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NZ TRANSPORT AGENCY

A cross-portfolio consideration of interventions impacting transport safety outcomes

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- Wellington City Council
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Abbreviations and acronyms

ACC	Accident Compensation Corporation
ANCAP	Australasian New Car Assessment Program
CCTV	closed circuit television
DHBs	district health boards
EV	electric vehicle
EVP	Electric Vehicles Programme
HGV	heavy goods vehicle
HV	heavy vehicle
ICE	internal combustion engine
KPI	key performance indicator
MfE	Ministry for the Environment
OECD	Organisation for Economic Co-operation and Development
PCBU	Persons conducting a business or undertaking
PPE	personal protective equipment
STAMP	Systems-Theoretic Accident Model and Processes
VAT	value-added tax
VKT	vehicle kilometres travelled
WHO	World Health Organization
WOF	Warrant of Fitness
YCAP	Youth Crime Action Plan

Contents

Executive summary

In this report, potential road safety co-benefits (benefits that are not intended as the primary outcome) across all government interventions (ie, not just within the traditional transport sector) were assessed. Interventions that have beneficial impacts on road safety as well as meeting their primary objectives outside of transport were identified during the first of two cross-portfolio workshops. Of the interventions identified, three have been presented as case studies because they were considered to have the best information available for analysis and illustrated a range of different ways in which interventions are developed. Additionally, road safety was not a primary objective of these interventions because such projects have direct road safety benefits rather than co-benefits.

Three case studies covered in this report

The case studies represent interventions across a range of government agencies and differ in the ways in which these programmes were designed. The research revealed a number of common themes across the case studies in relation to considering road safety co-benefits. These themes included:

1. Difficulty for agencies attempting to access and effectively use transport data.
2. Time constraints that prevent road safety co-benefits from being considered.
3. Not needing to consider road safety co-benefits to make a successful case for an intervention.

Following interviews with personnel involved in the interventions and analysis of reports, cabinet papers and, where available, international literature, we made the following conclusions.

1. Road safety co-benefits are often left out of intervention logics due to complexity, uncertainties, risks and resource pressures (case note 1).

> **Case note 1 – Difficulty of considering road safety co-benefits in changes to enrolment schemes**
>
> Section 3.3 explains that road safety co-benefits are difficult to consider in a typically complex intervention logic. Road safety co-benefits have been left out of the intervention logic for the Tomorrow's Schools reforms so that the Ministry of Education can focus on their primary objectives.

2. Road safety co-benefits are seldom carried through intervention logics for non-road safety projects (case note 2).

> **Case note 2 – Road safety co-benefits left out of Productivity Commission report**
>
> In the Productivity Commission report discussed in section 5.2, road safety co-benefits as a result of switching to a low-carbon economy were initially considered but were not included in the final report.

3. The following practical measures could be implemented to improve the likelihood of road safety co-benefits being included in intervention logics:
    a. improve sharing of road safety and transport data in a manner that is useful for the stakeholder
    b. improve resourcing of access to road safety expertise to other agencies to help them consider road safety co-benefits in their intervention designs
    c. actively encourage other agencies to consider road safety co-benefits.
4. Applying a systems approach, where co-benefits and disbenefits carry greater weight in the design of interventions, would be easier if working across agency boundaries was more explicitly encouraged in departmental key performance indicators (KPIs).
5. Other possible approaches include:
    a. conducting more interdisciplinary research
    b. where possible, undertaking a multi-level approach (case note 3)
    c. improving coordination between public sector agencies by co-developing interventions with intersecting interests (case note 4)
    d. listing co-benefits and disbenefits in advice to decision makers, even when not quantified, so that they can be considered in decision making.

> **Case note 3 – New Zealand Police undertaking a multi-level approach to reduce crime, victimisation and road trauma for Māori**
>
> New Zealand Police has undertaken a multi-level approach in its Turning of the Tide and Te Huringa o Te Tai strategies (section 4.2). New Zealand Police co-designed and implemented local action plans in partnership with iwi Māori based on the specific needs, context and values of local communities in order to achieve the goal of all Māori living full and prosperous lives, free from crime, victimisation and road trauma.

> **Case note 4 – Agencies working together through the Youth Crime Action Plan**
>
> Co-development of interventions is a key objective of the Youth Crime Action Plan, as discussed in section 4. It actively encourages agencies to stop working in silos and to implement joint approaches to addressing youth crime.

The following table maps the relevant outputs against each research aim.

Aim	Refer
To identify a set of interventions across different policy domains that have positive spillover effects on road safety, and to describe how those interventions work in ways that demonstrate their linkages to road safety	Three case studies and Appendix C
To identify common elements of systems approaches underlying those interventions and show their relevance to the transport sector	Conclusions 1 and 2
To draw lessons from intervention logics in other sectors that would inform road safety interventions	Case notes 3 and 4
To inform future evaluations of road safety interventions	Conclusions 3, 4, and 5

Abstract

This project aimed to identify interventions outside of the traditional transport sector with spillover effects on road safety and inform future evaluations of road safety interventions on how to include road safety co-benefits in programme design. The research found that road safety co-benefits are often left out of the intervention logics due to complexity, uncertainties, risks and resource pressures. The research also found that an enabler of a systems approach would be agreed key performance indicators (KPIs) that encourage agencies to work together on related issues. Two specific recommendations to simplify consideration of road safety co-benefits are to improve the sharing of road safety and transport data between agencies and to provide other agencies with access to road safety expertise to help them consider road safety co-benefits in their intervention designs.

1 Introduction

1.1 Context and scope

A key challenge for the public sector is to improve safety in a range of areas, including transport. Portfolio domains such as health, housing, and occupational safety share an objective of reducing or eliminating accidental injuries or deaths. Each public sector agency area has policy and/or operational interventions aimed at objectives outside the transport portfolio but may have spillover effects on road safety. This problem is not unique to New Zealand. A number of recent international studies have pointed to a need for an integrated policy approach to road safety. For example, health co-benefits of modal shifts to reduce emissions were identified in 2009 (Woodcock et al 2009), and decision makers have been encouraged to address transport, land use, and health as an integrated whole (McClure et al 2015).

This research was undertaken in the second half of 2019 and early 2020 and applies to all public sector agencies. The focus is on programme design where road safety is not a primary objective of the programme.

In this report, ‘road safety’ refers to the safety of all road users, including drivers, passengers, public transport users, motorcyclists, cyclists and pedestrians. It relates to the ability of all road users to remain free from death, serious injury, near misses, disability or economic hardship resulting from road use.

Figure 1.1 Lambton Quay, Wellington, with an arrow indicating the definition of a road as ‘building-to-building’

'Road' is defined as the main carriageway and all other spaces between structures on either side of the road. In an urban context, this is defined as 'building-to-building' (figure 1.1), whereas in rural areas this would be 'field-to-field' (figure 1.2). All roads that are accessible to the public are within the scope of this research. This includes roads owned by the Department of Conservation or New Zealand Defence Force that the public may use.

Policy and operational interventions created by New Zealand government agencies are aimed at portfolio-specific objectives. Some interventions will have spillover effects in other domains such as road safety. Where those spillover effects improve road safety, they are considered to be road safety co-benefits. Spillover effects can also be detrimental to road safety. Such negative effects are outside the scope of this research.

Figure 1.2 Rural road with arrow indicating scope of the road considered in this research

1.2 Aims

Waka Kotahi NZ Transport Agency (Waka Kotahi) has identified an opportunity for the transport sector to learn from how other agencies consider road safety co-benefits. This research looks across portfolios outside of the transport sector to:

- identify a set of interventions across different policy domains that have positive spillover effects on road safety, and to describe how those interventions work in ways that demonstrate their linkages to road safety
- identify common elements of systems approaches underlying those interventions and show their relevance to the transport sector
- draw lessons from intervention logics in other sectors that would inform road safety interventions
- inform future evaluations of road safety interventions.

The research takes into account the dynamics of wider social and economic systems and their interactions with road transport.

In addition to these formal research aims, the researchers, together with the steering group, identified an aim of using the consultation components of the research to promote the application of systems approaches to the development of interventions by public sector agencies.

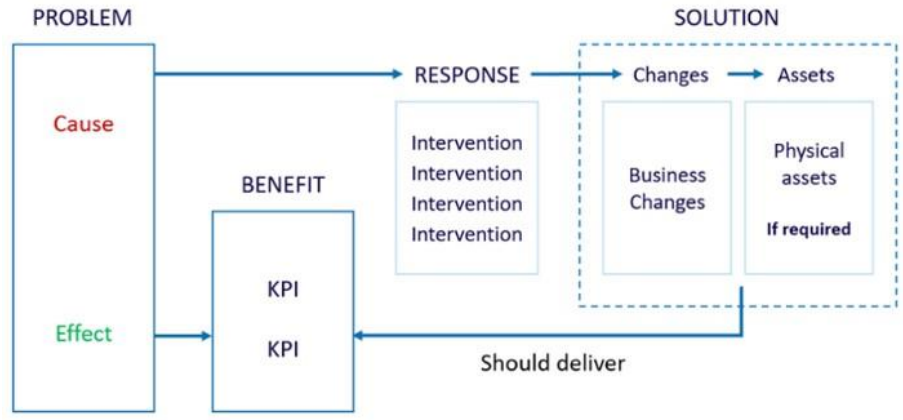
1.3 Intervention logic

An intervention logic is a test designed to confirm whether or not a proposed programme is evidence-based and sufficiently compelling to convince key stakeholders to invest in the programme. Government agencies in New Zealand follow the investment logic mapping technique as outlined by the New Zealand Treasury.[1] The investment management standard, which describes the investment logic mapping technique, was developed by the Victoria State Government Department of Treasury and Finance in Australia. It is a process for applying simple, common-sense ideas and practices that help organisations direct their resources to achieve the best outcomes from their investments (Victoria State Government 2017). The logic behind the investment management standard process is demonstrated in figure 1.3.[2]

In New Zealand, this technique is applied through two main components:

1. **The Investment Logic Map**: a simple flowchart that tells the story of an investment and outlines the underpinning logic.
2. **The Benefit Management Plan**: a description of the expected benefits and outcomes that the proposed programme will deliver.

Figure 1.3 Investment management standard logic flow (Source: Victoria State Government 2017)



1.4 Report structure

This report provides a description of the project methodology, including a summary of the literature review created in the first phase of this research project, which can be found in Appendix D. The core of the report is the presentation of three case studies of New Zealand government agency interventions with a focus on the intervention logics and reasoning behind the programmes in relation to road safety co-benefits.

The case studies illustrate how interventions are developed by agencies in practice, with the interventions in each case study being developed via their own individual development process. The presentation of each

[1] https://treasury.govt.nz/information-and-services/state-sector-leadership/investment-management/better-business-cases-bbc/bbc-methods-and-tools/investment-logic-mapping

[2] This is a simplified representation of the process. In reality, intervention design, implementation and evaluation is more complex and non-linear.

case study reflects the process followed in the development of that intervention. A discussion of relevant learnings for the consideration of road safety co-benefits is presented with each case study.

The report concludes with a discussion of common themes from the case studies and recommendations to support consideration of road safety co-benefits in intervention logics.

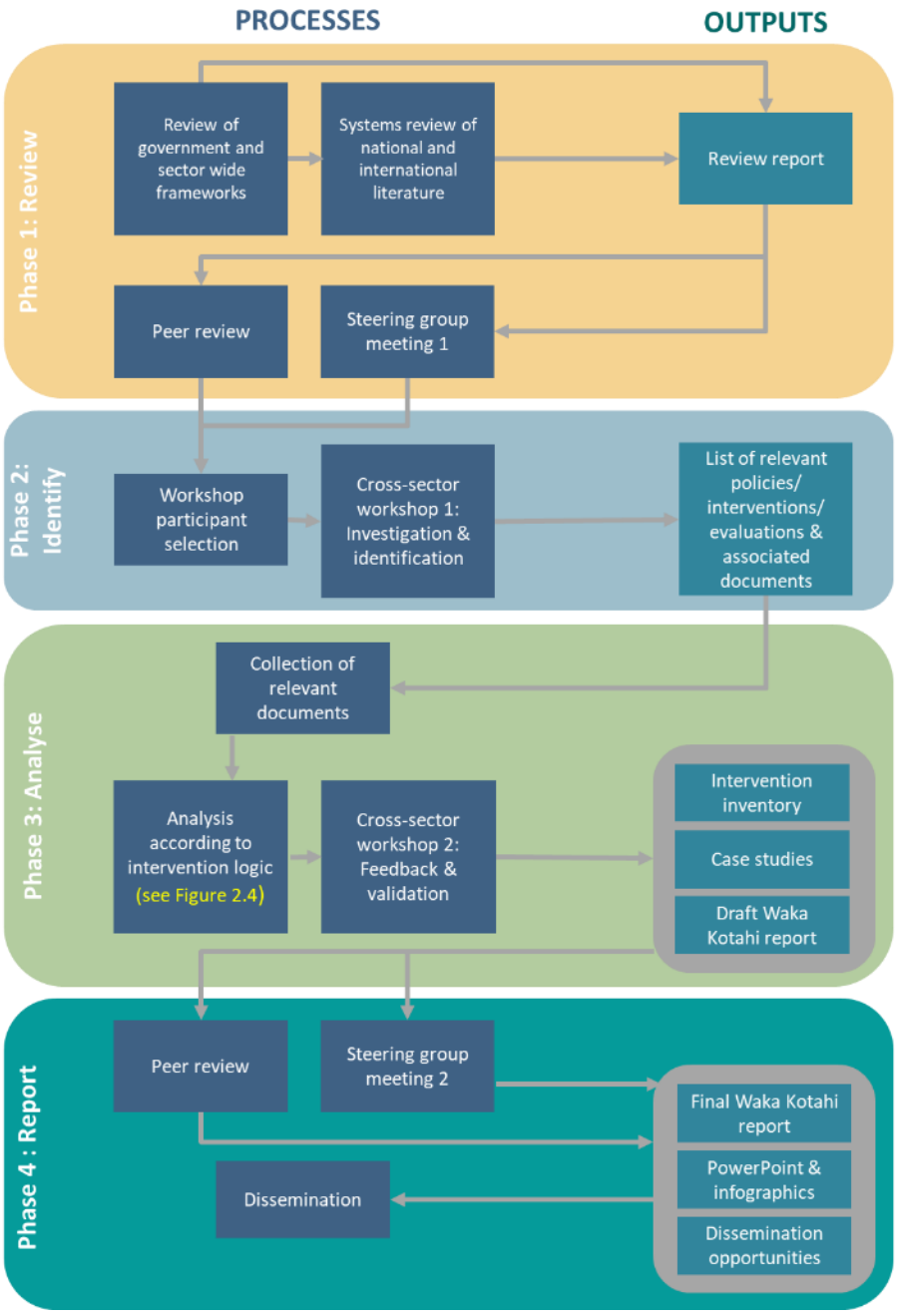
A summary of current WorkSafe New Zealand programmes where there are a number of interventions with potential road safety co-benefits is presented in Appendix B. These illustrate the types of opportunities that can arise from interventions by government agencies with overlapping goals.

2 Methodology

2.1 Overview

The overall project methodology is illustrated in figure 2.1.

Figure 2.1 Flowchart of the research methodology



A key feature of the research method was its interactive nature (figure 2.2). A fundamental concept of the research was that the researchers would engage with agencies that had considered road safety co-benefits and would share their respective learnings through several cross-portfolio workshops.

The first phase of the research project, the review stage, sought to answer the research question:

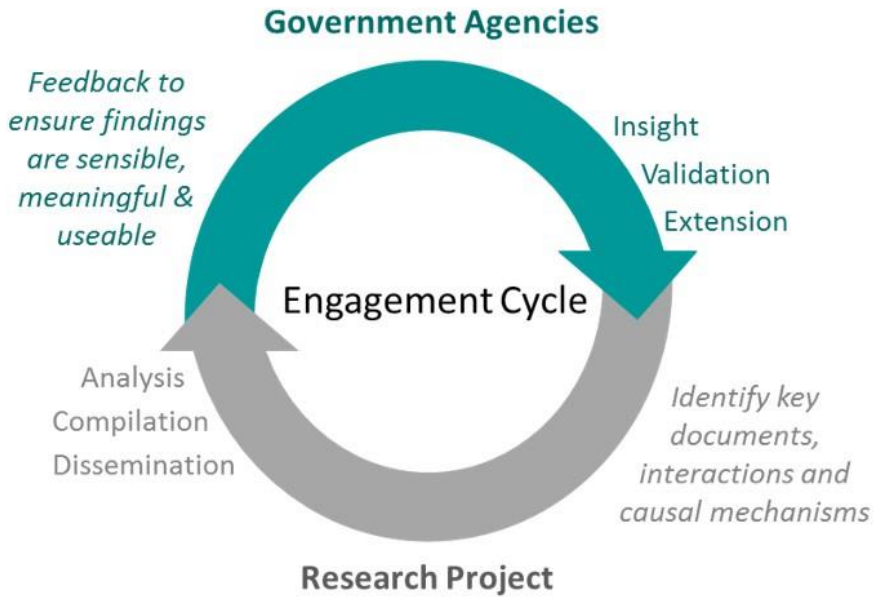
Which sectors have policies that are likely to impact on road safety in New Zealand?

A literature review was conducted to capture what information was available on road safety co-benefits in international literature. The results of this review were used to inform research to answer the question:

What policies, interventions and evaluations that might impact positively on road safety in New Zealand exist within these sectors, and how do these interactions work?

The first of the two cross-portfolio workshops helped the research team to identify interventions outside of the New Zealand transport sector to evaluate as possible case studies.

Figure 2.2 Process of engagement with government agencies



Following the workshop, we created and assessed an inventory of interventions. To be considered, road safety co-benefits needed to be present, but road safety could not be the purpose of the project. Those that do not appear as case studies in this report are listed in Appendix C. The three questions from the research brief which drove this phase were:

1. What are the causal mechanisms driving the interaction with road safety?
2. What does the intervention logic suggest are the contexts, assumptions, audiences etc in which this interaction has a positive effect?
3. How does international literature suggest these interventions work?

Finally, the impacts on transport accessibility were assessed (figure 2.3).

Figure 2.3 Logic behind the analysis of interventions and impacts on transport accessibility

To make this research accessible to intervention designers, we decided to present a few case studies where there was reasonably complete understanding and which illustrated different ways of developing interventions. To assist with this selection, we rated the interventions using a semi-quantitative scoring process on the following factors:

1. **Expected quality of intervention information:** Is there enough information available to understand the intervention and its potential road safety co-benefits well?
2. **Likely understanding of road safety co-benefits:** Are the road safety co-benefits apparent and able to be fully recognised and reported on?
3. **Expected strength of road safety co-benefits:** Could the identified co-benefits have a meaningful impact?

2.2 Summary of literature review

The literature review (Appendix D) answered the first research question: **Which sectors have policies that are likely to impact on road safety in New Zealand?** To do so, the following sub-questions were considered:

- What linkages have been identified through government and sector-wide frameworks and systems?
- What policies and interventions does international literature say may impact road safety?

The review found minimal literature where road safety co-benefits had been identified as a result of other government interventions.

A key outcome of the literature review was identification and discussion of the relevant New Zealand frameworks.

The authors of the literature review made the following recommendations:

- The Risk Management Framework developed by Rasmussen (figure 2.4) could guide a systems approach to road safety co-benefits (eg, through actor maps).
- An understanding of human factors should be used to link individual behaviour change to intervention and policy design.

Each of these is discussed in the following sections.

2.2.1 New Zealand Road Safety Actor Map

Actor maps are the first stage of the Accimap systems analysis process (Rasmussen 1997). They describe the actors and agencies involved in the transport system across higher systems levels that may influence road safety at the end user and environment levels. They are based on Rasmussen's (1997) Risk Management Framework, which guided this research (figure 2.4).

During the literature review, the New Zealand Road Safety Actor Map was developed by the literature reviewers (figure 2.5).

Actor maps help to make sense of a complex system without attempting to identify all the linkages. The New Zealand Road Safety Actor Map was found to be informative and useful in the cross-portfolio workshops as a reference for participants to apply systems thinking to the discussion of interventions. The New Zealand Road Safety Actor Map was updated following feedback from the workshops. While the map provides a holistic view of the New Zealand transport system from a systems perspective, it remains a simplification of a complex system and thus may never be fully complete. Workshop participants found the New Zealand Road Safety Actor Map and case-study-specific actor maps to be useful tools and took them away for use outside of this research project, fulfilling one of the research objectives, which was to encourage systems thinking across public sector development of interventions.

The structure of the actor map is based on that of McIlroy et al (2019) in their work mapping the United Kingdom transport system. This introduces the classification scheme of the six E's, extending the traditional intervention areas from Engineering, Education, and Enforcement, by adding Enablement, Economics, and Emergency response to more fully represent the intervention levers available. These are each represented with different coloured squares on the map. The contents of the map were informed by a previous application of the actor map to the New Zealand transport system (Trotter and Ivory 2019). This was then analysed and discussed by both the project steering group and workshop participants to ensure that all potential primary actors in the New Zealand transport system were represented.

Figure 2.4 Rasmussen's Risk Management Framework (Source: Rasmussen 1997)

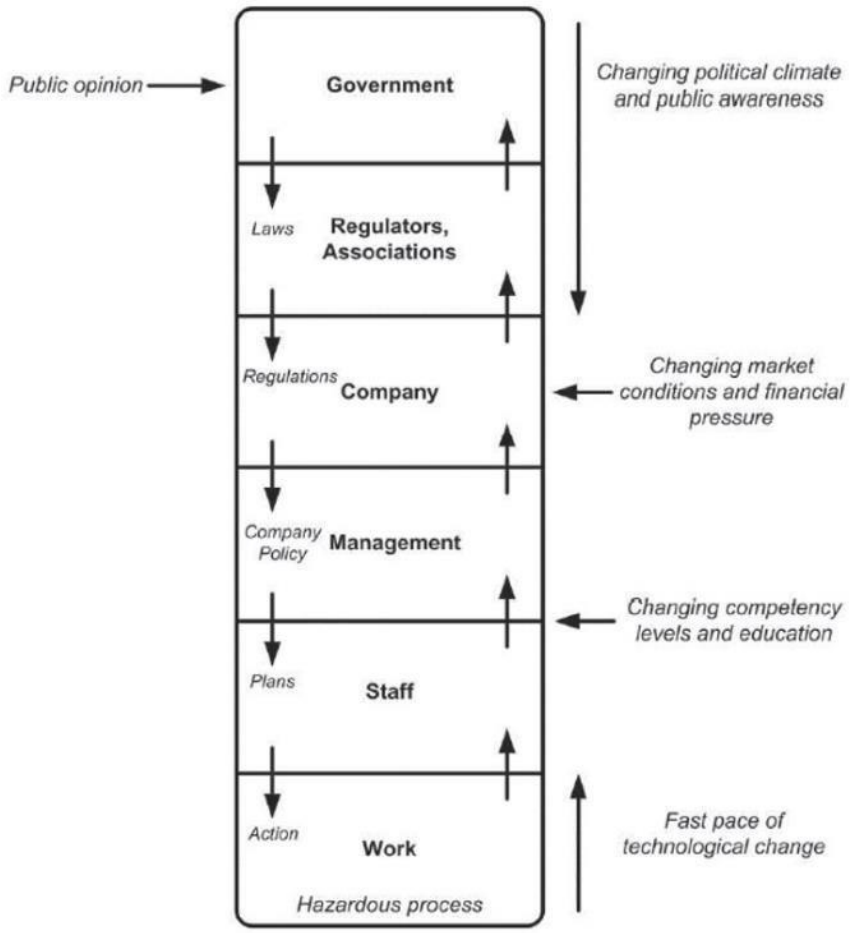
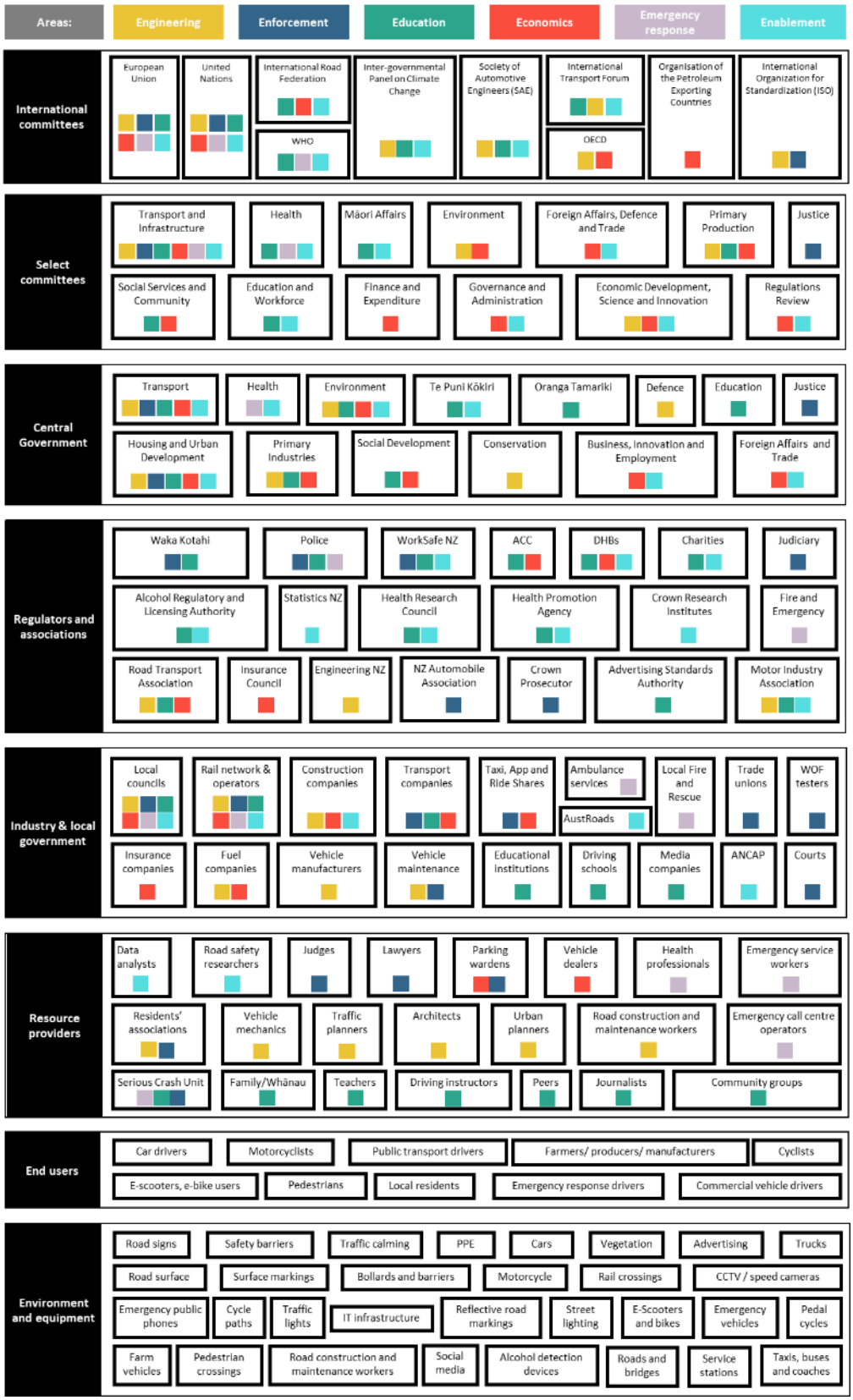


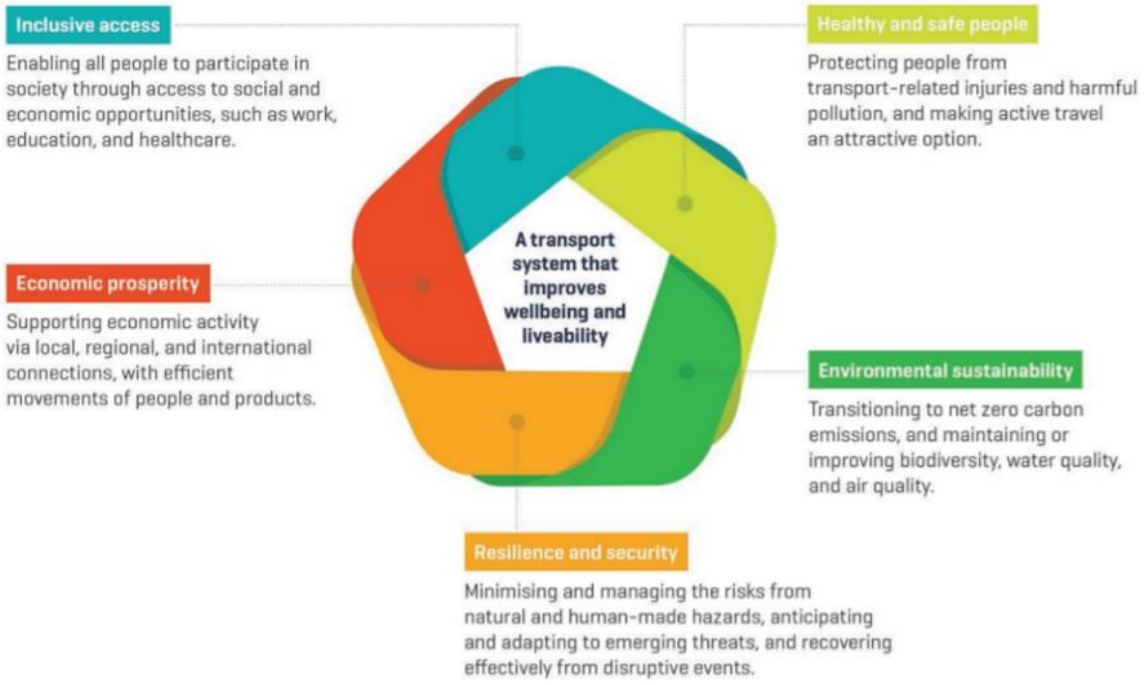
Figure 2.5 The New Zealand Road Safety Actor Map



Note: WHO = World Health Organization; OECD = Organisation for Economic Co-operation and Development; ACC = Accident Compensation Corporation; DHBs = district health boards; WOF = Warrant of Fitness; ANCAP = Australasian New Car Assessment Program; PPE = personal protective equipment; CCTV = closed circuit television

2.2.2 Existing policy frameworks and interactions

Figure 2.6 The Ministry of Transport's Transport Outcomes Framework

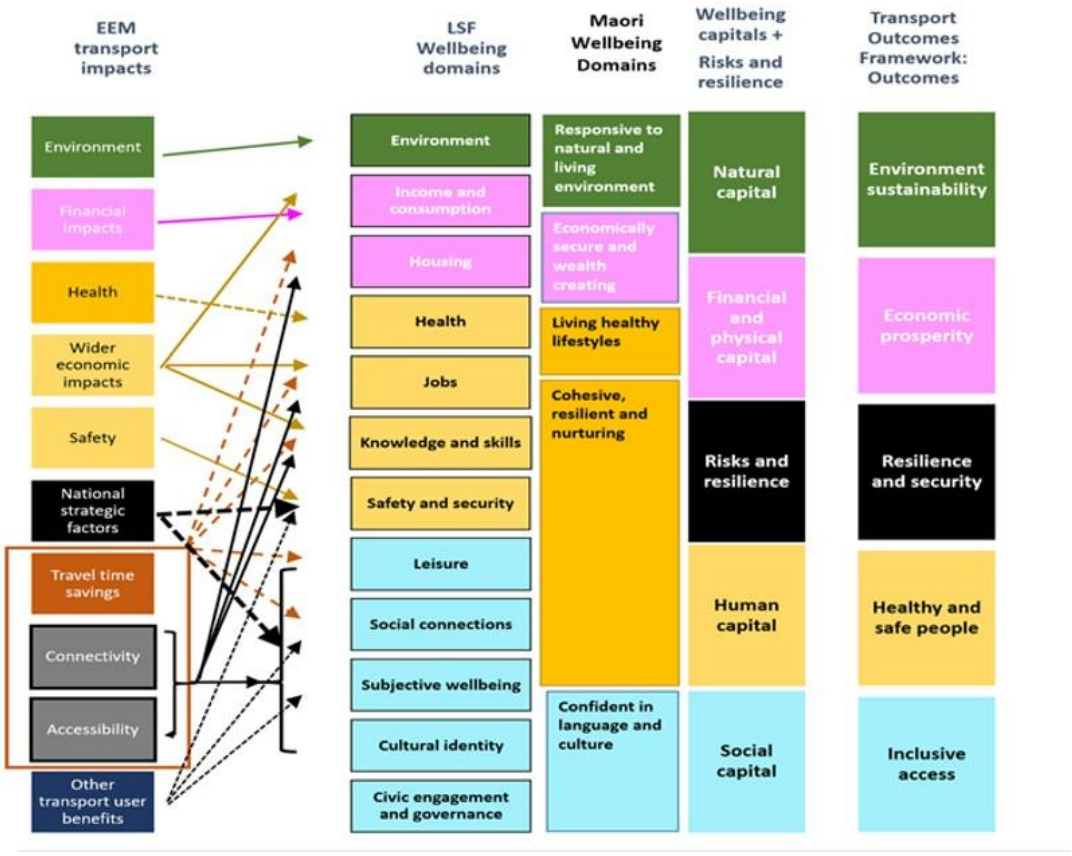


Key policy frameworks in use within New Zealand by the Ministry of Transport provided the basis for the identification of health, urban planning/housing, environment, workplace safety, employment, economics and culture as areas with potential co-benefits for road safety. International literature supported these findings and emphasis was found to be on portfolios such as the environment (figure 2.5) (Ministry of Transport 2018b).

In construction of the Transport Outcomes Framework, the Ministry of Transport also mapped the framework to others used across different government sectors (figure 2.6) (Parr and Caruana 2018). It is apparent from this mapping that there is a high degree of correspondence between the Transport Outcomes Framework and frameworks used by other New Zealand government departments. It also shows that relationships are not one-to-one, but are more complex.

The review found that road safety co-benefits could be found across multiple levels of the system. For example, there is a growing movement to consider road safety as a public health issue, which has led to a number of researchers applying intervention logics from the health sector to road safety. Similarly, environmental targets around carbon emissions mirror the Road to Zero road safety strategy (Ministry of Transport 2019b) and are likely to have overlapping key performance indicators (KPIs).

Figure 2.7 Mapping of the Transport Outcomes Framework against other frameworks commonly used by New Zealand government agencies (Parr and Caruana, 2018)



Note: EEM = Economic Evaluation Manual; LSF = Living Standards Framework

However, the review also acknowledged that the specific KPIs of each portfolio may be a barrier to an integrated approach.

In summary, the literature review found that there are potential inadvertent impacts on transport from interventions across all levels of the New Zealand transport system, particularly in areas such as environmental policy and carbon emissions. For example, strategies being applied in the environmental sector, such as those for the Climate Change Response (Zero Carbon) Amendment Act 2019, have similar elements to the Road to Zero strategy (Ministry of Transport 2019b) and may provide an opportunity for a coordinated approach. We acknowledged, however, that the specific KPIs of each portfolio may provide barriers to an integrated approach. These will need to be identified and overcome in order to make any significant safety gains.

2.2.3 Behaviour change wheel

A conclusion of the literature review is that an understanding of human factors should be used to link individual behaviour change to intervention and policy design. The review authors suggested that the behaviour change wheel (Michie et al 2011) is arguably the most useful individual behaviour change model for this research as it links individual behaviours to government-level factors (figure 2.7).

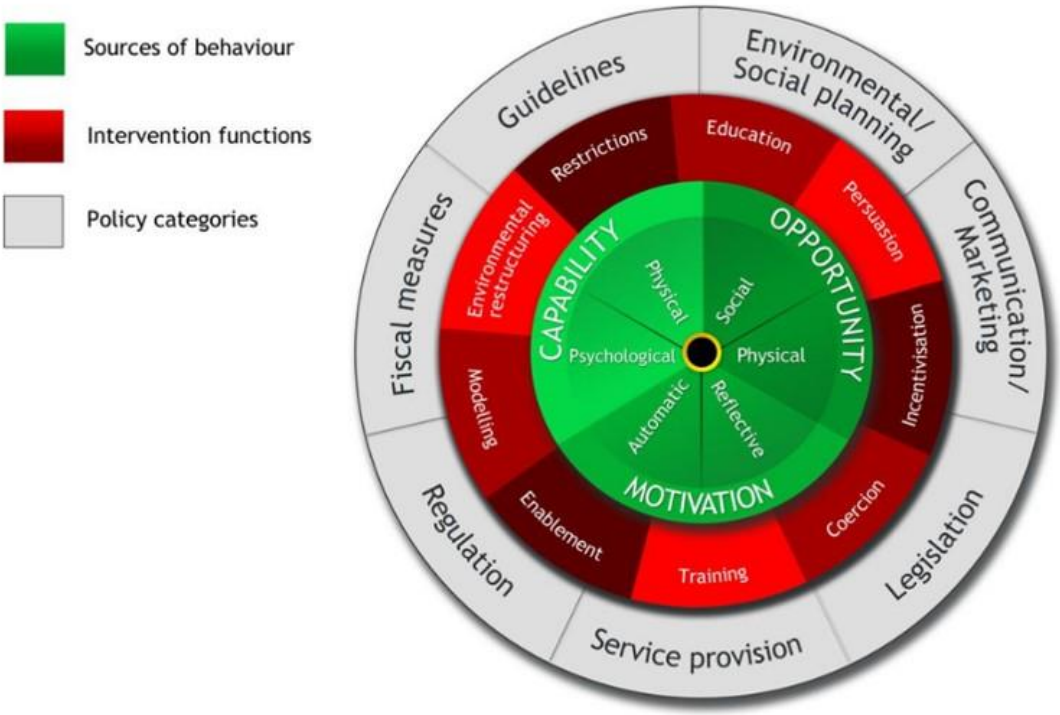
The behaviour change wheel is centred on an individual-level behaviour model in which behaviour is considered a product of the interaction between individual capability, motivation and opportunity. These three components are further broken down into six subcomponents:

- physical capability
- psychological capability
- physical opportunity (afforded by the environment)
- social opportunity (afforded by culture)
- motivation from reflective processes (evaluations and planning)
- motivation from autonomic processes (emotions and impulses).

These subcomponents are linked to the types of interventions that impact them. The nine interventions in the model are also derived from the 19 different behaviour change models synthesised. The interventions are:

- education
- persuasion
- incentivisation
- coercion
- training
- enablement
- modelling
- environmental restructuring
- restrictions.

Figure 2.8 Behaviour change wheel (Michie et al 2011)



The authors of the literature review adapted the behaviour change wheel from Michie et al (2011) to relate interventions to the policy areas that support them (table 2.1).

Table 2.1 Policy areas and interventions

Policy areas	Education	Persuasion	Incentivisation	Coercion	Training	Restriction	Environmental restructuring	Modelling	Enablement
Communication/Marketing	✓	✓	✓	✓				✓	
Guidelines	✓	✓	✓	✓	✓	✓	✓		✓
Fiscal			✓	✓	✓		✓		✓
Regulation	✓	✓	✓	✓	✓	✓	✓		✓
Legislation	✓	✓	✓	✓	✓	✓	✓		✓
Environmental/Social planning							✓		✓
Service provision	✓	✓	✓	✓	✓			✓	✓

In addition to these main findings of the literature review, the authors identified the following learnings and themes.

- There needs to be an improvement in coordination between agencies.
- A national policy is required to reconcile conflicting goals.
- Multi-level approaches need to be made.

2.3 Workshops

The workshop processes are described in Appendix A. The first of the two cross-portfolio workshops helped us to develop a list of potential interventions with road safety co-benefits in development or underway by government agencies. We later assessed these interventions under the three criteria set out in section 2.1.

Three interventions were chosen to be further investigated and reported:

1. **Reform of the Tomorrow's Schools system:** an intervention early in development but with the potential to have a great impact on road safety, particularly around schools.
2. **Youth Crime Action Plan**: an ongoing intervention that calls for government agencies to work together against youth offending, which has road safety co-benefits.
3. **Emissions reduction interventions:** as identified in the literature review, emissions reduction policy has crossover with transport. Some of the current and potential interventions to combat climate change may have road safety co-benefits.

WorkSafe New Zealand programmes were also identified as a group of mostly future interventions that are likely to have road safety co-benefits. As none of these programmes had progressed to a suitable stage to be considered as case studies, they are outlined in Appendix B. However, as a result of this research, WorkSafe and Waka Kotahi are exploring new opportunities for joint programmes.

The case studies and their findings were presented at the second cross-portfolio workshop to provide feedback to agencies that had contributed to the research and to validate the results. Participants were also invited to suggest ways in which the process of considering road safety co-benefits in intervention logics could be made easier (Appendix A).

3 Reform of the Tomorrow's Schools system

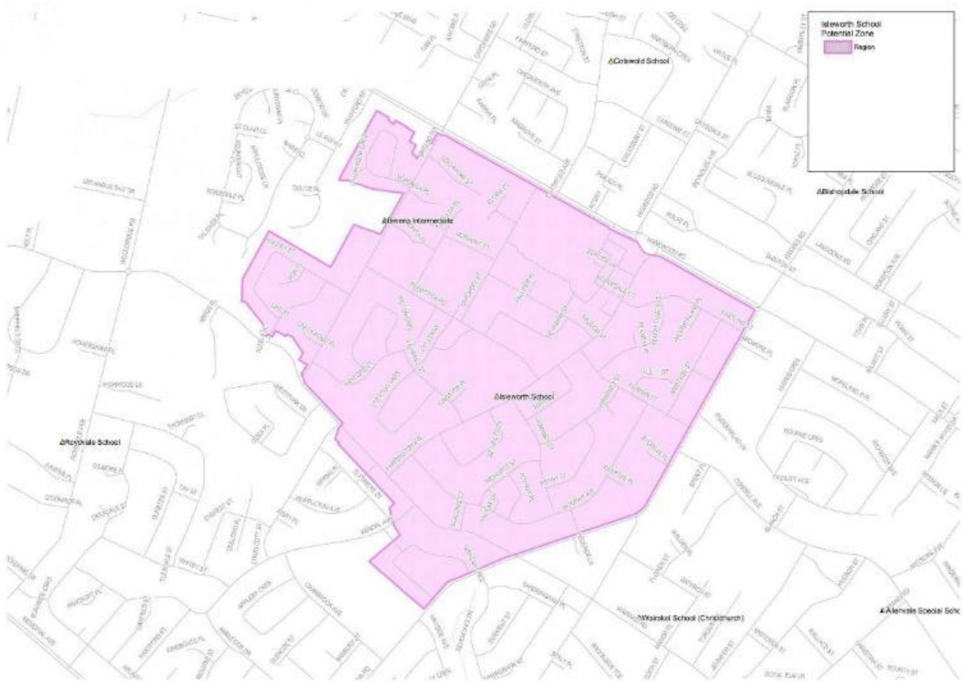
3.1 Context

The reform of the Tomorrow's Schools system (Hipkins 2019) presents the Government's approach to addressing the issues that the Independent Taskforce identified during the Tomorrow's Schools review (Tomorrow's Schools Independent Taskforce 2018). One way the Government is addressing these issues is through the Education and Training Bill currently being considered by the Education and Workforce Committee. This Bill includes a series of proposals to repeal and replace the Education Act 1989, the Education Act 1964, and the Industry Training and Apprenticeships Act 1992.

One proposal in the Education and Training Bill is to move the responsibility for developing an enrolment scheme from school boards of trustees to the Ministry of Education. The wider policy work around enrolment schemes is currently underway. However, enough is currently known about these interventions to discuss potential road safety co-benefits for the purposes of discussion in this report.

Enrolment schemes are a tool used when there is a risk of overcrowding at a school (figure 3.1). Under the current system, the Ministry of Education informs a school of the potential overcrowding. The board of trustees for that school then undertakes a process of consultation with the local community and nearby schools to develop a home zone that addresses the issue of overcrowding. Current legislation states that all students must be able to attend a reasonably convenient school. This is not defined because it depends on a range of factors, including the context of the local area around the school, such as the geography of the area, the distance to be travelled, public transport options, and traffic hazards.

Figure 3.1 An enrolment zone boundary



The enrolment scheme guarantees a place at that school for those living within the home zone, but families and whānau still have the choice about where their child or family member goes to school. For example, they may choose to attend a special character school, a private school, or other non-local school.

3.2 Causal mechanisms

The current enrolment scheme framework is school-centric with schools being incentivised to draw boundaries that they perceive as being best for their school. In some instances, this has resulted in schools putting in place zones that exclude 'less desirable' nearby communities or have a detrimental effect on other nearby schools in the network. From the Ministry of Education's perspective, key purposes of enrolment schemes include avoiding overcrowding and making the best use of the existing school networks. However, changes to school enrolment zones may influence school choice for some families and, in turn, their choice of transport mode to get to school. It is known that concentrated traffic congestion around schools and busy roadways greatly decreases child safety in walking to school (Wilson et al 2007).

The causal mechanisms driving the interaction with road safety are discussed in three categories: time, distance, and traffic density. These categories were identified by the researchers from discussions with the intervention designers. **Time** refers to the duration of a student's journey from their front door to the school grounds in the morning and from the school grounds to their front door in the afternoon. **Distance** is the amount of ground a student covers from home to school and vice versa. **Density** refers to the concentration of vehicles around the school. Traditionally, density is managed through local measures such as signage (figure 3.2).

Figure 3.2 Traffic management through road signage near a school

A Dunedin study across 12 schools found that approximately half of high school students were enrolled in the closest school. Of these students, nearly half used active modes of transport such as cycling or walking to travel to and from school. Only 9% of students who were not enrolled in their closest school were reported to have used an active mode of transport to get there (Mandic et al 2017). In a similar study in Dunedin, it was found that the optimal distance for walking to school was a distance less than or equal to 2.25 kilometres (Pocock et al 2019). This indicates that where an enrolment scheme for a school is designed such that the school campus is within 2.25 kilometres of its students, a significant portion of them will not use private vehicles to get to school, reducing traffic density around the school.

3.3 Intervention logic

At the time of conducting this research, the intervention logic was still being designed, so no formal documentation was available to be analysed. The researchers interviewed Ministry of Education staff involved in the design of the intervention to gain an understanding of the development process.

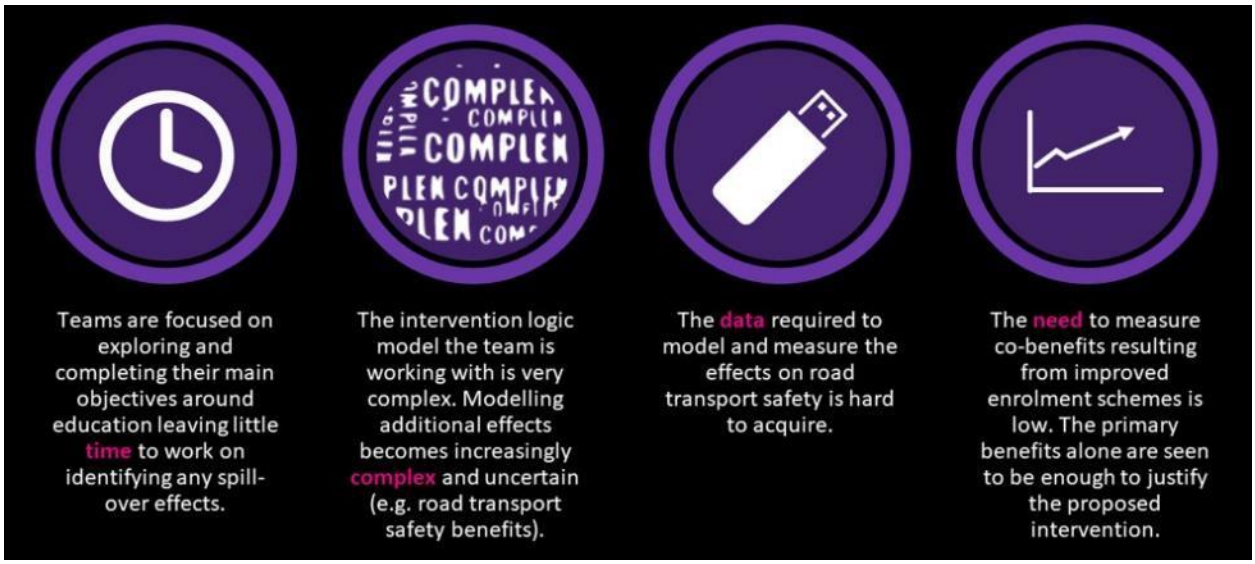
The intervention logic model being used by the team designing the intervention is complex. The focus of the Ministry of Education is mainly on avoiding overcrowding and making the best use of the existing school networks. For this, the Ministry of Education must take into account predicted community growth and a range of other factors.

In order to assess the potential effects of enrolment schemes on road safety, the team would have to know the local contexts of specific schools and gather appropriate road safety data (eg, accident reports, traffic counts, speeding infringements). If they did collect relevant data, they would then need the capability to correctly interpret and use the data to successfully identify and assess the road safety co-benefits. This is a difficult task and leads to another factor for the Ministry of Education when it comes to considering co-benefits: time. With road safety co-benefits being difficult to understand, predict and measure, it would require a lot of time, which the Ministry of Education may not have and which might need to be dedicated to assessing its main areas of focus.

Finally, there is no formal requirement for the Ministry of Education to take into account road safety co-benefits, but note that traffic hazards are included as a potential consideration in the applicable legislation for interpreting what a reasonably convenient school is.

The learnings are summarised in figure 3.3.

Figure 3.3 Summary of intervention logic learnings



3.4 Tomorrow's Schools review – actor map

The actor map for the proposed changes to school enrolment schemes as developed by the research team is displayed in figure 3.5. The highest primary actor in this system is the Ministry of Education (seen as 'Education' at the 'Central Government' level of the actor map). All of the other primary actors in this situation are at the 'Industry & Local Government' level and below.

This illustrates that in order to make an impact on road safety, many actors may need to be involved at the resource provider and end user levels. These actors sometimes have the opportunity to engage with their school's board of trustees as well as the Ministry of Education when a new enrolment scheme is designed. This is likely the best point in the process to consider road safety co-benefits as all parties can bring their understanding of the local context and local knowledge of road safety issues.

3.5 Transport accessibility

The Road to Zero strategy (Ministry of Transport 2019b) builds on the theme that by improving road safety, the accessibility of towns and cities is enhanced. For example, this would encourage parents to let their children walk to school. As the design of an enrolment scheme may influence the choice of school, an enrolment scheme that allows for safe active modes of transport as well as convenient public transport options will also impact transport accessibility (figure 3.4).

What are the causal mechanisms driving the interaction with transport accessibility?

The process to design and consult on an enrolment scheme is currently led by the board of trustees of that school. Safety of pupils is always an important consideration, including major roads and the availability of safe crossing locations for both able-bodied and disabled students. Distance is not a determinative factor. This means that enrolment schemes may not give priority to students that live the closest to the school. A lengthier commute to school influences the choice of mode of transport to get to school, which reduces accessibility.

What does the intervention logic suggest are the contexts, assumptions, audiences etc in which this interaction has a positive effect?

The intervention logic for enrolment schemes is complex. The focus of the Ministry of Education is mainly on avoiding overcrowding and making the best use of the existing school networks. For this, the Ministry of Education must take into account predicted community growth and a range of other factors, including accessibility.

The approach to this intervention can be seen through another lens. Currently, the enabling legislative and policy work is being done at a national level. This is too broad for potential transport accessibility co-benefits to be accurately and sufficiently modelled and measured. At the regional level, where the intervention will be implemented, consultation and research will allow for co-benefits such as transport accessibility to be considered as the view at that level is finer and there is more familiarity with the zone and its community.

Figure 3.4 Public transport in a residential area

How does international literature suggest these interventions work?

All the relevant international literature identified related to travel distance effects on transport accessibility. Research in the United States found that living within one mile of a school has the most significant effect on active travel to school (McMillan et al 2006). Active modes of travel are an accessible transport choice for most children (Wilson et al 2007). This result is similar to what was found by researchers in Dunedin who concluded that the optimum distance for high school students in Dunedin to walk to school was less than or equal to 2.25 kilometres (Pocock et al 2019).

Additionally, Dunedin provides an interesting case where few secondary schools are zoned. Without zoning, approximately half of high school students in Dunedin are enrolled in the closest school, and of these students, approximately half of them use active transport modes to travel to and from school (Mandic et al 2017).

3.6 Tomorrow's Schools review – summary

What are the causal mechanisms driving the interaction with road safety?

The three main causal mechanisms driving the interaction with road safety are traffic density, distance, and time.

Traffic density: the concentration of vehicles around a school. Higher traffic density is linked to decreased road safety.

Distance: the ground covered between a student leaving their home to stepping through the door at school and vice versa.

Time: the duration in which a student is exposed to a potential accident.

What does the intervention logic suggest are the contexts, assumptions, audiences etc in which this interaction has a positive effect?

While investigating the intervention logic for the proposed changes to enrolment schemes, the researchers found through interviews with Ministry of Education staff involved in the intervention design that these interactions are not currently being considered due to:

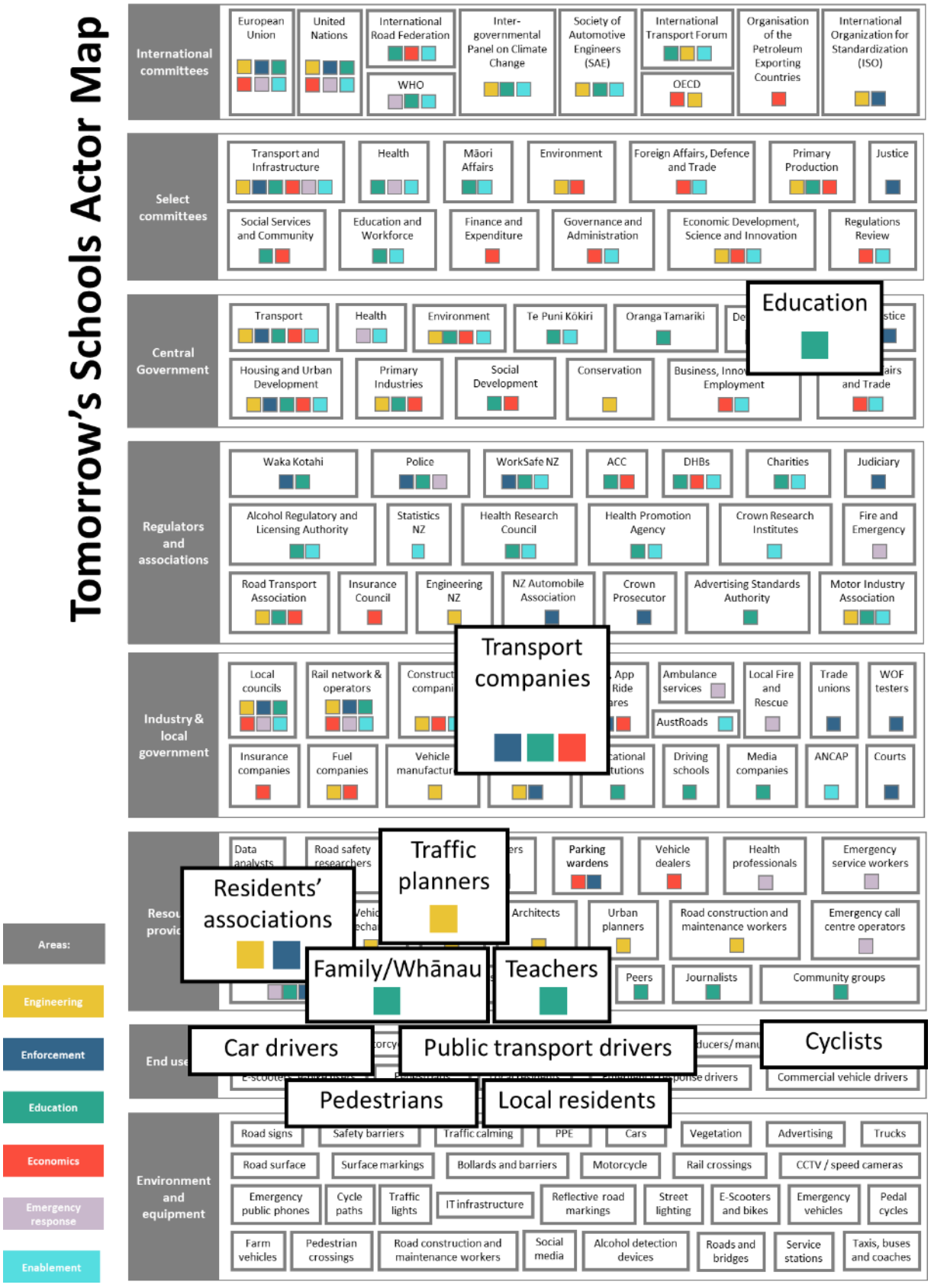
- **Complexity:** The primary objectives of the Ministry of Education are difficult to model and attend to in the intervention logic. Co-benefits such as road safety are also difficult to consider and the effects are less certain, so primary objectives are prioritised.
- **Need:** The need to consider road safety co-benefits is low. The proposed changes to enrolment schemes do not require such considerations outside of the primary objectives in order to be implemented.
- **Time:** The Ministry of Education has limited time in which to complete their main objectives and achieve their desired outcomes. The time required to take co-benefits such as road safety into consideration may not fit within their timeframe.
- **Data:** The Ministry of Education lacks the data to consider road safety co-benefits. Additionally, they would require outside expertise in order to effectively consider the co-benefits, given the appropriate data was available.

How does international literature suggest these interventions work?

It is known that concentrated traffic congestion around schools and busy roadways greatly decreases child safety in walking to school (Wilson et al 2007). A well-designed enrolment scheme could reduce private car use and, in turn, traffic density and congestion.

A Dunedin study across 12 schools found that approximately half of high school students were enrolled in the closest school. Of these students, nearly half used active modes of transport such as cycling or walking to travel to and from school. Only 9% of students who were not enrolled in their closest school were reported to have used an active mode of transport to get there (Mandic et al 2017). In a similar study in Dunedin, it was found that the optimal distance for walking to school was a distance less than or equal to 2.25 kilometres (Pocock et al 2019).

Figure 3.5 Actor map for the potential road safety co-benefits of proposed changes to school enrolment schemes



4 Youth Crime Action Plan

4.1 Context

The prevention of youth crime and rehabilitation of young people who offend has been a concern of the justice system for a long time. A key feature of the reforms is that they were politically driven. Any one young person in the justice system was one too many.

The current Youth Crime Action Plan (YCAP) programme had its genesis under a previous administration when the then Associate Minister of Justice encouraged the departments to build on previous reforms[3] and to implement joint approaches. The current administration has continued to implement reforms in this area, with 1 July 2019 marking the move of 17-year-old youth offending from the adult courts to the youth justice system (Ministry of Justice 2019).

From our interviews with officials who were involved with the development of the strategies, the benefits in terms of lives turned around were seen to be self-evident. It was also seen as self-evident that a siloed approach wasn't working. The outcome was a programme that was politically driven but also had widespread community support. As a consequence of the initial high level of political support, the programmes did not go through a rigorous intervention logic mapping.

An interview with a member of New Zealand Police involved in youth crime prevention revealed that the programme is seen as having road safety benefits through the following logic chain:

- Many youth offenders first come to the attention of New Zealand Police due to traffic offences.
- Some young people don't have access to legal cars to get a driver licence or to train to pass a licence test.
- Some young people will drive anyway, which then brings them to the attention of New Zealand Police.
- The youths get overwhelmed by fines, which leads to defaults and further court appearances.
- Untrained drivers are less skilled and therefore more likely to be involved in road accidents.
- Breaking this chain in a manner that diverts youths from the justice system and provides them with road safety skills and licences will reduce road trauma and improve road safety.

4.2 Strategies

New Zealand Police ran a related strategy that is featured in the YCAP with the vision that all Māori will live full and prosperous lives, free from crime and road trauma. While much of the strategy was focused on reducing Māori offending and re-offending, it also included a target to reduce the proportion of Māori fatalities in road accidents. This strategy was called the Turning of the Tide – a Whānau Ora Crime and Crash Prevention Strategy. It ran from late 2012 to the year ending May 2018.

[3] Fresh Start (https://www.msd.govt.nz/about-msd-and-our-work/publications-resources/corporate/annual-report/2010-11/reduced-re-offending-by-young-people.html) and Youth Offending Strategy – Te Haonga (Ministry of Justice and Ministry of Social Development 2002).

Figure 4.1 Ministry of Justice and New Zealand Police programmes

A multi-level approach was taken in the strategy to prevent offending and re-offending by working alongside other agencies, such as Te Puni Kōkiri, as well as community groups and whānau. Together, they worked on initiatives such as reducing youth access to drugs, alcohol, vehicles and weapons as well as encouraging greater engagement with whānau and community, with which they intended to create behavioural change that would prevent a child from becoming an offender in the first place (figure 4.2).

In 2016, an update was released on the New Zealand Police website providing an insight into the progress of the programme. At the time, there was no change in the proportion of casualties in serious crashes who were Māori; however, there was a 3% reduction in the proportion of fatal crash casualties who were Māori (New Zealand Police 2016). This can be seen as a road safety co-benefit of the work done under the Turning of the Tide strategy.

Since the Turning of the Tide strategy ended in 2018, New Zealand Police has developed and actioned a similar strategy, Te Huringa o Te Tai (figure 4.1). Launched in late 2019, this strategy has similar aims to the Turning of the Tide, with more emphasis on the victimisation of Māori, while still operating with the multi-level approach and overall vision, which includes a reduction in the road trauma suffered by Māori. However, a numerical target for reducing the proportion of fatal casualties in crashes who are Māori is no longer specified. The target is now qualitative as opposed to the quantitative approach taken in the Turning of the Tide.

A feature of these programmes is that they have been implemented at the police district level. Each of the 12 police districts has imbued the programme with their own character, reflecting the community and needs.

This allows islands of excellence to develop and for the most successful implementations be shared and duplicated.

Figure 4.2 New Zealand Police has worked to engage with Māori communities (Source: New Zealand Police 2019a)

4.3 Statistics

Over the period 2010–2018, approximately 9% of all police proceedings for young people aged 14 to 16 that were serious enough to go to either a family group conference or court were road related. Interventions to reduce youth offending are primarily intended to prevent crimes from being committed.

While youth crime is a broad domain of offences, just under 3% of Youth Court appearances were for traffic and regulatory offences in 2018. This has decreased since 2010 when 7% of Youth Court appearances were traffic related. These are likely to be conservative statistics as prior to 1 July 2019, non-imprisonable traffic offences were dealt with in the District Court, and since then, 17-year-olds have been included in the youth justice system. Over the period 2013–2018, 10% of all fleeing driver events recorded by New Zealand Police involved a driver between the ages of 11 and 17. Of these events, 17% resulted in a crash, 7% resulted in injuries, and 7 events resulted in death. Reducing the number of youth offenders will have road safety co-benefits.

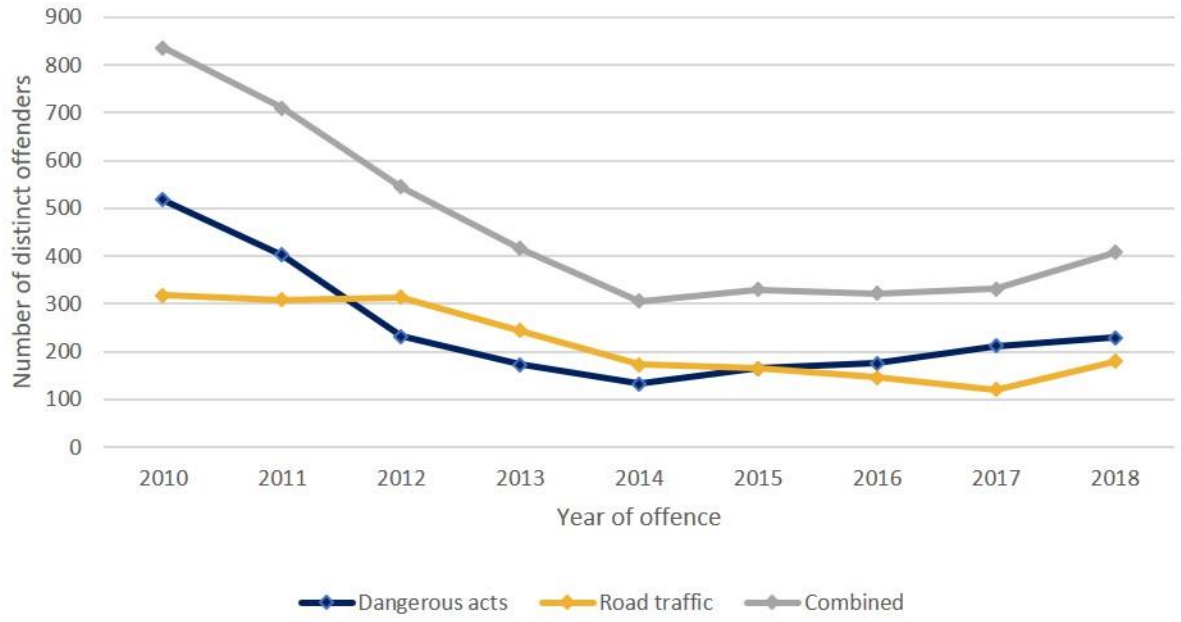
The Ministry of Justice has been providing insights into the performance of the youth justice system since 2010 through the Youth Justice Indicators reports. Youth Justice Indicators spreadsheets provide data from 2010 through to 2018. In this data, there are two traffic-related offence categories (Australian and New Zealand Society of Criminology divisions):

- dangerous acts, which includes dangerous/reckless driving and accidents involving injury
- road traffic, which accounts for vehicle regulatory offences, disqualified driving, and driving under the influence of drugs/alcohol.

Between 2010 and 2018, the number of young people aged 10 to 16 proceeded against for these road-related offences per year has reduced by 56% and 44% respectively (a reduction of 52% in the overall number proceeded against for non-fatal road-related incidents). This is demonstrated in figure 4.3.

It is important to note that any traffic offences that result in death are listed under homicides, which are not included in this statistic. This data also only includes those whose most serious offence in the year was traffic related. What this does show is that the strategies to combat youth crime have had some success in reducing the number of road-related offences committed per year. In 2014, this number started to rise again. In contrast, the number of distinct offenders has reduced by 24% since 2014. Court volumes are decreasing, which is principally the result of a greater use of alternative actions by New Zealand Police since 2014.

Figure 4.3 Number of distinct offenders who committed road-related offences between 2010 and 2018

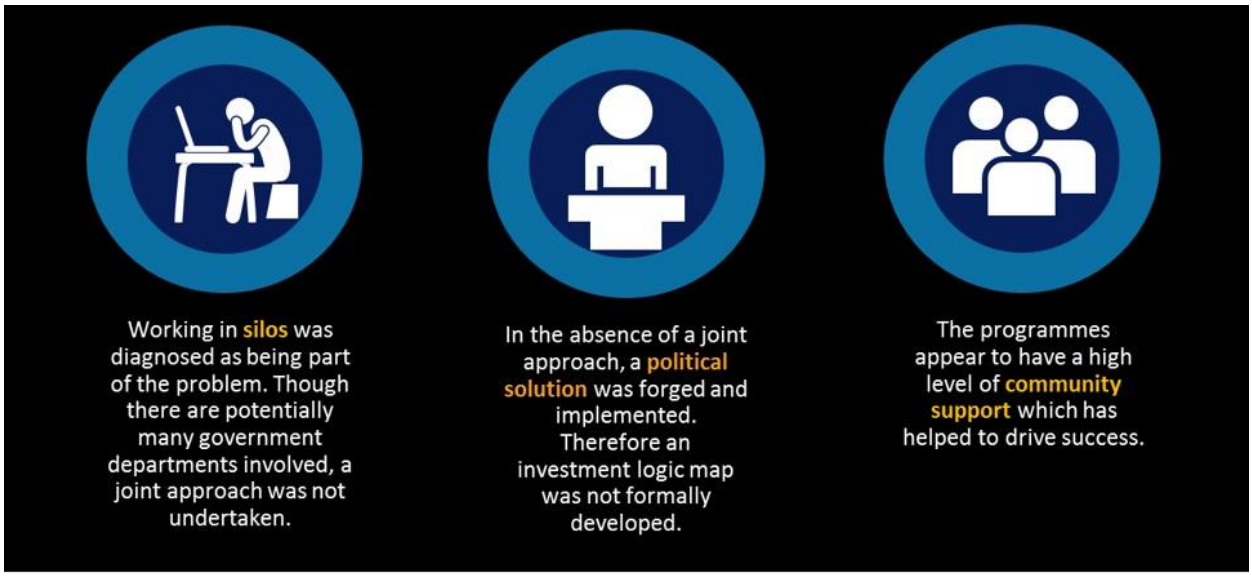


4.4 Learnings

A summary of the learnings from this case study is presented in figure 4.4. A feature of this case study is that working in silos was diagnosed as being part of the problem. As can be seen in the actor map developed by the researchers for the YCAP (figure 4.5), there are potentially many government departments involved. While many of these actors are in the higher levels (central government and select committees), a multi-level approach has been taken. Actors in the resource providers level are identified in the YCAP and are considered of great importance in reducing youth crime. Similarly, the impacts that the YCAP believes these actors can make to reduce youth crime are seen by the researchers in regard to road safety.

Government agencies have to operate within the parameters of government priorities, legislation and funding. There is limited scope to initiate systems approaches without Ministerial or Cabinet decisions. The then government's Better Public Services priorities (2012–2017) encouraged government agencies to work together to address complex, long-term issues. In this case, a political solution was forged and an investment logic map was not developed.

Figure 4.4 Summary of intervention logic learnings



Road safety was not a primary goal of the YCAP, but was clearly identified and viewed as a self-evident co-benefit. New Zealand Police has excellent access to road safety data through its policing activities and specialist in-house services such as the Serious Crash Unit.[4] Relevant performance targets were set for some years and continue to be monitored (New Zealand Police 2019b).

The number of youth offenders has decreased over the life of the programmes, and the programmes appear to have a high level of community support, which is an additional, qualitative indicator of success.

4.5 Transport accessibility

Interventions that address youth crime also address transport accessibility, particularly regarding the use of private motor vehicles. This is particularly important in rural areas that have little or no access to public transport. Implementation of the YCAP varies between police districts but includes interventions such as iwi-based programmes to:

- train young people how to drive safely
- help whānau to get a car into a fully warrantable and registered condition so that it can be used for the driving test.

An outcome is that the families concerned have access to cars that they know are safe and have licensed drivers who know how to drive safely. As these families are often amongst the most deprived, transport accessibility is a basic need that is not always met. Fewer crashes due to safer drivers means that vehicles are more likely to be available for private transport when needed.

What are the causal mechanisms driving the interaction with transport accessibility?

Interventions that help prevent youth offending can directly serve to improve transport accessibility.

[4] https://www.police.govt.nz/about-us/structure/teams-units/road-policing

For example, helping and encouraging young people to attain a driver licence improves traffic accessibility as well as reducing the likelihood of some regulatory traffic offences being committed (G Clark, pers comm).

What does the intervention logic suggest are the contexts, assumptions, audiences etc in which this interaction has a positive effect?

Whilst no formal intervention logic was followed in the creation of the YCAP, the decision making behind the programme was made at ministerial level. Getting agencies to work together towards common goals was seen as a pre-requisite for success in reducing youth crime. In the words of the YCAP:

> *Success in health should not come at the expense of success in education, welfare, or law and order. Smart on crime means that we intervene in lives sufficiently to address risk factors (weaknesses) and enhance protective factors (strengths) so that people can stand up under the pressures of youthfulness, the vulnerabilities of disengaged families, and not be left behind.* (Ministry of Justice, nd)

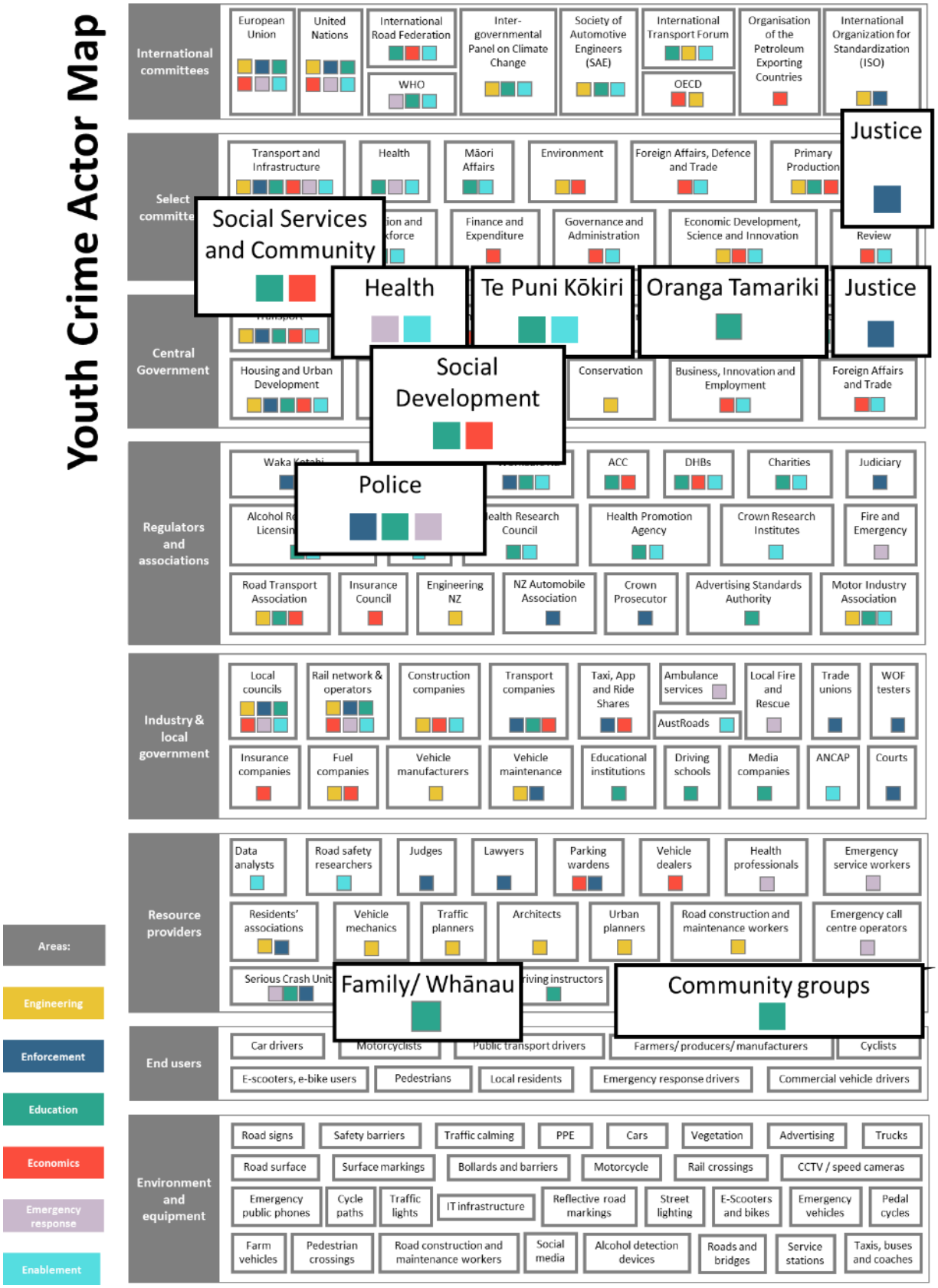
How does international literature suggest these interventions work in terms of transport accessibility?

None identified.

4.6 Youth Crime Action Plan – summary

What are the causal mechanisms driving the interaction with road safety?
The causal mechanisms between youth crime and road safety are seen through the following logic: • Many youth offenders first come to the attention of New Zealand Police due to traffic offences. • Some young people don't have access to legal cars to get a driver licence or to train to pass a licence test. • Untrained drivers are less skilled and therefore more likely to be involved in road accidents.
What does the intervention logic suggest are the contexts, assumptions, audiences etc in which this interaction has a positive effect?
No formal intervention logic was identified for the YCAP. Instead, the YCAP was created through direct action at the ministerial level. This allowed actions to be made to effectively encourage agencies to stop working in silos and to cooperate on interventions with common goals.
How does international literature suggest these interventions work?
No relevant international literature on youth crime interventions and their interactions with road safety was identified.

Figure 4.5 Actor map for youth crime prevention programmes such as the YCAP



5 Emissions reduction

5.1 Context

The transport sector is a key area for greenhouse gas emissions reductions in climate change policy. In 2017, approximately 41% of New Zealand's total greenhouse gas emissions were from the transport sector, of which 44% were from the road transportation category (Ministry for the Environment 2019). It is difficult for some transport sectors to reduce greenhouse gas emissions. Therefore, it is not surprising that emissions reduction interventions have been initially focused on the land transport sector.

Transport emissions are influenced by a wide range of actors, some of whom (eg, vehicle manufacturers) are located overseas, which New Zealand has limited influence over. Those that could have an influence on road safety from an emissions reduction standpoint are primarily high-level actors who determine the transport choices available to people. These high-level actors are identified in the actor map presented in figure 5.7. The policy intent is that the public's response to the available transport options reduces emissions, but it may also have road safety co-benefits.

5.2 Ministry for the Environment analysis

Research has been conducted by the Ministry for the Environment (MfE) into the co-benefits of emissions reduction. In that publication,[5] analysis was undertaken into the consequences of emissions reduction interventions across the energy, industrial processes and product use, agriculture, waste, land use, land-use change and forestry sectors. Of particular interest is the analysis that considered electric vehicles (EVs), freight to rail, and public transport.

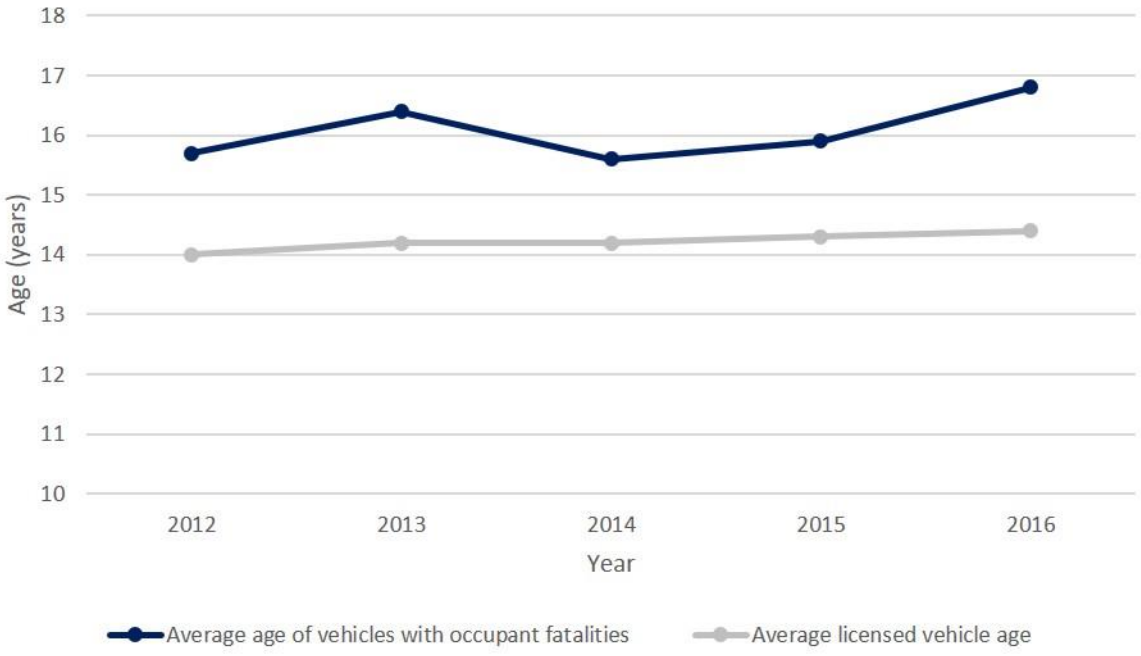
5.2.1 Electric vehicles

In the MfE report, the co-benefits of a shift from internal combustion engine (ICE) vehicles to EVs include a reduction in the number of deaths and restricted activity days lost per annum due to air pollution, and a reduction in noise pollution (MfE 2018).

However, another potential co-benefit of an accelerated programme of replacing ICE vehicles with modern EVs is improvement to the overall crash safety of the New Zealand light vehicle fleet. New Zealand has one of the oldest light vehicle fleets in the developed world, with an average vehicle age of 14.1 years in 2018 (Ministry of Transport 2018a). The average age of cars involved in fatal accidents over a period between 2012 and 2016 on Australian and New Zealand roads was higher than the average age of the licensed vehicle fleet (figure 5.1). In other words, older cars were over-represented in occupant fatality crashes (Smith 2018). Replacing older vehicles with modern EVs would decrease the average age of the New Zealand light vehicle fleet and could improve road safety depending on the safety features of the EVs being bought. Before 2009, EV safety was poor, but the more modern EVs are typically at least equal with other modern light vehicles in terms of crash test safety (Figenbaum and Kolbenstveldt 2013). Actual safety performance varies from model to model, as it does with ICE vehicles.

[5] *The co-benefits of emissions reduction: an analysis* (Ministry for the Environment 2018)

Figure 5.1 Comparison of the average age of a vehicle in New Zealand and the average age of vehicles with occupant fatalities by year



5.2.2 Freight to rail

MfE identified that removing freight from the road network to the rail network would have co-benefits on road safety as well as the intended emissions reductions. The safety co-benefit was mainly due to the severity of truck-related accidents compared to light vehicle on light vehicle accidents. A report by EY (2016) found that switching freight and passenger rail to the road network would add additional safety incident costs. The result of subtracting the costs of existing safety incidents for rail from these additional costs is the avoided safety cost of the rail network. This avoided cost was found to be $56 million to $61 million per annum for freight and $4 million to $7 million for passengers, neither of which were carried forward into the MfE analysis. These net safety benefits were calculated using the Ministry of Transport's value of statistical life, which was valued at $4.06 million per fatality, at June 2015 prices (Ministry of Transport 2016). In the same report, this was determined to be due to the fact that trucks (figure 5.2) are involved in fewer road accidents than light vehicles; however, the accidents they are involved in have higher rates of death and serious injury.

Figure 5.2 Example of a truck on New Zealand roads

5.2.3 Public transport

Whilst New Zealand is focusing on electrification of the ground vehicle fleet in order to reduce emissions, MfE reports that the potential for co-benefits is greater through increasing the use of both public and active transport modes (eg, buses (figure 5.3), trains, and bicycles). This has previously been investigated by McClure et al (2015), who concluded that minimising private vehicle use and maximising use of active transport modes achieves the primary goal of reducing emissions whilst also meeting desired societal benefits in other sectors such as health. Similarly, Stevenson et al (2016) found that the overall health of city populations could be positively influenced by government policies to actively pursue land-use elements that support a modal shift away from private vehicles towards active and public modes of transport.

Figure 5.3 Electric trolley bus service formerly operating in Wellington

Improved public transport is one of the Smart Growth policy levers that can be used to reduce demand for private automobile use (Litman 2015). As more people use public transport, fewer vehicles will be on the roads, which will help reduce the rate of increase in vehicle kilometres travelled (VKT) and congestion (figure 5.4). Not only does lowering VKT reduce emissions, it also lowers the amount of exposure to harm on roads. Ministry of Transport projections indicate that public transportation use will increase, especially in Auckland, by 2042/43. This, along with demand management road pricing and new forms of transportation, will assist in managing demand and lowering VKT (Ministry of Transport 2017). In addition, public transportation is a safer mode of transport compared to private vehicle use (Ministry of Transport 2015). The COVID-19 pandemic resulted in an accelerated uptake of working from home combined with a shift from public transport to private transport. Two months after the return to Alert Level 2, traffic counts in Auckland remained 10% down but had fully recovered in other main centres (Waka Kotahi 2020). It remains to be seen whether the shifts in travel demand are permanent and whether the growth in public willingness to use rapid forms of public transport will resume.

Figure 5.4 Motorway congestion in Auckland

Despite the identification of road safety co-benefits in the MfE analysis, those co-benefits were not carried forward into the emissions intervention logic (P Young, pers comm). Instead, the benefits accounted for in the development of recent emissions reduction policies were limited to direct economic benefits and health co-benefits such as a reduction in the number of premature deaths as a result of air pollution.

A clue as to why road safety co-benefits are not commonly considered is provided by a New Zealand Productivity Commission investigation. The commission evaluated how New Zealand could best transition to a low-emissions economy (New Zealand Productivity Commission 2018). In the Commission's report, the only co-benefits identified in relation to transport are health, environmental, and productivity related. An author of the report was interviewed by the researchers. Road safety co-benefits were considered in the analysis and in earlier drafts of the report; however, time constraints for analysis and space constraints led to these co-benefits being removed from the final edition (P Young, pers comm). The road co-benefits considered related to the improved safety of people using public transport as opposed to private vehicles. This was measured using the social cost of road crashes and injuries (Ministry of Transport 2019c). It is understood that just 5% of the benefits identified in the report arose from reduced vehicle damage, with the majority of the benefits being due to injuries and fatalities (Concept 2017).

The Productivity Commission investigation also illustrates how the choice of metrics affects how co-benefits are estimated. In the Commission's analysis, safety was measured in terms of the historical accident cost per VKT, which was then applied to projected traffic volumes in coming years. However, historical metrics do not take into account ongoing or accelerated improvements in the crash safety of the light passenger vehicle fleet. Used in this way, the measure therefore carries a degree of implicit bias towards mode shifting. While we expect that this had little influence on the positive outcomes of the Commission's analysis of mode shifting, choosing this metric prevented identification and analysis of fleet improvement benefits.

In both the MfE and Productivity Commission investigations, road safety co-benefits were identified and qualitatively considered. Due to time and space constraints, co-benefits that were potentially smaller and more difficult to quantify, such as road safety, were assigned a lower priority. In contrast, the co-benefits that were retained in the intervention logics for emissions reduction interventions typically have been quantitatively analysed and are measurable.

From our research across all sectors, we understand that any benefits that are only qualitatively assessed carry far less weight in the ultimate decision making. We conclude that a factor inhibiting the consideration of road transport safety co-benefits is that they are usually only qualitatively assessed.

5.3 Electric vehicles (potential)

Having considered the current New Zealand context, we looked at the impressive road safety gains that have been made in a number of European countries. While it may be partly coincidental, those same countries have also seen large increases in market share for EVs. A question is whether New Zealand could learn from these EV interventions on vehicle emissions and what road transport safety co-benefits could arise alongside the main emissions-reduction benefit.

What are the causal mechanisms driving the interaction with road safety?

In order to reduce vehicle emissions, there must be:

- a reduction in the total number of vehicles on New Zealand roads; or
- replacement of the fleet with modern vehicles that contribute fewer emissions; or
- both of the above.

Both factors contribute to road safety: the number of vehicles on the road contributes to level of exposure to harm, and the age of a vehicle affects the safety of occupants if a road accident occurs.

The Ministry of Transport is aware that the age of New Zealand's vehicle fleet contributes to road safety and that introducing newer vehicles will improve the safety of our roads (Ministry of Transport 2011). In May 2016, the Government announced an Electric Vehicles Programme (EVP).[6] The purpose of the EVP is to encourage the uptake of EVs in order to reduce the greenhouse gas emissions in the road transport sector by improving the accessibility and availability of EVs.

Figure 5.5 Electric vehicle using a bus lane in Norway

[6] https://www.transport.govt.nz/multi-modal/climatechange/electric-vehicles/

Initiatives that have been considered in the EVP include:

- an exemption from road user charges for EV owners
- government agencies coordinating activities to provide public charging infrastructure for EVs
- allowing EVs to use special access lanes on the state highway network and local roads at the discretion of road-controlling authorities (Ministry of Transport 2019a).

These incentives are similar to those used in European countries such as Norway, which leads the world in EV uptake (figure 5.5). While the EVP is in its infancy in New Zealand, the government initiatives in Norway, listed in table 5.1, have been underway since 1990. For this reason, we have looked to data from Europe to explore the potential road transport safety co-benefits of the EVP.

While the number of EVs on European roads is still too low to conduct reliable statistical studies of road safety of accidents and incidents, there have been no deaths in Norway as a result of road accidents involving EVs as of 2013 (Figenbaum and Kolbenstveldt 2013). This is likely to be influenced greatly by the number of EVs compared to ICE vehicles; however, the number of EVs in Norway is significant, with a market share of 5.6% achieved in 2013 (Gronnbil 2014) and reaching 51.9% in 2019 (Norwegian Road Federation, nd). In terms of fire safety, there is evidence that the EVs on the market as of 2017 are less prone to fires than ICE vehicles. Of at least 200,000 Nissan Leaf vehicles sold in the five years of production preceding 2017, only one fire incident is known (Larsson et al 2017). In the United States, the Department of Transportation National Highway Traffic Safety Administration concluded that the propensity and severity of explosions and fires for EVs with lithium-ion batteries is slightly less than, if not equal to, those for gasoline- or diesel-powered vehicles. However, the authors expect the consequences of fire incidents with EVs to be less severe than those of ICE vehicles due to the smaller amounts of flammable solvent in batteries compared to fuel tanks (Stephens et al 2017).

Table 5.1 Timeline of EV incentives in Norway (Norwegian Electric Vehicle Association 2019)

Incentive	Start Date	End Date
No purchase/import taxes on EVs	1990	–
No annual road tax	1996	–
No charges on toll roads and ferries	1997	2017
Free municipal parking	1999	2017
50% reduced company car tax	2000	2018
25% value-added tax (VAT) exemption on EVs	2001	–
Access to bus lanes	2005	–
25% VAT exemption on leasing EVs	2015	–
Local authorities allowed to limit the access to only EVs that carry additional passengers	2016	–
40% reduced company car tax	2018	–
Parking fee for EVs was introduced locally with an upper limit of a maximum of 50% of the full price	2018	–
Fiscal compensation for scrapping fossil-fuelled vans whilst converting to a zero-emission van	2018	–
50% maximum of the total amount charged on toll roads	2019	–
Class B licence holders may drive electric vans of class C1 (light lorries) up to 4250kg	2019	–

5.4 Discussion

Key learnings from this case study are presented in figure 5.6.

Figure 5.6 Summary of learnings from emissions reduction interventions

This case study illustrates how road safety co-benefits can be omitted from the final decision making even where a rigorous intervention design process has been followed. While the literature review (Appendix D) identified an expectation that this would be addressed through overlapping KPIs, in practice, agencies' intervention logics are ultimately focused on the core goals of the agency concerned, and road safety co-benefits tend to be left out.

5.5 Transport accessibility

Emissions reduction interventions include some that aim to improve transport accessibility. Improvements to public transport as a way of reducing the number of light vehicles on the road have the benefit of improving transport accessibility in their primary objective. Others include local government interventions, such as the plans to make the city/town centres of Queenstown and Wanaka car-free, improving transport accessibility for those who engage in active and public modes of transport.

What are the causal mechanisms driving the interaction with transport accessibility?

Emissions reduction interventions include a broad range of different strategies. Whilst some, such as the EVP, aim to reduce emissions through incentivising replacing high-emission vehicles with EVs, others look to encourage people to change their mode of transport to be more environmentally friendly. In both cases transport accessibility is impacted.

In the first case, the EVP improves accessibility to modern vehicles. Programmes like this have been successful overseas, with EVs having a 51.9% market share in 2019 (Norwegian Road Federation, nd). However, the design of the programme must be carefully considered because subsidies in one area may incur extra costs in another. For example, an increase in the price of fuels such as diesel as a way of incentivising an uptake of EVs may negatively impact those who, despite the incentives, are unable to afford to change their mode of transport. In this case, transport accessibility would be negatively impacted.

In cases in which the aim is to encourage the use of public and active modes of transport, transport accessibility can be improved through effective upgrades in public transport infrastructure. A literature review of transport accessibility concluded that the accessibility factor in designing public transport infrastructure is of great importance (Saif et al 2019).

What does the intervention logic suggest are the contexts, assumptions, audiences etc in which this interaction has a positive effect?

MfE (2018) noted in their co-benefits analysis that an increased uptake of public transportation and active modes of transport has a higher potential for co-benefits than replacing the light vehicle fleet with EVs. One such co-benefit is a reduction in congestion in New Zealand cities. Even bringing other New Zealand cities up to the levels of use of public and active transport that Wellington has would create considerable benefits for congestion (Shaw et al 2018). This decrease in congestion improves accessibility by reducing travel times.

5.6 Emissions reduction – summary

What are the causal mechanisms driving the interaction with road safety?

Emissions produced by light vehicles may be reduced by either replacing high-emission vehicles with low-emission vehicles such as EVs or by replacing the mode of transport a person uses. Replacing old high-emission vehicles with modern EVs may be replacing older, more dangerous vehicles with ones that have newer safety features, while changing from private vehicles to public transport or active transport such as cycling reduces congestion.

What does the intervention logic suggest are the contexts, assumptions, audiences etc in which this interaction has a positive effect?

Two reports were analysed:

- **Productivity Commission:** Road safety co-benefits were considered during the production of this report on transitioning to a low-carbon economy. However, they were not included in the published copy of the report because of time constraints and the need to keep the report concise, and there were other co-benefits considered that could be quantitatively discussed, unlike road safety.
- **MfE:** Road safety co-benefits were only considered in the MfE report chapter on switching freight from road to rail. It is not known exactly why road safety was not considered in either chapter on EVs or public transport. This may be due to the same, or similar, issues as were encountered by the Productivity Commission in their report.

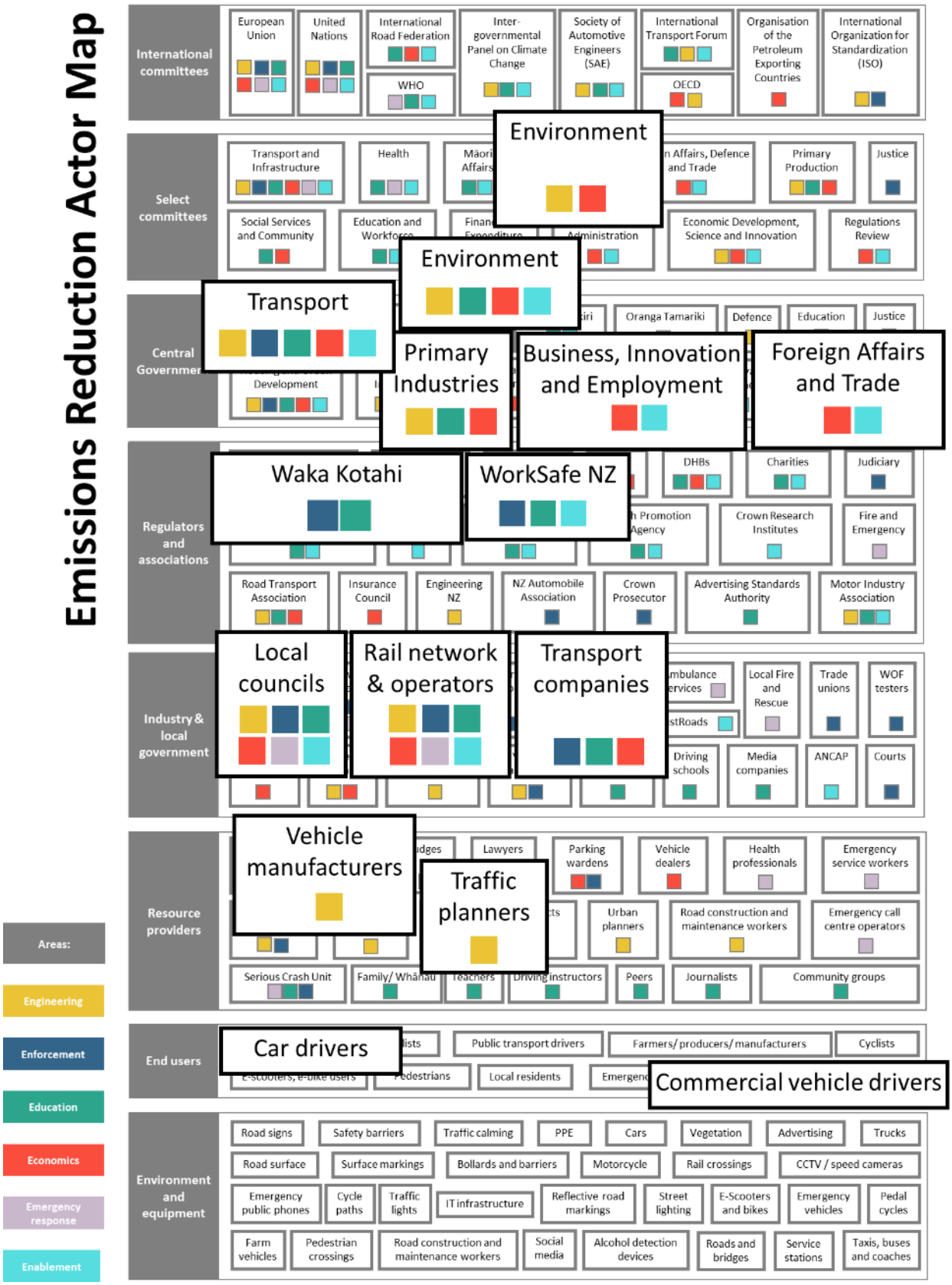
How does international literature suggest these interventions work?

- **EVs:** The average age of cars involved in fatal accidents over a period between 2012 and 2016 on Australian and New Zealand roads was higher than the average age of the licensed vehicle fleet. In other words, older cars were over-represented in occupant fatality crashes (Smith 2018).

  Before 2009, EV safety was poor, but the more modern EVs are typically at least equal with other modern light vehicles in terms of crash test safety (Figenbaum and Kolbenstveldt 2013).

  The Ministry of Transport is aware that the age of New Zealand's vehicle fleet contributes to road safety and that introducing newer vehicles will improve the safety of our roads (Ministry of Transport 2011).
- **Freight to rail:** A road safety co-benefit of shifting freight to rail was found to be a net safety benefit of $60.50 million to $56.24 million per annum (EY 2016).
- **Public transport:** Public transportation is a safer mode of transport compared to private vehicle use (Ministry of Transport 2015).

Figure 5.7 Actor map for emissions reduction interventions with potential road safety co-benefits



6 Discussion

6.1 Emergent themes

Applying a systems approach to policy development – where the interactions are understood and where government agencies act in a joint manner to maximise the overall welfare of society – has been recommended by many researchers (Jenkins et al 2010; McClure et al 2015; Salmon and Lenné 2014; Salmon et al 2012; Stevenson et al 2016).

Our research confirms that it's harder to successfully apply in practice and highlights the value in getting others to learn more about including road safety co-benefits in interventions.

Six common themes that emerged from this research are summarised below and illustrated in figure 6.1.

1. **Difficulty:** Taking account of co-benefits is difficult and uncertain.
2. **Resources:** Time and space constraints often prevent co-benefits from being taken into account, even when they are identified at the outset.
3. **Risk:** Taking into account co-benefits introduces risk for the policy proponents because co-benefits are often less well understood than the main benefits, and their magnitude and direction are less certain.
4. **Quantification:** Benefits that are quantified tend to carry more weight than those that are unquantified.
5. **Need:** If a policy is justifiable on its main benefits alone, then co-benefits tend to be omitted from the final analysis.
6. **Impact:** If co-benefits are not presented to decision makers, they will have little or no impact on the choice of interventions.

Figure 6.1 Common themes found in the research

While this research has been focused on road safety co-benefits, we expect that the same findings would apply to other forms of co-benefit.

These findings show how it is also rational, from the perspective of those engaged in developing the interventions, to remove anything that is not essential to justify the intervention.

6.2 Promoting road safety co-benefits

6.2.1 Workshop 2 recommendations

An output of the second cross-portfolio workshop was a list of recommendations put together by the workshop participants as to how to effectively influence consideration of road safety co-benefits in intervention logics. The full list is provided in Appendix A.

The most popular recommendation was to improve road safety data sharing between agencies and develop an understanding as to what the quality of the data is. This is partly due to the way data is recorded by each agency, which is both driven by and limited by their legislative mandate. For example, WorkSafe New Zealand is limited to activities taking place at workplaces and worksites despite road safety being affected by a worker's commute to and from work. Possible ways to improve access to data include:

- **data availability:** improving the portal at Waka Kotahi, which acts as a resource for any other agency that is considering an intervention with potential road safety impacts
- **liaison:** actively liaising with other agencies to provide them with access to transport safety skills to identify and assess co-benefits.

The second-most popular suggestion was to improve the resourcing and access to expertise in the transport sector. This is related to the first suggestion but arises because non-transport-sector agencies are not experts in using transport data and are potentially unable to confidently analyse and interpret the road safety data. The core idea is that someone within Waka Kotahi or other transport sector body helps other agencies to consider potential road safety co-benefits. This person would need to have expertise in working with transport sector data and would help manage risks by ensuring that the data was not misinterpreted. The expected benefit is that road safety co-benefits would be more likely to be quantified and incorporated into intervention logics and, by extension, into decision making.

The only other recommendation to receive more than two points was a change in the strategic direction of their portfolios with more of a focus on considering non-primary objectives in interventions. The lower scoring reflected an absence of consensus on whether this was achievable as it would involve adjusting each agency's KPI to foster co-development of interventions. Such changes would require the agreement of the relevant minister. However, if this could be achieved, the impact on developing more complementary and consistent approaches across government could be significant.

All other recommendations made were seen as less likely to greatly impact the system of developing intervention logics.

Other possible changes to improve consideration of road safety co-benefits that were not evaluated in the second cross-portfolio workshop include:

- **Co-creation of interventions**
  An alternative approach to developing more 'joint' thinking is for agencies in sectors with the greatest co-benefits to work together to develop interventions that meet the policy objectives of both. This is not a new idea but takes effort and has waxed and waned over time. A current example is actions taken by WorkSafe and Waka Kotahi to foster improved collaboration on intersecting issues where both agencies have a clear interest (eg, truck driver fatigue).

- **Listing co-benefits**
  Another approach would be to recognise that co-benefits will often be omitted from the main analysis, but to encourage policy advisors to simply list unquantified expected co-benefits and disbenefits when policy recommendations are made. This at least allows decision makers to be aware of the co-benefits. Often this will carry little weight. However, where the best way forward is balanced between several options, the co-benefits may prove to be decisive.

7 Conclusions

Following interviews with personnel involved in the interventions and analysis of reports, cabinet papers and, where available, international literature, our conclusions are as follows.

1. Road safety co-benefits are often left out of intervention logics due to complexity, uncertainties, risks and resource pressures (case note 1).

> **Case note 1 – Difficulty of considering road safety co-benefits in changes to enrolment schemes**
>
> As discussed in section 3.3, road safety co-benefits are difficult to consider in a typically complex intervention logic. Road safety co-benefits have been left out of the intervention logic for the Tomorrow's Schools reforms so that the Ministry of Education can focus on their primary objectives.

2. Road safety co-benefits are seldom carried through into final intervention logics for non-road safety projects (case note 2).

> **Case note 2 – Road safety co-benefits left out of Productivity Commission report**
>
> In the Productivity Commission report discussed in section 5.2, road safety co-benefits as a result of switching to a low-carbon economy were initially considered but were not included in the final report.

3. The following practical measures could be implemented to improve the likelihood of road safety co-benefits being included in intervention logics.
    a. Improve sharing of road safety and transport data in a manner that is useful for the stakeholder.
    b. Improve resourcing of access to road safety expertise to other agencies to help them consider road safety co-benefits in their intervention designs.
    c. Actively encourage other agencies to consider road safety co-benefits.
4. Applying a systems approach, where co-benefits and disbenefits carry greater weight in the design of interventions, would be easier if working across agency boundaries was more explicitly encouraged in departmental KPIs.
5. Other possible approaches include:
    a. conducting more interdisciplinary research
    b. where possible, undertaking a multi-level approach (case note 3)
    c. improving coordination between public sector agencies by co-developing interventions with intersecting interests (case note 4)
    d. listing co-benefits and disbenefits in advice to decision makers, even when not quantified, so that they can be considered in decision making.

Case note 3 – New Zealand Police undertaking a multi-level approach to reduce crime, victimisation and road trauma for Māori

New Zealand Police has undertaken a multi-level approach in its Turning of the Tide and Te Huringa o Te Tai strategies (section 4.2). New Zealand Police co-designed and implemented local action plans in partnership with iwi Māori based on the specific needs, context, and values of local communities in order to achieve the goal of all Māori living full and prosperous lives, free from crime, victimisation and road trauma.

Case note 4 – Agencies working together through the Youth Crime Action Plan

Co-development of interventions is a key objective of the Youth Crime Action Plan discussed in section 4. It actively encourages agencies to stop working in silos and to implement joint approaches to addressing youth crime.

The following table maps the relevant outputs against each research aim.

Aim	Refer
To identify a set of interventions across different policy domains that have positive spillover effects on road safety, and to describe how those interventions work in ways that demonstrate their linkages to road safety	Three case studies and Appendix C
To identify common elements of systems approaches underlying those interventions and show their relevance to the transport sector	Conclusions 1 and 2
To draw lessons from intervention logics in other sectors that would inform road safety interventions	Case notes 3 and 4
To inform future evaluations of road safety interventions	Conclusions 3, 4, and 5

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Appendix A: Cross-portfolio workshops

Table A.1 Workshop 1 (22 November 2019)

Name	Agency
David Keilty	ACC
Denis Mander	Department of Conservation
Anaru Silao	Ministry of Education
Emma Barraclough	Ministry of Transport
Kevin Oldham	Navigatus Consulting
Joshua Mills	Navigatus Consulting
Roger Fairclough	Neo Leaf Global
Tama Andrew	New Zealand Defence Force
Victor Cauty	Waka Kotahi
Jo Chang	Waka Kotahi
Maggie Trotter	Waka Kotahi
Iain McAuley	Waka Kotahi
Peter Jones	New Zealand Police
Nils van Lamoen	New Zealand Police
Anna Blomquist	Wellington City Council
Fiona Whyte	Wellington City Council
Robert McIlroy	WorkSafe New Zealand
Charlene Mathern	WorkSafe New Zealand

This workshop was held during the 'Identify' phase of the project, which proceeded immediately after the literature review was completed. The list of agencies invited to participate in this workshop was informed by and included in the literature review.

The aim of this workshop was to finish addressing the first research question (**Which sectors have policies that are likely to impact on road safety in New Zealand?**) by answering the question **What policies, interventions and evaluations that might impact positively on road safety in New Zealand exist within these sectors, and how do these interactions work?** This would provide the researchers with a preliminary list of interventions to investigate before starting the 'Analyse' phase of the research.

To achieve this, the workshop provided participants with background and context on this research project before splitting the participants into four groups to discuss and record public sector interventions with co-benefits. Each group then shared the results of their discussions with the other groups. This exercise was repeated with a focus on road safety co-benefits, with the interventions mentioned being recorded by the researchers.

Table A.2 Workshop 2 (13 February 2020)

Name	Agency
David Keilty	ACC
Denis Mander	Department of Conservation
Anaru Silao	Ministry of Education
Pam Southey	Ministry of Justice
Kevin Oldham	Navigatus Consulting
Joshua Mills	Navigatus Consulting
Roger Fairclough	Neo Leaf Global
Tama Andrew	New Zealand Defence Force
Jason Edgecombe	New Zealand Defence Force
Victor Cauty	Waka Kotahi
Jo Chang	Waka Kotahi
Maggie Trotter	Waka Kotahi
Nils van Lamoen	New Zealand Police
Anna Blomquist	Wellington City Council
Robert McIlroy	WorkSafe New Zealand
Charlene Mathern	WorkSafe New Zealand

The second cross-portfolio workshop was held at the end of the 'Analyse' phase of the research, following the conclusion of the 'Identify' phase. The purpose of this workshop was to feed back findings of the research to the participants who initially contributed in the previous workshop. This helped to ensure the findings were sensible, meaningful, and presented in a useable way.

The workshop consisted of a presentation of the three case studies (reform of the Tomorrow's Schools system, the Youth Crime Action Plan, and emissions reduction interventions) in a similar manner to this research report. The following research questions were answered and participants were encouraged to discuss the findings.

1. **What are the causal mechanisms driving the interaction with road safety?**
2. **What does the intervention logic suggest are the contexts, assumptions, audiences etc in which this interaction has a positive effect?**
3. **How does international literature suggest these interventions work?**

As the discussion of the findings progressed, suggestions as to how to make co-benefits more likely to be considered in future interventions were recorded on a whiteboard. To conclude the workshop, each participant was invited to put three ticks onto the whiteboard for whichever suggestions they believed would have the greatest influence. A participant could allocate all three of their ticks to a single suggestion if they wished to, as the total score for each suggestion was determined by the number of ticks allocated to it. The outcomes are shown in table A.3.

Table A.3 Scoring of process improvement recommendations at Workshop 2

Recommendation from Workshop 2	Score
Improved sharing of data and an understanding of its quality.	9
Improved resourcing and access to expertise in the transport sector to allow road safety co-benefits to be assessed.	7
Strategies allude to/reference leveraging co-benefits – adjustments to KPIs.	4
Improved access to relevant literature on road safety co-benefits.	2
Access to a test case of developing co-benefits in an intervention logic.	2
Other learnings from the resilience space.	1

The scoring system identified two clear improvements that workshop participants collectively thought would have the biggest impact on the ability of non-transport sector agencies to consider road safety co-benefits. Although unintended, the scores were influenced by participants' views on the recommendation's feasibility within the current public sector framework.

Appendix B: WorkSafe New Zealand initiatives

B.1 Purpose

The following summary has been compiled from a high-level scan of developing WorkSafe New Zealand (WorkSafe) health and safety initiatives to illustrate the range of potential road safety co-benefits arising from partnering with relevant WorkSafe intervention programmes. These are not presented as case studies because none had progressed to a suitable end point by the end of this research.

B.2 Overview

WorkSafe programmes aim to reduce the incidents of harm occurring in New Zealand's workplaces, with a particular focus on:

- raising health and safety awareness – both risks and how to address risk
- improving industry capability and leadership in managing health and safety
- improving attitudes towards health and safety in the workplace
- ensuring workers have a voice/representation/participation in health and safety.

WorkSafe activities include some impacts on road transport safety (either directly or indirectly). However, while WorkSafe projects have a focus on safety, this does not always equate to road safety impacts. Nevertheless, these projects may be of interest to other agencies such as Waka Kotahi because in some cases they may present road safety benefits (both direct and/or co-benefits).

Road transport is important for almost every industry in New Zealand – whether it is the trucks that supply goods and materials for a business, or the moving of machinery between work sites or farms. All of these involve interactions with roads and road-users. Much of the WorkSafe focus on vehicle-related aspects of workplace health and safety is limited to private property and 'off-road' sites; however, those activities also present risks to road safety (eg, at access points to and from the publicly accessible road network).

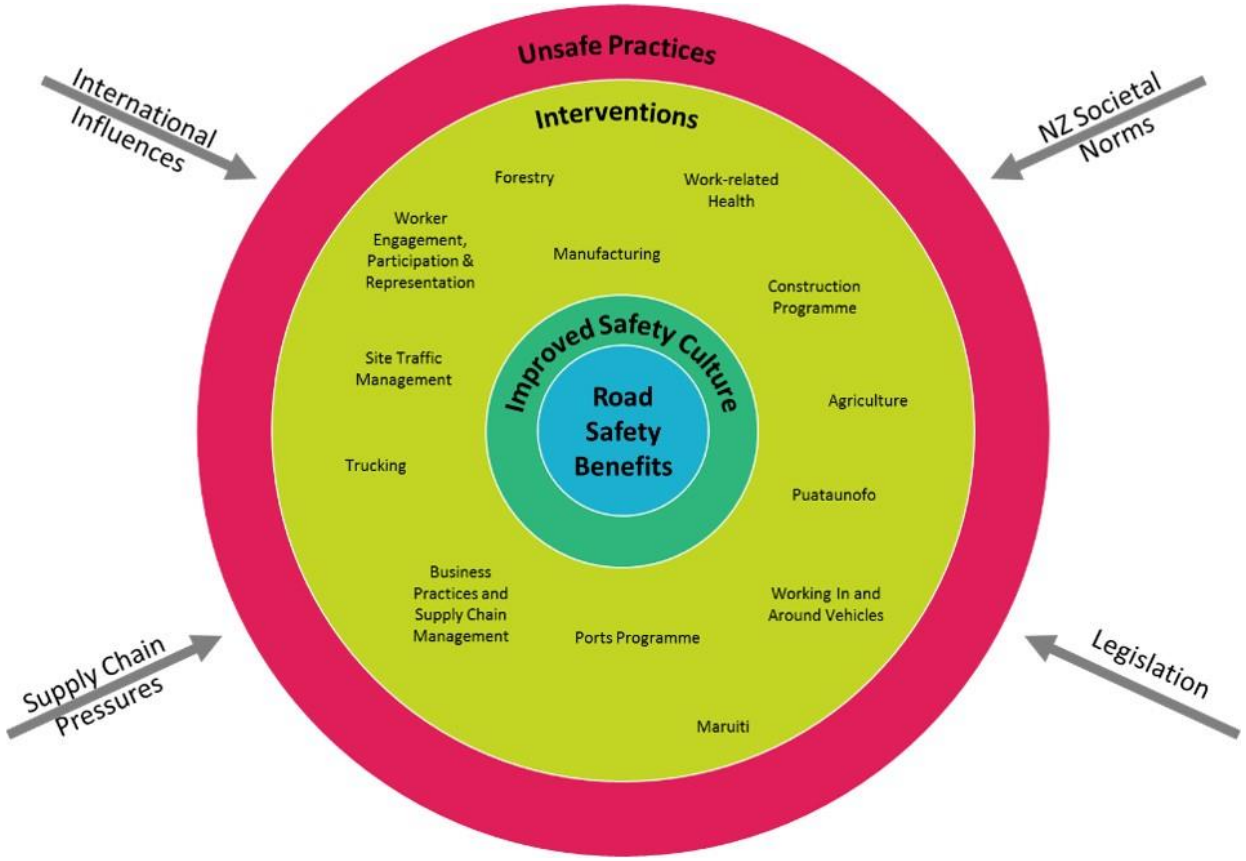
This section summarises some WorkSafe projects and their potential road safety co-benefits. An illustration of the range of projects discussed in this section and some key influences is shown in figure B.1.

The overarching vehicle-based programme, Working In and Around Vehicles, presents direct and co-benefits to Waka Kotahi. A number of programmes are under or related to Working In and Around Vehicles, including:

- site-traffic management
- seatbelts
- off-road/rugged terrain sites
- trucking
- business practices and supply-chain management.

Some of these programmes were identified as having potential road safety co-benefits and are included in this summary.

Figure B.1 WorkSafe interventions with potential road safety co-benefits



B.3 Industry programmes

B.3.1 Trucking

WorkSafe is in the early phases of developing a programme aimed at improving the health and safety of truck drivers in the trucking industry. At the moment, this work is in its initial stages of development. With the programme in an early phase, this could lead to successful identification and realisation of road safety co-benefits and may even present opportunities to partner with other government agencies to achieve this.

Whilst trucks are involved in fewer road accidents than light vehicles, the severity of the accidents in which they are involved is greater than that of light vehicle only accidents. A research scan conducted by the Centre for Automotive Safety Research and the University of Adelaide included discussion of problem areas impacting truck and road safety (Raftery et al 2011). Human and social factors were included in the scan and Gillett (2008), cited in Raftery et al (2011), found that, on average, New South Wales truck drivers were working longer hours during the week compared to other full-time employees. The number of hours a truck driver worked was directly related to increased stress levels.

Raftery et al (2011) found that there are a number of general and mental health issues (including substance use) associated with heavy vehicle (HV) safety that are at least as common among HV drivers as amongst the wider Australian population. This presents an opportunity for road safety co-benefits to be realised alongside an intervention into the health and safety of truck drivers. Effectively addressing these issues would be of value for the HV industry and all other road users, and it would also improve the general wellbeing of HV drivers themselves.

The key influencers in the system who may make the greatest impact in realising the potential co-benefits on road transport safety would be the truck drivers themselves, those in leadership positions in the trucking industry, and WorkSafe.

B.3.2 Ports programme

A programme is in place to improve the safety of operations at ports across New Zealand. This is looking at improving the overall health and safety of ports in New Zealand, which potentially would include road transport interactions (eg, vehicles entering ports). Numerous influences on safety have been identified, but one area of potential road safety co-benefits is the effects of port operational delays on road transport operations. Similar to what is discussed in section B.5.3 below in regard to supply chain management, delays in the supply chain may place pressure at other points of the operation. Such pressures can lead to speeding and other unsafe behaviours on the road.

For port operations, port leadership has the greatest ability to influence potential impacts on road safety.

B.3.3 Agriculture

Agriculture is one of New Zealand's largest industries. While most agricultural activities take place off road on private property, some programmes to improve safety in agriculture have potential co-benefits for road safety. Examples are:

- **Access**: Trucks and light vehicles come and go from agricultural land to bring supplies or to take produce to market. Farm access points may be in poor condition or poorly sited, both of which introduce hazards for other road users.
- **Occasional Road Use**: Farm vehicles such as tractors travel between farms, are not primarily designed for road use, and need to interact safely with all other road users.

Road safety co-benefits may be realised with an improved culture towards farm vehicle safety as well as greater care at access points between roads and farms.

Figure B.2 Example of an agricultural road hazard

B.3.4 Construction programme

With many large building projects underway and upcoming in New Zealand, WorkSafe has safety initiatives in place to ensure that these builds progress without incident. Often worksites use part of the public road to receive building materials. Opportunities for co-benefits include:

- **travel to site**: initiatives to get workers to and from the workplace safely each day
- **site access**: safe operation of machinery and vehicles by the access points between worksites and public roads.

Primary responsibility for worker safety rests at the director and leadership level of construction companies. Alongside encouraging and informing construction companies about workplace safety, WorkSafe also inspects construction work sites.

B.3.5 Forestry

Forestry is a large industry in New Zealand. Whilst safety has improved, WorkSafe has ongoing programmes aimed at further improvements to safety performance in the forestry sector. Forestry organisations generally operate on their own network of private roads. Intersecting issues with road safety are magnified by the large scale of equipment used in forest harvesting operations, including:

- **access points**: positioning, geometry and signage of transition points to and from public roads
- **compatibility**: use of small public roads by logging trucks and other heavy forest haulage vehicles
- **fatigue**: effects of long shifts with often heavy work on the alertness of drivers commuting to and from the work site
- **alcohol and other drugs**: effects of impairment at the worksite and in travel to and from the site.

Part of the strategy is the enablement of workers and ‘persons conducting a business or undertaking’ (PCBUs) through better risk identification and mitigation to identify safety issues and correct them where they can. There is also a range of improvements that are the responsibility of the forestry company leadership level, including leading cultural transformation in the industry, setting realistic production targets, ensuring that worksites don’t entail excessive travel for crews, efficient scheduling of log transport operations, and improvements to intersection geometry and signage.

Figure B.3 Example of a forestry worker interacting with a vehicle on the worksite

B.4 Targeted programmes

B.4.1 Maruiti

WorkSafe has developed a programme to address a disproportionate impact on Māori in workplaces. The Maruiti 2025 strategy aims to work with whānau and local Māori communities to achieve a healthier and safer home and work–life balance in order to reduce Māori workplace injury, health and fatality impacts to a level equal to or lower than non-Māori rates by 2025.

A successful programme is likely to have road safety co-benefits arising from raised awareness of safety, reduced fatigue and improved work–life balance.

B.4.2 Puataunofo

Puataunofo is an initiative that aims to improve the general attitudes towards safety amongst immigrant workers from the Asia-Pacific region. These workers operate across many industries, with some work being done on or alongside public roads.

There is potential for road safety co-benefits from this programme through improving the safety attitudes and awareness of these workers.

Primary actors in such programmes are cultural leaders and community groups as well as WorkSafe and the Ministry for Business, Innovation and Employment.

B.5 Other programmes

B.5.1 Worker engagement, participation and representation

While businesses, directors and workers have their own responsibilities in order to comply with the Health and Safety at Work Act 2015, the worker engagement programme aims to empower workers to speak out about safety at the workplace. This involves encouraging people to think about the work that they are undertaking and ensuring that any potentially unsafe practices are identified with those in leadership positions listening and taking into account the worker's concerns. This is a broad safety intervention and, while it does not specifically target road safety, there are workplaces in which this programme may have positive impacts on road safety. For example, farm workers may be empowered to consider where and when they are driving quad bikes and/or tractors on public roadways and the potential risks involved – depending on conditions such as the weather or traffic.

A key area of this programme is engaging with worker groups and representatives across sectors and working with them in order to promote improved attitudes towards health and safety, and their involvement in related discussion in the workplace. The primary actors in this case are both the workers exposed to the risks and those in leadership positions overseeing their work.

B.5.2 Site-traffic management

For some industries, transport and vehicle use mainly occurs on private property or on private roadways where there are workers on the ground as well as operating machinery or vehicles – this project looks to ensure safe interaction between vehicles, plant, workers and infrastructure.

However, one aspect of site-traffic management is the transition between the worksite and the public roadway. For example, worksites alongside busy highways may elect to manage the risks to both workers

and public road users at the transition point between the site and the roadway by only allowing left-hand turns out of the site to prevent works vehicles from having to cross both lanes of relatively high-speed traffic.

The primary actors in the interaction with road transport safety are the workers operating the works vehicles across the transition point between the worksite and a public roadway.

B.5.3 Business practices and supply chain management

WorkSafe has identified business practices and supply chain management as a key influence on attitudes in relation to safety in the workplace. Poor management of the supply chain may lead to unnecessary pressures for workers, which may lead to unsafe outcomes. For example, in the trucking industry some truck drivers may not be paid for time spent idle at either end of the supply chain or in some cases may have unrealistic expectations placed on them to get the goods from one site to another. This pressure to meet expectations may lead to poor decisions such as speeding on public roads, which risks not only the safety of the truck driver but also other road users.

As parts of the supply chain occur outside of the workplace and on public roads, this programme could have significant road safety benefits, both directly and in terms of co-benefits. Such co-benefits may be realised through partnerships with other government agencies such as Waka Kotahi, the Ministry of Transport, and New Zealand Police. These agencies and those in leadership positions in the workplace are all primary actors in ensuring the business practices and supply chain management are operating such that safety is a priority.

B.5.4 Work-related health

WorkSafe has an active programme focused on worker health. Many worker health initiatives also have co-benefits for road safety. The following are three work-related health risks in focus:

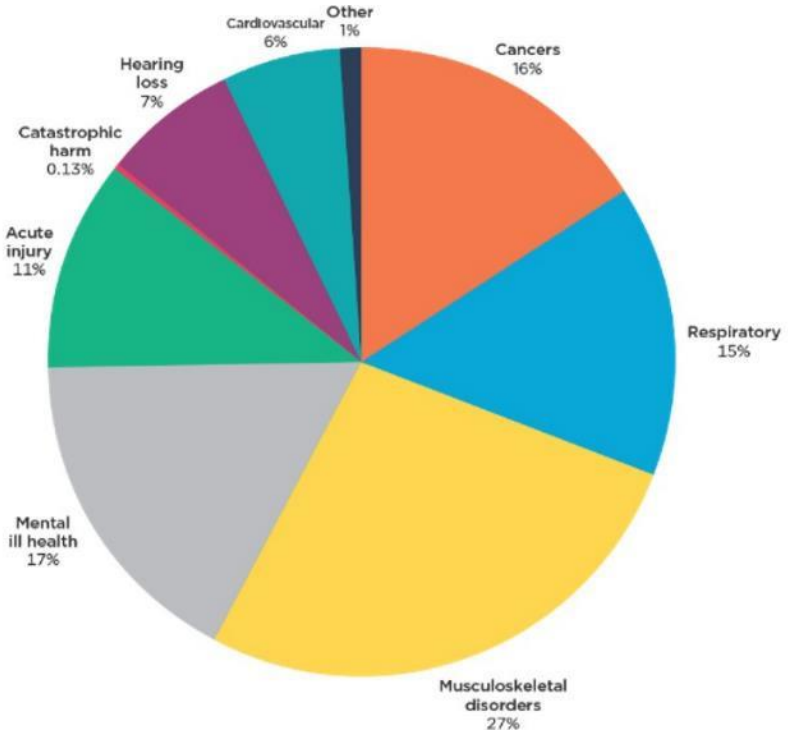
- carcinogen and airborne risks
- musculoskeletal disorders
- psychosocial risks/mental health harm.

The targeted programme outcomes include:

- improving the knowledge/understanding of work-related harms and effective approaches to reducing them
- strengthening WorkSafe programmes
- improving PCBU maturity – identifying and managing health risks
- leveraging cross-sector partnerships to address work-related health risks.

Truck drivers can experience a great deal of vibration from the engine. This may give rise to musculoskeletal disorders, which are usually identified as a health issue. They are the single largest contributor to the work-related disease burden (27%) (figure B.4; WorkSafe 2019) and share similar risk factors for poor outcomes from psychosocial risks. Musculoskeletal disorders also affect the ability of drivers to work safely. Similarly, other health issues such as psychosocial risks (which contribute not only to mental health but also to musculoskeletal disorders), cardiovascular disease, cancer, and mental ill health (which makes up 17% of the work-related disease burden) (figure B.4; WorkSafe 2019), play an important part in the ability of a driver to operate safely.

Figure B.4 Disease burden estimates from work-related injury and ill-health (Source: WorkSafe 2019)



Studies have shown the effect that some of these conditions have had on HV drivers in the United States and Australia. For example, severe and very severe depression was associated with an increased risk of being involved in a crash or near miss in the past 28 days by 4.5 and 5 times respectively (Hilton et al 2009). Gillett (2008), cited in Raftery et al (2011), found that in New South Wales, 13% of truck drivers were found to have some degree of depression; 91% of these were not in treatment. Heavy goods vehicle drivers were also found to have substantial barriers to treatment. Being divorced increased the odds of a driver being depressed or experiencing symptoms of anxiety. Twenty-seven percent of New South Wales truck drivers were identified as having the potential for hazardous or harmful alcohol use. Twenty-four percent were considered mild and 1% were in the highest risk category. Alcohol use was significantly related to anxiety levels. Mild to severe alcohol use also increased the risk of crashing. Depression symptoms had the largest effect on risk of crashing or having a near miss.

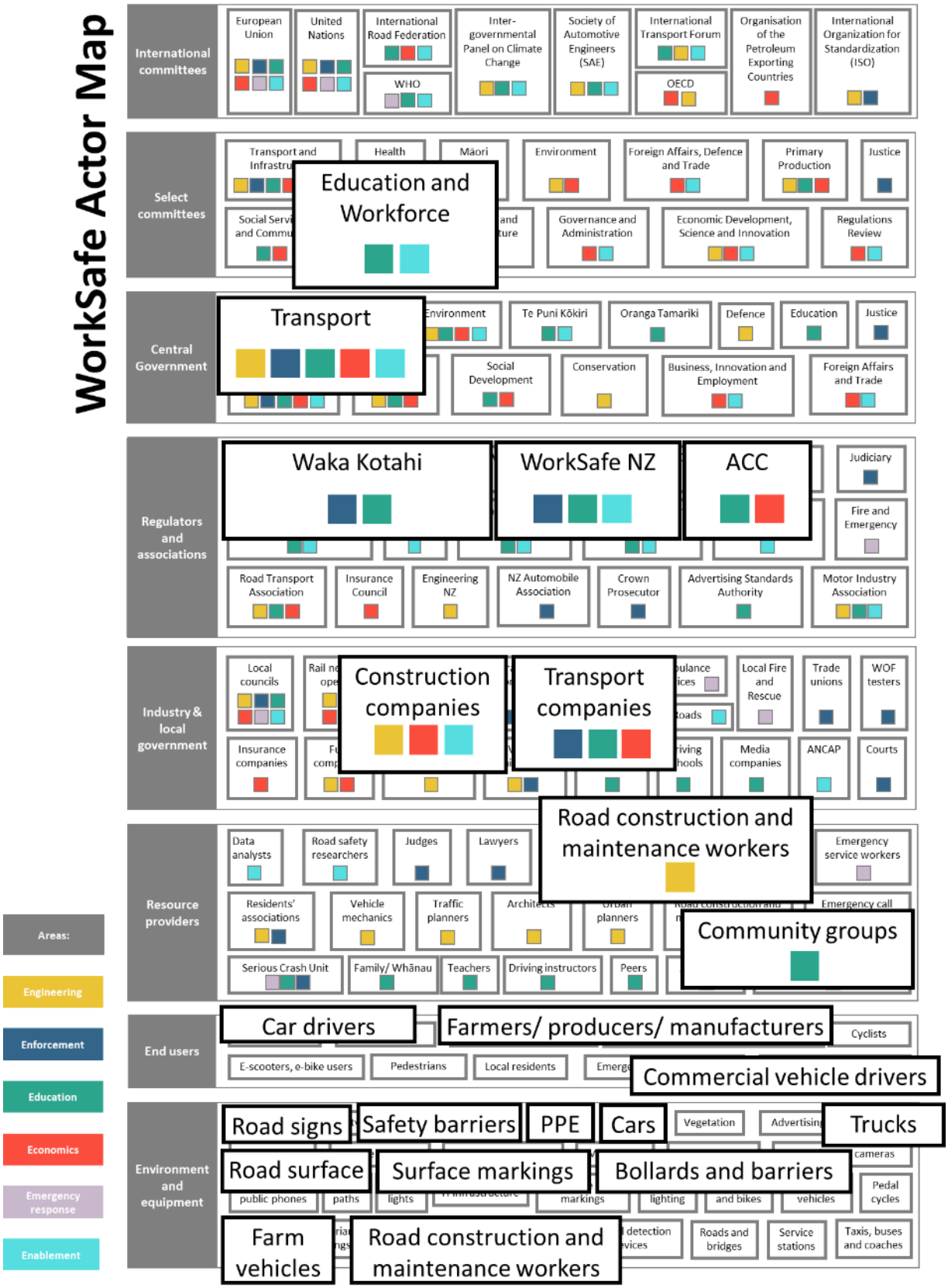
Reducing or eliminating these conditions from workplaces has co-benefits across health and work productivity but particularly in the ability to operate vehicles in a safe and responsible manner.

Primary actors in work-related health are both transport leaders and drivers. Key government agencies include WorkSafe and the Ministry of Health. The New Zealand Defence Force, as the operator of a significant trucking fleet, has a key role within its own operations.

B.6 Disclaimer

This information has been compiled through a high-level scan of developing WorkSafe health and safety initiatives and does not include all current or upcoming WorkSafe activities. To confirm all potential direct benefits and co-benefits for road safety, further engagement with WorkSafe would need to occur to confirm the full range of interventions/activities underway, the underlying logic and expected outcomes from those activities, and the full-range of potential impacts for road safety.

Figure B.5 Actor map of primary actors in relation to potential road safety co-benefits in WorkSafe programmes



Appendix C: Other interventions inventory

Intervention	Owner	Reason not explored
Car-less tourism	Local government bodies	No clear government agency involvement.
E-road devices in agency-owned vehicles	New Zealand Defence Force	Road safety was determined to be a primary benefit.
Effects of mental health on driving ability	Ministry of Health	Limited intervention information available.
Rehabilitation of drivers with addiction issues	Ministry of Health	Limited intervention information available.
Domestic violence interventions	New Zealand Police	Low ratings in all three selection categories outlined in section 2.3.
Illegal activity in trucking	WorkSafe New Zealand	Included in Appendix B.
Christchurch rebuild – urban planning	Christchurch City Council	Transport funded and hence considered a roading initiative.

Appendix D: Literature review

A cross-portfolio consideration of interventions impacting transport safety outcomes

Literature review

October 2019

C Cunningham, M Trotter and K Oldham

Waka Kotahi NZ Transport Agency research report TAR 18-06
Contracted research organisation – Navigatus Consulting Ltd

Executive summary

Many public sector portfolios share the aim of improving safety by reducing accidental injuries or deaths. Waka Kotahi NZ Transport Agency (Waka Kotahi) seeks to move beyond this siloed approach by adopting a systems perspective to address complex sociotechnical challenges.

The research seeks to find commonalities between identified intervention mechanisms to develop a cross-policy intervention logic for road safety, with the ultimate purpose of demonstrating how this intervention logic can inform future road safety interventions and support business case evaluation.

This literature and framework review represents the first project deliverable, based on phase 1 of this project. This phase addressed research question 1: Which sectors have policies that are likely to impact on road safety in New Zealand? To do so, it looked at two subsidiary questions:

- What linkages have been identified through government and sector-wide frameworks and systems?
- What policies and interventions does international literature say impact road safety?

The nature of this review makes it challenging; it was guided by Rasmussen's Risk Management Framework and Research Performance logic mapping, in which the output of one research activity constitutes the input for another research activity and so on until reliable results are produced.

A number of themes are identified below, and key takeaways are outlined from the review.

Improvement in coordination

Political support for policy initiatives may be greater when they offer improvements for multiple areas, such as combining transport safety with health or land-use development.

A number of these areas are outlined in this literature review; in particular, the role of transport safety as an important determinant of health. Links such as this can be utilised to achieve better outcomes for multiple sectors, including transport.

Packages of policy levers are generally more effective than a single instrument; however, the interaction between different goals makes establishing an effective transport policy difficult.

Better coordination and interdisciplinary research are needed.

National policy need

National policy would likely be needed to reconcile conflicting goals, as well as regional or city-based initiatives.

Future-focused policies and frameworks

The policies and frameworks need to enable adaptation to, and planning for, future challenges, such as those posed by new in-vehicle technology that will emerge in the next 50 years. They should be regularly reviewed for relevance and adaptability.

Strength of interdisciplinary approaches

Learnings from other disciplines can be borrowed and successfully adapted and applied to transport safety.

For example, inequities in transport are high, and there would be value in using a public health lens to approach these inequities.

Interaction of multiple harm reduction strategies, shared knowledge, intersectional initiatives, and multi-level approaches strengthens success.

A public health lens would implement a systems approach, where policy, the built environment, and culture are also considered together.

Multi-level approaches

Communities can be an important driver of change.

Company initiatives may be more impactful when undertaken in collaboration with government because new behaviours can be normalised more effectively when they are influenced by multiple sources in multiple ways.

Understanding of human factors

Psychological factors need to be understood to comprehend transport outcomes for people.

Stages of behaviour change need to be understood (ie, the steps that users will need to move through to get to the desired behaviour).

The behaviour change wheel can be used to link individual behaviour change to intervention and policy design. It has been applied in multiple domains and is arguably the most useful of the individual behaviour change models due to it linking individual behaviour to government-level factors.

We developed an actor map for New Zealand's transport system, which will provide further insight for informing participation in the proposed workshops. Based on the review findings, a list of key portfolios and agencies to involve in the following stages of the research was drafted for discussion with the project steering group. Following this discussion, the following list of participants was agreed.

Highest priority	Medium priority	Lower priority
• Waka Kotahi • Ministry of Transport • Ministry of Health • Ministry of Housing and Urban Development • Ministry for the Environment • Te Puni Kōkiri • Local Government New Zealand • Accident Compensation Corporation • WorkSafe New Zealand • Department of Conservation	• New Zealand Police • Fire and Emergency New Zealand • Ministry of Education • Ministry of Social Development • New Zealand Defence Force	• Oranga Tamariki • Alcohol Regulatory and Licensing Authority • Ministry of Business, Innovation and Employment • Ministry for Primary Industries • New Zealand Treasury • Department of Corrections

Abstract

Many public sector portfolios share the aim of improving safety by reducing accidental injuries or deaths. This research seeks to find commonalities between intervention mechanisms across portfolios to develop a cross-policy intervention logic for road safety. This literature review identifies which sectors have policies that are likely to impact road safety in New Zealand in order to recommend participants for in-depth workshops later in the project. To do so, it examines what linkages have been identified through government and sector-wide frameworks and what policies and interventions literature suggests could have spin-off benefits for road safety. Looking for potentially unintended effects of interventions outside the transport domain made this review challenging. Similar cross-policy reviews have not been conducted internationally. Key themes to emerge included the need for improvement in the coordination of national policy, the strength of interdisciplinary and multi-level approaches, and the importance of the understanding of human factors. Health, urban planning and the environment emerged as key policy areas likely to cross over with transport. Agencies identified as the highest priority for a more detailed investigation of policies in a workshop include the Ministry of Transport, Ministry of Health, Ministry of Housing and Urban Development, Ministry for the Environment, and Te Puni Kōkiri.

D.1 Introduction

Many portfolios within the public sector share the aim of improving safety by reducing or eliminating accidental injuries or deaths, including health, housing and workplace safety. This aim is shared by the transport portfolio. To date, there has been a tendency for each portfolio to focus on this challenge within its own silo; however, Waka Kotahi has sought to move beyond this siloed approach in addressing complex sociotechnical challenges by adopting a systems perspective. As part of this, Waka Kotahi is looking to reach out to other portfolio domains such as health, housing, and occupational safety that share a safety objective. While policy and/or operational interventions in these domains will be aimed at objectives outside the transport portfolio, they may have spillover effects on transport safety that Waka Kotahi can learn from and harness. For example, changes to emission level requirements for vehicle imports may have a primary aim of reducing New Zealand's carbon footprint, but may also benefit road safety by improving the average age and safety rating of New Zealand's vehicle fleet.

This research project aims to identify interventions across all government policy domains that impact on road safety and the mechanisms through which this impact occurs. The research will seek to determine commonalities between the identified interaction mechanisms in order to develop a cross-policy intervention logic for road safety, with the ultimate purpose being to demonstrate how this intervention logic can inform future road safety interventions and support business case evaluations. Figure D.1.1 summarises the specific research questions and techniques aimed at achieving this purpose.

Road safety, as used in this project, refers to the safety of all road users, including drivers, passengers, public transport users, motorcyclists, cyclists and pedestrians. It relates to the ability of all road users to remain free from death, serious injury, near misses, disability or economic hardship resulting from road use. This project is focused on all roads under the mandate of Waka Kotahi, including state highways and local and rural roads, as well as roads owned by the Department of Conservation, New Zealand Defence Force and forestry companies where there is an opportunity for public access.

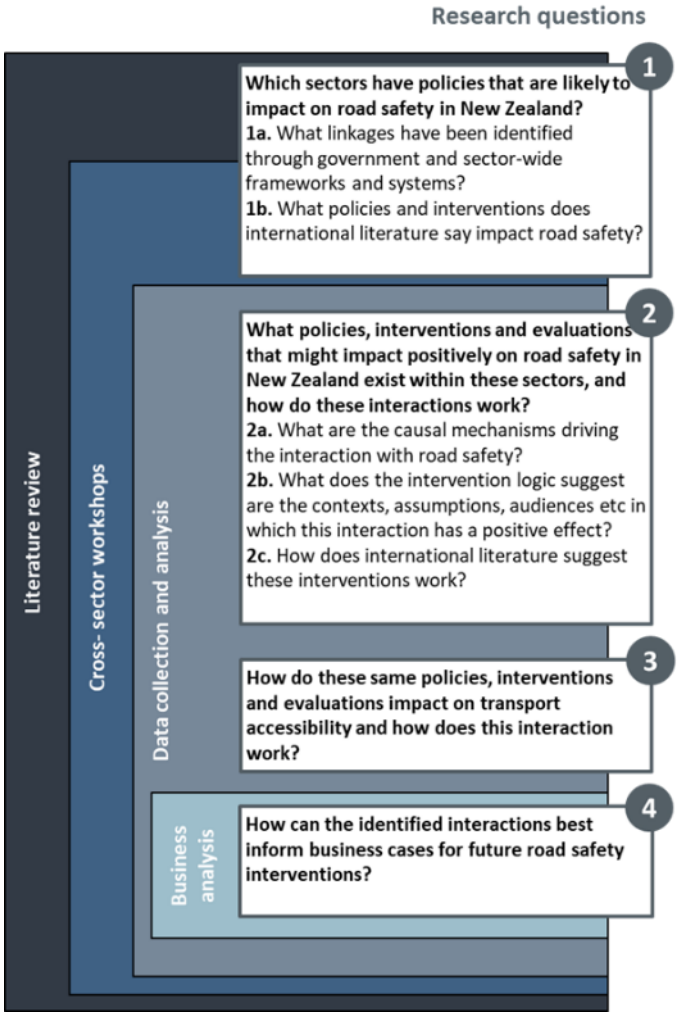
This literature and framework review represents the first project deliverable, based on phase 1 of this project. This phase addressed research question 1: Which sectors have policies that are likely to impact on road safety in New Zealand? To do so, it looked at two subsidiary questions:

- What linkages have been identified through government and sector-wide frameworks and systems?
- What policies and interventions does international literature say impact road safety?

Phases 2 to 4 will be documented in the final report in March 2020.

This review is based on the premise that transport is a complex sociotechnical system, and thus road safety is a systems phenomenon (Larsson et al 2010; Salmon et al 2012; Hughes et al 2016). The review is structured around a system-based framework for the review of such systems. This premise is explored in the following section.

Figure D.1.1 Project structure



D.1.1 Road safety as an emergent property of a complex sociotechnical system

Treating significant distributed infrastructure such as the transport network as a sociotechnical system is increasingly being recognised as valuable where decisions are made across geographies, jurisdictions, organisations, relationships (formal and informal) (Öberg et al 2016) and multiple levels (Rijke et al 2013). Systems thinking has led to advancements in safety in other hazardous sociotechnical systems such as aviation, mining and the nuclear industry (Larsson et al 2010). Sociotechnical systems are those that comprise a social subsystem (humans – as individuals and as part of teams – and the systems and structures through which they are coordinated) interacting with a technological subsystem (hardware and technical processes) for a purposeful reason (Walker et al 2008; Robertson et al 2015; Carden and Salmon 2016). The transportation network in New Zealand can be considered a sociotechnical system because it involves human and organisational components (eg, politicians, business owners, vehicle operators) as well as technology (eg, vehicles, information technology applications, roading, rail lines, bridges) working towards the shared goal of effective and safe mobility.

Systems phenomena such as safety, resilience and effectiveness emerge from the interactions of elements across the system (Robertson et al 2015). The impacts of these interactions propagate up and down the system levels, meaning governance decisions have an influence across all levels of the network (Cassano-Piche et al 2009). When investigating systems phenomena, actors and influencing factors are therefore considered as interdependent components of a whole, and no element is considered in isolation (Klein 2014).

The systems approach is increasingly the dominant paradigm in cutting edge road safety research. Many research groups across the world are applying this philosophy, focusing on how components across systems levels synergistically work together. Among multiple examples are Hughes and colleagues (Hughes et al 2015; Hughes et al 2016), and Salmon and colleagues (Salmon et al 2010; Salmon et al 2012; Salmon and Lenné 2014), as well as Larsson et al (2010) and McIlroy et al (2019). This is in contrast to a siloed approach, which has been commonly employed to date. Logistically, implementing interventions within portfolios can be simpler; however, deaths and serious injuries continue to occur on the road in New Zealand and internationally. A new approach is needed to continue on the road to zero harm to road users. The systems approach provides an opportunity to improve safety.

Adopting a systems-based perspective allows policy decisions to be considered within the context of the system as a whole, providing a multi-faceted understanding. This better enables the identification of opportunities where interactions can be improved or strengthened for a wide impact on the performance of the system overall (Trotter and Ivory 2019).

D.1.2 Systems frameworks

Looking for interactions across a portfolio of sectors inherently incorporates a systems perspective; however, the systems approach can be integrated further by considering impacts on road safety. Impacts on all aspects of the road user system need to be considered – those related to the road user themselves, as well as to the road infrastructure, the vehicles, and organisational aspects, such as road management, road safety audits, and safety culture. These impacts themselves may be interlinked (Salmon and Lenné 2014).

For example, drug driving is considered to be a road-user behaviour, but drug use is correlated with kinship and social norms. These same behaviours lead to demands on government resources across the whole spectrum of agencies, including social housing, health and justice. An intervention that successfully reduces drug-related risk-taking by addressing its health effects may also have significant co-benefits for the transport sector. In an in-depth look at the ‘fatal five’ driving behaviours in Queensland based on systems control structure modelling, Salmon et al (2019) found that drug-driving behaviour was influenced by factors across the system. At the parliamentary and legislative level, drug driving was less of a government priority than other behaviours. At the government agency, user group, industry association, court and university level, there was a failure to gain support from unions for testing, a disconnect between occupational health and safety regulations and work-driving incidents, a lack of research on safe limits, and financial constraints around enforcement. At the operational delivery and management level, there was an absence of testing by employers and financial constraints around enforcement. At the local management and supervision level, there was inadequate enforcement. And at the operating process and environment level, there was a lack of affordable public transport. This demonstrates how an intervention designed to address a problem transport behaviour requires a coordinated network approach.

Another example is speeding, which is considered a road-user behaviour, but can also interact with road infrastructure and the vehicle itself. Therefore, it may be impacted by policies affecting these. For example, vehicle import requirements may have a flow-on impact on safety by requiring technologies such as advanced emergency braking systems and other pre-collision systems as standard.

A number of models exist for system-based analysis of complex sociotechnical systems, including Rasmussen's (1997) Risk Management Framework (eg, Svedung and Rasmussen 2002; Cassano-Piche et al 2009; Jenkins et al 2010; Salmon et al 2010), Leveson's (2004) Systems-Theoretic Accident Model and Processes (STAMP) (eg, Ouyang 2010) and Dekker's (2018) Drift into Failure model. Some models are associated with a distinct analysis method. Accimap, a generic approach used to identify and link contributory failures across six sociotechnical system levels, accompanies Rasmussen's Risk Management Framework, while the Causal Analysis Using Systems Theory process model, adapted from Leveson (2011) and based on the STAMP, uses control theory and systems dynamics methods to describe the systemic control failures involved in a system. Although all systems models are underpinned generally by a systems approach, there are significant differences in terms of theoretical underpinning, the methodological approach adopted, and the outputs produced.

D.1.2.1 Rasmussen's Risk Management Framework and Accimap

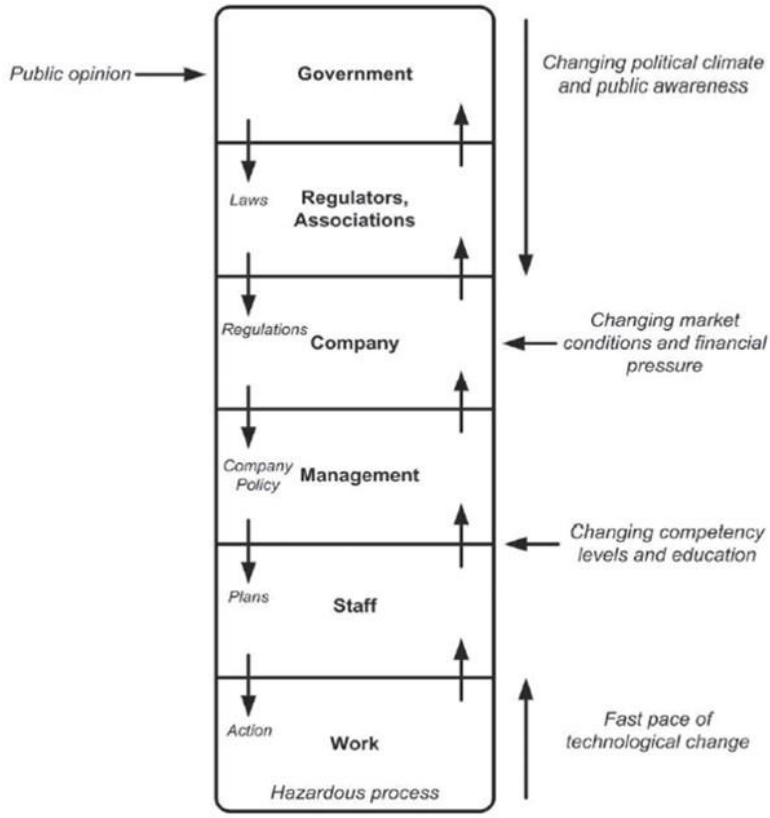
In analysing how policies impact road safety, the Navigatus team systematically considers impacts on each aspect of the roading system and the potential interactions between these, guided by Rasmussen's (1997) Risk Management Framework. Of the methods described above, this has the greatest number of road safety applications to date. It also provides a generic framework around which to structure investigations. This framework has already been adapted and applied successfully to examine the transportation system in New Zealand, so its use here enables us to build on this previous work (Blake et al 2019; Trotter and Ivory 2019).

Rasmussen's framework is particularly useful for considering complex networks such as transportation because of its all-encompassing structure, which consists of six systems levels, as shown in figure D.1.2. These levels have been adapted specifically for the New Zealand transport system in previous projects using the Accimap methodology for the Ministry of Transport. The levels are presented below, along with examples of actors from the New Zealand transport system at each level.

1. Government policy and budgeting (eg, politicians, ministries, National Crisis Management Centre, Waka Kotahi, Maritime New Zealand).
2. Regulatory bodies, associations, advisors and advocates (eg, Road Transportation Forum, Cycling Action Network, Federated Farmers).
3. Local area government, company management, planning and budgeting (eg, local government politicians, councillors, rail companies, road companies, shipping companies, fuel companies, engineering consultants, health organisations, Lifelines).
4. Technical and operational management (eg, contractors, utility coordinators, Road Network Management Alliance).
5. Actor activities and processes, including decision making and behaviours (eg, drivers, cyclists, engineers, designers, construction workers, farmers/producers, retailers).
6. Infrastructure and environment (eg, state highways, regional roads, vehicles, information technology, farms, factories, construction materials/equipment).

The framework focuses on interactions and emergence, so systems phenomena such as safety are viewed as emergent properties arising from the interactions between activities at different levels of the system. Changes at one level propagate throughout the system via these interactions, having both intended and unintended effects. This review focuses on identifying, where possible, the logic pathways through which unintended impacts on transportation safety may occur. Logic modelling is described briefly below.

Figure D.1.2 Rasmussen's Risk Management Framework (Source: Rasmussen 1997)



D.1.3 Logic modelling

Logic modelling is key to bringing together planning, evaluation and action within any sector (WK Kellogg Foundation 2001; Rohwer et al 2017). Logic models provide a 'map' by which programme rationale can be tested and confirmed in a rigorous and systematic way and help ensure decisions and investments are evidence-based and compelling (New Zealand Treasury 2019).

Two types of intervention logic modelling are important in relation to this project: Activities Approach and Research Performance. Activities Approach logic modelling maps how activities developed from available resources link to desired outcomes, while Research Performance logic modelling is non-linear and includes links from activity outputs back to inputs. The latter drives the literature review and framework review processes reported on in this review. The former will guide document review and inventory construction processes to come in phase 3.

D.2 Review method

This review aims to identify and examine research and intervention logics from areas outside of transportation that may have inadvertent impacts on road safety. The findings will indicate the portfolios that will be of most use to include in the major data collection phase of this project – the cross-portfolio workshop.

The nature of this review makes it challenging, in that the relationships and interactions with transport that this review is seeking to identify are, by definition, unintended or unrecognised within their domains, and as such, they are not reported on to a useful extent in academic research papers. This being the case, a systematic literature review method – searching a list of keywords in key journals – was not possible. Instead, the review process was guided by Research Performance logic mapping, in which the output of one research activity constitutes the input for another research activity and so on until reliable results are produced (WK Kellogg Foundation 2001).

Searches were conducted from within scientific literature using the following databases, as well as through websites of transport authorities in other countries, where these had English translations (predominantly, US, UK, Ireland, Australia, Canada, and EU-wide programmes):

- ScienceDirect
- Scopus
- ProQuest
- Google Scholar
- Academic OneFile
- Web of Science
- JSTOR
- SAGE
- EBSCOhost
- Taylor & Francis Online

Instead of beginning with papers identifying interventions in other sectors where outcomes have impacted road safety (or transport), due to their scarcity, the review used a ‘reverse engineered’ process following these steps:

1. We conducted an initial search for system-wide policy reviews identifying cross-sector interactions with road safety or other transport policies similar to this project, which revealed few similar pieces of work internationally. Key terms for this search were cross-sector review, cross-sector learning, cross-portfolio review, cross-portfolio learning, multi-portfolio, systems-based policy, interagency review, and interagency learning.
2. The New Zealand Transport Outcomes Framework, released by the Ministry of Transport in 2018, was then used as the starting point to identify portfolios for further investigation.
3. Additional New Zealand frameworks linked to the Transport Outcomes Framework via a Ministry of Transport networking study were also examined to identify relevant portfolios.
4. These key portfolios identified above were then scrutinised for behaviour change logics and mechanisms, which were then tested for relevance to transport.
5. Where mechanisms were identified, they were grouped according to the systems analysis framework described earlier, then by domain, and key interactions were identified.
6. We then described the potential relevance of these interacting mechanisms for transport.

Based on the review findings, a list of key portfolios and agencies to involve in the following stages of the research was drafted for discussion with the project steering group.

D.3 Results and discussion

A preliminary search of the literature reveals that a system-wide policy review identifying inadvertent cross-sector interactions with road safety or other transport policies of the scale Waka Kotahi desires has not been undertaken in other countries, or at least is not evident within the extant literature. This speaks positively to the forward thinking of Waka Kotahi, and necessitates a creative bottom-up process to identifying key interactions and sectors. Looking at research efforts focused directly on transport, in New Zealand there have been recent efforts by the Ministry of Transport to involve multiple industry sectors in research on transport mobility and resilience (eg, Blake et al 2019). Likewise, in the United States a very recent study has applied a systems-based framework (the 7P framework) to the assessment of highway safety programmes across the country (Hughes et al 2019). Among many recommendations from this research, Hughes et al (2019) recommend the following actions, which align with this project:

- *maximizing the contributions of all relevant participants by stimulating participants who can positively contribute to road safety outcomes and minimize the effects of participants who can negatively interfere;*
- *adopting additional alternative policy tools that broaden the range of actions that can be applied. These may include economic incentives, developing Safety Culture and climate, or capability development and standards for participants with poorer skills and knowledge;*
- *identifying other component parts that can be influenced to improve road safety or counteract if they would result in adverse road safety outcomes. These could include aspects of the transport and land-use system, society or economic context including broader government policy;*
- *identifying and maximizing the positive relationships between participants, policy tools, components and outcomes and minimize the negative influences; and*
- *describing the outcomes or purposes of individual actions in addition to the SHSPs [Strategic Highway Safety Plans] as a whole, and for specific sectors (such as heavy vehicles, geographic areas, road user groups of participants).*

The European Commission's Safety CaUsation, Benefits and Efficiency (SafetyCube) Horizon 2020 project used a systems method incorporating multiple government and industry sectors to develop an innovative road safety Decision Support System. This aimed to enable policymakers and stakeholders to select and implement the most appropriate strategies, measures and cost-effective approaches to reduce casualties of all road user types and all severities (Filtness et al 2016).[7] Users of the Decision Support System are able to look up information, research findings and examples by searching for road safety risk factors, road safety measures, road user groups or accident scenarios. This overlaps with the aim of Waka Kotahi for this project; however, while SafetyCube is developed from transportation research, this project looks to draw on domains outside of this and the influences they may have on transportation safety.

In the absence of directly applicable policy reviews, this section describes the frameworks that already exist in New Zealand and points to interacting domains and factors across other domains that could impact transport. The latter are described below in a framework similar to Rasmussen's (1997) framework. Although each level of this framework was considered separately, to simplify reporting, the government and regulatory

[7] https://www.roadsafety-dss.eu/

levels are reported together, as are the company and management levels and individual and work levels. Where particular sectors provide useful examples, these are highlighted in subcategories.

D.3.1 New Zealand frameworks

The New Zealand Ministry of Transport has established a useful systems framework to serve as a starting point for identifying key sectors for further examination. The Transport Outcomes Framework (Ministry of Transport 2018a), shown in figure D.3.1, indicates that policies in the health and disabilities, environmental, economic and security sectors may impact on transport and potentially road safety. These sectors will be the first to be scrutinised in a review of national and international literature. In construction of the Transport Outcomes Framework, the Ministry of Transport also mapped the framework to others used across different government sectors (figure D.3.2). This mapping process revealed additional sectors for initial scrutiny, including housing, income and culture.

Figure D.3.1 The Ministry of Transport's Transport Outcomes Framework (Source: Ministry of Transport 2018a)

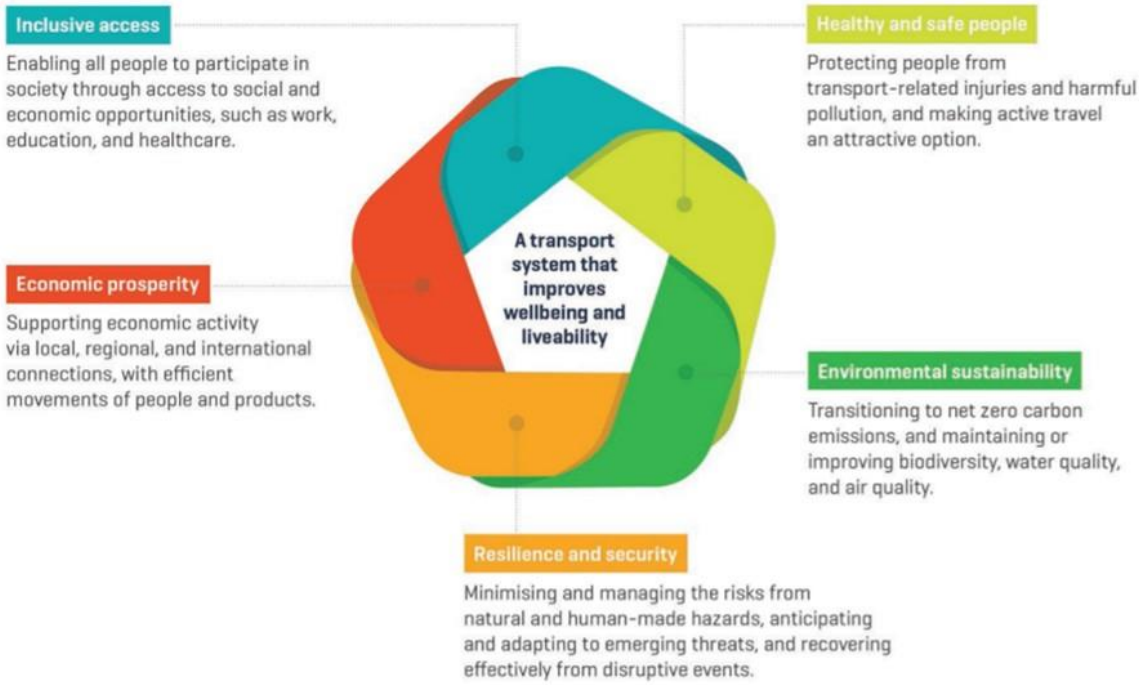
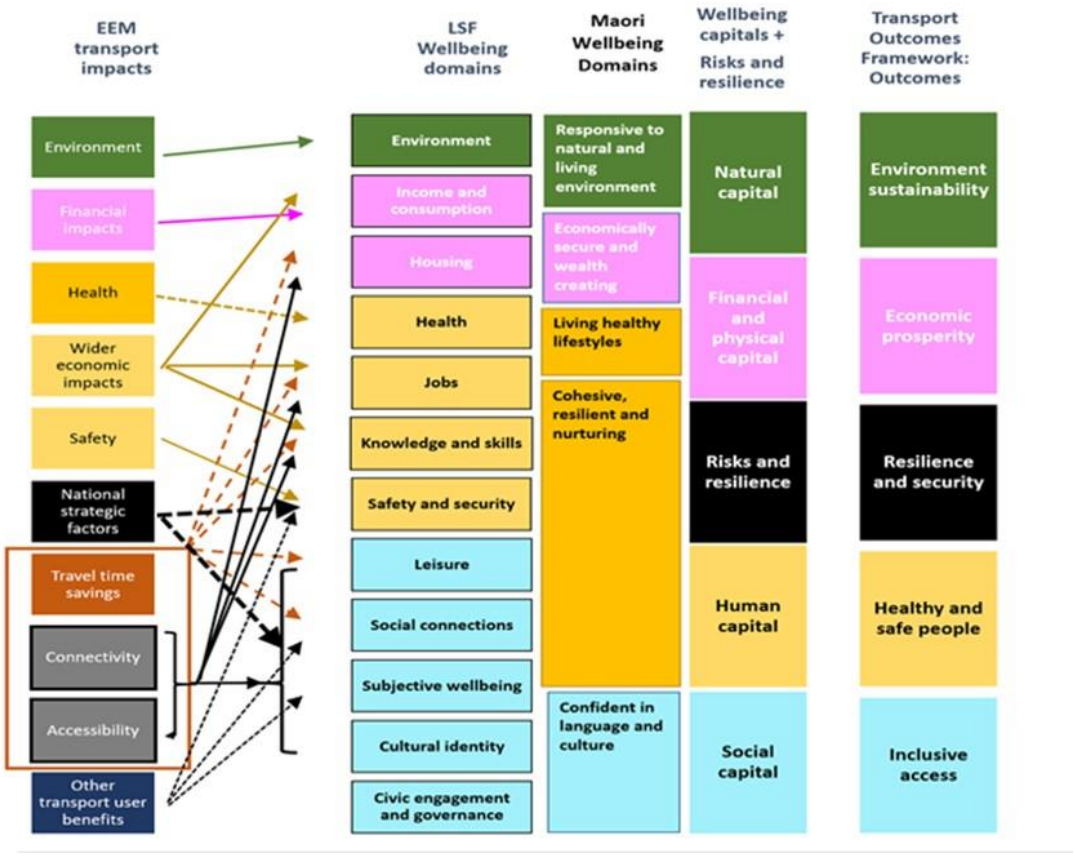


Figure D.3.2 Mapping of the Transport Outcomes Framework against other frameworks commonly used within New Zealand government departments (Source: Parr and Caruana 2018).



Note: EEM = Economic Evaluation Manual; LSF = Living Standards Framework.

D.3.2 Regulatory and policy levers

This section examines key policy levers available to government, including legislation and regulations, as well as policy drivers such as strategic plans, frameworks and targets. Key areas where inadvertent impacts on transport are likely to occur, as identified through the Ministry of Transport's mapping of relevant New Zealand frameworks, are included as sub-headings.

D.3.2.1 Urban planning

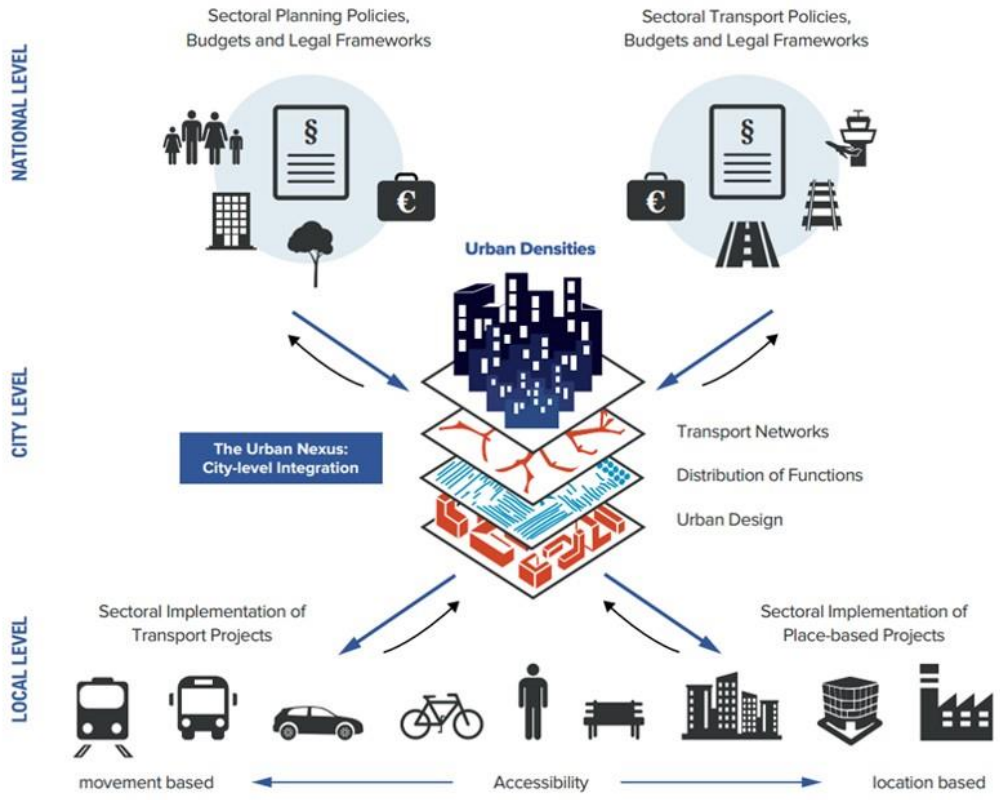
Policy is a critical component in delivering overall objectives (including environmental, cultural and social objectives) in urban planning (Ministry for the Environment 2010; Faherty and Morrissey 2014). Urban planning has widespread impacts on other sectors through many interactions: it impacts how materials and products move between people and areas, how people travel and work, and how organisations operate (Ellen MacArthur Foundation 2019).

More traditional planning policy levers, such as the use of zoning regulations, are used as planners seeks to minimise land-use conflicts and create stability (Minister and Elliot 2013). However, they obviously can result in subdivisions of similar uses, such as housing, and provide little variety. Areas of similar use can create a need to travel from home to meet basic needs (eg, commercial goods, healthcare and jobs). Smart Growth policies around the location and design of public facilities can help ensure important facilities are accessible by multiple modes, are affordable, and generate fewer automobile trips (Litman 2016).

Success factors in urban planning appear to be heavily influenced by how well different sectors have been integrated and considered in policy – like transport, housing and spatial planning (Gebetsroither-Geringer 2014). Additionally, integration of urban planning, transport and housing policy is considered necessary for improving health (Giles-Corti et al 2016).

Figure D.3.3 provides an example of how policy can often be siloed at a national level, with horizontal integration only taking place strongly at a city level (Rode 2016).

Figure D.3.3 Example of national-level policy silos and city-level policy integration from Rode (2016)



Two examples of regions that have taken a more integrated approach through their policy are:

- **California:** California requires regulatory approval of plans to align housing, spatial planning and transport targets under a 'Sustainable Communities Strategy' (meeting greenhouse gas emissions reduction targets) (Rode et al 2017).
- **South Africa:** South Africa has an 'Integrated Urban Development Framework', which compares housing, spatial planning and transport objectives in developing its overarching urban development objectives. The objectives are spatial integration; inclusion and access; growth; and governance. Each policy lever in the framework identifies opportunities and challenges for reaching the objectives (Rode et al 2017).

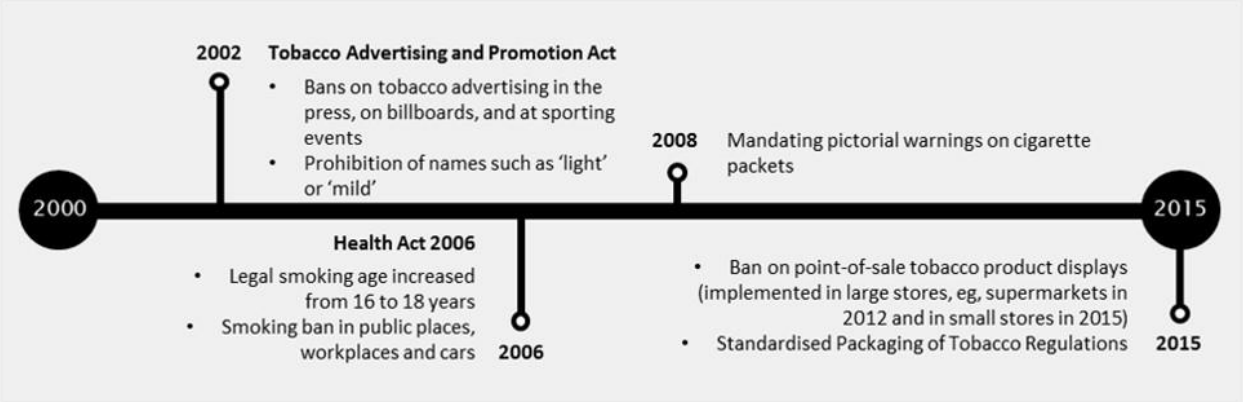
In New Zealand there appears to be a lack of higher strategy regarding land-use requirements, particularly the interaction that planning has with transport sustainability and environmental outcomes (Chapman et al 2017). A discussion document for a proposed National Policy Statement on urban development aims to address this (Ministry for the Environment 2019). Improved coordination between levels of governance (local and central) may lead to improved outcomes.

D.3.2.2 Health

Policy is used extensively to try to improve health outcomes. Policy tools that are more successful appear to be those that are based on social science research (Public Health England 2018). An example of successful policy approaches to health is the reduction in smoking and tobacco-related harm.

Figure D.3.4 shows a series of policies implemented in the United Kingdom from the early 2000s that have led to a decrease in smoking. Similar approaches have been taken in many countries, and stigma about smoking has increased (Riediger and Bombak 2018).

Figure D.3.4 Policy levers implemented in the United Kingdom to reduce tobacco harm



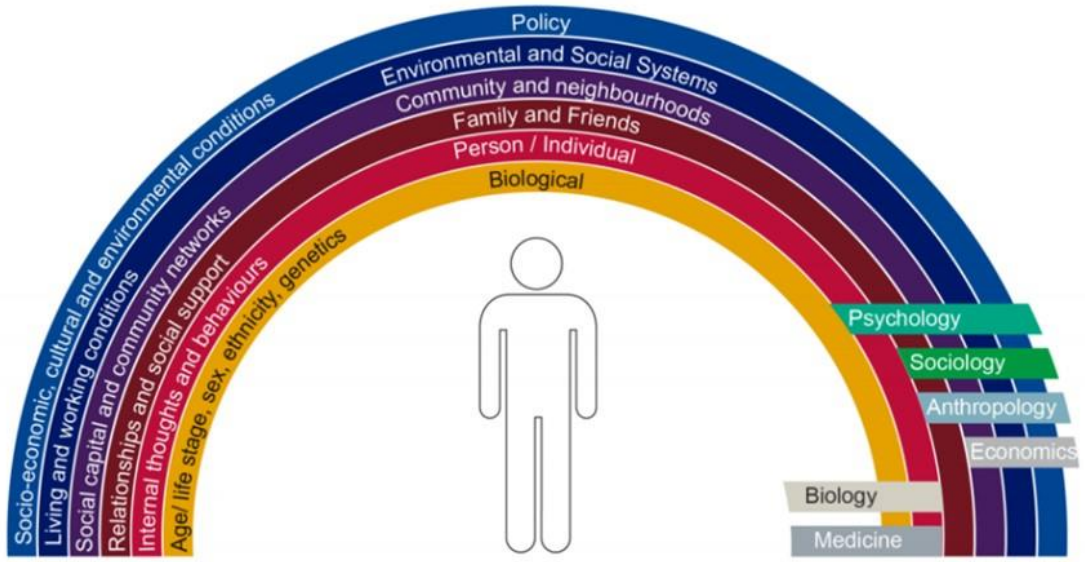
Similar approaches have been taken in New Zealand, with a number of central government policy levers implemented, which include tobacco control, taxation, and public health services. Local councils have also adopted their own policies to align with the Government's goal (Auckland Council 2016).

However, in New Zealand it was illustrated how important understanding the social science behind the issue was in achieving good outcomes. Low-income groups in New Zealand were found to have felt victimised by increases in tobacco taxes because they did not receive adequate support in cessation services (Hoek and Smith 2016). As with taxation on tobacco, fiscal policies targeting other health issues (sugar-sweetened beverages, unhealthy foods) have been implemented in countries such as Hungary, Finland, Norway, France, and several states in the US (Cornelsen et al 2008).

While taxation without supporting services can marginalise groups, funding that improves distribution and equity of healthcare can significantly improve health outcomes (Healy et al 2006). Examples of this are through targeted programmes, improving services to better meet the needs of communities, and making services more culturally appropriate to at-risk populations.

Creating and implementing policies that effectively do this requires an in-depth understanding of target groups and their needs. While this is often legislatively required in New Zealand, what this means in practice may not be well understood (Brewer et al 2015). In health, one of the challenges faced by some target groups is accessing or securing transport to and from clinic-based appointments (Anderson et al 2019). This is especially the case among more disadvantaged groups where people do not always have access to personal vehicles, and public transport to their home locations is either inconvenient or too expensive. Systems frameworks in domains like health are also useful in considering how interventions at different levels may impact transport safety. Figure D.3.5 shows a conceptualisation of behavioural and social sciences in health, which aims to support an interdisciplinary application of these disciplines.

Figure D.3.5 Figure developed by Public Health England (2018) conceptualising the contributions of behavioural and social sciences to the health domain



The contribution of a subset of these (which sit on the right side of figure D.3.5) to behaviour change is summarised below, with brief comment on how this can be applied to transportation safety issues.

Cognitive and behavioural psychology is the study of our internal mental processes (eg, attention, perception, problem solving). An example of how it has been applied in transport is assessing risk awareness in the context of driving tests, highlighting the importance of actions like visual search behaviour and its validity and reliability as a risk awareness indicator (Lidestam et al 2010). Social marketing techniques are also underpinned by psychological theory. Psychology is a strong theme in the road safety research community in New Zealand and internationally, with the University of Waikato and the University of Otago maintaining a specific transport psychology research capability (see Sam Charlton, University of Waikato, and Vanessa Beanland, University of Otago).

Sociology focuses on the context of peoples' lives, and how they interact, work and play. Transport policy decision makers use their values, perceptions and beliefs to discuss, interpret and solve problems. These are not necessarily reflective of larger society, and beliefs should be challenged when developing policy. Imran and Pearce (2015) suggest that in New Zealand, past discourses have been continuously reiterated, creating a path dependency that is a roadblock for creating sustainable transport in our largest cities.

Anthropology is the study of human cultures and societies, which is important in translating scientific knowledge into effective practice at community levels. **Ethnography** studies specific beliefs and practices of groups. An example of their use in transport is conducting interviews with drivers on their motivations and strategies in for-profit ride-sharing (Anderson 2014). Ride-sharing is an alternative transport mode that can reduce vehicle distance travelled, so understanding the motivations can help decision makers influence provision and use of services like this if they are assessed as having a net positive impact.

Behavioural economics is different from traditional economics because it acknowledges that our decision making is not always fully rational and is subject to biases. In transport, a proper appreciation of these contextual factors in peoples' real behaviour means more successful attempts to enable behaviour change that can improve peoples' lives at the same time as meeting transportation safety objectives (Metcalfe and Dolan 2012; Garcia-Sierra et al 2015).

Countries such as Germany, Switzerland, Austria and the Czech Republic require drivers to have first-aid skills. This may be required through driving schools or proven hours of first-aid training, with varying minimum hours and programme types between countries. Knowledge of first aid in drivers can reduce the consequences of traffic incidents (El-Sharkasy et al 2015; Kureckova et al 2017). First aid training, even if it is not current, may improve outcomes in road trauma (Arbon et al 2011); however, the SafetyCube project failed to find clear evidence of this, so the relationship is contentious.

Policy decisions around investment in ambulances and helicopters, improved techniques and training for extraction from vehicles, pre-hospital medical care (eg, paramedics) and pre-hospital trauma triage can also reduce the degree of road trauma experienced by those involved in traffic crashes. They are all included in the SafetyCube Decision Support System as health measures.[8]

D.3.2.3 Environment

An important and ongoing environmental policy response is governmental action happening throughout the world to combat climate change. Research on the impact of climate change policies has found the importance of top-down initiatives but stresses that they cannot be stand-alone in influencing behaviour change (Gunningham 2017). International agreements, implemented on a national scale, are most likely to be effective if there is good public support for them.

Policymakers are generally highly risk averse for multiple reasons (Howlett 2014). Due to this position, policy approaches often break problems down into many disparate parts rather than approach them comprehensively. With complicated issues like climate change, this increases the difficulty of responding effectively.

A case study in which radical policy change occurred is in the United Kingdom during 2006–2010. The pioneering 2008 Climate Change Act was highly ambitious and had a series of major policy initiatives (Carter and Jacobs 2014). This radical change was able to occur partly because of the visibility of the issue; the more visible an issue is, the more governments will need to respond consistently and substantively. In scenarios like this, there is competition created between political parties to take action, which can allow for more significant and impactful policy changes to be made.

Climate change is an example of an issue that interacts with transport (both impacts on and impacted by) (Arkell and Darch 2006; Koetse and Rietveld 2009).

While the government can take a more prescriptive approach through legislative requirements, it can also encourage businesses to voluntarily meet standards above what is required by law (Arimura et al 2016). An example of this is the certified environmental management system ISO 14001. This is one of the most widely used for environmental management and focuses on processes rather than outcomes. There have been mixed performance outcomes; some studies show improvements while others show no effect.

D.3.2.4 Application in transport

Political support may be greater when policy initiatives offer improvements for multiple areas, such as combining transport with health or land-use development (Dhondt et al 2013; Litman 2020). Transport is often an important determinant of health, and links such as this can be utilised to achieve better outcomes for multiple sectors (Thomson et al 2008; Turrell et al 2018). It is important to acknowledge, however, that agency KPIs may not always be served by an integrated approach, which continues to reinforce a siloed

[8] https://www.roadsafety-dss.eu/#/measure-search

approach to policy. Balancing specific agency demands will be important to the uptake of a systems perspective.

Studies have shown integrated urban and transport planning and design interventions are effective at influencing transport choices (van Wee 2002; Badland et al 2012; Giles-Corti et al 2016). Integrated planning is vital but typically planned by different agencies with different disciplines (as discussed in section D.3.2.1). An example of conflicting goals is in healthcare, where policy may concentrate services to reduce costs. While this creates a cost reduction in healthcare, it necessitates increased travel and could aggravate inequities in healthcare access (Noland 2004; Burke et al 2010; Donovan and Munro 2013).

In New Zealand, the Climate Change Response (Zero Carbon) Amendment Bill will govern greenhouse gas emissions when it comes into effect later in 2019. The emission reductions target is to reduce all greenhouse gases (except biogenic methane) to net zero by 2050 and to reduce emissions of biogenic methane within the range of 24–47% below 2017 levels by 2050, including to 10% below 2017 levels by 2030. This desire to reach zero emissions mirrors the Road to Zero transport plan in its aim of reducing harm to negligible levels. The strategies suggested to support the Zero Carbon Bill's implementation may have relevance to the transport case. These include the establishment of a commission, making emissions reduction plans publicly available, and ensuring annual monitoring and reporting.

Emissions targets will impact transport more directly; for example, through changes to vehicle emissions standards on imported vehicles and a move towards electrification, both of which may improve the average age and standard of the vehicle fleet, increasing the number of vehicles equipped with top of the line safety features. Emissions standards may also necessitate a move towards active transport modes. This will reduce exposure to vehicle-related harm, but will need to be balanced by increased safety efforts in these alternative modes.

Salmon et al (2019), discussed in section D.1.2, and McClure et al (2015) used systems modelling to demonstrate how coordinated public health approaches can have significant road safety gains. McClure et al (2015) showed that an optimal reduction in the public health burden attributable to land transport came when transport safety risk reduction policies were combined with land-use and transport policies that minimised reliance on individual motorised transport and maximised use of active transport modes. They concluded that local, national, and international decision makers should address transport, land use, and health as an integrated whole.

Better coordination and interdisciplinary research are needed. National policy would likely be needed to reconcile conflicting goals, rather than regional or city-based policy (Hale 2019). The interaction between different goals makes establishing an effective transport policy difficult, and packages of policy instruments are generally more effective than a single instrument (May et al 2003; May 2005).

The National Road Safety Committee is a group of government agencies with responsibilities for road safety and is the principal public sector forum for communicating, coordinating and agreeing upon top-level strategy between agencies on road safety issues. Core members include the Ministry of Transport, Waka Kotahi, New Zealand Police, ACC and Local Government New Zealand, with the Health, Education, Justice and Business, Innovation and Employment ministries as well as the Energy Efficiency and Conservation Authority and WorkSafe as associate members. The National Road Safety Committee has previously been responsible for implementing the national road safety action plans; however, an independent review suggests that its mandate and role could be strengthened.

New Zealand agencies have many policies impacting on transport, including:

- fuel taxes (National Land Transport Fund, ACC levies, local authority fuel taxes)
- warranting, registration, and licensing (Waka Kotahi)

- National Drug Policy (Ministry of Health)
- energy strategies (Ministry of Business, Innovation and Employment)
- importation fees (New Zealand Customs Service)
- planning and consenting processes (Ministry of Housing and Urban Development).

Improving health through addressing inequalities is common but is not generally applied to transport-related injuries and fatalities (Christie 2018). Inequities in transport are high in New Zealand (Kingham et al 2007; Lucas and Jones 2012; Boussauw and Vanoutrive 2017; Ministry of Transport 2019).

There would be value in using a public health lens to approach these inequities. A recent New Zealand presentation considered the question 'What if transport was an urgent public health issue?' (Hale 2019). The speaker emphasised the importance of using a systems approach, where policy, the built environment, and culture are considered together. The example of tobacco was used (which we have also discussed in section D.3.2.3) and an explanation provided of 'nudge' theory – how to create behavioural change through the environment rather than requiring people to rely on willpower alone (eg, New Zealand's Smoke-free Environments Act 1990). Another example of the value of viewing transport through a public health lens, identified by Filtness et al (2015), is in the potential benefits obtained by linking healthcare for addiction with recidivist drink/drug driving convictions.

There are several elements to success of this sort of legislative change according to Hale (2019), including the need to have:

- a shared goal
- a duty of care
- public engagement and participation
- monitoring and reporting on risk
- coordinated decision making
- upstream risk reduction.

There are approaches used overseas that improve local performance. For example, local transport authorities in England are obligated to submit five-year plans for local transport (Marsden et al 2013). Using this approach, outcomes were more likely to be achieved than otherwise, even if the targets themselves were not met.

However, this approach is still siloed and lacks a bigger picture perspective. As with other countries, New Zealand is considered by some commentators to require a higher-level approach, one based on a national, evidence-based framework (Hale 2019). New Zealand initiatives like the Road to Zero are a step towards a national approach. This is a safe system approach that looks at all elements of the road system together rather than focusing on a single safety intervention (Ministry of Transport 2019; figure D.3.6). As with 'Vision Zero', the Swedish concept from which the 'Road to Zero' is derived, the concept is that the entire road system should be optimised, not just the individual components (like the road users). The latter conceptualisation is systems-based; however, key differences remain between Vision Zero approaches and current systems-thinking based approaches. In particular, Vision Zero derives from Reason's (1990) Swiss Cheese model and thus focuses on failure points in one part of the system being prevented from forming an error trajectory by the other parts of the system. More systems-based approaches do not view negative safety outcomes as a trajectory of failures through layers of defences, but rather as emergent properties of networks of actors and activities behaving as normal. This conceptualisation necessitates the holistic

understanding of system behaviour. Internationally, application of systems theory-based methods is advocated to better investigate the causes of road trauma and how to design effective interventions (Hughes et al 2019; Salmon et al 2019).

This project has the opportunity to provide this systems-based perspective to the ongoing development of the Road to Zero strategy by Waka Kotahi.

Figure D.3.6 Road to Zero: A New Road Safety Strategy for New Zealand (Ministry of Transport 2019)

D.3.3 Company and community levers

A key pathway through which policy and regulatory decisions and interventions can impact individual behaviour is via the translation of these into company policy, procedures and culture. Company factors needn't be directly related to transportation safety to have an impact; for example, health and safety, wellbeing, financial, productivity and market pressures can all impact when and how someone may travel and the timeframes they have to do so.

D.3.3.1 Workplace health and safety

Workplace health promotion is commonly used by companies to improve their workers' productivity (Cancelliere et al 2011). Programmes have evolved over time, and recently cognitive behavioural therapy has been combined with exercise classes in various company employee wellness programmes (Edries et al 2013; Takechi et al 2015; Luberto et al 2017). These programmes appeared to be beneficial in improving health-related behaviours.

The goal of cognitive behavioural therapy is to change patterns of thinking and behaviour. While employee wellness programmes may be more traditionally focused on reducing work-related stress, understanding the principles and skills of cognitive behavioural therapy can help employees manage stress responses through their thoughts and emotions.

The examples show how a tool developed for one purpose (ie, as a psychotherapy treatment) can be applied in different disciplines to achieve good results.

D.3.3.2 Community

Communities can spark action and take on a supervisory role to achieve better outcomes in their neighbourhoods. An example of this in New Zealand is when the Piha community lobbied for beach alcohol bans over high-risk periods (eg, New Year's Eve) and a coalition was formed with the local council and police.

Alcohol bans were implemented, enforced by police, and had the outcome of reducing alcohol harm in the community's area (Conway 2002). Success came from the interaction of many harm reduction strategies, shared knowledge, intersectional initiatives, and a multi-level approach. The success also strengthened the community's ability to tackle future issues (Paterson 2014).

D.3.3.3 Environment

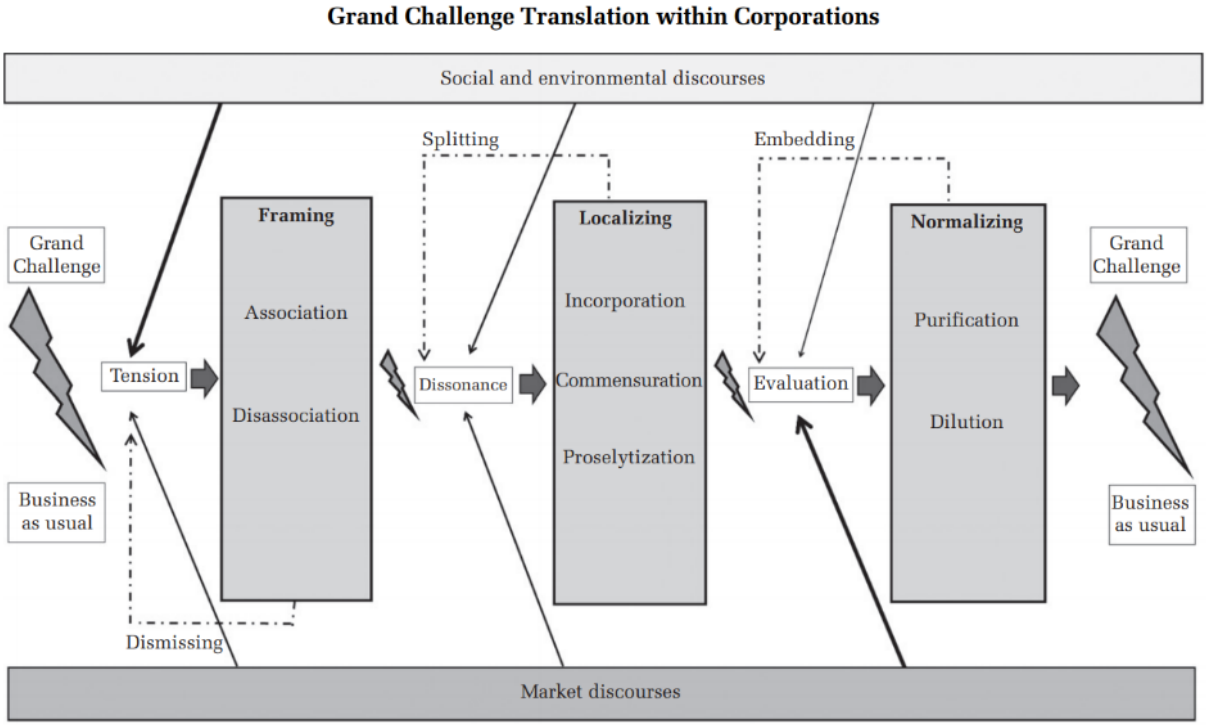
Companies take many actions to improve environmental outcomes. These may be motivated by meeting legislative requirements, creating or maintaining a positive image, or for other reasons.

A study in 2018 looked at the improvement in environmental farm practices from food retailers and manufacturers that had committed to addressing sustainability issues further down their supply chains (Thorlakson et al 2018). In this particular study, it was found that a company-led (Woolworths) standard programme ('Farming for the Future') significantly improved most environmental management practices that the programme targeted.

While companies can have substantial impacts on environmental outcomes without the necessity of regulatory pressure, initiatives may be more impactful in collaboration with government (Bocken 2017). Government incentives can also be used to encourage maximum uptake of successful policies/procedures by relevant companies. New behaviours can be normalised more effectively when they are influenced by multiple sources in multiple ways.

A study of Australian corporations found there were a number of stages the corporations went through as they translated the issues of climate change into their business model. These stages were defined as 'framing, localizing, and normalizing' (Wright and Nyberg 2017); these stages are shown in figure D.3.7. Framing refers to interpreting, defining and communicating an issue in order to gain the support of external and internal stakeholders; for example, how to understand the road safety as a business issue. Localisation refers to making new framings locally relevant through conventions that find compromises between competing goals; for example, how to align the challenge improving road safety with local practices. Normalising refers to realigning practices and activities with dominant organisational discourses; for example, how to adapt earlier road safety initiatives in order to maximise shareholder value. The process moves from taking something challenging and nebulous and translates it to 'business as usual'. There are many stumbling blocks in this process, particularly the tension between environmental and social discourses, compared to market pressures.

Figure D.3.7 Challenges in the translation of issues within corporations (Wright and Nyberg 2017)



D.3.3.4 Application in transport

An example of company-leveraged improvements in transport safety occurred at the company British Telecommunications. Work-related travel safety at the company was addressed through a driver risk assessment, monitoring, and improvement programme (Wallington et al 2014). The programme resulted in reductions in costs and in all road collision types. The company demonstrated a strong understanding that road safety is a work-related health and safety issue. For companies that take this approach, there can also be significant additional benefits in efficiency, quality, environmental targets, marketing and other areas.

While there is a lack of data on New Zealand's size of work-related road harm; crash records do not record the journey purpose, and road crashes are not included in WorkSafe's Serious Injury Outcome Indicators (Ministry of Transport 2018b). The Ministry of Transport, Waka Kotahi and ACC have issued guidance for businesses for 'Vehicles as a Workplace' (Ministry of Transport 2018b). While government can affect business change through regulatory measures, there are other ways to influence businesses – including through industry partnerships, research funding, subsidies, and education.

The examples in this section show that company and supervisory levers can be effective in many areas. A few key ideas are listed below.

- Theories from other disciplines can be borrowed and successfully adapted and applied in other areas.
- Interaction of multiple harm reduction strategies, shared knowledge, intersectional initiatives, and multi-level approaches appears to strengthen the likelihood of success.
- Communities can be an important source to drive change.
- Company initiatives may be more impactful when undertaken in collaboration with government because new behaviours can be normalised more effectively when they are influenced by multiple sources in multiple ways.

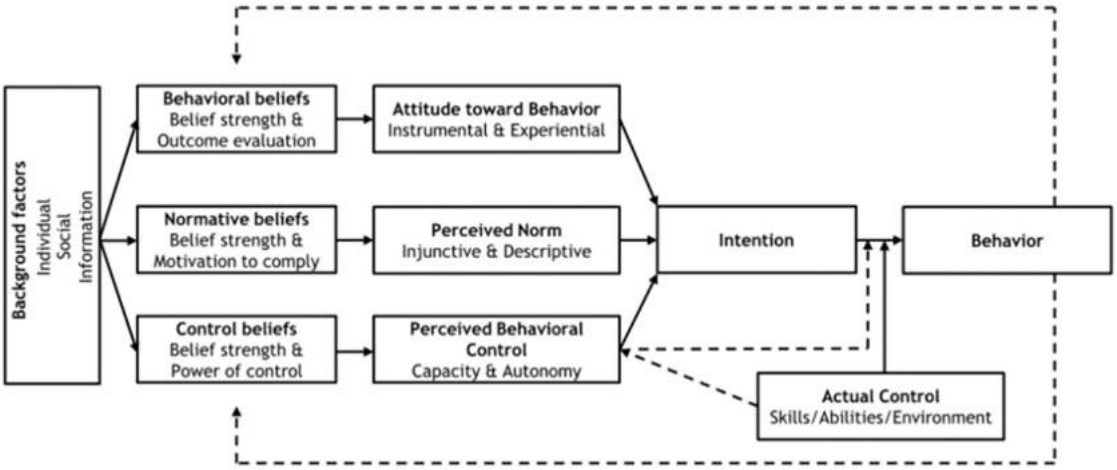
D.3.4 Individual levers

A significant amount of research effort has been given to identifying behavioural change levers at the individual level. Much of this research has come from the field of psychology, and the resulting theories tend to be agnostic to domain; however, development and application of these theories has predominantly been in the health and environmental sectors.

One of the most prominent approaches for understanding and influencing behaviour began as the Theory of Reasoned Action, which was extended as the Theory of Planned Behaviour (Ajzen 1991) and in its current iteration is known as the Reasoned Action Approach (Fishbein and Ajzen 2010) (figure D.3.8).

In this approach, a behaviour is performed as a result of a person's intention, moderated by the control they have over their performance, which is a result of their level of actual ability and skill and the environment they are in. For example, a driver may intend to secure their infant safely in a car seat, but they may not know how to correctly install the car seat they have, or a quality car seat may not be available at an affordable price in the area they live in. Targeting areas that influence actual control is a key lever for increasing the likelihood of an intention to behave safely translating into safe behaviour.

Figure D.3.8 Reasoned Action Approach model (Fishblein and Aizen 2010)



An intention to behave in a particular way is formed through a person's attitude towards the behaviour, both instrumental – the anticipated positive and negative consequences – and experiential – the perceived positive and negative consequences of the behaviour. This attitude results from a person's behavioural beliefs and is determined by the strength of those beliefs and an evaluation of the outcomes of the behaviour. For example, a driver may believe that a car seat doesn't offer much protection to an infant in a crash and that they are unlikely to be pulled over to have their car seat checked. Thus, their attitude towards securing an infant safely in a car seat may be that there are few negative consequences of not doing so, meaning they are unlikely to form an intention to do so.

Intentions are also a product of a person's perceived norms. These norms are both injunctive – based on a perception of what ought to be done – or descriptive – based on perceptions of what others are doing. A person's perceived norms are based on their normative beliefs and are affected by the strength of these beliefs and the extent to which a person is motivated to comply with these beliefs. For example, a driver may be strongly motivated to comply with the law. Their perceived norms may thus be that people ought to follow

the road rules and secure their infant safely in a car seat and that many people with infants are using car seats. They may therefore form the intention to use one too.

Intentions are also products of a person's perceived behavioural control, which is made up of their perceived capacity (also known as self-efficacy) and perceived autonomy – control over performance. The latter is mitigated by the person's actual control (skills, abilities, environment). Perceived behavioural control stems from a person's control beliefs depending on the strength and power of these beliefs. For example, if a driver believes that they won't be able to work out how to install a car seat correctly and won't be able to afford one anyway, their level of behavioural control will therefore be low and they will be unlikely to form an intention to act.

These three types of beliefs relating to a behaviour – behavioural, normative and control – are all influenced by background factors relating to the individual and their past experiences, the society they live in and have lived in previously, and the information to which they have been exposed.

Following this model, behaviour change comes from identifying beliefs and using targeted interventions to alter these. Changed beliefs then lead to changed intentions and thereby behaviours. Combining interventions to target beliefs with those targeting actual control will create the greatest likelihood of behaviour change. When choosing interventions from a range of options, the degree to which interventions target these aspects can be used to guide selection.

These models have been applied in a wide range of domains, most prominently health and sustainability, but also transport, and meta-analyses support their use in intervention development (eg, Godin and Kok 1996; Webb et al 2010).

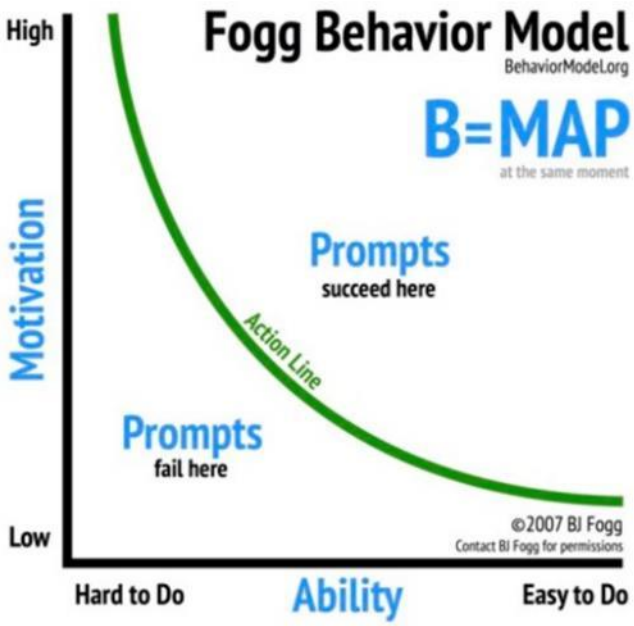
This model has received criticism on a number of fronts in recent times, predominantly in relation to its focus on rational reasoning rather than unconscious influences, the minor role of emotions and the influence of past behaviour on the future, and its limited predictive validity and utility (Sniehotta et al 2014). There is evidence to show that factors such as habit strength, self-determination, and identity and changing the salience, cost and reinforcement choices of behavioural choices outside of an individual's awareness have a greater impact on behaviour without necessarily impacting intention or perceived behavioural control (summarised in Sniehotta et al 2014). The following models may be more effective in the road transport space because they incorporate a motivational element and provide greater utility by providing a practical pathway from individual behaviour to supporting processes and techniques to policy.

In the Fogg Behavior Model, behaviour is seen as a product of motivation, ability and prompts (figure D.3.9). Motivation relates to basic instincts such as pleasure/pain, hope/fear, and social acceptance/rejection, while ability is affected by time, money, physical effort, brain cycles, social deviance and degree of routine. Prompts are triggers that remind people to perform a behaviour. Different levels of motivation and ability determine whether a prompt will be successful. It is therefore important to consider the motivation and ability levels of the different groups being targeted for behaviour change, and where necessary, address these through further interventions.

Prompts themselves can be made more effective through personalised tailoring based on target groups' attitudes, perception of performance and self-efficacy. Tailored messages better engage people's attention. They are more likely to be noticed and remembered. Tailored messages elicit more effortful processing through deeper consideration and utilisation of schemas. This relationship needs to be thought through as more thorough processing of the message might not always be desirable. Tailored messages also elicit emotional processing, which interacts with the relationship with effortful processing: positive emotional processing leads to a decrease in effortful processing, while negative emotional processing leads to an

increase in effortful processing. Tailoring also promotes self-referencing, which promotes a comparison between actual and ideal behaviours.

Figure D.3.9 Fogg Behavior Model (Fogg 2019)



Note: 'B=MAP' refers to the equation 'behaviour = motivation × ability × prompts'

The transtheoretical model (also called the stages of change model; Prochaska and DiClemente 1983) describes the stages that a person moves through in changing their behaviour (figure D.3.10) and the practical processes that can support them in these different stages (table D.3.1).

Figure D.3.10 Transtheoretical (stages of change) model (Prochaska and DiClemente 1983)

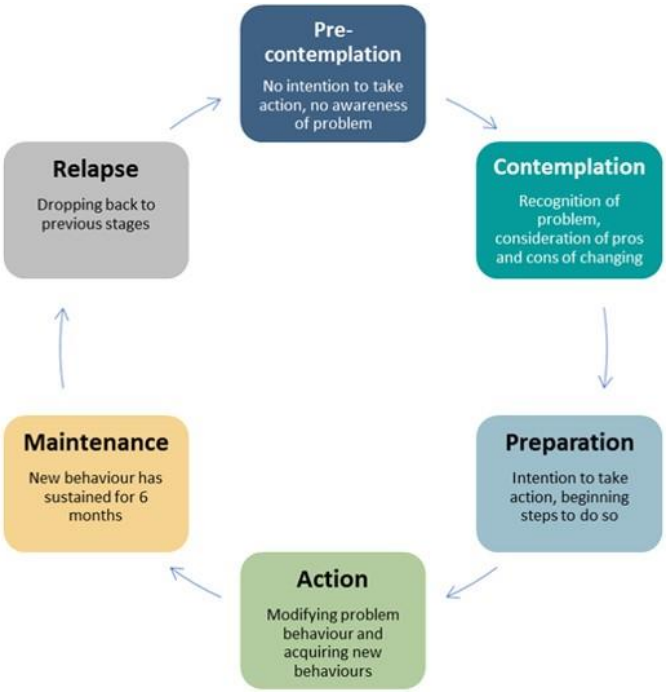


Table D.3.1 Processes for change by stages of change model (adapted from Prochaska and DiClemente 1983)

Process	Process details	Pre-contemplation	Contemplation	Preparation	Action	Maintenance
Consciousness raising (getting facts)	Increasing awareness via information education and personal feedback about the desired behaviour	✓	✓			
Dramatic relief (attention to feelings)	Pay attention to negative feelings in relation to the undesired behaviour and positive feelings in relation to the desired behaviour	✓	✓			
Environmental re-evaluation (your effect on others)	Realise the current impact on others and how this could be improved	✓	✓			
Social liberation (notice public support)	Focus on society's positive support of the desired behaviour in comparison to the undesired behaviour	✓	✓			
Self re-evaluation (new self-image)	Realise desired behaviour is part of who a person wants to be		✓	✓		
Self-liberation (make commitment)	Believe in ability to change and commit to doing so			✓	✓	
Helping relationships (get support)	Associate with people supportive of change			✓	✓	✓
Counter-conditioning (use substitutes)	Find positive behaviours to substitute in place of the undesired behaviour			✓	✓	✓
Reinforcement management (use rewards)	Increase the reinforcement coming from desired behaviours and decrease that coming from undesired behaviours				✓	✓
Stimulus control (manage environment)	Use reminders and cues that encourage desired substitutions				✓	✓

Finally, the behaviour change wheel (Michie et al 2011) synthesises 19 behaviour change frameworks from across multiple disciplines (figure D.3.11). The behaviour change wheel has been applied in multiple domains and is arguably the most useful of the individual behaviour change models due to it linking individual behaviour to government-level factors, a more systems-based perspective. This overcomes a common criticism of individual-level models – that the effects of all other biological, social, environmental, economic, medical and cultural influences are mediated through conscious beliefs and attention. This has not been borne out empirically (Sniehotta et al 2014).

The behaviour change wheel is centred on an individual-level behaviour model in which behaviour is considered a product of the interaction between individual capability, motivation and opportunity. These three components are further broken down into six subcomponents:

- physical capability
- psychological capability
- physical opportunity (afforded by the environment)

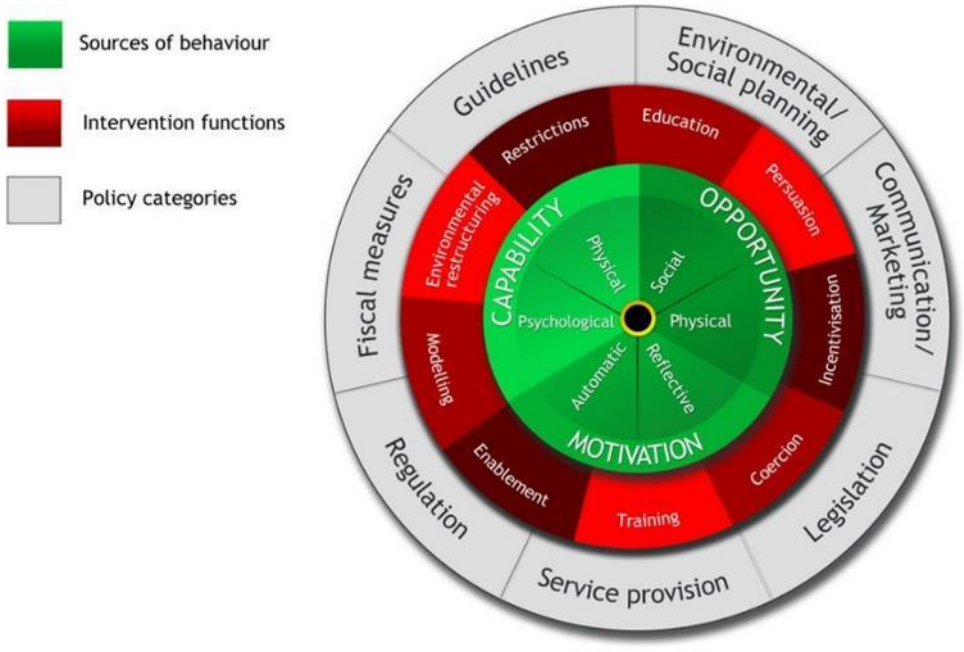
- social opportunity (afforded by culture)
- motivation from reflective processes (evaluations and planning)
- motivation from autonomic processes (emotions and impulses).

These subcomponents are linked to the types of interventions that impact them. The nine interventions in the model are also derived from the 19 different behaviour change models synthesised. The interventions are education, persuasion, incentivisation, coercion, training, enablement, modelling, environmental restructuring, and restrictions.

Michie et al (2011) describe the links as follows (note, their examples are medical but could apply equally to transport safety).

1. *Physical capability can be achieved through physical skill development which is the focus of training or potentially through enabling interventions such as medication, surgery or prostheses.*
2. *Psychological capability can be achieved through imparting knowledge or understanding, training emotional, cognitive and/or behavioural skills or through enabling interventions such as medication.*
3. *Reflective motivation can be achieved through increasing knowledge and understanding, eliciting positive (or negative) feelings about behavioural target.*
4. *Automatic motivation can be achieved through associative learning that elicit positive (or negative) feelings and impulses and counter-impulses relating to the behavioural target, imitative learning, habit formation or direct influences on automatic motivational processes (e.g., via medication).*
5. *Physical and social opportunity can be achieved through environmental change.*

Figure D.3.11 The behaviour change wheel (Michie et al 2011)



Finally, the different interventions are related to the policy areas that could support them. These relationships are described in table D.3.2.

Examples of individual levers being applied for behaviour change are given below.

Table D.3.2 Policy areas and interventions (adapted from Michie et al 2011)

Policy areas	Education	Persuasion	Incentivisation	Coercion	Training	Restriction	Environmental restructuring	Modelling	Enablement
Communication/Marketing	✓	✓	✓	✓				✓	
Guidelines	✓	✓	✓	✓	✓	✓	✓		✓
Fiscal			✓	✓	✓		✓		✓
Regulation	✓	✓	✓	✓	✓	✓	✓		✓
Legislation	✓	✓	✓	✓	✓	✓	✓		✓
Environmental/Social planning							✓		✓
Service provision	✓	✓	✓	✓	✓			✓	✓

D.3.4.1 Technology

An important aspect of individual levers is understanding the audience (Department of the Prime Minister and Cabinet 2019). This enables prompts to be tailored and different intervention types to be enacted depending on which stage of change intervention audiences are located. Mobile applications (apps) can be utilised in this process. In urban planning, understanding the goals of users is critical. While apps can be used to build awareness and provide information, they can also be used in a more participatory way by helping to build a dialogue and accommodate peoples' knowledge into the planning processes (Ertiö 2015). As mobile participation is fairly new, longer-term implications are not known yet, but they must be properly embedded within governance structures to be effective (Kleinhans et al 2015). Waka Kotahi has piloted two rideshare apps – Ridemate in Auckland and Choice in Queenstown – as part of their 'Mobility Marketplace'.

Apps intended to influence behaviour are numerous in areas such as weight loss (eg, Noom,[9] MyFitnessPal[10]), exercise (eg, Strava,[11] Freeletics[12]), learning (eg, Babbel[13]), and quitting smoking (eg, Smoke Free[14]). The majority of these work by providing motivational support and behavioural norms through connection with other users and or trainers.

In transport, apps have been applied to promote sustainable travel behaviours. There appear to have been small but significant impacts resulting from the use of some apps, such as decreases in driving distance. To

[9] https://www.noom.com/programs/health-weight/exsf01d#/

[10] https://www.myfitnesspal.com/

[11] https://www.strava.com/

[12] https://www.freeletics.com/en/

[13] https://www.babbel.com/

[14] https://smokefreeapp.com/

get the greatest intervention effect, the stages of behaviour change need to be understood (ie, steps users will need to move through to get to the desired behaviour) (Sunio and Schmöcker 2017).

D.3.4.2 Health

The Theory of Planned Behaviour and Reasoned Action Approach (described above) has dominated health-related behaviour change intervention development and research; however, this has begun to change in more recent times (Sniehotta et al 2014). In the United Kingdom the model of smoking cessation includes individual levers that are based on empirically tested behaviour change techniques (Public Health England 2018). Individual levers include 'stop smoking services' and digital 'stop smoking' interventions. eMobile apps have been used for interactive patient education and may be useful in reducing racial disparities in health literacy (Finkelstein and Cha 2016). The importance of considering disparities and inequities in the design and implementation of health initiatives is discussed in section D.3.2.2.

D.3.4.3 Environment

In a review of psychological strategies to promote household recycling, social modelling was found to be one of the more persuasive of individual levers analysed (Varottoa and Spagnollia 2017).

Social modelling is where information is passed through demonstration or discussion; where people learn through observation. This relates to the normative beliefs aspect of the Reasoned Action Approach model and to the reflective aspect of motivation and social aspect of opportunity in the behaviour change wheel. One of the studies recruited community members who participated in a recycling programme to be 'block leaders'. Block leaders modelled recycling behaviour and convinced others to participate, which proved to be more effective than sole information provision. This study stresses the importance of planning interventions in the context of a deeper understanding of the target audience, particularly when effectiveness of an intervention should be personalised, such as with information, feedback and recommendations.

D.3.4.4 Application in transport

The important takeaway for application in transport is how well psychological factors need to be understood to comprehend transport outcomes for people (Stanley and Vella-Brodrick 2009). When designing interventions, it is important to understand which psychological mechanism is being targeted (eg, attitudes, beliefs, motivation, perceived control/opportunity) and to use the extensive literature already in existence to identify the type of interventions most relevant to this targeted mechanism. Additionally, to get the greatest intervention effect, the interventions need to be tailored to the stages of behaviour change of the target audience (Sunio and Schmöcker 2017).

The individual-centred approach underpins much of the work of Waka Kotahi in the education, advertising and behaviour change spaces; however, it is not sufficient to only focus on individual-based levers (Salmon et al 2019). As described by the behaviour change wheel in this section and the systems perspective guiding this review, government policy, organisation practices and the wider community and social environment impact how effective these levers will be by affecting social norms, beliefs, opportunities, and perceived and actual control. The most effective way to drive desired behaviour in relation to transport will be to focus on a suite of controls across all levels addressed in this review using the links suggested in the behaviour change wheel.

D.3.5 Actor map

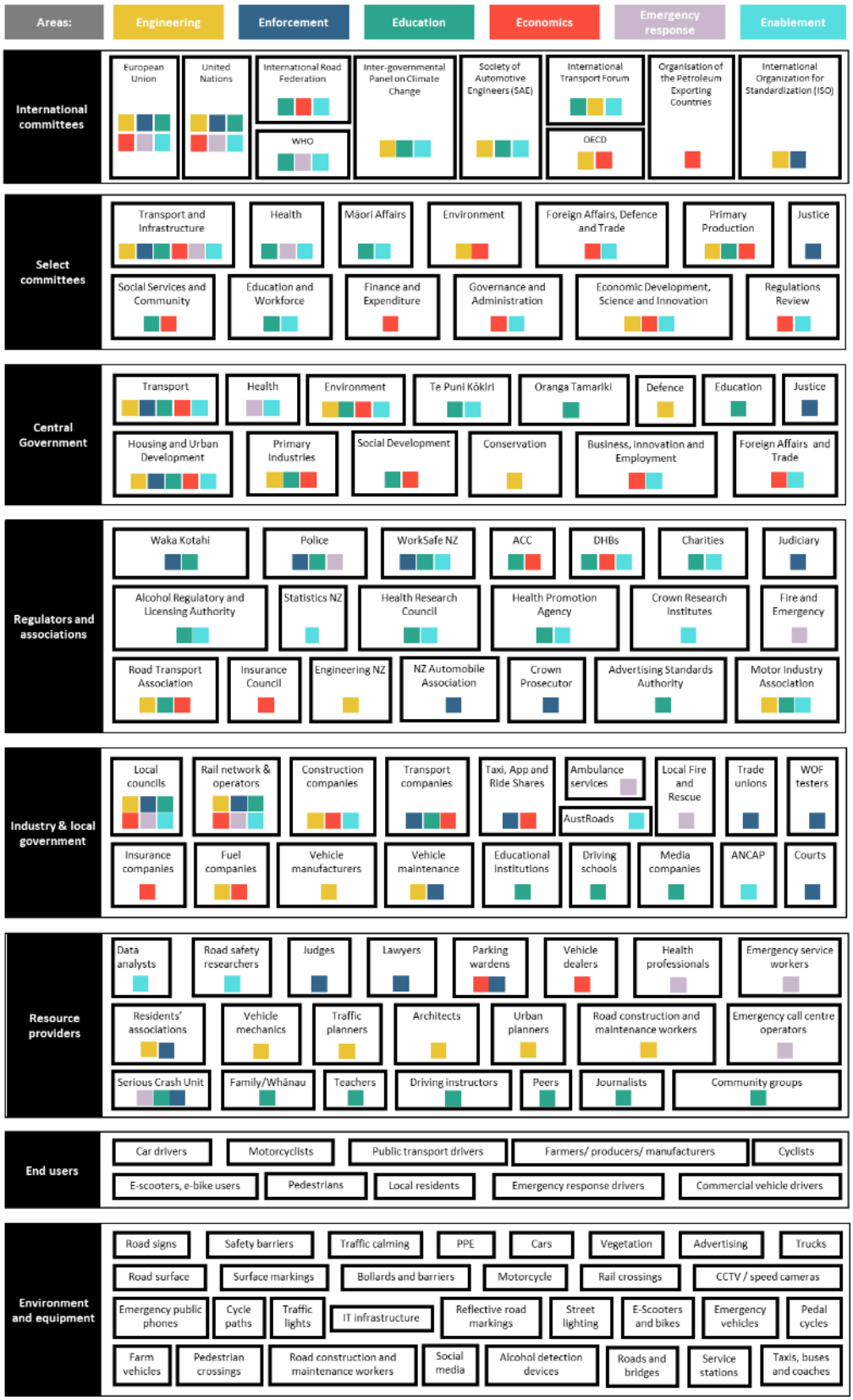
Actor maps are the first stage of the Accimap systems analysis process and describe the actors and agencies involved in the transport system across all systems levels. They are based on Rasmussen's (1997)

Risk Management Framework, which has guided this review throughout. We used the construction of this actor map (figure D.3.12) as a tool for informing participation in the workshops to come in the following phase of the project, as well as for obtaining a holistic overview of the New Zealand transport system.

Its structure is based on that of McIlroy et al (2019) in their work mapping the UK transport system. Its contents have been informed by this literature review and a previous application of the actor map method to the New Zealand transport system by Trotter and Ivory (2019). This actor map uses McIlroy's (2019) additional classification scheme that identifies through which of six different safety perspectives the higher-level actors can influence road safety at the end-user and environment levels. These perspectives are the three traditional perspectives – Engineering, Education, and Enforcement – and three modern perspectives – Economics, Enablement, and Emergency response (the 6 E's). These are represented by colour-coded squares in figure D.3.12. The actor map was developed through several iterations by the research team and then updated according to feedback from the steering group.

The actor map and literature review were analysed and discussed by the project steering group, and potential participants for the following research stage were prioritised based on the findings. The prioritised list is presented in section D.4.1.

Figure D.3.12 Actor map of New Zealand's road transport system



Note: WHO = World Health Organization; OECD = Organisation for Economic Co-operation and Development; ACC = Accident Compensation Corporation; DHBs = district health boards; WOF = Warrant of Fitness; ANCAP = Australasian New Car Assessment Program; PPE = personal protective equipment; CCTV = closed circuit television

D.4 Conclusions

This literature aimed to address the research question 'Which sectors have policies that are likely to impact on road safety in New Zealand?' To do so, it looked at two subsidiary questions:

- What linkages have been identified through government and sector-wide frameworks and systems?
- What policies and interventions does international literature say impact road safety?

Addressing these questions would enable the selection of agencies to participate in the main data collection activity of this project – the cross-portfolio workshop.

Previous mapping of key policy frameworks in use within New Zealand by the Ministry of Transport provided the basis for the identification of health, urban planning/housing, environment, workplace safety, employment, economics and culture as areas with potential links to transport. A review of international literature supported these findings and emphasised the importance of the health, housing and urban development, and environment portfolios in particular. The review also emphasised the importance of adopting a systems-based framework incorporating these sectors in order to achieve significant improvements in road safety.

The review identified potential inadvertent impacts on transport from interventions across all levels of the system, particularly in the health sector. There is a growing movement to consider road safety as a public health issue, and a number of researchers have been applying intervention logics from this sector to road safety already, particularly at the policy level, but also at the individual behaviour change level. Likewise, strategies being applied in the environmental sector, such as those for the Zero Carbon Bill, have similar elements to the Road to Zero strategy and may provide an opportunity for a coordinated approach. It should be acknowledged though that the specific KPIs of each portfolio may provide barriers to an integrated approach. These will need to be identified and overcome in order to make any significant safety gains.

In addition to findings pertaining directly to the specific research questions, a number of key themes and lessons from the literature were identified. These are summarised below.

Improvement in coordination

- Political support for policy initiatives may be greater when they offer improvements for multiple areas, such as combining transport safety with health or land-use development. A number of these areas are outlined in this literature review; in particular, the role of transport safety as an important determinant of health. Links such as this can be utilised to achieve better outcomes for multiple sectors, including transport.
- Packages of policy levers are generally more effective than a single instrument; however, the interaction between different goals makes establishing an effective transport policy difficult.
- Better coordination and interdisciplinary research are needed.
- National policy is needed to reconcile conflicting goals, as well as regional or city-based initiatives.
- Future-focused policies and frameworks are needed to enable adaptation to, and planning for, future challenges, such as those posed by new in-vehicle technology that will emerge in the next 50 years. They should be regularly reviewed for relevance and adaptability.

Strength of interdisciplinary approaches

- Learnings from other disciplines can be borrowed and successfully adapted and applied to transport safety. For example, inequities in transport are high, and there would be value in using a public health lens to approach these inequities.
- Interaction of multiple harm-reduction strategies, shared knowledge, intersectional initiatives, and multi-level approaches strengthens success.
- A public-health lens could be used to implement a systems approach, where policy, the built environment, and culture are considered together.

Multi-level approaches

- Communities can be an important driver of change.
- Company initiatives may be more impactful when undertaken in collaboration with government because new behaviours can be normalised more effectively when they are influenced by multiple sources in multiple ways.

Understanding of human factors

- Psychological factors need to be understood to comprehend transport outcomes for people.
- Stages of behaviour change need to be understood (ie, steps users will need to move through to get to the desired behaviour).
- The behaviour change wheel can be used to link individual behaviour change to intervention and policy design. It has been applied in multiple domains and is arguably the most useful of the individual behaviour change models due to it linking individual behaviour to government-level factors.

D.4.1 Next steps

The next step in this research project is to hold a workshop with policymakers from across the government portfolios identified in this review as potentially having inadvertent impacts on road safety. Participants will be asked to reflect on the unintended as well as intended impacts of their portfolio on road safety.

Where interactions with road safety are identified, participants will be asked to provide details of the relevant policies and how documentation on these can be obtained. Participants will also reflect on the causal mechanisms driving these interactions with road safety and accessibility in preparation for further research steps in the project.

Based on the findings of this literature review, a preliminary list of potential participants was produced. This was developed further in consultation with the project steering group. The final prioritised list is presented in table D.4.1.

Table D.4.1 Agencies recommended to contribute to workshops

Highest priority	Medium priority	Lower priority
• Waka Kotahi • Ministry of Transport • Ministry of Health • Ministry of Housing and Urban Development • Ministry for the Environment • Te Puni Kōkiri • Local Government New Zealand • Accident Compensation Corporation • WorkSafe New Zealand • Department of Conservation	• New Zealand Police • Fire and Emergency New Zealand • Ministry of Education • Ministry of Social Development • New Zealand Defence Force	• Oranga Tamariki • Alcohol Regulatory and Licensing Authority • Ministry of Business, Innovation and Employment • Ministry for Primary Industries • New Zealand Treasury • Department of Corrections

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