



# Bilingual traffic signage – a research note

International experiences and outcomes

October 2021

K O'Donnell, Waka Kotahi NZ Transport Agency, Wellington  
M Trotter, Waka Kotahi NZ Transport Agency, Wellington

Waka Kotahi NZ Transport Agency research note 005

ISSN 2703-5654 (electronic)

Waka Kotahi NZ Transport Agency  
Private Bag 6995, Wellington 6141, New Zealand  
Telephone 64 4 894 5400; facsimile 64 4 894 6100  
[NZTAresearch@nzta.govt.nz](mailto:NZTAresearch@nzta.govt.nz)  
[www.nzta.govt.nz](http://www.nzta.govt.nz)

O'Donnell, K., & Trotter, M. (2021). *Bilingual traffic signage: International experiences and outcomes* (Waka Kotahi NZ Transport Agency research note 005).



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**Keywords:** *best-practice, bilingual, cost, cultural aspiration, cultural protection, road signs, safety, signage design, te reo Māori, traffic signage, translation*

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## Acknowledgements

The authors would like to thank Dr Vanessa Beanland (University of Otago) and Dr Hamish Mackie (Mackie Research and Consulting Ltd) for improving this document through their peer reviews, and Cheryll McMorran for her peerless editing support.

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## Executive summary

As part of fulfilling the objectives of Te Reo Rangatira to ensure te reo Māori is visible, empowered, heard and spoken (Te Reo Kitea, He Tari Whakamanawa, Te Reo Rongohia, Ngā Tikanga), Waka Kotahi NZ Transport Agency is examining the potential for including te reo Māori on traffic signage nationally.

The Behaviour and Choice team of Waka Kotahi was asked to investigate two of several research questions that were proposed to the Minister of Transport in MIN-3512 Te Reo Māori Policy for Road Signs in November 2020. The key questions addressed in this paper are:

1. What are the likely impacts of bilingual signage on road safety?
2. What can we learn from international experiences with introducing bilingual signage?

The research undertook to identify international precedents for bilingual traffic signs, especially where a second language had been introduced to monolingual contexts. Key elements of interest were (a) signage details, including category and form; (b) process details, including translation, testing and introduction to communities; and (c) impact on safety, including on traffic signage effectiveness, road user comprehension and deaths and serious injuries (DSIs).

The use of bilingual traffic signage is common around the world and considered 'standard' in the European Union. Culture, safety and commerce appear to be the primary impetuses behind bilingual signage. Moves towards bilingual signage can represent one offshoot of cultural aspiration (the desire to enrich or grow culture) or cultural protection for languages under threat. Bilingual signage has also been used to enhance public safety among minority groups who may be ethnocultural or commercial in nature (eg tourists).

Bilingual signage is represented among all categories of traffic signage, particularly on *advisory signs*, and more rarely, on *warning* and *regulatory signs*.

Few studies have found evidence of major safety impacts associated with bilingual signage. In a post hoc assessment in Scotland, there was no evidence that DSIs became more frequent on routes where bilingual signage had been implemented. There was a degree of uncertainty among the experimental studies that found evidence of performance decrements among road users. First, methodological issues limited the extent to which their findings could be generalised to real on-road conditions; second, the size of the performance decrements (eg in terms of longer sign-reading comprehension times) did not necessarily translate into driving that was less safe, as individuals could compensate for the additional cognitive loads they experienced. In practice, the potential negative effects of sign complexity could be mitigated through the application of evidence-based design guidance. Even so, trade-offs could be necessary to maximise both cultural aspiration/protection and safety factors.

We found that the following evidence-based design guidance had the potential to mitigate the potential negative effects of sign complexity on public safety while providing for cultural aspirations/protection:

Best-practice traffic sign design leverages:

- familiarity
- compatibility
- standardisation.

Best practice also requires the effective use of:

- shape, colours and icons
- font design and colour
- language differentiation and judicious use of language primacy
- careful sign messaging and translation.

International experiences pointed to the need for the following processes in the effective implementation of bilingual signage:

1. robust stakeholder engagement that maps the values, preferences and concerns of relevant stakeholders
2. an iterative design process that incorporates best-practice design and research with the needs and requirements of the relevant stakeholders
3. the development of relevant legislation and standards to enable bilingual traffic signage
4. pragmatic budgeting, potentially with staged implementation across traffic sign categories
5. targeted communication, education and engagement to successfully transition the public
6. ongoing monitoring to determine the effects of any new sign designs, as well as to close the research gaps that were identified in the overseas cases.

An important next step in the process of implementing bilingual signage in Aotearoa New Zealand is to develop appropriate translations within the best-practice design guidelines described in this paper. It will also be important to develop a plan, prior to implementation, for monitoring the effects of the new bilingual signage. Policy change to the Land Transport Rule Traffic Control Devices 2004 Rule 54002/2004 is also a key next step to legally enable bilingual signage, as is the development of an accompanying education and engagement campaign.



# 1 Background

## 1.1 Waka Kotahi te reo Māori policy

Te Reo Rangatira (Waka Kotahi Te Reo Māori Policy) was created in 2019 to support the promotion of te reo Māori in Waka Kotahi NZ Transport Agency, and in the work the Agency does. The policy supports the commitment of Waka Kotahi to its obligations under Te Ture mō Te Reo Māori 2016 (Māori Language Act 2016), which created a partnership between the Crown and iwi/Māori for the revitalisation of te reo Māori. Te Reo Rangatira contributes to Maihi Karauna, the Crown's strategy for Māori language revitalisation for 2018 to 2023. This envisions Kia māhorahora te reo – everywhere, every way, for everyone, every day – a strong, healthy and thriving Māori language.

### **The objectives of Te Reo Rangatira are:**

- Te Reo Kitea – Māori language that is visible. Waka Kotahi will look throughout the organisation for opportunities to recognise and promote te reo Māori in its everyday business.
- He Tari Whakamanawa – empowered and inspired organisation. Waka Kotahi commits to developing its staff and raising the organisation's capability to support te reo Māori internally and externally.
- Te Reo Rongohia – Māori language is heard and spoken. Waka Kotahi commits to increasing the speaking of te reo Māori and its proper pronunciation.
- Ngā Tikanga – conventions. Waka Kotahi will use official conventions in communications and publications when using te reo Māori.

## 1.2 Potential for te reo Māori on traffic signage

As part of fulfilling these objectives, Waka Kotahi is examining the potential for including te reo Māori on traffic signage. The following research questions were proposed to the Minister of Transport in MIN-3512 Te Reo Māori Policy for Road Signs in November 2020:

1. What are the preferences and aspirations of Māori for the language on road signage?
2. What are the likely impacts of bilingual signage on road safety?
3. What can we learn from international experiences with introducing bilingual signage?
4. What words and phrases could be used, and how might national consistency fit with appropriate local expression?
5. What are the best mechanisms for using and representing te reo Māori on roadside infrastructure and in road safety messaging?

The Waka Kotahi Behaviour and Choice team were asked to review the international literature to address questions 2 and 3 above. This document reports the results of this research.

### **1.2.1 Special considerations for traffic signage**

Traffic signage differs from signage used in other contexts, such as entry/exit, toilets and other building facilities, and health and safety warnings, because of the unique challenges faced in the roadside context. For example, traffic signs must be identified and understood in a fraction of a second as people glance up from the roadway while driving. They must also be understood by the full range of people who travel on New Zealand's roads, including locals, visitors and tourists – people from a diverse range of backgrounds and cultures. It was therefore necessary to consider research specific to traffic signage. It is important that any introduction of a second language to traffic signs in Aotearoa New Zealand will not significantly

compromise the safety and performance aspects of the current signage. Bilingual signage has been introduced successfully overseas after consideration of these aspects, so there is merit in learning from these examples.

### 1.3 Present research goals

Specifically, this research sought to identify from the published literature the international precedents for using bilingual traffic signs, especially where a second language has been introduced to monolingual contexts, and to establish the following where possible:<sup>1</sup>

#### 1. Signage details:

- a. the categories of sign that were made bilingual (eg *advisory*, *warning*, *regulatory*) and the order these were done in, if applicable
- b. the form of the addition to the signage (position – eg underneath original text; font – eg italics, colour, etc) and any changes that were required to signage shape.

#### 2. Process details:

- a. the translation process – how decisions were made about the right words to use
- b. the testing process for the new signage – for comprehension, user acceptance, reaction times, behavioural impact, etc
- c. the process of introducing bilingual signage onto the network (when, where, order of signs, communications and engagement, education, policy/law changes,<sup>2</sup> etc).

#### 3. Impact on safety:

- a. the factors that evidence shows have an impact on road signage effectiveness and how bilingual signage could impact these
- b. the impact of bilingual signage on road user comprehension, reaction time, behavioural response, etc
- c. the impact of bilingual signage on deaths and serious injuries (DSIs).

#### 4. Other ways indigenous languages or culture were included in road signage or markings.

Our findings in relation to the above questions and the implications of these findings for how Waka Kotahi can move towards implementation of bilingual signage are discussed in the following sections.

It should be noted that a significant amount of the information pertaining to the introduction of bilingual signage, particularly in relation to the implementation and decision-making processes, is likely to be held by specific jurisdictions but was not publicly available or easily accessible for review and thus is not included here.<sup>3</sup> Examples include specifications or standards developed, engagement and communication plans, and engineering design development guides. Following the completion of this review, attempts will be made to

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<sup>1</sup> The information necessary to address all these questions was not available in every case.

<sup>2</sup> In the case of communications and engagement, education and policy/law changes, this was at a high level only for the purposes of directing SMEs in these areas to examples for their closer scrutiny.

<sup>3</sup> Direct consultation with the Welsh Government Translation Service and Transport Scotland (September 2021) confirmed this view. A search of the United Kingdom National Archives revealed no records pertaining to the change process, education or communications related to the implementation of bilingual signage in either Wales or Scotland.

source this additional information using the connections of Waka Kotahi project team members to people in specific relevant overseas jurisdictions.

## 1.4 Traffic sign categories

This review focuses specifically on traffic signage and does not cover other road markings. Requirements for the design, construction, installation, operation and maintenance of traffic signage are governed by the Land Transport Rule Traffic Control Devices 2004 Rule 54002/2004 (NZ Transport Agency, 2010). Road Controlling Authorities must follow the requirements set out in this Rule. The Rule describes three categories of traffic signs that are used in different contexts:

1. *regulatory signs* (stop, give way, speed limit, parking, etc) that require or prohibit certain actions
2. *warning signs* (both permanent and temporary) that inform road users of hazards
3. *advisory signs* that provide road users with information or guidance (including information about destinations, routes, amenities, distances, etc).

All three categories of signs are considered in this review.

## 2 Scan of international practice

### 2.1 International drivers for change

Bilingual traffic signage is used to varying extents in many countries (see Table 2.1 below); in the European Union it is described as being ‘standard’ (European Foundation of Human Rights, 2014). However, the reasons for implementing bilingual signage are varied and include:

- cultural aspiration
- cultural protection
- improved safety
- assistance for temporary visitors
- multilingual communication being the norm or default.

Predominantly, bilingual signage involves using one language derived from the majority of language speakers and one from the non-majority culture. The introduction of the non-majority language can be driven by champions from either the majority or non-majority culture, or by a combination of both, leading to a wide range of processes and experiences.

In many cases, bilingual signage is introduced because the majority language does not represent the local culture, due to a history of colonialism or normalised occupation. In these cases, the implementation of bilingual signage has strong themes of social justice because social processes have resulted in linguistic dominance – historically, when languages are assigned different levels of importance and there is a history of varying social and political status according to one’s spoken language. A case study reflecting this is described in section 2.3.

Moves toward bilingual signage may represent a form of cultural aspiration, or a desire to enrich or grow culture. Although this may arise from a position of strength – where a vibrant culture is strongly represented – it may also represent cultural protection for languages under threat of dying out. Indeed, the Framework for the Protection of National Minorities (Council of Europe, 1994) singles out signage as one avenue through which member States should ‘endeavour’ to protect minorities. However, anecdotally, there is evidence of bilingual signage being used as a political distraction against a backdrop of ongoing systemic discrimination or governmental policies that continue to marginalise minority cultural groups. The presence of bilingual signage can mask ongoing discrimination. Further discussion of these cultural drivers is given in section 2.4.

Bilingual signage can be used to enhance public safety for minority groups, particularly where migration has resulted in greater numbers of people who do not speak the local language fluently. In contrast, perceived negative safety effects are often a key focus of opposition to bilingual signage (see the discussion in section 2.6). However, majority ethnocultural groups can instigate the use of bilingual signage by incorporating language from other cultural groups, particularly other majority ethnocultural groups – not all bilingual signage involves languages from minority or repressed ethnocultures. For example, it might aim to assist the largest demographic of tourist visitors in their route finding, to enhance tourists’ safety, or to facilitate commerce when using non-traffic signage.

In some regions where there is a long history of multiple, distinct cultures living side by side (eg Sri Lanka), multilingual signage has grown organically from necessity. Bilingual signage in general has not always been a topic of debate; sometimes it is the natural outcome of people living and working side by side.

To summarise, culture, safety and commerce appear to be the primary motivations for bilingual signage.

## 2.2 Scan of regions where bilingual traffic signage is used

Table 2.1 Scan of regions, jurisdictions and languages where bilingual signage is used<sup>4</sup>

Region	Jurisdiction	Languages, locale(s)
Americas	Canada	French, English (New Brunswick, Manitoba, Ontario, Ottawa, Alberta); Scots Gaelic, English (Nova Scotia); Inuktitut, English (Nunavut) Note: Quebec prioritises French (allowed to use English, with restrictions)
	United States	English, Spanish (limited border locales, South) English, French (limited border locales, North) English, Russian (limited border locales, Alaska) English, Klallam (Port Angeles, Washington State)
Asia	China	Mandarin, Uyghur (limited, Xinjian) Mandarin, Mongolian (limited, Mongolia) Mandarin, Zhuang (Guangxi) Mandarin, Korean (Yanbian Korean Autonomous Prefecture) Mandarin, English (limited, Beijing, Shanghai)
	India	Hindi, English (and other regional languages) Urdu, Arabic (synchronic digraphia) (Hindustani)
	Japan	Japanese, English (direction signs, national highways, urban areas)
	Vietnam	Vietnamese, English (Ho Chi Minh City)
	Sri Lanka	Sinhala, Tamil, English (in a variety of configurations, including all three used together in some advisory signage)
Europe	Belgium	Dutch, French (Brussels)
	England	Welsh, English (Wales) English, Ulster Scots (limited, Northern Ireland) Scots Gaelic, English (Scotland)
	Finland	Swedish, Finnish (Sami in the North)
	Germany	German, Sorbian (Brandenburg, Saxony)
	Greece	English, Greek (virtually all traffic signs are bilingual) Greek, Albanian (contested, limited border locales)
	Italy	Italian, German (South Tyrol)
	Republic of Ireland	Irish Gaelic, English
	Switzerland	French, German (eg Bern, Fribourg, Valais)
	Turkey	Turkish, Kurdish (Eastern Anatolia) Turkish, English (airports, tourist areas)
	Wales	Welsh, English
Middle East	Israel	Hebrew, Arabic, English
	Saudi Arabia	Arabic, English

<sup>4</sup> Due to time and resource constraints, a scan of Central and South American, African and Pacific jurisdictions was omitted. Based on the ubiquity of bilingual traffic signage in the areas that were scanned, it was assumed that bilingual traffic signage was likely to be present in those jurisdictions.

## 2.3 The Welsh case

### 2.3.1 Overview

Wales was chosen as a case study due to elements of similarity with the Aotearoa New Zealand experience (discussed below) and because there was readily available literature on the Welsh experience. A deeper dive into the literature revealed a range of socio-political issues, policy issues and technical issues. These are described below, along with further information from the scan of international literature where relevant.

Wales as a region has a complicated history of conflict with England that culminated in occupation, becoming part of the Kingdom of Great Britain in 1707. Notwithstanding the passage of several hundred years, Wales still has a distinct cultural heritage, including a distinct language (Cymraeg or y Gymraeg, commonly called Welsh). Language data collected regularly since 1911 shows that Welsh literacy continues to fall (Jones, 2012), with the prevalence of English-language media implicated in this downward trend (Wyburn, 2018). Indeed, this concern applies across cultures internationally, as non-English-language speakers strive to maintain social cohesion and national identity in the face of increasingly globalised, predominantly English-language entertainment media (Brooks, 2006; Chiang, 2007).

The genesis of bilingual signage in Wales is uncertain. However, the late 1960s and 1970s was a watershed period for public opinion on bilingual traffic signage. English-language traffic signage was both ubiquitous and seen as an oppressive symbol of the ongoing anglicisation of Wales and the extended decline of Welsh culture (Merriman & Jones, 2009). At the time of the United Kingdom 1971 Census, speakers of the Welsh language accounted for 19.9% of the population and its usage was in rapid decline (Coupland, 1989; Paxton, 1975).

Non-violent protests by members of the Cymdeithas yr Iaith Gymraeg (the Welsh Language Society, a popular organisation, mostly youth and university students) attempted to make visible a popular public desire for recognition of the Welsh language officially, and local council representation petitioned the British Government for translation advice and permission to implement bilingual *advisory signage* (in particular, for route signage, place and direction signage such as car parking and public conveniences). Although the view of the committee responsible for assessing these initial requests was favourable, the broader government response was mixed. A local British Government body, the Welsh Office's Roads Division, objected on the grounds that acceding to the requests would, to paraphrase, permit signposting to be used to further the cause of Welsh nationalism or independence (Merriman & Jones, 2009).

The campaign of lobbying by the public (see Figure 2.1), along with limited civil disobedience from 1966, culminated in 1969 in the British Government conceding to local councils the authority to adopt bilingual signage for *advisory signs* showing directional and place-related information. Unsubstantiated concerns regarding public safety were cited as the reason for not allowing bilingual *advisory, warning or regulatory signs*. 'Natural justice' and cultural safety conflicted with perceived decrements in public physical safety, as well as an undercurrent of British nationalism.



In 1971, the Bowen Committee of Inquiry into Bilingual Traffic Signs received a range of submissions on the wider use of bilingual signage; for example, commercial and aesthetic grounds were argued by the Wales Tourist Board, who lobbied for bilingual signage. The Committee sought insight from authorities in nine European Union countries within which bilingual signage was already in use, with special attention to how two languages might be differentiated. Eventually, the variables of font type, colour and size, as well as using upper-case letters, were rejected in favour of different spacing and placing Welsh in a position of prominence above the English-language text.

When the British Government announced approval of bilingual road signage in 1972, there was widespread criticism of both the Welsh-language primacy on the proposed signage and the assumed costs of implementing bilingual signage. Critics blamed ‘the politics of distraction’ during a period of high unemployment and argued for more effective methods of language promotion. There was opposition from both non-Welsh people and Welsh people who did not speak the Welsh language. Implementation lagged, with successive local councils neglecting bilingual signage and mixed efforts persisting into the 1980s. Nonetheless, the campaign to bring the Welsh language into the mainstream through bilingual signage has been labelled an effective and symbolic campaign for Welsh culture (Merriman & Jones, 2009). Now, bilingual traffic signage incorporating both Welsh and English is ubiquitous.

### 2.3.2 Commentary

The implementation of bilingual signage in Wales was characterised by parallel bottom-up processes. The first of these occurred through a popular movement working through local council channels to effect change in legislation and budgeting, as well as lobbying central government for change. The second process, also a popular movement, involved non-violent protest to effect change through political pressure, sparking the public imagination. In addition, sympathetic political and technical leaders at both the national and local levels supported or advocated for change in the face of mixed resistance from the incumbent decision-makers or populist political figures in central government. As described by Merriman and Jones (2009), for the proponents the issue was largely cultural, whereas the opponents rallied primarily around safety – polarised opposites both advocating for the public good. Although some complaints cited nationalism as the driver behind bilingual signage, the primary impetus appears to have been cultural protection, or a desire to repair centuries of cultural suppression in schools and exclusion from government. Cultural protection and safety are addressed in more detail below.

**Figure 2.1** Cyfeillion yr Iaith (Friends of the Language) demonstrate in support of Welsh-language signage, April 1971



## 2.4 Cultural protection or aspiration

Thematically, culture, safety and commerce appear to be the primary impetuses for bilingual signage internationally. Signage is singled out in the European Union in the Framework for the Protection of National Minorities, to which member States are held accountable. Although there are cases where bilingual or multilingual signage has grown organically over long periods, in other cases the topic carries the weight of historical conflict or injustice:

*Against the background of long-running tensions surrounding mono-/bilingual signs, questions of design and prominence arising from the use of two or three languages on the same traffic board may convey an important message about the status of a language. (Dewolf, 2018, p. 11)*

Although the previous case focused on Wales, within the British Isles alone bilingual signage has carried this weight. This includes Ireland, Scotland and Cornwall (Merriman & Jones, 2009), featuring threatened indigenous languages with histories of official cultural suppression or marginalisation.

In Aotearoa New Zealand, the Treaty of Waitangi enjoins the Crown and its entities to afford all the ordinary people of Aotearoa New Zealand protection, as well as the same rights and duties. Historically, in the realm of culture, Māori have not received the same protections as all ordinary people of Aotearoa New Zealand, with the Māori language suppressed in the past (De Bres, 2011; Keegan & Cunliffe, 2014). The United Nations Educational, Scientific and Cultural Organization (UNESCO) now officially classifies te reo Māori as ‘vulnerable’ (Moseley, 2010). The 2018 New Zealand Census (Statistics New Zealand, 2018b) found that only one quarter (26.4%) of Māori people could read te reo Māori ‘very well’, ‘well’ or ‘fairly well’, and a report from Te Puni Kōkiri, the Ministry of Māori Development, said Māori language rates were declining (Te Puni Kōkiri, 2006). *The Social Report 2016: Te pūrongo oranga tangata* (Ministry of Social Development, 2016) observed a continuing decline from 2006 in spoken te reo. Accordingly, te reo capability has been identified as one of three key measures of whether Māori cultural aspirations are being achieved (Manatū Taonga, 2017). In this context, the impetus behind the call for bilingual Māori–English signage can be considered both cultural protection for a vulnerable language and cultural aspiration, a desire to foster a vibrant and connected culture.

## 2.5 Cultural impact

Bilingual traffic signage may comprise an important part of an overarching strategy for strengthening Māori language and culture in Aotearoa New Zealand. Whereas in the case of Wales, the bilingual traffic signs were seen as being symbolic, in this country, they have the potential to expose a broad spectrum of New Zealanders to the Māori language. Exposure is likely to normalise the language among many of those for whom it is currently unfamiliar and to socialise Māori culture among people who do not often have contact with it.

For some indigenous societies internationally, their cultures have become invisible in the day-to-day lives of the majority, placing them at further risk of marginalisation and of being perceived as threatening by virtue of being unknown. The twin processes of socialising and normalising are likely to have significant, ongoing benefits in terms of reducing social conflict, as the culture of the ‘other’ becomes familiar and therefore, less threatening. By continuing to bring Māori culture into the mainstream, the purposes of both cultural protection and cultural aspiration are served.

In the Welsh case, bilingual signage alone has not been able to halt the continuing decline in fluency in the Welsh language. However, proponents of bilingual signage have argued that it remains part of a package of necessary initiatives.



## 2.6 Safety and performance

### 2.6.1 Common concerns

The design of bilingual or multilingual traffic signage is complicated by the conflicting goals of physical safety and cultural aspiration. In the Welsh case, there appears to have been an early collective decision to prioritise cultural benefits over safety decrements (see below); this has been seen as a judgement of collective good or collective utility (Merriman & Jones, 2009). Common concerns or objections, though, have tended to focus on safety and cost.

Due to the relative ubiquity of bilingual traffic signage internationally, it is apparent that many regional- and national-level bodies have judged cost an insufficient argument to halt implementation. Further, multilingual signage can be nearly cost neutral, depending on the implementation strategy chosen; for example, the cost may be minor in the context of overall road sign budgets if sign replacement can be incorporated into ongoing maintenance programmes (McDonald, 2020). Whether this is an option in the New Zealand context will depend on policy-level changes to the Traffic Control Device Rule.

### 2.6.2 Safety concerns and real-world outcomes

Safety concerns appear to be more grounded than cost objections, as well as appealing to a wider range of parties. In contexts where the proposed language is a minority language, a 'middle majority' can be swayed by an overtly logical anti-change argument that flags safety as a concern. Proponents of bilingual signage can proactively address these safety implications as an effective strategy for addressing legitimate fears among road users for whom cultural factors are not so acute. In contrast to potential safety decrements, there are cases where bilingual signage has been used to improve safety (see section 2.7). This will be particularly salient if te reo Māori becomes understood more widely in the future.

The existing research results regarding the safety impacts of bilingual signage have been inconsistent. Based on a literature review, Dewolf (2018) argued that three-line, multilingual messages on traffic signs are unlikely to have an impact on reading times and driving safety; that is, bilingual signage in general does not have negative safety effects. Over a series of papers, the Transport Research Laboratory (United Kingdom) took the position that bilingual signage creates only insubstantial increases in comprehension time, with readers attending to the language with which they are most familiar (Kinnear et al., 2012).

*There is reasonable evidence to infer bilingual signs increase the demand of the driving task, [but] drivers appear able to absorb this extra demand, or negate it by slowing down, which ultimately results in no detectable change in accident rates. (Kinnear et al., 2012, p. 1)*

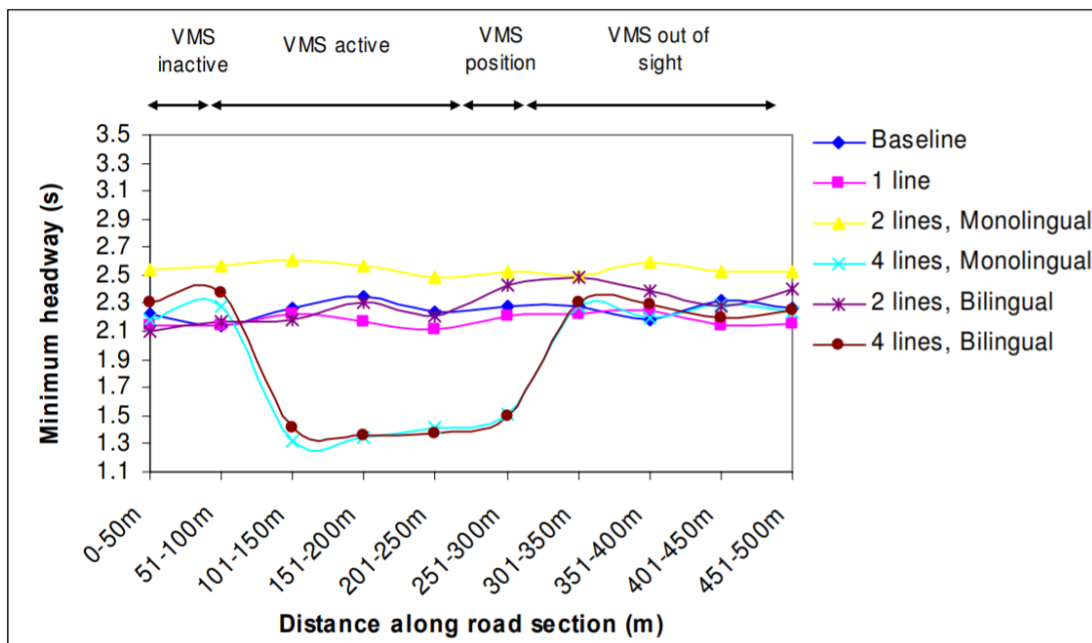
More telling, Kinnear et al. (2012) found no evidence of increased DSIs on bilingual signage routes in Scotland versus comparison routes, suggesting that overall accident rates had not changed. However, they observed several confounds and unknowns, such as an increase in sign size of up to 90% in the new bilingual signs and old signs being replaced with new signs in better condition, among other issues. They also suggested potential negative impacts for road users who are unfamiliar with local roads, such as tourists and visitors.

In contrast, after a series of experiments, Rutley (1972a, 1972b) concluded that adding Welsh to *advisory signage* (in this case relating to signs giving directional information) increased reading times for all tested signs except for very simple signage. For both Welsh- and English-language speakers, sign comprehension time increased, equivalent in duration to travelling an extra 18 metres at 50 km/h and 42 metres at 112 km/h. Rutley considered these figures a likely underestimate because the testing was conducted in conditions that were more optimal than the real world, where road users would face greater cognitive demands. Where

English was placed in the top/primary position, there was no observed increase in reading time. Adding supplementary signs to a larger *regulatory sign* (a decision intended to assist the reader) was also linked to longer signage comprehension times. However, the negative effect varied according to the visual characteristics of the sign, as the placement and positioning of the different languages, as well as font differentiation and colour, provided effective remedies for increased sign complexity.

Jamson et al. (2005) found that while there was no difference in reading and comprehension performance for two-line signs (no matter what language was used), signs with more lines of text caused confusion and those with more than four lines could substantially impact the behaviour of road users. Figure 2.2 (below) illustrates the negative effects of a high cognitive workload condition, represented by signage complexity, on vehicle following distances. For variable message signs (VMS), four-line designs, whether mono- or bilingual, showed a substantive decrease in performance in terms of safe driving behaviour. However, there was no substantive difference in performance between the mono- or bilingual traffic sign designs that had similar levels of complexity. The salient factors appeared to be information density and potentially, language differentiation, not specifically the number of languages used (assuming at least one was known to the reader). High information loads have been linked to decrements in decision-making quality and ability in a range of situations (Bodenhausen & Lichtenstein, 1987; Buchanan & Kock, 2001, Chewing & Harrell, 1990).

**Figure 2.2 Following distances in the high workload condition (Jamson et al., 2005, p. 11)**



### 2.6.3 Compensatory strategies and trade-offs

According to the ‘environmental load’ perspective in environmental psychology, people have limited capacity for processing incoming stimuli and ‘overloading’ leads to the use of several coping strategies (Moser & Uzzell, 2003); cross-disciplinary psychology likewise points to compensatory strategies and cognitive trade-offs when dealing with high information loads (Roetzel, 2019). These perspectives tell us that to manage aggregate cognitive demands, road users will compensate (eg potentially slowing down when passing signs that are more complex), ‘absorb’ the extra cognitive demands temporarily, or make trade-offs and selectively ignore some information. The relative balance of the use of trade-offs, or individuals’ ability to absorb the extra demand, varies according to individuals’ differing biology and cognition (eg cognitive and perceptual

capacities, or preference for risk), and the cognitive demands placed on them by the external environment (eg characteristics of the vehicle they are using, or environmental variables such as weather).

Trade-offs may be conscious and within our control, or unconscious and largely out of our control. For example, when facing high information loads, road users may (consciously or unconsciously) accept shorter safety margins when following other vehicles, or because of lack of attention, they may be less likely to notice decelerating vehicles. Modifying the placement of bilingual traffic signs relative to what they are specifically signposting, giving road users more time to interpret them, may be an effective mitigation for complexity (McDonald, 2020). Such measures are likely to require changes to existing Traffic Control Device Rules.

### 2.6.4 Sign complexity and language translation

In an investigation of variable-message bilingual traffic signage, the factors of complexity and sign length (not specifically language) were implicated as contributors to performance decrements (Anttila, 2000). In China, an investigation of non-transport-related signage found that a lack of standardisation and erroneous translation could lead to confusion for foreign visitors and monolingual users, especially those whose language had been added to the signage. Problems of translation error are not confined to China. Figures 2.3 and 2.4 highlight an incorrect translation English–French translation used on traffic signs in Fredericton, Canada (CBC News, 2015). In Wales, a bilingual pedestrian sign offered contradictory messages, instructing people to ‘look left’ in Welsh and to ‘look right’ in English (BBC, 2006). Translation errors may be most salient for bilinguals who speak multiple languages and thus simultaneously interpret both languages, with corresponding increments in cognitive load (addressed below in section 2.9.2). The Welsh Government Translation Service advised Waka Kotahi directly in 2021 that machine translation, such as Google Translate, should not be relied on.

Figure 2.3 Bilingual translation error



Figure 2.4 Meaning of the French wording



### 2.6.5 Summary of safety and performance factors

A summary of safety and road user performance factors that have been measured in the existing literature, and a high-level summary of their outcomes, is presented in Table 2.2.

**Table 2.2** Sample of measured safety and motor vehicle driver performance factors

Performance factors	Outcomes observed	Country – reference
Signage comprehension time	Longer with increased sign complexity and for bilingual signs, indicating increased cognitive load. Uncertainty and mixed conclusions regarding effect size in real-world performance.	Wales – Jamson et al. (2005) Wales – Rutley (1972a, 1972b)
Visual attention to signage stimuli <sup>5</sup>	Greater with increased sign complexity and for bilingual signs, indicating that both conscious and unconscious attention is heightened. Uncertain effect on real-world performance.	China – Yang et al. (2020) Finland – Anttila et al. (2000)
Following distances while driving	Smaller with increased cognitive load, sign complexity and for bilingual signs, indicating distraction and real-world decrements in safety.	Wales – Jamson et al. (2005)
Driving acceleration, driving speed	Greater with increased cognitive load, sign complexity and for bilingual signs, indicating that road users may compensate for increased comprehension times, as well as lost time, with driving behaviours that are less safe. Inconsistent with other research indicating that motor vehicle drivers slow down when signage is complex.	China – Yang et al. (2020) Wales – Jamson et al. (2005)
DSI rates	No evidence that DSIs become more frequent on routes with bilingual signage versus comparison routes, although confounds include increase in sign size and new signs being in better condition.	Scotland – Kinnear et al. (2012)

## 2.7 Bilingual signs as a safety intervention

While incorporating additional languages into traffic signage has raised safety concerns, it has also been used to reduce negative safety outcomes. In many parts of Britain, bilingual signage has been implemented to improve safety outcomes at specific locations for groups at risk of injury. For example, railway station *warning signs* in West London use English–Punjabi signs; in Cheshire County, highway engineers advocated for English–Polish *warning signage* around road construction works (Merriman & Jones, 2009).

In Japan, English-language text was incorporated into *warning* and *regulatory signage*, including *stop-signs* and *give-way signs*, in response to the high and increasing number of traffic accidents involving people from foreign countries, estimated to be 178 in 2012 and rising in subsequent years (Butler, 2016). Their guide signs are normally in Japanese and English; *warning signs* are purely pictorial; and *regulatory signs* are in Japanese and English (see Figure 2.5 to Figure 2.10). Jamson et al. (2005) observed that safety factors in the Japanese example were enhanced because of the respective languages' relative distinctiveness, which aids preconscious attention targeting the language that is most relevant for road users.

In regions of Aotearoa New Zealand where people of Māori descent are overrepresented in vehicle crash statistics, or where they represent a large proportion of the local population, bilingual traffic signage may impart benefits in terms of reducing harm on our road network. This effect may be smaller than in Britain or Japan, as in those cases, the targeted ethnocultural groups were not necessarily fluent in the prevalent language, whereas in Aotearoa New Zealand, English use is widespread among Māori.

<sup>5</sup> As a proxy for cognitive load.

Figure 2.5 Guide signs: Detour



Figure 2.6 Guide signs: Ramp ahead



Figure 2.7 Regulatory signs: Stop (1963–2017)



Figure 2.8 Regulatory signs: Stop (2017–present time)



Figure 2.9 Regulatory signs: Yield (to 2017)



Figure 2.10 Regulatory signs: Yield (2017–present time)





## 2.8 Bilingual sign categories

Overall, our investigation showed that bilingual signage has been used for all categories – *advisory*, *warning* and *regulatory*. The tendency has been to focus on *advisory signage* more than other categories; it is particularly rare in *regulatory signage*. Notably, in 30 European countries the *stop sign* is displayed only in English, despite distribution spanning a wide range of regional languages. Likewise, as mentioned in the previous section, Japan uses English alongside Japanese on its *stop* and *give-way signs*, as well as some *advisory signs*. This reflects English’s position as the ‘most spoken language’ worldwide when counting both native and non-native speakers (Ethnologue, 2021). For this reason, English is used in other safety-critical transport-related communications, to ensure consistency and prevent critical misunderstandings; for example, in aviation all pilots must be able to understand and communicate in English.

Across Europe, other *regulatory* and *warning signs* are generally icon based, with any written text included in supplementary plates. The next sections provide details of specific countries that we investigated.

### 2.8.1 Finland

*Regulatory* and *warning signage* is predominantly icon based, with some English-language signs (notably, the *stop sign* is displayed only in English). A few special case signs are bilingual, using Finnish and English (see Figure 2.11). Several regions, notably Lapland in the North and the border with Sweden, may use bilingual *advisory signage*, in the Finnish–Swedish or Finnish–Sami languages (see Figure 2.12).

**Figure 2.11** A rare bilingual *regulatory sign* is used by police in Finland when instructing road users to stop. (This differs from the Finnish stop sign used at intersections, which is in English only.)



**Figure 2.12** Region-specific bilingual directional signage



### 2.8.2 Republic of Ireland

Bilingual text is used for *advisory signage* providing directional and tourist information, with Irish Gaelic (in italics) above English (in capitals) and equal font size. The fonts themselves differ, with the font used for Gaelic being the one that is traditionally used across a broader context than just traffic signs. *Advisory signs* giving directional information are differentiated for regional and national roads, as well as for motorways (see Figure 2.13 and Figure 2.14). *Regulatory* and *warning traffic signs* remain predominantly icon based. Some

*regulatory signs* are in English (eg the *stop sign*), while 'yield' or *give-way signs* may be in either English or Irish Gaelic only. If written language is used for a *warning sign*, this tends to be English, while multilingual signage may be used in special circumstances, such as for educating foreign visitors as they enter the country.

Figure 2.13 Regional road



Figure 2.14 National road



### 2.8.3 Spain

Bilingual signs may appear in autonomous communities, such as Galicia, Basque, Navarre and Catalonia, with the local language and Spanish displayed together, either in equal fonts (see Figure 2.15) or differentiated by font style (eg font type, bold or italics – see Figure 2.16). They are predominantly *advisory signage*, rather than *regulatory or warning signs*.

Figure 2.15 Directional signs, La Seu d'Urgell – Spain



Figure 2.16 Directional signs, Basque – Spain



### 2.8.4 Wales

Bilingual traffic signs are deeply embedded in Wales. A scan of the *Welsh Government Traffic Signs and Road Markings Standards* (Llywodraeth Cymru, 2018) suggests that in Wales, bilingual signage can be said to be truly ubiquitous. *Advisory, regulatory and warning signs* all feature examples using both Welsh and English captions. Supplementary or secondary signage is commonly used in combination with signage that is predominantly iconographic in nature (see Figure 2.17 to Figure 2.20). One exception is the *stop sign*, which is English only.

Figure 2.17 School warning sign



Figure 2.18 School warning sign plan

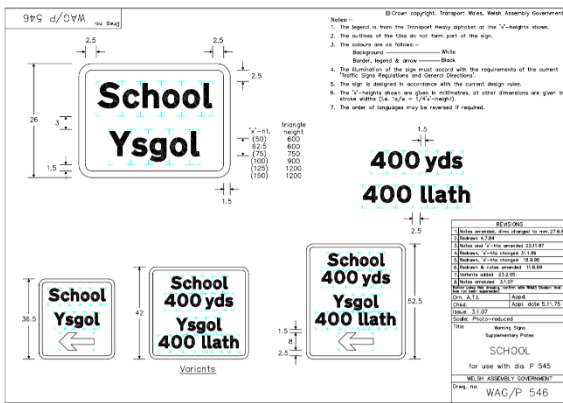


Figure 2.19 Give-way regulatory sign plan

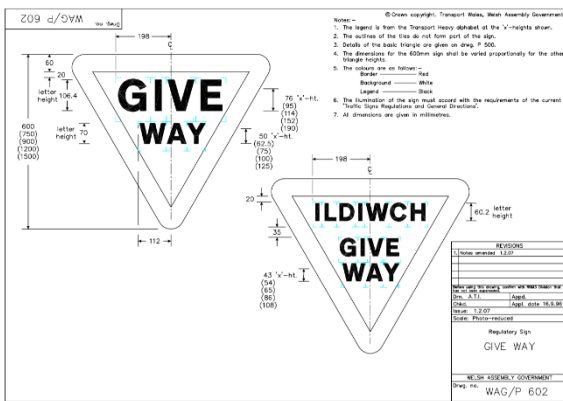


Figure 2.20 Bilingual directional signage



### 2.8.5 Summary

Across the surveyed regions, bilingual signage is commonly used for *advisory signage*. In most cases, it is extremely rare to see bilingual *safety and regulatory signage*, with notable exceptions being in Finland and Wales. Across the European Union, the English language seems to have been adopted as an international language for use in *safety and regulatory signs* if the local majority language is not used. Notably, although in



Wales bilingual *regulatory signage* is used, the *stop sign* remains in English only, as per the European Union Standard, which provides for *regulatory signs* such as the *stop sign* to be in either the local language or English, not both. Table 2.3 summarises these findings.

**Table 2.3 Overview of bilingual traffic sign categories in use**

Region jurisdiction	Advisory	Warning	Regulatory
European Union	✓	*	*
Finland	✓	*	*
Republic of Ireland	✓	*	*
Spain	✓	✗	✗
Wales	✓	✓	✓

\* Rare, featuring only one or a few cases of bilingual signage in the relevant category.

## 2.9 Three challenges

### 2.9.1 Methodological limitations

This research found a range of methodological limitations in the extant literature, which led to uncertainty in the results. In Scotland, an impact assessment of the implementation of bilingual English–Gaelic traffic signage observed that in some cases, the new signs were up to twice as large as, or otherwise visually superior to, the monolingual signs that they replaced (Puzey, 2008). Although the authors detected no increments in harm in terms of DSIs, they could not rule out decrements in safety through a like-for-like comparison. The presence of larger roadside furniture (road signs in this case) also poses a greater hazard. Thus, the ‘safety case’ in Scotland was positive but inconclusive.

In Wales, Rutley (1972a)<sup>6</sup> observed that laboratory conditions and road test-track conditions did not sufficiently represent real road conditions and cautioned that the negative effects of bilingual signage that they observed could be larger in practice. Despite this, decision-makers concluded, in their implementation of Welsh language in traffic signage, that safety decrements were minor – as have other jurisdictions. Although experimental research suggested that road users’ performance might worsen,<sup>7</sup> later real-world assessment of traffic safety outcomes revealed no worsening of DSIs, according to empirical data in other jurisdictions (Kinneer, 2012). However, the issue is complex and depending on the specific combination of factors in each case, it appears that safety could be *either* improved *or* worsened by the implementation of bilingual signage, depending on the specific design elements used. This highlights the importance of following evidence-based design guidance (see Chapter 3).

<sup>6</sup> Rutley (1972a): This laboratory-based and track-based driving experiment conducted in Wales observed participants’ reading comprehension and driving performance in relation to a variety of monolingual and bilingual *advisory traffic signs* showing directional information. It took them longer to interpret nearly all the bilingual traffic signs. The mean reading time for which the drivers’ eyes were off the road while reading the signs was 20.3% greater for bilingual signs than monolingual signs (2.2 seconds versus 1.8 seconds).

<sup>7</sup> Rutley (1972b): This experimental procedure on a controlled track tested reading times on two types of advanced directional *advisory signs* for primary routes in Wales. It tested Welsh people who mainly spoke Welsh; Welsh people who mainly spoke English; and English people who spoke only English. The results found that when drivers’ preferred language was placed first (above), reading times were improved. Conversely, when their non-preferred language was placed first, then reading comprehension times were extended: 37.0% longer (3.9 seconds versus 2.8 seconds).

### 2.9.2 Some inconsistent results

When investigating the safety impacts of bilingual signage for ‘balanced’ bilinguals who were equally proficient in the majority and minority languages, there were some negative (but inconsistent) results. Research in cross-cultural psychology has found evidence that bilinguals who are fluent in multiple ‘mother tongues’ can face increased cognitive demand as they *simultaneously* interpret both languages and conduct a comparative analysis of meaning. In an investigation of bilingual *advisory signs* using both Mandarin and English, Yang et al. (2020) reported that most readers attended to the language with which they were most familiar, but for bilinguals, the cognitive load was greater than for Mandarin-speaking monolinguals. Further, they found that for Mandarin-speaking monolinguals, the words in the additional language could require extra subconscious processing, despite them only paying conscious attention to the Mandarin main text.

This issue is salient for the context of Aotearoa New Zealand as the country becomes increasingly multicultural, with more languages spoken by a wider variety of cultures. It may also be important for safety among foreign tourists and visitors who face both a highly novel and informationally complex environment, as well as potentially unfamiliar languages. There is little existing research on the implications of bilingual signage for visitors who are not native speakers of the languages depicted. Further, the existing research does not seem to address any consideration of the implications of bilingual road signage for people from the ethnoculture – in our case, Māori – whose language is newly being depicted, but who themselves do not speak the language fluently. The potential impacts of bilingual road signage on both indigenous monolinguals and bilinguals in general are significant gaps in the literature on the subject.

### 2.9.3 Balancing cultural needs and public physical safety

When implementing bilingual signage, the two main considerations have appeared to be communities’ cultural needs and public physical safety (as distinct from cultural safety). In some cases, these considerations have aligned; in other cases, communities have made the explicit decision to prioritise cultural needs over potential public safety decrements. Where cultural safety is under threat (such as when an indigenous language is under threat of extinction), the aggregate public good may demand that relatively small decrements in public physical safety should be ranked below cultural needs. Arguably, the experimental research has pointed towards a negligible negative effect on safety, with post hoc assessments finding no negative effect on DSIs if the design is done well. However, in some cases best-practice design and cultural needs may conflict, and sub-optimal sign design could lead to negative outcomes that are more substantial. It is important to diagnose correctly where the aggregate public good lies, and then design effective bilingual signs that maximise the good while minimising any safety decrements. This includes identifying an implementation approach that minimises risk. This is discussed further in the next chapter.

## 3 Best-practice guidance

### 3.1 Best-practice design

As outlined earlier, compared to other types of signage that a person may come across while on foot (eg signage for entry/exit, toilets and other building facilities, and health and safety warnings), traffic signs present unique challenges. To allow sufficient time for road users to react, traffic signs must be identified and understood in a fraction of a second as people glance up from the roadway. If a sign requires a long glance time, it can distract from the driving task and increase the risk of collision, especially if motorists are not following the '2-second rule', keeping a two-seconds following distance between vehicles. Road signs must also be understood by the full range of people who travel on New Zealand's roads, including locals, visitors and tourists; that is, people from a diverse range of backgrounds and cultures. For these reasons, some principles of traffic sign design differ from general signage design guidance and it is important to consider traffic-sign-specific research. Some of the key principles are discussed below.

#### 3.1.1 Implications of general traffic signage principles for bilingual signage

The importance of information complexity in the performance of traffic signage has been highlighted in the literature. Generally, high information loads lead to reduced attention, an overreliance on simplified heuristics and prior 'knowledge', or a tendency to disregard additional information so as to maintain a given level of attention. Highly complex traffic signage has the potential to become 'invisible', as road users can become overwhelmed by an increase in complexity in an already complex driving task. Indeed, Jamson et al. (2005) found evidence of reduced driving performance when reading complex signs whether the driver was monolingual or bilingual. Decrements in performance include following distances that are less safe and driving behaviour that is more aggressive, such as faster acceleration manoeuvres (Jamson et al., 2005; Yang et al., 2020). There may be optimal levels of complexity in traffic sign design, with tipping points where additional complexity results in disproportionately worsening outcomes in terms of road users' quality of cognition and their resulting behaviour.

Traffic sign complexity can be reduced, and traffic sign comprehension enhanced, through the application of three ergonomic principles that have been identified as being significantly correlated with the probability of people driving correctly when comprehending traffic signs (Ben-Bassat & Shinar, 2006). These are:

1. familiarity
2. compatibility
3. standardisation.

*Familiarity* relates to the frequency with which people driving experience a sign or components of it; *compatibility* relates to the degree of correspondence between the symbols and text making up a sign and the message it is attempting to convey; and *standardisation* relates to the consistency with which the colour, shape, symbols and other features of the sign are used to represent that particular message. International studies have concluded that the effect of standardisation and the flow-on effects for familiarity are crucial to a sign's effectiveness (eg Jamson & Mrozek, 2017).

While the design process itself does not affect road users' familiarity with a specific new sign, it is possible to incorporate sign features and messages that are already familiar to drivers because of their use in other forms of signage. If these familiar components are used in a manner that is consistent with other signs, it is possible to achieve a high degree of standardisation, leading to higher levels of comprehension.

The environmental context in which signs are situated can also affect how well they are understood. Other cues in the location of the sign can indicate its meaning and help to encourage the correct behavioural response. However, this should not replace good sign design.

### 3.1.2 Signage ‘grammar’: shape, colour and iconography

Although the introduced terms or language in bilingual signage may be unfamiliar, if other aspects of the sign remain unchanged, the road users’ familiarity with the overall sign and the degree of standardisation across the network should not be impacted significantly, reducing the likelihood of negative effects on comprehension. This particularly relates to the shape, colour and icons of the signage. Research suggests that road users are influenced by the ‘grammar’ used in the signage to which they are exposed (Bazire & Tijus, 2009). For example, diamond-shaped signs represent a particular type of information or warning, round signs represent another type, and certain colours are reserved for specific meanings or signage categories. Across cultures, the use of red in traffic signs has been shown to denote the highest level of warning and be associated most strongly with hazards (Ng & Chan, 2009). Red requires attention and potentially indicates warning or negation. In Aotearoa New Zealand, red is associated with *stop* and *speed-limit signs*, *lane closures* on motorway variable-message signs, *wrong-way signs* and *road-closure signs*. If these conventions are violated, comprehension can be affected negatively. When bilingual translations are introduced on signs, it will be important that they do not require the shape or background colour of the signage to change from what is currently specified.

Bazire and Tijus (2009) demonstrated that road users’ main focus when interpreting traffic signs is on the icon or symbol component of the signs where these are applicable (in Aotearoa New Zealand, this is relevant to *warning* and *regulatory signage* in most instances). Early studies into the recognition of symbolic traffic signs (eg Ells & Dewar, 1979) suggested that symbolic representations are better comprehended by drivers, particularly in sub-optimal conditions. However, later studies have indicated that traffic signs that include a combination of text and symbols are more likely to be comprehended correctly and faster than those with symbols alone (Shinar & Vogelzang, 2013). To minimise recognition time, maximise familiarity and maintain standardisation, it will be important that bilingual signage in Aotearoa New Zealand retains the icons already in use on the network alongside any new text elements. It will also be important that text and icon elements have a high degree of compatibility. This will also have comprehension benefits for people for whom neither English nor Māori are their primary language.

### 3.1.3 Signage text

In Aotearoa New Zealand, to ensure visibility from a sufficient distance at a prescribed road speed, it will be important that the size of the font on any signage to which a second-language translation is introduced is not reduced. In this country, font type and size are standardised across signage categories and approach speeds according to Schedule 1 of the Land Transport Rule Traffic Control Devices 2004 Rule 54002/2004. When combined with the need to maintain the standard signage shape, the necessity of maintaining the font size may limit the length and number of words that can be introduced. In fact, limiting the number of words and lines of text in bilingual signage has been observed by Dewolf (2018) and Jamson et al. (2005) to improve reading time and comprehension; having fewer words represented reduced information complexity.

The signs themselves could increase in size to accommodate additional text while maintaining the appropriate font size and position in relation to sign borders. However, there are cost implications for any significant size increase, both in the additional material used for the sign itself and the additional supports required to safely erect larger, heavier signs. There are also potential safety implications for larger signage; while increased sign size can lead to increased visibility and conspicuity, which enhances road user safety,

larger signs can block sight lines and obscure oncoming traffic, decreasing road user safety. Larger traffic signs also present an enlarged roadside hazard in the case of run-off events.

### 3.1.4 Language differentiation and language primacy

The research has shown that where a specific language is understood by most people, placing that language in a position of primacy above a supplementary language enhances sign comprehension for most road users. Implicitly, the positive effects on safety are also likely to be enhanced for members of an ethnocultural group whose primary language is that of the majority, not their heritage language.

In Wales, Ireland and Finland, the English-language text is placed in a secondary position relative to the Welsh text. However, in Greece and Spain, the national languages are prime and the indigenous languages are placed in a secondary position. In many cases where the indigenous language is placed in a position of spatial primacy, additional methods of differentiation are used to enhance comprehension by visually drawing a distinction between the two texts. These include varying font types and sizes, as well as the use of upper-case letters and colour. Relative to non-traffic signage, travel speeds mean that users of traffic signage face briefer windows in which to observe, interpret and correctly act on the information provided by the signs. Differentiation has the potential to reduce the number of words that people must read before they correctly interpret messaging. The importance of differentiation is heightened when the same alphabet is being used, as is the case with te reo Māori and English.

Trade-offs may be necessary to maximise both cultural aspirations/protection and safety factors. Nonetheless, as seen below in Figure 3.1 to Figure 3.5, both the cultural needs and safety needs of communities can be met through effective design and visual cues that use differentiation to enhance both readability and the language of special interest.

Using visual means to differentiate two languages on a sign is a critical strategy for enhancing public safety when a less commonly spoken language is placed in a position of spatial primacy. Differentiation is particularly effective when it draws on the cognitive ergonomic principles of familiarity and standardisation, which impact signage comprehension. Where a specific font is associated more generally with a specific language in all forms of text, its use in traffic signage can assist road users to identify rapidly which language they should focus on. Irish road signs are particularly effective with this technique (see Figure 3.5). In contrast, a rare bilingual stop sign example shown in Figure 3.6 does not use any text-based differentiation. Colours that have specific standardised meanings can also be used to draw attention to the appropriate language. However, it is important that the colour that is used to differentiate the second language does not already have other standardised uses, as this can distract from or confuse other important information on the signage. For example, in Scotland, one colour (yellow) is used for both route number and Scottish text, while another colour (white) is used for English text and distance values (see Figure 3.3). This may lead to slower cognitive processing and a greater likelihood of misinterpretation than, say, the Irish signage shown in Figure 3.5.

Te Puni Kōkiri, the Ministry for Māori Development, has proposed sign guidelines for non-traffic applications (Te Puni Kōkiri, 2016). These include the placement of Māori text in a position of primacy (ie above English text) and avoiding other differentiating elements should they imply English-language primacy (eg font types and sizes, use of upper case and colour). However, because of the speed and glance times involved, a different approach is required for traffic signage to prevent harm to the public.



Figure 3.1 In France, languages are differentiated by font type and bold elements



Figure 3.2 In Greece, font types are identical, but colour differentiation is used



Figure 3.3 In Scotland, colour may be used to differentiate language



Figure 3.4 In other cases, Scottish traffic signs may use identical font elements



Figure 3.5 In Ireland, a specific font associated with Gaelic in multiple kinds of signage and text media is used in traffic signage to differentiate from English



Figure 3.6 Rare example of a bilingual stop sign (Canada)



### 3.1.5 Signage categories

The small increases in comprehension time noted in some of the literature may mean that bilingual signage would be most appropriate for applications that are less time critical, such as *advisory signage*, allowing road users sufficient time to interpret them. Internationally, this is the category of signs that is most commonly

bilingual. Overseas, *warning* and *regulatory signage* tend to be predominantly iconographic and monolingual, allowing fast comprehension when reaction times are more critical to physical safety. However, examples of bilingual *regulatory signs* do exist, such as the Canadian *stop sign* shown in Figure 3.6 above. This suggests that a phased approach to implementation, beginning with *advisory signage*, could be most appropriate. This is discussed further in section 3.2.

### 3.1.6 Signage message and translation

Both signage complexity and sign length have an impact on reading comprehension and contribute to road user performance decrements (Anttila et al., 2000). Keeping the terms/phrases adapted as short and simple as possible, preferably less than four lines, can mitigate negative safety effects (Dewolf, 2018).

Care should be taken to ensure translations correctly reflect the message and that translations cannot be interpreted in multiple or inappropriate ways, as in the English-to-French translation shown previously in Figure 2.3 and Figure 2.4.

It is also well established in the literature that using a positive message to describe an action or behavioural response (ie what you want road users *to do*) rather than the negative alternative (ie what *not to do*) can increase the ability of road users to respond appropriately. This should also be considered during the translation process.

In summary, to minimise any potential safety impacts of introducing bilingual signage, the signage design should follow the guidelines shown in Table 3.1.

**Table 3.1 Design guidelines for bilingual signage**

Factor jurisdiction	Guidance
Signage 'grammar'	Maintain standardised signage grammar (eg background colour, signage shapes and font sizes).
Icons	Where appropriate (eg <i>warning signs</i> ), maintain familiar, standardised icons (where the shape itself is not an icon) alongside text.
Text differentiation	Clearly differentiate the two languages through at least one variable, but ideally more (eg colour plus italics). This is particularly important where the two languages share the same script, as Māori and English do, and when the minority language is positioned above the majority language.
Length	Keep the message as short and simple as possible, ideally with fewer than four lines of text.
Consistency	Keep the message standardised across all signage on the network.
Translation alignment	Ensure the translated terminology accurately reflects the desired message; ie there is close alignment between the two languages in the message given.
Interpretations	Ensure there are not multiple possible interpretations of the translated message.

## 3.2 Best-practice implementation

Our survey of bilingual traffic signage, which focused on the European Union, found little information specifically on the process of the implementation of bilingual signage. We suspected that much of this information is held within the various institutions responsible for the original implementation within specific jurisdictions, rather than in any publicly available literature. Further attempts will be made to obtain information on implementation directly through our agency counterparts overseas. It was possible to infer that the processes differed depending on the triggers for change, whether they were bottom-up, popular movements that were mainly interested in cultural aspiration or cultural protection, or top-down, mainly

instigated by senior leaders and technical specialists, with a focus on safety or commercial priorities. It is clear that risks arising from the need to balance multiple, sometimes competing, elements can delay, derail or distract from a best-practice, best-design implementation of bilingual signage.

These risks include:

- unaligned public interests, leading to conflict that could be avoided
- financial risks, dependent on the implementation strategy, that are exacerbated if design does not conform to best practice or existing standards
- erroneous performance assessments, such as using assessment methodology that is not fit for purpose (ie real-world performance assessment), or making unlike comparisons, meaning the assessments may be unreliable.

Stakeholder interests, design and language translation constitute a major intersection of the work of creating bilingual signage, requiring an iterative approach that can occur over extended periods. The following sections describe the elements of best-practice implementation for New Zealand.

### **3.2.1 Robust stakeholder engagement**

This maps the values, preferences and concerns of the relevant stakeholders. Māori stakeholders may wish to prioritise *advisory signage*, as representing a larger body of Māori-language text across the transport network, thus having more impact in terms of promoting te reo Māori. Some stakeholders may be concerned about the use of an additional language element making sign comprehension slower, negatively impacting physical safety. It is notable that while there often appears to be conflict between the aspects of culture and safety, both are interested in an aggregate good. Waka Kotahi is well placed to mediate this discussion and help stakeholders understand the competing demands of good design, as well as where the ‘competing’ interests align.

### **3.2.2 An iterative, evidence-based design process**

This incorporates both best-practice design and the needs and requirements of the relevant stakeholders. Design can be used to mitigate realistic stakeholder concerns; for example, the translation should align the meaning across both languages. Design can also be informed by robust evaluation of driving performance via simulator testing for various situations.

### **3.2.3 Development of relevant legislation or standards**

Bilingual signage is not currently accommodated under the Land Transport Rule Traffic Control Devices 2004 Rule 54002/2004. Changes to this piece of legislation will be required to enable implementation of bilingual signage. Development of signage standards will follow from the design process and evaluation.

### **3.2.4 Pragmatic budgeting**

There are cost implications for the installation of new signage. The extent of these will depend on which signs are changed and their installation schedule. One potential approach could be to target specific sign categories, such as *advisory signage*, for implementation first, on the basis that these present the lowest level of risk in terms of increased reaction times. Other sign categories could be scheduled for replacement over an extended period, enabling evaluation of the initial phase to inform later implementation. Signage could be replaced all at once or as part of a regular maintenance schedule.



### 3.2.5 Targeted public communication

It is important to inform the public about both the changes and the reasons for them. Overseas cases paint a mixed picture. In some instances, the public were not consulted and bilingual signage was implemented on limited routes. Consequently, according to anecdotal accounts, some people using the roads were surprised and alarmed when attempting to navigate routes with new bilingual signage. Proactive communication has the potential to defuse tension before it occurs, bringing all people who use our roads along on the journey.

### 3.2.6 Ongoing monitoring

Whether on a short- or long-term basis, given the degree of uncertainty over the real-world performance of bilingual signs, a pragmatic interpretation suggests that ongoing monitoring is necessary. In the Scottish case described by Kinnear et al. (2012), post hoc comparisons were carried out but the comparison areas were not always sufficiently similar, meaning the conclusions were limited. A well-designed monitoring and performance plan designed in advance of signage implementation would ensure conclusions are robust. This could include a limited trial with simulator, on-road and structured subjective testing to quantify any potential safety decrements, before widespread roll-out. However, given the inconclusiveness of the literature, careful evaluation of design would be needed to ensure the measures are likely to detect any effects.

## 3.3 Insight on out-of-scope questions

This research originally set out to address questions 2 and 3 of the research questions presented to the Minister of Transport in MIN-3512 Te Reo Māori Policy for Road Signs in November 2020; however, during this research, several findings pertinent to research questions 4 and 5 also came to light. These are documented here.

#### **Research question 4: What words and phrases could be used, and how might national consistency fit with appropriate local expression?**

While the nature of the exact te reo Māori terms that might be used in bilingual signage in New Zealand was not examined in this research, we found that both signage complexity and sign length impact comprehension and contribute to road user performance decrements (Anttila et al., 2000). Keeping the terms/phrases adopted as short and simple as possible, preferably less than four lines, could mitigate negative safety effects (Dewolf, 2018).

Standardisation is one of the key cognitive ergonomic principles that support effective comprehension of traffic signage (Ben-Bassat & Shinar, 2006). It is important that the shapes and colours of signage are used consistently across the network and that the terminology in the text component is consistent. Inconsistency can cause confusion in those viewing the signage, potentially increasing their reaction times and distraction levels. This would negatively impact the effectiveness of the sign if reaction time was critical to physical safety, such as in *warning* or *regulatory signs*. The magnitude of the effect of such inconsistency should be considered alongside cultural appropriateness. For example, the use of a 'W' in one region and a 'Wh' in another region may not be a sufficiently large inconsistency to warrant not using the correct regional form; however, entirely different translations or phrasing would be problematic.

#### **Research question 5: What are the best mechanisms for using and representing te reo Māori on roadside infrastructure and in road safety messaging?**

This report has focused on Traffic Control Devices, which are governed by the Land Transport Rule Traffic Control Devices 2004 Rule 54002/2004, and the equivalent of this signage overseas. Other types of roadside signage include billboards and other types of advertising described in Part 3 of the Traffic Control Devices

Manual. There are far fewer restrictions on these types of signage in terms of colours and messages, as they do not have the legal status and traffic management imperative of Traffic Control Devices; however, a range of different legislations still dictate their composition and placement. One of these restrictions is that these signs cannot imitate Traffic Control Devices in their design. While there is no restriction preventing the use of te reo Māori in this type of signage, there are restrictions on the number and type of elements that can be included, so the signs do not create a distraction for road users. The Waka Kotahi Traffic Control Device committee can provide detailed guidance on the use of te reo Māori for this signage type.

## 4 Opportunities and recommended next steps

### 4.1 Translation

Chapter 3 has provided guidelines on incorporating bilingual terminology into monolingual signage in ways that maximise comprehension and minimise any negative safety impacts. These include maintaining standardised background colour, signage shapes and font sizes; including standard icons (where the shape itself is not an icon) alongside text; clearly differentiating the two languages through at least one variable, but ideally more (eg different colour and italics); keeping the messages as short and simple as possible, as well as consistent across all signage; and ensuring the translated terminology accurately reflects the desired message, with close alignment between the two languages and elimination of multiple possible interpretations.

In terms of the last of these suggestions, an important next step in the process of implementing bilingual signage in Aotearoa New Zealand is to develop appropriate translations that meet the guidelines outlined above. This will require a series of deliberate conversations involving a multidisciplinary group made up of accredited te reo Māori translators, iwi representatives, the te reo Māori entities Te Mātāwai and Te Taura Whiri i te reo Māori (Māori Language Commission), and Te Mātangi (Waka Kotahi Māori Partnerships Team) and other Waka Kotahi staff (including signage design, human factors psychology and road safety experts). National and regional bodies and professional cultural advisors could be important connections for identifying and engaging key participants in these hui.

These conversations will be particularly important for decisions that include significant socio-political elements, such as the positioning of language on each sign. In terms of positioning, *if* the two languages are sufficiently differentiated, the comprehension time increase that could result from having the majority language positioned below the bilingual translation may be traded against the potential positive cultural benefits of having te reo Māori positioned above English. These conversations will also be important for considering local variations and developing terminology that is appropriate for standardised use across the country. It should be noted that places that are already known exclusively by Māori names will not necessarily require the addition of an English name.

Our scan of the literature has not identified detailed descriptions of how the translation and consultation processes have been conducted overseas, but it may be possible to source this information by reaching out directly to those involved in bilingual implementation in specific jurisdictions, should this be considered useful.

### 4.2 Design and research

Further research is needed to inform the signage design process. Ideally, this should be multi-method research that draws on both human factors techniques and kaupapa Māori research techniques.

Initially, further information should be sought from overseas jurisdictions regarding the details of their implementation processes, including how decisions were made about which signage categories to focus on; how complex, high-text signage is dealt with; how communication and engagement with the public was carried out; and any lessons learned.

Research should also inform the design iteration process by addressing the following questions:

1. Are the Māori translations correct, appropriate, comprehensible, etc?
2. How do Māori road users respond to the sign designs (in terms of safety as well as other measures – eg attitudinal response)?

3. How do non-Māori road users respond to the sign designs?
4. How do non-New Zealand road users respond to the sign designs?

A range of techniques can be used to address these questions, including expert evaluations, structured subjective testing (eg attitudinal surveys, focus groups), limited simulator trials and on-road trials. These techniques can enable the quantification of any potential safety decrements and the establishment of road user preferences and buy-in before widespread roll-out, minimising road user pushback when informed designs are used alongside a clear communications, education and engagement process.

### 4.3 Monitoring plan

Section 3.2 indicated the importance of developing a plan prior to implementation for monitoring the effects of the new signage – a key next step towards implementing bilingual signage in Aotearoa New Zealand. The plan should be developed with input from the Waka Kotahi Traffic Device Control committee and outline a methodology for reviewing the impact of bilingual signage on people travelling on our roads, including issues of safety, usability and cultural awareness. It could employ multiple monitoring approaches, such as controlled field testing, observational studies, public perception surveys or focus groups and DSI analysis, setting out when, in relation to signage commissioning, each approach should be employed.

While the monitoring should focus on all people driving on New Zealand roads, the impacts of bilingual signage on tourists and 'balanced' bilinguals (ie those who are equally proficient in both languages) have not yet received much attention in the literature and this could be an area for future research in the long term.

While this review of the literature could not identify any pre-implementation monitoring plans, this information may not have been published and made accessible to the public. Further information could be sought directly from jurisdictions that have implemented bilingual signage, should this be seen as useful.

### 4.4 Policy

As noted earlier, legally enabling bilingual signage would require a change to the Land Transport Rule Traffic Control Devices 2004 Rule 54002/2004. Waka Kotahi is currently working with the Ministry of Transport to identify the policy implications and enable the necessary changes.

### 4.5 Communications, education and engagement

The implementation of bilingual signage should be accompanied by a proactive communications, education and engagement campaign for those travelling on New Zealand roads, to assist in managing knowledge, expectations and public perceptions of risks. It is anticipated that while a proportion of the public may initially have a negative perception of bilingual signage, this perception will diminish over time, as the use of te reo Māori on traffic signage is normalised.

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