness of the assessment tool.
- Add a map feature at the start of the assessment tool to allow users to identify the start and end point of their assessment area. Adding photo examples to some of the more descriptive metrics, such as greenery and surface quality, would assist in reducing subjectivity and improve inter-rater reliability.
- Add a save feature to allow users to edit and compare scores at a later date. To support this, it would be helpful if fields for notes accompanied each metric score, and if users could upload and save plans for reference.
- Develop the street assessment tool to identify key access deficiencies and present them alongside the key safety deficiencies (metrics scored 0) to prepare an inclusive list of deficiencies.
- Create case studies to demonstrate use of the tool would be beneficial particularly for less frequent users of the assessment tool.

6.5 Areas for further research

The PLOS Framework and assessment tool, although informed by the customer insights research, have not been validated or verified as reflecting pedestrians' needs or perceptions, particularly with regard to the effect the factors have on the pedestrian experience and the relative importance of these factors. Hence the following further work is considered necessary before the framework is deployed:

- Validate that the framework and assessment tool reflect customer ratings for a range of street types to ensure they have captured pedestrians' needs and perceptions.

The following areas of further research have also been identified:

- Test whether the framework aligns or otherwise with the barriers and motivators of people with disabilities.
- Validate whether the tool reflects pedestrian volumes, ie establish if pedestrian volumes increase following improvements in PLOS scores.
- Adjust and potentially expand the PLOS Framework and assessment tool to reflect the nationwide street families once these are confirmed through the ONF project.
- Map the PLOS Framework and assessment tool to other jurisdictions' movement and place frameworks if necessary.
- Apply the assessment tool to a range of different street environments around New Zealand, particularly in smaller towns and townships where the tool has yet to be tested.
- Ascertain how the five identified PLOS outcomes and the framework can be used at a network level, particularly to inform the ONF customer service level statements. Data requirements will also need to be established.

- Identify how the online assessment tool can be developed to implement PLOS assessments of journeys, for example through the inclusion of distance and directness.
- Identify how intersections could be assessed within the tool or whether other tools or a separate intersection assessment tool would be more effective.

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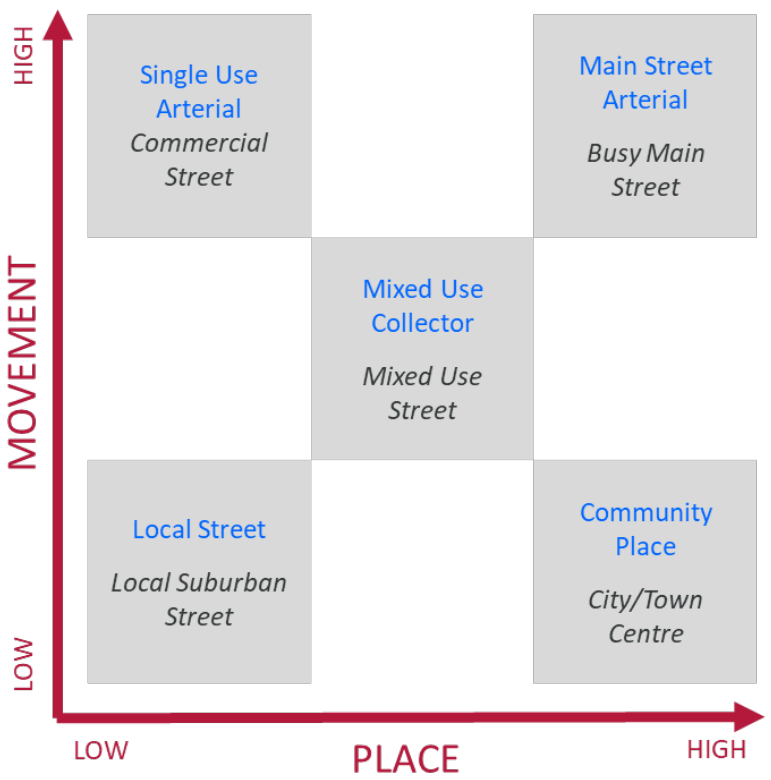
Appendix A: Developing the PLOS Framework

A1 Interpretation and application of customer insights

To ensure customer centricity, Kantar TNS's work used lay-person language and words/descriptions provided by the participants. Some of the findings did not align with terminology used in the built environment industry. These aspects were discussed with Kantar TNS to ensure the terminology used in the framework could be easily interpreted by practitioners while still capturing the meaning of the customer insights. For example, 'raised bumps on road' was associated with both speed bumps and raised courtesy crossings. Another example is one of the key factors identified in the customer insights research, 'signs and markings'. By observing a focus group discussion and discussing with Kantar TNS, it was evident that the essence of this factor related to a desire for clarity around right of way and path users. While signs and markings are certainly aspects that can improve this, there are other methods as well.

The terms used in the movement and place framework are commonly used by transport practitioners. These were adjusted in consultation with Kantar TNS to lay-person language for use in the customer insights research, as shown in italics in figure A.1.

Figure A.1 Street types by movement and place function



A2 Initial analysis

The PLOS Framework was developed through an iterative approach. First, the factors that were identified as important from the customer insights surveys were mapped against the five street types in the framework.

These five types used in the customer insights research albeit with different terminology (as described in the above section and figure A.1). This ensured consistency with the qualitative research and applicability of the tool to a range of street functions. The mapping exercise resulted in a total of 19 factors for the five street types as shown in table A.1.

The factors were based on those identified in the customer insights surveys, with some wording changes to reflect industry interpretation. All factors are considered relevant for all street types; however, 11 key factors were identified as being particularly important for all street types. These are shown in bold in the table below. Where the corresponding street type cell is shaded dark green, Kantar TNS found that the factor's importance was 'dialled up' for that street type.

Table A.1 Factors associated with each street type

Street function		Commercial street	Busy main street	Mixed use street	Local suburban street	Town centre space
	Movement and place functions	High M, Low P	High M, High P	Medium M, Medium P	Low M, Low P	Low M, High P
Factor	Footpath width including deviation					
	Traffic speed					
	Traffic volume					
	Composition of traffic					
	Visibility					
	Pedestrian crossings					
	Separation from traffic					
	Footpath quality					
	Signs and markings					
	Lighting					
	Greenery					
	Path users (*cycle lanes*)					
	Presence of others					
	Clean and tidy					
	Openness					
	Proximity to shops					
	Seating					
	Shelter/shade					
	Points of interest					

Note: Where factors contain words in brackets, the factor name has been altered from the terminology used by Kantar TNS. The term in brackets reflects the corresponding Kantar TNS factor.

Three possible levels of outputs were identified:

1 Overall PLOS score

2 Scores for key outcomes

3 Scores for each factor.

A3 Skeleton framework development

The initial analysis (table A.1 above) was presented at a stakeholder workshop in Christchurch, which involved representatives from Waka Kotahi NZ Transport Agency and territorial local authorities in Canterbury. Discussion included measurability of factors at street and network levels and potential groupings of factors. There was general support for the three levels of scoring, but it was emphasised that the framework needed to be manageable and applicable at the level of insight required for particular applications.

An overview of the concurrent One Network Framework (ONF) project was also presented by Waka Kotahi representatives at the workshop. The draft ONF classifies corridors by movement functions for different modes and place functions. It is likely that this PLOS research will be used to form customer service level statements for walking and possibly the overarching pedestrian outcomes.

Drawing on feedback from the Christchurch workshop and the expected needs of the ONF, the skeleton PLOS Framework was developed. It was identified that attributing different metrics to pedestrian outcomes would have the following benefits:

- Customer centricity
- Ability to integrate with the ONF by assuming the metrics as pedestrian mode customer outcomes
- A similar scoring structure to Healthy Streets, which was identified as the most appropriate base system from those studied in the literature review (as discussed in section 3.9.3). This includes the ability to present scores for individual metrics, outcomes (referred to as indicators in the Healthy Street approach) and an overall score.

Figure A.2 illustrates the initial proposed wheel-style PLOS Framework. The five key outcomes were developed by reviewing the customer insights research and grouping the metrics from the initial analysis. Several alternative arrangements were considered for the outcomes and central statement, for example combining safety and security. The overarching statement in the middle, ‘a relaxing experience for all’, was developed to reflect Kantar TNS’ key finding that ‘pedestrians’ core need is to relax’. An initial phrase of ‘walking is relaxing’ was presented to the steering group and stakeholder workshop attendees. It was agreed that focusing on experience and specifying ‘for all’ would better encompass customer-centric PLOS.

Figure A.2 Initial PLOS wheel with five key outcomes

The metrics were adjusted to reflect recommendations from the Christchurch stakeholder workshop while still keeping the essence of the customer insights. For example, ‘openness’ was replaced with ‘visibility to others’ and ‘pedestrian crossings’ was split into three metrics (location of crossings, type of crossings and crossing design). These metrics were mapped to each of the customer outcomes and some metrics contributed to multiple outcomes.

The PLOS wheel and the table of metrics were presented to a stakeholder workshop held in Auckland. This workshop involved practitioners from Waka Kotahi, Wellington City Council, Auckland Council and Auckland Transport. As in the Christchurch workshop, stakeholders supported the three levels of scoring. Overall, the initial framework was supported and understood. Several minor changes to the metrics were suggested. Stakeholders highlighted incorporating needs of people with disabilities into the metrics and outcomes.

Based on the feedback from the second workshop and further consideration of the customer insights research and literature review findings, the framework was developed into a ‘skeleton tool’. The tool included the same five outcome areas with 16 metrics. Scoring descriptions were developed for each metric, many of which varied for different street types. The metric scores were between 4 (best) and 0 (worst).

Outcome scores in the draft framework were calculated as the average score of metrics that contributed to each outcome and scaled to 10. Similarly, the overall PLOS score was reported as the average of all metric scores.

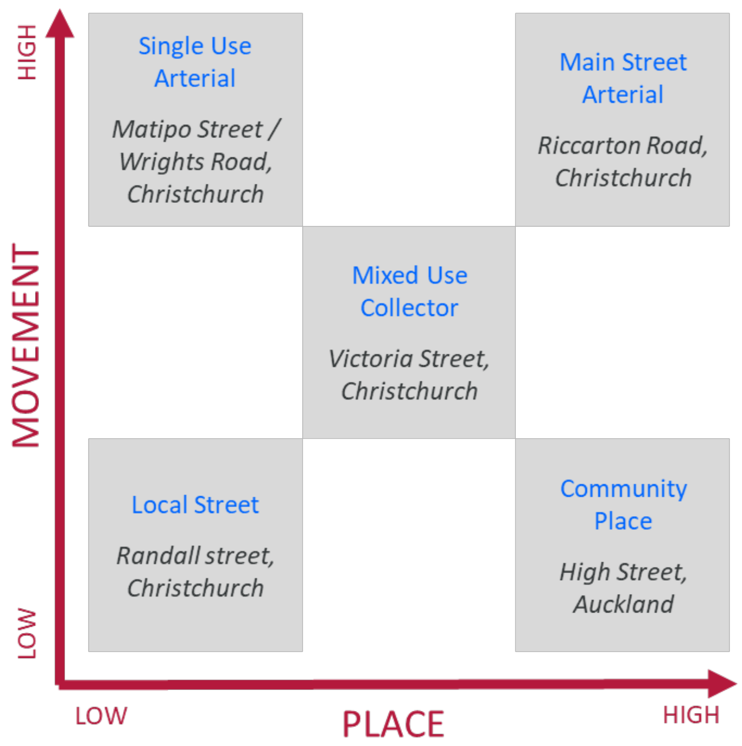
Following further internal testing, a beta assessment tool was developed for the draft PLOS Framework. The assessment tool prompted practitioners to enter information about the street being assessed. It then displayed the metric scoring descriptions for the corresponding street type. Practitioners could enter the scores for each metric for multiple street layout options. The beta assessment tool then calculated and displayed the overall PLOS score, outcome scores, key deficiencies (any metrics that scored 0) and individual metric scores. The outcome ‘wheel’ was later refined to illustrate the overarching factors of safety and amenity.

A3 Case studies

A3.1 Site selection

Five case studies were undertaken as an initial test of the draft PLOS Framework. The study sites were selected in consultation with the Project Steering Group and local road controlling authorities. Christchurch and Auckland sites were chosen due to proximity to the research group. One street of each of the five movement/place street types was selected. Where possible, streets with recent or planned upgrades were assessed. Figure A.3 shows the five streets selected for testing in relation to their movement and place functions.

Figure A.3 Case study sites by movement and place street type



The case study assessments involved an iterative process. Where deficiencies in the assessment tool were found, changes were made to the metric descriptions and scores and the score summaries for each case study reflect these changes. The case studies were undertaken using the draft PLOS Framework and the beta assessment tool. As the case studies informed further refinements of the framework and assessment tool, the results displayed are different from the final framework and assessment tool described in section 5.3.

A3.2 Matipo Street/Wrights Road (single use arterial)

No single use arterial roads with planned or recently undertaken upgrades were identified in Christchurch or Auckland for the case study. Therefore, the PLOS of an existing environment was assessed only. Wrights Road and Matipo Street are adjoining roads located in Addington, Christchurch. Matipo Street and Wrights Road between Blenheim Road and Birmingham Drive are classified as minor arterial roads in the Christchurch District Plan. The study area was bounded by Princess Street in the north and Birmingham Drive in the south, resulting in a length of approximately 630 m. Land on both sides of this road is zoned commercial office and industrial heavy. As shown in figure A.4, the assessment area includes a railway level crossing, one side road and several vehicle accessways to large car parking areas.

Figure A.4 Extent of single use arterial case study site (Canterbury Maps 2020)

The PLOS assessment for the Matipo Street/Wrights Road site was a desktop study, using aerial photography from Canterbury Maps (accessed December 2019) and Google Street View (2018 imagery accessed December 2019).

The overall PLOS score indicated a poor walking environment. The results clearly identified crossings as the major PLOS issue for the study area, both due to scores of 0 for the metrics ‘crossing the street – frequency and type of crossing’ and ‘crossing side streets – quality of crossings’, and a very low score for the appropriate crossings outcome. These results are consistent with observations from the assessment, which noted very limited support for crossing the street, side roads and vehicle accessways, as well as overall limited provision for pedestrians.

Although this case study did not involve comparison of options, it demonstrated how the PLOS Framework could be used to identify gaps and deficiencies in an existing environment and scope areas for improvement. Scoring of existing environments only is also beneficial for comparing alternative sites to prioritise areas for improvement projects.

Overall, the PLOS scoring aligned with expectations. However, the case study raised two key gaps in the draft framework, namely consideration of rail level crossings and greenery outside the road reserve. The draft framework overlooked the positive contribution that greenery adjacent to the road reserve and in public spaces alongside streets has on the pedestrian experience. Rail level crossings have been incorporated into the 'crossing the street' metrics and the description of greenery has been extended to consider greenery within the road reserve and adjacent public space.

The overall PLOS score, outcome scores and key deficiencies are shown in table A.2.

Table A.2 Matipo Street/Wrights Road PLOS scores

	Existing
Safe from vehicles	3.8
Secure	7.5
High-quality paths	3.3
Pleasant & attractive street environment	3.2
Appropriate crossings	1.3
Overall score (maximum 10)	**3.5**
Critical deficiencies (metric score of 0)	Footpath width Crossing the street – frequency and type of crossing Crossing side streets – quality of crossings Vehicle accessways Mix of path users

A3.3 Riccarton Road (main street arterial)

Riccarton Road is classified as a main distributor street in the Christchurch District Plan and a regional strategic road in the ONR classification system. Riccarton Road has a high movement function, and a high place function between Clarence Street and Matipo Street, meaning it was assessed as a main street arterial. Within this approximately 500 m length of Riccarton Road, the surrounding land use is primarily commercial core, with some residential suburban and residential medium density zones. Figure A.5 shows the previous road layout and the upgrade plans.

Riccarton Road is currently being upgraded between Clarence and Matipo Streets. Changes include speed limit reduction from 50 km/h to 30 km/h, a planted median, cycle lane upgrades, additional cycle parking, bus priority lanes and removal of on-street parking. As the upgrade is currently in construction, the PLOS scoring was undertaken through a desktop study of the Christchurch City Council scheme plans, Google Street View and Canterbury Maps aerial photography.

Figure A.5 Existing Riccarton Road environment (Canterbury Maps 2020) and proposed upgrade (Christchurch City Council 2019a)

The upgrades improved the overall PLOS score, with the main improvements relating to safe from vehicles. All outcome scores were improved except ‘secure’. This was expected as the upgrades included vehicle speed reduction, crossing facility improvements and additional greenery but did not improve surveillance or lighting. All PLOS metric scores increased or stayed the same. This aligned with expectations because no aspects of the scheme design were anticipated to negatively affect pedestrian experience.

The PLOS assessment identified key opportunities for further improvement on Riccarton Road. In particular, footpath width scored 0 in the existing scheme and one in the proposed schemes (mainly due to obstacles causing pinch points and deviations from the desired path).

Undertaking this main street arterial case study identified several opportunities for improvement in the draft PLOS Framework. Difficulties in assessing crossfall were identified. While windows facing the street positively affect surveillance, many shop windows on Riccarton Road were filled with advertising or window displays, meaning they provided little contribution to surveillance. It was also noted that provision of CCTV could be included in the surveillance metric. However, the availability of CCTV locations may make assessment of the metric difficult. Describing and assessing the engaging surroundings metric objectively was also identified as a difficulty in the PLOS Framework.

The overall PLOS score, outcome scores and key deficiencies are shown in table A.3 and illustrated in figure A.6.

Table A.3 Riccarton Road PLOS scores

	Existing	Option 1
Safe from vehicles	2.1	4.3
Secure	6.3	6.3
High-quality paths	4.2	5.8
Pleasant and attractive street environment	3.6	5.4
Appropriate crossings	3.8	5.6
Overall score (maximum 10)	**3.8**	**5.4**
Critical deficiencies (metric score of 0)	Footpath width Vehicle accessways Mix of path users	

Figure A.6 Riccarton Road PLOS outcome scores

A3.4 Victoria Street (mixed use collector)

Victoria Street is listed as a collector road in the Christchurch District Plan. The surrounding properties are primarily zoned commercial central city business, with some zoned open space community parks. Land use is primarily office and retail, including several food and beverage activities. Further surrounding land use is residential (residential central city zone). While this street was assessed with the mixed use collector scores, it should be noted that the place function of Victoria Street is more likely medium-high than medium. The full length of Victoria Street (Bealey Avenue to Kilmore Street) was assessed using the draft PLOS Framework. The existing environment was assessed based on a site visit. There is a proposed upgrade plan for Victoria Street, which was assessed via a desktop study. The proposed upgrade includes gateway treatments defining an existing 30 km/h area, raised platforms and patterned surfaces at intersections, a new raised crossing point with kerb buildouts, tactile indicators and additional street trees. Plans for the proposed upgrades are shown in figure A.7.

Figure A.7 Victoria Street proposed upgrades (Christchurch City Council 2019b)

The proposal improves PLOS, with the most significant improvement being appropriate crossings. As with Riccarton Road, the secure score does not change because there are no changes to lighting or surveillance. Review of the metric scores showed that key opportunities for further PLOS improvement for Victoria Street related to heavy vehicle volume and vehicle accessways, which both scored 0.

The PLOS scoring aligns with expectations. Crossing facilities were clearly identified as the main deficiency in the existing walking environment.

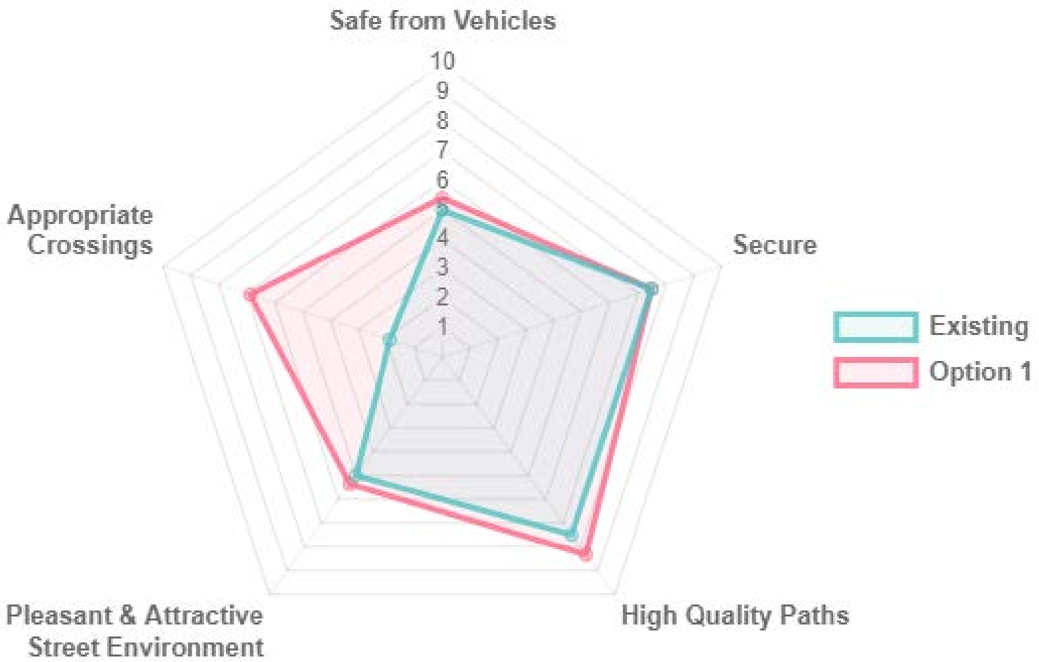
This case study highlighted that some streets have occasional instances of significant greenery, which contribute to walkability but were not captured in the draft PLOS Framework. Additionally, it was found there was little range in the appropriate crossings outcome scores primarily because this outcome had only two contributing metrics, whereas some outcomes had up to seven metrics. The scoring descriptions for the crossings metrics were also complex as they were trying to consider the frequency, type, and quality of the crossings together within a metric. It was therefore decided to split the two crossings metrics into four. The additional metrics caused crossings to have a slightly higher contribution to the overall score than the draft framework. This was considered appropriate due to the impacts of poor crossing facilities on overall PLOS.

The overall PLOS score, outcome scores and key deficiencies are shown in table A.4 and illustrated in figure A.8.

Table A.4 Victoria Street PLOS scores

	Existing	Option 1
Safe from vehicles	5.0	5.4
Secure	7.5	7.5
High-quality paths	7.5	8.3
Pleasant and attractive street environment	5.0	5.4
Appropriate crossings	1.9	6.9
Overall score (maximum 10)	**5.0**	**6.5**
Critical deficiencies (metric score of 0)	Crossing the street – frequency and type of crossing	

Figure A.8 Victoria Street PLOS outcome scores



A3.5 Randall Street (local street)

Randall Street is a local street in Richmond, Christchurch, which has recently been upgraded. The surrounding land use is residential apart from one early childhood centre. Randall Street extends from Stapletons Road to North Parade, a length of approximately 300 m, with two crossroads intersections in between. The full length of the street was assessed. Prior to the upgrade, the street had a wide unmarked carriageway with narrow footpaths and long crossing distances. The upgrades included widened and resealed footpaths, kerb buildouts at intersections, tactile indicators and a raised platform at the T-intersection with Stapletons Road. The previous walking environment (referred to as existing) was assessed using Canterbury Maps and Google Street View, whereas the upgraded environment was assessed based on a site visit. Figure A.9 shows the upgraded Randall Street.

Figure A.9 Upgraded Randall Street

The increase in overall PLOS score was primarily due to path quality and crossings improvements, as reflected in the significant changes in outcome scores. Again, the scores for 'secure' did not change. Comparison of metric scores showed that surveillance, comfort features and engaging surroundings were the main PLOS deficiencies in the upgraded street.

Interestingly, the outcome score for pleasant and attractive street environment, increased only very slightly. While the metric scores were individually intuitive, the upgraded street seemed significantly more pleasant than the previous environments. However, the poor footpath quality and crossing provision may have been the cause of the previous environment seeming relatively unpleasant and unattractive.

It was noted that the draft PLOS Framework was not clear about the contribution of unmarked parking to separation from traffic, consideration of kerb cutdowns associated with vehicle crossings, and the length of crossing the street. The metrics were refined to count unmarked parking as 2 m separation from traffic, exclude vehicle crossing cutdowns as informal crossing opportunities and consider the length of crossings and the contribution of kerb buildouts and refuge islands within the crossing metrics.

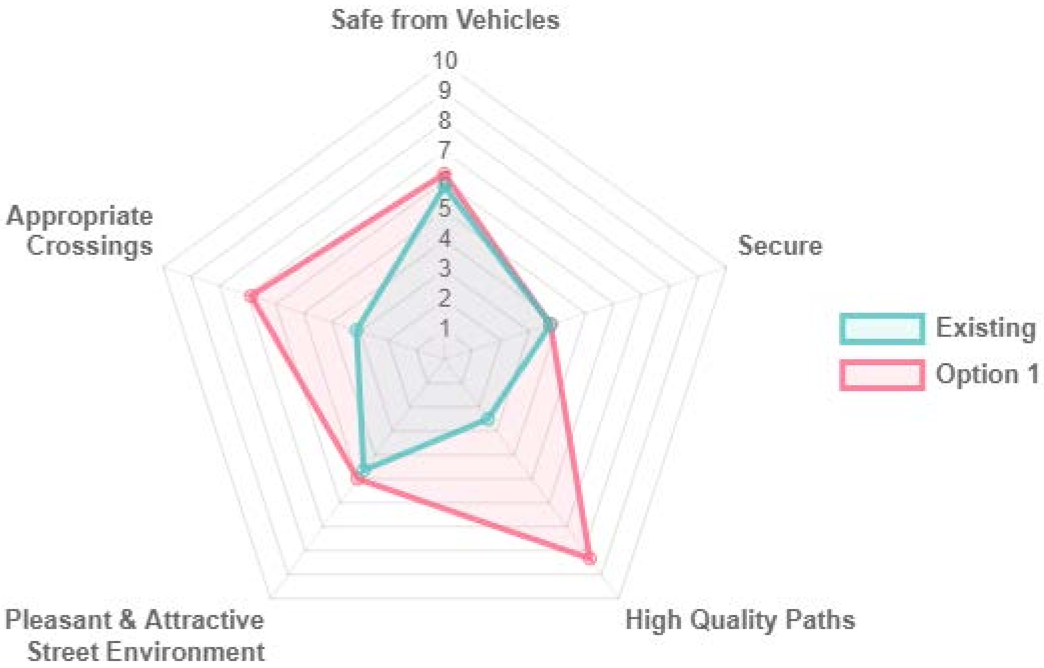
Another interesting finding from this case study was that the mix of path users metric could be scored highly if the footpath was of such poor condition that path users would not be able to travel at more than 10 km/h.

The overall PLOS score, outcome scores and key deficiencies are shown in table A.5 and illustrated in figure A.10.

Table A.5 Randall Street PLOS scores

	Existing	Option 1
Safe from vehicles	5.8	6.3
Secure	3.8	3.8
High-quality paths	2.5	8.3
Pleasant and attractive street environment	4.6	5.0
Appropriate crossings	3.1	6.9
Overall score (maximum of 10)	**4.0**	**6.3**
Critical deficiencies (metric score of 0)	Footpath width Surface quality	

Figure A.10 Randall Street PLOS outcome scores



A3.6 High Street (community place)

High Street in Central Auckland was selected as a case study for a community place (high place function and low movement function). The street is one way and adjacent properties are primarily retail activities (zoned business city centre zone). High Street has recently been upgraded between Shortland Street and Vulcan Lane, while the rest of the street is yet to be upgraded. The ‘existing’ (not upgraded) section had narrow footpaths with high pedestrian demands and on-street parking. The upgrades included footpath widening, more street furniture and greenery, as shown in figure A.11. Both sections of the street were assessed using the draft PLOS Framework, with information collected from site visits. This case study was undertaken by a practitioner who was unfamiliar with this research project.

Figure A.11 Upgraded High Street

All outcome scores were higher for the upgraded section than the existing section. Notably, the upgrade resolved the major PLOS deficiencies associated with footpath width and mix of path users. The upgraded section had a higher score for safe from vehicles. One reason for this was because the upgraded area had fewer vehicle crossings. While the change in score was not a result of the upgrade, it highlights how it is important to consider factors that affect the walking environment outside the factors that a project has a direct impact on.

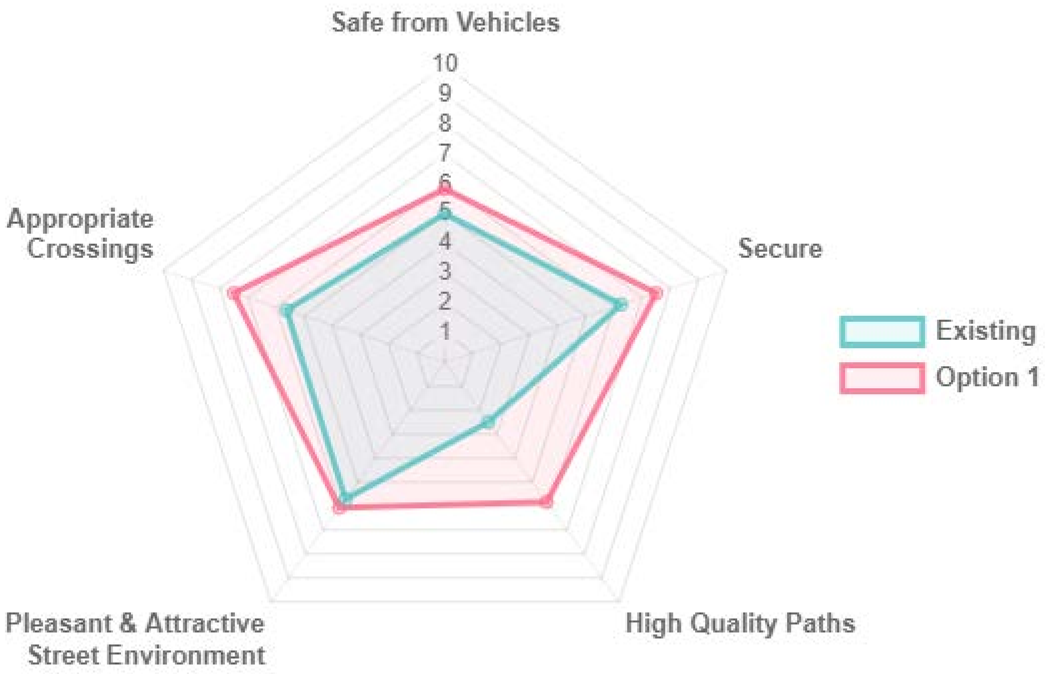
This case study highlighted the importance of multiple levels of scoring, ie an overall score, outcome scores and metric scores. For example, as seven metrics contributed to the pleasant and attractive street environment outcome score, few upgrade projects would be comprehensive enough to result in a significant increase in the outcome score. However, on inspection of the metric scores it was clear that the contribution of one metric such as greenery caused a significant improvement.

The overall PLOS score, outcome scores and key deficiencies are shown in table A.6 and illustrated in figure A.12.

Table A.6 High Street PLOS scores

	Existing	Option 1
Safe from vehicles	5.0	5.8
Secure	6.3	7.5
High-quality paths	2.5	5.8
Pleasant & attractive street environment	5.7	6.1
Appropriate crossings	5.6	7.5
Overall score (maximum 10)	**5.1**	**6.4**
Critical deficiencies (metric score of 0)	Footpath width	

Figure A.12 High Street PLOS outcome scores



A4 Practitioner testing

Feedback from the practitioner testing is summarised in the following sections as overarching feedback, specific feedback and suggested enhancements to the assessment tool.

As the practitioner testing was undertaken with the draft PLOS Framework and beta assessment tool, much of the following feedback was incorporated into the final PLOS Framework and assessment tool (presented in chapter 5).

A4.1 Overarching feedback

Practitioners reported that the tool was generally straightforward and quick to use. There was high-level support for the prominence of urban realm factors, consideration of the Healthy Streets philosophy and displaying metric, outcome and overall scores. The tool could also lead designers to identify opportunities to further improve the environment for pedestrians. Other suggestions included:

- The tool should link to relevant guidance such as *RTS14* (NZ Transport Agency 2015) where appropriate.
- Existing pedestrian demand should be considered with place function to enable prioritisation of where improvements should be made.
- Scores should be reported as A to F rather than 0 to 10 to enable compatibility with LOS for other modes.
- Scores based on numerical ranges, such as traffic speeds and volumes, should be entered as the raw number rather than categorised to improve granularity.

- There should be more interaction between contributing metrics rather than adding them to determine outcome and overall scores.
- The outcome names should better reflect the combination of safety and amenity contributing metrics.

It was also questioned how PLOS would compare with LOS for other modes. This was outside the scope of this research project and the concurrent ONF project is expected to address this.

Practitioners also questioned how the five street types in the assessment tool related to the ONF currently in development and whether the movement function related to traffic or pedestrian movement.

A4.2 Specific feedback

Specific feedback relating to individual metrics was received:

- Footpath width (metric 1) – suggestion that crowding should be incorporated and query as to how a street with no footpath would be scored.
- Surface quality (metric 2) – comment that grating covers may or may not be an issue depending on design and noted there was a significant difference between a score of 0 and a score of 1.
- Gradient and crossfall (metric 3) – error in scoring description, suggestion that gradient and crossfall are separate metrics, comment that the effect of gradient and crossfall on PLOS is continuously proportional.
- Separation from moving traffic (metric 4) – query whether a very wide footpath achieves separation from moving traffic, clarify edge of path s edge of clear unobstructed path.
- Crossings (metrics 8A, 8B, 9A and 9B) – require clarification of the difference between the four metrics, suggestion that the metric should refer to guidance, suggestion that there is more emphasis on pedestrian delay, crossing distance and turning radii, suggestion that type and frequency of crossing should be considered separately, noted pedestrians dislike diverting more than 30 m, require clarification between ‘most’ and ‘some’ subtleties in descriptions.
- Vehicle accessways (metric 10) – explanation is too long and complex, suggestion that number of accessways and volumes are combined as driveway intensity of activity or number of conflicts.
- Mix of path users (metric 11) – needs clarification and explanation as to how the metric score affects outcome scores, noted the inclusion of micromobility depends on legislation outcomes.
- Surveillance (metric 12) – noted street improvements are unlikely to increase the score for this metric, suggestion that presence of other path users, surveillance from passing vehicles and presence of graffiti and litter contribute to this metric.
- Lighting (metric 13) – noted this metric is difficult to assess during daylight hours, noted lighting can be compromised by large spacings, and it was suggested the score should range from 0 to 4 rather than 1 to 4.
- Comfort features (metric 15) – noted this metric is very dependent on street type and context and more clarification between ‘some’ and ‘few’ comfort features recommended.
- Engaging surroundings (metric 16) – description of +1 factor needs clarification.

In addition to feedback about specific metrics, practitioners:

- recommended that pedestrian delay is a key factor at intersections
- queried how the framework could align with jurisdictions using different movement and place frameworks

- suggested including carriageway width as a metric
- queried how slip lanes could be assessed with the crossing metrics
- queried how shared paths should be considered in the framework
- suggested including pedestrian and cycle volumes or demand to assist in determining appropriate path widths
- noted the separation of appropriate crossings and safe from vehicles may be misleading because safety from vehicles is a fundamental aspect of an appropriate crossing.

A4.3 Suggested tool enhancements

Several practitioners noted the tool would be more fit for purpose if it allowed users to save scores and results. It was also noted the description of metrics with possible +1 score options would be improved by only displaying the +1 explanation for relevant street types.